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Drug Prescribing Patterns in the General Medical Services Scheme in Ireland and Projected Costs to 2026

A thesis submitted to the
National University of Ireland, Cork
for the degree of
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Guide: Terms are defined on first occurrence in thesis and abbreviations are used thereafter

EU	European Union
GDP	Gross Domestic Product
OECD	Organisation for Economic Co–operation and Development
VAT	Value Added Tax
OOP	Out of Pocket
GMS	General Medical Services
CDS	Community Drug Schemes
IMF	International Monetary Fund
ECB	European Central Bank
CSO	Central Statistics Office
HSE	Health Service Executive
PCRS	Primary Care Reimbursement Service
ATC	Anatomical Therapeutic Chemical
ISPOR	International Society For Pharmacoeconomics and Outcomes Research
IHEA	International Health Economics Association
ECHE	European Conference on Health Economics
BMC	BioMed Central
RSAI–BIS	Regional Science Association International–British and Irish Section
OLS	Ordinary Least Squares
DARE	Database of Abstracts of Reviews of Effects

NHS	National Health Service
EED	Economic Evaluation Database
GP	General Practitioner
UK	United Kingdom
NCPE	National Centre for Pharmacoeconomics
IPHA	Irish Pharmaceutical Healthcare Association
DPS	Drug Payments Scheme
LTI	Long Term Illness
ARIMA	Autoregressive Integrated Moving Average
HTD	High Tech Drug
DTSS	Dental Treatment Services Scheme
EEA	European Economic Area
HSE–COS	Health Service Executive Community Ophthalmic Services
MTS	Methadone Treatment Scheme
HAA	Health (Amendment) Act 1996
USC	Universal Social Charge
FOI	Freedom of Information
AIE	Access to Information on the Environment
HEAR	Higher Education Access Route
GPVC	General Practitioner Visitor Card
PPSN	Personal Public Service Number
US	United States
MCS	Monte Carlo Simulation
US	United States

PSA	Probability Sensitivity Analysis
DSA	Deterministic Sensitivity Analysis
ACG	Adjusted Clinical Group
IRR	Incidence Rate Ratio
SSR	Sum of Squared Residuals
TFR	Total Fertility Rate
AC	Average Cost
RGA	Region, Gender & Age Cohort
LHO	Local Health Office
CPI	Consumer Price Index
RSA	Region, Sex, Age Cohort
N	Nervous System
C	Cardiovascular System
A	Alimentary Tract and Metabolism
R	Respiratory System
WHO	World Health Organisation
ML	Mid–Leinster
NE	North–East
VIF	Variance Inflation Factor
PPI	Proton Pump Inhibitor
CVD	Cardiovascular Disease
APMI	Association of Pharmaceutical Manufacturers of Ireland
ESRI	Economic and Social Research Institute
HPRA	Health Products Regulatory Authority

MMP	Medicines Management Programme
CEA	Cost–Effectiveness Analysis
CUA	Cost Utility Analysis
LYG	Life Year Gained
QALY	Quality Adjusted Life Year
HTA	Health Technology Assessment
ICER	Incremental Cost–Effectiveness Ratio
ATL	Above the Line
BTL	Below the Line
HIQA	Health Information and Quality Authority
IMB	Irish Medicines Board

Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

Signature: **Date:**

Dedication

To Nana, for all the support and love. You will never be forgotten.

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Abstract

The primary objective is to investigate the main factors contributing to GMS expenditure on pharmaceutical prescribing and projecting this expenditure to 2026. This study is located in the area of pharmacoeconomic cost containment and projections literature. The thesis has five main aims:

1. To determine the main factors contributing to GMS expenditure on pharmaceutical prescribing.

2. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2006 Central Statistics Office (CSO) Census data and 2007 Health Service Executive–Primary Care Reimbursement Service (HSE–PCRS) sample data.

3. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2012 HSE–PCRS population data, incorporating cost containment measures, and 2011 CSO Census data.

4. To investigate the impact of demographic factors and the pharmacology of drugs (Anatomical Therapeutic Chemical (ATC)) on GMS expenditure.

5. To explore the consequences of GMS policy changes on prescribing expenditure and behaviour between 2008 and 2014.

The thesis is centered around three published articles and is located between the end of a booming Irish economy in 2007, a recession from 2008–2013, to the beginning of a recovery in 2014. The literature identified a number of factors influencing pharmaceutical expenditure, including population growth, population aging, changes in drug utilisation and drug therapies, age, gender and location. The literature identified the methods previously used in predictive modelling and consequently, the Monte Carlo Simulation (MCS) model was used to simulate projected expenditures to 2026. Also, the literature guided the use of Ordinary Least Squares (OLS) regression in determining demographic and pharmacology factors influencing prescribing expenditure.

The study commences against a backdrop of growing GMS prescribing costs, which has risen from €250 million in 1998 to over €1 billion by 2007. Using a sample 2007 HSE–PCRS prescribing data (n=192,000) and CSO population data from 2008, (Conway et al., 2014) estimated GMS prescribing expenditure could rise to €2 billion by

2026. The cogency of these findings was impacted by the global economic crisis of 2008, which resulted in a sharp contraction in the Irish economy, mounting fiscal deficits resulting in Ireland's entry to a bailout programme. The sustainability of funding community drug schemes, such as the GMS, came under the spotlight of the EU, IMF, ECB (Trioka), who set stringent targets for reducing drug costs, as conditions of the bailout programme. Cost containment measures included: the introduction of income eligibility limits for GP visit cards and medical cards for those aged 70 and over, introduction of co–payments for prescription items, reductions in wholesale mark–up and pharmacy dispensing fees. Projections for GMS expenditure were reevaluated using 2012 HSE–PCRS prescribing population data and CSO population data based on Census 2011. Taking into account both cost containment measures and revised population predictions, GMS expenditure is estimated to increase by 64%, from €1.1 billion in 2016 to €1.8 billion by 2026, (ConwayLenihan and Woods, 2015).

In the final paper, a cross–sectional study was carried out on HSE–PCRS population prescribing database (n=1.63 million claimants) to investigate the impact of demographic factors, and the pharmacology of the drugs, on GMS prescribing expenditure. Those aged over 75 ($\boldsymbol{\beta = 1.195}$) and cardiovascular prescribing ($\boldsymbol{\beta = 1.193}$) were the greatest contributors to annual GMS prescribing costs. Respiratory drugs (Montelukast) recorded the highest proportion and expenditure for GMS claimants under the age of 15. Drugs prescribed for the nervous system (Escitalopram, Olanzapine and Pregabalin) were highest for those between 16 and 64 years with cardiovascular drugs (Statins) were highest for those aged over 65. Females are more expensive than males and are prescribed more items across the four ATC groups, except among children under 11, (ConwayLenihan et al., 2016).

This research indicates that growth in the proportion of the elderly claimants and associated levels of cardiovascular prescribing, particularly for statins, will present difficulties for Ireland in terms of cost containment. Whilst policies aimed at cost containment (co–payment charges, generic substitution, reference pricing, adjustments to GMS eligibility) can be used to curtail expenditure, health promotional programs and educational interventions should be given equal emphasis. Also policies intended to affect physicians prescribing behaviour include guidelines, information (about price and less expensive alternatives) and feedback, and the use of budgetary restrictions could yield savings.

Chapter 1

Introduction

1.1 Introduction

This thesis charts the time period between 2007 and 2014, and is situated against a backdrop of cuts in public expenditure on health in response to a global financial crisis, population growth and growth in the elderly proportion of the population in Ireland. The focus of this thesis is to investigate the impact of pharmaceutical expenditure, as Ireland recovers from the impact of austerity policies at a time, when the population is not only forecasted to rise, but the proportion of those aged 65 (old persons) and over is projected to rise rapidly. This study is located in the area of pharmacoeconomic cost containment and projections literature.

The economic downturn has affected many countries within the European Union (EU[1]) with many implementing strict austerity policies, such as taxation increases and public expenditure decreases. General government expenditure as a percentage of Gross Domestic Product (GDP[2]) decreased on average by 2.5% between 2009 and 2013 across Organisation for Economic Co–Operation and Development (OECD[3]) countries. The

[1]The EU is a unique economic and political partnership between 28 European countries, (EU, 2015).

[2]GDP measures the value of the total output of goods and services in the country over a calendar year, (Leddin and Walsh, 2013).

[3]The OECD help governments foster prosperity and fight poverty through economic growth and financial stability. The OECD analyse and compare data to predict short and medium term trends, (OECD, 2015*b*).

OECD argues that this is a direct consequence of the financial crisis, where there is a slowdown or a reduction in government expenditure compared to the growth of GDP. Most OECD countries have cut back on government expenditure, where the biggest cut backs have occurred in Estonia (7.3%) and Ireland (6.9%). The 2014 OECD data shows that government expenditure decreased by 10.7% in Greece and by 9.9% in Slovenia between 2013 and 2014 due to once–off measures of capitalising their domestic banks, (OECD, 2015*a*).

Annual growth in health spending per capita decreased in real terms between 2009 and 2012 in 14 of the 28 countries within the EU, reversing a trend of steady increases. The average annual growth rate in health expenditure per capita (EU28) increased by 4.7% between 2000 and 2009 and fell by 0.6% between 2009 and 2012. The Irish average annual growth rate in health expenditure per capita increased by 6.3% between 2000 and 2009 and fell by 3.7% between 2009 and 2012. Ireland experienced one of the biggest decreases in health spending per capita, after Luxembourg (5.1%) and Greece (9.0%), (OECD, 2014).

Health expenditure accounts for a significant component of GDP. In 2009, it accounted for 11.6% in France, 9.9 % in Ireland, 10.2% of GDP in Greece and Portugal. Health spending as a share of GDP decreased for many EU countries following the economic crisis. EU countries (EU28) allocated on average 7.3% of GDP to health spending in 2000, increasing to 9.0% in 2009, before falling to 8.7% in 2012. Germany committed 10.4% of GDP to health spending in 2000 and rising to 11.8% in 2009, before falling to 11.3% in 2012 (one of the highest in the EU),(OECD, 2014). Reductions in public expenditure on health were achieved through various measures across the EU. Due to the significant contribution of pharmaceuticals to total health expenditure (25% in Greece (2007), 21% in Portugal (2008) and 17.5% in Ireland (2009), the pharmaceutical sector was targeted to contribute to a reduction in expenditure, (Vandoros and Stargardt, 2013). Measures included; price reductions to drug manufacturers, promotion of generic drug prescribing, introduction and increases in co–payments, reference

pricing, wholesaler margins and Value Added Tax (VAT) rates, (Volger et al., 2011).

During the global economic crisis, the economy was experiencing increasing pharmaceutical expenditure and challenging economic circumstances in Ireland. The Irish economy officially fell into recession in the final quarter of 2008, (CSO, 2008). As depicted by the American definition, an economy is said to be in recession, when it experiences two consecutive quarters (6 months) of negative economic growth. General government debt as a percentage of GDP increased rapidly during the economic crisis from 27.48% in 2007 to 127.85% in 2014. In 2014, out of 33 OECD countries, Ireland had the 5^{th} highest general government debt as a percentage of GDP (It increased from 68.36% in 2009 to 127.85% in 2014), two places above the OECD weighted average. General government debt per capita increased from $28,383 in 2009 to $62,531 in 2014. Ireland had one of the highest rates of all 33 OECD countries only to be exceeded by Japan ($86,682) in 2013, (OECD, 2015*a*). Ireland officially exited recession in September 2013, when GDP grew by 0.4% between quarter one and quarter two 2013, (CSO, 2013).

In 2012, Ireland spent 14% of total government expenditure on healthcare which is comparable with the EU average (EU28). The Netherlands had the highest proportion at 20% and Cyprus had the lowest proportion at 8%. Irish health spending accounted for 8.9% of GDP, just above the EU average (EU28) of 8.7%. Netherlands recorded the highest value at 11.8% and Romania the lowest at 5.6%, (OECD, 2014). In 2013, Ireland had increased its expenditure on health to 17.4%. The OECD analysis disaggregates government expenditure by function for each country. For example, health, social protection, education etc. According to a 2015 OECD report, Ireland spent 1.3% less on health between 2007 and 2013, where the government spent 6.4% more on social protection over the same time period, (OECD, 2015*a*). This may be explained by increases in unemployment levels and consequently higher unemployment benefits being paid out by the Social Protection Department. The Irish standardised unemployment rate increased from 4.7% in 2007 before peaking at 14.7% in 2012, before falling to

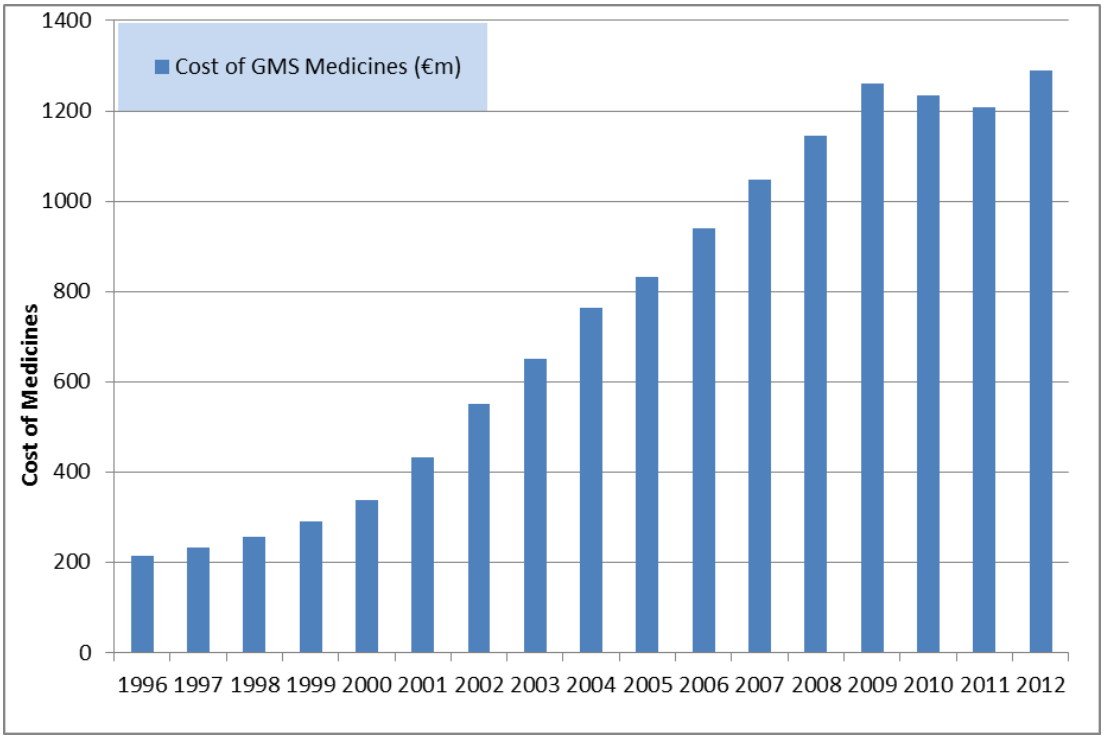
13.1% in 2013, (CSO, 2015*b*). The OECD reports out-of-pocket (OOP) medical expenditure as a share of final household consumption increased from 2.5% in 2007 to 3.2% in 2012. OOP are borne by the individual patient as the full cost of the health good or service is not covered by either public or private insurance. The OECD states this increase is due to the Irish economic crisis, (OECD, 2015*a*).

Irish pharmaceutical expenditure per capita relative to other OECD countries has increased significantly since 2000. Ireland's position has moved from 20$^{\text{th}}$ highest of 27 countries in 2000 to 3$^{\text{rd}}$ highest of 25 countries in 2010. Irish per capita spending on pharmaceuticals was the highest in the EU and was 34% above the EU average in 2010, (Brick et al., 2013). Irish pharmaceutical spending per capita in 2012 was the third highest amongst EU countries at €500, 40% above the EU average (€350), (OECD, 2014). The total cost of General Medical Services (GMS) prescriptions has increased from €249 million in 1998 to €1.28 billion in 2012, a 414% increase (various annual PCRS Reports, 1998–2012). The GMS scheme is the largest Community Drug Scheme (CDS[4]) in Ireland and all CDS will be explained in detail in chapter two. Those who are eligible for the GMS scheme are entitled to free prescription drugs and appliances. GMS expenditure accounted for 9% of the overall health budget in 2012, (Department of Health, 2012).

Figure 1.1 illustrates cost of GMS medicines between 1996 and 2012. GMS medicines increased from €215 million in 1996 to €1.29 billion in 2012, an increase of 501%. GMS medicines increased by approximately €1 billion (487%) between 1996 and 2009. GMS medicines decreased for the first time (between 1996 & 2010) to €1.23 billion in 2010 and further decreased to €1.21 billion in 2011, before increasing again to €1.29 billion in 2012.

[4]There are 11 CDS in Ireland where individuals are entitled to free or subsidised healthcare.

Figure 1.1: **Cost of GMS Medicines (€Millions) between 1996 and 2012**



Source: (**Various PCRS Reports 1998–2012**)

The sustainability of funding these community drug schemes have come under the spotlight of the EU, International Monetary Fund (IMF[5]) and European Central Bank (ECB[6]) (Troika), who have identified pharmaceutical expenditure as a target area for cost reductions. The challenge for Ireland and many of our EU counterparts is containing pharmaceutical expenditure, but policies are severely restricted by population growth and growth in the elderly component of our populations, the main consumers of prescribed drugs, (Barry et al., 2010) and (Layte et al., 2009).

Thus the focus of this thesis is to investigate the impact of pharmaceutical expenditure, as Ireland recovers from the impact of austerity policies at a time, when the

[5]The IMF is an organisation of 188 countries, which works to foster global monetary co–operation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty around the world, (IMF, 2015).

[6]The ECB's main task is to maintain the euro's purchasing power and thus price stability in the euro area, (ECB, 2015).

population is not only forecasted to rise, but the proportion of those aged 65 (old persons) and over is projected to rise rapidly. The Central Statistics Office (CSO) estimate the number of old persons will almost double from 532,000 in 2011 to 991,000 in 2031, (CSO, 2013). This introductory chapter outlines the rationale for researching the GMS scheme and the objective of this research. The methodological approaches applied in this thesis will be discussed. Lastly, the structure of the thesis will be specified.

1.2 Objective and Aims of the Research

The research problem is focused on GMS expenditure projections and drug prescribing patterns in Ireland. The research problem is addressed across four journal articles. The primary objective is to investigate the main factors contributing to GMS expenditure on pharmaceutical prescribing and projecting this expenditure to 2026. This thesis has five main aims, which are specified below.

1. To determine the main factors contributing to GMS expenditure on pharmaceutical prescribing.

    - To construct and develop projections for population, coverage, claims rates and average claims cost variables using CSO[7] population projections (Census 2006) and sample Health Service Executive[8]–Primary Care Reimbursement Service[9] (HSE–PCRS) pharmacy data (2007).

2. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2006 CSO Census data and 2007 HSE–PCRS sample data.

    - Quantify the estimated impact on GMS expenditure of these four variables by old health board region, gender and age cohort in five year intervals to 2026.

[7]The CSO is responsible for the collection, compilation, extraction and dissemination for statistical purposes of information relating to economic, social and general activities and conditions in the Irish State, (CSO, 2015*a*).

[8]The public body responsible for the organisation and delivery of health care in Ireland.

[9]The public body responsible for the processing and reimbursement of GMS claims.

3. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2012 HSE–PCRS population data incorporating cost containment measures, and 2011 CSO Census data.

    - To construct and develop projections for population, coverage, claims rates and average claims cost variables using CSO population projections (Census 2011) and population HSE–PCRS pharmacy data (2012), which incorporates cost containment policies introduced following the onset of the economic crisis.
    - Quantify the estimated impact on GMS expenditure of these four variables by old health board region, gender and age cohort in five year intervals between 2016 and 2026.

4. To investigate the impact of demographic factors and the pharmacology of drugs (Anatomical Therapeutic Chemical (ATC[10])) on GMS expenditure.

    - Investigate the impact of regional variation on GMS expenditure by ATC group.
    - Investigate the impact of gender variation on GMS expenditure by ATC group.
    - Investigate the impact of age variation on GMS expenditure by ATC group.

5. To explore the consequences of GMS policy changes on prescribing expenditure and behaviour between 2008 and 2014.

    - Investigate the impact of policy changes on GMS coverage rates between 2008 and 2014.
    - Investigate the impact of policy changes on the average cost per claimant between 2008 and 2014.
    - Investigate the impact of policy changes on claims rates between 2008 and 2014.

[10]The ATC classification system divides drugs into different categories according to the organ or system on which it is acting upon, (WHO, 1990).

Aims two and three will project the effects of future changes in population, coverage, claims rates and average claims cost on GMS costs in Ireland under three scenarios to 2026. This thesis projects GMS expenditure based on two years, year before recession (2007) and 2012, following the introduction of cost containment measures. This research models GMS costs under a best case scenario (scenario 1), most likely scenario (scenario 2) and worst case scenario (scenario 3). As outlined in the introductory section, Ireland has one of the highest pharmaceutical expenditure per capita. Taking account of demographic changes in the population, the Irish economy cannot sustain this growth in GMS expenditure.

1.3 Publication Plan

This thesis is a compilation of published work over the past four years, as depicted in Figure 1.2. There follows a list of each publication, in the sequence that it was published or presented, with its title, along with the journal or conference in which the work has been disseminated. It is noted that Aisling ConwayLenihan, the author of this thesis, has been the primary author on all publications. This work has been based on a research question developed by the author under the primary guidance of Dr. Noel Woods.

1. 'The implications of regional and national demographic projections for future GMS costs in Ireland through to 2026'. This paper was published in the BioMed Central (BMC[11]) Health Services Research journal in October 2014.

2. 'Irish population and GMS coverage projections by health board region, gender and age cohort out to 2026'. This has been submitted and is currently under review in the Irish Business Journal.

3. 'Irish GMS Cost Projections and its Implications between 2016 and 2026'. This paper was published in the Pharmacoeconomics Open Access Journal in November 2015.

[11]BMC is an open access, peer-reviewed journal that publishes in the area of health services research.

4. 'Factors influencing the variation in GMS prescribing expenditure in Ireland'. This paper was published in the Health Economics Review in March 2016.

Conference Proceedings

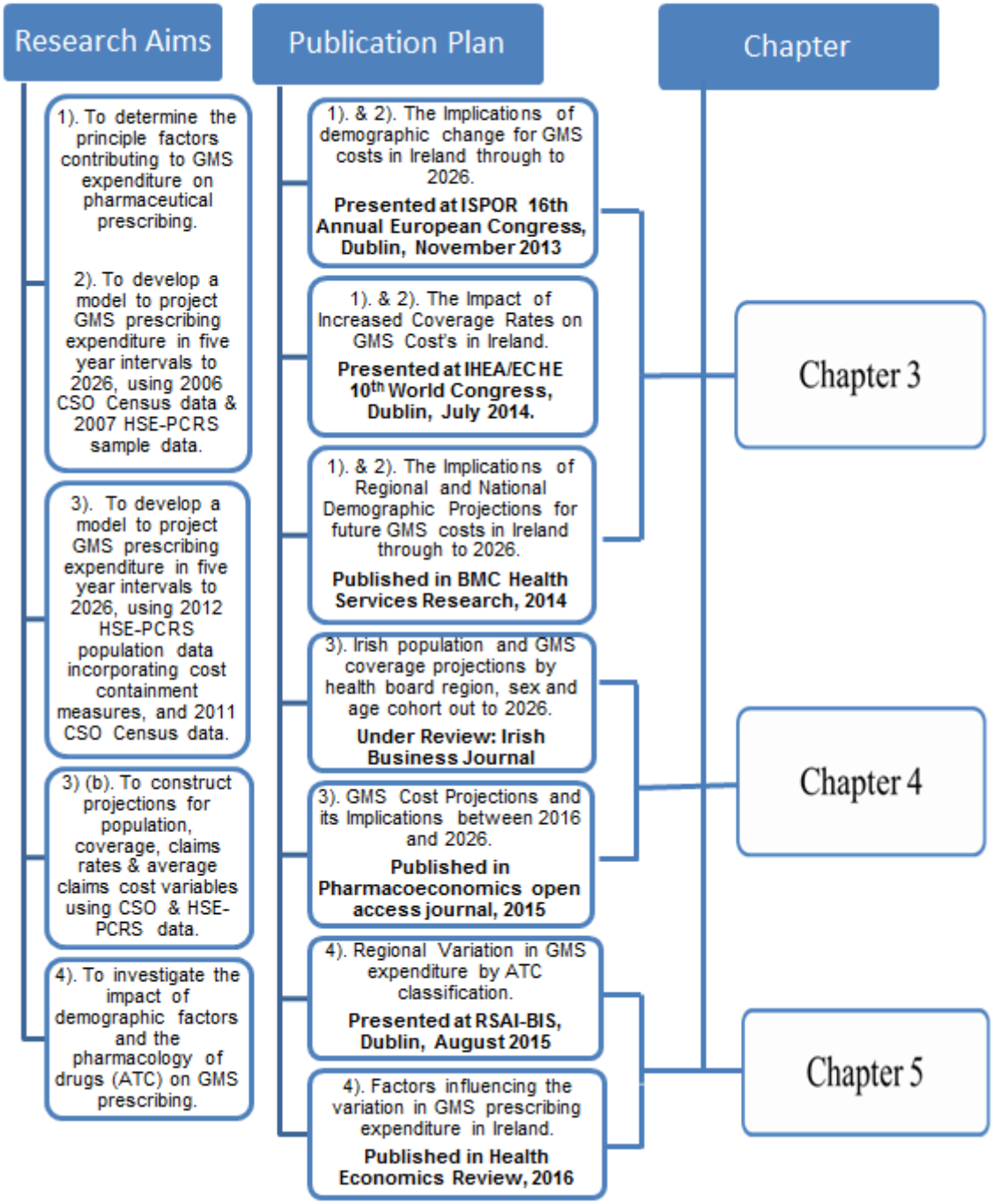
5. 'The Implications of demographic change for GMS costs in Ireland through to 2026'. This paper was presented at the International Society For Pharmacoeconomics and Outcomes Research (ISPOR[12]) 16th Annual European Congress in Dublin in November 2013. The proceedings of this conference have been peer–reviewed and published.

6. 'The Impact of Increased Coverage Rates on GMS Costs in Ireland'. This paper was presented at the International Health Economics Association/European Conference on Health Economics (IHEA/ECHE[13]) 10th World Congress in Dublin in July 2014. The proceedings of this conference have been peer–reviewed and published.

7. 'Regional Variation in GMS expenditure by ATC classification'. This paper was presented at the Regional Science Association International–British and Irish Section (RSAI–BIS) in Dublin in August 2015. The proceedings of this conference have been peer–reviewed and published.

[12]ISPOR is an international multidisciplinary professional membership society that advances the policy, science, and practice of pharmacoeconomics and outcomes research, (ISPOR, 2015).
[13]Both bodies held a joint congress in Dublin 2014.

Figure 1.2: **Research Aims and Publication Plan**



1.4 Methological Approach

Driven by the objective and aims of this thesis, quantitative methods were employed. A quantitative methodology was used to derive variable (population, GMS coverage, average cost per claimant and claims rate) projections and GMS cost projections. A quantitative method was employed to identify the factors that influence pharmaceutical expenditure.

1.5 Structure of the Research

This thesis consists of seven chapters, which altogether encompass two peer–reviewed conference presentations, poster presentation and four journal articles. Chapter one introduces the research topic and outlines the rationale for the research, publication plan and structure of the thesis. Chapter two is comprised of a comprehensive literature review. Firstly, pharmaceutical cost containment measures are explored, pharmaceutical expenditure projections and drivers of pharmaceutical expenditure are explored, followed by a detailed description of the community drug schemes in Ireland, and specifically the GMS scheme. This chapter also details the methodologies used; Monte Carlo Simulation Model and Ordinary Least Squares (OLS) Regression. Chapter three presents the implications of regional and national demographic projections for future GMS costs in Ireland through to 2026 (Paper 1).

The fourth chapter is comprised of two papers. The first paper updates Irish population (CSO, 2013) and GMS coverage (PCRS, 2012) projections by old health board region, gender and age cohort (Paper 2). The latter half of chapter 4 updates GMS expenditure projections using 2012 HSE–PCRS population data (Paper 3) following the implementation of cost containment measures. Chapter 3 is based on a sample HSE–PCRS 2007 database and 2008 CSO population projections, whereas chapter 4 is based on 2013 CSO population projections and 2012 HSE–PCRS population prescription database. Chapter five examines the factors that influence the variation in Irish GMS prescribing expenditure (Paper 4). Chapter six charts the GMS policy changes

between 2008 and 2014. Chapter seven concludes and summarises the findings of the research. The recommendations and the scope for future research are also presented in the final chapter.

Chapter 2

Literature Review

2.1 Introduction

The purpose of the review of literature is to locate the study in terms of existing research on drug expenditure projections and the factors influencing drug expenditure globally and particulary in terms of the GMS scheme in Ireland. The examination of the literature will identify the statistical methods previously employed and variables used in similar studies. Furthermore, the review will provide an appreciation of the type of results to expect; this will provide a benchmark for the findings of this research. As the focus of the research is GMS expenditure projections and factors influencing drug prescribing expenditure patterns in Ireland, the literature review will concentrate on this research problem. However, as many of the methodological approaches considered have been applied outside the area of health economics, literature from other disciplines are included, where appropriate. Several databases were searched to identify relevant literature; MEDLINE, CINAHL, EMBASE, EconLit and Business Source Complete. Searches were also performed in the Database of Abstracts of Reviews of Effects (DARE), the National Health Service (NHS) Economic Evaluation Database (EED) and the Cochrane Library methodology register. The search strategy was developed using combinations of various search terms relevant to the research topic. Searches were limited to studies in the English language.

This chapter is structured as follows: in section 2.2, pharmaceutical cost containment is explored from both an international and an Irish context. In section 2.3, drivers of drug expenditure are identified. Pharmaceutical expenditure and demographic projections in Ireland is examined in section 2.4. Community drug schemes are described in section 2.5 and the GMS scheme, upon which this thesis is primarily based. Section 2.6 details the methodologies used in this thesis. Finally, section 2.7 concludes the literature review.

2.2 Pharmaceutical Cost Containment (International Literature)

The purpose of this section is to review the international and Irish literature on pharmaceutical cost containment measures. This will identify the cost containment measures that have been implemented internationally and the savings they have generated where available. This section will also identify the cost containment measures that have been implemented in Ireland and their associated savings where available.

Health and pharmaceutical cost containment is a matter of concern for policy makers and is high on the politicial agenda internationally. (Mousnad et al., 2014) frames the principle cost containment strategies into four broad categories; educational, managerial, administrative and financial. Educational strategies incorporate continuing education programmes, practice guidelines, drug committees and patient information packages. Managerial and administrative strategies can control the regulation of marketing and commerical information, such as direct–to–consumer advertising. Managerial strategies control positive and negative lists, reference pricing (incentive pricing), reimbursement schemes, disease management strategies and practice guidelines. Administrative and financial strategies include fixed or directive budgets for prescribing, regulation of prices, price and volume agreements, co–payments and financial incentives to pharmacists to promote generic drugs and improve pharmacy services, (Mousnad et al., 2014).

In Germany, a number of pharmaceutical cost initiatives have been introduced. These include price regulation (fixed prices for drugs), positive (reimbursable drugs) and negative (non–reimbursable drugs) lists, co–payment charges (user charge paid by the patient) and caps on physician prescribing, (Schulenburg, 1997) and (Breyer, 2002). A German study found that savings accummulated from the introduction of reference pricing[1] equated to 9% of total pharmaceutical expenditure in 2001, (Busse, 2001). In Spain, pharmaceutical cost containment was high on the political agenda between 1996 and 2002. Supply side policies introduced during this time include updated negative list, reference pricing, payment system to pharmacies and pharmaceutical industry–government agreements, (Puig-Junoy, 2004). In Turkey, (Vancelik et al., 2007) found that the influence of pharmaceutical companies on General Practitioner (GP) drug prescribing through promotional and educational courses, acted as a barrier to cost containment.

A study examined the effect regulation had on pharmaceutical revenues across 19 countries between 1992 and 2004. (Sood et al., 2009) found increased regulation in OECD countries over the 12 year period, with direct price controls being the most common form of regulation. Economic evaluations was found to be the fastest growing regulation. Two countries had this regulation in place in 1992, increasing to 10 countries by 2004. Direct price controls and economic evaluations had the biggest impact on pharmaceutical revenue. (Sood et al., 2009) argued if direct price controls and other regulations were introduced to an unregulated market, they would greatly reduce pharmaceutical costs.

A Norwegian study analysed the drug pricing strategies implemented by government between 1994 and 2004. Norway has focused on pricing systems in the fight against drug containment costs. (Hakonsen et al., 2009) suggests direct price control through

[1]Reference pricing is the setting of a standard reimbursement price, or reference price, for a group of interchangeable medicines.

international reference pricing is the most successful pricing strategy, as opposed to indirect pricing strategies, such as reference based pricing, generic substitution and index pricing. Reference pricing was introduced in British Colombia in 1995 to contain drug expenditure of its publicly funded drug benefit plan, Pharmacare, but the cost savings were lower than expected, (Schneeweiss et al., 2002). (Dylst et al., 2011) undertook a literature review on the impact of reference pricing systems in 22 European countries. They found reference pricing led to a decrease in pharmaceutical expenditure growth in the short term but not in the long term. In 2010, generic pricing was introduced in Ontario. (Law et al., 2011) estimated that this policy resulted in savings of between $181 million and $194 million in the final 6 months of 2010. This Canadian study also found, if Ontario generic prices were applied nationally, Canadian drug expenditure would reduce by 4.9% to $1.28 billion.

(Ess et al., 2003) reviewed European policies for controlling drug expenditure and identified three pricing policies; product price control, reference pricing and profit control (mainly used in the United Kingdom (UK)). They found that countries with a high drug consumption have lower drug prices (Spain, Greece, France) and countries with low drug consumption have higher drug prices (Netherlands, Switzerland, Denmark). This can result in higher drug expenditure per capita in countries with lower price levels. For example, France had a $337 drug expenditure per person, whereas Denmark had $165 drug spend per person. Drug expenditures are not found to be lower in countries with price controls, (Ess et al., 2003).

(Morgan and Astolfi, 2015) analysed the financical impact of the global financial crisis on health expenditure across OECD countries. Many OECD countries introduced cost containment measures in 2009 and the measures intensified in 2011. Pharmaceutical expenditure contributes 17.5% of average current health expenditure in OECD countries. Between 2009 and 2011, Greece reduced pharmaceutical expenditure by 19.5%, approximately €1 billion through cost containment measures. Cost containment measures included price cuts, the re-introduction of a positive list, changes in the

profit margins of pharmacies and wholesalers, and tenders for hospital drugs, (Vandoros and Stargardt, 2013). (Goranitis et al., 2014) argues Greek cost containment measures were not well targeted and were introduced as a quick and easy fix to fiscal adjustment, while ignoring the need for structural reform. Portugal and Spain reduced pharmaceutical expenditure by 20% and 8% respectively. In 2011, Portugal reduced pharmaceutical expenditure through price reductions, centralised purchasing of drugs and guidelines to reduce administration costs, (Morgan and Astolfi, 2015). (Almarsdóttir and Traulsen, 2005) warns policy makers against a narrow policy focus on reducing pharmaceutical costs, without considering the broader objective of medicine use and its impact on health outcomes. Cost containment strategies should be evidence based and consider the impact they will have on public health.

2.2.1 Cost Containment in Ireland

Pharmaceutical cost containment has been high on the political agenda in Ireland, especially since the onset of the economic crisis in 2008. (Murphy, 2008) maintains cost containment is not about cutbacks but about "better strategy, better management, better service provision and taking the best options". In 2005, (Tilson et al., 2005) examined the potential impact of implementing a system of generic substitution on the community drug schemes in Ireland. This research was motivated by a five fold increase in the cost of medicines on the community drug schemes. This study highlighted the potential savings to be made from the introduction of generic substitution. However, (Tilson et al., 2005) argued that decison makers should also implement incentives for pharmacists to prescribe generically and for prescribers to allow generic substitution, so that maximum potential savings could be realised. (Barry et al., 2008) documented the nature, growth and cost of the Irish community drug schemes between 1997 and 2007. Community drug expenditure increased five–fold over this period to €1.74 billion in 2007. Price Controls were introduced to the Irish market in 1993, where the price of medications were linked to the average of the wholesale price in selected EU

countries. The National Centre for Pharmacoeconomics (NCPE) found this cost containment measure could potentially result in savings of approximately €16 million in 2004. (Barry et al., 2008) maintains cost containment measures such as price controls, trade agreements, pharmacoeconomic evaluations and generic substitution could be threatened by the emergence of expensive cancer and chronic treatments.

(Barry and Tilson, 2010) argue decision makers should consider the reimbursement of new high cost drugs with evidence development. However, they contend reimbursement based on evidence development will be the exception, rather than the rule. Evidence is generated to validate reimbursment decisions and inform future decision making. A review group explored the scope for further economies in drug usage in the Irish healthcare setting in 2009, (Barry et al., 2009). The review group developed 11 recomendations with a target of €65 million in savings. Recommendations included; savings via the Irish Pharmaceutical Healthcare Association (IPHA[2])/HSE agreement, cost–effectiveness of drugs reimbursed under community drug schemes, informing patients of pricing of medicines to optimise value for money and reduce wastage, generic prescribing and pricing, GP incentives to enhance cost–effective prescribing, continuity across hospital and communtiy prescribing and review wholesale margins and payments to pharmacies, (Barry et al., 2009). (Tilson and Barry, 2010) reviewed developments in pharmacoeconomic evaluation in furtherance of the cost containment objective. Reimbursement decisions underlied by cost–effectiveness for certain medicines were introduced in September 2006 and all medicines were considered from 2009, (Tilson and Barry, 2010).

(Walshe and Kenneally, 2013) investigated the savings from pharmaceutical cost containment policies in 2011. Community drug scheme costs are driven by three components; number of eligible persons, price of drugs/services and volume of drugs/services prescribed. Recently, both the number of eligible persons and number of items have

[2]IPHA represents the international research based pharmaceutical industry in Ireland and its members include prescription and non–prescription manufacturers, (IPHA, 2015).

increased on the GMS scheme, whereas the price of drugs has decreased. Following the IPHA/HSE agreement in 2006, the price of drugs have decreased and this study estimated savings of €200 million in 2011. Reductions in retail and wholesale mark–up and the new dispensing fee structure led to estimated savings of €100 million in 2011. Restrictions in scheme eligibility and increased co–payments led to estimated savings of €80 million in 2011. (Walshe and Kenneally, 2013) claim the three cost containment policies resulted in savings of €380 million for the Irish economy in 2011. Some of the cost containment policies shifted the cost burden from the public purse to private individuals, such as co–payment charges, (Thomas and Burke, 2012).

The international literature has shown that some cost containment measures can be more successful than others in reducing pharmaceutical expenditure. Following the onset of the economic crisis in Ireland, pharmaceutical cost containment measures came to the forefront. (Tilson et al., 2005) and (Barry et al., 2008) highlighted the growth in the cost of medicines on community drug schemes up to 2007. This growth is not sustainable in Ireland and this thesis seeks to estimate the implications of cost containment on future cost projections.

2.3 Drivers of Pharmaceutical Expenditure

The purpose of this section is to examine the factors that are influencing Irish and international pharmaceutical expenditure. This section examines the results of previous studies on factors influencing drug expenditure, in order to benchmark the findings of the subsequent investigation.

It is well documented in the literature that population is a driver of Irish health care expenditure, (Layte et al., 2007) and (Barry et al., 2010). A Canadian study (Canadian Institute for Health Information, 2012), identified six cost drivers of drug expenditure; population growth, population aging, general inflation, price effects, volume effects and

mix of drugs. They found population growth and population aging had the least effect on drug spending with volume effects and the mix of drugs having the most significant effect of the six cost drivers. A British Colombian study found an increase in the older population and the rate at which they utilised medicines accounted for under half of the total drug expenditure increase between 1991 and 2001. Changes in the mix of drugs and the type of drug selected, explained over half of the observed drug expenditure increase, (Morgan et al., 2004).

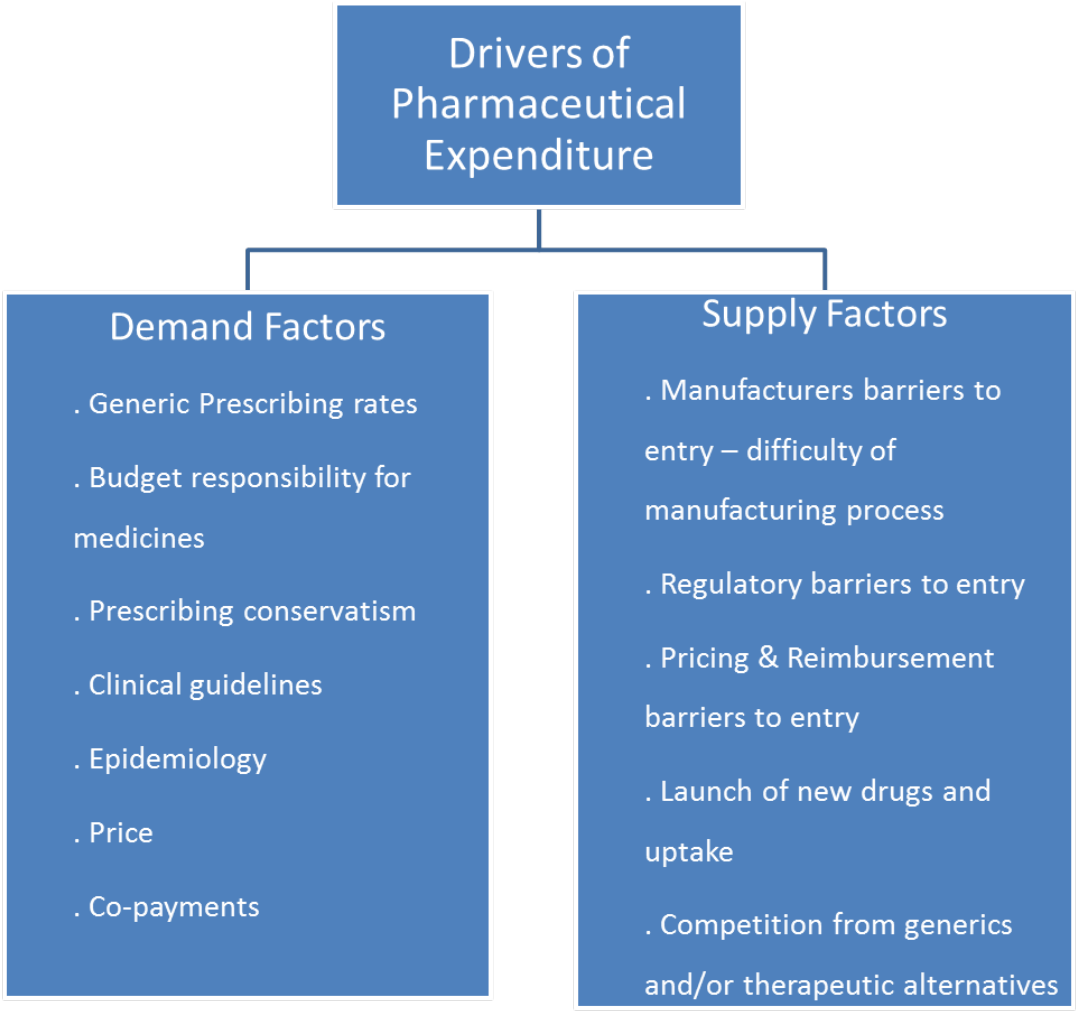
(Bech et al., 2010) found increasing life expectancy leads to an exponential increase in health care expenditure. The literature also points to advances in medical technology as a driver of health care expenditure (Cutler, 1995), (Newhouse, 1992) and (Fuchs, 1996). A study in Taiwan found an increase in the rate of technological innovation introduces new pharmaceutical drugs into the health care system, subsequently leads to a rise in health expenditure, (Hsieh et al., 2013). A systematic review of the factors influencing pharmaceutical expenditure found that drug utilisation, drug therapies, price and new drugs were the major drivers of pharmaceutical expenditure, (Mousnad et al., 2014). The review identified a number of studies, where price changes of drugs resulted in a positive and negative effect on drug expenditure i.e., a change in the price of existing drugs results in higher and lower drug expenditure respectively. The most commonly used methods to model price changes included trend analysis, decomposition and econometric analysis.

(Mousnad et al., 2014) found changes in drug utilisation and drug therapies had a major impact on drug expenditure increases. Changes in drug quantities can be measured by the number of prescriptions (volume) and types of drugs prescribed (mix). Changes in drug therapies can be measured by the incidences, in which, multiple drug groups are used (polytherapy). New innovative drugs, which are more effective and more expensive, was found to influence pharmaceutical expenditure, (Mousnad et al., 2014).

Other explanatory variables identified in the literature include age, gender and location (region). (Mousnad et al., 2014) found in their systematic review that the age group 45–64 were more likely to utilise prescription items than the age group 65–84. A Spanish study examined how gender and age influenced prescription drug use and found a higher prevalence of prescription drugs in males in younger children, up to 14 years of age, (Fernández-Liz et al., 2008). A Swedish study found more drugs were dispensed amongst males under 10 years, (Loikas et al., 2013). An Irish study investigating prescribing antibiotics trends in a paediatric sub–population found that male participants (0–4 age cohort) were more likely to receive an antibiotic prescription than female participants, (Keogh et al., 2012).

It is well documented that females visit doctors more regularly than men, hence higher female prescribing rates with a resulting effect of higher drug costs. In Spain (Fernández-Liz et al., 2008), Sweden (Loikas et al., 2013) and British Colombia (Morgan, 2006), there is a higher incidence of prescribing amongst females compared to males. (Loikas et al., 2013) found women were dispensed more drugs in all age groups, except for the age group 0–10, where there was higher dispensing amongst males. (Fernández-Liz et al., 2008) found drug prescribing is 23% higher in females than males and that age is statistically more significant than gender ($P<0.05$). (Mousnad et al., 2014) found drug utilisation is higher among females compared to males. (Morgan, 2006) found population change contributed very little to drug expenditure increases but age, gender, volume and type of drugs prescribed, contributed to a rise in drug expenditure. (O'Neill et al., 2013) identified the demand and supply factors that are driving Swedish pharmaceutical expenditure. These factors are applicable to many international countries. Figure 2.1 summarises the factors that affect the demand for drugs and the factors that affect the supply of drugs.

Figure 2.1: **Drivers of Pharmaceutical Expenditure - Demand & Supply Factors**



Source:(**O'Neill et al, 2013**)

In Ireland, two studies explored regional variation. (Naughton et al., 2006) examined the distribution of chronic conditions across the old health board regions in Ireland and found the Midlands had the highest prevalence of chronic conditions with the Western and North–Western regions having the lowest prevalence of chronic conditions. Furthermore, (Usher et al., 2005) examined the prescribing prevalence of insulin dependent and non-insulin dependent diabetes across regions in Ireland. They found the Midlands and the Mid–Western regions had the highest prescribing ratios for both types of diabetes and the North–Western region had the lowest prescribing ratio.

This thesis proposes to explore the factors that are influencing pharmaceutical expenditure in Ireland, such as age, gender and geographical location. This review informs us of the results to expect, based on existing research.

2.4 Pharmaceutical Expenditure Projections in Ireland

The purpose of this section is to review the literature on pharmaceutical projections in Ireland and identify the empirical methods utilised. This section also reviews demographic projection studies and identifies the assumptions, on which population forecasts were made.

Research is limited in the area of health and drug expenditure projections in Ireland. (Bennett et al., 2009) projected the impact of demographic change on the demand for three community drug schemes (GMS, DPS[3], LTI[4]) in Ireland. They adopted two models, linear current use model (current trends continue in linear fashion) and a regression model to project future prescribing for three community drug schemes. This study was based on 2006 data and incorporated population projections (Morgenroth, 2009), where the population is estimated to grow from 4.24 million in 2006 to 5.1 million in 2021, (Barry et al., 2010). A sensitivity analyis was performed around the current

[3]Drug Payments Scheme
[4]Long Term Illness

use and regression model (± 10%) estimates. They found that drug ingredient costs[5] are likely to be between €1.5 billion (current use model) and €2.3 billion (regression model) for the three community drug schemes (GMS, LTI & DPS) by 2020, with the GMS scheme accounting for the largest proportion (€806 million, 67.2%). Their analysis was disaggregated by HSE age cohort ranging from the under 5s to the over 75s. Drug ingredient costs increase with age reaching a peak among those aged 70 years and over. The current model projects ingredient costs for the three community drug schemes for the over 75s to lie between €400,000 and €450,000, whereas the regression model projects ingredient costs to lie between €500,000 and €600,000. Older age groups were found to be prescribed a higher volume and more expensive prescription items, (Bennett et al., 2009).

(Heaney et al., 2009) predicted 2012 community drug expenditure using 2007/2008 annual PCRS Statistical Analysis of Claims and Payments reports. They applied an autoregressive integrated moving average (ARIMA) model to the national prescribing database to predict future drug expenditure. The ARIMA model predicted that community drug expenditure will increase from €2.29 billion in 2008 to between €2.3 billion and €3 billion in 2012. In 2008, 73% of prescription items were prescribed to GMS persons, 22% to DPS persons, 4% to LTI persons and 1% to the High Tech drugs scheme.

2.4.1 Demographic Projections in Ireland

The CSO is the primary source of Irish population statistics and projections. The current CSO projections (CSO, 2013) incorporating international migration and fertility assumptions, project the national population of the Republic of Ireland to be 5.19 million in 2031. The CSO collects primary population data (Census) every five years, the most recent being Census 2011. The Irish population is living longer and life expectancy has significantly improved over the last 85 years. (CSO, 2015*a*) publishes Life

[5]The ingredient cost of a drug is comprised of the ex–factory price and the wholesale mark–up.

Table 2.1: **Life Expectancy by Gender 1926–2011**

Year	Males	Females
1926	57.4	57.9
1946	60.5	62.4
1966	68.6	72.9
1986	71.0	76.7
2006	76.8	81.6
2011	78.3	82.7

Source: (**CSO**, 2015a)

Tables, which details the life expectancies of both genders, as illustrated in Table 2.1. The most recent Life Table (No.16) was published in 2015, with a reference period 2010–2012. In the 85 year period, life expectancy has improved by approximately 21 years for men and 25 years for women. (CSO, 2015*a*) attributes this improvement to decreasing mortality rates and in particular, infant mortality rates.

(Blackwell, J. & Associates, 2001) were commissioned by the Department of the Environment and Local Government to produce population forecasts, labourforce and housing demand forecasts for the national spatial strategy. Projections were based on CSO data (1999–2000) and forecasts were produced in five year intervals out to 2030 by CSO regions. Twelve scenarios were developed, some of which were used for sensitivity analysis. (Blackwell, J. & Associates, 2001) estimated the national population will lie between 4.39 million and 4.95 million in 2020.

A United Nations report found the >60s population in Ireland will increase from 781,000 (17.1%) in 2012 to 1,735,000 (28.7%) in 2050. They also reported a more than doubling in the over 80s population, from 134,000 (2.9%) to 445,000 (7.4%) between 2012 and 2050, (United Nations, 2012). The size and structure of the population will

be a key determinant of GMS costs in the future. (Connell and Pringle, 2004) carried out a report on population aging in Ireland between 2002 and 2021. They estimated that the older male age group (>65) will increase from 9.7 per cent in 2002 to between 13.9 per cent and 14.1 per cent in 2021. The older female age group (>65) will increase from 12.5 per cent in 2002, to between 15.8 per cent and 16.4 per cent in 2021.

This thesis will develop population projections and they will be incorporated into drug expenditure projections. The literature on drivers of drug expenditure (Section 2.3) identified population growth and population aging as factors that influence drug expenditure.

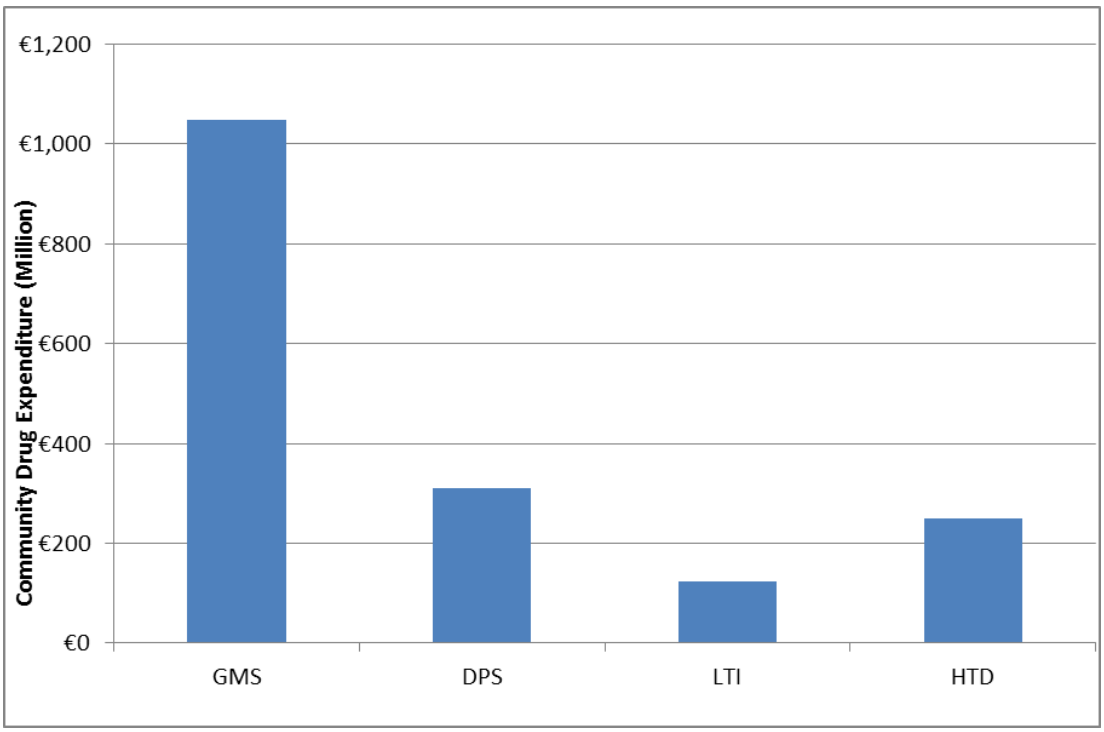
2.5 Drug Prescribing in Ireland – Community Drug Schemes

The objective of this section is to describe the community drug schemes in Ireland and the complexity around the eligibility for each scheme. The number of persons eligible for each scheme and the associated cost, where available, is detailed. At the time of writing this section, 2012 was the most recent data available. Therefore all data is based on the year 2012.

There are 11 Community Drug Schemes in Ireland, the largest being the GMS. The four most expensive CDS in Ireland, where a person has entitlement to free or subsidised healthcare; is the GMS, DPS, LTI and High Tech Drug (HTD) schemes. All scheme claims are processed and paid by the PCRS. Other schemes include the Dental treatment Services Scheme (DTSS), European Economic Area (EEA), Health Service Executive Community Ophthalmic Services (HSE–COS), Methadone Treatment Scheme (MTS), Health Amendment Act 1996 (HAA) and Primary Childhood Immunisation scheme.

The PCRS has two functions. Firstly, the PCRS administers and processes all community drug claims on behalf of the state and secondly, reimbursement of contractors. The PCRS arranges payments to contractors, such as GPs, community pharmacists, dentists and optometrists/ophthalmologists. PCRS expenditure is driven by expenditure on drugs and medical appliances, as opposed to fees and allowances. The Irish Fiscal Advisory Council found that 70% of PCRS expenditure was on drug and medical appliances in 2014, (IFAC, 2015). The four most expensive community drug schemes, cost approximately €1,732 million in 2007 and this increased to €1,923 million in 2012 (11% increase). Figure 2.2 illustrates the payments to pharmacists by community drug scheme and shows the GMS scheme is the largest of the four drug schemes, it accounted for approximately 60% of community drug expenditure in 2007.

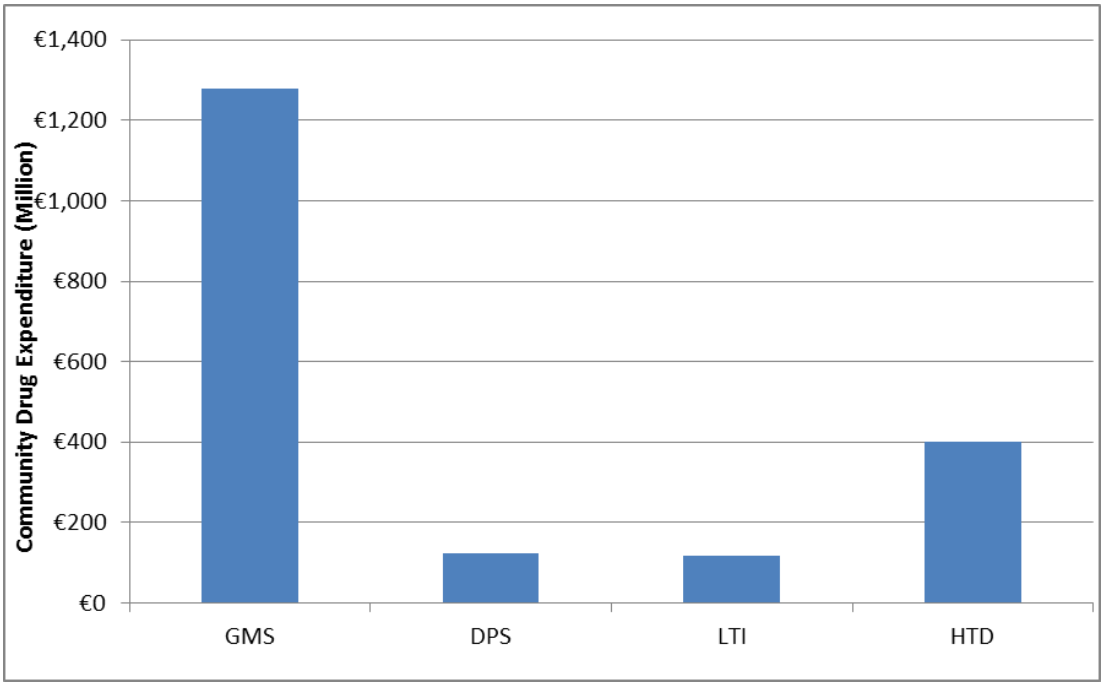
Figure 2.2: **Community Drug Scheme Expenditure (€) 2007 - Payments to Pharmacists**



Source: (**PCRS**, 2007)

The LTI scheme is the smallest of the four drug schemes accounting for approximately 7% of community drug expenditure, (PCRS, 2007). Figure 2.3 illustrates community drug expenditure for 2012.

Figure 2.3: **Community Drug Scheme Expenditure (€) 2012 - Payments to Pharmacists**



Source: (**PCRS**, 2012)

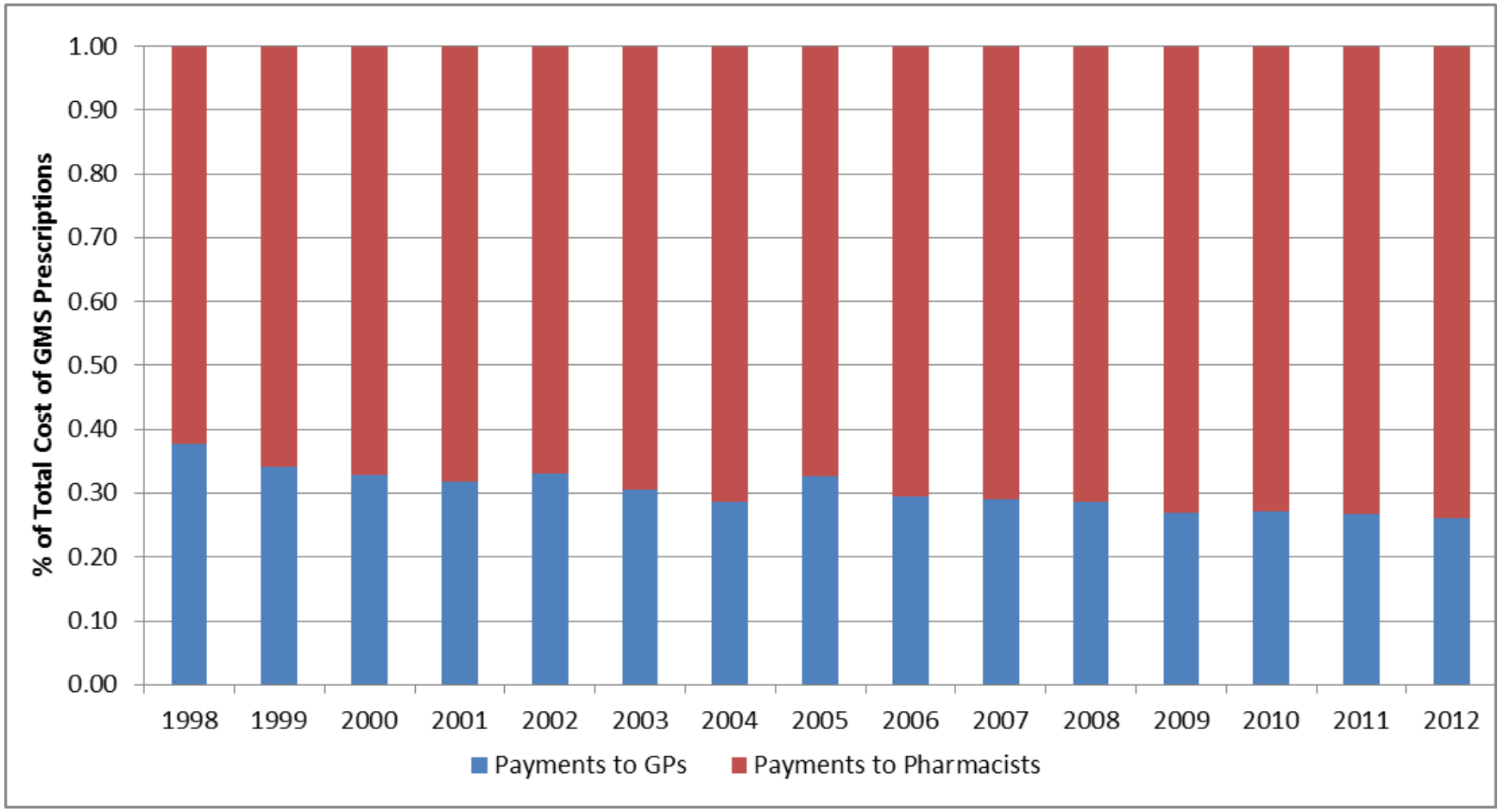
GMS expenditure as a proportion of CDS expenditure increased to approximately 66% in 2012, a 6 percentage point increase between 2007 and 2012. The LTI scheme remains the smallest of the four community drug schemes at approximately 6% of expenditure. The HTD scheme increased from approximately 14% to 21% of expenditure between 2007 and 2012. The most notable change is the DPS scheme, which decreased from approximately €310 million (18%) in 2007 to approximately €125 million (6%) in 2012, (PCRS, 2012). This decrease in expenditure, may be attributed to the increased payment contribution by the patient. There was a 55% increase in the payment per patient, increasing from €85 in 2007 (PCRS, 2007) to €132 in 2012. This was a result of the implementation of a policy change in budget 2012, (PCRS, 2012).

2.5.1 General Medical Services Scheme

GMS expenditure is comprised of payments to GPs (fees and/or allowances) and payments to pharmacists. GP payments are paid on a per capita basis. GPs are also entitled to claim out-of-hours payments (where patients are seen outside normal practice hours) or where special services (excisions, suturing, vaccinations, catheterisation, family planning etc.) are delivered, (Keane et al., 2015). In Figure 2.4, the total cost of GMS prescriptions is the sum of total payments to GPs and total payments to pharmacies. In 1998, 62% of the total cost of GMS prescriptions were paid to Pharmacists and 38% to Doctors. Payments to Pharmacists as a proportion increased to 74% and payments to GPs decreased to 26% in 2012.

GMS payments increased from €414 million in 1998 to €1.73 billion in 2012, a 318% increase. The total payments to GPs increased from €156 million in 1998 to €451 million in 2012, a 189% increase. The total payments to Pharmacists increased from €258 million in 1998 to €1.28 billion in 2012, a 396% increase, (GMS Payments Board, 1998) and (PCRS, 2012). The data presented in the GMS (Payments) Board Annual Reports between 1998 and 2000 is based on the old currency, the Irish Pound. For comparability purposes, data in 1998 to 2000 reports are converted to the single monetary unit, the Euro. An exchange rate of £1 = €1.27 was applied and used throughout the thesis, where required, (Central Bank of Ireland, 2012). Policy measures can be both demand and supply side. Demand side policies target prescribing physicians, pharmacists and patients that alter the demand for community drug schemes. Supply side policies affect the price of drugs. This thesis will primarily focus on demand side policies given the available data but the penultimate chapter of this thesis will also focus on supply side policies that have been introduced during the economic crisis to contain drug expenditure.

Figure 2.4: **Proportion of Payments to GPs & Pharmacists, 1998–2012 – GMS Scheme**



Source: (**Various PCRS Reports 1998–2012**)

Those who are eligible for the GMS scheme (medical card holders) are entitled to a range of health services (medical benefits) and non–medical benefits free of charge.

Medical Benefits

- General Medical and Surgical Services, including all in–patient services and out–patient services in a public hospital (including consultant services).
- Medical and Midwifery Care for mothers and infants.
- A choice of General Medical Practitioner from those doctors, who have a contract with the HSE.
- Supply of prescribed approved medicines and appliances (subject to prescription charges).
- Dental, Ophthalmic and Aural services.
- A maternity cash grant for each child born.

  Source: National GMS Assessment Guidelines, (HSE, 2015)

Non–Medical Benefits

- Medical Card holders whose income is more than €10,036 pay the Universal Social Charge (USC)[6] but at a maximum rate of 4%.
- The Freedom of Information (FOI)[7] application fee for a Medical Card holder in relation to non–personal information is €10 (standard fee is €15).
- Medical Card holders are eligible for reduced charges for appeals under the Access to Information on the Environment (AIE)[8] regulations.

[6]The USC is a tax payable on gross income and three rates were introduced in 2011, these rates were revised in 2015, (Revenue, 2015*a*).

[7]The FOI Act gives every person the legal right to access official records held by Government Departments or other public bodies, (FOI, 2015).

[8]This is information relating to the environment held by, or for, a public authority and must be made available on request, subject to certain exceptions, (DECLG, 2015).

- Medical Card holder is an eligibility criterion for Higher Education Access Route (HEAR), a college and university admissions scheme that offers places on reduced points and extra college support to school leavers from socio–economically disadvantaged backgrounds.

- Medical Card holders may also be exempt from paying school transport charges in publicly funded second–level schools.

- Medical Card holders may also be exempt from paying State exam fees in publicly funded second–level schools.

- Medical Card holders can avail of childcare at reduced rates under the Community Childcare Subvention Scheme.
  (**Source: Keane et al., 2015**)

Eligibility for the GMS is governed by legislation and any person "ordinarily resident" in the state is considered for a medical card. If you have been resident for the previous three tax years then you become ordinarily resident from the beginning of the fourth year. If one leaves the country, one will no longer be "ordinarily resident" if they have been non–resident for three continuous tax years, (Citizens Information, 2015). There are three main categories of people entitled to a medical card:

1. Applicants and their dependants, whose asessable income comes within certain income guidelines (the income guideline is €184 for a single person living alone who is under 66 years and a couple is €266.50).

2. Applicants and their dependants whose assessable income is in excess of the income guidelines, where the HSE considers that to refuse a medical card would cause undue hardship (discretionary cases).

3. A person from another EU member state, a person with retention entitlement under government schemes (can retain their medical card for specified time period), a person affected by the drug Thalidomide and Symphysiotomy (regardless of their income), (HSE, 2015).

Approximately 40% (1.85 million) of the population were eligible for the GMS in 2012, (PCRS, 2012). In the majority of cases, a completed GMS prescription form by the GP is presented to a pharmacy that has an agreement with the HSE to dispense drugs and appliances. In some rural areas, GPs who hold contracts can dispense directly to the GMS claimant. All GMS claims are processed and reimbursed by the PCRS. The government introduced patient co–payment charges for medical card holders for the first time to raise revenue to alleviate the drug expenditure bill. A co–payment is a fixed payment made by the claimant per prescription item. The aim of a co–payment is to reduce overall pharmaceutical expenditure and utilisation. Co–payments do not differ for brand and generic medicines, (Sokol et al., 2005). On the 1st of October 2010, a 50 cent per item charge subject to a monthly ceiling of €10 per family was introduced. The co–payment increased to €1.50 with a monthly ceiling of €19.50 per family from the 1st of January 2013. This was further increased for the financial year, 2014, where the co–payment increased to €2.50 with a monthly ceiling of €25.00 per family. Any eligible GMS person, who is prescribed a drug or appliance by a registered GP, registered Dentist or registered nurse prescriber, by a community pharmacy contractor are liable for this charge. The PCRS redeem this co–payment from the community pharmacy, (PCRS, 2012).

Since the 1st of July 2001, all persons aged 70 years or over were entitled to a medical card. This entitlement changed on the 1st January 2009 when new medical card limits were introduced. If a single person earned €700 or more per week (€36,500 per year) or a couple earned €1,400 or more per week (€73,000 per year), they were no longer entitled to a medical card, (Barry et al., 2010). From the 5th of April 2013, income limits were reduced to €600 per week for a single person and €1,200 per week for a married couple. In Budget 2014, income limits were further reduced to €500 per week for a single person and €900 per week for a couple, (Department of Finance, 2013). Table 2.2 details the impact of this policy change between 2008 and 2009.

Table 2.2: **Number of Eligibile GMS Persons over 70 2008–2012**

Year	**2008**	**2009**	**2010**	**2011**	**2012**
Eligible Persons	351,853	337,669	345,806	348,519	354,811
% Change		- 4.03	2.40	0.78	1.80

Source: (**Various PCRS reports 2008–2012**)

14,184 fewer persons were eligible for the medical card in 2009, approximately a 4% decrease. The number of eligible persons increased by 2.40% in 2010, 0.78% in 2011 and 1.80% in 2012. The number of eligible persons increased although income eligibility rates were reduced. The recession may explain this increase through a rise in the unemployment rate, hence more people being eligible for the GMS scheme.

General Practitioner Visit card

In 2005, the HSE introduced the General Practitioner Visit Card (GPVC). Any person who is ineligible for the GMS scheme but falls within certain income limits, may apply for a GPVC. This entitles one to visit their GP free of charge. GPVC income limits are as follows; if a single person aged 70 or over has an income over €500, but not exceeding €700 per week, that person is eligible for a GPVC. A married couple aged 70 or over and whose income is over €900, but not exceeding €1,400 per week are eligible for a GPVC. A single person living alone aged up to 65 years and aged 66 years and over with a weekly income of €276 and €302 respectively, are eligible for a GPVC, (HSE, 2015). All claims are processed and reimbursed by the PCRS. On the 31st of December 2005, 5,079 persons were eligible for the GP visit card, (PCRS, 2005). This increased to 131,102 by the 31st of December 2012, (PCRS, 2012). The number of GP visit cards increased steadily between 2005 and 2012. Table 2.3 specifies the number of GP visit cards issued between 2005 and 2012, 131,102 (2.86%) persons were eligible for the GP visit card in 2012.

Table 2.3: **Number of GP Visit Cards Issued 2005–2012**

Year	GP Visit Card	% of Population Covered
2005	5,079	0.13%
2006	51,760	1.22%
2007	75,589	1.78%
2008	85,546	2.02%
2009	98,325	2.32%
2010	117,423	2.77%
2011	125,657	2.74%
2012	131,102	2.86%

Source: (**Keane et al. (2015)**)

2.5.2 Other Community Drug Schemes

Drug Payments Scheme

Any person, who is ineligible for the GMS scheme can benefit, if their spending on drugs and appliances exceeds €144 in any calendar month, for an individual or family[9]. Any dependents between 18 and 23 years of age in full-time education may also be included. The DPS scheme was introduced on the 1st of July 1999. The monthly threshold has increased from €120 in January 2010 to €132 in January 2012, to €144 in January 2013. This represents a 20% increase between 2010 and 2013. In order to avail of the DPS scheme, any person or any family member (<18) must register with the PCRS. If the monthly threshold is exceeded, the PCRS reimburses the additional costs to the pharmacist. In 2012, approximately 32% (1.46 million) of the population availed of this scheme, (PCRS, 2012).

[9]Individuals with mental or physical impairment who is unable to maintain oneself may also be included in the family regardless of age.

Long Term Illness Scheme

Any person who suffers from one or more illnesses[10] are entitled to obtain drugs and appliances free of charge, irrespective of income under the LTI scheme. They must be resident in Ireland and have a Personal Public Service Number (PPSN[11]). One must obtain approval from the HSE for this scheme. In 2012, 1.52% (150,598) of the population availed of this scheme, (PCRS, 2012).

High Tech Drugs Scheme

The HTD scheme was introduced in November 1996, (Barry et al., 2009). High tech medicines are generally only prescribed or initiated in the hospital setting and are purchased by the HSE. Medicines such as anti–rejection drugs for transplant patients or medicines used in conjunction with chemotherapy or hormonal therapy are prescribed through community pharmacies, for which pharmacists receive a patient care fee. In recognising the complexity of these particular medicines pharmacists are paid a patient care fee of €62.03 per month to cover dispensing, counselling and advice on their safe and effective use. The PCRS reimburses pharmacies for the cost of medicines and patient care fees, (PCRS, 2012).

European Economic Area Scheme

European residents from the EEA may be eligible for emergency GP services, who are on a temporary visit to the state. They are entitled to see a GP and be dispensed prescriptions from any pharmacy, who have entered an agreement with the state. On presentation of a valid E128 form, students, posted workers and their dependents are eligible for full medical services, (Gorecki et al., 2012).

[10] Acute Leukaemia, Mental Handicap, Cerebal Palsy, Mental Illness (in a person under 16), Cystic Fibrosis, Multiple Sclerosis, Diabetes Insipidus, Muscular Dystrophies, Diabetes Mellitus, Parkinsonism, Epilepsy, Phenylketonuria, Haemophilla, Spina Bifida, Hydrocephalus, Conditions arising from the use of Thalidomide.

[11] The PPSN is allocated by the Department of Social Protection and is a unique reference number that is to be used by one in all dealings with Public Service Agencies, (Revenue, 2015*b*)

Methadone Treatment Scheme

Under the Methadone Treatment scheme, approved clients may be prescribed and dispensed Methadone by doctors and pharmacists. PCRS reimburses doctors' capitation fees and the ingredient cost of the Methadone to community pharmacies, (Gorecki et al., 2012).

Health (Amendment) Act 1996 Scheme

Under this scheme, patients who have contracted Hepatitis C directly or indirectly from the use of Human Immunoglobulin Anti D or were a recipient of another blood product or blood transfusion within the state, are eligible for certain health services without charge. These services include GP services, pharmaceutical services, dental services and optometric/ophthalmic services and are paid for by the PCRS, (Gorecki et al., 2012).

Dental Treatment Services Scheme

This scheme allows eligible GMS persons to avail of dental treatments and clinical procedures, such as routine treatments (are available to all eligible persons) and full upper and lower dentures. Dental treatments include a free oral examination every calender year, free emergency dental treatment, two fillings per annum and all extractions. Dentists may also prescribe medicines as well as treat eligible persons, (Gorecki et al., 2012).

Primary Childhood Immunisation Scheme

The national primary childhood immunisation scheme aims to eliminate, as far as possible, conditions such as Diphtheria, Polio, Measles, Mumps, Rubella and Meningococcal C Menigitis by immunising the total child population, (Gorecki et al., 2012).

HSE Community Ophthalmic Services Scheme

This scheme entitles medical card holders and their dependents free eye examinations and spectacles/appliances, (PCRS, 2012).

These community drug schemes (EEA scheme, Health (Amendment) Act 1996, Methadone Treatment Scheme, DTSS prescriptions and Pharmacy Training Grants, payments to dentists and optometrists) accounted for €93.62 million in 2007 (PCRS, 2007) and €110.73 million in 2012 (PCRS, 2012), this represents a 18.28% increase. The PCRS also reimburse immunisations (Pneumococcal, Influenza, Hepatitis B and the combined Pneumococcal/Influenza) for GMS eligible persons, as specified under an agreement, between the Department of Health and the Irish Medical Organisation, (PCRS, 2012).

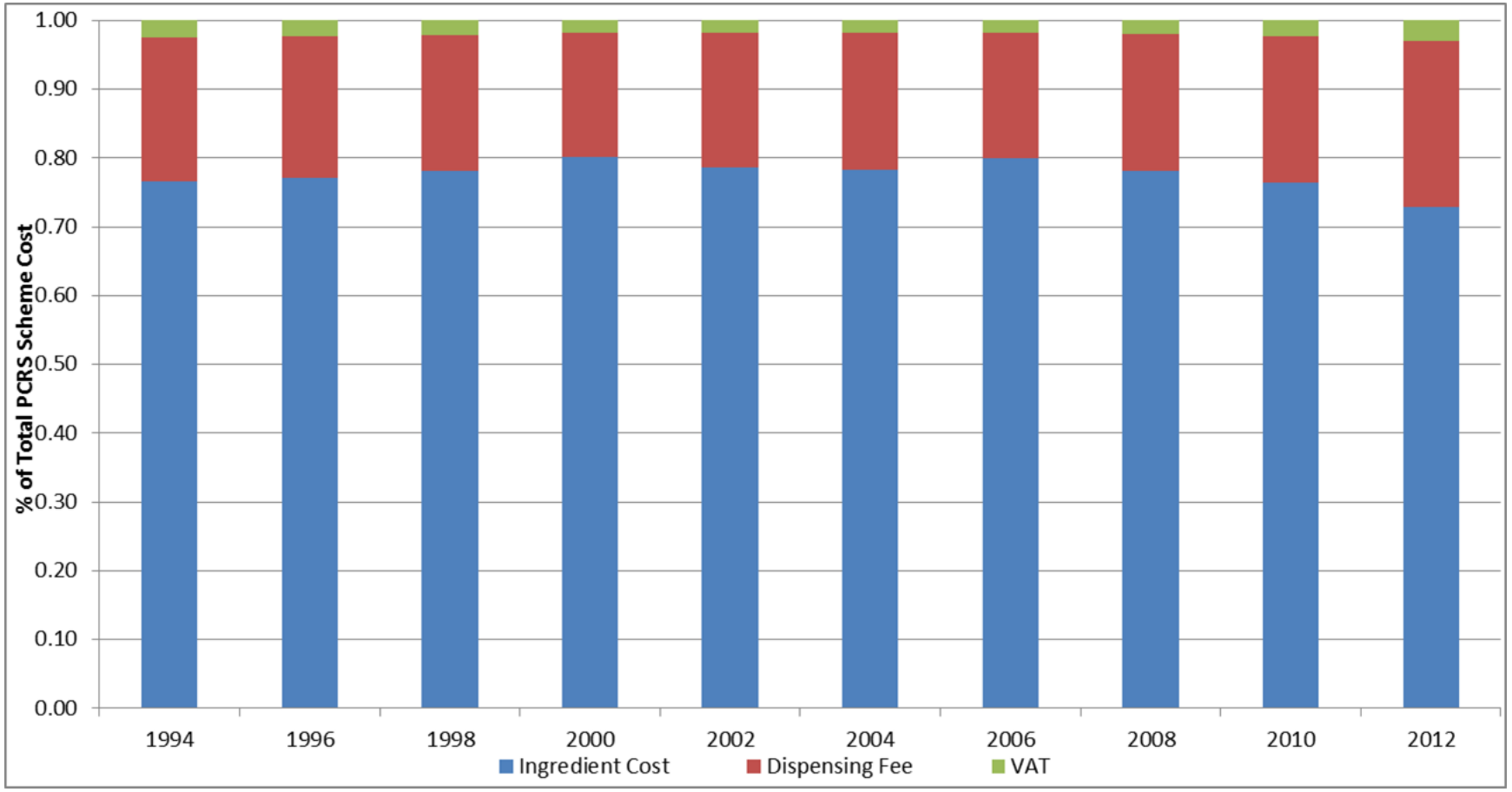
Breakdown of Payments to Community Pharmacists under State Schemes

A payment to a Pharmacist consists of the ingredient cost of the drug, pharmacy dispensing fee and VAT under the GMS and DTSS schemes. VAT is levied at 0 per cent on oral pharmaceuticals and at the standard rate (23 per cent as of 1st January 2012) on other pharmaceuticals. Pharmacies are reimbursed the ingredient cost of items dispensed, dispensing fees, mark–up and VAT under the DPS, LTI and EEA schemes.

The ingredient cost of a drug comprises of the ex–factory price and the wholesale mark-up. It can also include retail mark–up depending on the state scheme. The ex–factory price is agreed between the state and the representative body of drug manufacturers and importers. The ex–factory price is set with reference to the currency adjusted average price to the wholesaler in nine nominated EU member states (Belgium, Denmark, France, Germany, Netherlands, Spain, UK, Finland and Austria), (IPHA, 2012). The wholesale mark–up is 12% for fridge items and 8% for any other drug items. Wholesale mark–up was reduced from 17.66% in March 2008 to 8% in June 2011. Pharmacists receive a 20% retail mark–up on items dispensed under the LTI and DPS schemes. In July 2009, pharmacy retail mark–up was reduced from 50% to 20%. No retail mark–up is applied to items dispensed under the GMS scheme, (Gorecki et al., 2012). The dispensing fee varies between €3.50 and €5.00 for the GMS, DPS, LTI, EEA and HAA (1996) schemes. The pharmacy receives €5.00 for each of the first

1,667 items dispensed, €4.50 for each of the next 833 items dispensed and €3.50 for each other item dispensed in that month, (Government of Ireland, 2011). Figure 2.5 disaggregates the payment to Pharmacists by ingredient cost, dispensing fee and VAT.

Figure 2.5: **Proportion of Payments to Pharmacists, 1994–2012**



Source: (**Various PCRS Reports 1994–2012**)

Ingredient cost increased from €85 million (77%) in 1994 to €743 million (80%) in 2006 and €932 million (73%) in 2012. The ingredient cost proportion of prescriptions is declining since 2007. The dispensing fee, as a proportion of the total cost of prescriptions has increased from €23 million (21%) in 1994 to €309 million (24%) in 2012. The dispensing fee proportion fluctuated between 1994 and 2008, but has increased thereafter. This increase may be explained by a change in dispensing fee structure. Pharmacists were paid €3.60 per item up to 2008. This changed in 2009 when a sliding fee structure (€3.50–€5.00) was introduced, (Gorecki et al., 2012). VAT as a proportion of total cost of prescriptions has remained constant at 2% between 1994 to 2010, but increased slightly to 3% in 2011 and 2012 respectively. This may be explained by the VAT increase from 21% to 23% on the 1st of January 2012.

This thesis will focus on one community drug scheme only, the GMS scheme. The GMS scheme is the largest of the community drug schemes, where approximately 40% of the Irish population were eligible in 2012. The GMS scheme accounted for approximately 66% of payments to pharmacists for community drug expenditure in 2012, up from 60% in 2007.

2.6 Methodologies

The purpose of this section is to review the literature and identify empirical methods on pharmaceutical cost projections. This section will inform the modelling of pharmaceutical cost projections in chapters 3 and 4 and modelling the factors that influence GMS prescribing expenditure in Chapter 5.

2.6.1 Predictive Modelling

Predictive modelling uses a statistical model to predict furture outcomes. Modelling health and drug expenditure projections varies considerably internationally. In Spain,

(Calderon-Larranaga et al., 2010) applied diagnosis and pharmacy based risk models to predict drug use and found predictive models based on pharmacy data had a higher capacity to predict pharmacy costs than models based on diagnostic data. A number of predictive studies have been undertaken in the United States (US) on future health care costs, which inform future prescribing costs, (Zhao et al., 2005), (Wrobel et al., 2004), and (Sales et al., 2003). (Zhao et al., 2005) also found that drug based models using (Ordinary Least Squares (OLS) Regression) are superior in predicting pharmacy costs compared to diagnosis models. These studies predicted drug expenditures for the Medicare scheme (Wrobel et al., 2004) and a veteran health population (Sales et al., 2003), respectively, and their models included demographic and health status variables. (Sales et al., 2003) predicted drug costs in the US using a pharmacy based measure of risk adjustment. Both studies found combined drug and diagnostic data are superior in predicting total health care costs. (Powers et al., 2005) compared cost modelling approaches for predictive modelling of healthcare and pharmacy costs. They found pharmacy claims data used with a simple OLS model provides similar predictive accuracy than more advanced econometric models.

A number of studies on drug expenditure projections have been carried out in the United States, (Hoffman et al., 2013), (Shah et al., 2003) and (Burner and Waldo, 1995). Projections were primarily based on historical trends in health expenditure, (Cuckler et al., 2013), (Keehan et al., 2012) and (Sisko et al., 2014). The three studies estimated national health expenditure based on assumptions around economic (varying levels of economic growth) and demographic variables for a 10 year period. (Cuckler et al., 2013) estimated that health spending will grow on average by 5.8% annually to $2.4 trillion between 2012 and 2022 based on a sluggish economic recovery in 2013, coupled with an expansion in coverage due to the Affordable Care Act and an aging population. (Schumock et al., 2015) developed projections on drug expenditure and incorporated historical trends in drug expenditure and expected changes in the drugs market that may influence drug expenditure in 2015. They projected 12% to 14% increases in total drug expenditures in clinics, and 5% to 7% increases in hospitals. Health care and drug

expenditure projections are based on a particular set of assumptions, which may or may not be true. (Van Vliet, 1992) argues 80% of the variation in individual annual health care expenditures is "fundamentally unpredictable" and variation in older persons is more predictable than for younger persons.

(O'Neill et al., 2013) highlights the limited amount of literature for drug expenditure projections. They put forward two approaches for drug expenditure projections. The first method is a top down approach, based on assumptions around macroeconomic variables, such as GDP and demography. The second method is a bottom up approach, based on quantities and prices of drugs and future developments that will affect these. The NHS study projected drug expenditure between 2012 and 2015 taking account of both demand and supply factors, with specific focus on supply factors. This study projected the total UK medicines bill to increase between 3.1% and 4.1% between 2011 and 2015, based on three scenarios and certain assumptions, (O'Neill et al., 2013). (Thiébaut et al., 2013) forecast French national drug expenditure based on demographic and epidemiological (chronic illness) factors out to 2029. They used a Markovian micro–simulation model based on a representative sample of 10,328 observations.

They found that drug expenditure will increase annually by between 1.1% and 1.8% for the over 25s, they attribute the increase to the aging population and changes in health status. (Wettermark et al., 2010) forecast drug expenditure in the region of Stockholm, Sweden over a two year period, 2010–2011. They used a linear regression analysis and applied it to historical drug sales between 2006 to 2009. They predicted drug expenditure (ambulatory and hospital) would increase by 2% in 2010 and 4% in 2011 and their model would act as an "early warning system".

2.6.2 Monte Carlo Method

The Monte Carlo method is a statistical sampling technique invented by Stanislaw Ulam during World War II in 1946. He was working on the US Manhattan project with John Von Neumann. Ulam was contemplating the probabilities of winning a card game of Solitaire, when he developed the Monte Carlo Method. In 1949, the Monte Carlo method was first published in the journal of the American Statistical Association, (Metropolis and Ulam, 1949). Monte Carlo simulation (MCS) is based on running a computer algorithm a number of times and drawing on random numbers, using random number generators. MCS is based on repeatedly sampling from a chance process and random numbers can be generated through Microsoft Excel. The excel number generator simulates a uniform (0,1) distribution, where every number between 0 and 1 are likely to be selected. The distribution of results may be examined visually through histograms, (Barreto, 2006).

MCS is becoming more popular across a number of different fields and is widely used in economic evaluations of pharmaceuticals and other healthcare technologies to aid decision making, (Weinstein et al., 2003). This paper also states a study based on good modelling makes all the assumptions explicit and transparent and clearly indicates all results are conditional on assumptions made. (O'Kelly et al., 2012) produced a white paper on lifecycle modelling and simulation. They suggested that simulation methods like Monte Carlo are advancing fields such as Physics, Chemistry and Economics and there is a need for modelling and simulation to improve drug development. They suggest that full exploitation of computational models could reduce the expenditure on drug development by as much as 50%.

The objective of a model is to inform decision making and allocation of health care resources. Model based analysis generate specific estimates or outcomes and modelers have a responsibility to report uncertainty around these outcomes, (Briggs et al., 2012).

Drug utilisation and expenditure is difficult to forecast due to a number of uncertainties. These uncertainties include the rate of adoption of new medicines, various ongoing health care reforms, and activities to improve the quality and efficiency of prescribing. MCS is a numerical model that employs statistical sampling to forecast under uncertainty. (Briggs et al., 2012) differentiates between four types of uncertainty associated with decision modeling; Stochastic uncertainty, parameter uncertainty, heterogeneity and structural uncertainty. Stochastic uncertainty (first order uncertainty) refers to the random variability in outcomes between patients. Parameter uncertainty (second order uncertainty) is characterised by the uncertainty in the estimation of the parameter. Heterogeneity refers to the variability between patients due to different attributes (age, gender) of those patients. Structural uncertainty can be underlied by the assumptions of the model.

The Monte Carlo model is an appropriate model to use when there is uncertainty around the input parameters. Parameter uncertainty refers to the accuracy of an input parameter estimation. Imprecision in parameters can arise due to limited knowledge and evidence. A probability distribution is used to characterise the uncertainty in input parameters (O'Hagan et al., 2005). The uncertainty can be generated through MCS to determine uncertainty in the model output. (O'Hagan et al., 2005) refer to this process, as Probability Sensitivity Analysis (PSA). (Briggs et al., 2012) argue that parameter uncertainty may be represented by PSA or Deterministic Sensitivity Analysis (DSA).

PSA addresses joint uncertainty through probability distributions in input parameters. There are three features of a PSA: characterising uncertainty in input parameters, propagate parameter uncertainty through the model using MCS and reporting the implications of parameter uncertainty (Briggs et al., 2006). "In a DSA, parameter values are varied manually to test the sensitivity of the model's results to specific parameters or sets of parameters", (Briggs et al., 2012, 837). (Briggs et al., 2012) argue PSA is a preferable method of addressing uncertainty in input parameters. Probability distributions are applied to input parameters to characterise the uncertainty. Probability

distributions such as Normal, Binomial, Poisson, Beta distributions etc. (Sugiyama, 2007) highlighted the importance of assigning an appropriate probability distribution to uncertain variables in developing a comprehensive MCS model. MCS is used to propagate the parameter uncertainty through a set number of iterations, for example, 100,000 iterations. This entails a random draw from each uncertain input parameter. This will generate 100,000 expected costs for each age cohort, region and gender (O'Hagan et al., 2005). (Briggs et al., 2012) suggests that a tornado diagram is an appropriate way of presenting PSA. The model outcome is displayed along the horizonatal axis and the model parameters along the vertical axis. The longest bar on the top of the tornado diagram reflects the parameter with the widest uncertainty and the other bars are displayed in descending order of length.

Decision analytical modelling is used to complement cost effectiveness analysis/evaluations. Quantitative methods are employed to examine the clinical, epidemiological and economic evidence base of the technology/decision under review. This generates a specific outcome and reports the uncertainty surrounding this outcome and informs health decisions, (Briggs et al., 2012). The benefit of such a model is that it allows "what if" scenarios to explore the sensitivity of projections to changes in variables. (Nuijten, 2004) identified and evaluated statistical uncertainty and the negligence of statistical uncertainty in modelling studies. This study found a health economic model might be severely biased if statistical uncertainty is not taken into account. An MCS model was deemed an appropriate methodology to use for this research, given the uncertainty around the input parameters. This research is not focused on decision analytical modelling for health economic evaluations. MCS model was adopted to forecast GMS costs through to 2026 and inform future health policy. This methodology was applied to journal papers 1 and 3.

2.6.3 Modelling variation in Pharmaceutical Expenditure

This section aims to explore the various methodologies used to model the variation in pharmaceutical expenditure. The literature will inform modelling the factors that influence GMS drug expenditure in Ireland, which will be investigated in chapter 5.

A number of studies use OLS regression to model the variation in pharmaceutical drug expenditure. Other models that are used include logistic regression, mixed model, tobit model and poisson regression models. (Aguado et al., 2008) modelled the variability in prescription drug expenditure using a two part model in a Catalonian population. The first part was a logistic regression which was applied to predict the incurrence of drug expenditure and the second part used a linear mixed model. The proportion of variance of the incurrence of expenditure explained by Adjusted Clinical Groups (ACG[12]) was 0.29 in adults and 0.21 in children. ACGs explained 35.4% of cost in adults and 22.4% in children. A Catalonian study used a Tobit and OLS model to explain drug expenditures, (García-Goñi and Ibern, 2008).

An Italian study investigated the physician and patient characteristics associated with prescription costs. They ran poisson regression models to estimate the incidence rate ratio (IRR) of prevalence. The IRR assessed the prevalence of using drugs by gender and geographical area. Linear regression models were performed to test the possible association between average drug expenditure and physicians characteristics. They found that age was a predicitive factor in drug expenditure and it was significantly higher for females. They also found that physician prescribing decisions are influenced by a myriad of external factors, (Orzella et al., 2010).

[12]The Adjusted Clinical Group (ACG) estimates individual health status and risk for health services use based on age, gender and diagnoses assigned over a specific time period, usually a year, (Aguado et al., 2008).

(Fernández-Liz et al., 2008) ran a multivariable regression analysis to investigate the association between the average cost per patient, age and gender. Expenditure per patient was observed to increase with age. Patients in the 65–74, 75–84 and over 85 age cohorts were 16.1, 19.7 and 18.8 times higher than those in the reference age cohort (0–4). They found gender had no statistical significant difference between males and females. A Spanish study used an OLS model (4 variants) to explain the variation in pharmacy expenditure. The dependent variable was total pharmacy cost per person and independent variables included both demographic variables and chronic conditions. The fourth model explained 57% (R^2=0.57) of the variation in total pharmacy cost, (Vivas et al., 2011).

A study in Uganda identified predictors of pharmaceutical expenditure to aid budget decisions and allocations. The dependent variable had four different specifications; total pharmaceutical expenditure, per capita district pharmaceutical expenditure, pharmaceutical expenditure per district health facility and pharmaceutical expenditure per outpatient department visit. The study used the Andersens behaviour model of health services utilisation to identify independent variables likely to influence health care utilisation and pharmaceutical expenditure. They used OLS to estimate the parameters and the models had explanatory power ranging from 51% to 82%. The log–linear model explained approximately 79% (R^2=0.79) of the variation in the logarithm of total pharmaceutical expenditure among the study districts, (Mujasi and Puig-Junoy, 2015).

A more recent Spanish study used linear regression models (2) to explain pharmaceutical expenditure in primary health care. The models were estimated using OLS and both models had a similar level of explanatory power, 52.5% (model 1) and 47.5% (model 2), (Vivas-Consuelo et al., 2014). Three American studies used OLS regression models to examine the predictability of drug expenditure, (Wrobel et al., 2004), (Zhao et al., 2005) and (Powers et al., 2005). (Wrobel et al., 2004) examined the predictability of drug expenditures (6 models) for the Medicare population, using 2000 data. Their key finding suggested it was possible to predict approximately 23% of the

variation in Medicare drug expenditures using a prospective model, that included basic demographic characteristics and health status measures. Demographic variables only explained 5% of the variation in pharmaceutical expenditure.

(Zhao et al., 2005) compared the predictive performance of three models and found a model containing both drug and diagnostic data predicted health costs better (R^2=0.168) than a model including either type of data alone. This study used weighted OLS estimates. (Powers et al., 2005) compared alternative econometric cost modeling techniques to model healthcare costs using pharmacy claims data. Models examined included OLS regression, Log–transformed OLS regression with smearing estimator and 3 two–part models using OLS regression, Log–OLS regression with smearing estimator, and generalised linear modeling. They found a simple OLS model may provide similar predictive accuracy to more advanced econometric models. An OLS model including age, gender and annual pharmacy cost had higher explanatory power (R^2=0.089) than the other models.

2.6.4 Regression modelling and Ordinary Least Squares

A linear model is used to summarise the relationship between two variables, $\boldsymbol{\beta_1}$ informs the model shape (slope) and $\boldsymbol{\beta_0}$ informs the location (intercept) of the model, as summarised in Equation 2.1. The model predicts values on the outcome (dependent) variable from the predictor (independent) variable. This is known as a simple regression.

$$\boldsymbol{Y_i} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 X_i} + \boldsymbol{\epsilon_i} \tag{2.1}$$

$\boldsymbol{Y_i}$ = Outcome variable

$\boldsymbol{\beta_0}$ = Y intercept

$\boldsymbol{\beta_1}$ = Parameter

$\boldsymbol{X_1}$ = Predictor variable

$\boldsymbol{e_i}$ = error term

A multiple regression model consists of a number of predictor (independent) variables, as detailed in Equation 2.2, (Field, 2012).

$$\boldsymbol{Y_i = \beta_0 + \beta_1 X_i + \beta_2 X_i + \beta_n X_n i + \epsilon_i} \tag{2.2}$$

$\boldsymbol{Y_i}$ = Outcome variable

$\boldsymbol{\beta_0}$ = Y intercept

$\boldsymbol{\beta_1}$ = Parameter

$\boldsymbol{X_1}$ = Predictor variable

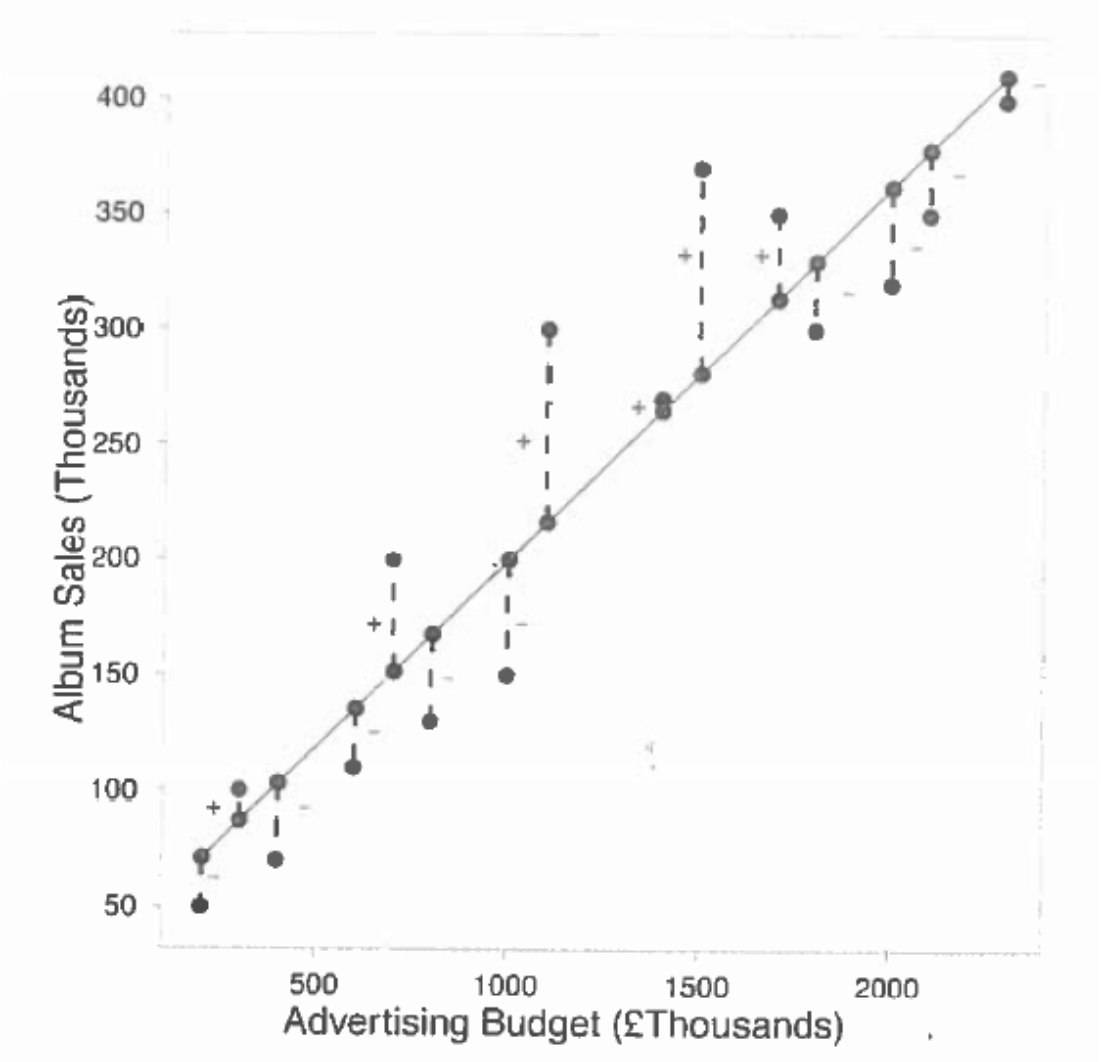
$\boldsymbol{X_2}$ = Another predictor variable

$\boldsymbol{X_n}$ = nth predictor variable

$\boldsymbol{e_i}$ = error term

OLS is used to estimate the parameters (B-values) associated with each predictor variable. OLS is a mathematical regression technique, in which the parameters of the model are estimated using the method of least squares. The (B-values) describe the model that minimises the sum of squared differences. The differences between what the model predicts (predicted values) and the observed values is known as residuals. The residuals are the vertical distances between what the model predicted and the observed data. Residuals can be visualised by plotting an outcome and predictor variable on a scatterplot. Figure 2.6 illustrates the linear trend between two variables, album sales (dependent variable) and advertising budget (independent variable). The vertical dotted lines represent the residuals, the differences between the trend line and actual data. Residuals can be positive or negative, when they are squared, it cancels out the negatives. The sum of squared residuals ($\mathrm{SS}_{\boldsymbol{R}}$) assesses the error in the model. The $\mathrm{SS}_{\boldsymbol{R}}$ determines how well a certain line fits the data. If the squared differences are large, the line is not representative of the data and if the squared differences are small, the line is representative of the data. The OLS model is used to estimate the B-values, that explains the regression model, that best fits the data, (Field, 2012).

Figure 2.6: **Scatterplot of an Outcome Variable and Predictor Variable**



Source:(Field, 2012)

Following a review of the literature and expert opinion, the Monte Carlo (Chapter 3 & 4) and OLS regression (Chapter 5) models were deemed the most appropriate models to use. Expert[13] opinion on the Monte Carlo model was sought from a statistician in Darmstadt University, Germany and expert opinion on the OLS regression model was sought from a statistician in University College Cork, Ireland.

2.7 Conclusion

This chapter examined the pharmaceutical cost containment measures from both a global and domestic level. (Sood et al., 2009) examined the effect pharmaceutical revenue had on 19 OECD countries and found that direct price controls and economic evaluation were more successful in reducing pharmaceutical expenditure than other regulations. A number of pharmaceutical cost containment measures have been introduced in Ireland and (Walshe and Kenneally, 2013) found that cost containment measures (on pricing, mark–up, dispensing fees, restrictions to eligibility and co–payments) led to estimated savings of €380 million in 2011. The literature has identified the key factors driving pharmaceutical expenditure. Previous results indicate that we can expect that age, gender and geographical location will be influential in contributing to pharmaceutical expenditure.

The literature has shown that very little research has been carried out on pharmaceutical cost projections in Ireland, (Bennett et al., 2009) and (Heaney et al., 2009). The main contribution of this thesis will include pharmaceutical cost projections for the GMS scheme in Ireland. The CSO has been the main source of population projections for many researchers, albeit some adjustments have been made to CSO data. This thesis will use CSO population projections and make the necessary adjustments to regions and age to match the structure of the health dispensing data. The literature identifies the 11 community drug schemes in Ireland. This thesis is focusing on the

[13]I consulted an experienced statistician for both the Monte Carlo Method and the OLS regression and we teased out the appropriate model to use, given the data available.

largest community drug scheme, the GMS scheme. Overall GMS payments (including GP & Pharmacy) increased from €414 million in 1998 to €1.73 billion in 2012, a 318% increase. This increase has mainly been driven by the increase in the payments to pharmacists. In modelling pharmaceutical cost projections, the literature identifies various modelling approaches. This thesis focused on the Monte Carlo method following a review of the literature and discussions with with my supervisor and a statistician.

This study is located in the area of pharmacoeconomic cost containment and projections literature. A review of the literature identified the methodologies used to explain the factors influencing drug expenditure. Numerous studies have used an OLS regression to model drug expenditure variation. An OLS regression model was adopted to model the factors influencing Irish pharmaceutical expenditure. The literature review has provided the theoretical background, methodological foundation and expected results for this thesis. The next chapter uses the Monte Carlo method to project GMS expenditure in five year intervals to 2026.

Chapter 3

Implications of Regional and National Demographic Projections for future GMS costs in Ireland through to 2026 (2007 data)

3.1 Introduction

Expenditure on pharmaceuticals is one of the fastest growing elements of total health spending within the EU. Pharmaceutical expenditure within the EU exceeded €180 billion in 2008 and accounted, on average, for approximately 17 per cent of EU countries total expenditure on health, (Walshe and Kenneally, 2013). In 2009, Ireland had one of the highest pharmaceutical spends per capita of the OECD countries after the US, Canada and Greece, (Gorecki et al., 2012). In Ireland, pharmaceutical expenditure accounted for 16.9 per cent of total health expenditure in 2007 and pharmaceutical spend per capita was $602.6 and peaked at 17.9 per cent and $677 in 2010, (OECD, 2013). The four most expensive CDS schemes in Ireland accounted for approximately

85 per cent of total drug expenditure in Ireland in 2007, (OECD, 2013). The annual cost of medicines under community drug schemes in Ireland increased from €564m in 2000 to €1,961m in 2009, before falling by an estimated 8 per cent by 2011 following a series of cost containment measures, (Walshe and Kenneally, 2013). Following a sharp contraction in the Irish economy in 2008, resulting in mounting fiscal deficits, the sustainability of funding these community drug schemes have come under the spotlight of the EU, IMF and ECB (Troika) who have set stringent targets for reducing drug costs as conditions of the bailout[1] programme. Whilst the Troikas' main cost containment measure is on the substitution from proprietary to generic prescribing, the challenge for Ireland and many of our EU counterparts in containing expenditure on pharmaceuticals is severely restricted by the growth in the elderly component of our populations, the sub–group with the greatest consumption of prescribed drugs.

This chapter projects regional and national demographic projections and its implications on GMS costs for 2016, 2021 and 2026. It aims to project the cost implications of future changes in population (section 3.2), GMS coverage (section 3.3), average cost per claimant (section 3.4) and claims rate (section 3.5) on GMS costs. The data used for the analysis is based on a PCRS sample (n=192,000) for 2007. The cost projection model is explained in section 3.6. To address the uncertainty around projections, the most likely (mean) scenario and a high (maximum) and low (minimum) scenario were modelled. MCS model will be employed to forecast GMS costs through to 2026 in section 3.7. MCS is a numerical model that employs statistical sampling to forecast under uncertainty. The results are detailed in section 3.8 and discussed in section 3.9. Conclusions are summarised in section 3.10.

[1]Ireland received €85 billion of financial aid as part of the EU–IMF programme, of which €17.5 billion came from the national pension reserve fund and other domestic cash resources. €50 billion was allocated to the day-to-day running of the state and €35 billion to the banking system, (Oireachtas, 2010).

3.2 Population

The principal data source is the CSO Regional Population Projections 2011–2026, which will project both regional and national demographics. The CSO incorporated three assumptions into their projections; mortality, fertility and international migration. The CSO determined six scenarios for the national projections; M1F1, M1F2, M2F1, M2F2, M0F1 and M0F2. The CSO only considered two of these for regional population projections; M2F1 and M0F1. The regional projections were classified by year of age, gender and region. M2 represents continuing but declining international migration, whereas M0 sets net international migration to a value of zero. F1 represents the fertility assumption. Fertility is the number of births as a function of the number of women of child bearing age (15–49). The CSO focused on the age group (20–39), as 90% of births are borne to women of this age. F1 represents assumes the Total Fertility Rate (TFR[2]) will remain constant (TFR =1.9) at the 2006 level for the lifetime of the population projections, (CSO, 2008).

The national assumptions around mortality were applied uniformly across all regions. Mortality will decrease in line with increases in life expectancy. For males, life expectancy will increase by 7.6 years from 76.7 years in 2006 to 84.3 years in 2026. For females, life expectancy will increase by 4.8 years from 81.5 years in 2006 to 86.3 years in 2026. The CSO made assumptions around internal migration, using a recent[3] and traditional[4] scenario based on inter–regional flows. The M2F1 traditional scenario (M2F1T) was the principal scenario used in the CSO projections, (CSO, 2008). Hence this scenario was adopted as the central scenario for population projections for this thesis. The M2 scenario was also used by (Layte et al., 2009, 10), in projecting population to 2021; they described it as a more "plausible" migration outcome.

[2]TFR is defined as the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age–specific fertility rates, (The World Bank, 2015).

[3]Recent Scenario: The pattern of inter–regional flows observed in the year to April 2006 is applied up to 2026, (CSO, 2008).

[4]Traditional Scenario: The 1996 pattern of inter–regional flows is applied in 2016 and kept constant thereafter, with the difference between the 2006 and 1996 patterns apportioned over the years between 2006 and 2016, (CSO, 2008).

(Morgenroth, 2009) utilised the M2 scenario as its principal scenario for population projections.

3.2.1 Age and Region Adjustments

The CSO population data was reconciled to conform to the HSE old health board regions and age cohorts.

Age Adjustment

The CSO data was detailed by year of age, gender, county and region. In order to conform to HSE age cohorts, the CSO data was reconciled into eleven age cohorts, as detailed in Table 3.1.

Table 3.1: **HSE Age Classifications**

Age Category
< 5
5–11
12–15
16–24
25–34
35–44
45–54
55–64
65–69
70–74
> 75

Source: (**PCRS**, 2007)

Regional Adjustments

The CSO[5] and HSE[6] regional composition is comparable for five out of the eight regions. The HSE Eastern, North–Eastern and North–Western regions are not comparable with the CSO Border, Dublin and Mid–East regions. Adjustments were made to the CSO data to correlate with the three HSE regions using the 2006 Census. Population data was ascertained from the 2006 Census for males, females and total for all the

[5]See Appendix A Table A.1 for details of composition of the CSO regions.
[6]See Appendix A Table A.2 for details of composition of the HSE regions.

counties affected in these 3 regions, (CSO, 2007).

Eastern Region

The CSO Dublin and Mid–East 2007 data were combined and classified by the HSE age cohorts and gender. This region is comparable with the HSE Eastern region except for County Meath. An adjustment factor for males and females was established based on the 2006 Census, which details population by county, age and gender. The adjustment factor for County Meath[7] was established as a proportion of the Eastern region (Dublin, Meath, Kildare and Wicklow) 2006 data. The adjustment factor was applied to the Eastern region[8] 2007 data and it established estimated population data for County Meath. In order to conform to the HSE Eastern region; Dublin, Kildare and Wicklow were aggregated and Meath 2007 data was removed. The above method was applied for the estimated population for the Eastern region for 2011 and the population projections for 2016, 2021 and 2026 using the 2006 adjustment factor.

North–Eastern and North–Western Regions

The CSO Border region 2007 data was classified by the HSE age cohorts and gender. This region is comparable with the HSE North–Eastern region with the addition of county Meath and the North–Western region. An adjustment factor[9] for males and females was established for all counties in the border region based on the 2006 Census, which details population by county, age and gender. The adjustment factor for each county was established as a proportion of the Border region (Cavan, Donegal, Leitrim, Louth, Monaghan and Sligo) 2006 data. The adjustment factor was applied to the Border region 2007 data and it established estimated population data for each county. Cavan, Louth, Meath and Monaghan were aggregated for 2007 to form the North–Eastern region[10]. Donegal, Leitrim and Sligo were aggregated for 2007 to form the North–Western region[11]. The above method was applied for the estimated population

[7]See Appendix A Table A.3 for the Meath adjustment factor.
[8]See Appendix A Table A.4 for the Eastern region population estimates for 2007.
[9]See Appendix A Table A.5 for the North–Eastern and North–Western adjustment factors.
[10]See Appendix A Table A.11 for the North–Eastern region population estimates for 2007.
[11]See Appendix A Table A.12 for the North–Western region population estimatess for 2007.

for the North–Eastern and North–Western regions for 2011 and population projections for 2016, 2021 and 2026 using the 2006 adjustment factors.

Population

The total population for 2007[12] was calculated by age cohort and gender. Three scenarios minimum, mean and maximum were developed. The most likely scenario (mean) is the primary scenario used in the CSO projections; M2F1T. The lower bound scenario is M0F1T and the upper bound scenario is the difference between the lower bound and the most likely scenario, as detailed in Table 3.2. The CSO MOF1T scenario sets international migration (M0) to zero, using fertility rates (F1) and internal migration (traditional) as explained earlier. The three scenarios detailed in Table 3.2 were applied to the population data for each of the five years[13]. The CSO lower bound scenario represents an increase in population of 9.03% between 2002 and 2007, 3.54% between 2007 and 2011, 4.23% between 2011 and 2016, 3.41% between 2016 and 2021 and 2.48% increase between 2021 and 2026[14].

[12]See Appendix A Table A.13 for the total population 2007 by age cohort and gender.
[13]See Appendix A Table A.14 for 2011, 2016, 2021 and 2026 population projections.
[14]See Appendix A Table A.18 for detailed breakdown of population scenarios.

Table 3.2: **Population Scenarios 2007–2026**

Scenarios	Population Growth Rate (%)
Scenario 1	**Minimum (Lower Bound)**
2007	9.03
2011	3.54
2016	4.23
2021	3.41
2026	2.48
Scenario 2	**Mean (Most Likely)**
2007	10.30
2011	8.45
2016	8.73
2021	6.99
2026	4.49
Scenario 3	**Maximum (Upper Bound)**
2007	11.58
2011	13.35
2016	13.24
2021	10.57
2026	6.51

3.3 GMS Medical Card Coverage

GMS coverage refers to the population proportion who are eligible for the GMS scheme. The main source of GMS coverage data is the PCRS Statistical Analysis of Claims and Payments, Annual Reports. The PCRS published a report in 2007 detailing the number of persons eligible for the GMS medical card by age cohort, gender and region. The PCRS report states that 28.85 per cent of the population (1,221,695 persons) were eligible for the medical card in 2006, whereas 30.10 per cent (1,276,178 persons) were eligible in 2007. Table 3.3 details the population proportion who were eligible for the medical card by age, gender and region in 2007. The total number of eligible persons are expressed as a proportion of the population (Equation 3.1). In 2007, everyone over the age of 70 was eligible for a medical card, therefore ten age cohorts are presented.

$$\textbf{GMS Coverage} = \frac{\textbf{Number of GMS Persons}}{\textbf{Population}} \tag{3.1}$$

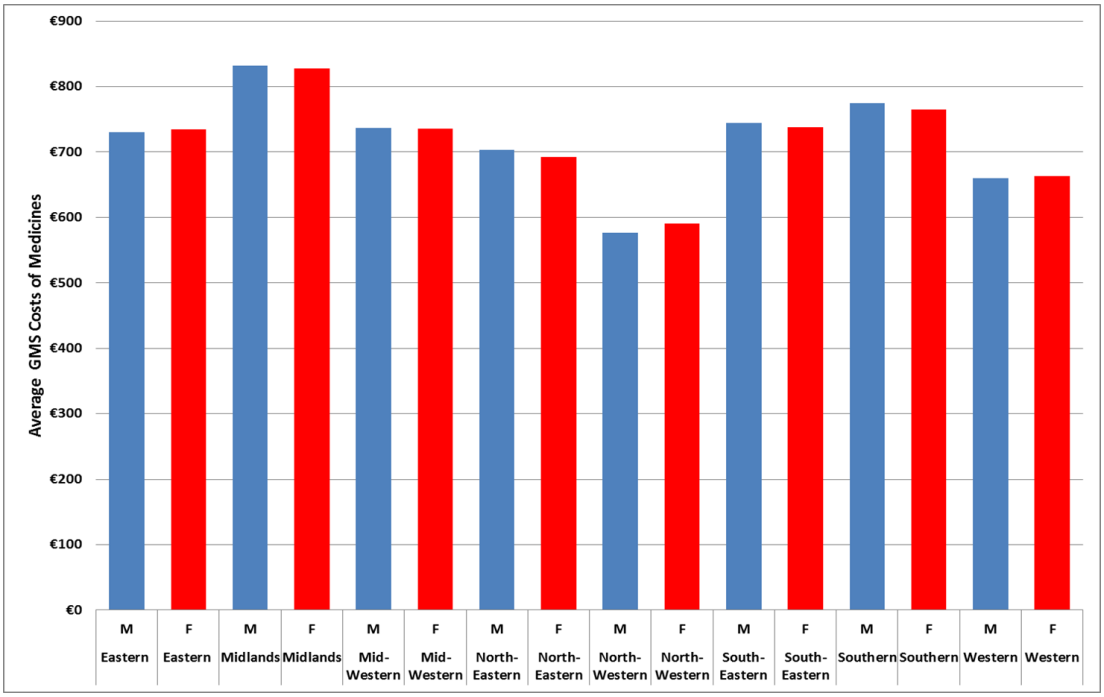
Table 3.3: **Population Proportion with GMS card in 2007**

Region	**0–5**	**5–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	>70
Eastern										
Males	0.26	0.30	**0.26**	**0.10**	**0.08**	**0.13**	**0.14**	**0.20**	**0.34**	1.00
Females	0.26	0.30	**0.26**	**0.16**	**0.15**	**0.18**	**0.17**	**0.25**	**0.43**	1.00
Midlands										
Males	0.28	0.31	0.30	0.16	0.12	0.17	0.19	0.29	0.45	1.00
Females	0.29	0.32	0.31	0.24	0.22	0.23	0.23	0.36	0.56	1.00
Mid–Western										
Males	0.29	0.33	0.29	0.18	0.14	0.19	0.20	0.30	0.47	1.00
Females	0.30	0.32	0.31	0.25	0.24	0.24	0.24	0.36	0.55	1.00
North–Eastern										
Males	**0.24**	**0.28**	0.26	0.15	0.11	0.15	0.18	0.28	0.43	1.00
Females	**0.24**	**0.28**	0.27	0.23	0.19	0.20	0.21	0.34	0.54	1.00
North–Western										
Males	**0.41**	**0.44**	**0.42**	**0.28**	**0.23**	**0.30**	**0.32**	**0.43**	**0.62**	1.00
Females	**0.39**	**0.43**	**0.42**	**0.38**	**0.34**	**0.35**	**0.35**	**0.48**	**0.66**	1.00
South–Eastern										
Males	0.30	0.32	0.30	0.18	0.15	0.18	0.21	0.32	0.49	1.00
Females	0.29	0.32	0.30	0.27	0.25	0.24	0.25	0.39	0.60	1.00
Southern										
Males	0.28	0.29	0.27	0.15	0.13	0.17	0.20	0.30	0.47	1.00
Females	0.28	0.28	0.26	0.21	0.21	0.22	0.23	0.36	0.57	1.00
Western										
Males	0.31	0.34	0.33	0.19	0.14	0.21	0.25	0.37	0.53	1.00
Females	0.30	0.34	0.33	0.26	0.22	0.26	0.27	0.40	0.63	1.00

Table 3.3 highlights the regions with the lowest and highest coverage rates. The North–Eastern region had the lowest male and female GMS coverage in the <5 and 5–11 age cohorts. The Eastern region has the lowest male and female GMS coverage in the seven age cohorts up to 70 years. However, the North–Western region has the highest male and female GMS coverage in the nine age cohorts. The Eastern region had the lowest number of persons eligible for the GMS scheme with 24.08 per cent in 2006 and 24.87 per cent in 2007. In contrast, the North–Western region had the highest number of persons eligible for the GMS scheme with 43.38 per cent in 2006 and 44.48 per cent in 2007, (PCRS, 2007, 43).

The PCRS report also details the percentage of the population who were eligible for the GMS scheme by age cohort, gender and county in 2006[15] and 2007. Meath (19.97%) and Kildare (23.43%) had the lowest number of persons eligible in 2006 and 2007 and Donegal had the highest number of persons eligible with 48.35 per cent in 2006 and 49.29 per cent in 2007, (PCRS, 2007, 43). In recent PCRS reports (2009–2011), the HSE region classifications are not comparable to the 2007 region classifications for GMS eligibility[16]. There are eight HSE regions in the PCRS 2007 report but there are four HSE regional classifications in the 2009 report and subsequent reports. Therefore, no comparisons on eligibility for the GMS scheme were made due to regional classification differences. Figure 3.1 illustrates for both males and females, the Midlands is the most expensive region and the North–Western region is the least expensive for the average GMS cost of medicines per person.

Figure 3.1: **Average GMS Cost of Medicines per person by Gender & Region 2007**



[15]See Appendix A Table A.19 for the number of eligible persons for the GMS scheme by region in 2006 and 2007.

[16]Table 9, PCRS Reports 2009 & 2011

As stated earlier, the North–Western region had the highest number of persons eligible for the GMS scheme in 2007, yet they are the least expensive in terms of average cost of medicines per person. The estimated population for the North–West is 242,406 and 258,707 for the Midlands in 2007. The North–West has an older population, where 3.14 per cent of the total population are between 70 and 74 and 5.92 per cent are over 75 compared to 2.82 per cent and 4.9 per cent for the Midlands. Although the North–West[17], has an older population and higher GMS eligibility, it is the least expensive of the eight regions.

Table 3.4 details the average GMS cost of medicines per person by gender and region. The average GMS cost for a male in the Midlands is €831.85 and €828.14 for females compared to €576.72 and €591.04 in the North–West. Table 3.5 specifies the cost of medicines by age cohort and region.

[17]See Appendix A Table A.20 for the projected population for the North–West and the Midlands region.

Table 3.4: **Average GMS Cost of Medicines per Person by Gender & Region, 2007**

Region	**Gender**	**Average GMS Cost (€)**
Eastern	Male	730.70
Eastern	Female	734.43
Midlands	Male	**831.85**
Midlands	Female	**828.14**
Mid–Western	Male	736.75
Mid–Western	Female	735.78
North–Eastern	Male	703.10
North–Eastern	Female	692.06
North–Western	Male	**576.72**
North–Western	Female	**591.04**
South–Eastern	Male	744.80
South–Eastern	Female	737.37
Southern	Male	774.92
Southern	Female	764.58
Western	Male	660.02
Western	Female	663.55

Source: (**PCRS**, 2007)

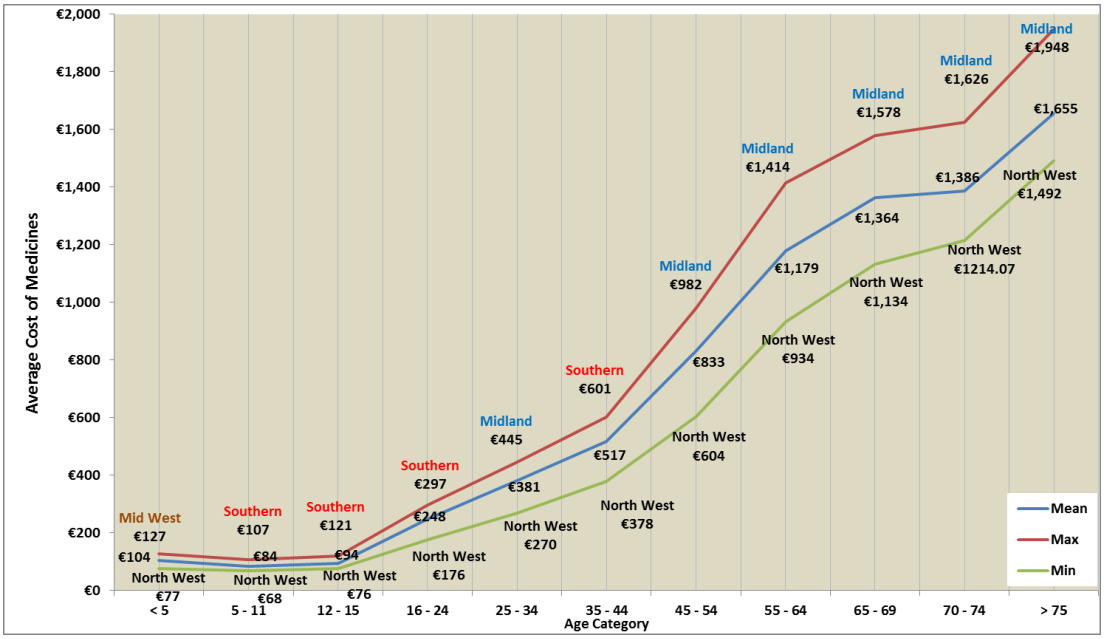
Table 3.5: **Average GMS Cost of Medicines per Person by Age Cohort and Region (€) 2007**

Region	**0–5**	**5–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern	92.04	72.21	76.09	234.18	359.31	489.32	886.51	1260.45	1503.20	1383.83	1701.09
Midlands	103.89	84.30	86.93	278.30	**444.51**	583.78	**981.72**	**1413.87**	**1578.36**	**1626.10**	**1948.21**
Mid–Western	**126.51**	100.91	116.63	272.28	414.14	564.13	864.27	1229.40	1362.89	1382.59	1664.11
North–Eastern	89.72	71.94	87.54	206.09	302.81	420.65	701.11	1017.91	1204.30	1306.08	1570.18
North–Western	**76.90**	**68.45**	**75.62**	**176.08**	**269.64**	**378.12**	**604.37**	**933.96**	**1133.85**	**1214.07**	**1491.67**
South–Eastern	118.15	91.84	107.69	280.13	406.04	585.11	914.69	1254.85	1448.24	1425.89	1685.02
Southern	118.81	**106.88**	**120.95**	**297.29**	435.94	**601.32**	950.35	1288.68	1459.45	1448.95	1638.70
Western	109.10	75.43	82.98	236.75	412.04	515.52	762.12	1029.68	1220.25	1298.55	1537.26

Source: (**PCRS**, 2007)

The North–West region has the lowest GMS cost of medicines per person in the 11 age cohorts. The Mid–West region has the highest GMS cost of medicines per person for under–fives and the Southern region has the highest cost of medicines between the ages 5 and 24 and between 35 and 44 years. In the remaining six age categories, the Midlands is the most expensive region. The Midlands is between 23 per cent[18] and 38 per cent more expensive than the North–West in the five oldest age categories. Figure 3.2 illustrates the mean cost, maximum cost and minimum cost of medicines per person by age cohort and region in 2007[19].

Figure 3.2: **Average Regional Variation in GMS cost of Medicines per person (€) 2007**



3.4 Average Cost per claimant

The average cost per claimant[20] is the total cost of claimants divided by the number of claimants and this was estimated from the sample 2007 PCRS database (Equation 3.2).

[18]See Appendix A Table A.22 for the regional variation (Midlands & North–West) in GMS cost of medicines per person 2007.

[19]See Appendix A Figure A.1 for the average regional variation in GMS cost of medicines per person 2007.

[20]See Appendix A Table A.23 for the average cost per claimant 2007.

A claimant is a person who makes a claim on a GMS medical card.

$$\textbf{Average Cost per Claimant} = \frac{\textbf{Total Cost of Claimants}}{\textbf{Number of Claimants}} \tag{3.2}$$

3.4.1 Description of Sample PCRS Database

The sample database consists of 192,000 observations extracted from the 2007 PCRS GMS population data. The geographical area is the former Health Board, of which there are 8. The are 100 observations by gender and age cohort in each monthly file used in this analysis. For example, 0–5 Eastern male, there are 100 observations. 192,000/100 = 16,000 in each month. The variables include; ingredient cost, VAT, dispensing fee, total cost, number of prescription items and number of prescription forms, and are disaggregated by month (12), age cohort (10), gender (2) and region (8). Ingredient cost refers to the cost of the drug before VAT and dispensing fees are added. VAT is the level of tax each drug determines. The dispensing fee is the amount each Pharmacist receives for prescribing each drug. Total cost is the sum of the ingredient cost, VAT and dispensing fee. All variables are expressed in euros. Number of items refers to the number of individual drug items dispensed on each form. The number of forms refers to the number of prescriptions issued to each GMS claimant.

3.5 Claims Rate

The claims rate[21] was estimated using both the PCRS 2007 annual report and the sample 2007 PCRS database. The claims rate is the proportion of medical card holders who make a claim (Equation 3.3). Of the 1,276,178 medical card holders in 2007, 1,225,131 made a claim on the card giving a claims rate of 96 per cent in 2007.

[21] See Appendix A Table A.24 for the claims rate 2007.

$$\textbf{Claims Rate} = \frac{\textbf{Number of Claimants}}{\textbf{GMS Population}} \tag{3.3}$$

3.6 Cost Projection Model

The cost projection model will incorporate four variables; population, GMS coverage, average cost per claimant and the claims rate (Equation 3.4) to estimate total costs.

$$\textbf{Total Cost} = f\,(\textbf{GMS Coverage}, \textbf{Average Cost per Claimant}, \textbf{Claims Rate}, \textbf{Population}) \tag{3.4}$$

Population estimates and projections will be based on CSO projections. GMS coverage is the estimated proportion eligible for the medical card in 2007. Coverage projections will be based on 2011 data as this is the most up to date data available at the time of projections. Average cost per claimant will be estimated for 2011 and projected in time intervals from 2016 through to 2026, based on 2007 sample data. Claims rates were assumed to remain constant for the lifetime of the projections. The HSE have not published any claims data in 2007 by region, age cohort and gender, so an estimate for average cost per claimant and the claims rate was established, based on the 2007 PCRS sample database. The four variables were classified by region, gender and age cohort. In the sample 2007 PCRS database, there are 10 age groupings, whereas there are 11 HSE age groupings. For the purpose of cost projections, the two HSE age cohorts (<5 and 5–11) were aggregated to form 0–11 age cohort to correspond with the PCRS sample database. For population data, the two age cohorts were aggregated.

For GMS coverage, an adjustment was applied to the two age cohorts based on population weightings. Population weightings[22] were established based on the total

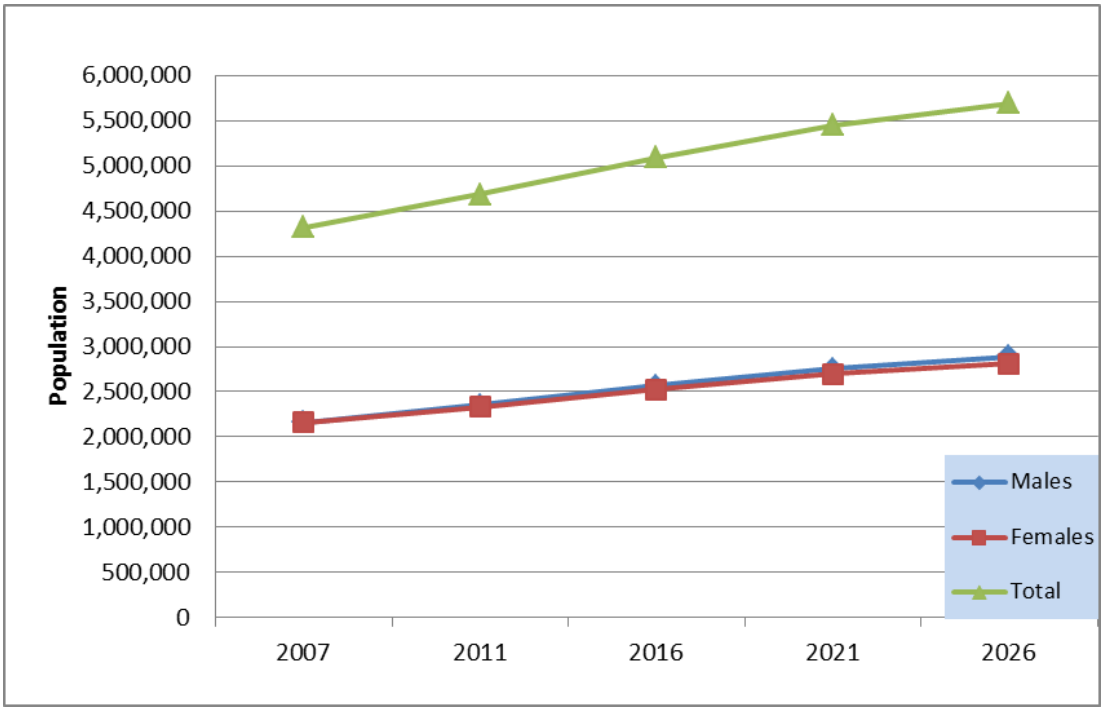
[22]See Appendix A Table A.25 for population weightings that were applied to the coverage parameter.

population in 2007. For example, there is an estimated 55,247 males in the Eastern region under five and 68,969 males between five and eleven years in 2007. The former figure was expressed as a proportion of 124,216 (55,247 + 68,969) to give the population weighting for a male <5 in the Eastern region. This method was applied to all 8 regions by gender and age cohort. These weightings were multiplied by the GMS coverage in 2007 for the age cohorts <5 and 5–11 and aggregated and replaced by the age cohort 0–11. The ten age cohorts are now comparable with the 2007 PCRS sample database. Three scenarios were developed for each variable; minimum, mean and maximum.

3.6.1 Variable 1: Population Estimates and Projections

The population of Ireland is projected to grow rapidly with a sharp increase in both the birth rate and in the elderly population. The following results are based on the most likely population scenario. Figure 3.3 estimates the population of Ireland will increase from 4,320,760 in 2007 to 5,696,000 in 2026, an estimated increase of 31.83 per cent. The male population is estimated to increase from 2,163,340 in 2007 to 2,886,398 in 2026, an increase of 33.42 per cent. The female population is estimated to increase from 2,157,420 in 2007 to 2,809,602 in 2026, an increase of 30.23 per cent. Male population is increasing at a marginally faster rate than the female population, as illustrated in Figure 3.3. For example, the male population is estimated to increase by 9.13 per cent, whereas the female population is set to increase by 8.33 per cent between 2011 and 2016.

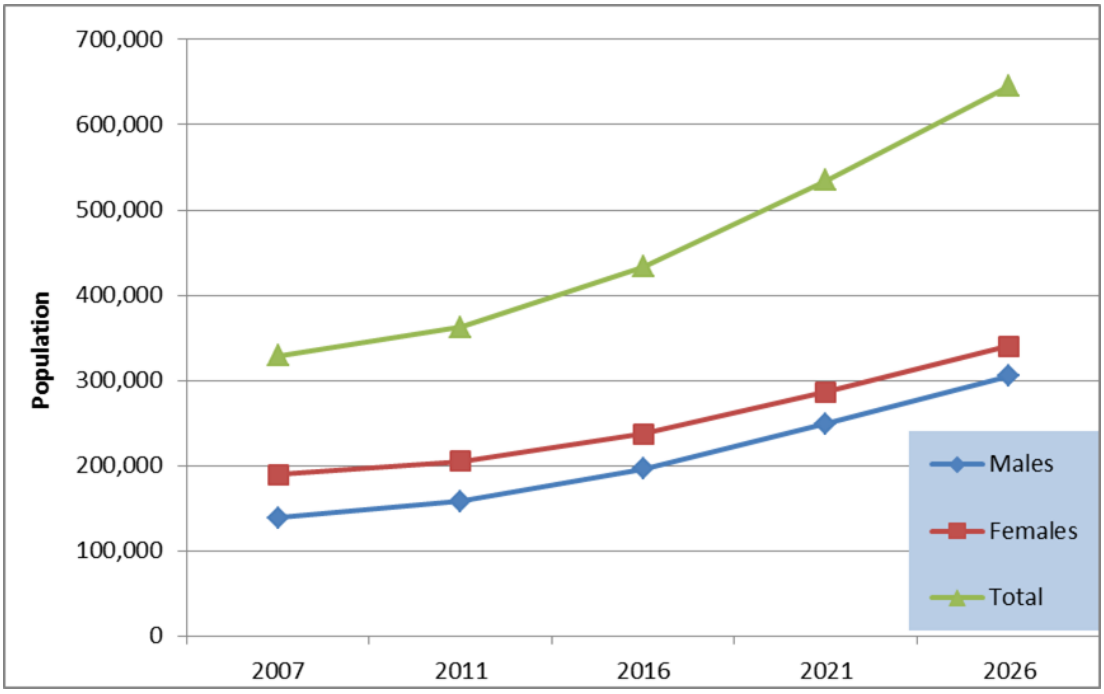
Figure 3.3: **Population Growth 2007 – 2026**



The number of old persons (65 years and over) as classified by the CSO will almost double over the lifetime of the population projections. In 2007, there are 144,239 persons between 65 and 69 years, this increases by 82.88 per cent to 263,789 in 2026. In the 70 to 74 age category there is an 85.36 per cent increase from 119,950 in 2007 to 222,340 in 2026. The >75s realises the largest increase over the lifetime of the projections, where the population more than doubles from 208,756 in 2007 to 422,859 in 2026, an increase of 102.43 per cent. The >70s includes two age cohorts; 70–74 and >75. These two age cohorts were summed together for the purpose of this analysis.

Figure 3.4 shows that population of the over 70s will increase in the first three time periods (2007–2011, 2011–2016 and 2016–2021) and will increase at a slower rate of 22.58 per cent between 2021 and 2026.

Figure 3.4: **Population Growth over 70s, 2007 – 2026**



This is also a feature of the male and female population growth rates. The male population is growing at a faster rate than the female >70s population. For example, the male population is growing by 24.05 per cent, whereas the female population is growing by 15.89 per cent between 2011 and 2016. The total population is projected to grow by 96.28 per cent over the lifetime of the projections. Table 3.6 compares the CSO national population projections with the population projections reconciled with the HSE regions using the M2F1T scenario.

Table 3.6: **Comparison of National Population Projections (M2F1T Scenario)**

Year	CSO Projections	Projections reconciled with HSE Regions
2007	4,339,000	4,320,760
2011	4,686,300	4,685,743
2016	5,095,000	5,095,004
2021	5,451,000	5,451,088
2026	5,696,000	5,696,000

Estimated population[23] for 2007, 2011, 2016, 2021 and 2026 are classified by gender, age cohort and region. Following the age and region adjustments, there is very little difference between the CSO projections and the estimated projections for this research.

Regional Population Estimates and Projections

Regional population is expressed as a proportion of total population. In terms of regional population change, the Eastern region consisted of 35.46 per cent of the overall population in 2007, that proportion is projected to increase to 38.20 per cent by 2026, whereas the Southern region will decrease from 14.56 per cent in 2007 to 13.62 per cent in 2026. Regional population was estimated for 2007, 2011[24] and projected for 2016[25], 2021[26] and 2026. The remaining regions will see a decrease in population apart from the Western region, which will remain constant. Figure 3.5 and Figure 3.6 illustrate the regional population changes between 2007 and 2026[27].

[23]See Appendix A Table A.26 for population estimates and projections for 2007, 2011, 2016, 2021 and 2026.
[24]See Appendix A See Figure A.2 for the regional population proportion 2011.
[25]See Appendix A See Figure A.3 for the regional population proportion 2016.
[26]See Appendix A See Figure A.4 for the regional population proportion 2021.
[27]See Appendix A See Figure A.5 for the regional population proportion compared, 2007 and 2026.

Figure 3.5: **Regional Population Proportions 2007**

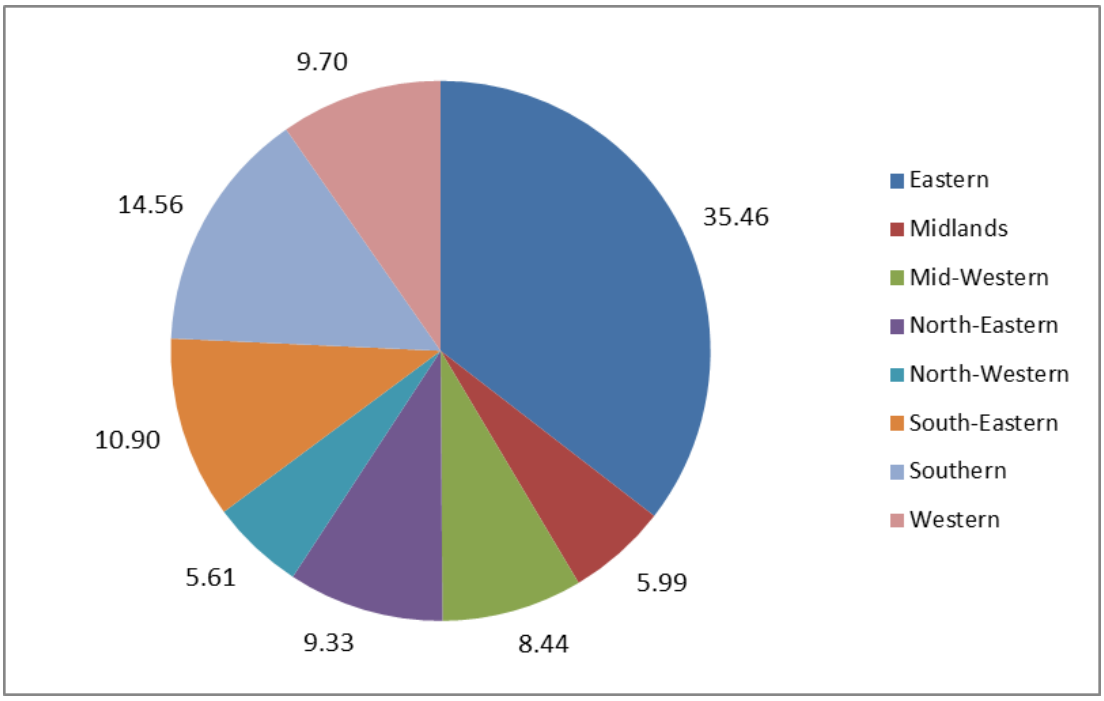


Figure 3.6: **Regional Population Proportions 2026**

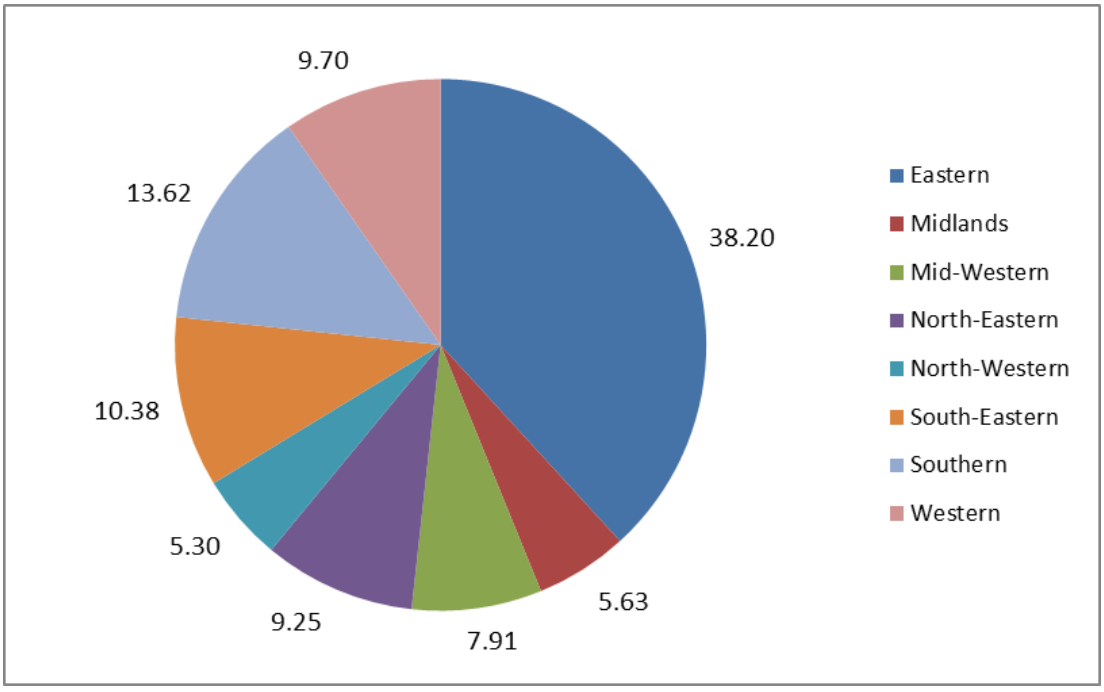


Table 3.7: **Population Growth (%) by Region and Gender**

Region	2007–2011	2011–2016	2016–2021	2021–2026
Eastern				
Males	10.11	11.27	9.53	6.72
Females	9.14	10.7	9.30	6.64
Total	**9.62**	**10.98**	**9.42**	**6.68**
Midlands				
Males	10.37	8.25	5.02	2.15
Females	8.58	6.18	3.13	0.76
Total	**9.49**	**7.24**	**4.11**	**1.48**
Mid–Western				
Males	7.23	7.91	6.45	4.17
Females	5.93	5.55	3.97	1.97
Total	**6.59**	**6.75**	**5.24**	**3.12**
North–Eastern				
Males	8.93	8.96	6.89	4.05
Females	8.14	8.22	6.38	3.82
Total	**8.54**	**8.60**	**6.64**	**3.94**
North–Western				
Males	7.85	7.30	5.50	3.31
Females	7.19	6.50	4.82	2.89
Total	**7.52**	**6.90**	**5.16**	**3.10**
South–Eastern				
Males	8.78	8.22	6.03	3.61
Females	7.39	6.36	4.28	2.21
Total	**8.09**	**7.30**	**5.18**	**2.93**
Southern				
Males	7.05	7.06	5.36	2.79
Females	6.66	6.60	5.01	2.62
Total	**6.86**	**6.83**	**5.18**	**2.71**
Western				
Males	8.00	8.27	6.74	4.29
Females	8.79	9.06	7.38	4.77
Total	**8.39**	**8.66**	**7.06**	**4.53**

Regional projections by Gender

Table 3.7 shows the Midlands will have the highest population growth between 2007 and 2011 (9.49 per cent). The Eastern region will have the highest population growth in the three time intervals between 2011 and 2026. The Mid–Western region will see the lowest increase in population in the two time intervals between 2007 and 2016 and the Midlands region between 2016 and 2026.

Regional projections by Age

The North–Western region has the highest percentage of 70 to 74 year olds and >75s for 2007, 2011, 2016, 2021 and 2026. The North–Eastern region has the lowest percentage of 70 to 74 year olds for 2007 and 2016, whereas the Eastern region has the lowest percentage of 70 to 74 year olds for 2011, 2021 and 2026. The Eastern region has the lowest percentage of >75s for each of the five years. Table 3.8 aggregates the two age cohorts 70–74 and >75s to form the >70s. The Eastern region will envisage the largest growth in population between 2007 and 2021 and the Midlands region between 2021 and 2026. This trend is replicated for male population growth for the >70s. The Eastern region will see the greatest female population growth between 2007 and 2011 and 2016 and 2026. The South–Eastern region will foresee the largest female population growth between 2011 and 2016.

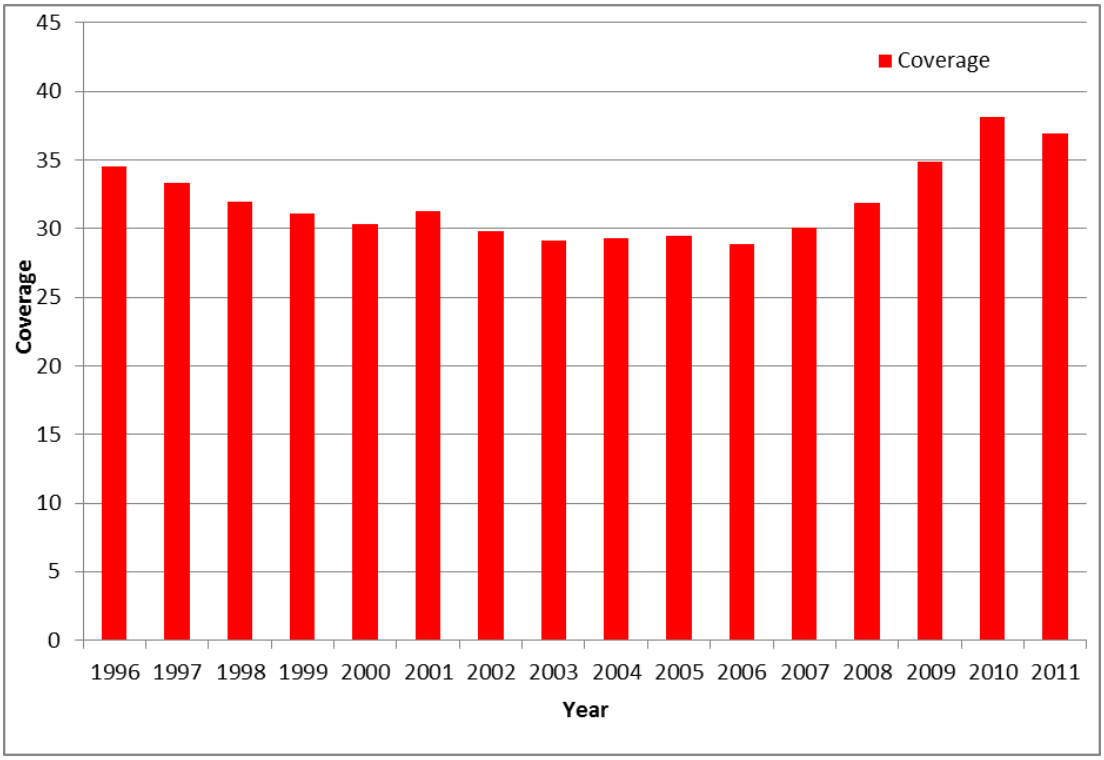
Table 3.8: **Population Growth of the >70s by Region and Gender**

Region	2007–2011	2011–2016	2016–2021	2021–2026
Eastern				
Males	16.37	26.66	29.24	23.97
Females	9.67	17.35	21.75	20.09
Total	**12.35**	**21.21**	**24.99**	**21.82**
Midlands				
Males	11.73	23.61	27.18	25.11
Females	6.60	15.77	20.79	20.08
Total	**8.85**	**19.31**	**23.78**	**22.49**
Mid–Western				
Males	12.82	22.98	26.54	21.53
Females	7.76	16.12	20.96	18.10
Total	**9.95**	**19.17**	**23.52**	**19.71**
North–Eastern				
Males	12.86	23.94	26.53	21.95
Females	7.07	14.33	20.40	18.35
Total	**9.54**	**18.55**	**23.21**	**20.05**
North–Western				
Males	11.20	22.46	25.19	21.09
Females	5.81	12.79	19.66	17.48
Total	**8.20**	**17.18**	**22.29**	**19.23**
South–Eastern				
Males	15.33	23.93	25.60	22.10
Females	8.97	18.03	19.99	18.27
Total	**11.73**	**20.68**	**22.57**	**20.08**
Southern				
Males	13.17	23.48	26.22	21.78
Females	7.88	15.17	19.19	17.17
Total	**10.12**	**18.78**	**22.37**	**19.32**
Western				
Males	9.92	20.08	25.06	21.02
Females	4.35	12.94	19.61	19.27
Total	**6.79**	**16.17**	**22.16**	**20.11**

3.6.2 Variable 2: GMS Coverage Estimates and Projections

The GMS coverage[28] for 2007 was formulated by dividing the GMS population by the total estimated population. The GMS population is the number of people who are eligible for the medical card by region, age and gender, which was published in the annual 2007 PCRS report. For this research, this was taken as the most likely coverage rate (mean scenario) for 2007. The estimated population is based on CSO data. Figure 3.7 detail the percentage of people who were eligible for the medical card between 1996 and 2011 and Table 3.9 also includes the number of eligible GMS persons.

Figure 3.7: **Percentage of Eligible GMS Persons, 1996 – 2011**



Source: (**Various PCRS Reports, 1996–2011**)

[28]See Table 3.3 for the population proportion who have a GMS card by age, region and gender.

Table 3.9: **Number and Percentage of Eligible GMS Persons, 1996–2011**

Year	Persons	Percentage
1996	1,252,385	34.54
1997	1,219,852	33.32
1998	1,183,554	31.95
1999	1,164,187	31.09
2000	1,148,055	30.32
2001	1,199,454	31.24
2002	1,168,745	29.84
2003	1,158,143	29.11
2004	1,148,914	29.33
2005	1,155,727	29.50
2006	1,221,695	28.85
2007	1,276,178	30.10
2008	1,352,120	31.89
2009	1,478,560	34.87
2010	1,615,809	38.11
2011	1,694,063	36.92

Source: (**Various PCRS Reports, 1996–2011**)

Table 3.10: **Coverage Scenarios 2007**

Scenarios	**Coverage**
Scenario 1	**Minimum**
28.85	0.958472
Scenario 2	**Mean**
31.60	1.049967
Scenario 3	**Maximum**
38.11	1.266113

In order to estimate 2007 coverage rates; three scenarios were established as detailed in Table 3.10. The minimum, mean and maximum scenarios were calculated based on historical coverage data between 1996 and 2010[29]. 30.10 per cent of the GMS population were eligible for a medical card in 2007. In order to determine the minimum scenario, 28.85 was expressed as a proportion of 2007 national coverage rate (30.10%) to form a weighting. 0.958472 was multiplied uniformly across region, gender and age cohort by coverage 2007. In order to determine the maximum scenario, 38.11 was expressed as a proportion of 2007 national coverage rate to form a weighting. 1.266113 was multiplied uniformly across region, gender and age cohort by coverage 2007. The mean scenario was taken as the most likely coverage rate[30].

The Irish economy officially fell into recession in the final quarter of 2008. The cyclical impact is evident between 2008 and 2011. The number of eligible persons increased from 1,352,120 to 1,694,063, an increase of 341,943 persons, (PCRS, 2011) reports this as the highest number of medical card holders ever recorded up to 2011. Coverage 2011 was calculated by dividing the GMS population by the estimated mean population for 2011. Three scenarios[31] were formulated based on the historical coverage data between

[29]See Table 3.9 for historical GMS coverage rates between 1996 and 2010.
[30]See Appendix A Table A.41 for 3 coverage scenarios 2007.
[31]See Appendix A Table A.44 for 3 coverage scenarios 2011.

1996 and 2011 (See Table 3.9). A weighting was applied to the mean coverage rate 2011. The minimum and maximum coverage rates were determined from the historical data and were expressed as a proportion of the national coverage rate. This weighting was uniformly applied to the mean coverage 2011 rate by region, gender and age cohort. Scenario 1 and 3 were determined using this methodology. If the >75 age cohort for each region and gender exceeded 1.00, an adjustment factor (Equation 3.5) was applied.

$$\textbf{Adjustment Factor} = \boldsymbol{Min(> 75 - \lambda(1.00 - 70\ to\ 74\ age\ cohort))} \quad (3.5)$$

The >75 value for each region and age cohort was scaled downwards. Lambda can take any value between 0 and 0.99. For example, if the projected population for >75 in a given region is 100 but the number of projected GMS eligible persons is 105, GMS coverage rate is 1.05. As this value exceeds 1.00, the adjustment factor above was applied, to scale the value below 1.00.

Coverage projections 2016 through to 2026 were based on the reference year 2011 (coverage 2011 data), as this was the most up to date data available at the time of projections. In order to project coverage 2016, three scenarios; minimum, mean and maximum were calculated based on the historical coverage data between 1996 and 2011 in Table 3.9. The minimum value (0.2885) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 5,095,004. This generated an estimated number of eligible persons of 1,469,909. The difference between total number of eligible persons 2011 (1,694,063) and 2016 (1,469,909) was derived and expressed as a proportion (0.867682). This value was multiplied by coverage 2011 to generate scenario 1 coverage 2016[32] by region, gender and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, gender and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort.

[32]See Appendix A Table A.47 for coverage scenario 1, 2016.

The mean value (0.3160) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 5,095,004. This generated an estimated number of eligible persons of 1,941,706. The difference between total number of eligible persons 2011 (1,694,063) and 2016 (1,627,344) was derived and expressed as a proportion (0.960616). This value was multiplied by coverage 2011 to generate scenario 2, coverage 2016[33] by region, gender and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, gender and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort.

The maximum value (0.3811) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 5,095,004. This generated an estimated number of eligible persons of 1,941,706. The difference between total number of eligible persons 2011 (1,694,063) and 2016 (1,941,706) was derived and expressed as a proportion (1.146183). This value was multiplied by coverage 2011 to generate scenario 3 coverage 2016[34] by region, gender and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, gender and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort.

This methodology was replicated to determine coverage projections 2021[35] and coverage projections 2026[36]. Three scenarios were calculated for each year. 2021 and 2026 coverage projections were based on the most likely projected population of 5,451,088 and 5,696,000 respectively. An adjustment factor was applied to the >75 age cohort of scenario 2, 2021 and 2026 coverage rates as the coverage values exceeded 1.00. For scenario 3, the adjustment factor did not scale the data sufficiently below 1.00. Therefore,

[33]See Appendix A Table A.48 for coverage scenario 2, 2016.
[34]See Appendix A Table A.49 for coverage scenario 3, 2016.
[35]See Appendix A Table A.50 for coverage scenarios 1, 2 and 3, 2021.
[36]See Appendix A Table A.53 for coverage scenario 1, 2 and 3, 2026.

Table 3.11: **Number of GMS eligible persons & Coverage Projections (3 Scenarios), 2016–2026**

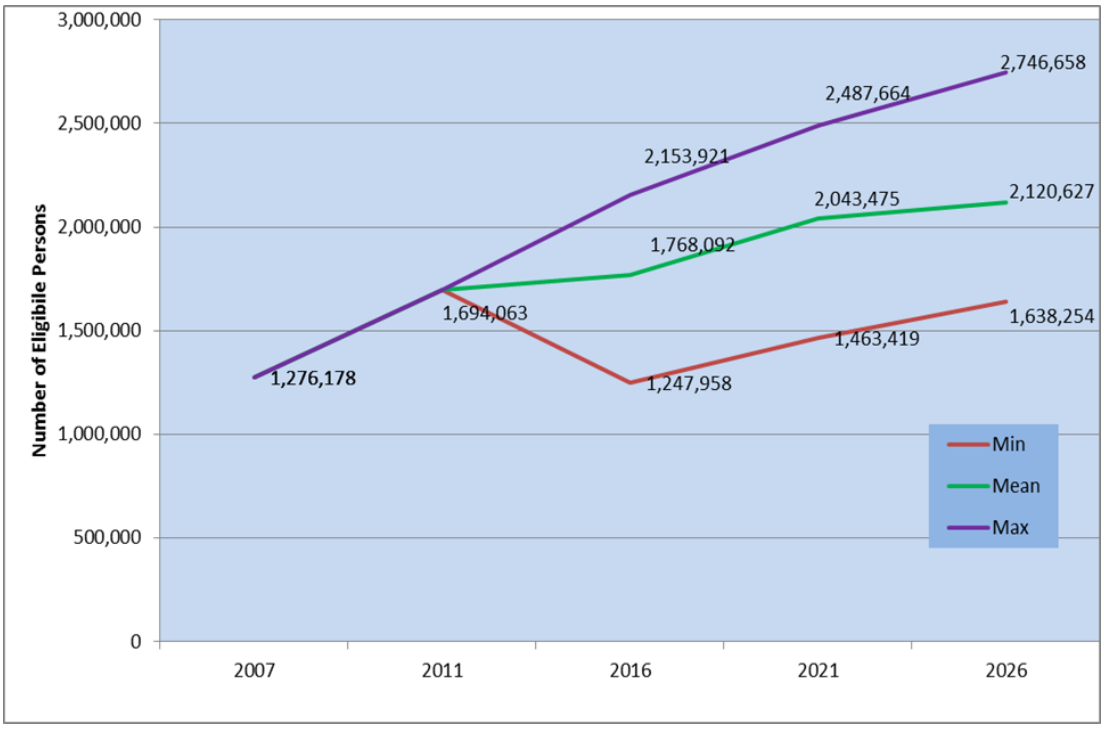
Scenario	Year	No.of Eligible Persons	Population	Coverage (%)
Mean	2007	1,276,178		30.10
Mean	2011	1,694,063		36.92
Minimum	2016	1,247,958		24.49
Mean		1,768,092	5,095,004	34.70
Maximum		2,153,921		42.28
Minimum	2021	1,463,419		26.85
Mean		2,043,475	5,451,088	37.49
Maximum		2,457,664		45.64
Minimum	2026	1,638,254		28.76
Mean		2,120,627	5,696,000	37.23
Maximum		2,746,658		48.22

0.99 coverage rates were applied uniformly across all regions, genders and age cohorts for the 70–74 and >75 age cohorts for the years 2021 and 2026. Number of eligible persons and coverage projections are presented in Table 3.11.

In Table 3.11, 2007 and 2011 are actual figures and 2016 through to 2026 are projected figures. Coverage rates are based on the most likely population level for each year. Coverage is estimated to be approximately 34.70 per cent in 2016, 37.49 per cent in 2021 and 37.23 per cent in 2026. Figure 3.8 estimated the number of eligible GMS persons will lie between 1.2 and 2.1 million in 2016, 1.5 and 2.5 million in 2021 and 1.6 and 2.7 million in 2026[37].

[37]See Appendix A Figure A.6 for GMS coverage Projections (%) 2016 – 2026.

Figure 3.8: **Number of eligible GMS Persons (Projections–3 Scenarios), 2016–2026**



3.6.3 Variable 3: Average Cost per claimant Estimates & Projections

The average cost per claimant[38] was estimated from the sample PCRS database 2007 and the PCRS annual report 2007. The (PCRS, 2007) reports that the average pharmacy cost per eligible GMS person was €856.14 in 2007. The PCRS sample database estimates the average cost per eligible GMS person as €1,221.06. The PCRS annual report figures are approximately 30% lower than the estimated figures, therefore the estimated figures were scaled downwards based on the regional totals of the annual 2007 report[39]. Three possible scenarios were generated with the mean cost per claimant being the most likely scenario. A 95% confidence interval was applied, establishing a lower bound[40] (minimum scenario) and upper bound (maximum scenario) around the mean cost per claimant using the standard deviation estimated from the PCRS sample database.

[38]See Appendix A Table A.23 for the average cost per claimant 2007.
[39]See Appendix A Table A.56 for comparison of regional totals.
[40]See Appendix A Table A.57 for 3 average cost per claimant scenarios re–estimated 2007.

Average Cost (AC) per claimant historical growth rates were determined and an assumption was made that the historical growth evolution would continue in estimating the ac per claimant for 2011 and projections between 2016 and 2026. The average GMS pharmacy cost for 2007 was €856.14 and €761.51 in 2011, a reduction of approximately 11.05 per cent. This reduction was uniformly applied by region, gender and age cohort to determine AC per claimant 2011 (3 scenarios)[41]. Historical data (2003–2010) was used in the formulation of the 2016, 2021 and 2026 projections. The minimum, mean and maximum average cost per claimant data was determined by each region. For example, the minimum average cost per claimant for the Eastern region between 2003 and 2010 is €588.26. This figure was subtracted from the minimum Eastern male total figure and expressed as a proportion. The proportion was multiplied by 2007 minimum Eastern male to formulate 2016 minimum eastern male. This methodology was applied across all regions, genders and age cohorts for the mean and maximum scenarios to formulate 2016 mean and maximum scenarios.

2021 and 2026 average cost per claimant projections were estimated based on the historical growth rates between 2003 and 2010. For example, the minimum negative growth for the Eastern region is 10.04% between 2003 and 2010. 2016 minimum Eastern male and female figures were scaled down by 10.04% to formulate 2021 Eastern male and female minimum scenario. This method was applied across all regions, genders, age cohorts and scenarios. 2021 minimum Eastern male and female figures were scaled down by 10.04% to formulate 2026 Eastern male and female minimum scenario. This method was applied across all regions, genders, age cohorts and scenarios.

[41]See Appendix A Table A.64 for three average cost per claimant (€) scenarios by age cohort, gender and region 2011.

3.6.4 Variable 4: Claims Rate Estimates and Projections

The claims rate[42] is the proportion of medical card holders who make a claim. The claims rate was estimated to be 57 per cent from the sample PCRS database. The (PCRS, 2007) reports that more than 96 per cent of eligible GMS persons availed of services in 2007. A weighted regional adjustment based on Table 9.1 (PCRS, 2007) was applied to the estimated claims rate data. An adjustment factor (Equation 3.6 & Equation 3.7) was applied to scale upwards the estimated claims rate data.

$$\textbf{Adjustment Factor} = \boldsymbol{raw\ rate} + \boldsymbol{\lambda}(\mathbf{1.00} - \boldsymbol{raw\ rate}) \tag{3.6}$$

$\boldsymbol{raw\ rate}$ = the estimated 2007 claims rate

$\boldsymbol{\lambda}$ = Lambda

$$\boldsymbol{\lambda} = \frac{\boldsymbol{Y} - \boldsymbol{\Sigma}(\boldsymbol{w_1 r_1 ..... w_8 r_8})}{\mathbf{1.00} - \boldsymbol{\Sigma}(\boldsymbol{w_1 r_1 ..... w_8 r_8})} \tag{3.7}$$

$\boldsymbol{Y}$ = claims rate PCRS Report 2007

$\boldsymbol{w}$ = weightings of numbers covered for each region

$\boldsymbol{r}$ = claims rate estimated from sample database 2007,

$\boldsymbol{r}$ = where $\boldsymbol{r_1}$ is the Eastern region and $\boldsymbol{r_8}$ is the Western region

A 95 per cent confidence interval was applied to the claims data, to establish a lower bound (minimum) and upper bound (maximum). Three scenarios[43] were generated by region, gender and age cohort.

The Irish government introduced patient co–payment for medical card holders for the first time on the 1st October 2010. A 50 cent per item prescription charge up to a maximum of €10 per family per month. This was subsequently increased to €1.50

[42] See Appendix A Table A.24 for the claims rate 2007.
[43] See Appendix A Table A.67 for 3 claims rate scenarios 2007.

Table 3.12: **Percentage of Eligible GMS Persons who availed of services, 1998–2011**

Year	Percentage
1998	88%
1999	88%
2000	88%
2001	88%
2002	90%
2003	94%
2004	96%
2005	95%
2006	95%
2007	96%
2008	91%
2009	94%
2010	93%
2011	93%

Source: (**Various PCRS Reports**, 1998–2011)

per prescription item in January 2013 and €2.50 per prescription item in December 2013. (Sinnott, Guinane, Whelton and Byrne, 2013) conducted a qualitative study on the 50 cent Irish co–payment charge. They found that patients were mostly accepting of the 50 cent charge and it did not affect patient demand for drugs. The national claims rate has not changed since the co–payment introduction. 93 per cent of eligible GMS persons availed of services in 2010 and 2011, (PCRS, 2011). Table 3.12 details proportion of GMS persons who availed of services between 1998 and 2011. This has remained above 90 per cent since 2002. Therefore, this research will hold claims rate scenarios constant for the lifetime of the projections.

3.7 Monte Carlo Simulation Model

The MCS model identifies uncertain (explanatory) variables and an uncertain (dependent) function. The uncertain variables are populaton, coverage, claims rate and average cost per claimant. Each uncertain variable is specified by age cohorts (10), gender (2) and regions (8) giving a total of 160 cells to be modelled for each variable. The dependent variable is the estimated historical cost of the GMS scheme for 2007

and 2011 and the projected cost for 2016, 2021 and 2026. In order to prepare the data for Monte Carlo Simulations, the probability and cumulative probability of finding a person within each region, gender and age cohort (RGA) class were calculated. The MCS model employs statistical sampling to forecast under uncertainty. MCS generates a large number (100,000) of outcomes which is representative of your decision and assesses your decisions and the impact of risk, allowing for better decision making under uncertainty. Taking a large number of simulations (100,000), gives an excellent approximation to the true distribution of projected cost. The equation (Equation 3.8) used for simulations is;

$$\textbf{Probable cost} = \textbf{Expected cost} + \boldsymbol{error} \tag{3.8}$$

where error is an ensemble for the Monte Carlo Simulation, having a normal distribution with zero mean and standard deviation of 5% of cost.

The probability is the empirical probability (proportion) calculated by the quotient of class members over count of all members which lies between 0 and 1. The cumulative probabilities were calculated which gave a weight of occurrence within a particular RGA class. A macro was written in Visual Basic Editor in Microsoft Excel to run the simulations. (Sugiyama, 2007) highlighted the importance of assigning an appropriate probability distribution to uncertain variables in developing a comprehensive MCS model. A Normal distribution was applied to estimate costs to allow for uncertainty in the model. As the cost nationally is fundamentally based on the sum of costs at an individual level, the Central Limit Theorem was applied here, which states that the sum of random variables will be approximately distributed, (Bain and Engelherdt, 1991). An MCS with 100,000 iterations was used to propagate the uncertainty in the model. All statistical analyses were performed using Minitab statistical package (Minitab 16). The MCS results were imported into Minitab for analysis.

3.8 Results

The MCS projects total pharmacy cost could rise to €1,317 million in 2016 and may lie between approximately €644 million and €2,150 million. The total pharmacy cost could rise to €1,626 million in 2021 and may lie between approximately €704 million and €2,876 million. The total pharmacy cost is projected to rise to €1,985 million in 2026 and may lie between approximately €742 million and €3,672 million, as illustrated in Figure 3.9. These cost projections are subject to assumptions made around the four variables.

Figure 3.9: **Historical Projections and Projected Pharmacy Cost (€M) to 2026**

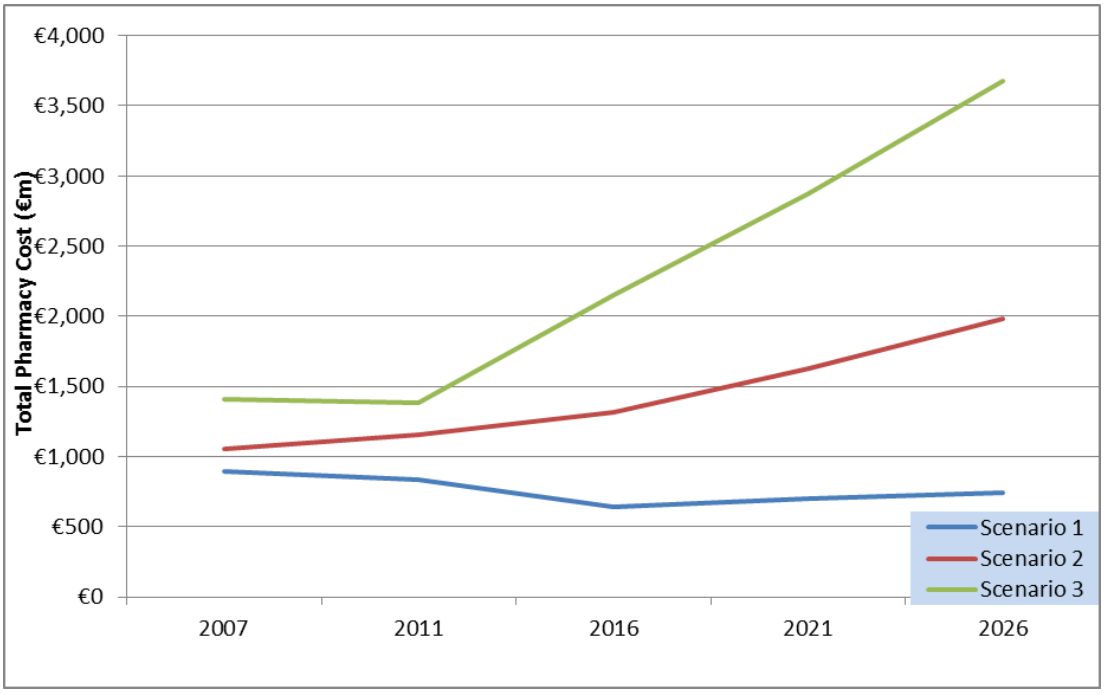


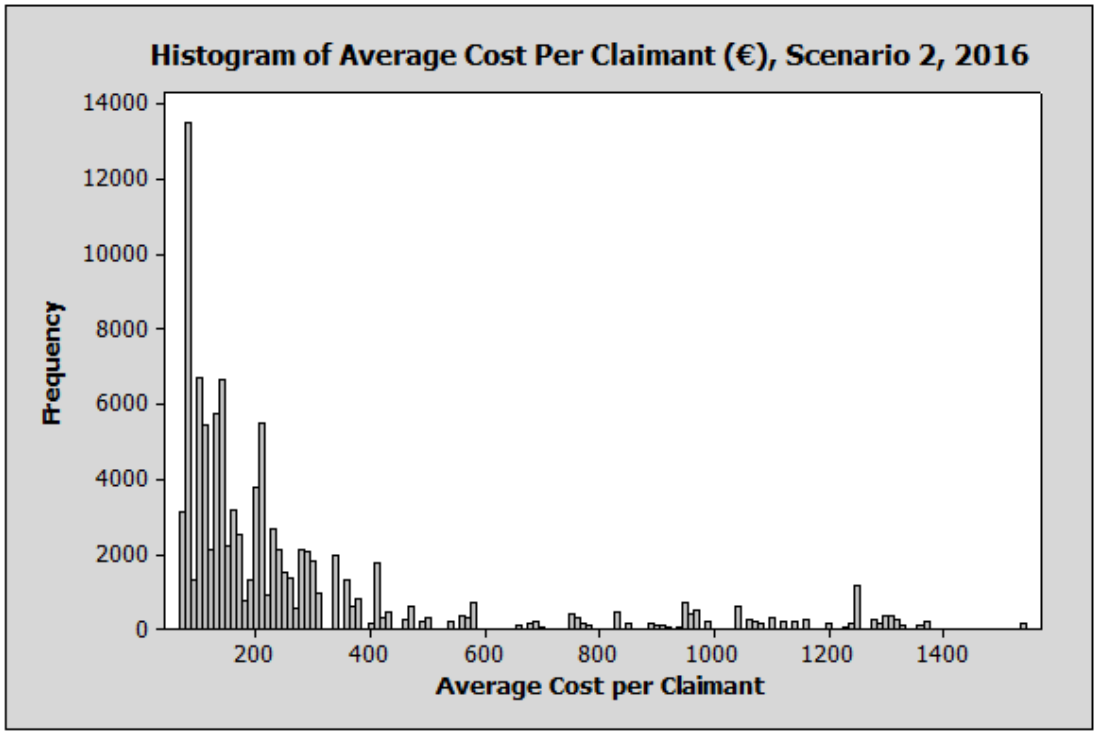
Table 3.13: **Descriptive Analysis of Average Cost per Claimant (€) 2016–2026 (Scenario 2)**

Year	♯ of Simulations	Mean	SE Mean	Standard Deviation	Min	Q1	Median	Q3	Max
2016	100,000	272.31	0.912	149.32	69.63	106.19	167.59	286.14	1541.72
2021	100,000	312.61	0.994	314.45	78.65	121.29	190.43	330.86	1579.73
2026	100,000	366.81	1.18	272.28	86.68	135.56	241.10	371.60	1602.28

3.8.1 Descriptive Statistics

The descriptive analysis[44] of 100,000 simulations for scenario 2 in 2016 projected an average cost per claimant of €272.31 (minimum €69.63 and maximum €1,541.72). This is projected to be €312.61 in 2021 (minimum €78.65 and maximum €1,579.73) and €366.81 in 2026 (minimum €86.68 and maximum €1,602.28) as detailed in Table 3.13[45].

Figure 3.10: **Histogram of Average Cost per Claimant (€), Scenario 2, 2016**



[44]See Appendix A Table A.70 for descriptive analysis scenario 1, 2016–2026.
[45]See Appendix A Table A.71 for descriptive analysis scenario 3, 2016–2026.

Figure 3.10 illustrates the simulation results for scenario 2, 2016. The majority of simulations show an average cost per claimant of €600 or less. For scenario 1[46], the average cost per claimant is €300 or less and approximately €800 or less for scenario 3[47].

Figure 3.11 illustrates the simulation results for scenario 2, 2021. The majority of simulations show an average cost per claimant of €700 or less. For scenario 1[48], the average cost per claimant is €300 or less and approximately €1,050 or less for scenario 3[49].

Figure 3.11: **Histogram of Average Cost per Claimant (€), Scenario 2, 2021**

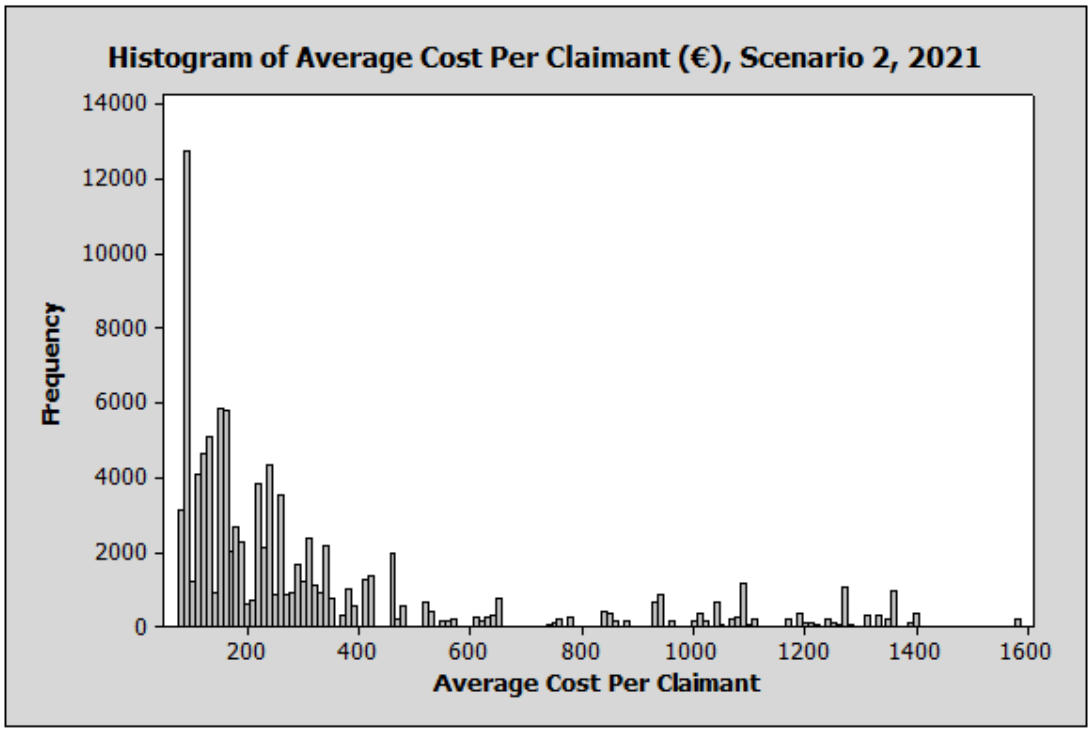
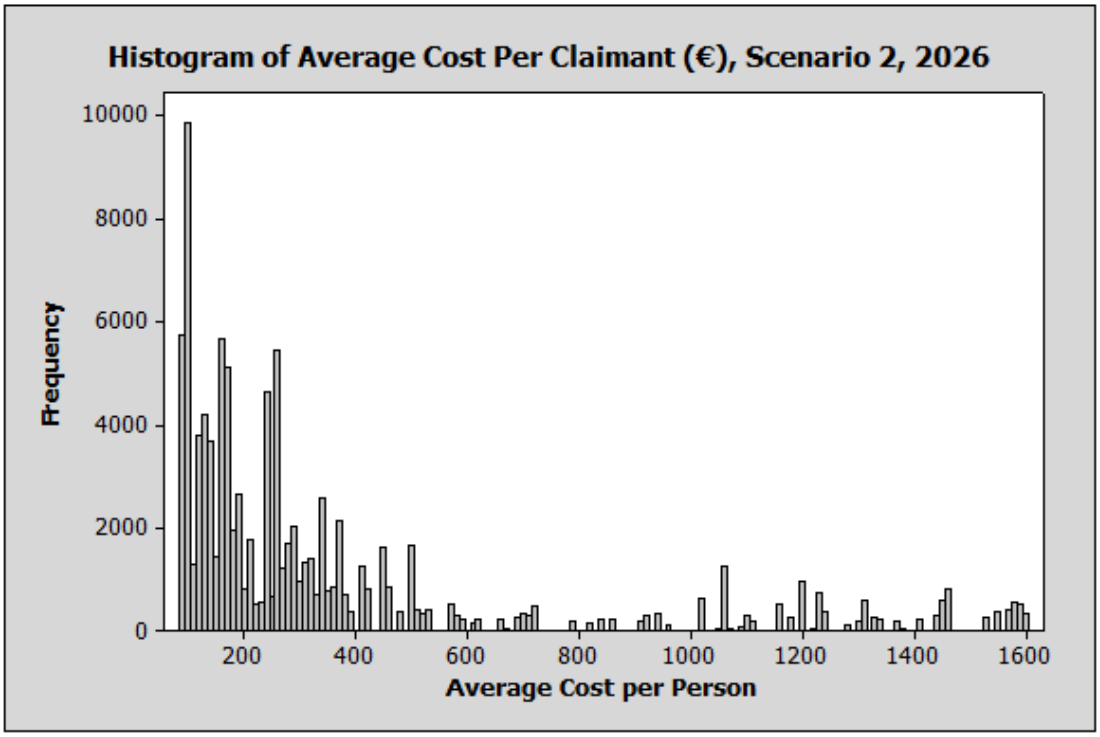


Figure 3.12 illustrates the simulation results for scenario 2, 2026. The majority of simulations show an average cost per claimant of €750 or less. For scenario 1[50], the average cost per claimant is €300 or less and approximately €1,400 or less for scenario 3[51].

[46]See Appendix A Figure A.7 Histogram of Average Cost per Claimant, Scenario 1 2016.
[47]See Appendix A Figure A.8 Histogram of Average Cost per Claimant, Scenario 3 2016.
[48]See Appendix A Figure A.9 Histogram of Average Cost per Claimant, Scenario 1 2021.
[49]See Appendix A Figure A.10 Histogram of Average Cost per Claimant, Scenario 3 2021.
[50]See Appendix A Figure A.11 Histogram of Average Cost per Claimant, Scenario 1 2026.
[51]See Appendix A Figure A.12 Histogram of Average Cost per Claimant, Scenario 3 2026.

Figure 3.12: **Histogram of Average Cost per Claimant (€), Scenario 2, 2026**



3.8.2 Statistical Analysis

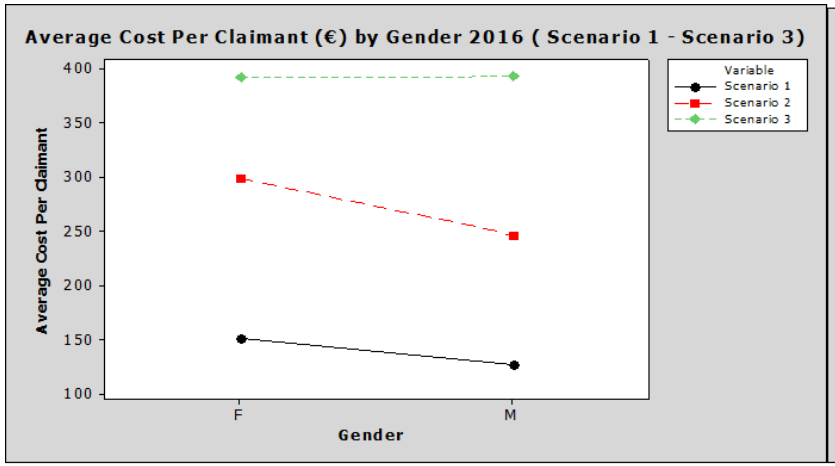
The statistical analysis for the three scenarios in 2016 identify the effect the three variables (age, gender and region) have on the average cost per claimant. These results are illustrated in Figure 3.13. It was found that the main factors driving GMS costs in 2016 were found to be;

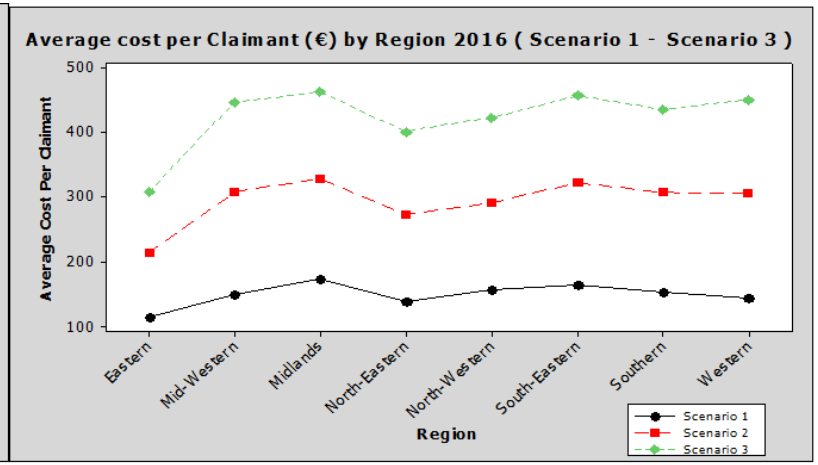
- age, and in particular those aged 0–11, and those aged >70
- being resident in the Midlands region
- being female

These results show a similar picture for 2021[52] and 2026, as illustrated in Figure 3.14.

[52]See Appendix A Figure A.13 Statistical Analysis Scenario 1 – Scenario 3, 2021.

Figure 3.13: **Statistical Analysis Scenario 1 – Scenario 3, 2016**





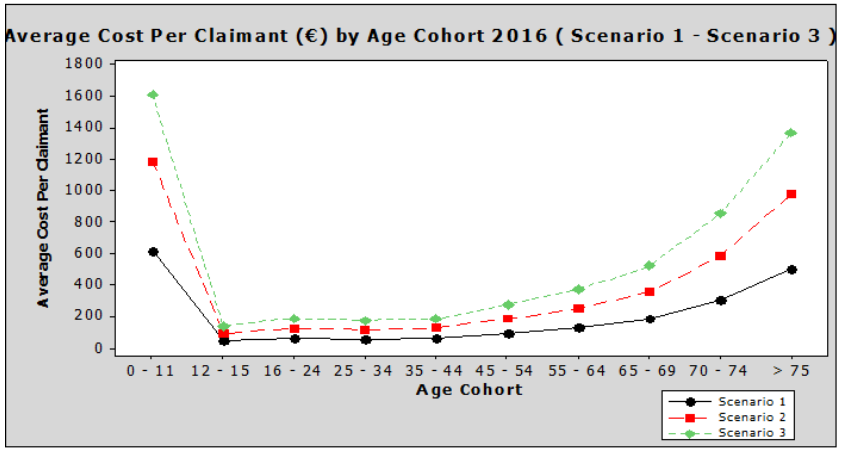
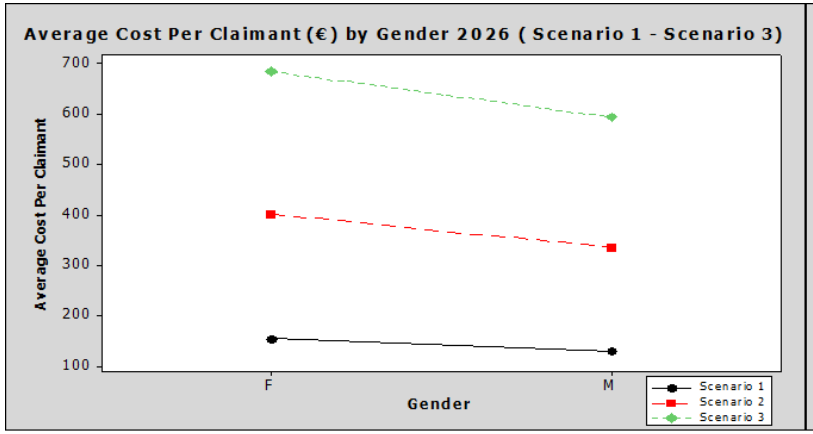
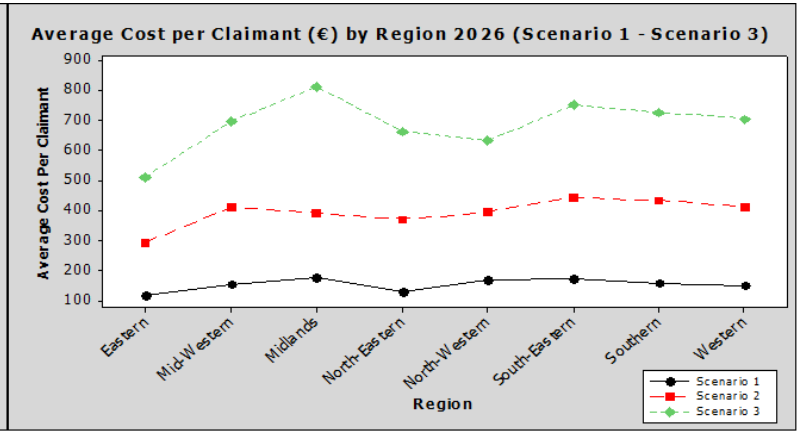


Figure 3.14: **Statistical Analysis Scenario 1 – Scenario 3, 2026**





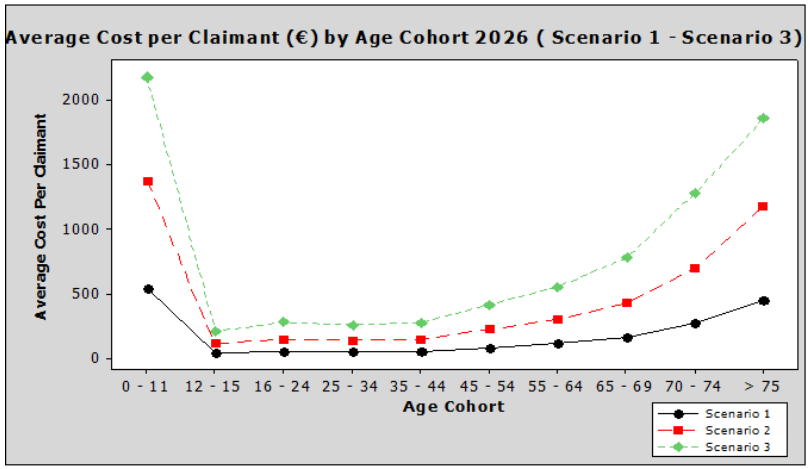
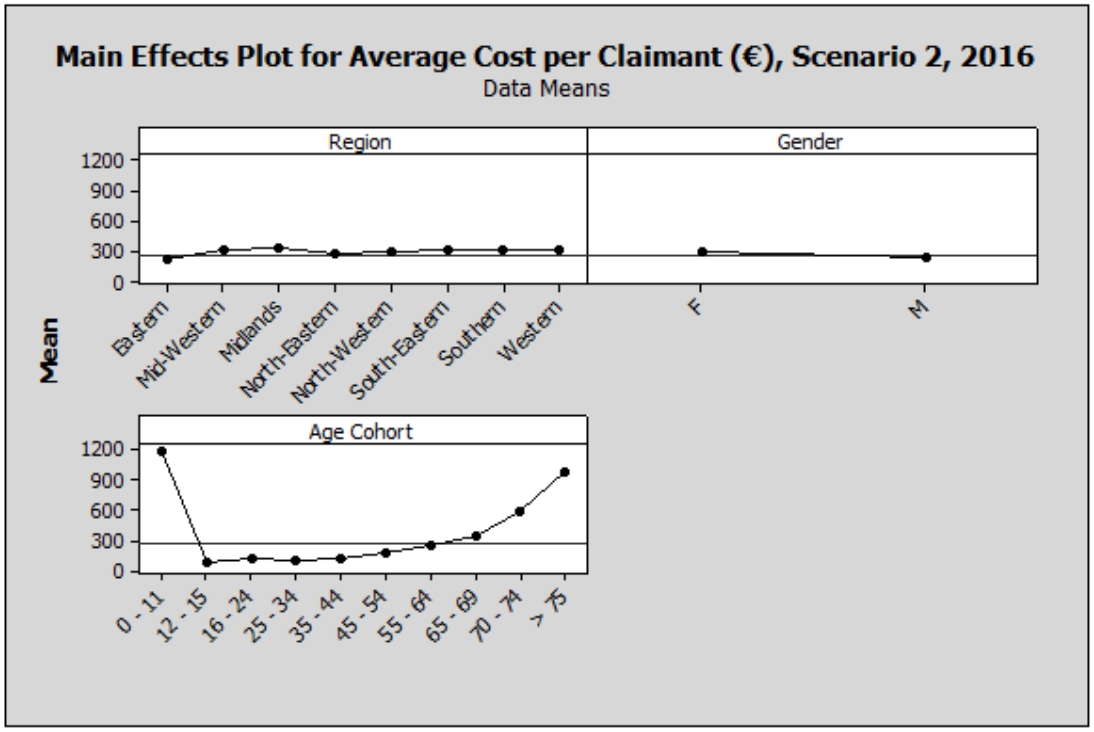


Figure 3.15 (Main Effects Plot) depicts age as the most significant driver of cost compared to the other two variables.

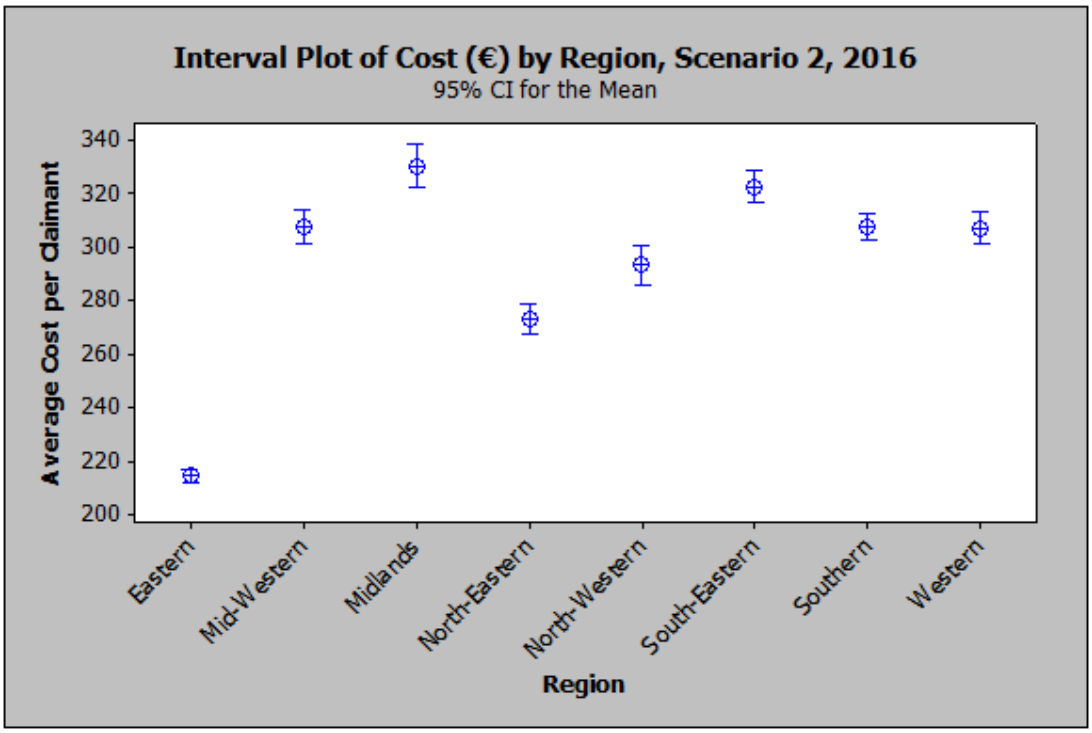
Figure 3.15: **Main Effects Plot Scenario 2, 2016**



A Main Effects Plot is used to examine differences between level means for one or more factors. A Main Effects Plot graphs the response mean for each factor; old health board region, sex and age cohort. Age cohorts show the greatest response, especially <11s and >70s. Scenarios 1 and 3[53] also confirm this result. These results portray a similar picture for 2021[54] and 2026[55]. This is further compounded by the interval plot of cost by region, gender and age cohort. Figure 3.16 forecasts the Midlands as the most expensive region and the Eastern region as the least expensive for scenario 2, 2016.

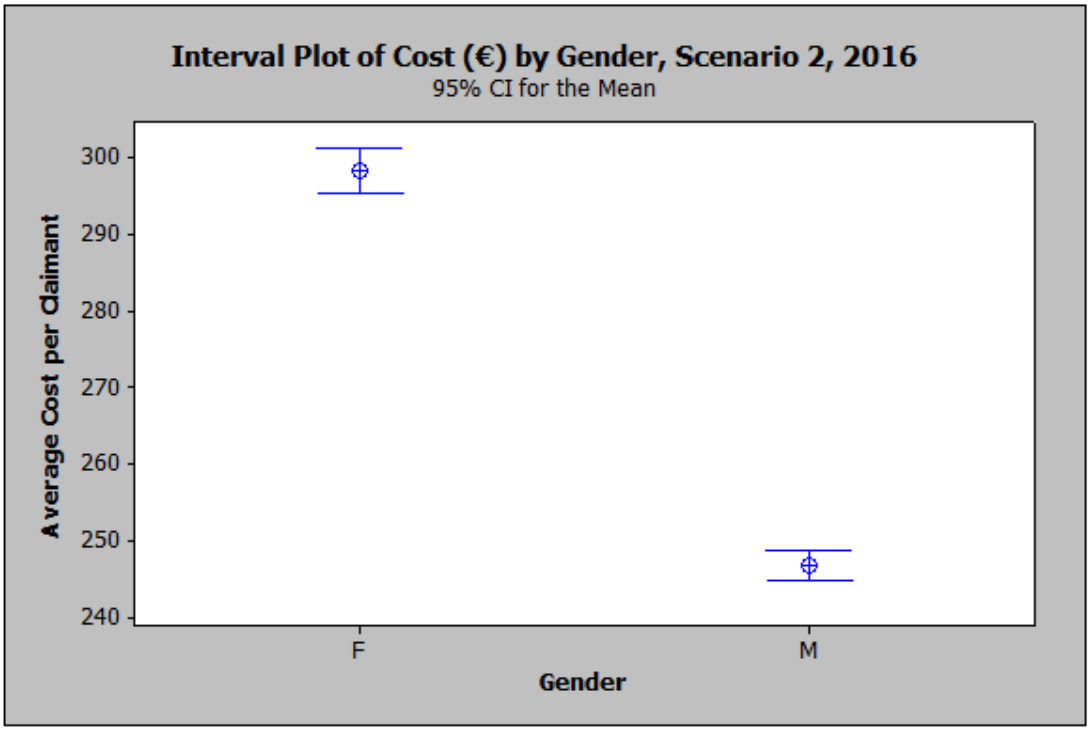
[53]See Appendix A Figure A.14 for Main effects Plot Scenario 1 & Scenario 3, 2016.
[54]See Appendix A Figure A.15 for Main Effects Plot Scenarios 1 & Scenario 3, 2021.
[55]See Appendix A Figure A.16 for Main Effects Plot Scenarios 1 & Scenario 3, 2026.

Figure 3.16: **Interval Plot of Cost by Region, Scenario 2, 2016**



One can be 95 per cent confident that the average cost per claimant will lie between €320 and €340 (Midlands region) and €210 and €220 (Eastern Region). The interval plot of cost by gender forecasts females to be more expensive than males for scenario 2, 2016. One can be 95 per cent confident that the female average cost per claimant will lie between €295 and €300 and the male average cost per claimant will lie between €244 and €248 (Figure 3.17).

Figure 3.17: **Interval Plot of Cost by Gender, Scenario 2, 2016**



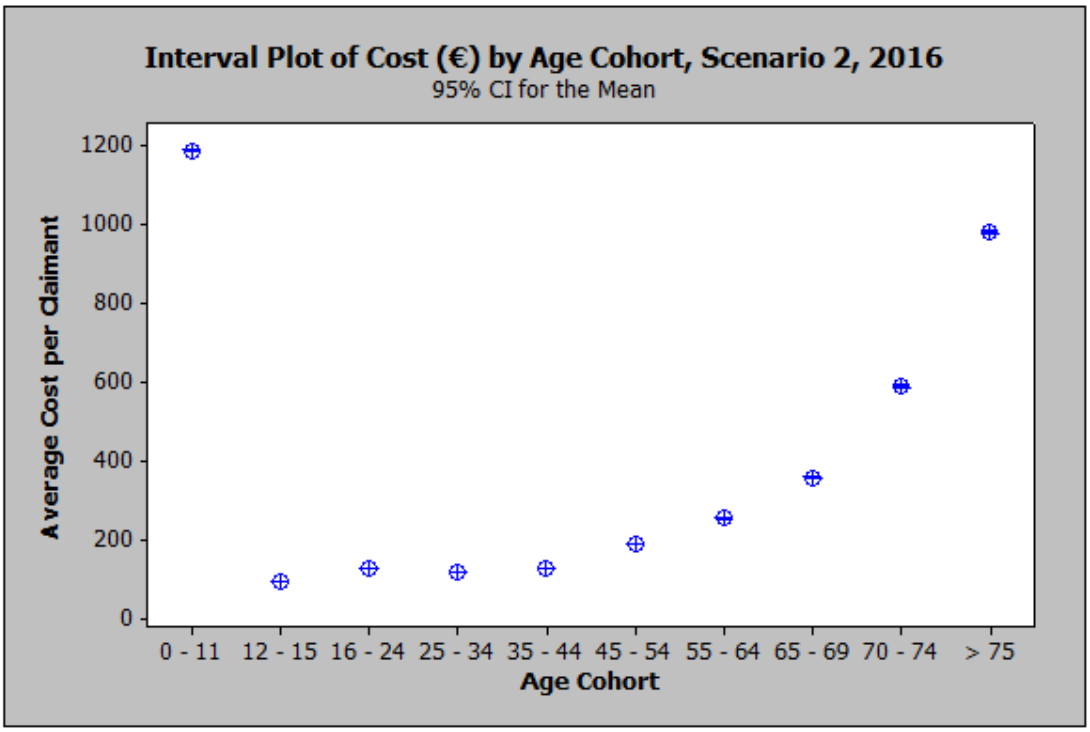
The interval plot of cost by age cohort, forecasts children under 11 and the >75s as the most expensive age cohorts for scenario 2, 2016. We can be 95 per cent confident that the average cost per claimant in the under 11 category will be approximately €1,200 and the average cost per claimant in the >75s category will be approximately €1,000 (Figure 3.18). Scenario 1[56] and Scenario 3[57] forecast similar results for 2016 by region, gender and age cohort to Scenario 2. 2021[58] scenarios forecast comparative results to 2016 scenarios, results for scenarios 1 and 3 are presented in Appendix A.

[56]See Appendix A Figure A.17 Interval Plot of Cost by region, gender & age cohort, Scenario 1, 2016.

[57]See Appendix A Figure A.18 Interval Plot of Cost by region, gender & age cohort, Scenario 3, 2016.

[58]See Appendix A Figure A.19 Interval Plot of Cost by Region, Gender and Age Cohort, Scenario 2, 2021.

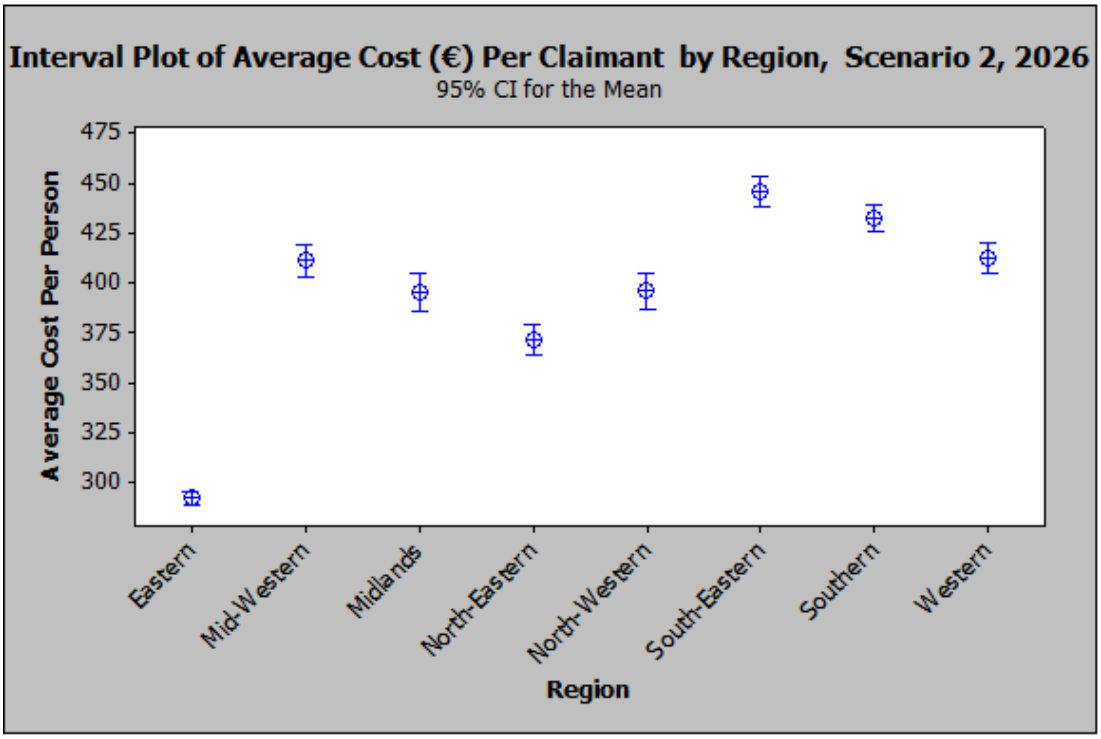
Figure 3.18: **Interval Plot of Cost by Age Cohort, Scenario 2, 2016**



The interval plot of cost by gender and age cohort for 2026[59] forecasts comparative results to 2016 and 2021 for each scenario. The interval plot of cost by region forecasts the South–East as the most expensive region and the Eastern region as the least expensive (Figure 3.19) for scenario 2, 2026. Scenario 1 and scenario 3 illustrate a similar picture to previous years, therefore results are presented in Appendix A.

[59]See Appendix A Figure A.20 Interval Plot of Cost by Gender and Age Cohort, Scenario 2, 2026.

Figure 3.19: **Interval Plot of Cost by Region, Scenario 2, 2026**



3.9 Discussion

Population growth and an aging population will be a driver of future Irish health care costs. It is well documented in the literature that population is a driver of Irish health care expenditure, (Layte et al., 2007) and (Barry et al., 2010). Population growth is the effect of changes in the size of the population on health care expenditure, such as drug spending. Other things being equal, an increase in population size will increase total drug spending. This research estimates that the Irish population will have increased by approximately 33 per cent by 2026. Population aging is the effect of changes in the age distribution of the population on spending. Irish people are living longer. Over a 20 year period (1986–2006), Irish males are living 5.8 years longer to an age of 76.8 years, whereas Irish females are living 4.9 years longer to an age of 81.6 years, (CSO, 2009). An aging population will result in increased spending if the use and cost of drugs increase with age for the average individual within the population. CSO projections forecast the number of elderly people will have grown by 200,000 by 2021, (CSO,

2008). A Canadian study identified population growth and population aging as two of six drivers of drug expenditure, (Canadian Institute for Health Information, 2012). They also identified general inflation, price effects, volume effects and mix of drugs as drivers of drug spending.

(Bech et al., 2010) argues a shift in the proportion of the population being elderly caused a shift in the health care expenditure in fifteen EU countries. That is, as people are living longer, it represents a shift in expenditure from one age group to another. As mentioned above, both Irish males and females are living longer. This may justify the addition of a 12^{th} HSE age cohort, the >80s and renaming >75s to 75–79 to represent a shift in population, where people are living longer.

High birth rates will also contribute to population growth and future health care costs. The CSO recorded 72,225 births in 2012 in Ireland, which is 19.3 per cent higher than 2002 figures, (CSO, 2012). Eurostat found Ireland had the highest fertility rate (2.05) in the European Union (EU27) in March 2013, (Eurostat, 2013). Ireland has on average two live births per woman. This research shows the 0–11 age cohort is a key driver of future health care costs. Population growth, aging population and high fertility rates under existing policies will have a knock on effect on future GMS coverage rates. That is, more people will be eligible for medical cards.

Since July 2001, everyone over the age of 70 had an entitlement to a free medical card. In January 2009, eligibility for the GMS scheme changed for the >70s. New medical card income limits were introduced. A single person with an income of €700 per week (€36,500 per year) or a couple with an income of €1,400 per week (€73,000 per year) were no longer entitled to a free medical card, (Barry et al., 2010). Budget 2014 reduced the income limits to €500 per week for a single person and €900 per week for a married couple, (Department of Finance, 2013). This policy change will reduce the eligibility rates and reduce overall coverage rates, holding all other factors constant. Due to the three drivers of future health costs as mentioned above, GMS

coverage is likely to increase, thus increasing health costs. To counter this increase, the Irish government needs to consider further decreasing the income limits for medical cards, while taking account of equity.

The Midlands region is the most expensive and the North–West is the least expensive old health board region between 2003 and 2009 in terms of the average pharmacy cost per eligible GMS person. The Midlands cost ranged from €649.14 in 2003 to €943.28 in 2009 and the North–West ranged from €521.91 and €787.19 over the same time period, (PCRS, 2009). This research shows that this trend is forecasted to continue to 2026. The regional variation in cost may be explained by the following two studies. The distribution of chronic conditions was examined across the old health board regions and it was found the Midlands had the highest prevalence of chronic conditions with the Western and North–Western regions having the lowest, (Naughton et al., 2006). The prescribing prevalence of insulin dependent and non-insulin dependent diabetes was examined across regions, (Usher et al., 2005). They found the Midlands and the Mid–Western regions had the highest prescribing ratios for both types of diabetes and the North-Western region had the lowest prescribing ratio. It is well documented that females visit doctors more regularly than men, hence prescribing rates are higher for females with a resulting effect of higher health costs. These results confirm this, with females forecasting higher costs than males for all scenarios.

The claims rate, i.e. the proportion who make a claim on a medical card, has been above 90 per cent since 2002. The Irish government introduced a patient co–payment system in October 2010 for medical card holders with a 50 cent per prescription charge, capped at €10 per month and in Budget 2014, this was increased to €2.50 per prescription item, with a monthly cap of €25, (Department of Finance, 2013). (Sinnott, Guinane, Whelton and Byrne, 2013) conducted a qualitative study on the 50 cent co–payment charge and found that patients were mostly accepting of the charge and it did not affect patient demand for drugs. No research has been done on subsequent increases in the patient co–payment Irish system. More expensive co–payment charges exist in

the UK (Schafheutle, 2008), Italy (Atella et al., 2005) and Australia (Doran et al., 2005). These studies show that an expensive co–payment system can affect the utilisation and demand for drugs. It is well documented in the literature that co–payment charges can reduce the utilisation of both essential and non–essential medicines in vulnerable populations such as the poor, elderly and chronically ill, (Rice and Matsuoka, 2004) and (Lexchin and Grootendorst, 2004). Therefore, the Irish government needs to be mindful of the ill–effects of future increases in prescription charges as these groups comprise the GMS population in Ireland.

(Bennett et al., 2009) compiled projections on future prescribing for three of the community drug schemes; GMS scheme, DPS and LTI scheme. They used two models to predict trends in future prescribing; a linear current use model (2006 data) and a regression analysis model. They found ingredient costs are likely to be between €1.5bn and €2.3bn for the three community drug schemes (GMS, LTI & DPS) in 2020 with the largest increase in the GMS scheme. This research projects total pharmacy cost rising to €1.6bn in 2021 for the GMS scheme. The ingredient cost incorporates approximately 80 per cent of the total cost of prescriptions. The total cost of prescriptions is comprised of the ingredient cost, dispensing fee and VAT. (Bennett et al., 2009) projections do not take into account the impact of the recession on the demand for pharmaceuticals, the price reductions under the IPHA/HSE agreement, or the possible impact of generic substitution and reference pricing. Despite the IPHA/HSE agreement, overall pharmaceutical expenditure continued to increase post 2006 no doubt reflecting the key drivers of population growth and aging, although there has been a moderation in expenditure growth. Some of the recent moderation in pharmaceutical expenditure growth is undoubtedly due to the measures taken by the State and some by the decline in demand due to the recession, (Gorecki et al., 2012). This research updates and expands the (Bennett et al., 2009) projections for the GMS scheme only. In addition, this research includes demographic and regional population changes, policy variables and provides a Monte Carlo sensitivity analysis of the results.

A number of predictive studies have been undertaken in the United States on future health care costs, which also inform future prescribing costs. (Wrobel et al., 2004) and (Sales et al., 2003) predicted drug expenditures for the Medicare scheme and a veteran health population respectively and their models included demographic and health status variables. These studies found combined drug and diagnostic data is superior in predicting total health care costs. (Zhao et al., 2005) compared the predictive performance of diagnosis and drug based models to predict health care costs in the US. They found drug based models predict future pharmacy costs more effectively than diagnosis based models and a combined drug and diagnostic model is a better predictor of future health care costs than either model alone.

3.10 Conclusion

The results show the sensitivity of GMS cost projections to demographic, coverage, claims rate and average cost per claimant changes. The projections and simulations map the likely evolution of GMS cost, given existing policies and demographic trends. Over the next decade, Ireland's population will experience rapid growth. This growth coupled with an aging population will result in an increase in both the coverage rate and the claims rate, thus the projected increase in overall prescribing costs. However, these costs can be contained by government policy initiatives. Downward adjustment of the income eligibility limits can be used to curtail the coverage rates and upward adjustments to the co–payment patient prescription charges can be utilised to reduce the claims rate, thus curbing the overall average cost per claimant. These projections are conditional upon the assumptions and data on which the model is built and remain subject to substantial uncertainty given the variable nature of future economic trends and policy decisions. The next chapter projects GMS expenditure using more recent population GMS data (2012) and CSO (2013) population projections based on Census 2011. The GMS database includes the cost containment measures introduced since the economic crisis began. Using the more up to date data, an MCS model will be run to determine GMS expenditure projections in five year intervals between 2016 and 2026.

Chapter 4

GMS cost projections and its implications between 2016 and 2026 (2012 data)

4.1 Introduction

This chapter projects GMS expenditure in five year intervals between 2016 and 2026. The data used for this analysis is based on HSE–PCRS population data (2012) and CSO Regional Population Projections (2016–2031). To address the uncertainty around projections, the most likely (mean) scenario and a high (maximum) and low (minimum) scenario were modelled. A Monte Carlo Simulation model will be employed to forecast GMS costs through to 2026. In the previous chapter, GMS cost projections were based on sample 2007 PCRS data and CSO population projections based on 2006 census. This study estimated GMS expenditure to increase from €1.1 billion in 2011 to €1.9 billion by 2026.

The conclusion drawn in this study was that age (<11 and >70), females and the Midlands region were found to have the most significant effect on future GMS costs in Ireland, (Conway et al., 2014). This research was based on a sample database for the

year 2007, a year before the Irish economy slipped into a deep recession. Since then, the CSO has revised its population projections downwards, coupled with the impact of Irish government cost containment measures, this advocates that the projections of the previous chapter are likely to be overestimated. This research sets out to redress the overestimate by utilising;

1. 2012 GMS population prescription data.
2. 2013 CSO population projections.

This chapter aims to utilise the most recent available data to project Irish GMS cost from 2016 to 2026 and to examine the implications of the estimated impact on GMS expenditure. National and regional population is described in section 4.2. Policy variables are explored in subsequent sections; GMS coverage (section 4.3), average cost per claimant (section 4.4), the HSE–PCRS population prescribing database (2012) is described in section 4.5 and the claims rate (section 4.6). Section 4.7 details the cost projection model and various methodologies used to project each of the four variables. The Monte Carlo Simulation model is explained in section 4.8 followed by the descriptive and statistical analysis in section 4.9. The results are discussed in section 4.10 and conclusions are drawn in section 4.11.

4.2 Demographic variable: Regional and National Population

The 2012 population data was estimated by old health board region, sex and age cohort for comparison purposes with earlier work. There are eight regions (Eastern, South-Eastern, Southern, Western, Mid–West, Midlands, North–West and North–East) within the old health board structure in Ireland. The primary data source is the CSO Regional Population Projections 2016–2031, which projects both regional and national population. The CSO has made a number of assumptions around international migration, fertility, mortality and inter–regional flows. The current CSO release (2013)

applies two international migration assumptions; M2 and M3. Under the M2 assumption, all regions are forecasted to experience positive population growth, whereas the M3 assumption estimates net negative international migration (positive emigration) between 2011 and 2031 and varying regional population growth, where some regions will not experience population growth. The CSO only considered one fertility assumption in the current release, F2. The F2 scenario assumes the total fertility rate will decrease from 2.1 to 1.6 between 2010 and 2026 and remain constant thereafter. The most recent CSO population projections (CSO, 2013) have lower projected estimates compared to the previous population projections (CSO, 2008). The lower projections are mainly driven by a fall in fertility. The CSO used the national mortality assumption across all regions, where mortality rates are expected to decrease by 3.5% for males and 2.5% for females per annum. The CSO estimate an improvement in life expectancy for males from 78.3 years in 2011 to 83 years in 2031. For females, the CSO estimates 82.9 years in 2011 to 86.6 years in 2031, (CSO, 2013).

The fourth assumption was made around internal migration between regions. The CSO incorporated three scenarios; recent, traditional and a modified scenario into the current projections. The recent scenario assumes the pattern of inter–regional flows observed in the year to April 2011 is applied to 2031. The modified scenario assumes a pattern of increased movement to Dublin at the expense of all other regions, except the Mid–East. The traditional scenario assumes a gradual reversal of the 1996 pattern of inter–regional flows by 2021 and remains constant thereafter. The CSO developed different scenarios (6) for their regional population projections, (CSO, 2013). The M2F2 traditional scenario (M2F2T) was the main scenario used in the CSO projections and is the scenario that has been adopted for this research.

This was deemed the most appropriate[1] scenario to use at the time of population projections. In the previous chapter, M2F1T was adopted as the central scenario for

[1]Personal Communication: A conversation took place between the CSO population statistician and the researcher to confirm the M2F2T was the most appropriate scenario to use.

population projections through to 2026, which was deemed to be the most appropriate at the time of projections, (CSO, 2008).

The CSO projections are classified by year of age, sex and region. In order to reconcile the CSO data with the HSE–PCRS data structure, two adjustments (age adjustment and region adjustment) were applied to the data. The HSE identifies eleven age cohorts ranging from the <5s to the >75s. The CSO data was aggregated according to each HSE age cohort. CSO regions are not comparable with three of the HSE regions. The HSE Eastern, North–Eastern and North–Western regions are not comparable with the CSO Border, Dublin and Mid–East regions. An adjustment factor was estimated using the 2011 Census data for the three regions as this was the most up to date Census data available at the time of calculations. The same methodology was applied using the 2006 Census in the previous chapter.

For example, to estimate the Eastern region (Dublin, Kildare and Wicklow), the CSO Mid–East (Meath, Kildare and Wicklow) and Dublin data was aggregated. From the 2011 CSO Census, the number of persons in Meath, Kildare, Wicklow and Dublin were aggregated by age cohort and sex. County Meath was expressed as a proportion of the total region to form a weighting by age cohort and sex. This weighting was multiplied by the Eastern region 2012 to estimate Meath 2012 by age cohort and sex. Meath values were taken from the Eastern region to estimate the HSE Eastern region (Dublin, Kildare & Wicklow) 2012. The same methodology using the Census 2011 to establish weights was applied to estimate the HSE North–West and North–East regions. Regional and national population projections were estimated for 2016, 2021 and 2026 by age cohort, sex and HSE region using the same methodology. A lower and upper bound scenario were also developed around the mean population scenario for each projected year. The CSO M3F2T[2] scenario was used to develop projections for the lower bound scenario. An upper bound scenario was estimated as follows; (M2F2T–M3F2T) + M2F2T.

[2]Lower population estimates due to positive emigration.

Table 4.1: **Population Scenarios 2012–2026**

Scenarios	**Population**	**Population Growth Rate (%)**
Scenario 1	**Population (M3F2T)**	**Minimum (Lower Bound)**
2006	4,239,848	
2012	4,586,796	8.18
2016	4,669,239	1.80
2021	4,779,069	2.35
2026	4,853,886	1.57
Scenario 2	**Population (M2F2T)**	**Mean**
2006	4,239,848	
2012	4,586,796	8.18
2016	4,687,000	2.18
2021	4,876,000	4.03
2026	5,044,000	3.45
Scenario 3	**(M2F2T - M3F2T) + M2F2T**	**Maximum (Upper Bound)**
2012	(8.18 - 8.18) + 8.18	8.18
2016	(2.18 - 1.80) + 2.18	2.57
2021	(4.03 - 2.35) + 4.03	5.71
2026	(3.45 - 1.57) + 3.45	5.33

The total population for 2012[3], 2016[4], 2021[5] and 2026[6] was calculated by region, age cohort and sex. A lower bound and upper bound scenarios were determined around the mean population. Table 4.1 specifies the population scenarios. The minimum scenario estimates the population will grow by 1.80% between 2012 and 2016, 2.35% between 2016 and 2021 and 1.57% between 2021 and 2026.

[3]See Appendix C Table C.1 for the estimated population 2012.
[4]See Appendix C Table C.2 for the estimated population 2016.
[5]See Appendix C Table C.3 for the estimated population 2021.
[6]See Appendix C Table C.4 for the estimated population 2026.

4.3 Policy Variable: GMS Coverage

GMS coverage is the proportion of the population who are eligible for the GMS scheme. GMS coverage projections through to 2026 is updated using PCRS Statistical Analysis of Claims and Payments, Annual Report 2012 and updated CSO population projections (2013). Minimum, mean and maximum GMS coverage rates were determined from the historical data between 1996 and 2012. The PCRS report states that 40.40% of the population (1,853,877 persons) were eligible for the medical card in 2012, the highest level since data was published in 1996 (1,252,385, 34.54%), (PCRS, 2012). The mean coverage rate is the number of eligible GMS persons divided by the estimated population for 2012. Table 4.2 details the estimated population proportion who had the medical card by age, sex and HSE region in 2012. GMS coverage rates for 2012 show a similar trend to 2007 coverage rates. Table 4.2 indicates the Eastern region has the lowest male and female GMS coverage for all age cohorts except 12–15 (Southern) and the North–Western region has the highest male and female GMS coverage in all 11 age cohorts.

Table 4.2: **Estimated Population Proportion with GMS card (Scenario 2) in 2012**

Region	**0–5**	**5–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern											
Males	**0.32**	**0.41**	0.39	**0.26**	**0.19**	**0.24**	**0.25**	**0.27**	**0.36**	**0.79**	**0.79**
Females	**0.31**	**0.41**	0.39	**0.31**	**0.24**	**0.28**	**0.25**	**0.29**	**0.49**	**0.85**	**0.85**
Midlands											
Males	0.40	0.49	0.46	0.39	0.32	0.34	0.33	0.36	0.47	0.85	0.91
Females	0.40	0.49	0.46	0.46	0.39	0.39	0.35	0.40	0.62	0.90	0.93
Mid–Western											
Males	0.38	0.44	0.41	0.37	0.33	0.33	0.32	0.35	0.48	0.86	0.91
Females	0.37	0.45	0.42	0.42	0.38	0.36	0.33	0.39	0.59	0.90	0.94
North–Eastern											
Males	0.37	0.46	0.46	0.38	0.31	0.33	0.32	0.35	0.48	0.87	0.96
Females	0.37	0.47	0.45	0.43	0.36	0.37	0.34	0.39	0.61	0.93	0.98
North–Western											
Males	**0.44**	**0.54**	**0.54**	**0.49**	**0.42**	**0.42**	**0.42**	**0.45**	**0.56**	**0.93**	**0.99**
Females	**0.45**	**0.54**	**0.51**	**0.53**	**0.46**	**0.45**	**0.41**	**0.47**	**0.69**	**0.92**	**0.98**
South–Eastern											
Males	0.41	0.48	0.46	0.42	0.36	0.36	0.36	0.40	0.52	0.87	0.93
Females	0.40	0.47	0.45	0.47	0.41	0.39	0.36	0.43	0.65	0.92	0.96
Southern											
Males	0.34	0.42	**0.38**	0.33	0.28	0.30	0.30	0.34	0.47	0.85	0.90
Females	0.34	0.41	**0.38**	0.35	0.32	0.33	0.31	0.37	0.60	0.90	0.94
Western											
Males	0.38	0.49	0.47	0.41	0.34	0.35	0.36	0.40	0.53	0.86	0.90
Females	0.38	0.47	0.47	0.47	0.39	0.38	0.37	0.42	0.65	0.92	0.95

4.4 Policy Variable: Average Cost per Claimant

The average cost per claimant is the total cost of claimants divided by the number of claimants (Equation 4.1) and this was calculated using the population 2012 HSE–PCRS database.

$$\textbf{Average Cost per Claimant} = \frac{\textbf{Total Cost of Claimants}}{\textbf{Number of Claimants}} \tag{4.1}$$

The average cost per claimant was determined for each year between 2009 and 2012 from the HSE–PCRS population database, as this was the only available data. This estimate was based on four years of population data, whereas in the last chapter, this variable was estimated using one single year of sample data. There is considerable variation in the data year on year. For example, the average cost per claimant for a male in the 12–15 age cohort in the Eastern region grew by 10.97% between 2009 and 2010, decreased by 2.32% between 2010 and 2011 and increased by 6.19% between 2011 and 2012.

This variation may be explained by the economic crisis, an increase in GMS eligibility rates and the Irish government objective of containing drug costs. Due to the variation in the cost data, it was decided to take a four year average cost per claimant between 2009 and 2012 and this was taken as the base for projections of this variable. Table 4.3 details the 2012 average cost per claimant by region, sex and age cohort. The average cost per claimant for a female in the $>$ **75** age cohort is €1,739.97, which is 18 times the average cost per claimant of a female in the 0–11 age cohort (€98.80) in the Eastern region. The average cost per claimant for a male in the $>$ **75** age cohort is €1,664.57, which is 15 times the average cost per claimant of a male in the 0–11 age cohort (€113.48) in the Eastern region.

Table 4.3: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2012**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**	**Total**
Eastern											
Males	113.48	127.37	201.23	365.94	510.81	855.44	1,237.19	1,485.09	1,386.07	1,664.57	**810.19**
Females	98.80	114.57	189.31	300.26	472.01	847.53	1,208.08	1,377.45	1,432.66	1,739.97	**785.60**
Midlands											
Males	118.76	128.68	201.86	374.39	518.32	877.09	1,336.29	1,604.53	1,520.33	1,755.20	**837.11**
Females	111.62	114.39	215.22	338.88	544.14	913.62	1,360.81	1,512.64	1,559.94	1,866.88	**841.08**
Mid–Western											
Males	147.54	203.73	230.99	408.58	572.34	867.71	1,242.21	1,427.18	1,350.00	1,584.24	**796.37**
Females	134.05	135.03	228.85	361.43	534.61	867.97	1,249.48	1,378.84	1,436.28	1,662.20	**786.70**
North–Eastern											
Males	122.59	133.68	194.74	337.89	454.54	784.18	1,197.15	1,437.36	1,384.60	1,680.58	**779.55**
Females	105.40	115.28	205.75	297.92	431.60	778.82	1,139.90	1,351.51	1,455.74	1,755.58	**766.41**
North–Western											
Males	119.71	139.33	182.37	316.48	454.98	688.82	1,042.02	1,271.62	1,293.01	1,540.28	**717.06**
Females	98.14	107.87	169.22	286.02	430.32	664.28	1,042.22	1,262.87	1,304.42	1,628.30	**704.35**
South–Eastern											
Males	147.56	156.89	246.70	425.07	569.71	899.74	1,285.17	1,480.59	1,386.74	1,576.78	**813.62**
Females	125.54	148.78	240.16	364.71	550.94	922.42	1,280.35	1,410.48	1,437.33	1,634.62	**799.91**
Southern											
Males	125.00	154.44	213.75	371.83	505.60	858.64	1,227.69	1,463.63	1,420.74	1,679.72	**801.24**
Females	101.50	115.02	207.95	309.59	490.88	850.47	1,213.54	1,409.92	1,468.50	1,749.23	**785.70**
Western											
Males	130.56	135.46	209.06	374.00	523.25	802.33	1,120.81	1,351.70	1,359.05	1,570.20	**756.45**
Females	113.30	119.35	200.26	335.85	483.53	793.71	1,118.12	1,265.60	1,375.55	1,678.85	**741.31**
Total	**119.60**	**134.37**	**208.59**	**348.05**	**502.97**	**829.55**	**1,206.31**	**1,405.69**	**1,410.69**	**1,672.95**	**782.67**

Average cost per claimant percentiles were calculated to determine a lower bound and upper bound scenario. Percentiles (1%, 5%, 10%, 20% and 80%, 90%, 95% and 99%) were calculated by region, sex and age cohort. These calculations showed significant variation in the data. For example, the mean average cost per claimant for a male in the 0–11 age cohort in the Eastern region is €124.28. The 10% percentile for this cohort was €8.47 and the 90% percentile for this cohort was €192.49. In the older age cohorts there is more pronounced variation. For example, the mean average cost per claimant for a male in the over 75s age cohort in the Eastern region is €1,673,22. The 10% percentile for this cohort was €217.45 and the 90% percentile for this cohort was €3,625.64. The inter–quartile range values were also calculated, these values also showed significant variation around the mean. Therefore, the mean values (Table 4.3) were reduced uniformly by 5%[7] for the lower bound scenario and increased uniformly by 5%[8] for the upper bound scenario.

4.5 Description of 2012 HSE–PCRS Population Database

The GMS population data for the year 2012 was sourced from the HSE–PCRS database. The database is compiled of approximately 60 million observations. The 2012 database denotes one observation as one prescription item. For example, if a prescription form contains five items, this will be represented as five separate observations in the database. The 2007 PCRS sample database is detailed per prescription form, per month and the data was aggregated by claimant. Forty variables are quantified in this database, of which, seven variables are specific to this research. The HSE Local Health Office (LHO) number, year of age, sex, dispense number and total cost (ingredient cost, VAT and dispensing fee).

[7]See Appendix C Table C.5 for 2012 Average cost per Claimant scenario 1.
[8]See Appendix C Table C.6 for 2012 Average cost per Claimant scenario 3.

Table 4.4: **Local Health Offices (LHO Codes) by Old Health Board**

Region (Old Health Board)	LHO Codes
Eastern	Dublin South (1), Dublin South East (2), Dublin South City (3), Dublin South West (4), Dublin West (5), Kildare/West Wicklow (6), Wicklow (7), Dublin North West (10) Dublin North Central (11), Dublin North (12)
Midlands	Laois/Offaly (8), Longford/Westmeath (9)
Mid–Western	Clare (21), North Tipperary/East Limerick (22), Limerick (23)
North–Eastern	Cavan/Monaghan (13), Louth (14), Meath (15)
North–Western	Donegal (19), Sligo/Leitrim (20)
South–Eastern	Carlow/Kilkenny (29), Waterford (30), South Tipperary (31), Wexford (32)
Southern	South Lee Cork (24), North Lee Cork (25), West Cork (26) Kerry (27), North Cork (28)
Western	Galway (16), Mayo (17), Roscommon (18)

4.5.1 Description of Variables

HSE LHO Number: Any person can register with their local health office (32 offices in Ireland) to determine eligibility for the GMS scheme, (Department of Social and Family Affairs, 2014). If successful, a person will be granted a GMS card which will contain personal information such as name, medical card number and time period the medical card is valid for. The LHO areas were aggregated into the old health board regions, which this analysis is based on; Eastern, North–Western, North–Eastern, Midlands, Mid–West, South–Eastern, Southern and Western regions. Table 4.4 details the local health offices in each region.

Year of Age: The data was detailed by year of age. The age at the start of the year was taken as the age for the full year and aggregated into the relevant age cohort. The year of age data was aggregated by each HSE age cohort (10) ranging from 0–11 to the >75s.

Sex: The data is compiled of male and female observations.

Dispense Number: A dispense number is allocated when a single medical card is issued. If a single individual gets a medical card in January of a specific year and doesn't misplace it during the year, all of the individual's prescription items for that year will have the same dispense number. However, if a single individual gets a medical card in January and gets one replacement card during the year, there will be two dispense numbers relating to that individual's prescription items for that year. Personal communication from the PCRS informed the researcher that if a new medical card is issued, a new dispense number is generated. For example, if a medical card is lost, a new medical card is issued and a new dispense number is generated.

Total cost: Total cost is the sum of the ingredient cost, VAT on the ingredient cost, dispensing fee and VAT on dispensing fee. The ingredient cost of a drug is comprised of the ex–factory price and the wholesale mark–up. The wholesale mark–up is 12 per cent for fridge items and 8 per cent for any other drug items. The retail mark–up is zero for any items dipensed under the GMS scheme, (Brick et al., 2013). A zero per cent VAT rate is levied on oral drugs and all other drugs are levied at the higher rate of 23 per cent.

Summary Statistics of PCRS Population database, 2012

- Mean cost per Claimant – €751.09
- Median Cost per Claimant – €210.70
- Standard Deviation – €1,323.10
- Inter–Quartile Range – €44.83 – €936

4.6 Policy Variable: Claims Rate

The claims rate is the proportion of the GMS population who make a claim. 1,853,877 held medical cards in Ireland in 2012, of which, 1,649,950 made a claim (claims rate = 89%). The national and regional claims rate totals were determined from the 2012 PCRS Annual Report.

In order to determine a mean claims rate by old health board region, sex and age cohort, a weighting was calculated based on the number of eligible GMS persons in 2012. A weighted regional adjustment was applied to the estimated 2007 claims rate data (Conway et al,. 2014) by region, sex and age cohort (Equation 4.2).

$$\boldsymbol{\lambda = \frac{Y - \Sigma(w_1 r_1 ..... w_8 r_8)}{1.00 - \Sigma(w_1 r_1 ..... w_8 r_8)}} \tag{4.2}$$

$\boldsymbol{Y}$ = claims rate totals PCRS Report 2012

$\boldsymbol{w}$ = weightings of numbers covered for each region 2012

$\boldsymbol{r}$ = claims rate estimated from sample database 2007,

$\boldsymbol{r}$ = where $\boldsymbol{r_1}$ is the Eastern region and $\boldsymbol{r_8}$ is the Western region

This methodology was replicated for the eight regions. An adjustment factor (Equation 4.3) was applied to the 2007 claims rate incorporating the lambda value for each region to calculate the 2012 claims rate, the most likely scenario (Table 4.5).

$$\textbf{Adjustment Factor} = \boldsymbol{raw\ rate + \lambda(1.00 - raw\ rate)} \tag{4.3}$$

$\boldsymbol{raw\ rate}$ = the estimated 2007 claims rate

$\boldsymbol{\lambda}$ = Lambda

Table 4.5: **Mean (Scenario 2) Claims Rate 2012**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern										
Males	0.73	0.51	0.60	0.65	0.69	0.75	0.82	0.88	0.89	0.93
Females	0.68	0.53	0.71	0.75	0.76	0.80	0.88	0.89	0.92	0.90
Midlands										
Males	0.93	0.88	0.90	0.91	0.92	0.94	0.97	0.97	0.97	0.98
Females	0.93	0.88	0.93	0.94	0.94	0.96	0.98	0.98	0.98	0.98
Mid–Western										
Males	0.89	0.81	0.84	0.86	0.87	0.91	0.94	0.95	0.95	0.98
Females	0.89	0.82	0.90	0.89	0.90	0.93	0.94	0.97	0.96	0.96
North–Eastern										
Males	0.82	0.74	0.77	0.79	0.81	0.87	0.89	0.93	0.91	0.93
Females	0.82	0.74	0.87	0.85	0.86	0.88	0.92	0.92	0.93	0.93
North–Western										
Males	0.85	0.78	0.80	0.81	0.82	0.86	0.90	0.92	0.94	0.93
Females	0.83	0.78	0.85	0.87	0.87	0.88	0.91	0.94	0.94	0.94
South–Eastern										
Males	0.85	0.76	0.78	0.80	0.83	0.87	0.92	0.94	0.92	0.95
Females	0.86	0.76	0.86	0.87	0.87	0.89	0.93	0.96	0.95	0.97
Southern										
Males	0.91	0.85	0.88	0.88	0.90	0.93	0.95	0.95	0.96	0.97
Females	0.90	0.85	0.92	0.91	0.93	0.94	0.97	0.97	0.97	0.98
Western										
Males	0.84	0.77	0.80	0.82	0.84	0.87	0.90	0.91	0.93	0.93
Females	0.84	0.77	0.87	0.86	0.86	0.88	0.92	0.93	0.94	0.94
Total	**0.85**	**0.77**	**0.83**	**0.84**	**0.85**	**0.88**	**0.92**	**0.94**	**0.94**	**0.95**

A lower bound and upper bound claims rate scenarios were determined using historical data. National and regional claims rate scenarios were determined between 2005 and 2012. Although annual PCRS reports are available from 1998, only annual reports from 2005 onwards were included in this analysis. Cost of medicines data was not available in the format required prior to 2005. The minimum (lower bound) and maximum (upper bound) national and regional claims rate were determined. The lowest national claims rate was 88% and highest national claims rate was 96% (2007 level) and these formed the minimum and maximum scenarios respectively. Equation 4.4 was applied by region (8), sex (2) and age cohort (10) across 160 cells.

$$\textbf{Claims Rate 2012 Scenario 1} = \boldsymbol{raw\ rate} + (\boldsymbol{raw\ rate} * \boldsymbol{min\ rate}) \quad (4.4)$$

$\boldsymbol{raw\ rate}$ = the estimated 2012 mean claims rate

$\boldsymbol{min\ rate}$ = the minimum claims rate 2005–2012

The mean claims rate in 2012 was scaled by the minimum national and regional claims rate values to determine the lower bound claims rate scenario 2012 by region, sex and age cohort. As the maximum claims rate was 96%, 2007 claims rate from the previous chapter was taken as the upper bound scenario. The lower and upper bound scenarios[9] were generated by region, sex and age cohort.

[9]See Appendix C Table C.7 for claims rate scenarios 1 & 3, 2012.

4.7 Cost Projection Model using 2012 data

In order to project total GMS costs (Equation 4.5) through to 2026, four variables will be used; population, GMS coverage, average cost per claimant and the claims rate.

$$\textbf{Total Cost} = f\,(\textbf{Population, GMS Coverage, AC per Claimant, Claims Rate}) \tag{4.5}$$

Population estimates and projections will be based on CSO data projections. The most recent CSO population projections are based on Census 2011. The previous chapter is based on CSO population projections, which are underpinned by Census 2006. Coverage projections will be based on 2012 data as this is the most up to date data available at the time of projections. Average cost per claimant and claims rate projections will be based on HSE–PCRS 2012 population data and projected in five year intervals between 2016 through to 2026. The four variables were classified by region, sex and age cohort. To maintain consistency and comparability with the previous projections (Chapter 3), the two HSE age cohorts (<5 and 5–11) were aggregated to form 0–11 age cohort.

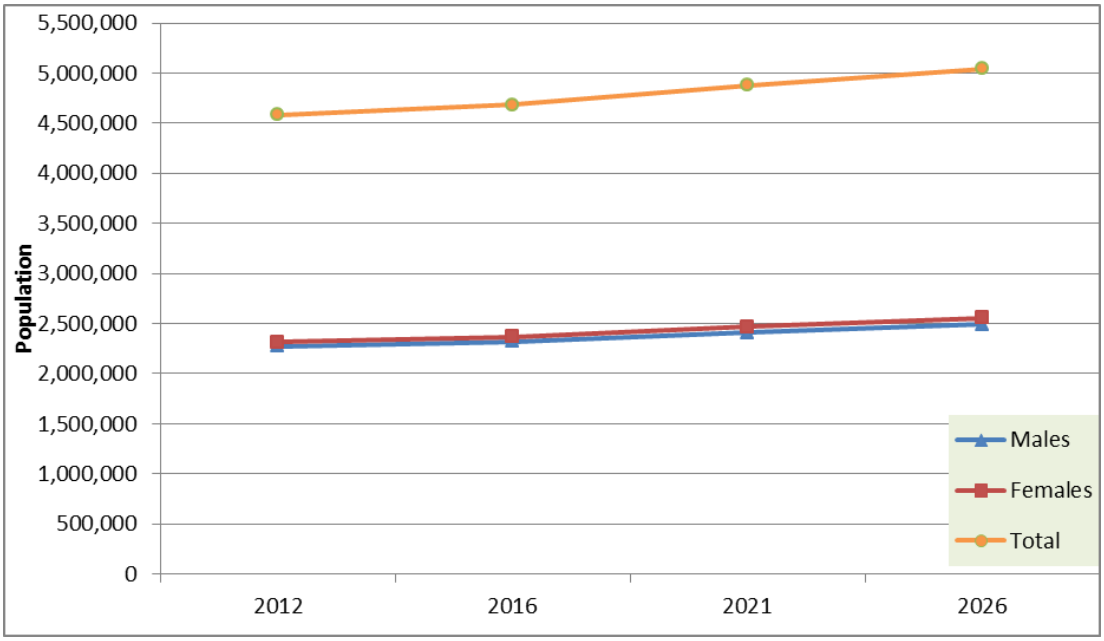
For GMS coverage, an adjustment was applied to the two age cohorts based on population weightings. Population weightings[10] were established based on the total population in 2012. For example, there is an estimated 65,673 males in the Eastern region under five and 76,185 males between five and eleven years in 2012. The former figure was expressed as a proportion of 141,858 (65,673 + 76,185) to give the population weighting (0.462947) for a male, under five in the Eastern region. This method was applied to all 8 regions by sex and age cohort. These weightings were multiplied by the GMS coverage in 2012 for the age cohorts <5 and 5–11 and aggregated and replaced by the age cohort 0–11. Population weightings were established and applied for 2016, 2021 and 2026. Three scenarios were developed for each variable.

[10]See Appendix C Table C.9 for population weightings that were applied to the coverage parameter.

Variable 1: Population Estimates and Projections

The population of Ireland is projected to grow over the lifetime of the projection period. The following results are based on the most likely population scenario. Figure 4.1 estimates the population of Ireland will increase from 4,586,388 in 2012 to 5,043,894 in 2026, an estimated increase of 9.98 per cent.

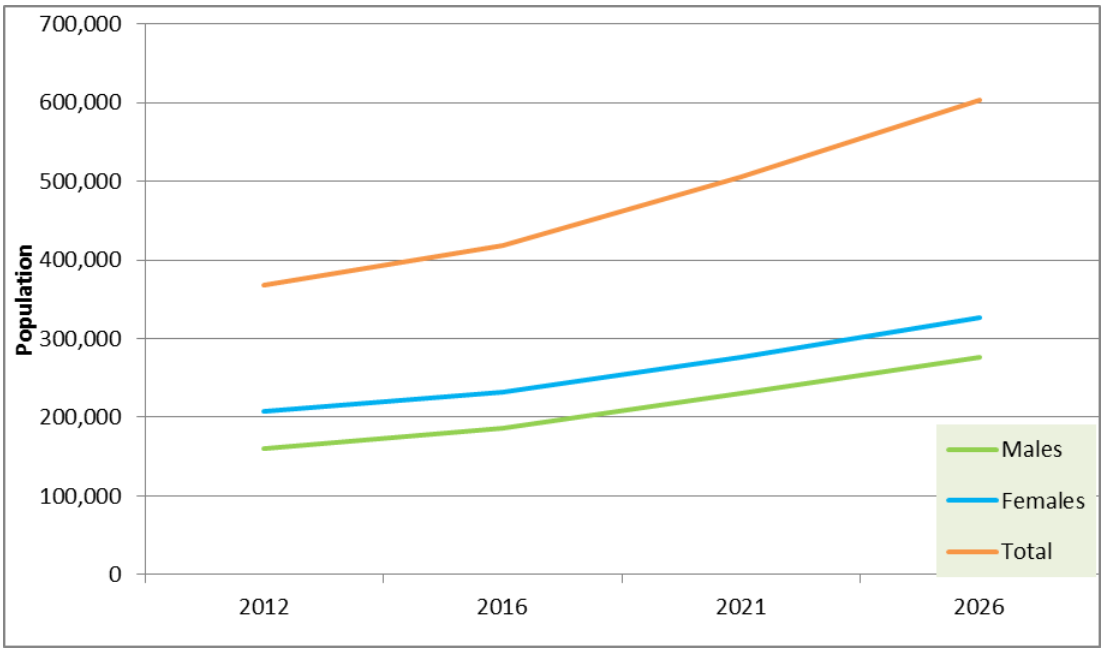
Figure 4.1: **Estimated Population Growth 2012 – 2026**



The male population is estimated to increase from 2,274,357 in 2012 to 2,489,827 in 2026, an increase of 9.47 per cent. The female population is estimated to increase from 2,312,031 in 2012 to 2,554,067 in 2026, an increase of 10.47 per cent. Female population is increasing at a marginally faster rate than the male population, as illustrated in Figure 4.1. The updated CSO population projections (CSO, 2013) are more conservatve than population projections (CSO, 2008). The number of old persons (65 years and over) will see a significant increase over the lifetime of the population projections. In 2012, there are 180,872 persons between 65 and 69 years, this increases to 252,016, an increase of 39.33 per cent in 2026. In the 70 to 74 age category there is an 60.03 per cent increase from 132,510 in 2012 to 212,050 in 2026. The >75s experience the

largest increase over the lifetime of the projections, where the population increases from 235,122 in 2012 to 390,800 in 2026, an increase of 66.21 per cent. The >70s includes two age cohorts; 70–74 and >75. These two age cohorts were summed together for the purpose of this analysis. Figure 4.2 shows that the total >70 population is projected to grow by 63.98 per cent over the lifetime of the projections.

Figure 4.2: **Estimated Population Growth Over 70s, 2012 – 2026**



The male population is expected to grow at a higher rate than the female >70s population. The male population is expected to grow by 72.20 per cent, whereas the female population is expected to grow by 57.63 per cent between 2012 and 2026. Table 4.6 compares the CSO national population projections with the population projections reconciled with the HSE regions using the M2F2T scenario and previous population projections. Estimated population[11] for 2012, 2016, 2021 and 2026 are classified by sex, age cohort and region.

[11]See Appendix C Table C.10 for population scenario projections for 2012–2026.

Table 4.6: **Comparison of National Population Projections (M2F2T Scenario)**

Year	CSO Projections	Current Projections reconciled with HSE Regions	Previous Projections - M2F1T (Conway et al,. 2014)
2012	4,586,796	4,586,388	4,685,743
2016	4,687,000	4,686,790	5,095,004
2021	4,876,000	4,876,368	5,451,088
2026	5,044,000	5,043,894	5,696,000

Dependency Ratio

The dependency ratio (ratio of population aged >65 to the population aged 18–64) indicates the likely impact of population aging. The dependency ratio is estimated to increase from 0.21 in 2016, to 0.24 in 2021 and to 0.27 in 2026. The inverse (ratio of population aged 18–64 to the population aged >65 shows those of working age who support the older population of >65 can be more informative, (Barrett et al., 2011). It decreases from 4.54 in 2016, to 3.95 in 2021 to 3.49 in 2026.

Regional Population Estimates and Projections

Regional population is expressed as a proportion of total national population, as illustrated in Figure 4.3. The Eastern region will see an increase in population over the lifetime of the projections. The seven other regions will see a reduction in population between 2012 and 2026. The Eastern region is projected to grow from 35.26 per cent in 2012 to 37.17 per cent of the population in 2026. This increase is at the expense of all other regions. The Western region experiences the largest decrease over the lifetime of the projection period from 9.60 per cent in 2012 to 9.03 per cent in 2026, as illustrated in Figure 4.4.

Figure 4.3: **Regional Population Proportions 2012**

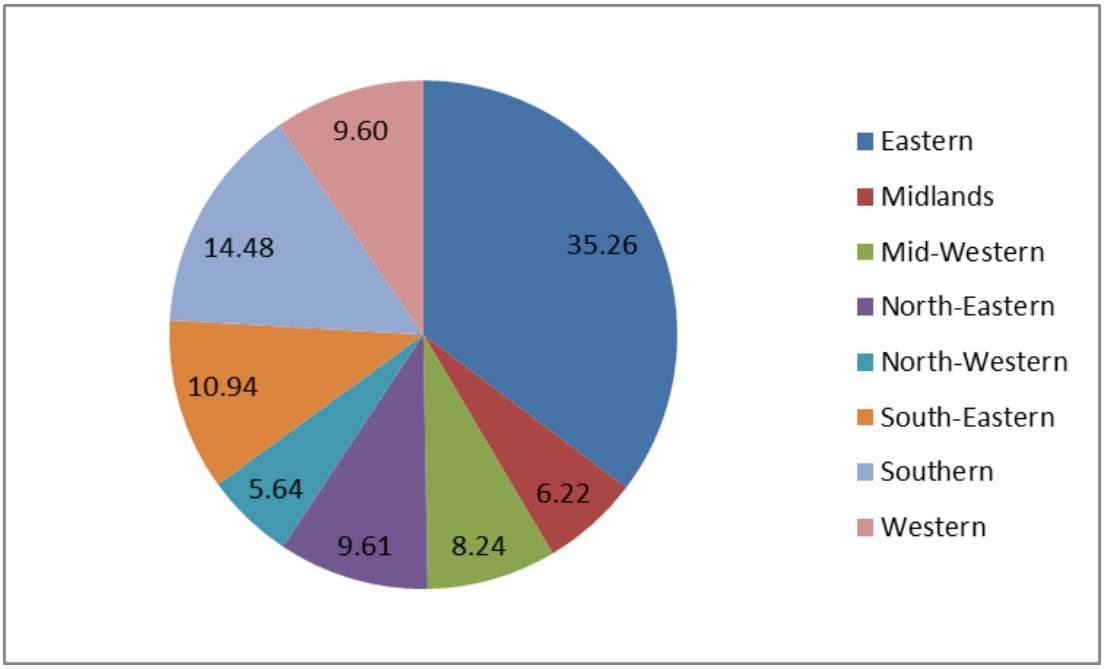
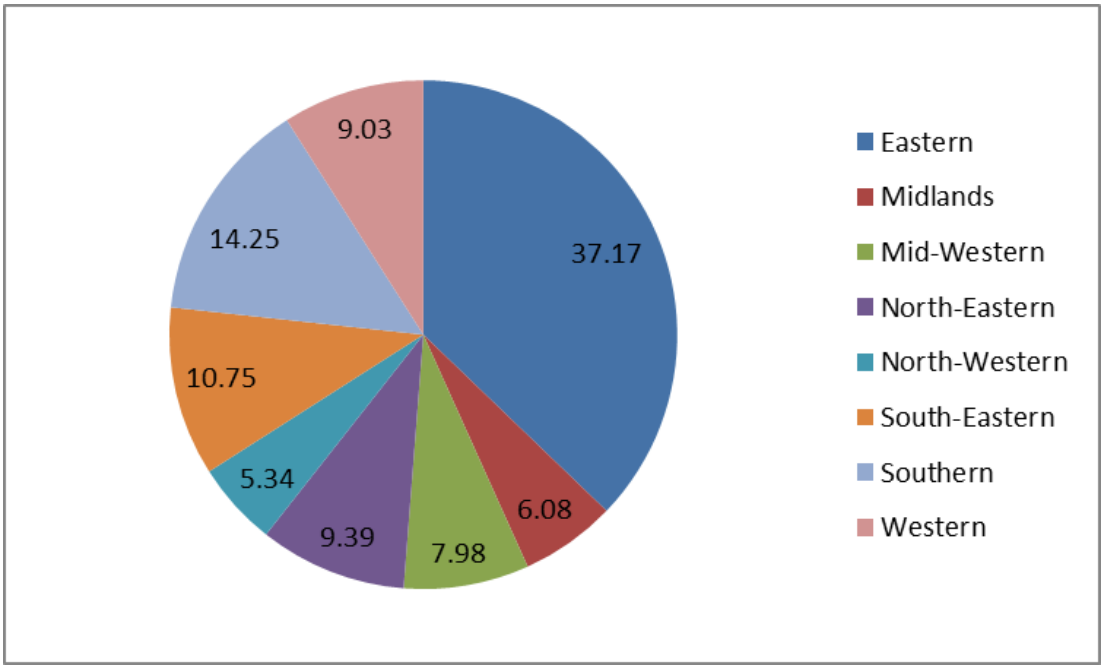


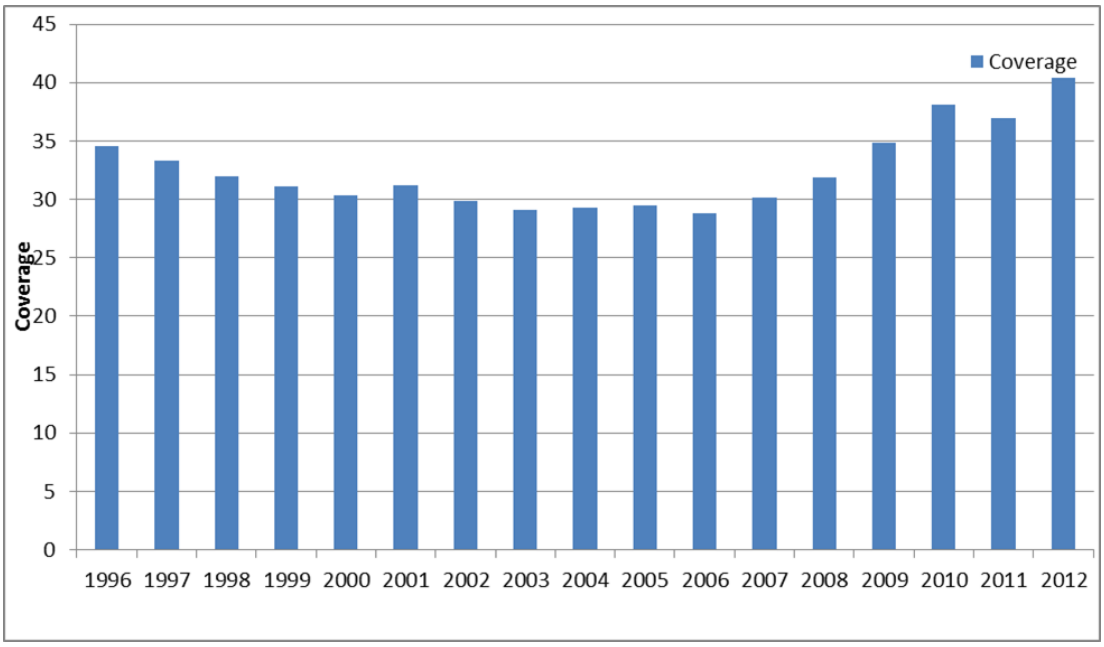
Figure 4.4: **Regional Population Proportions 2026**



Variable 2: GMS Coverage Estimates and Projections

The GMS coverage[12] for 2012 was formulated by dividing the GMS population by the total estimated population. The GMS population is the number of people who are eligible for the medical card by region, age and sex. Figure 4.5 and Table 4.7 detail the percentage and number of people who were eligible for the medical card between 1996 and 2012.

Figure 4.5: **Percentage of Eligible GMS Persons, 1996 – 2012**



Source:(**Various PCRS Reports, 1996-2012**)

[12]See Table 1.2 for the population proportion who have a GMS card by age, region and sex, 2012.

Table 4.7: **Number & Percentage of Eligible GMS Persons, 1996–2012**

Year	Persons	Percentage	Percentage Change
1996	1,252,385	34.54	
1997	1,219,852	33.32	-1.22
1998	1,183,554	31.95	-1.37
1999	1,164,187	31.09	-0.86
2000	1,148,055	30.32	-0.77
2001	1,199,454	31.24	0.92
2002	1,168,745	29.84	-1.40
2003	1,158,143	29.11	-0.73
2004	1,148,914	29.33	0.22
2005	1,155,727	29.50	0.17
2006	1,221,695	28.85	-0.65
2007	1,276,178	30.10	1.25
2008	1,352,120	31.89	1.79
2009	1,478,560	34.87	2.98
2010	1,615,809	38.11	3.24
2011	1,694,063	36.92	-1.19
2012	1,853,877	40.40	3.48

Source:(**Various PCRS Reports, 1996–2012**)

Table 4.8: **Coverage Scenarios 2012**

Scenarios	**Coverage Percentage change**	**Coverage**
Scenario 1	**Minimum Percentage Change**	**Minimum**
28.85	-1.40	0.986000
Scenario 2	**Mean Percentage Change**	**Mean**
32.43	0.37	1.003663
Scenario 3	**Maximum Percentage Change**	**Maximum**
40.40	3.48	1.034800

In order to estimate 2012 coverage rates; three scenarios were established as detailed in Table 4.8. The minimum, mean and maximum scenarios were calculated based on historical coverage data between 1996 and 2012[13]. In order to determine the minimum and maximum scenarios for 2012, the minimum and maximum percentage coverage change was determined from the data in Table 4.7. Coverage 2012 was scaled down by 1.40% uniformly across region, sex and age cohort to estimate coverage 2012, scenario 1[14]. In order to determine the 2012 maximum coverage scenario (scenario 3)[15], coverage 2012 was scaled up by 3.48% uniformly across region, sex and age cohort. The mean scenario was taken as the most likely coverage rate. The three scenarios were formulated by region, age cohort and sex. The number of eligible persons increased from 1,352,120 in 2008 to 1,853,877 in 2012, an increase of 501,757 persons (37.11% increase). (PCRS, 2012) reports this as the highest number of medical card holders ever recorded in Ireland.

An adjustment factor (Equation 4.6) was applied to the 2012 coverage data. If the >75 age cohort for each region and sex exceeded 1.00, an adjustment factor was applied. The >75 value for each region and age cohort was scaled downwards below

[13]See Table 4.7 for historical GMS coverage rates between 1996 and 2012.
[14]See Appendix C Table C.22 for the 2012 coverage scenario 1.
[15]See Appendix C Table C.23 for the 2012 coverage scenario 3.

1.00. For example, if the projected population for the >75 in a given region is 100 but the number of projected GMS eligible persons is 103, GMS coverage rate is 1.03. As this value exceeds 1.00, the adjustment factor below was applied to scale the value below 1.00.

$$\textbf{Adjustment Factor} = \boldsymbol{Min(> 75 - \lambda(1.00 - 70\ to\ 74\ age\ cohort))} \tag{4.6}$$

Coverage projections 2016 through to 2026 were based on the reference year 2012 (coverage 2012 data), as this was the most up to date data available at the time of projections. In order to project coverage 2016, three scenarios; minimum, mean and maximum were calculated based on the historical coverage data between 1996 and 2012 (Table 4.7). The minimum value (0.2885) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,352,139. The difference between total number of eligible persons 2012 (1,853,877) and 2016 (1,352,139) was derived and expressed as a proportion (0.729357). This value was multiplied by coverage 2012 to generate scenario 1 coverage 2016[16] by region, sex and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, sex and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort. A 2016 population weighting (Equation 4.7) for the <5 age cohort is expressed as follows:

$$\textbf{Population Weighting} < 5 = \frac{\textbf{68,112}}{\textbf{68,112 + 85,993}} = \textbf{0.441984} \tag{4.7}$$

The population weighting for the 5 to 11 age cohort is 0.558016. The weightings (0.441984 & 0.558016) were multiplied by the coverage rates; 0.23 and 0.30 to form the coverage rate for the 0–11 (0.27) age cohort. The mean value (0.3243) was multiplied

[16]See Appendix C Table C.24 for coverage scenario 1, 2016.

by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,519,926. The difference between total number of eligible persons 2012 (1,853,877) and 2016 (1,519,926) was derived and expressed as a proportion (0.819863). This value was multiplied by coverage 2012 to generate scenario 2, coverage 2016[17] by region, sex and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, sex and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort.

The maximum value (0.4040) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,893,463. The difference between total number of eligible persons 2012 (1,853,877) and 2016 (1,893,463) was derived and expressed as a proportion (1.021353). This value was multiplied by coverage 2012 to generate scenario 3 coverage 2016[18] by region, sex and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons 2016 by region, sex and age cohort. Population weightings were applied to the coverage age cohorts of <5 and 5–11 to determine the 0–11 age cohort. An adjustment factor was applied to the >75 age cohort of scenario 3, 2016 as the coverage values exceeded 1.00. For the >75 age cohort, the adjustment factor did not scale the data sufficiently below 1.00. Therefore, 0.99 coverage rates were applied uniformly across all regions and genders.

This methodology was replicated to determine coverage projections 2021[19] and coverage projections 2026[20]. Three scenarios were calculated for each year. 2021 and 2026 coverage projections were based on the most likely projected population of 4,876,368 and 5,043,894 respectively. An adjustment factor was applied to the 70–74 age cohort of scenario 3, 2021 and 2026 coverage rates as the coverage values exceeded 1.00.

[17]See Appendix C Table C.25 for coverage scenario 2, 2016.
[18]See Appendix C Table C.26 for coverage scenario 3, 2016.
[19]See Appendix C Table C.27 for coverage scenarios 1, 2 and 3, 2021.
[20]See Appendix C Table C.30 for coverage scenarios 1, 2 and 3, 2026.

Table 4.9: **GMS Coverage Projections 2016–2026 based on 2012 data**

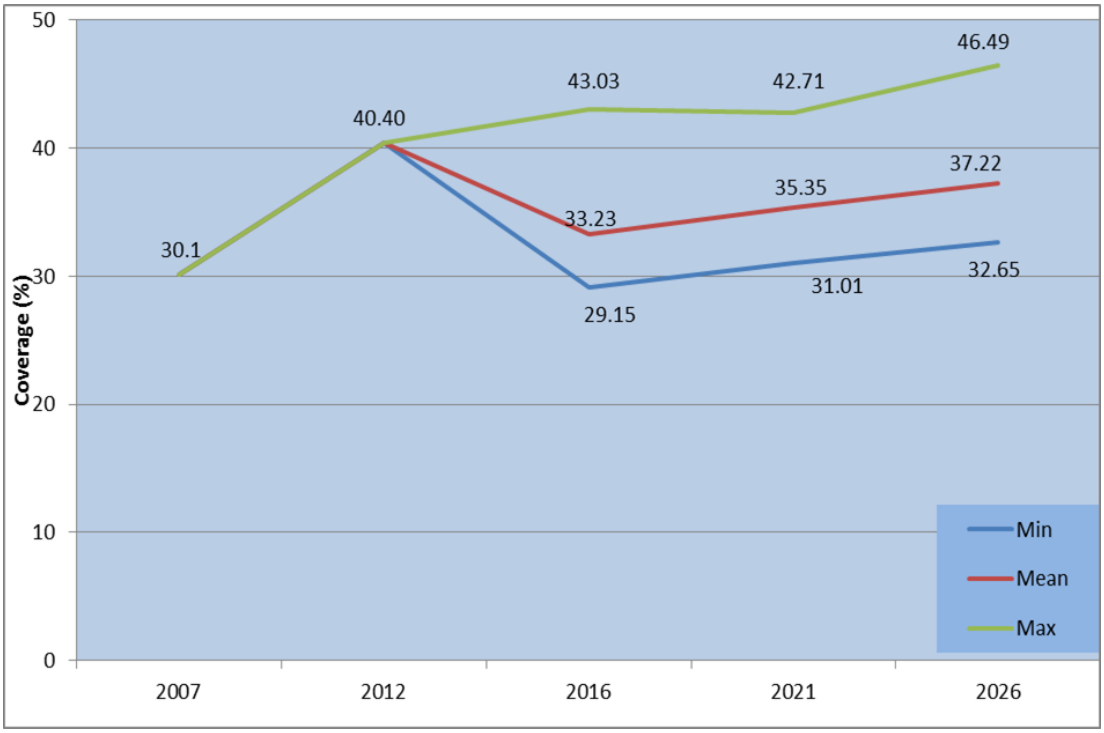
Scenario	Year	No. of Eligible Persons	Population	Coverage (%)
Mean	2012	1,853,877		40.40
Minimum	2016	1,366,229		29.15
Mean		1,557,570	4,686,790	33.23
Maximum		2,016,889		43.03
Minimum	2021	1,512,215		31.01
Mean		1,724,002	4,876,368	35.35
Maximum		2,082,718		42.71
Minimum	2026	1,646,661		32.65
Mean		1,877,198	5,043,894	37.22
Maximum		2,345,123		46.49

For the >75 age cohort, the adjustment factor did not scale the data sufficiently below 1.00. Therefore, 0.99 coverage rates were applied uniformly across all regions and genders.

Number of eligible persons and coverage projections are presented in Table 4.9. In Table 4.9, 2012 are actual figures and 2016 through to 2026 are projected figures. Coverage rates are based on the most likely population level for each year. The most likely coverage rate is estimated to be approximately 33.23 per cent in 2016, 35.35 per cent in 2021 and 37.22 per cent in 2026, as illustrated in Figure 4.6. It is estimated that the number of eligible GMS persons will lie between 1.3 million and 2.0 million in 2016, 1.5 million and 2.0 million in 2021 and 1.6 million and 2.3 million in 2026[21].

[21] See Appendix C Figure C.1 for Number of Eligible Persons updated Projections 2016 – 2026.

Figure 4.6: **GMS Coverage Projections Updated (%) 2016–2026**



Variable 3: Average Cost per claimant Estimates and Projections

The four year average cost per claimant plus or minus 5% formed the basis of projections between 2016 and 2026. Average cost per claimant data was only available between 2009 and 2012 and this was analysed for projection purposes. Historical annual growth rates were calculated between 2009 and 2012. The minimum, mean and maximum growth rates were determined over this time period by region, sex and age cohort. The historical growth rates showed huge variation in the data across all age cohorts during this recessionary period. Therefore, a four year average of the Irish health inflation rate Consumer Price Index (CPI[22]) was determined between 2009 and 2012. There is also inflation variation year on year during this time period, as described in Table 4.10. The four year average of 2% was applied annually to determine average cost per claimant for 2016, 2021 and 2026 for all 3 scenarios.

[22]The CPI measures the overall change in the prices of goods and services of a typical basket of goods and services every month, (CSO, 2015*a*).

Table 4.10: **Consumer Price Index (All items, health items) 2008 - 2012, Ireland (Base Dec2011 = 100)**

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**4 year average**
Health Items	92.9	96.2	96.8	100.0	100.5	
Annual % Change In CPI	-	3.5	0.6	3.4	0.5	**2.0**

Source:(**CSO, 2012**)

The minimum 2012 average cost per claimant (scenario 1) values by region, sex and age cohort were uniformly increased by 2% to determine 2016 scenario 1 average cost per claimant by region, gender and age cohort. Equation 4.8 was applied to males in 0–11 age cohort in the Eastern region to determine the minimum (scenario 1) 2016 value for males in the 0–11 age cohort in the Eastern region. There is a four year interval between 2012 and 2016 so all values were compounded by 4. This methodology was applied across all data values to estimate 2016 scenario 1[23], scenario 2[24] and scenario 3[25] average cost per claimant.

$$\textbf{Min 2016} = \boldsymbol{Min}\textbf{2012}(\textbf{1} + \textbf{0.02})^{\textbf{4}} \tag{4.8}$$

The minimum 2016 average cost per claimant (scenario 1) values by region, sex and age cohort were uniformly increased by 2% to determine 2021 scenario 1 average cost per claimant by region, gender and age cohort. Equation 4.9 was applied to males in 0–11 age cohort in the Eastern region to determine the minimum (scenario 1) 2021 value for males in the 0–11 age cohort in the Eastern region. There is a five year interval between 2016 and 2021 so all values were compounded by 5. This methodology was applied across all data values to estimate 2021 scenario 1[26], scenario 2[27] and scenario 3[28] average cost per claimant.

[23]See Appendix C Table C.33 scenario 1 average cost per claimant 2016.
[24]See Appendix C Table C.34 scenario 2 average cost per claimant 2016.
[25]See Appendix C Table C.35 scenario 3 average cost per claimant 2016.
[26]See Appendix C Table C.36 scenario 1 average cost per claimant 2021.
[27]See Appendix C Table C.37 scenario 2 average cost per claimant 2021.
[28]See Appendix C Table C.38 scenario 3 average cost per claimant 2021.

$$\textbf{Min 2021} = Min\textbf{2016}(\textbf{1} + \textbf{0.02})^{\textbf{5}} \tag{4.9}$$

The minimum 2021 average cost per claimant (scenario 1) values by region, sex and age cohort were uniformly increased by 2% to determine 2026 scenario 1 average cost per claimant by region, gender and age cohort. Equation 4.10 was applied to males in 0–11 age cohort in the Eastern region to determine the minimum (scenario 1) 2026 value for males in the 0–11 age cohort in the Eastern region. There is a five year interval between 2021 and 2026 so all values were compounded by 5. This methodology was applied across all data values to estimate 2026 scenario 1[29], scenario 2[30] and scenario 3[31] average cost per claimant.

$$\textbf{Min 2026} = Min\textbf{2021}(\textbf{1} + \textbf{0.02})^{\textbf{5}} \tag{4.10}$$

Variable 4: Claims Rate Projections

In the previous chapter, claims rate projections based on 2007 data were held constant throughout the lifetime of the projections. Claims rate scenarios have been re estimated based on 2012 data and these estimates will form the basis of projections for 2016, 2021 and 2026. The three claims rate scenarios are to remain at 2012 levels throughout the lifetime of the projections. The 2012 data incorporates policy changes implemented as a result of the economic crisis beginning in 2008. The recession and subsequent bailout put pressure on public health spending and various revenue raising measures were introduced across the community drug schemes, including the GMS. The Department of Health introduced a prescription charge, a 50 cent charge per prescription item for all GMS card holders on the 1st of October 2010.

[29]See Appendix C Table C.39 scenario 1 average cost per claimant 2026.
[30]See Appendix C Table C.40 scenario 2 average cost per claimant 2026.
[31]See Appendix C Table C.41 scenario 3 average cost per claimant 2026.

4.8 Monte Carlo Simulation Model

A MCS model was employed due to the uncertainty around the input parameters. MCS was employed to propagate the parameter uncertainty through 100,000 iterations. The MCS model identifies uncertain variables and an uncertain function. The uncertain variables are population, coverage, claims rate and average cost per claimant. Each uncertain variable has age cohorts (10), sex (2) and regions (8) giving a total of 160 cells to be modelled for each variable. The dependent variable is the projected total cost for 2016, 2021 and 2026. In order to prepare the data for Monte Carlo Simulations, the probability and cumulative probability of finding a person within each region, sex and age cohort (RSA) class were calculated.

The probability is the empirical probability (proportion) calculated by the quotient of class members over count of all members, which lies between 0 and 1. The cumulative probabilities were calculated, which gave a weight of occurrence within a particular class (RSA). A macro was written in Visual Basic Editor in Microsoft Excel to run the simulations. A Normal distribution was applied to estimate costs to allow for uncertainty in the model. The Central Limit Theorem can be applied, which states that the sum of random variables (4 variables) will be approximately distributed, (Bain and Engelherdt, 1991). The MCS results were imported into Minitab for analysis. All statistical analyses were performed using Minitab statistical package (Minitab 17).

4.9 Descriptive and Statistical Analysis

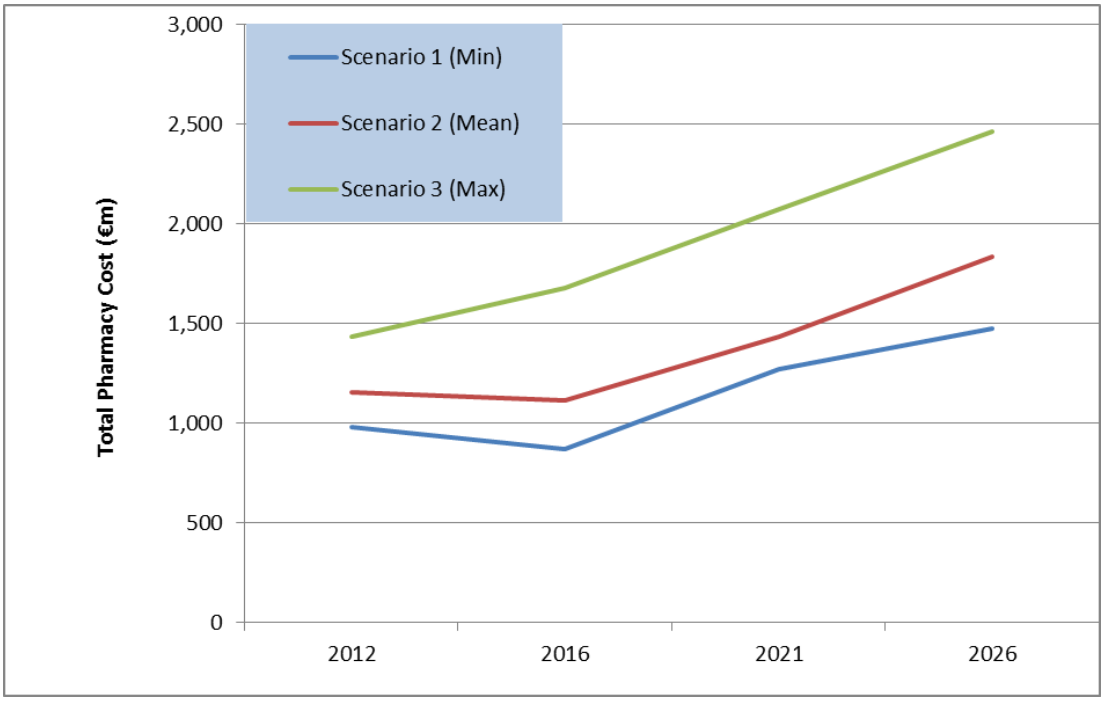
Table 4.11 details the projected total pharmacy cost is expected to lie between €869 million and €1.68 billion in 2016, €1.27 billion and €2.07 billion in 2021 and €1.47 billion and €2.47 billion in 2026.

Table 4.11: **Comparison Conway et al (2014) Previous Projections with current GMS Cost (€M) projections, 2012 – 2026, Scenarios 1 – 3**

Year	Scenario 1 (€)	Scenario 2 (€)	Scenario 3 (€)
2016	644 869	1,317 1,111	2,150 1,678
2021	703 1,272	1,626 1,435	2,876 2,075
2026	742 1,474	1,985 1,837	3,672 2,466

The most likely scenario (scenario 2) projects total pharmacy cost will be €1.11 billion in 2016, €1.43 billion in 2021 and €1.84 billion in 2026. The cost projections are subject to assumptions around the four variables. Comparing these total pharmacy cost estimates with the previous chapter projections based on 2007 data, this set of projections are tighter around the mean scenario estimates, as illustrated in Figure 4.7.

Figure 4.7: **Total Pharmacy Cost(€M) Estimates and Projections 2012–2026**



The range is not as large as previous projections between scenario 1 and scenario 3 estimates. For example, the 2007 based projections lie between €644 million and €2.15 billion in 2016, €703 million and €2.88 billion in 2021 and €742 million and €3.67 billion in 2026. The most recent cost projections in Table 4.11 are based on the most up to date CSO population projections, which are more conservative than the population projections used in the previous chapter. This contributed to more conservative GMS cost projections compared to previous projections.

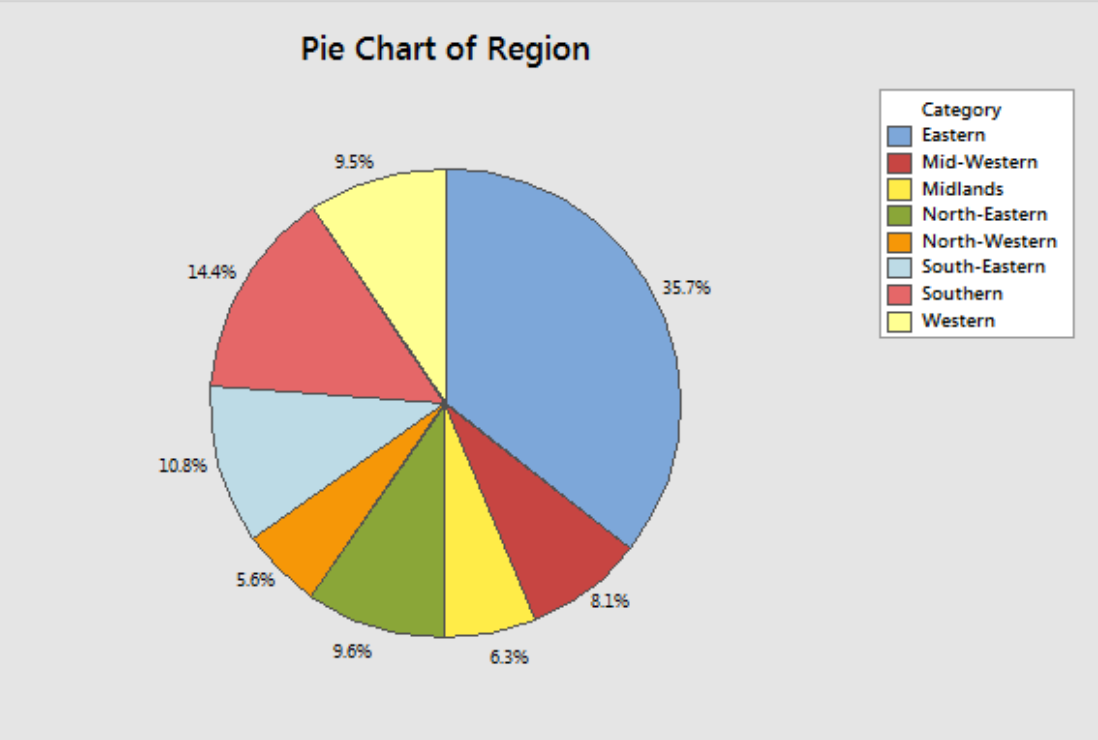
Table 4.12: **Descriptive Analysis of Average Cost per Claimant (€) 2016–2026 (Scenario 2)**

Year	♯ of Simulations	Mean	St.Dev	Min	Q1	Median	Q3	Max
2016	100,000	249.96	348.24	21.25	46.02	106.22	253.43	1573.57
2021	100,000	307.45	418.28	24.58	53.49	131.46	317.64	1806.92
2026	100,000	384.13	508.22	28.14	62.34	166.06	384.36	2063.84

4.9.1 Descriptive Analysis

The descriptive analysis of 100,000 simulations for 2016, 2021 and 2026 is detailed in Table 4.12. These results reflect the most likely scenario (scenario 2). There is considerable variation in the cost results with 25% of the data lying below €46.02 and 75% of the data lying above €253.43 in 2016. Q1 increases to €53.49 in 2021 and €62.34 in 2026, while Q3 is estimated as €317.64 in 2021 and €384.36 in 2026. The average cost per claimant is estimated to be €249.96 in 2016, €307.45 in 2021 and €384.13 in 2026. The median is estimated to be €106.22 in 2016, €131.46 in 2021 and €166.06 in 2026. The variation in the minimum and maximum cost values indicate the difference between claimants in 2012. For example, the lowest average cost per claimant is €21.25 and the highest average cost per claimant is €1,573.57. This variation is also evident in 2021 and 2026. Figure 4.8 quantifies the proportion of cost in each old health board region.

Figure 4.8: **Pie Chart of Cost (€), Scenario 2 2016**



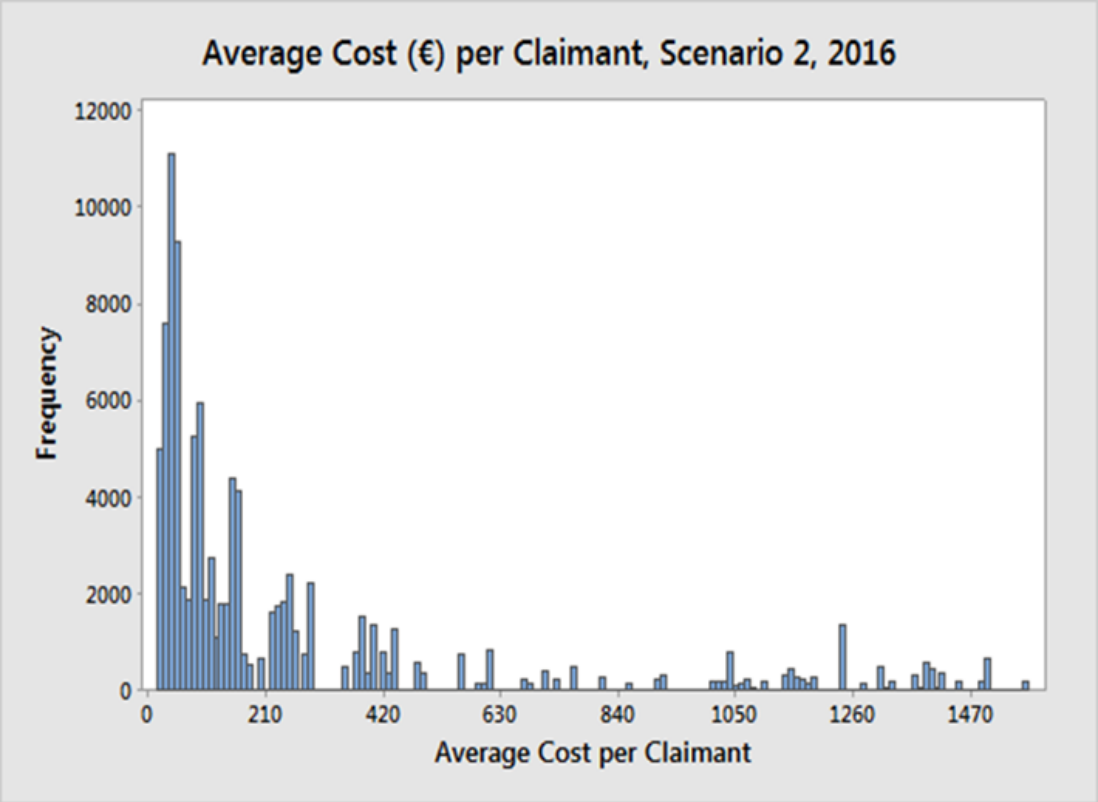
35.7% of cost can be attributed to the Eastern region, 14.4% to the Southern region, 10.8% to the South–Eastern region, 9.6% to the North–Eastern region, 9.5% to the Midlands region, 8.1% to the Mid–Western region, 6.3% to the Midlands region and 5.6% to the North–Western region. A similar picture is estimated for 2021[32] and 2026[33].

4.9.2 Statistical Analysis

The histogram plots the distribution of cost with a higher frequency of claimants having a lower average cost per claimant and a lower frequency having a higher average cost per claimant, as illustrated in Figure 4.9.

[32]See Appendix C Figure C.2 Pie Chart of Cost (€), Scenario 2 2021
[33]See Appendix C Figure C.3 Pie Chart of Cost (€), Scenario 2 2026

Figure 4.9: **Histogram of Cost (€), Scenario 2 2016**



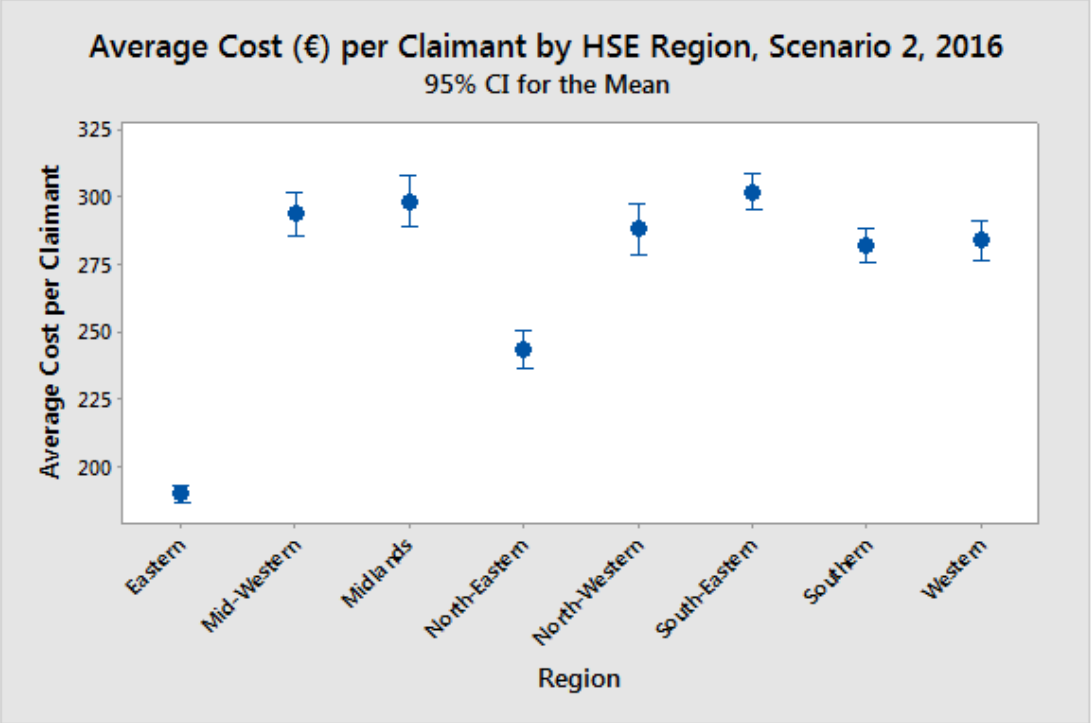
The histogram reiterates the descriptive analysis in Table 4.12, there is significant variation in cost with the lowest claim of €21.25 and the highest claim of €1,573.57 in 2016. The estimated distribution and frequency of cost shows a similar picture for 2021 and 2026[34].

Interval Plot of Cost by Region, Sex and Age Cohort

In Figure 4.10, one can be 95% confident that the average cost for a claimant in the Midlands region is €300 and approximately €200 for a claimant living in the Eastern region in 2016.

[34]See Appendix C Figure C.4 Histogram of Cost 2021 & 2026

Figure 4.10: **Interval Plot of Cost by Region, Scenario 2 2016**

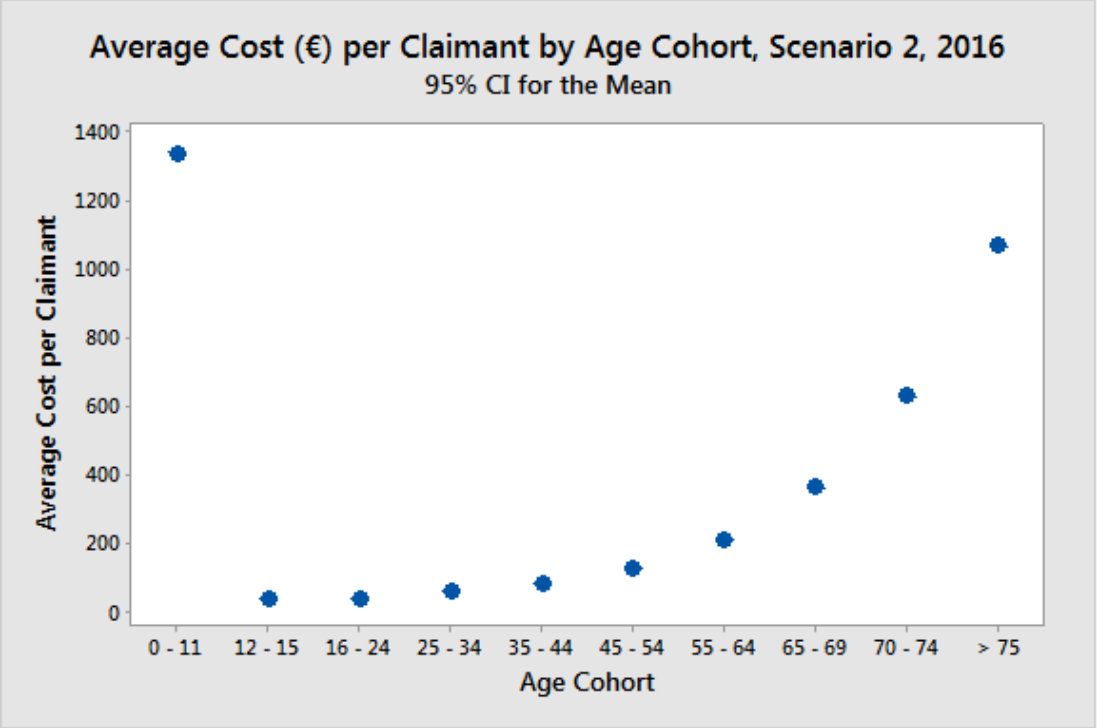


The average cost for a claimant living in the remaining six regions lies between €200 and €300. In 2021[35], the projections show one can be 95% confident that the average cost for a claimant in the South–Eastern region is €375 and approximately €225 for a claimant living in the Eastern region. In 2026[36], the projections show one can be 95% confident that the average cost for a claimant in the Midlands region is €475 and approximately €300 for a claimant living in the Eastern region.

In 2016, one can be 95% confident that the average cost per claimant lies between €1,300 and €1,400 for the 0–11 age group, lies between €700 and €800 for the 70–74 age group and between €1,100 and €1,200 for the over 75s, as illustrated in Figure 4.11.

[35]See Appendix C Figure C.6 Interval Plot of Cost by Region, Scenario 2 2021
[36]See Appendix C Figure C.7 Interval Plot of Cost by Region, Scenario 2 2026

Figure 4.11: **Interval Plot of Cost by Age Cohort, Scenario 2 2016**

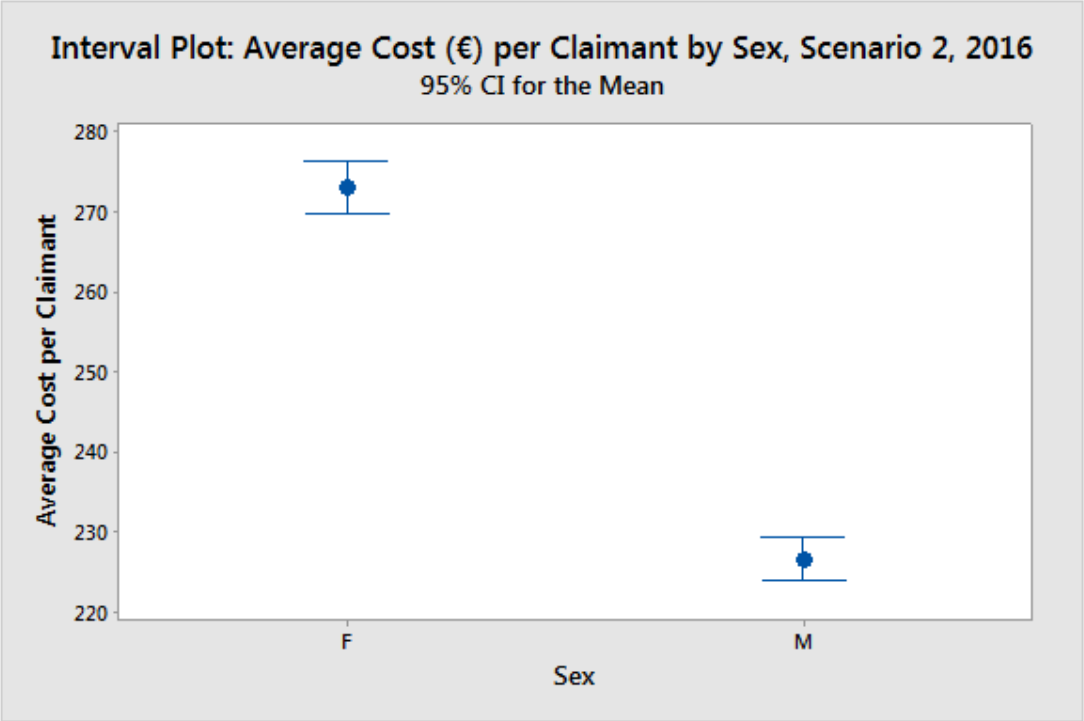


Estimates for these high cost groups continue for 2021 and 2026. In 2021[37], one can be 95% confident that the average cost per claimant lies between €1,500 and €1,600 for the 0–11 age group, lies between €700 and €800 for the 70–74 age group and between €1,200 and €1,300 for the >75s. In 2026[38], one can be 95% confident that the average cost per claimant will be approximately €1,750 for the 0–11 age group, lies between €800 and €1,000 for the 70–74 age group and approximately €1,500 for the >75s.

In 2016, one can be 95% confident that the average cost per claimant lies between €270 and €280 for a female and between €225 and €230 for a male, as illustrated in Figure 4.12.

[37]See Appendix C Figure C.8 Interval Plot of Cost by Age Cohort, Scenario 2 2021
[38]See Appendix C Figure C.9 Interval Plot of Cost by Age Cohort, Scenario 2 2026

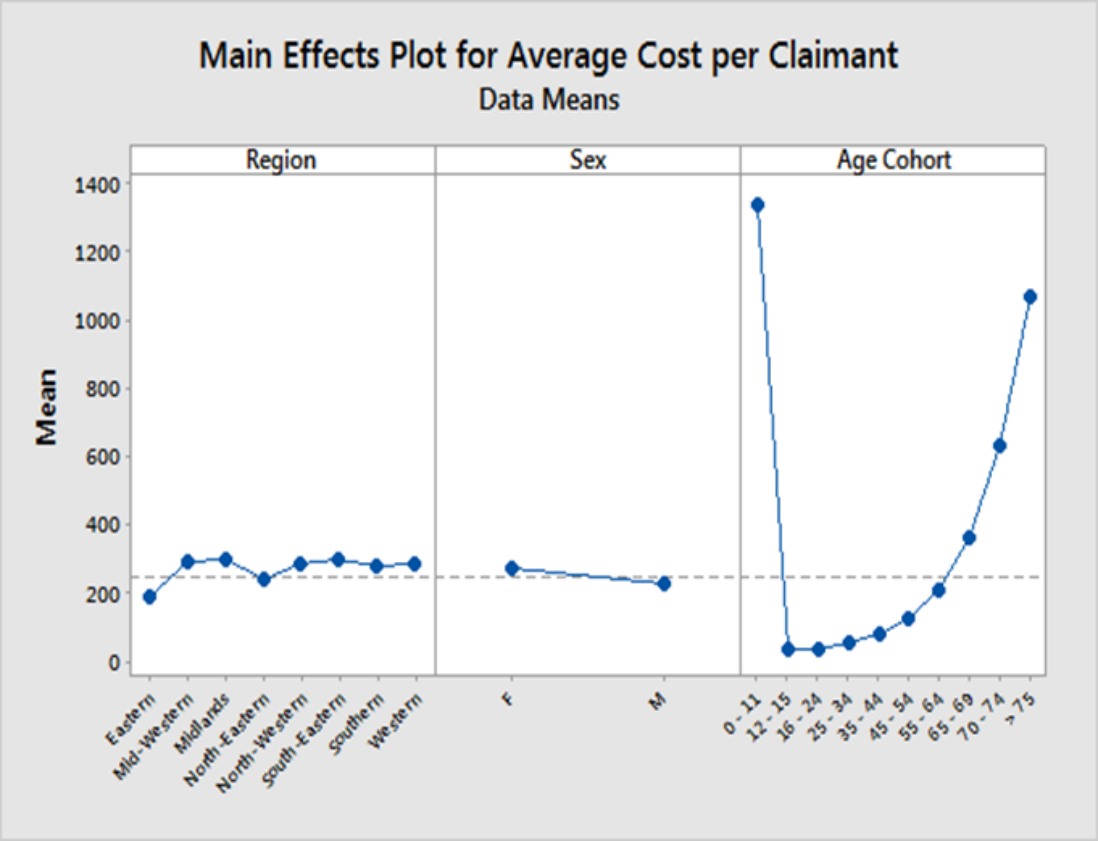
Figure 4.12: **Interval Plot of Cost by Sex, Scenario 2 2016**



In 2021[39], one can be 95% confident the average cost per claimant increases to between €330 and €340 for females and between €280 and €290 for males. One can be 95% confident, the average cost per claimant increases to between €415 and €425 for females and between €345 and €355 for males in 2026[40]. In Figure 4.13, the Main Effects Plot examines the differences between the three variables; old health board region, sex and age cohort.

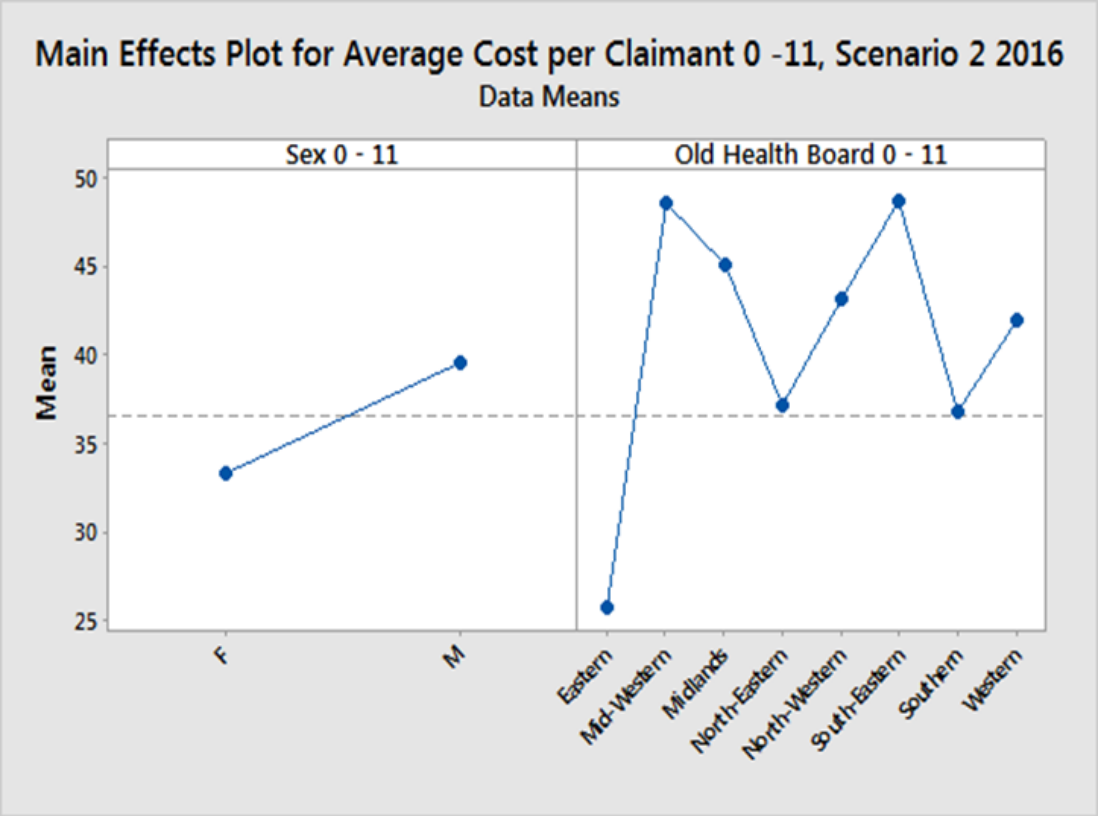
[39]See Appendix C Figure C.10 Interval Plot of Cost by Sex, Scenario 2 2021
[40]See Appendix C Figure C.11 Interval Plot of Cost by Sex, Scenario 2 2026

Figure 4.13: **Main Effects Plot, Scenario 2 2016**



A Main Effects Plot is used to examine differences between level means for one or more factors. There is a main effect when different levels of a factor affect the response differently. A Main Effects Plot graphs the response mean for each factor; old health board region, sex and age cohort. Sex is showing no main effect with 6 of the 8 old health board regions showing some effect; Mid–Western, Midlands, North–Western, South–Eastern, Southern and Western regions. Age cohorts show the greatest response, especially <11s, 65–69 and the >70s. These three age cohorts were further analysed. Figure 4.14 shows that males, Mid–Western and South–Eastern regions are driving costs in the <11s age group.

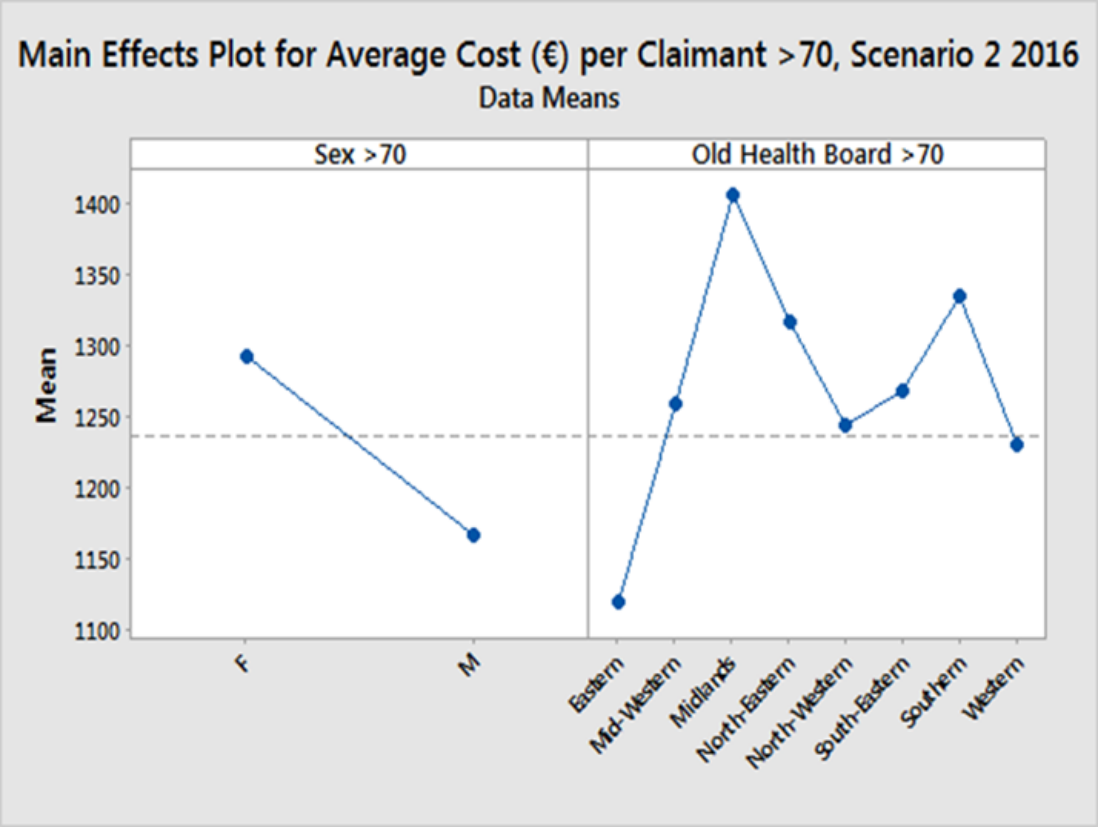
Figure 4.14: **Main Effects Plot 0–11, Scenario 2 2016**



These results were also found in 2026[41]. However, the projected results for scenario 2, 2021 show a different picture. Females in the North–West and South–Eastern regions are driving the average cost per claimant for the age cohort 0–11[42] in said regions. In Figure 4.15, females, the Midlands and Southern regions are driving costs in the >70s in 2016. These results were also found in 2026[43]. Females and alternativley the Mid–Western and South–Eastern regions are driving average costs per claimant in 2021[44].

[41]See Appendix C Figure C.12 Main Effects Plot 0–11, Scenario 2 2026.
[42]See Appendix C Figure C.13 Main Effects Plot 0–11, Scenario 2 2021.
[43]See Appendix C Figure C.14 Main Effects Plot >70, Scenario 2 2026.
[44]See Appendix C Figure C.15 Main Effects Plot >70, Scenario 2 2021.

Figure 4.15: **Main Effects Plot >70, Scenario 2 2016**



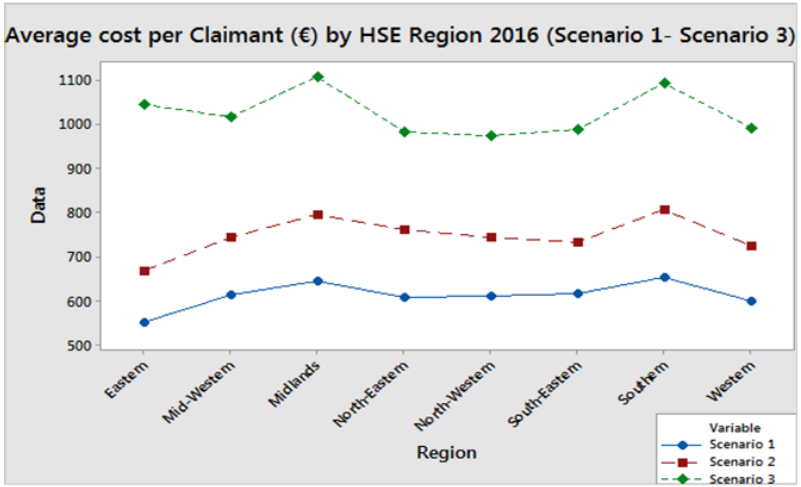
Average cost per claimant (€) by sex and region, Scenario 1–Scenario 3

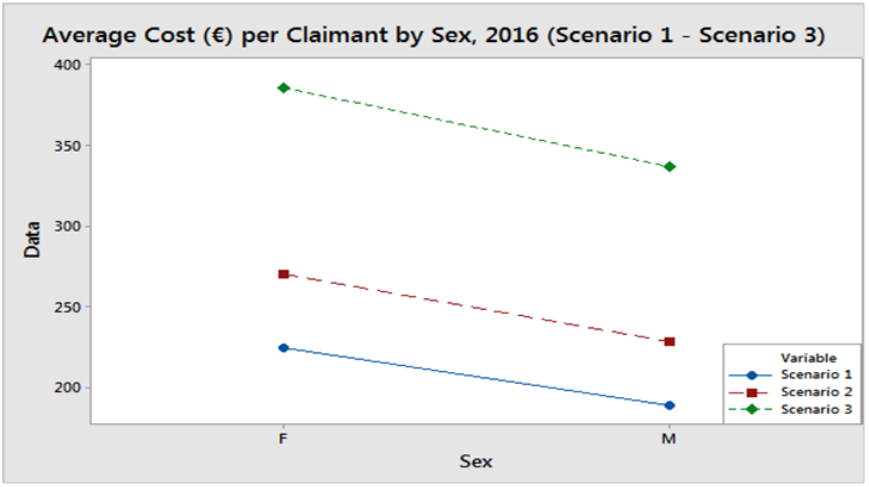
The average cost per claimant scenarios 1, 2 and 3 are illustrated in Figure 4.16. The Midlands and the Southern regions are the most expensive regions and the Eastern and Western regions are the least expensive regions for all three scenarios. Females are driving costs more than males for all three scenarios. The <11s and the older age cohorts are driving costs for all three scenarios. Similar trends were found for sex and age in 2021 and 2026. In 2021[45] and 2026[46], the South–Eastern and the Midlands regions are estimated to be the most expensive regions, while the Eastern and North–Eastern regions are estimated to be the least expensive regions.

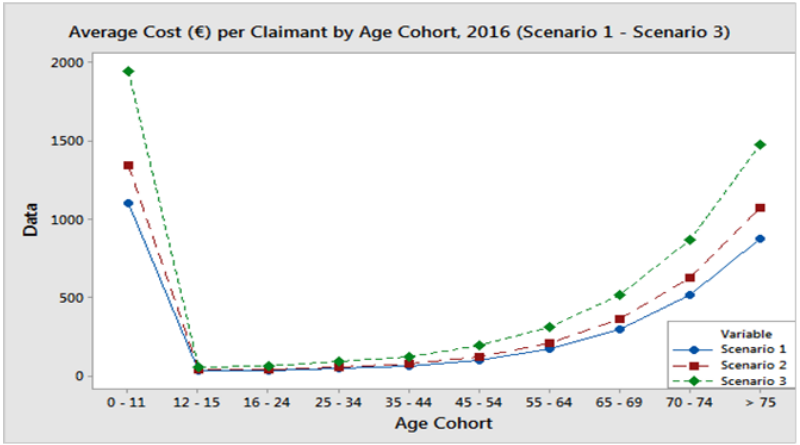
[45]See Appendix C Figure C.16 Average cost per Claimant (€) by old health board region, sex & Age cohort, Scenario 1 - Scenario 3 2021.

[46]See Appendix C Figure C.17 Average cost per Claimant (€) by old health board region, sex & Age cohort, Scenario 1 - Scenario 3 2026.

Figure 4.16: **Average cost per Claimant (€) by old health board region, sex & age cohort, Scenario 1 - Scenario 3 2016**







4.10 Discussion

In this chapter, the factors influencing GMS costs were identified. These include growth in the overall population, growth in the proportion over 70, age, gender and region. Irish population is projected to grow by approximately 10% between 2012 and 2026. The over 70s population is estimated to grow by 64% with males over 70 estimated to grow by 72% over the projection period. An aging population will significantly contribute to overall GMS costs and has the potential to cause an increase in GMS coverage rates, claims rates and average cost per claimant. According to a WHO report, a key driver of health care costs is growth in the overall size of the population. Population aging is also a driver of health care costs, but not to the same extent, (Thomson et al., 2014).

(Barrett et al., 2011) reported in an Irish study on aging, that the dependency ratio was 0.18 in 2011 rising to 0.23 in 2021. This research shows similar estimates for 2021, with a dependency ratio of 0.24. (Barrett et al., 2011) argued the inverse of the dependency ratio was more informative and they estimated a value of 5.7 in 2011 falling to 4.4 in 2021. In this research, the inverse is estimated to be 3.95 in 2021. An aging population, leading to an increased dependency ratio, will put financial pressures on future health costs.

The current GMS cost projections are more conservative than the previous projections. (Conway et al., 2014) estimate GMS cost projections will rise to €1.3 billion in 2016, €1.6 billion in 2021 and €2 billion in 2026. The updated research estimated GMS cost projections will rise to €1.1 billion in 2016, €1.4 billion in 2021 and €1.8 billion in 2026. The updated projections are more conservative because, the 2012 health data includes cost containment measures and the CSO population projections are based on lower expected fertility rates.

(Conway et al., 2014) found that females, age (<11 & >70) and the Midlands region were driving GMS costs out to 2026. The updated research confirms those findings and contributes the following; males, the Mid–Western and South–Eastern regions are driving GMS costs in the under 11s in 2016 and 2026. Females, Midlands and Southern regions are driving GMS costs in the over 70s in 2016 and 2026. However, females, North–Eastern and South–Eastern are estimated to drive GMS costs in the under 11s in 2021. Females, Mid–Western and South–Eastern regions are estimated to drive GMS costs in the over 70s in 2021.

The updated results show that younger male children (<11) are a driver of GMS costs in Ireland. This may be explained by a higher incidence of drug prescribing amongst male children. An Irish study investigating prescribing antibiotics trends in a paediatric sub–population found that male participants (0–4 age cohort) were more likely to receive an antibiotic prescription than female participants, (Keogh et al., 2012). A Spanish study examined how gender and age influenced prescription drug use and found a higher prevalence of prescription drugs in males aged 0–4 and 5 to 14 years of age, (Fernández-Liz et al., 2008). A Swedish study found more drugs were dispensed amongst males under 10 years, (Loikas et al., 2013).

In 2011, a new government was formed in Ireland with an objective of implementing a single–tier health service through the introduction of universal health insurance with free medical care for all, (Government of Ireland, 2011). In Budget 2015, the Irish government partially met this objective, by announcing free General Practitioner (GP) care for all children under 6 years of age. As this is one of the most expensive age groups, the Irish government may have been better advised to implement this policy in a less expensive age group, such as adolescents, as a pilot measure.

Females over 70 years are driving GMS costs in Ireland. In Spain (Fernández-Liz et al., 2008), Sweden (Loikas et al., 2013) and British Colombia (Morgan, 2006), there is a higher incidence of prescribing amongst females compared to males. (Morgan,

2006), found that population aging only explained 1 point of the observed annual drug expenditure growth. The drug expenditure growth is largely explained by the increase in the age/sex specific numbers of prescriptions filled per patient and mix of products selected per prescription.

The Midlands region is the most expensive region and the Eastern region is the least expensive region for GMS costs. Upon further investigation at age cohort level, GMS costs differ across the eight regions. The Mid–Western and South–Eastern are the most expensive regions for the under 11s , the Midlands for the over 70s and the Eastern region is the least expensive region for both age cohorts. A high prevalence of chronic conditions in the Midlands region (Naughton et al., 2006) coupled with (Usher et al., 2005) findings, that the Midlands and the Mid–Western regions had the highest prescribing rates for type 1 and type 2 diabetes may explain high GMS expenditure in this region.

In terms of policies on cost containment, in November 2012, a three year agreement was formulated between IPHA, the Department of Health and the HSE. The agreement applies to medicines prescribed and reimbursed on the community drugs scheme, including the GMS. This agreement led to reductions in the cost of in–patent and off–patent pharmaceuticals, (IPHA, 2012). It was widely reported that this agreement would yield over €400 million for the Irish state over three years. The Irish government estimated €16 million in drug savings in 2012 across all community drug schemes[47], €116 million in 2013, €136 million in 2014 and €150 million in 2015, (Oireachtas, 2012*a*). According to a recent WHO report (Nolan et al., 2015), the agreement resulted in actual savings of €190 million. In 2013, a number of cost containment measures were introduced. GMS eligibility income criteria were lowered, co–payment charges were increased and new legislation was enacted on reference pricing and generic substitution. These policy changes will reduce future GMS expenditure.

[47]Minister for Health, James Reilly stated a breakdown in projected savings was not available by community drug scheme.

Limitation

The researcher investigated the possibility of developing estimates of the variables by the current regional HSE structure, which incorporates four regions (Dublin Mid–Leinster, Dublin North–East, West & South). However, this was not possible for the population variable[48]. Further research investigating the 2013 policy changes on future GMS expenditure would be very useful.

4.11 Conclusion

Growth in population and population aging will contribute to future GMS expenditure growth through the channels of increased average cost per claimant, GMS coverage and claims rates. However, cost containment measures; co–payment charges, generic substitution, reference pricing and GMS eligibility criteria can decelerate the pace of GMS expenditure growth. Co–payment charges are likely to reduce claims rates. Reference pricing and generic substitution are likely to reduce average cost per claimant and eligibility criteria will lower GMS coverage rates. These projections are conditional upon the assumptions and data on which the model is built and remain subject to substantial uncertainty. The health sector in Ireland has a rapidly changing policy environment and this research went in some way to address these changes given the data that were available. The next chapter will identify the factors that are influencing GMS prescribing expenditure, using the population 2012 HSE–PCRS database.

[48]Personal Communication: with a CSO population Statistician and I was advised that the population data was only available by county but I required further disaggregation. For example, North Tipperary resides in HSE West and South Tipperary resides in HSE South. Therefore the research was based on the 8 old health board regions when further disaggregation was not available.

Chapter 5

Factors influencing the variation in GMS prescribing expenditure in Ireland

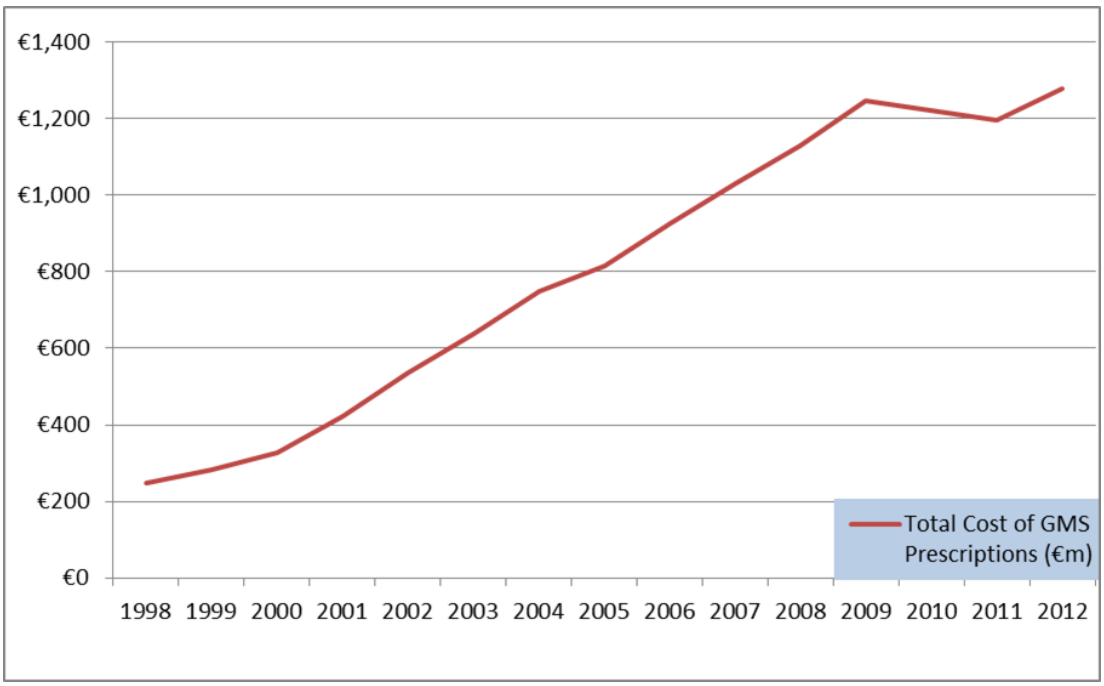
5.1 Introduction

This chapter investigates the composition and drivers of GMS drug expenditure in Ireland in 2012. Pharmaceutical expenditure is a considerable and growing cost to the health care system in many EU countries, including Ireland. Pharmaceutical expenditure growth is not a recent phenomenon but has been growing faster than GDP in all European countries since the 1980s, (Ess et al., 2003). Therefore, it is important to explain the factors that are influencing this expenditure to ensure the sustainability of the Irish health care system. A knowledge of pharmaceutical expenditure trends would aid policy makers in decisions around limited resource allocation, optimum budget allocation, and future policy decisions.

The GMS is a community drug scheme in Ireland, where eligible persons are entitled to free medication and appliances. The GMS scheme is means tested and eligibility is based on income. In July 2001, all persons over 70 were granted a free medical card.

Due to the economic crisis, eligibility criteria were introduced on the 1st of January 2009, where all persons over 70 are means tested. GMS prescription expenditure rose rapidly after 2000, as illustrated in Figure 5.1.

Figure 5.1: **Total Cost (€M) of GMS Prescriptions between 1998–2012**



Source:(**Various PCRS Annual Reports, 1998-2012**)

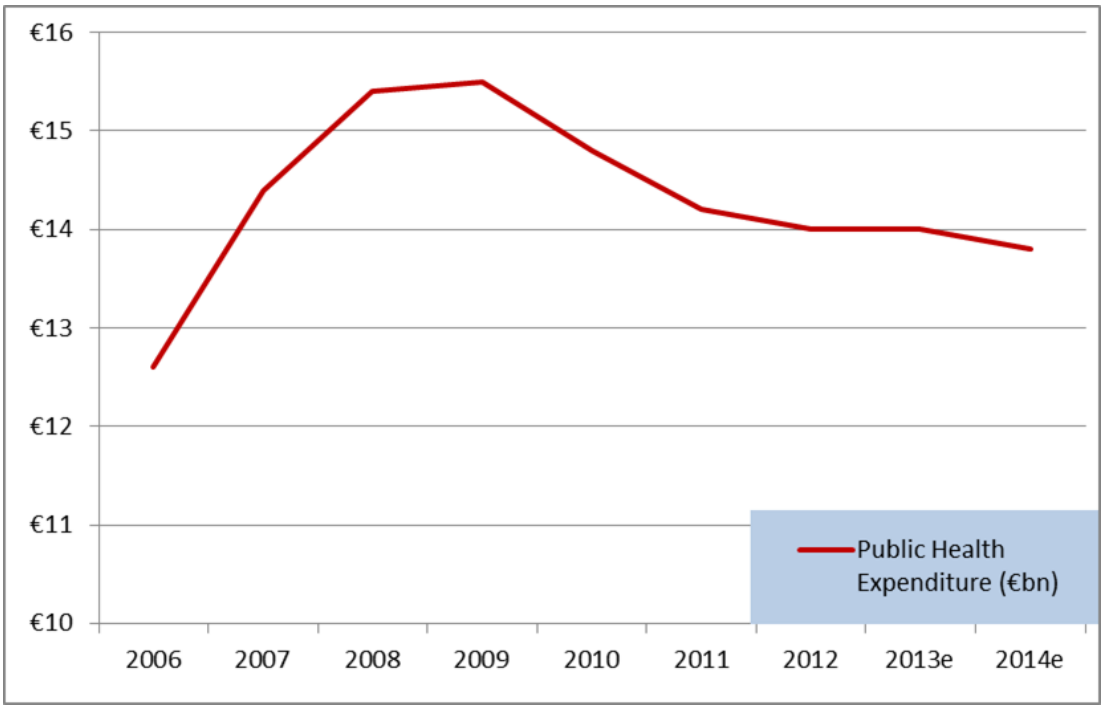
The total cost of GMS prescriptions has increased from €249 million in 1998 to €1.24 billion in 2009, this represents a 400% increase between 1998 and 2009. The total cost of GMS prescriptions decreased in 2010 and 2011 before increasing again to €1.28 billion in 2012. These reductions may be explained by reductions in the health budget. Overall, the total cost of prescriptions increased by 414% between 1998 and 2012. During this time, GMS coverage rates increased from 34.54% of the population in 1998 to 40.40% in 2012. GMS coverage refers to the proportion of the population who have a medical card.

The government has introduced cost containment measures during the economic crisis to combat this trend, such as co–payment charges, GMS eligibility criteria, reference pricing and generic substitution, (Nolan et al., 2015). Co–payment charges have

been increased on a phased basis since 2010. In 2010, a 50 cent per item was introduced, this increased to €1.50 in 2013 and to €2.50 in 2014. Reference pricing and generic substitution legislation was passed in 2013 with the objective of increasing the usage of generics and reduce the price of interchangeable pharmaceuticals, (Government of Ireland, 2013). Despite these cost containment measures, Irish pharmaceutical spending per capita as a share of GDP in 2012 was the third highest amongst 25 EU countries at €500, 40% above the EU average (€350). Belgium had the highest spend per capita at €550 and Denmark had the lowest spend per capita at €195, (OECD, 2014).

According to (Gorecki et al., 2012), approximately 14% of public health expenditure is spent on pharmaceuticals in Ireland. Public expenditure on health peaked in 2009 at €15.5 billion and decreased by 11% between 2009 and 2014, as shown in Figure 5.2, (Nolan et al., 2015).

Figure 5.2: **Public Expenditure on Health (€Bn) in Ireland between 2006–2014**



e – estimate Source:(**Nolan et al, 2015**)

In Table 5.1, Ireland spent 14% of total government expenditure on health, which is comparable with the EU28 average. The Netherlands had the highest proportion at

Table 5.1: **Health Expenditure as a share of total Government Expenditure 2012**

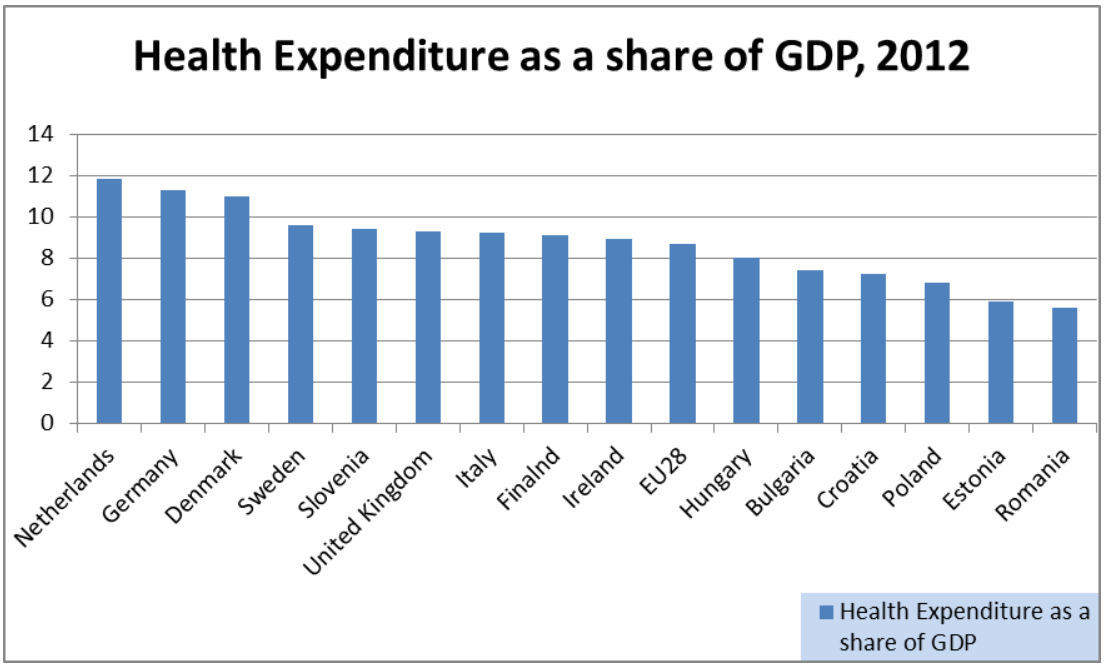
EU28	**% of Total Gov Exp**	**EU28**	**% of Total Gov Exp**
Netherlands	20%	*EU28*	*14%*
Germany	19%	**Luxembourg**	14%
Austria	16%	**Portugal**	13%
United Kingdom	16%	**Malta**	13%
France	16%	**Croatia**	13%
Denmark	16%	**Romania**	12%
Slovak Republic	15%	**Lithuania**	12%
Sweden	15%	**Finland**	12%
Belgium	15%	**Estonia**	12%
Czech Republic	14%	**Bulgaria**	12%
Ireland	*14%*	**Greece**	12%
Italy	14%	**Poland**	11%
Spain	14%	**Hungary**	10%
Slovenia	14%	**Latvia**	9%
Cyprus	8%		

Source:(**OECD, 2014**)

20% and Cyprus had the lowest proportion at 8%. Irish health spending accounted for 8.9% of GDP, just above the EU28 average of 8.7%, (OECD, 2014).

Netherlands recorded the highest health expenditure as a percentage of GDP (11.8%) and Romania recorded the lowest (5.6%), as illustrated in Figure 5.3, (OECD, 2014).

Figure 5.3: **Health Expenditure as a share of GDP (%), 2012**



Source:(**OECD, 2014**)

Irish pharmaceutical expenditure per capita relative to other OECD countries has increased significantly since 2000. The threefold increase in the cost of GMS medicines contributed to this increase, as shown in Figure 1.1 (Chapter 1). Ireland's position has moved from 20th highest of 27 countries in 2000 to 3rd highest of 25 countries in 2010. Irish per capita spending on pharmaceuticals was the highest in the EU and was 34% above the EU average in 2010, as reported by (Brick et al., 2013). (Conway et al., 2014) projected GMS costs for Ireland in five year intervals to 2026. This study found GMS expenditure is expected to rise to €2 billion by 2026. There are fourteen ATC groups as specified in Table 5.2.

Table 5.2: **Anatomical Therapeutic Chemical Classification System**

ATC Group	Major Therapeutic Classification	Function
A	Alimentary Tract & Metabolism	These medications (Proton Pump Inhibitors) reduce the secretion of gastric (stomach) acid.
B	Blood and Blood Forming Organs	These medications decrease platelet aggregation & where blood vessels are damaged, they reduce platelet activation.
C	Cardiovascular System	These medications lower Cholesterol and are commonly known as Statins.
D	Dermatogicals	
G	Genito Urinary System & Sex Hormones	
H	Systemic Hormonal Preps. excl. Sex Hormones & Insulins	
J	Anti–infectives for Systemic Use	
L	Antineoplastic & Immunomodulating Agents	
M	Musculo–Skeletal System	
N	Nervous System	These medications (antidepressants) are used to treat certain pain disorders and anxiety.
P	Antiparasitic Products, Insecticides & Repellents	
R	Respiratory System	These are inhaled medications, Adrenergics & other drugs for obstructive airway diseases.
S	Sensory Organs	
V	Various	These medications include Diabetic Test Strips & (Clinical Nutritional Products)comprise of sip feeds, readymade milk, juices, yoghurt or savoury drinks.

Source:(**PCRS, 2012**)

Since 1998, between 67% and 70% of total annual GMS expenditure has been accounted for, by four of the ATC groups; Nervous (N) system, Cardiovascular (C) system, Alimentary Tract and Metabolism (A) system and Respiratory (R) system, as detailed in Table 5.3 (Various Annual PCRS Reports). In 1998, the sum of the four ATC groups (N, C, A & R) was €136 million of total GMS expenditure (14 ATC groups) €203 million (67%) (PCRS, 2008), this peaked in 2010 at €848 million of a total GMS expenditure of €1.2 billion (70%). In 2012, €872 million of total GMS expenditure (€1.29 billion) was recorded across the four ATC groups equating to 68% of GMS expenditure, (PCRS, 2012). Given the rise in GMS expenditure, the objective of this research is to investigate the significant drivers of GMS expenditure, whilst controlling for age, gender, regional disparities, and the ATC groups.

Table 5.3: **GMS ATC Expenditure(€M) 1998–2012**

Year	A	C	N	R	Total GMS Cost (4 ATC Groups)	Total GMS Cost (14 ATC Groups)	% Total
1998	31.34	42.76	38.67	23.39	**136.16**	203.15	**67%**
1999	35.72	48.37	44.34	25.44	**153.87**	229.30	**67%**
2000	42.07	57.07	52.66	28.07	**179.87**	266.83	**67%**
2001	67.71	93.46	87.10	43.58	**291.85**	434.02	**67%**
2002	84.55	121.59	111.12	52.00	**369.26**	550.90	**67%**
2003	50.26	72.87	48.69	38.65	**210.47**	315.83	**67%**
2004	114.93	178.90	150.83	68.21	**512.87**	763.32	**67%**
2005	126.64	200.68	164.84	74.44	**566.60**	831.44	**68%**
2006	142.82	228.67	187.98	83.92	**643.39**	940.22	**68%**
2007	161.19	250.85	215.04	94.29	**721.37**	1,048.40	**69%**
2008	177.09	269.76	237.95	102.45	**787.25**	1,145.29	**69%**
2009	194.94	291.07	268.53	117.19	**871.73**	1,260.25	**69%**
2010	183.40	276.68	272.50	115.01	**847.59**	1,207.34	**70%**
2011	169.87	245.10	289.18	113.35	**817.50**	1,207.34	**68%**
2012	172.76	239.06	302.85	115.34	**830.01**	1,224.87	**67%**

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

Source:(**PCRS Annual Reports 1998–2012**)

5.2 Methodology

5.2.1 Study Population

A cross-sectional study was carried out on the Irish HSE–PCRS pharmacy claims database for the year 2012. The data is detailed per prescription item (observation) and each GMS claimant is identified by a unique dispense number. This number identifies the number of items each GMS claimant has been prescribed in that particular year. There are approximately 60 million observations in the database and following aggregation by GMS claimant, one observation was created per GMS claimant. There are 1,630,775 GMS claimants in the population database. There are forty variables in this database, of which seven are pertinent to this research. These include demographic information (age, sex, region), cost data (ingredient cost, VAT, dispensing fees) and ATC group. For the purpose of this analysis, total cost is the sum of ingredient cost, VAT and dispensing fees. These variables were described in the previous chapter (Chapter 4).

The ATC code on the first level of the ATC classification system is used throughout this study. In the ATC classification system, the active substances are divided into different groups according to the organ or system on which they act and their therapeutic, pharmacological and chemical properties. Drugs are classified in groups at five different levels. The drugs are divided into fourteen main groups (1^{st} level), with pharmacological/therapeutic subgroups (2^{nd} level). Prescribing data is coded using the World Health Organisation (WHO[1]) ATC classification system, (WHO, 2007).

The data were analysed by the four HSE regions; Dublin Mid–Leinster (ML), Dublin North–East (NE), West and South. The West has the largest number of GMS eligible persons in 2012 with 501,055 persons (27%), followed by the South with 498,597 persons (27%), Dublin ML wth 463,481 persons (25%) and Dublin NE with 390,744 (21%), (PCRS, 2012). Analysing the data at LHO level was considered, but a number of GMS

[1]The WHO primary role is to direct and co–ordinate international health within the United Nations system, (WHO, 2015).

claimants were found claiming from different LHOs therefore not providing an accurate individual total cost in one single location. Data is available by year of age and was aggregated into the eleven HSE age cohorts; <5s, 5–11, 12–15, 16–24, 25–34, 35–44, 45–54, 55–64, 65–69, 70–74 and the >75s. Data management and analysis was carried out in SPSS 22 and Microsoft Excel.

5.2.2 Empirical Model

The dependent variable is the log of annual pharmaceutical expenditure by GMS claimant for all models. The log of total cost was used as the cost data is positively skewed (Skewness = 16.140). A log transformation was applied to normalise the data and this approach has been previously used by, (Powers et al., 2005) and (Aguado et al., 2008). Three models were developed to investigate the association between the total GMS cost per claimant and the independent variables. The first model (Equation 5.1) estimated the impact on the log of annual total cost per claimant using OLS regression whilst controlling for age, sex, and HSE region (3 levels – 1 Dublin ML, 2 Dublin NE, 3 South). The square and cube of age ($\boldsymbol{age^2}$ and $\boldsymbol{age^3}$) were considered as age has a non–linear relationship with the Log of total cost[2]. The inclusion of these two variables did not add to the explanatory power of the model, so they were excluded. The reference categories were, Dublin NE, Males, 12–15 age group and the ATC group 'R' as these were the least expensive in their respective categories.

$$\boldsymbol{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \epsilon_i} \tag{5.1}$$

$\boldsymbol{Y_i}$ = Log of Total Cost

$\boldsymbol{\beta_0}$ = Y intercept, the constant of the model

$\boldsymbol{X_1}$ = Age

$\boldsymbol{X_2}$ = Sex (F)

$\boldsymbol{X_3}$ = Dublin ML

$\boldsymbol{X_4}$ = West

[2]See Appendix F Figure F.1 for the Log of Total Cost, which shows that age is not linear with cost.

$\boldsymbol{X_5}$ = South

$\boldsymbol{\beta}$ = is the coefficient corresponding to each independent variable

$\boldsymbol{e_i}$ = error term

The second model (Equation 5.2) included eight independent variables. It included the five demographic variables from model 1 and the three ATC groups, 'N', 'C' and 'A'. The impact of the independent variables on the log of total cost was estimated.

$$\boldsymbol{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + ... + \beta_8 X_8 + \epsilon_i} \quad (5.2)$$

$\boldsymbol{Y_i}$ = Log of Total Cost

$\boldsymbol{\beta_0}$ = Y intercept, the constant of the model

$\boldsymbol{X_1}$ = Age

$\boldsymbol{X_2}$ = Sex (F)

$\boldsymbol{X_3}$ = Dublin ML

$\boldsymbol{X_4}$ = West

$\boldsymbol{X_5}$ = South

$\boldsymbol{X_6}$ = Alimentary Tract & Metabolism

$\boldsymbol{X_7}$ = Cardiovascular

$\boldsymbol{X_8}$ = Nervous

$\boldsymbol{\beta}$ = is the coefficient corresponding to each independent variable

$\boldsymbol{e_i}$ = error term

The third model (Equation 5.3) included 17 independent variables. The year of age variable is replaced by ten dummy variables for age cohort and the ATC groups and demogrpahic variables (regions and sex) are retained.

$$\boldsymbol{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + ... + \beta_{17} X_{17} + \epsilon_i} \quad (5.3)$$

$\boldsymbol{Y_i}$	= Log of Total Cost
$\boldsymbol{\beta_0}$	= Y intercept, the constant of the model
$\boldsymbol{X_1}$	= Sex (F)
$\boldsymbol{X_2}$	= Dublin ML
$\boldsymbol{X_3}$	= West
$\boldsymbol{X_4}$	= South
$\boldsymbol{X_5}$	= Alimentary Tract & Metabolism
$\boldsymbol{X_6}$	= Cardiovascular
$\boldsymbol{X_7}$	= Nervous
$\boldsymbol{X_8}$–$\boldsymbol{X_{17}}$	= 10 Age Cohorts
$\boldsymbol{\beta}$	= is the coefficient corresponding to each independent variable
$\boldsymbol{e_i}$	= error term

Assumptions of Multiple Regression

The models were estimated by OLS regression. OLS estimates the parameters (B-values) associated with each predictor variable. The differences between what the model predicts (predicted values) and the observed values is known as residuals. The assumptions of multiple regression can be checked from the residuals output, (Field, 2012). The residuals were tested for normality, homoscedasticity and linearity for each of the three models, (Pallant, 2007). Normality can be checked by inspecting the Histogram[3] of the dependent variable (Log of Total Cost). The residuals are normally distributed around the dependent variable.

[3]See Appendix F Figure F.2 for the Histogram of the dependent variable for model 1, model 2 (Figure F.3) and model 3 (Figure F.4).

Linearity can be checked by inspecting the Normality Probability Plot[4]. In the Normal Probability Plot, the points are lying in a relatively straight line from bottom left to top right, indicating no major deviations from normality, (Pallant, 2007). Homoscedasticity can be checked by inspecting the Scatterplot[5] of the standardised residuals.

Multicollinearity is the relationship between the independent variables of the model that exists, when the independent vaiables are highly correlated (r=0.9). Multicollinearity can be checked using the correlations output of the model. This output also checks for the relationship between the independent variables and dependent variable with a correlation coefficient of 0.3 or above. Collinearity Diagnostics including the Variance Inflation Factor (VIF) and Tolerance factors were obtained to test for Multicollinearity. Tolerance produces output values for each independent variable and shows how much of the variability of one independent variable is not explained by the other independent variables in the model. If the Tolerance values are less than 0.1, it indicates multicollinearity exists. The VIF is the inverse of the Tolerance value and if the values exceed 10, multicollinearity is evident. The Tolerance values for models 1 to 3 in this study are greater than 0.1 and VIF values are less than 10, indicating the multicollinearity assumption is not violated, (Pallant, 2007).

Outliers were checked by inspecting Mahalanobis and Cook's Distances. Cook's Distance and leverage (Mahalanobis Distance) measure the influence of outliers on a model and determines the influence of the observed value of the outcome variable over the predicted values, (Field, 2012). In order to identify outliers, a critical chi–square value was determined. The number of independent variables determines the critical value. In model 1, there are 5 independent variables, therefore the critical value is 20.52, (VassarStats: Website for Statistical Computation, 2015). From the residuals

[4]See Appendix F Figure F.5 for the Normality Probability Plot for model 1, model 2 and model 3. The linearity plot is the same for the 3 models, so one visual is in Appendix F.

[5]See Appendix F Figure F.6 for the Scatterplot for model 1, model 2 (Figure F.7) and model 3 (Figure F.8).

output table, the maximum Mahalanobis distance value is 11.589, which is less than the critical value of 20.52.

In model 2, there are 8 independent variables and the critical value is 26.12, (VassarStats: Website for Statistical Computation, 2015). The maximum Mahalanobis distance value is 27.387, which exceeds the critical value of 26.12 slighlty. In model 3, there are 17 independent variables and the critical value is 40.80, (VassarStats: Website for Statistical Computation, 2015). The maximum Mahalanobis distance value is 39.067 , which is less than the critical value of 40.80. The Cook's Distance identifies if any of the outliers have any undue influence on the model. If the maximum value for Cook's Distances is greater than 1, this suggests outliers may influence the model, (Pallant, 2007). For all three models, the maximum value for Cook's Distances is less than 1.

The Casewise Diagnostics present information on standardised residual values above 3.0 or below -3.0. In a normally distributed dataset, one would expect 1% of cases to fall outside this range, (Pallant, 2007). In model 1, 8,373 cases of 1,630,775 were outside this range and is less than 1% of GMS claimants (0.5%). Therefore, the outliers will have a relatively small impact on the model. Both model 2 (7,175 cases, 0.4%) and model 3 (8,734 cases, 0.53%) have less than 1% of total GMS claimants. Statistical significance was reported at the 0.05 level.

5.3 Population Results – Descriptive Statistics

This section reports the descriptive statistics of the population HSE–PCRS database of 60 million observations. The results are reported by sex, region, age cohort, ATC group and average cost per claimant. In each subsection, results are initially reported as a proportion of total GMS expenditure (14 ATC groups) and subsequently reported by GMS expenditure (4 ATC groups – N, C, A & R). With reference to the ATC groups, 52% were prescribed an 'N' prescription item, 45% an 'A' prescription item, 39% an 'R' prescription item and 36% a 'C' prescription item. Of all GMS claimants,

316,950 (19%) are not prescribed any ATC (N, C, A, R) item and they account for approximately €19 million of total cost and they determine an average cost of €60.82 per GMS claimant. The following descriptive analysis will be based on the remaining GMS claimants (1,313,825), who were prescribed an 'N', 'C', 'A' or 'R' prescription item.

Table 5.4 reports the summary descriptive statistics of 1.63 million GMS claimants. The average cost of a GMS claimant is €751.09 and the mean cost varies, depending on the variable. The mean cost increases with age cohort, with the over 75s having the highest mean cost per claimant (€1,686). A number of variables have a minimum cost of €3.27, which is a non–dispensing fee. A pharmacist receives a non–dispensing fee when a GMS claimant presents a prescription form of three items and they only require two items on the form. The pharmacist will receive a non–dispensing fee for the third item. The maximum cost of €298,167 indicates the GMS claimant was male, residing in the Dublin NE region and in the 45 to 54 age group.

Table 5.4: **Summary Descriptive Data (€)**

Variable	Observations	Mean	Standard Deviation	Min	Max
Total Cost per Claimant	1,630,775	751.09	1,323.10	3.27	298,166.90
Log of Total Cost per Claimant	1,630,775	5.29	1.839	1	13
Females	900,561	763.01	1,308.58	3.27	218,670.11
Males	730,214	736.40	1,340.63	3.27	298,166.90
Dublin ML	427,257	760.71	1,339.29	3.27	190,799.66
Dublin NE	319,464	739.88	1,457.74	3.27	298,166.90
West	431,976	729.60	1,238.48	3.27	77,485.73
South	452,078	770.48	1,285.05	3.27	72,695.99
<5	126,950	127.32	501.52	3.50	24,711.86
5–11	137,417	123.63	527.55	3.27	32,472.27
12–15	71,199	138.59	512.61	3.27	26,076.22
16–24	163,579	209.80	594.83	3.27	32,460.26
25–34	188,482	346.01	879.01	3.27	67,475.28
35–44	190,891	496.97	1,182.51	3.27	190,799.66
45–54	160,200	824.54	1,581.43	3.27	298,166.90
55–64	159,919	1,191.32	1,518.11	3.27	43,180.57
65–69	91,345	1,366.19	1,508.65	3.56	26,875.40
70–74	115,631	1,386.62	1,428.85	3.56	27,320.84
>75	225,162	1,686.38	1,564.10	3.27	218,670.11

Table 5.5: **2012 GMS Prescription Expenditure (€M) by ATC Group & Sex**

ATC Group	Female	Male	GMS Prescription Cost (€)	% of Total GMS Prescription Cost
N	**178.02 (59%)**	124.82 (41%)	302.85	25%
C	**125.31 (52%)**	113.75 (48%)	239.06	20%
A	**96.23 (56%)**	76.53 (44%)	172.76	14%
R	**62.80 (54%)**	52.54 (46%)	115.34	9%
Total (€)	**462.37**	367.64	830.01	68%

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

5.3.1 Total Cost by ATC Group & Sex

In 2012, 56% (€687m) of total GMS expenditure was accounted for by females and 44% (€538m) was accounted for males. There is variation by ATC groups amongst females and males. In Table 5.5, the ATC group 'N' accounted for 25% (€303m) of total GMS cost (€1.225bn), 'C' accounted for 20% (€239m), 'A' accounted for 14% (€173m) and 'R' accounted for 9% (€115m). At the extremes, 59% (€178m) of the nervous system expenditure is accounted for by females and 41% (€125m) by males, whereas 52% (€125m) of cardiovascular expenditure is accounted by females and 48% (€114m) by males. Whereas, 56% (€96m) of the alimentary & tract metabolism system expenditure is accounted for by females and 44% (€86m) by males, whereas 54% (€63m) of respiratory expenditure is accounted by females and 46% (€52m) by males. Females represent a higher proportion of GMS expenditure across the four most expensive ATC groups.

Table 5.6: **Number & Percentage of GMS Claimants by ATC group & Sex**

ATC Group	Female	Male
N	503,107 (31%)	349,877 (29%)
C	330,333 (20%)	263,635 (22%)
A	432,901 (27%)	301,194 (25%)
R	352,789 (22%)	276,878 (23%)
Total	**900,561 (55%)**	**730,214 (45%)**

N = nervous System, C = cardiovascular System, A = alimentary tract & Metabolism, R = respiratory System

In Table 5.6, both males and females account for a higher proportion of nervous drugs and a lower proportion of cardiovascular drugs. Of the 900,561 female GMS claimants, and 730,214 male GMS claimants, 31% and 29% were prescribed 'N' items respectively. As reported in Table 5.5, the nervous system is the most expensive ATC group for females and males. Females record a higher porportion of prescription items for ATC groups 'N' and 'A' but males record a higher proportion of prescription items for the ATC groups 'C' and 'R'.

5.3.2 Total Cost by ATC Group & Region

In 2012, 27% (€325m) of total GMS expenditure (14 ATC Groups) was recorded in Dublin ML, 19% (€236m) was recorded in Dublin NE, 26% (€315m) was recorded in the West and 28% (€349m) was recorded in the South. There is some regional variation by ATC Group in Table 5.7. The South makes up 29% of the total ATC cost, Dublin ML 26%, West 26% and Dublin NE 19%. A 10% difference exists between the most expensive region (South) and the least costly region (Dublin NE).

Table 5.7: **2012 GMS Expenditure (€M) by ATC Group and Region**

Region	N	C	A	R	Total (€)	% of Total ATC Cost (4 ATC Groups)
Dublin ML	79.85	61.18	46.26	31.39	218.67	26%
Dublin NE	**56.05**	**46.45**	**33.05**	**22.46**	**158.01**	**19%**
West	78.91	60.38	44.25	29.36	212.91	26%
South	**88.04**	**71.05**	**49.20**	**32.13**	**240.42**	**29%**
Total (€)	302.85	239.06	172.76	115.34	830.01	100%

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

Although the South is the most expensive region across the four ATC groups, it does not record the highest proportion across all of the 4 ATC groups. The percentage of GMS claimants prescribed drugs varies slightly across the regions. The ATC group 'N' records the highest proportion across the four regions. Dublin ML and Dublin NE record the highest proportions in two ATC groups (N & R) and the West and South record the highest percentage of cardiovascular GMS patients. Dublin ML and Dublin NE record the lowest proportions for the ATC group 'C' and the West and South record the lowest percentage for the ATC group 'R'.

Table 5.8: **Number & Percentage of GMS Claimants by ATC group & Region**

Region	N	C	A	R	Region Total
Dublin ML	230,292 (31%)	153,403 (20%)	196,099 (26%)	168,980 (23%)	**427,257 (26%)**
Dublin NE	165,028 (31%)	110,042 (21%)	139,845 (26%)	120,642 (23%)	**319,464 (20%)**
West	238,250 (30%)	158,186 (22%)	193,039 (26%)	163,219 (22%)	**431,976 (26%)**
South	219,414 (30%)	172,337 (22%)	205,112 (26%)	176,826 (22%)	**452,078 (28%)**

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

In Table 5.8, of the 427,257 GMS persons in Dublin ML, 31% were prescribed nervous drugs, whereas only 20% were prescribed cardiovascular drugs. Of the 431,976 GMS persons in the Western region, 30% were prescribed nervous drugs, whereas 22% were prescribed cardiovascular drugs. Of the 319,464 GMS persons in Dublin NE, 31% were prescribed nervous drugs, whereas 21% were prescribed cardiovascular drugs. Of the 452,078 GMS persons in the South, 30% were prescribed nervous drugs, whereas 22% were prescribed cardiovascular drugs.

Figure 5.4: **Number of GMS Eligible Persons and Claimants, 2012**

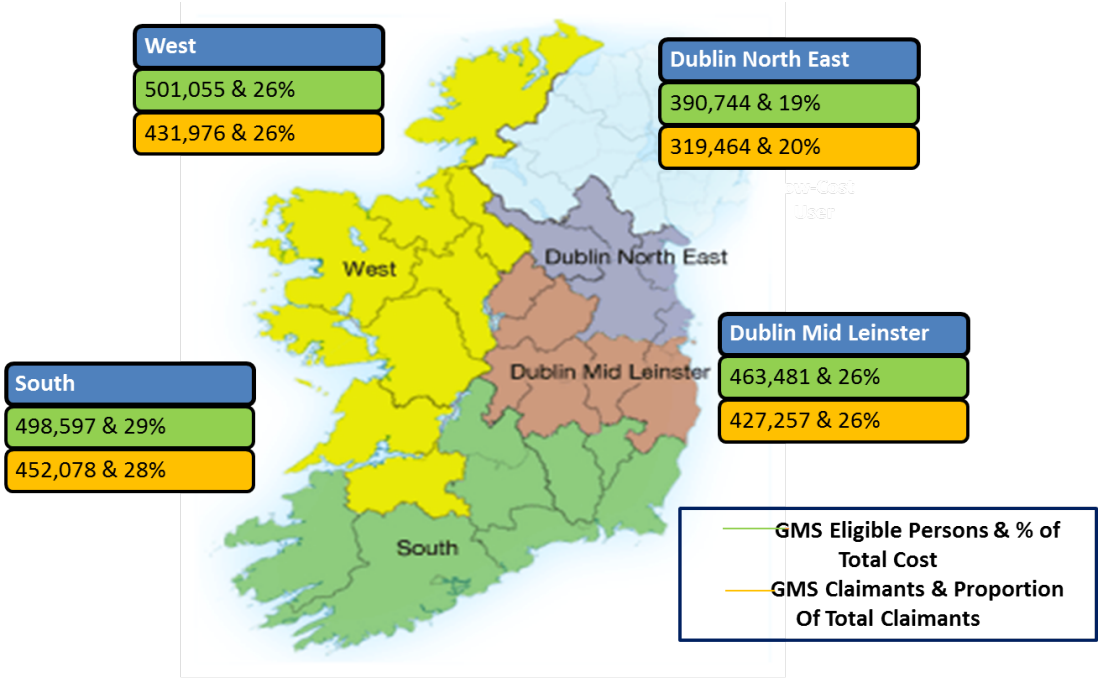


Figure 5.4 illustrates the number of eligible GMS persons, percentage of total GMS cost and the number of claimants. A claimant is a person who has a GMS medical card and makes a claim. The South has the highest number of claimants (452,078) and generates the highest proportion of total GMS cost (29%). Dublin NE has the lowest number of claimants (319,464) and generates the lowest proportion of total cost (19%). The proportion of claimants for each region from the pharmacy database is as follows; South is 28%, Dublin ML is 26%, West is 26% and Dublin NE is 20%. This research shows for ATC 'R', 'N' and 'C' the Southern region is the most costly region and Dublin NE is the least costly region. When age and sex are incorporated into the analysis, this regional trend continues[6] [7] [8].

[6]See Appendix F Table F.1, the 3 age groups up to 15 years, the analysis represents an averaging across three age cohorts (<5, 5–11, 12–15). The Southern region contributes on average 31% of total ATC cost (M–30%, F–31%) and Dublin NE has the lowest average contribution (18%) of total ATC cost (M–18%, F–19%).

[7]See Appendix F Table F.2 and Table F.3, for the 5 age groups from 16 to 64 years, the nervous system analysis represents an averaging across five age cohorts, the Southern region contributes the highest average proportion (30%) of total ATC cost (M–31%, F–30%) and Dublin NE has the lowest average contribution (18%) of total ATC cost (M–17%, F–18%).

[8]See Appendix F Table F.4, for the 3 older age cohorts (65+), the cardiovascular system analysis represents an averaging across three age cohorts (65–69, 70–74, >75). The Southern region contributes on average 30% of total ATC cost (M–30%, F–30%) and Dublin NE has the lowest average contribution (20%) of total ATC cost (M–19%, F–20%).

Table 5.9: **2012 GMS Expenditure (€000) by Age Cohort**

Age Cohort	**Total GMS Cost (€000)**	**% of Total GMS Cost**
<5	15,194	1.24%
5–11	17,169	1.40%
12–15	10,161	0.83%
16–24	33,086	2.70%
25–34	63,975	5.22%
35–44	93,361	7.62%
45–54	130,263	10.63%
55–64	**186,397**	**15.22%**
65–69	123,625	10.09%
70–74	157,289	12.84%
>75	**394,347**	**32.20%**
Total	**1,224,867**	**100%**

5.3.3 Total Cost by ATC Group & Age Cohort

In 2012, total GMS expenditure varied with age. In Table 5.9, total GMS cost increases with age up to 12 years, where we see a reduction, before increasing from 16 years upwards. The over 75s accounted for 32.20% (€394m) of total GMS cost. The 55–64 age group records the second highest proportion of 15.22% (€186m). There is variation in GMS costs by ATC groups between age cohorts, as portrayed in Table 5.10.

Table 5.10: **GMS Expenditure (€M) by ATC group and Age Cohort**

Age Cohort	N	C	A	R	Total
<5	0.57	0.35	0.88	**2.01**	3.81
5–11	1.78	0.29	1.13	**4.33**	7.53
12–15	1.87	0.11	0.97	**2.15**	5.10
16–24	**9.32**	0.52	3.44	3.91	17.20
25–34	**27.11**	1.80	7.29	5.32	41.52
35–44	**39.83**	6.83	12.39	7.62	66.68
45–54	**46.03**	19.31	19.79	11.32	96.45
55–64	**46.33**	40.68	29.53	18.56	135.11
65–69	23.58	**31.59**	19.27	13.06	87.49
70–74	27.10	**43.61**	23.28	15.22	109.21
>75	79.32	**93.97**	54.78	31.85	259.92
Total (€)	**302.85**	**239.06**	**172.76**	**115.34**	**830.01**

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

One must bear in mind the age bandwidths are not equal across the 11 HSE age cohorts. The respiratory system is driving GMS costs up to the age of 15 years. The three age cohorts account for 52% (€8.5m) of total ATC cost for these age groups. The nervous system is driving GMS costs, from 16 years to 64 years. The five age cohorts account for 47% (€168m) of total ATC cost for these age groups.

In the older age cohorts (65+), of the four ATC groups, the cardiovascular system accounts for the highest expenditure. The three age cohorts account for 37% (€169m) of total ATC cost for these age groups. Apart from the over 75s, the 55–64 age cohort is

Table 5.11: **Number & % of GMS Claimants by ATC group & Age Cohort**

Age Cohort	N	C	A	R
<5	14,650 (16%)	1,510 (2%)	29,879 (32%)	**45,562 (51%)**
5–11	9,479 (10%)	1,544 (2%)	21,685 (24%)	**59,026 (64%)**
12–15	15,824 (28%)	1,070 (2%)	11,601 (20%)	**28,226 (50%)**
16–24	**68,535 (40%)**	8,329 (5%)	42,384 (25%)	53,556 (31%)
25–34	**105,699 (42%)**	19,746 (8%)	63,928 (26%)	60,275 (24%)
35–44	**117,954 (39%)**	37,804 (13%)	76,408 (26%)	66,547 (22%)
45–54	**105,991 (34%)**	64,603 (21%)	80,690 (26%)	60,627 (19%)
55–64	**109,098 (29%)**	103,347 (27%)	98,186 (26%)	66,717 (18%)
65–69	60,627 (26%)	**70,251 (30%)**	61,176 (26%)	39,768 (17%)
70–74	75,234 (26%)	**93,863 (32%)**	77,671 (26%)	47,999 (16%)
>75	169,893 (27%)	**191,901 (30%)**	170,487 (27%)	99,263 (16%)
Total	**852,984 (52%)**	**593,968 (36%)**	**734,095 (45%)**	**629,667 (39%)**

N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

the biggest driver of GMS costs across the 4 ATC groups, it accounts for 16% (€135m) of total ATC costs (€830m) (Table 5.10).

In Table 5.11, 51% of GMS claimants in the under 5s age group are prescribed 'R' prescription items, whereas only 2% are prescribed 'C' prescription items. In the 25–34 age group, 42% of GMS claimants were prescribed 'N' drugs, whereas only 8% are prescribed 'C' prescription items. In the over 75s age cohort, 30% of GMS claimants were prescribed 'C' drugs, whereas only 16% are prescribed 'R' prescription items. In Table 5.11, the highest proportions are highlighted. Respiratory drugs recorded the

highest proportion and expenditure (Table 5.10 & Table 5.11) in the three age cohorts up to 15 years. Montelukast (R03DC03), which treats obstructive airway diseases, such as asthma is the most costly drug up to 15 years. This drug represents 29% (€2.4m) of total 'R' costs (€8.5m).

The Nervous system recorded the highest proportion and expenditure (Table 5.10 & Table 5.11) in the five age cohorts between 16 and 64 years. Escitalopram (N06AB10), which treats depression and anxiety is the most costly drug for 16 to 24 year olds. It represents 8% (€734m) of total 'N' expenditure (€9.3m) for that age cohort. Olanzapine (N05AH03), which treats psychotic conditions, such as Schizophrenia and Bipolar disorder is the most costly drug for 25 to 34 year olds. It represents 9% (€2.5m) of total 'N' expenditure (€27m) for that age cohort. Pregabalin (N03AX16), which treats conditions, such as Epilepsy is the most costly drug for the three age cohorts between 35 and 64 years. It accounts for 13% (€17m) of total 'N' expenditure (€132m). Cardiovascular drugs recorded the highest proportion and expenditure (Table 5.10 & Table 5.11) in the three age cohorts over 65. Atorvastatin (C10AA05), which treats high cholesterol is the most costly drug for the over 65s. It represents 24% of total 'C' expenditure (€169m). Esomeprazole (A02BC05) is the most expensive alimentary tract and metabolism drug in 2012. Esomeprazole is proton pump inhibitor (PPI), which is used to treat certain stomach and oesophagus conditions, such as ulcers and acid reflux. It accounts for 18% (€31m) of total 'A' expenditure (€173m).

Females were more expensive than males, except for children and adolescence. When age cohort was analysed by sex and region, males were more expensive than females up to 15 years for the respiratory system, as detailed in Table 5.12. Males record a higher proportion for those up to 15 years in two ATC groups (R & C) and a higher proportion up to 11 years for the ATC group 'N'[9]. Females record a higher proportion in the remaining age cohorts.

[9]See Appendix F Table F.5, Table F.6 and Table F.7 for the crosstabulation of age cohort, sex and ATC group (R, C & N).

Table 5.12: **Respiratory GMS Expenditure (€) by Region and Sex, 0–15**

Region	Female	Male	Total GMS Cost (€)
(Under 5)			
Dublin ML	194,707	**295,397**	490,104
Dublin NE	154,078	**231,784**	385,862
West	195,501	**310,445**	505,946
South	261,969	**364,911**	626,880
Total	806,255	**1,202,537**	2,008,792
(5–11)			
Dublin ML	417,999	**628,912**	1,046,911
Dublin NE	326,158	**505,103**	831,261
West	455,184	**694,747**	1,149,931
South	517,314	**785,288**	1,302,602
Total	1,716,656	**2,614,050**	4,330,705
(12–15)			
Dublin ML	202,551	**335,747**	538,298
Dublin NE	147,628	**214,218**	361,847
West	232,378	**355,887**	588,265
South	263,584	**401,880**	665,464
Total (€)	846,141	**1,307,733**	2,153,874

Table 5.13: **GMS Average Cost per Claimant (€) by ATC Group & Age Cohort**

Age Cohort	N	C	A	R
<5	4.47	2.75	6.94	**15.82**
5–11	12.97	2.10	8.20	**31.52**
12–15	26.32	1.48	13.61	**30.25**
16–24	**56.98**	3.21	21.05	23.89
25–34	**143.84**	9.56	38.70	28.21
35–44	**208.67**	35.77	64.92	39.93
45–54	**287.34**	120.52	123.53	70.65
55–64	**289.68**	254.39	184.69	116.08
65–69	258.16	**345.80**	210.95	142.93
70–74	234.36	**377.19**	201.33	131.60
>75	352.29	**417.35**	243.28	141.46

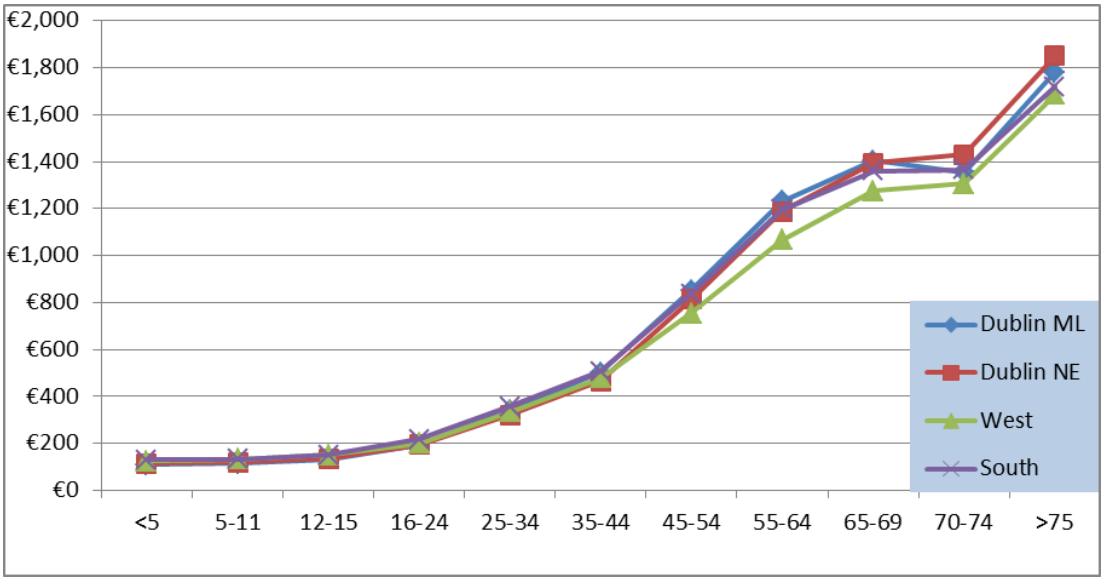
N = nervous System, C = cardiovascular System, A = alimentary tract & metabolism, R = respiratory System

Average Cost per Claimant

Table 5.13 portrays the average cost per GMS claimant in 2012. The average cost per claimant up to 15 years is the highest for the respiratory system across the four ATC groups, it is the highest between 16 and 64 years for the nervous system and the highest average cost per claimant for 65 years and over is the cardiovascular system. These findings correspond to earlier findings reported in Table 5.10, the respiratory system is the most costly ATC group up to 15 years, the nervous system between 16 and 64 years and the cardiovascular system for the over 65s.

Figure 5.5 illustrates average GMS cost per claimant by age category and region.

Figure 5.5: **Average Cost per Claimant by Age Category & Region, 2012**



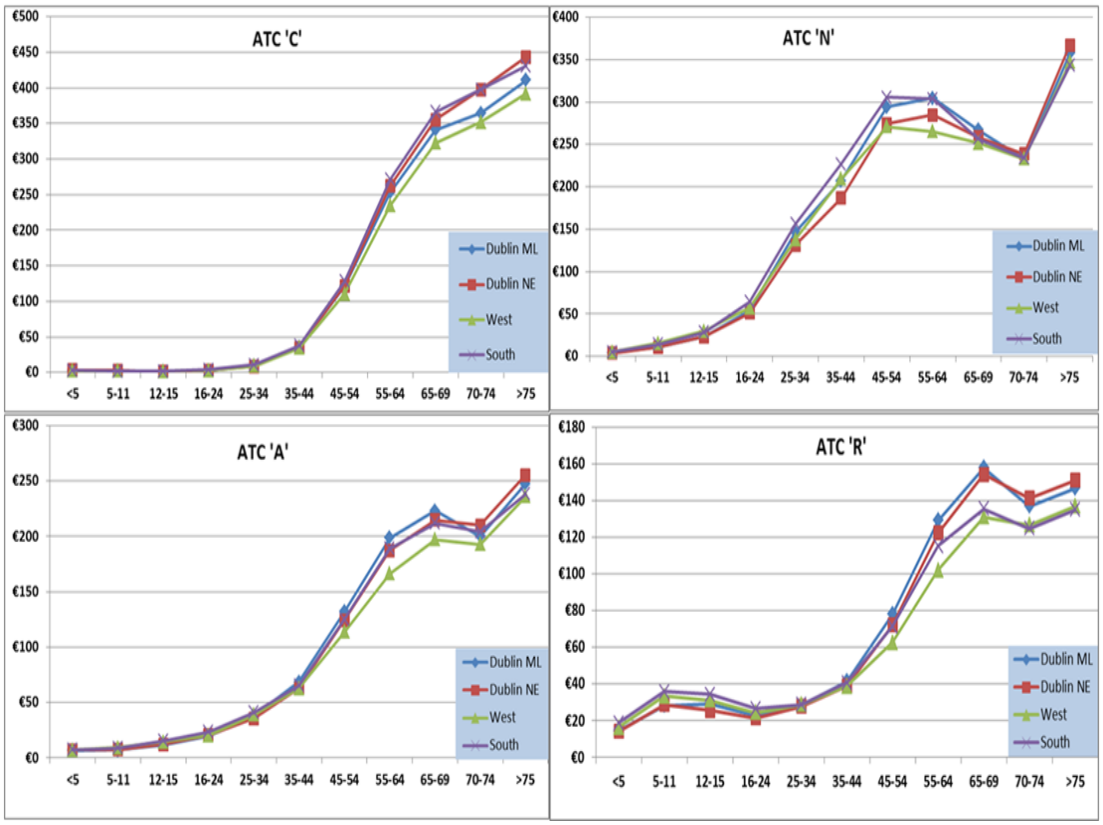
Very little difference is evident between the regions up to 44 years. The West is the least expensive region from 45 years upwards and Dublin NE is the most expensive region for the over 70s. The average cost rises steadily to 69 years, then levels out slightly, before increasing again from 75 years. The average cost per claimant for the population is €751.10[10] with two regions falling below the average (Dublin NE & West) and two regions above the average (Dublin ML & South). The average cost per claimant ranges from €110.12[11] in the under 5s in Dublin ML to €1,781.74 in the over 75s. The average cost per claimant ranges from €114.84 in the under 5s in Dublin NE to €1,851.08 in the over 75s. The average cost per claimant ranges from €123.78 in the under 5s in the West to €1,685.20 in the over 75s. The average cost per claimant ranges from €129.59 in the under 5s in the South to €1,718.83 in the over 75s.

[10]See Appendix F Table F.8 for the total GMS Cost, number of claimants and average GMS cost per claimant.

[11]See Appendix F Table F.8 for the total GMS Cost, number of claimants and average GMS cost per claimant.

Figure 5.6 compares average GMS cost per claimant by age category and region across the four ATC groups.

Figure 5.6: **Average GMS Cost per Claimant by Age Category, Region & ATC Group, 2012**



Average cost per claimant increases from 44 years for the ATC groups 'C', 'A' and 'R' and at an earlier stage from 24 years for the ATC group 'N'. The average cost per claimant for ATC group 'C' ranges from €2.52 in the under 5s in the Dublin ML region to €443.51 in the over 75s in the Dublin NE region. The average cost per claimant for ATC group 'N' ranges from €3.50 in the under 5s to €367.09 in the over 75s in Dublin ML. The average cost per claimant for ATC group 'A' ranges from €6.60 in the under 5s to €247.19 in the over 75s in Dublin ML. The average cost per claimant for ATC group 'R' ranges from €14.04 in the under 5s to €150.81 in the over 75s in Dublin NE.

Summary of Descriptive Statistics

The descriptive analysis produced the following key results. Females are more expensive than males across the 4 ATC groups and 4 regions, with the biggest variation in the nervous system and the smallest variation in the cardiovascular system. However, boys under 15 are more expensive than girls for the 'R' and 'C' ATC group. HSE regions show a greater variation at age cohort level. The respiratory system is the most costly ATC group up to 15 years, the nervous system between 16 and 64 years and the cardiovascular system for the over 65s. This finding is augmented by the average cost per claimant analysis. The South is the most expensive region and the Dublin NE is the least expensive region. The following section reports the findings of the empirical analysis.

5.4 Empirical Analysis

Table 5.14 presents the results of the empirical analysis based on estimates from the three models. Model 1 shows that whilst age, sex and region are all significant drivers of expenditure, sex (female) makes the strongest unique contribution ($\boldsymbol{\beta = 0.107}$) in explaining total cost, when the variance explained by all the other variables in the model are controlled for. Of the three regions, the South had the greatest impact ($\boldsymbol{\beta = 0.056}$). However, when the ATC groups are included in model 2, the impact of sex is diluted, with cardiovascular prescribing most influential ($\boldsymbol{\beta = 1.229}$) and the explanatory power of the model increases from 40.2% to 60.4%. All 8 predictors have positive ($\boldsymbol{\beta}$) coefficients indicating positive relationships and make a statistically significant contribution ($P<0.0005$) to the prediction of total cost, except Dublin ML, which has a negative ($\boldsymbol{\beta}$) coefficient (-0.003). Model 3 was expanded to include dummy variables for the age cohorts. In model 3, the inclusion of age dummies expectedly shows those aged over 75 ($\boldsymbol{\beta = 1.195}$) added most to GMS costs. The explanatory power of model 3 increases to 60.5%. All variables in each of the three models make a statistically significant contribution ($P<0.0005$) to the prediction of total cost.

Table 5.14: **OLS Estimates, Regression Analysis Log (Total Cost) - Models 1 to 3**

Variables	Model 1			Model 2			Model 3		
	Beta	**CI95%**	**t-stat**	**Beta**	**CI95%**	**t-stat**	**Beta**	**CI95%**	**t-stat**
Constant	3.339			3.288			3.324		
Sex (F)	0.107	(0.103;0.112)	47.84	0.018	(0.015;0.022)	10.07	0.025	(0.021;0.029)	13.66
Age	0.044	(0.044;0.045)	1043.44	0.015	(0.015;0.015)	306.74			
Dublin ML	0.026	(0.019;0.032)	7.76	-0.003	(-0.008;0.002)	-1.16	-0.003	(-0.009;0.002)	-1.20
West	-0.017	(-0.024;-0.011)	-5.16	0.008	(0.003;0.014)	3.07	0.009	(0.003;0.014)	3.21
South	0.056	(0.050;0.063)	17.08	0.038	(0.033;0.043)	14.21	0.037	(0.032;0.043)	14.00
Alimentary				0.911	(0.907;0.915)	440.64	0.903	(0.899;0.907)	436.51
Cardiovascular				1.229	(1.224;1.234)	478.42	1.193	(1.188;1.198)	452.28
Nervous				0.927	(0.923;0.931)	456.61	0.947	(0.943;0.951)	454.63
<5							0.117	(0.106;0.128)	21.57
5–11							0.103	(0.092;0.113)	19.23
16–24							0.237	(0.227;0.247)	45.55
25–34							0.370	(0.360;0.381)	72.09
35–44							0.475	(0.465;0.485)	92.06
45–54							0.706	(0.696;0.717)	131.29
55–64							0.957	(0.946;0.968)	172.64
65–69							1.071	(1.059;1.083)	173.49
70–74							1.126	(1.114;1.137)	189.07
>75							1.195	(1.184;1.206)	215.44
Adjusted R^2	0.402			0.604			0.605		

Baseline: Males, Dublin NE, 12–15, ATC Group 'A'

5.5 Discussion

The total cost of GMS prescriptions increased by 414% between 1998 and 2012. This research identified the factors that influenced GMS expenditure by sex, region, age and ATC group. The explanatory power of the models based on demographic data alone have been improved by the inclusion of the most significant ATC groups, in terms of overall contribution to GMS expenditure (R^2=0.604). The results show that HSE regions and sex do not make the same contribution in explaining total GMS cost as age cohorts and the 4 ATC groups. Of GMS claimants, 52% are prescribed nervous system drugs, and account for 25% of total GMS expenditure. 45% of GMS claimants are prescribed alimentary tract and metabolism drugs, and account for 14% of total GMS expenditure. 39% of GMS claimants are prescribed respiratory drugs, and account for 9% of total GMS expenditure. 36% of GMS claimants are prescribed cardiovascular drugs, and account for 20% of total GMS expenditure.

Similar results are reported in the following studies, (Morgan, 2006), (Gerdtham et al., 1998), (Vivas et al., 2011) and (Orzella et al., 2010). A Swedish study found 19% of drug spending can be attributed to nervous drugs, 16% to cardiovascular drugs and 14% to alimentary drugs, (Gerdtham et al., 1998). A Spanish study examined pharmaceutical expenditure on chronic conditions and attributed 16% of cost to the cardiovascular system, 11% to the respiratory system and 10% to alimentary tract and metabolism system, (Vivas et al., 2011). A population study on drug expenditure in British Colombia in 1996 and 2002 found the top three most expensive ATC groups to be cardiovascular, nervous system and alimentary tract and metabolism with the nervous sytem accounting for 25% of of total drug expenditure in 2002, (Morgan, 2006). (Orzella et al., 2010) found the cardiovascular system (highest expenditure) accounted for 35% of the total expenditure and alimentary tract and metabolism accounted for 14% of total expenditure.

Respiratory drugs was the main contributor to GMS drug expenditure in children up to the age of 15 and this finding is supported by the literature, (Mueller et al., 1997) and (Fernández-Liz et al., 2008). With an increasing incidence of asthma in developed countries, its not surprising that drugs for the treatment of obstructive airway diseases, such as Montelukast, is amongst the greatest contributors to expenditure for ATC group 'R'. A childhood study in Ireland reported that cigarette smoke, atopy, and the presence of certain furry pets, are determinants of respiratory symptoms in children, (Yarnell et al., 2003). Esomeprazole, a PPI, is the most expensive alimentary tract and metabolism item. In 2012, PPIs were the second most expensive group of medicines after statins, (PCRS, 2012). An Australian study investigated the utilisation of PPIs and found Esomeprazole to be the second most prescribed PPI and the second most expensive group of medicines after statins, (Hollingworth et al., 2010). An Irish study on the GMS scheme investigated whether cost savings could be made by changes in prescribing practice. They found if Esomeprazole was substituted with a less expensive alternative, it would create savings of approximately €3.3 million, (McGowan et al., 2005).

These results show the nervous system records the highest proportion (52%) in 2012 and makes the second strongest contribution in explaining total GMS cost in model 2 (Table 5.14). The three most expensive nervous drugs across the age groups are, Escitalopram (16–24 years), Olanzapine (25–34 years) and Pregabalin (35–64 years). A study investigating the determinants of prescribing innovation by GPs, using a GMS prescribing database in Ireland, found the adoption of new prescription drugs, such as Escitalopram, is not uniform across all GPs, indicating the potential for targeted intervention to stimulate prescribing innovation, (Bourke and Roper, 2012).

Although cardiovascular prescriptions has the lowest proportion (36%) in this research, it makes the strongest unique contribution in explaining total GMS cost for model 2 (Table 5.14). This may be explained by the cost per prescription item for

cardiovascular drugs. In 2012, Statins (Atorvastatin, Rosuvastatin, Pravastatin, Simvastatin and Fluvastatin) were the most expensive GMS medicines by ATC costing €91.9 million, (PCRS, 2012). Atorvastatin has since come off patent, which should reduce future cardiovascular expenditure. The substitution of generic prescribing for these drugs would lead to cost savings. A study based on an elderly Irish population (70 years) found that cardiovascular disease (CVD) is the most prevalent condition across all old health board regions, using a 2006 Primary Care Reimbursement Service pharmacy database, (Naughton et al., 2006).

This research found that females account for more than half of GMS claimants in 2012, and were more expensive across the 4 ATC groups with the highest expenditure for the nervous system and the smallest in the cardiovascular system. This finding is supported by the literature. A study conducted amongst men and women on a Swedish population in 2010, found a greater proportion of men were prescribed cardiovascular drugs compared to women and a greater proportion of women were prescribed nervous system drugs, (Loikas et al., 2013). A British Colombian study found a higher female per capita expenditure on nervous and alimentary tract and metabolism drugs and males a higher per capita drug expenditure on cardiovascular drugs, (Morgan, 2006). A Swedish study investigating coronary artery disease found it to be more common in men over 60 than females, (Johnston et al., 2011). This research reported males under 11 years are prescribed more prescription items than females. An Irish study found that males under 11 were driving GMS costs, (ConwayLenihan and Woods, 2015). A Swedish (Loikas et al., 2013) and Catalan study (Fernández-Liz et al., 2008) reported a similar finding, higher drug usage in males (<10, <14) compared to females.

The impact of age on expenditure followed a similar pattern as observed in the literature, highest expenditure on respiratory drugs for those under 15, highest expenditure on nervous system drugs for those between 16 and 64, and highest expenditure on cardiovascular drugs for those aged 65 and over. This research shows that respiratory drugs are driving GMS drug expenditure in children up to 11 years and this

finding is supported by the literature, (Mueller et al., 1997) and (Fernández-Liz et al., 2008). An Irish study found that children (0–11) and the elderly (70+) will be a key driver of future drug costs, (Conway et al., 2014). A European study of three countries (UK, Italy & Netherlands) found the respiratory system to be one of three ATC groups with the highest prevalent rates in children, (Sturkenboom et al., 2008). The results show the cardiovascular system records the highest usage for those aged 65 and over. A study in Ireland found that cardiovascular disease is the most prevalent condition in an elderly population aged 70 and over, (Naughton et al., 2006), indicating the trend has continued in Ireland between 2004 and 2012. A Danish study investigated the driving forces of increasing utilisation of cardiovascular drugs, found treatment intensity and prevalence contributed to drug expenditure costs rather than population aging, (Kildemoes et al., 2008).

Results show regional variation in GMS expenditure by ATC group with the Southern region recording the highest GMS expenditure and Dublin NE recording the lowest. Dublin ML records the highest proportion of GMS claimants prescribed a nervous prescription item and Dublin NE records the lowest proportion of GMS claimants prescribed a cardiovascular prescription item. A recent Irish study investigated regional variation in medication taking behaviour and found little overall difference between the regions, (O'Shea et al., 2014). Two Irish studies found variations for Ischaemic heart disease and diabetes respectively, in prescribing by old health board regions, (Bennett et al., 2002) and (Usher et al., 2005). They found high prescribing rates in the Midlands and Eastern regions and low prescribing rates in the Western and North–Western regions. Furthermore, an Irish study found variation in projected drug costs by old health board regions, where the Midlands region was the most expensive region which is now part of the Dublin ML region, (Conway et al., 2014).

Research on prescribing in Canada reported that characteristics and the areas where they live, affect prescription use and this may explain regional variations in prescription drug use. For example, area level measures of population health and socioeconomic

status affected the likelihood of prescription use. They found area level concentrations of one or more ethnic minorities were negatively associated with purchases of all types of medicines, except statins, (Morgan et al., 2010).

This study is subject to certain limitations. The HSE has pre–defined age cohorts, therefore making it difficult to re–construct age cohorts to make comparisons. The age bandwidths are not equal across the 11 HSE age cohorts. The data showed a number of GMS persons claiming from different LHOs, therefore, not providing an accurate individual total cost in one single location. There are 32 LHOs in Ireland, which are divided across the four regions. It was decided to analyse the data at regional level given the inaccuracies at LHO level.

5.6 Conclusion

All European countries have common concerns about growing drug expenditures. The growing proportion of the elderly, the increase in the incidence and duration of chronic diseases, the continuing development of health technologies, and the increase in health expectation of society, are common factors across all countries. This research indicates that growth in the proportion of elderly claimants and associated levels of cardiovascular prescribing, particularly for statins, will present difficulties for Ireland in terms of cost containment. The primary prevention of CVD is dependent on the effective reduction of the major risk factors, particularly tobacco control and a healthier diet. Policies aimed at population–wide CVD prevention, such as legislating for smoke–free public spaces, banning dietary transfats, or halving daily dietary salt intake are generally effective and cost saving.

Based on prevalence rates and related prescribing costs of asthma among children up to the age of 15, it is imperative that public health resources and educational efforts are targeted to improve asthma control and reduce the disease burden on both the healthcare system and society.

Expenditure on nervous system drugs in Ireland are highest for those aged between 16 and 64, in particular, drugs for the treatment of anxiety and depression. The treatment of anxiety and depression is vitally important with the growth in suicidal related deaths in Ireland. Whilst pharmacological treatments are often necessary, changes in prescribing practice combined with psychological therapies, cognitive methods, and self–help strategies, can yield cost savings. Since October 2013, a generic substitute for Esomeprazole is now available, which could generate substantial savings in alimentary tract prescribing. Whilst policies aimed at cost containment such as co–payment charges, generic substitution, reference pricing, and adjustments to GMS eligibility can be used to curtail expenditure, health promotional programs and educational interventions should be given equal emphasis. Furthermore, policies intended to affect physicians prescribing behaviour include guidelines, information (about price and less expensive alternatives) and feedback, and the use of budgetary restrictions could also yield savings.

The following chapter will examine the consequences of GMS policy changes on prescribing expenditure between 2008 and 2014.

Chapter 6

GMS Policy Changes between 2008 and 2014

6.1 Introduction

This chapter examines the policies that were introduced in response to the economic crisis. The main cost containment measures introduced by the government in response to the recommendations from the Troika will be examined. The impact of these policy measures on GMS prescribing patterns and expenditure is then investigated. A timeline of the policy changes is presented for the period between 2008 and 2014. The policy changes are documented in Table 6.1, Table 6.3 and Table 6.4.

In the 10 year period to 2007, the health budget quadrupled due to rising national income. This increase went in some way to rectify the decades of under–spending in health, (Burke et al., 2014). Following the onset of the economic crisis, various efforts were made in Ireland to reduce drug expenditure from both demand and supply side factors. This thesis has primarily focused on three policy variables; GMS coverage, average cost per claimant and claims rate and this chapter will focus on the policy changes that impact these variables. The policy changes introduced in Ireland between 2008 and 2014 that affect GMS coverage are explored in section 6.2, the policy changes

that affect the claims rate are explained in section 6.3 and section 6.4 identifies the policy changes that affected the average cost per claimant. Some research has been done on the monetary savings resulting from these policy changes, this is included where the research is available. A summary of the findings is presented in section 6.5.

6.2 GMS Coverage – Policy Changes

GMS coverage refers to the proportion of the population who have a medical card. Eligibility criteria and income limits influence GMS coverage rates. The following policy changes affected the proportion of the over 70 population who were eligible for a medical card. In July 2001, the Minister of Finance, Charlie McCreevy announced free medical care to all persons over 70 years of age, (Government of Ireland, 2000). The number of eligible persons increased from 1.1 million in 2000 to 1.2 million in 2001, an increase of 9.1%, (GMS Payments Board, 2001). This increase may be attributed to the policy change implemented in July 2001. In the annual GMS (Payments) Board report, the data is not disaggregated by age, therefore it is not possible to quantify the impact of the policy change in the over 70s between 2000 and 2001. Table 6.1 overleaf details the GMS policy changes between 2008 and 2014. In October 2008, Budget 2009 ended universal healthcare for all those aged 70 years and over. This age group protested against the policy change and allegedly, approximately 15,000 people protested outside Dail Eireann. The coalition government succumbed to public protest and partly reversed the policy change, (RTE, 2008). The Minister of Health, Mary Harney set the income limits to €700 for a single person and €1,400 for a married couple on the 1st January 2009.

Table 6.1: **Summary: GMS Coverage Policy Changes: 2008–2014**

Date	**GMS Policy Change**
October 2008	The budget ended the arrangement, whereby medical cards were free to all over 70 and replaced it with a means test. This was revised on 21st October 2008 due to public demand, whereby the majority maintained eligibility over 70.
January 2009	New medical card income limits. €700 per week and €34,400 per year (single), €1,400 per week and €72,800 per year (couple).
March 2009	Anyone over 70 had to make a declaration before the end of March 2009. Since 31st March 2011, 10,182 medical cards have been returned, a further 9,264 medical cards were cancelled (HSE verification process).
April 2010	DoH cut entitlements to medical card patients under the Dental Treatment Services Scheme (DTSS).
July 2011	Medical card issuance is centrally managed by the PCRS & has been moved from LHOs across the country.
April 2013	New medical card income limits. €600 per week (single), €1,200 per week (couple).
January 2014	New medical card income limits. €500 per week (single), €900 per week (couple).

The government argued that 95% of those aged 70 and over would retain their medical card. Any person over the age of 70 with a medical card was asked to notify the HSE if they were above the income threshold, before the end of March 2009. In 2008, 351,853 over 70s had medical cards, (PCRS, 2008). In 2009, this decreased to 337,669, a decrease of 4%. There was an 4.38% reduction of male medical card holders and 3.77% of female medical card holders between 2008 and 2009, (PCRS, 2009). While there was a reduction in the number of eligible persons over 70, the cost of medicines for this age group increased. In 2008 for the 70–74 age cohort, the average total cost of medicines was €1,462.54 (PCRS, 2008) and this increased to €1,640.65 in 2009, a 12.2% increase, (PCRS, 2009). In 2008 for the >75 age cohort, the average total cost of medicines was €1,805.74 (PCRS, 2008), and this increased to €1,961.04 in 2009, a 8.6% increase, (PCRS, 2009). (Walshe and Kenneally, 2013) found due to the restricted GMS eligibility for the over 70s, increased monitoring of payments and scheme verification, combined with increased co–payment of €120 for the DPS scheme led to estimated savings of €80 million in 2011. There was a 2% (6,047) reduction in the number of eligible persons of those aged 70 and over between 2008 and 2010, following the policy change. The average cost per claimant for those aged 70 and over was €1,599 in 2010. This policy change has led to estimated savings of €9.67 milllion.

In Budget 2010, the government cut entitlements to medical card holders under the DTSS. Medical card holders can avail of dental services under 'emergency case' only. Payments to dentists totalled €86.83 million in 2009, (PCRS, 2009) and this fell to €52.3 million in 2011, a 39.7% decrease in payments, (PCRS, 2011). This decrease occurs at a time, when the number of GMS eligible persons increased from 1.5 million in 2009, (PCRS, 2009) to 1.7 million in 2011, (PCRS, 2011). This policy change has led to estimated savings of €34.53 milllion.

In 2011, the processing of medical cards was centralised to one body, the PCRS. Originally, medical cards were processed at LHO level. The purpose of the centralisation project was threefold:

1. Provide for a single uniform system of medical card application processing, thereby replacing the different systems previously operated through more than 100 offices across the country.

2. Streamline work processes and reduce the numbers of staff involved in medical card processing from approximately 450 to 150.

3. Ultimately ensure a far more accountable and better managed medical card processing system, **Source:(HSE, 2012)**.

As a result of this centralisation project, the PCRS now process 94% of medical card applications and reviews them within 15 days, (HSE, 2012). The centralisation of medical cards brought standardisation of eligibility criteria and it allowed government departments to interlink. Medical cards were reviewed between 2012 and 2014. 65,000 medical cards were withdrawn between September 2013 and March 2014 resulting in huge public and political discontent, (Nolan et al., 2015). A number of personal stories were portrayed through the media highlighting some medical conditions, but not all. Following this discontent, the government suspended reviews of all discretionary medical cards and set up an expert panel, chaired by Professor Frank Keane with an objective of reviewing medical need for medical card eligibility. The expert panel reviewed media coverage between the 1st of January and May 2014, and found a total of 772 articles relating to discretionary medical cards, (Keane et al., 2015).

Table 6.2: **Number of Discretionary Medical Cards Issued 2009–July 2014**

Year	Discretionary Card	% of GMS Population Covered
2009	79,625	5.4%
2010	80,524	5.0%
2011	74,281	4.4%
2012	63,126	3.4%
2013	50,294	2.7%
July–2014	65,993	3.7%

Source: (**Keane et al. (2015)**)

The expert panel found reduced variation in the assessment of medical card eligibility following centralisation and that an appropriate level of transparency, consistency and equity is emerging. In 2013, 50,294 (2.7% of the GMS population) had discretionary medical cards, this increased to 65,993 (3.7% of the GMS population) in July 2014, as specified in Table 6.2. This increase is a likely consequence of the Irish government policy change of suspending the review of medical cards during this period. The expert panel made 22 recommendations, some of which are listed below.

1. "The expert panel recommends that financial hardship or means testing should remain the main discriminator for selecting the large majority of those eligible for a medical card, which is consistent with other health systems in the European Union."

2. "The expert panel recommends that in the absence of international objective and reproducible methods of measuring burden of disease and illness it is neither feasible or desirable to list conditions in priority order for medical card eligibility. A listing approach risks inequity by diagnosis and a further fragmentation of services."

3. "The expert panel recommends that, as a working principle, discretionary medical cards should only be provided to the individual with the index condition, and not to the entire family." (Keane et al., 2015)

In April 2013, medical card income limits were reduced for the over 70s to €600 per week for a single person and €1,200 per week for a couple, as detailed earlier in Table 6.1. If a single person has an income between €600 and €700 and a couple has an income between €1,200 and €1,400, the medical card will be replaced with a GP visit card, (Department of Finance, 2012). These limits were further reduced in January 2014, resulting in less people over 70 being eligible for the GMS scheme. They were reduced to €500 per week for a single person and €900 per week for a couple, (Department of Finance, 2013). In 2012, there was 354,811 eligible persons aged 70 and over and this decreased to 348,616 in 2013, a decrease of 2%. The eligible number of those aged 70 and over decreased, following the second income limit reduction (policy change)[1].

6.3 GMS Claims Rate – Policy Changes

The claims rate is the proportion of the GMS population who make a claim on their medical card. Co–payment charges were introduced in the Irish health system in 2010, where medical card holders made a monetary contribution for every prescription item. Co–payments have two key objectives; reduce moral hazard and raise revenue, (Drummond and Towse, 2012). Moral hazard is the inefficient use of prescription medicines, when the cost to the patient (medical card holder) is zero, (Drummond and Towse, 2012). The Irish economy contracted by more than 10% between 2008 and 2010, unemployment more than trebled to 13.8% in 2010 and debt as a percentage of GDP rocketed from 25% of GDP in 2005 to more than 100% of GDP in 2010, (Thomas et al., 2012). The economic downturn in the economy coupled with the banking crisis

[1]The 2014 annual PCRS report has not yet been published, therefore it is not possible to determine the impact of the third income limit change.

Table 6.3: **Summary: GMS Claims Rate Policy Changes: 2008–2014**

Date	GMS Policy Change
October 2010	The budget introduced patient co–payment for medical card holders with a 50 cent per item charge and a monthly ceiling of €10 per family.
January 2013	Patient co–payment for medical card holders increase to €1.50 per item charge and a monthly ceiling of €19.50 per family.
December 2013	Patient co–payment for medical card holders increase to €2.50 per item charge and a monthly ceiling of €25 per family.

put huge budgetary pressures on the public purse and in particular, the health system. The health budget was cut by approximately €2 billion, a reduction of 17% between 2008 and 2010, (Thomas et al., 2012). The following policy changes were introduced as revenue raising measures during the Irish economic crisis. The economic climate led to the introduction of co–payment charges in 2010 and subsequently in 2013, as detailed in Table 6.3.

On the 1st of October 2010, the government introduced co–payment charges for the first time for medical card holders. GMS patients were required to pay 50 cent for each prescription item and was capped at €10 per family per month. The number of GMS prescriptions increased from 12.79 million in 2004 to 15.65 million in 2008 and the number of dispensed items increased from 35 million in 2004 to 48.21 million in 2008. To address the associated costs of the GMS scheme, a prescription charge of 50 cent per item was introduced in Budget 2010, (Department of Finance, 2010*b*). The government estimated that the co–payment charge would return €15 million in 2010 (partial year) and €25 million in a full year to the exchequer, (Department of Finance, 2010*a*).

On the 1st of January 2013, co–payment charges were further increased to €1.50 per prescription item to a maximum for €19.50 per family per month. According to the 2013 Expenditure Report, the government estimated that prescriptions charges would raise €51 million, (Department of Finance, 2013). A subsequent increase in co–payment charges was introduced in Budget 2014. The co–payment charge was increased to €2.50 per prescription item and was capped at €25 per family per month. The 2014 Expenditure Report estimated this policy change would yield savings of €43 million in 2014, (Department of Finance, 2014). This policy change may have led to a drop in the annual GMS claims rate. The claims rate decreased from 94% in 2009 to 93% in 2010 and 2011 and 89% in 2012, but increased slightly in 2013[2] to 90% (Various PCRS Reports 2009–2013).

An Irish study found following a meta–analysis, an 11% increased odds of non–adherence to medicines in public insured populations, where co–payments for medicines are required. (Sinnott, Buckley, O' Riordan et al., 2013) argue a balance between the financial benefits and financial repercussions of cost–sharing policies must be achieved. A subsequent study showed a decrease in use of all medicines with a greater decrease in less–essential medicines than essential medicines. An essential medicine is one which improves health benefits and extends life. An exception to this pattern was that adherence to treat mental health issues, such as anti–depressants and anxiolytic/hypnotic medicines, these medications declined by a larger extent than other essential and less–essential medicines. This study focused on public insured populations, which typically comprise of older and low income populations, such as Medicare and Medicaid in America and the GMS scheme in Ireland, (Sinnott, 2014). Policy makers need to be mindful of the implications and potential cost of non–adherence. Two European studies (Schafheutle, 2008) and (Atella et al., 2005) and an Australian study (Doran et al., 2005) found that an expensive co–payment system can affect the utilisation and demand for drugs. Co–payment charges can reduce the utilisation of both essential and

[2]The 2014 annual PCRS report is not yet published so no figures for the 2014 claims rate is available.

non–essential medicines in vulnerable populations, such as the poor, elderly and chronically ill, (Rice and Matsuoka, 2004) and (Lexchin and Grootendorst, 2004). Therefore the Irish government needs to be mindful of the ill–effects of future increases in co–payments as these groups comprise the GMS population in Ireland.

6.4 GMS Average Cost per Claimant – Policy Changes

The average cost per claimant is the total cost of GMS claimants divided by the number of GMS claimants. The average cost per claimant is influenced by the reimbursement price for drugs. The reimbursemnt price for GMS drugs is comprised of the ex–factory price, wholesale mark–up, dispensing fee and VAT. The ex–factory price is determined by an agreement between the state and the drug manufacturers. The ex–factory price is agreed between the Department of Health and the HSE (who represent the state) and the representative body of drug manufacturers and importers. The ex–factory price is set with reference to the currency adjusted average price to the wholesaler in nine nominated EU member states (Belgium, Denmark, France, Germany, Netherlands, Spain, UK, Finland and Austria), (IPHA, 2012). (Walshe and Kenneally, 2013) estimated €200 million in savings in 2011, following price reductions in off–patent and generic drugs coupled with a GMS rebate from drug manufacturers from 3.53% to 4% (January 2010).

The wholesale mark–up on GMS drugs was reduced from 17.7% in March 2008, to 10% in July 2009, and a final decrease to 8% in June 2011, as described in Table 6.4.

Table 6.4: **Summary: GMS Average Cost per Claimant Policy Changes: 2008–2014**

Date	GMS Policy Change
March 2008	Wholesale mark–up reductions from 17.7% to 10% in July 2009, to 8% in June 2011.
July 2009	Sliding dispensing fee structure introduced based on the number of items. €5 for 1,667 items, €4.50 next 833 items & €3.50 per subsequent item.
January 2012	VAT increased from 21% to 23% (non–oral medications).
November 2012	IPHA/APMI Agreement Off–patent drugs will be reduced to 60% of the original price from 1st November 2012 and to 50% from 1st November 2013. Drugs due to go off patent from 1st November 2012 will be reduced to 70% of the original price and subsequently to 50%. Price reductions averaging up to 16% on 400 patent protected products will be subject to a price review.
May 2013	Health (Pricing & Medical Goods) Act 2013 Reference Pricing and Generic Substitution.
May 2013	Preferred Drugs Initiative.

The wholesale mark–up is 12 per cent for fridge items and 8 per cent for any other drug items, (Gorecki et al., 2012). The ingredient cost of a drug is the sum of the ex–factory price and the wholesale mark–up. The dispensing fee is the payment a pharmacist receives from the state for dispensing GMS drugs. In March 2008, the dispensing fee was €3.60 per item. A sliding dispensing fee structure was introduced in July 2009. The pharmacy receives €5.00 for each of the first 1,667 items dispensed, €4.50 for each of the next 833 items dispensed and €3.50 for each other item dispensed in that month, (Government of Ireland, 2011). Following changes to the pharmacy dispensing fees, a reduction in retail mark–up for the DPS scheme and a reduction in

the aforementioned wholesale mark–up, resulted in savings of €100 million in 2011, (Walshe and Kenneally, 2013). VAT is levied at 0% for oral medications. VAT on non–oral medications was increased from 21% to 23% on the 1st of January 2012.

On the 1st of November 2012, the state and drug manufacturers agreed the terms of a new three year agreement. The agreement was formulated between IPHA, APMI[3] the Department of Health and the HSE. The agreement applies to medicines prescribed and reimbursed on the community drugs scheme, including the GMS, DPS, LTI and HTD scheme. This agreement led to reductions in the cost of in–patent and off–patent pharmaceuticals, as detailed in Table 6.4. According to the IPHA agreement, the reductions are as follows. "For patent expired medicines whose price is currently above 60% of the original price to wholesaler, the price will reduce on 1st November 2012 to 60% of the original price to wholesaler. Twelve months after the first price reduction, the price to wholesaler will be reduced to 50% of the original price to wholesaler".

"For medicines due to go off patent from 1st November 2012, the price will reduce to 70% of the original price to wholesaler. Twelve months after the first price reduction, the price to wholesaler will be reduced to 50% of the original price to wholesaler", (IPHA, 2012).

The price of up to 400 patent protected products, which have been available on the HSE Community drug schemes prior to the 1st September 2006 will be subject to a price review. Price reductions averaging up to 16% are expected from this review process. The price of all patented medicines will be realigned downwards to the currency–adjusted average price to the wholesaler in the nominated EU member states in which the medicine is available, (IPHA, 2012). It was widely reported that this agreement would yield over €400 million for the Irish state over three years. According

[3]APMI: Association of Pharmaceutical Manufacturers of Ireland, promotes and supports the common interests of the generic industry in Ireland and are at the forefront of offering quality affordable medicines to the Irish population, (APMI, 2015).

to a recent Economic and Social Research Institute (ESRI[4]) report, when one offsets the new pharmaceutical costs of €210 million, the agreement results in net savings of €190 million, (Nolan et al., 2015).

Following a parliamentary question to Minister of Health, James Reilly, requesting a breakdown of the projected €400 million savings to the state, the actual savings to the state were disclosed. Minister Reilly estimated that €16 million in drug savings would be made in 2012, €116 million in 2013, €136 million in 2014 and €150 million in 2015. He also stated that a breakdown of savings by scheme is not available and the cost of new drugs is estimated to be €210 million over the next three years, (Oireachtas, 2012*a*). The estimated savings are €402 million over the 3 years. Taking account of the cost of new drugs, this results in actual savings of €192 million and not €400 million that was originally claimed. The ESRI report further argues as the savings were not realised in this deal, it led to the need for a supplementary health budget in December 2012. The HSE required an additional €360 million, (Oireachtas, 2012*b*). The Troika (EU/IMF/ECB) expressed concern over health budget overruns with a particular focus on pharmaceutical prices, costs to the state of private practice in public hospitals, salary levels and medical card costs, (European Commission, 2013).

On the 28$^{\text{th}}$ May 2013, new legislation (Health Pricing & Medical Goods Act 2013) was enacted. This legislation enables the state more powers to negotiate drug prices with drug manufacturers other than the agreements. The objective of the Act is to increase the usage of generics and reduce the price of interchangeable pharmaceuticals. Generic penetration varies across EU member states. This ranges from less than 20% by value in Belgium, Finland, France, Greece, Ireland, Italy and Spain, to between 20% and 40% in Austria, Denmark, Germany, the Netherlands, Portugal, Sweden, Hungary and the UK, and to over 40% in Poland, (EC, 2009). Previously, when a specific brand of drug was prescribed for a patient, a pharmacist could only supply that particular

[4]The ESRI produces economic and social research in Ireland that informs public policymaking, (ESRI, 2015).

brand, even when less expensive generic versions of the same drug were available. The Act now permits pharmacists to substitute drugs prescribed, provided that they have been designated as safely interchangeable by the Health Products Regulatory Authority (HPRA), formerly the Irish Medicines Board (IMB). The IMB changed its name to HPRA on the 1st of July 2014. The role of HPRA is to protect and enhance public and animal health by regulating medicines, medical devices and other health products, (Health Products Regulatory Authority, 2015).

If a medical card holder would like to receive a particular brand of drug that costs more than the reference price, then the medical card holder will have to pay the additional cost of that product. In cases where substitution is prohibited for clinical reasons and the doctor prescribes a specific drug, medical card holders will not face any additional costs, if the prescribed drug costs more than the reference price. As stated in the previous chapter, Statins were the most expensive (€91.90m) GMS drugs prescribed in 2012, where Atorvastatin cost the state €61.42 million, (PCRS, 2012). Following the introduction of the new legislation, the Department of Health reported the new reference price for Atorvastatin products will be 70% less compared to May 2013 prices. The Department of Health estimate reference pricing will generate savings in the region of €50 million in 2014, (Department of Health, 2013). (Gemmill et al., 2008) found in a review article, that generic substitution and reference pricing, increase competition amongst brand name and generic manufacturers and are effective at lowering ex–factory prices for pharmaceuticals.

In 2013, the HSE Medicines Management Programme (MMP) was developed to encourage safe, effective and cost–effective prescribing. The MMP has undertaken a number of initiatives aimed at enhancing evidence–based and cost–effective prescribing nationally, such as the Preferred Drug Initiative. This initiative identifies a single drug within a therapeutic class, which is evidence based and clinically equivalent to all other agents in the class, but offers cost–effective advantages. This initiative offers guidance on selecting, prescribing and monitoring a drug for a particular condition. For example,

if prescribing a Statin, Simvastatin is recommended and if prescribing a Proton Pump Inhibitor, Lansoprazole is recommended. This initiative intended to generate savings of €20 million in 2013, (HSE, 2014).

6.4.1 Pharmacoeconomic Assessment

All new drugs to market are subject to pharmacoeconomic assessment by the National Pharmacoeconomic Centre since 2009. The National Pharmacoeconomic Centre facilitates healthcare decisions on healthcare technologies, such as pharmaceuticals, diagnostics and devices. Following the IPHA agreement in 2012, the state has the right to assess new and existing technologies. Pre–existing items deemed to be non–cost effective were removed from the reimbursement list e.g., Glucosamine in 2010. Pharmacoeconomic evaluations can be in the form of Cost–Effectiveness analysis (CEA[5]) or Cost–Utility analysis (CUA[6]). CEA is measured in cost per life year gained (LYG) and CUA is measured in cost per quality adjusted life year (QALY[7]). A cost effectiveness threshold of €45,000/QALY has been adopted by the National Pharmacoeconomic Centre in accordance with the Irish Health Technology Assessment (HTA[8]) guidelines, (Barry et al., 2008).

For example, Pravastatin (Lipostat), which treats coronary heart disease has a cost per QALY of €42,250, therefore it was reimbursed. Omalizumab (Xolair), which treats asthma, has a cost per QALY of €57,196, which exceeded the threshold, therefore it was not reimbursed, (Barry et al., 2009). However, there maybe exceptions. Sunitinib had a cost per QALY of €57,280 and although it was above the cost effectiveness threshold, it was funded due to its innovative nature, (Tilson and Barry, 2010). (Bridges et al.,

[5]CEA is an economic evaluation that compares the costs and outcomes of alternative treatments, (Kielhorn and Schulenburg, 2000).

[6]CUA is an economic evaluation that is used to compare costs and benefits of alternative health treatments where quality of life is paramount, (Kielhorn and Schulenburg, 2000).

[7]A QALY measures both the quality and quantity of years a patient has, (Kielhorn and Schulenburg, 2000).

[8]"The HTA guidelines provide an overview of the principles and methods used in assessing health technologies", (HTA, 2015).

2010) puts forward the argument of whether a fixed cost–effectiveness threshold should be maintained in the United States. Benefits of fixed thresholds, include consistency and transparency for policymakers, but the rigidity of the fixed threshold may not allow for exceptions. The pharmacoeconomic assessment is a key cost saving tool for the reimbursement of pharmaceuticals in Ireland, as it allows for the use of economic evaluations, such as CEA and CUA. This tool will be important for containing GMS and community drug schemes expenditure.

The pharmacoeconomic evaluation is completed in approximately 3 months and involves the following steps;

- Preliminary rapid review which takes between 2 and 4 weeks.
- Cost–effectiveness threshold – new drugs with an incremental cost–effectiveness ratio (ICER) below €45,000/QALY, tend to be reimbursed.
- The increasing importance of budget impact assessment in reimbursement decisions.
- Conditional reimbursement.
- Cost–effectiveness evaluation of existing medicines that are currently reimbursed. (**Source: (Tilson and Barry, 2010)**)

Table 6.5 documents the GMS policy changes that have been enacted and their associated savings.

Table 6.5: **GMS Policy & Estimated Annual Savings: 2008–2015**

GMS Policy	**Estimated Annual Savings**
Eligibility changes for the >70s, 2009	€9.67 million[9]
DTSS Enitlements changed, 2010	€34.57 million
50 cent co–payment, 2010	€25 million(*)
€1.50 co–payment, 2013	€51 million(*)
€2.50 co–payment, 2013	€43 million(*)
IPHA/APMI Agreement (2012–2015)	€190 million(**)
Reference Pricing, 2013	€50 million(***)
MMP, 2013	€20 million(****)

([9]6,047 less eligible >70s in 2010 compared to 2008, average cost per claimant >70 in 2010 is €1,599.12. 6,047 * €1,599.12 = €9.67m)
(* = Gov Estimate, ** = ESRI Estimate, * = DOH Estimate, **** = HSE Estimate)**

In Table 6.5, the first two estimated savings are based on researcher's own calculations. The annual estimates are based on the year before and after the policy change. For example, entitlements were cut to the DTSS scheme in April 2010, resulting in a reduction of 31% of 'Above the Line[10]' (ATL) treatments and 70% reduction in 'Below the Line[11]' (BTL) treatments. The total cost of the DTSS scheme in 2009 was €86.77 million and reduced to €52.2 million in 2011, a reduction of €34.57 million. Further research identifying cost savings following the implemetation of GMS policies would be very useful. In the first four years of the crisis (2008–2012), Ireland achieved some efficiencies in health and achieved 'more with less'.

While the number of people covered for free care increased, hospital activity increased with a much lower budget. From 2013 onwards, the number of people covered decreased and rationing of care (hospital & home care) took hold, (Burke et al., 2014).

6.5 Conclusion

This chapter documents the GMS policy changes and charts the time period pre and post recession (2008–2014) in Ireland. The GMS policy changes that affected GMS coverage, claims rates and average cost per claimant are summarised in Table 6.1, Table 6.3 and Table 6.4. Some research has been done on the savings generated as a result of the policy changes and this research has been included, where available. The final chapter of this thesis will summarise the key findings and identify recommendations.

[10] ATL treatments are uncomplicated procedures e.g. oral examination, (PCRS, 2011).
[11] BTL treatments are advanced procedures e.g. Prosthetics, (PCRS, 2011).

Chapter 7

Conclusion and Recommendations

7.1 Introduction

The main focus of the thesis is on pharmaceutical expenditure on the publically funded GMS scheme, which is the largest of the community drug schemes in Ireland, covering 40% of the population in 2012. The research commenced in 2011 as part of a Health Research Board (HRB) funded grant aimed at identifying the main factors influencing GMS expenditure on pharmaceutical prescribing and projecting this expenditure over the coming decade. The research was carried out against a backdrop of growing GMS prescribing costs, which had risen from approximately €250 million in 1998 to over €1 billion by 2007. Most observers expected this growth to continue as both the Irish population, and the proportion of the population aged over 70, was projected by the CSO to grow strongly over the coming decade. The investigation of the main factors influencing GMS expenditure on pharmaceutical prescribing and projections in 5 year intervals to 2026 was undertaken and published (Conway et al., 2014). The projections were undertaken using a sample of 2007 PCRS prescribing data and CSO population data, (CSO, 2008).

The economic backdrop to the GMS expenditure projections of prescribing costs completely changed following the global economic crisis of 2008, which resulted in a sharp contraction in the Irish economy and mounting fiscal deficits. Ireland was forced to enter a now well documented bailout programme. The sustainability of funding the community drug schemes, such as the GMS, came under the spotlight of the EU, IMF and ECB (Troika), who set stringent targets for reducing drug costs, as conditions of the bailout programme. Cost containment measures included: the introduction of income eligibility limits for GP visit cards and medical cards for those aged 70 and over, introduction of co–payments for prescription items, reductions in wholesale mark–up and pharmacy dispensing fees. Also, during this period the CSO revised its growth predictions for the Irish population downward. The population changes coupled with the impact of cost containment measures on prescribing costs raised questions as the cogency of the (Conway et al., 2014) paper.

An investigation was undertaken using 2012 HSE–PCRS prescribing population data following the implementation of the cost containment measures. The CSO population data was based on Census 2011. The cost containment measures coupled with updated CSO population projections were incorporated into the prediction model revaluating the impact on projected prescribing costs and were published in (ConwayLenihan and Woods, 2015).

7.2 Objective and Aims

The primary objective is to investigate the main factors contributing to GMS expenditure on pharmaceutical prescribing and projecting this expenditure over the coming decade. The thesis has five main aims:

1. To determine the main factors contributing to GMS expenditure on pharmaceutical prescribing.

2. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2006 CSO Census data and 2007 HSE–PCRS sample data.

3. To develop a model to project GMS prescribing expenditure in five year intervals to 2026, using 2012 HSE–PCRS population data, incorporating cost containment measures, and 2011 CSO Census data.

4. To investigate the impact of demographic factors and the pharmacology of drugs (ATC) on GMS expenditure.

5. To explore the consequences of GMS policy changes on prescribing expenditure and behaviour between 2008 and 2014.

7.3 Literature Review

The purpose of the literature review was to locate the study in terms of existing literature on pharmaceutical expenditure projections and the factors influencing pharmaceutical expenditure globally. The literature review examined international and Irish pharmaceutical cost containment measures initially and they were found to be a matter of concern for policy makers and high on the political agenda globally. (Morgan and Astolfi, 2015) found many countries introduced cost containment measures in 2009 and the measures intensified in 2011. For example, Greece reduced pharmaceutical expenditure by 19.5%, Portugal by 20% and Spain by 8% between 2009 and 2011. (Sood et al., 2009) found direct price controls and economic evaluation were more successful in reducing pharmaceutical expenditure compared to other forms of regulation. (Almarsdóttir and Traulsen, 2005) warns policy makers that cost containment strategies should be evidence based and they should consider the impact they will have on public health. (Tilson et al., 2005) and (Barry et al., 2008) highlighted the growth in the cost of medicines on community drug schemes in Ireland up to 2007. (Walshe and Kenneally, 2013) investigated the savings from cost containment policies in Ireland in 2011. They found the IPHA/HSE agreement, reductions in retail and wholesale mark–up, new dispensing fee structure, restrictions to eligibility and the introduction of co–payment charges led to savings of €380 million for the Irish economy in 2011.

The literature identified a number of factors influencing pharmaceutical expenditure. These factors included population growth, population aging, new innovative drugs and changes in drug utilisation and drug therapies, age, gender and location. Apart from (Bennett et al., 2009) and (Heaney et al., 2009), very little research has been carried out on pharmaceutical cost projections in Ireland. There are eleven community drug schemes in Ireland and the GMS scheme is the largest, where a person has entitlement to free healthcare. This thesis focused primarily on the GMS scheme.

This research is located between the end of a booming Irish economy in 2007 and traces the steps in government cost containment from the recession in 2008 to the recovery in 2014. The literature review has identified the main factors influencing growth in prescribing expenditure, particularly those relevant to this research, such as population growth, population aging, coverage, etc. These were included in the prediction model. The literature identified the methods previously used in predictive modelling and consequently, coupled with advice from Darmstadt Statistics Department, a MCS was used to simulate future GMS expenditure to 2026. Also, the literature guided the use of OLS regression in determining demographic and pharmacology factors influencing prescribing expenditure. Finally, the literature review has provided a benchmark for the type of results to expect.

7.4 Data and Methods

7.4.1 Data

(Conway et al., 2014) was based on CSO population projections (CSO, 2008) and a HSE–PCRS sample database (2007). The sample database consists of 192,000 observations extracted from the 2007 PCRS GMS population data. The variables include; ingredient cost, VAT, dispensing fee, total cost, number of prescription items and number of prescription forms, and are disaggregated by month (12), age cohort (10), gender (2) and region (8). Population data was sourced from the CSO regional population projections 2011–2026. Data was detailed by year of age, gender, county and region, taking

account of international migration, fertility and inter–regional flows.

(ConwayLenihan and Woods, 2015) were based on CSO population projections (CSO, 2013) and a population HSE–PCRS database (2012). (ConwayLenihan et al., 2016) was primarily based on the 2012 population HSE–PCRS database. There are approximately 60 million observations in the database and the data was aggregated to create one observation per claimant (n=1.63 million claimants). There are 40 variables in the database, of which 7 are included in this research. These include demographic information (age, sex, region), cost data (ingredient cost, VAT, dispensing fees) and ATC group. The pharmacology is coded using the WHO ATC classification system. The analysis of the pharmacology is undertaken at the 1st level of the ATC classification system. The CSO regional population projections 2016–2031 provided updated projections based on the 2011 Irish census. Data was detailed by year of age, sex, county and region, incorporating assumptions around mortality, fertility, international and internal regional migration.

7.4.2 Methods

Modelling drug expenditure projections varies considerably internationally. A number of studies in the United States based projections on historical trends, (Cuckler et al., 2013), (Keehan et al., 2012), (Sisko et al., 2014) and (Schumock et al., 2015) but studies on drug expenditure projections is limited, (O'Neill et al., 2013). Modelling drug expenditure projections varies from Markovian micro–simulation (Thiébaut et al., 2013), linear regression (Bennett et al., 2009) and (Wettermark et al., 2010) and Macroeconomic and Microeconomic approaches (O'Neill et al., 2013). Following advice from a statistician, a Monte Carlo Simulation model was adopted to forecast GMS expenditure and inform future health policy. Drug utilisation and expenditure is difficult to forecast due to a number of uncertainties, Monte Carlo Simulation is a numerical model that employs statistical sampling to forecast under uncertainty, (Briggs et al., 2012).

A number of studies have used OLS regression to model the variation in pharmaceutical drug expenditure. Two Spanish studies used OLS regression to model pharmaceutical expenditure, (Fernández-Liz et al., 2008) and (Vivas et al., 2011). A study in Uganda (Mujasi and Puig-Junoy, 2015) and three American studies, used OLS regression models to examine the predictability of drug expenditure, (Wrobel et al., 2004), (Zhao et al., 2005) and (Powers et al., 2005). Previous results show that age, gender and geographical location are influential in contributing to pharmaceutical expenditure. The projections for prescribing expenditure for 2026 was subject to scenario analysis.

7.5 Results

(Conway et al., 2014) reports Ireland's population will experience rapid growth coupled with an aging population over the next decade. This will result in an increase in GMS coverage rates, thus the increase in projected prescribing costs. Those aged 70 and over and children under 11 will be significant drivers of GMS costs.

(ConwayLenihan and Woods, 2015) reports the Irish population is estimated to grow by approximately 10% between 2012 and 2026, whereas the over 70s are expected to grow by 64%. Increased coverage rates are likely, given an increase in population and the over 70s living longer. The model predicted GMS expenditure is estimated to increase by 64%, from €1.1 billion in 2016 to €1.8 billion by 2026 (most likely scenario), ceteris paribus. On the 16^{th} of December 2015, the Minister of Health, Leo Varadkar announced the HSE National Service Plan for 2016, with an approximate cost of €13 billion. Minister Varadkar reported that approximately 40,000 less medical cards were issued in 2015 and the HSE estimate 50,000 less medical cards will be issued in 2016, due to rising employment levels, (HSE, 2015). Given this recent announcement, the best case scenario may be realised, that GMS expenditure is estimated to increase to €1.3 billion in 2021 and €1.5 billion in 2026.

(ConwayLenihan and Woods, 2015) also reported that males, the Mid–Western and South–Eastern regions are driving GMS costs in the under 11s. Females, Midlands and Southern regions are driving GMS costs in the over 70s. These projections remain subject to substantial uncertainty given the variable nature of future economic trends, policy decisions and assumptions made at the time of projections.

Those aged over 75 ($\boldsymbol{\beta = 1.195}$) and cardiovascular prescribing ($\boldsymbol{\beta = 1.193}$) were the greatest contributors to annual GMS prescribing costs. Respiratory drugs, such as Montelukast recorded the highest proportion and expenditure for claimants under the age of 15. Drugs prescribed for the nervous system, such as Escitalopram, Olanzapine and Pregabalin were highest for those between 16 and 64 years with cardiovascular drugs, such as Statins, were highest for those aged over 65. Females are more expensive than males and are prescribed more items across the four ATC groups, except among children under 11, (ConwayLenihan et al., 2016).

7.6 Recommendations

1. Ireland will experience rapid population growth and in particular, the elderly population (>65) over the next decade. A downward adjustment of the income eligibility limits can be used to curtail the GMS coverage rates and thus curbing GMS expenditure for this age group, however equity must be borne in mind.

2. Respiratory drugs that treat asthma and obstructive airway diseases recorded the highest proportion and expenditure for claimants up to the age of 15 years. This research recommends that public health resources and educational campaigns are run to improve asthma control and reduce the disease burden and associated costs on both the healthcare system and society.

3. Expenditure on nervous system drugs in Ireland are highest for those aged between 16 and 64, in particular, drugs for the treatment of anxiety and depression. The treatment of anxiety and depression is vitally important with the growth in

suicidal related deaths in Ireland. Whilst pharmacological treatments are often necessary, changes in prescribing practice combined with psychological therapies, cognitive methods, and self–help strategies, can yield cost savings.

4. Growth in the proportion of elderly claimants and associated levels of cardiovascular prescribing, particularly for statins, will present difficulties for Ireland in terms of cost containment. The primary prevention of CVD is dependent on the effective reduction of the major risk factors, particularly tobacco control and a healthier diet. Policies aimed at population–wide CVD prevention, such as legislating for smoke–free public spaces, banning dietary transfats, or halving daily dietary salt intake are generally effective and cost saving, (Gerdtham and Lundin, 2004).

5. The Irish government introduced a co–payment of 50 cents for all GMS patients and subsequently increased it to €1.50 in January 2013 and to €2.50 in December 2013. It is well documented in the literature (Schafheutle, 2008), (Atella et al., 2005), (Doran et al., 2005), (Rice and Matsuoka, 2004) and (Lexchin and Grootendorst, 2004) that increased co–payments result in a decrease in the demand for essential medicines. However, Irish research found that both co–payments (50 cent & €1.50) were associated with larger reductions in adherence to less–essential medicines than essential medicines, with the exception of anti–depressant and anxiolytic/hypnotic medicines, (Sinnott, Buckley, O' Riordan et al., 2013) and (Sinnott, Guinane, Whelton and Byrne, 2013).

   This research recommends that the Irish government investigate the adherence to both essential medicines and less–essential medicines of the €2.50 co–payment and identify if there is an optimal co–payment between €1.50 and €2.50. Small co–payments may be of value as a cost sharing policy tool because the reductions to essential medicines, apart from anti–depressants and anxiolytic/hypnotic medicines, were minimal. The Irish government may investigate and consider an alternative method of co–payment, rather than a flat charge. In Spain, pharmaceutical co–payment was changed, where pensioners pay 10% of the drug price

and general workers pay 50%, since April 2012, (Vivas-Consuelo et al., 2014). GMS claimants pay a percentage of the final price as opposed to a flat charge.

6. The over 75s are the most expensive age cohort for drug expenditure on the GMS scheme. A regular review of drug items by GPs in the community setting for this age group should be put in place by the HSE/PCRS. This review may identify unnecessary drugs and consequently may lead to cost savings.

7. An ESRI report (Gorecki et al., 2012), makes a series of supply side recommendations to promote cost savings around the price and prescribing of drugs. Supply side measures have been advocated as better policy tools than demand side measures, such as patient co–payments in controlling expenditure, (Thomson and Mossialos, 2004). This study supports the recommendations put forward by (Gorecki et al., 2012).

8. Continued negotiations on drug prices between drug companies and the State, where 'value for money' is secured and the promotion of cost effective prescribing. Prescribers should have the necessary information available, such as the price of drugs when administering a prescription form to GMS patients and private patients. This will help to shift the burden of cost away from the private patient and/or State.

9. Maximise the support for pharmacies to provide accurate and detailed electronic GMS data. Following communication with a number of community pharmacists working in Ireland throughout the course of this research, it became apparent, of the 11 community drug schemes, pharmacies do not record transactions electronically for two schemes, DTSS and EEA. Pharmacists must manually code each item on a script each month for patients presenting with DTSS and EEA scripts. This research recommends all community drug schemes prescriptions be recorded and sent electronically to the PCRS each month.

Data Analysis Recommendations

10. The annual PCRS report currently presents data in the form of 11 age cohorts,

these age cohorts are not of equal bandwidth. This research recommends that the age cohorts should be equalised to ensure standardised and robust data analysis. It is recommended that we move towards the European model of representing age cohorts. For example, health data in Spain is analysed using 10 age cohorts[1] ranging from the 0–4 to the $\geq$85, where the intervening age cohorts are of equal width, (Fernández-Liz et al., 2008). Similarly, in Italy, health data is analysed using 9 age cohorts[2] ranging from the 0–4 to the $\geq$75, where the intervening age cohorts are of equal width, (Orzella et al., 2010).

11. During the course of this research, it became apparent that the CSO and the HSE do not analyse data by comparable regional structures. It is recommended that one standard set of regions be established and all Irish organisations should collect and analyse data according to this regional structure.

12. This research recommends the PCRS produce supporting excel files of the statistical tables in the annual report. The CSO supports many of their publications with excel files. If the PCRS took a similar approach, it would be of enormous benefit to health researchers.

7.7 Limitations

HSE–PCRS Prescribing Database

- Chapters 3 and 4 were based on a sample (192,000 observations) and population (60 million observations) HSE–PCRS prescribing database respectively. This data is collected by the PCRS to produce annual statistical and claims reports and only certain variables are included. The incorporation of other variables on socio-economic status (income, educational status, geographical location) would prove very useful for research purposes. A well documented limitation of this database is the lack of a unique health identifier, which precludes the link between pharmacy

[1]Spain: 0–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, $\geq$85
[2]Italy: 0–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, $\geq$75

and other health data, such as mortality data. A unique identifier[3] was announced by the Health Information and Quality Authority (HIQA) on the 5th of August 2015 on a pilot basis. Currently, patients are given a different number in every health or social service that they utilise. Unique health identifiers would improve future research and analysis.

- The output of papers 1 to 3 is in the format of the old health board regions. The old health board regions (8) are no longer comparable to the current HSE regional structure (4), which was changed in 2010. Personal communication took place between the researcher and a CSO population statistician. The CSO advised the population data was only available at county level. The PCRS data is available at LHO level and some LHOs crossed boundaries. For example, North Tipperary was part of LHO number 22 along with East Limerick and resided in the West, whereas South Tipperary was part of LHO number 31 and resided in the South. If CSO data was available at this disaggregated level, this would prove beneficial for future analysis.

- The data in this thesis are analysed by the HSE–PCRS age cohorts (11). The age cohorts are not of equal width, so the total cost of prescriptions is not equally distributed by age cohort. This limitation must be borne in mind, when analysing the results of this thesis.

7.8 Future Research

This study has identified a number of avenues for interesting and policy relevant future research.

- Upon investigation of the 2012 HSE–PCRS database, it was evident that different data sets existed within the population database. Characteristics of high cost and low cost drug users in Ireland for the GMS scheme would be both interesting and informative.

[3]An individual health identifier is a unique, non–transferable number assigned to all individuals using health and social care services in Ireland, which will last for their lifetime,(HIQA, 2015).

- A time series anlysis of GMS drug expenditure charting the time period before, during and after the economic crisis.
- A comparative study analysing the monetary impact of reference pricing and generic substitution. A study comparing 2012 (year before policy change) and 2014 (year after policy change) using HSE–PCRS prescribing data.
- This thesis focused on the four principle ATC groups in terms of GMS expenditure, an investigation of the remaining 10 ATC groups would be informative.
- This research identified males under 11 in the Mid–Western and South–Eastern regions are driving GMS expenditure. This research recommends an analysis of drug prescribing by each region for this age group. For example, the Mid–Western region had 26,770 eligible GMS persons and the South–Eastern region had 39,864 persons in 2012, whereas the Eastern region had 101,866 eligible GMS persons. Yet, the Mid–western and South–Eastern regions are driving GMS costs for this age group.
- Those aged over 70 in the Midlands and Southern regions have been identified as a driver of GMS costs. This research recommends an analysis of drug prescribing by each region for this age group. For example, the Midlands region had 21,365 eligible GMS persons and the Southern region had 55,813 persons in 2012, whereas the Eastern region had 109,114 eligible GMS persons. Yet, the Midlands and Southern regions are driving GMS costs for this age group.
- Forecast drug utilisation by ATC group.

7.9 Conclusion

The problem for Ireland's policy makers is to contain pharmaceutical expenditure during a period, where rapid population growth is forecasted, coupled with an aging population profile, with those aged 70 and over projected to increase by 64% between 2012 and 2026. This research indicates that growth in the proportion of the elderly claimants

and associated levels of cardiovascular prescribing, particularly for statins, will present difficulties for Ireland in terms of cost containment. Cost containment measures; co–payment charges, generic substitution, reference pricing and GMS eligibility criteria can decelerate the pace of GMS expenditure growth. Co–payment charges are likely to reduce claims rates. Reference pricing and generic substitution are likely to reduce average cost per claimant and eligibility criteria will lower GMS coverage rates.

Appendix A

Appendix A (Chapter 3 Appendices)

The tables and charts generated in this Appendix are based on authors own calculations.

Table A.1: **CSO Region Breakdown**

1.Border Cavan Donegal Leitrim Louth Monaghan Sligo	**5.Mid–East** Kildare Meath Wicklow
2.Midlands Laoighis Longford Offaly Westmeath	**6.Mid-West** Clare Limerick City Limerick County North Tipperary
3.West Galway City Galway County Mayo Roscommon	**7.South–East** Carlow Kilkenny South Tipperary Waterford City Waterford County Wexford
4.Dublin Dublin City Dun Laoghaire-Rathdown Fingal South Dublin	**8.South–West** Cork City Cork County Kerry

Source: (**CSO**, 2008)

Table A.2: **PCRS 2007 Region Breakdown**

1.Eastern Area Dublin Kildare Wicklow	**5.North–Western** Donegal Leitrim Sligo
2.Midlands Laois Longford Offaly Westmeath	**6.South–Eastern** Carlow Kilkenny Tipperary S.R, Waterford Wexford
3.Mid–Western Clare Limerick Tipperary N.R.	**7.Southern** Cork Kerry
4.North–Eastern Cavan Louth Meath Monaghan	**8.Western** Galway Mayo Roscommon

Source: (**PCRS**, 2007)

Table A.3: **Meath Adjustment Factor**

Age Category	**Males**	**Females**
0–5	0.1217	0.1188
5–11	0.1171	0.1174
12–15	0.1098	0.1081
16–24	0.0853	0.0801
25–34	0.0915	0.0916
35–44	0.1113	0.1056
45–54	0.1023	0.0942
55–64	0.0976	0.0901
65–69	0.0872	0.0762
70–74	0.0849	0.0766
$>$ 75	0.0866	0.0777

Table A.4: **Eastern (Dublin, Kildare and Wicklow) Region Population Projections 2007**

Age Category	**Males**	**Females**	**Total**
0–5	55,247	52,762	**108,009**
5–11	68,969	64,981	**133,949**
12–15	36,963	34,735	**71,698**
16–24	105,579	106,367	**211,946**
25–34	155,003	153,021	**308,024**
35–44	113,788	113,266	**227,054**
45–54	88,923	92,638	**181,562**
55–64	68,092	708,27	**138,918**
65–69	22,773	25,011	**47,784**
70–74	17,590	21,187	**38,777**
$>$ 75	23,721	40,778	**64,499**
Total	**756,648**	**775,573**	**1,532,221**

Table A.5: **North–Eastern Region Adjustment Factors – Cavan Adjustment Factor**

Age Category	**Males**	**Females**
0–5	0.1186	0.1164
5–11	0.1415	0.1444
12–15	0.1358	0.1369
16–24	0.1343	0.1297
25–34	0.1379	0.1300
35–44	0.1406	0.1355
45–54	0.1446	0.1364
55–64	0.1412	0.1297
65–69	0.1377	0.1221
70–74	0.1499	0.1416
$>$ 75	0.1644	0.1478

Table A.6: **Louth Adjustment Factor**

Age Category	**Males**	**Females**
0–5	0.2728	0.2729
5–11	0.2330	0.2418
12–15	0.2240	0.2269
16–24	0.2413	0.2470
25–34	0.2619	0.2734
35–44	0.2526	0.2492
45–54	0.2240	0.2239
55–64	0.2066	0.2222
65–69	0.2092	0.2232
70–74	0.1929	0.2052
$>$ 75	0.1675	0.2018

Table A.7: **Monaghan Adjustment Factor**

Age Category	**Males**	**Females**
0–5	0.1218	0.1183
5–11	0.1188	0.1135
12–15	0.1213	0.1272
16–24	0.1266	0.1222
25–34	0.1301	0.1176
35–44	0.1176	0.1161
45–54	0.1215	0.1171
55–64	0.1174	0.1152
65–69	0.1059	0.1162
70–74	0.1187	0.1241
$>$ 75	0.1133	0.1170

Table A.8: **North–Western Region Adjustment Factors – Donegal Adjustment Factor**

Age Category	Males	Females
0–5	0.3449	0.3453
5–11	0.3286	0.3285
12–15	0.3363	0.3314
16–24	0.3091	0.3053
25–34	0.2896	0.3017
35–44	0.3037	0.3147
45–54	0.3021	0.3087
55–64	0.3225	0.3219
65–69	0.3337	0.3289
70–74	0.3174	0.3125
> 75	0.3148	0.2998

Table A.9: **Leitrim Adjustment Factor**

Age Category	Males	Females
0–5	0.0478	0.0487
5–11	0.0588	0.0579
12–15	0.0593	0.0572
16–24	0.0565	0.0548
25–34	0.0590	0.0531
35–44	0.0611	0.0589
45–54	0.0704	0.0675
55–64	0.0700	0.0672
65–69	0.0751	0.0678
70–74	0.0777	0.0704
> 75	0.0857	0.0764

Table A.10: **Sligo Adjustment Factor**

Age Category	**Males**	**Females**
0–5	0.0941	0.0984
5–11	0.1192	0.1139
12–15	0.1233	0.1204
16–24	0.1321	0.1409
25–34	0.1215	0.1242
35–44	0.1243	0.1256
45–54	0.1375	0.1463
55–64	0.1424	0.1438
65–69	0.1384	0.1418
70–74	0.1434	0.1461
$>$ 75	0.1542	0.1572

Table A.11: **North–Eastern (Cavan, Louth, Meath and Monaghan) Region Population Projections 2007**

Age Category	**Males**	**Females**	**Total**
0–5	16,814	15,623	**32,437**
5–11	21,427	20,429	**41,857**
12–15	11,120	10,547	**21,667**
16–24	25,918	24,547	**50,465**
25–34	34,933	34,002	**68,935**
35–44	32,145	30,372	**62,517**
45–54	24,968	23,611	**48,579**
55–64	19,047	18,072	**37,119**
65–69	6,047	5,860	**11,907**
70–74	4,863	5,170	**10,033**
$>$ 75	7,014	10,800	**17,814**
Total	**204,297**	**199,033**	**403,330**

Table A.12: **North–Western (Donegal, Leitrim and Sligo) Region Population Projections 2007**

Age Category	**Males**	**Females**	**Total**
0–5	8,689	8,255	**16,944**
5–11	12,614	11,800	**24,414**
12–15	7,074	6,570	**13,644**
16–24	15,922	15,349	**31,271**
25–34	17,144	17,082	**34,226**
35–44	17,131	16,936	**34,067**
45–54	15,443	15,292	**30,734**
55–64	13,429	12,612	**26,041**
65–69	4,678	4,430	**9,108**
70–74	3,769	3,834	**7,603**
$>$ 75	5,937	8,418	**14,355**
Total	**121,829**	**120,577**	**242,406**

Table A.13: **Estimated Population 2007**

Age Category	**Males**	**Females**	**Total**
0–5	158,436	150,899	**309,335**
5–11	208,273	197,580	**405,853**
12–15	113,157	107,538	**220,695**
16–24	289,996	282,487	**572,483**
25–34	381,935	370,087	**752,022**
35–44	322,509	314,454	**636,963**
45–54	267,540	264,592	**532,132**
55–64	210,943	207,389	**418,332**
65–69	71,674	72,565	**144,239**
70–74	57,155	62,795	**119,950**
$>$ 75	81,722	127,034	**208,756**
Total	**2,163,340**	**2,157,420**	**4,320,760**

Table A.14: **Estimated Population 2011**

Age Category	**Males**	**Females**	**Total**
0–5	176,288	166,556	**342,844**
5–11	223,508	213,495	**437,003**
12–15	119,878	113,272	**233,150**
16–24	269,361	265,205	**534,566**
25–34	431,230	415,338	**846,568**
35–44	361,786	343,581	**705,367**
45–54	294,035	290,038	**584,073**
55–64	234,484	231,852	**466,336**
65–69	86,098	86,958	**173,056**
70–74	63,099	67,457	**130,556**
$>$ 75	94,822	137,402	**232,224**
Total	**2354589**	**2,331,154**	**4,685,743**

Table A.15: **Estimated Population 2016**

Age Category	**Males**	**Females**	**Total**
0–5	192,048	181,207	**373,255**
5–11	248,383	235,669	**484,052**
12–15	129,894	124,266	**254,160**
16–24	266,260	258,780	**525,040**
25–34	417,702	409,056	**826,758**
35–44	424,065	396,257	**820,322**
45–54	329,320	317,944	**647,264**
55–64	260,221	257,894	**518,115**
65–69	105,793	106,939	**212,732**
70–74	79,092	82,644	**161,736**
$>$ 75	116,812	154,758	**271,570**
Total	**2,569,590**	**2,525,414**	**5,095,004**

Table A.16: **Estimated Population 2021**

Age Category	**Males**	**Females**	**Total**
0–5	193,067	182,038	**375,105**
5–11	271,845	256,900	**528,745**
12–15	142,822	135,535	**278,357**
16–24	283,177	274,430	**557,607**
25–34	363,423	357,989	**721,412**
35–44	473,138	443,977	**917,115**
45–54	372,962	351,091	**724,053**
55–64	291,139	287,855	**578,994**
65–69	116,643	118,040	**234,683**
70–74	98,322	102,088	**200,410**
$>$ 75	150,477	184,130	**334,607**
Total	**2,757,015**	**2,694,073**	**5,451,088**

Table A.17: **Estimated Population 2026**

Age Category	**Males**	**Females**	**Total**
0–5	179,668	169,255	**348,923**
5–11	275,391	259,831	**535,222**
12–15	156,563	147,834	**304,397**
16–24	303,303	291,326	**594,629**
25–34	333,798	325,892	**659,690**
35–44	446,047	428,089	**874,136**
45–54	430,441	400,425	**830,866**
55–64	324,740	314,409	**639,149**
65–69	131,465	132,324	**263,789**
70–74	109,278	113,062	**222,340**
$>$ 75	195,704	227,155	**422,859**
Total	**2,886,398**	**2,809,602**	**5,696,000**

Table A.18: **Population Scenarios**

Scenarios	**Population**	**Population Growth Rate (%)**
Scenario 1	**Minimum(Lower Bound)**	
Year	**Population**	**(% Growth)**
2002	3,917,203	
2007	4,270,763	9.03
2011	4,422,000	3.54
2016	4,609,000	4.23
2021	4,766,000	3.41
2026	4,884,000	2.48
Scenario 2	**Mean(Most Likely)**	
Year	**Population**	**(% Growth)**
2002	3,917,203	
2007	4,320,760	10.30
2011	4,685,743	8.45
2016	5,095,004	8.73
2021	5,451,088	6.99
2026	5,696,000	4.49
Scenario 3	**Maximum(Upper Bound)**	**(% Growth)**
2007	[(10.3 - 9.03) + 10.3]	11.58
2011	[(8.45 - 3.54) + 8.45]	13.35
2016	[(8.73 - 4.23) + 8.73]	13.24
2021	[(6.99 - 3.41) + 6.99]	10.57
2026	[(4.49 - 2.48) + 4.49]	6.51

Table A.19: **Eligible persons for the GMS Scheme by Region 2006 & 2007**

Region	**2006**		**2007**	
	Number	**%**	**Number**	**%**
Eastern				
Dublin	289,790	24.43	298,100	25.11
Kildare	41,116	22.1	43,656	23.43
Wicklow	29,934	23.7	31,251	24.76
Total	**360,840**	**24.08**	**373,007**	**24.87**
Midlands				
Laois	18,173	27.12	19,441	28.99
Longford	13,091	38.10	13,747	39.97
Offaly	20,726	29.36	22,208	31.34
Westmeath	22,329	28.12	23,559	29.69
Total	**74,319**	**29.56**	**78,955**	**31.37**
Mid–Western				
Clare	33,556	30.29	35,484	31.98
Limerick	54,242	29.50	58,352	31.70
Tipperary N.R	21,175	32.09	22,429	33.97
Total	**108,973**	**30.22**	**116,265**	**32.20**
North–Eastern				
Cavan	20,939	32.74	22,429	35.04
Louth	37,809	34.09	38,374	34.49
Meath	32,476	19.97	34,098	20.94
Monaghan	16,527	29.61	17,312	30.92
Total	**107,751**	**27.40**	**112,213**	**28.47**
North–Western				
Donegal	71,058	48.35	72,590	49.29
Leitrim	11,638	40.36	12,309	42.52
Sligo	19,956	32.76	20,566	33.77
Total	**102,652**	**43.38**	**105,465**	**44.48**
South–Eastern				
Carlow	16,840	33.27	18,384	36.51
Kilkenny	20,885	23.90	21,817	24.92
Tipperary S.R	29,150	35.10	30,242	36.34
Waterford	37,414	34.66	39,423	36.52
Wexford	42,679	32.43	44,751	33.97
Total	**146,968**	**31.92**	**154,617**	**33.55**
Southern				
Cork	138,720	28.85	146,072	30.35
Kerry	42,792	30.65	44,687	31.96
Total	**181,512**	**29.25**	**190,759**	**30.71**
Western				
Galway	68,451	29.63	71,692	30.95
Mayo	48,944	39.58	50,867	41.08
Roscommon	21,285	36.26	22,338	38.01
Total	**138,680**	**33.55**	**144,897**	**34.98**

Source: (**PCRS**, 2007)

Table A.20: **Midlands Population Projections 2007**

Age Category	**Males**	**Females**	**Total**	**% Total**
0–5	10,193	9,733	19,926	**7.07**
5–11	13,762	13,085	26,847	**10.38**
12–15	7,280	7,018	14,298	**5.53**
16–24	16,977	16,081	33,058	**12.78**
25–34	21,244	20,045	41,289	**15.96**
35–44	19,547	18,830	38,377	**14.83**
45–54	16,660	15,517	32,177	**12.44**
55–64	12,566	11,975	24,541	**9.49**
65–69	4,159	4,077	8,236	**3.18**
70–74	3,577	3,715	7,292	**2.82**
$>$ 75	5,199	7,467	12,666	**4.90**
Total	**131,164**	**127,543**	**258,707**	**100.00**

Table A.21: **North–West Population Projections 2007**

Age Category	**Males**	**Females**	**Total**	**% Total**
0–5	8,689	8,255	16,944	**6.99**
5–11	12,614	11,800	24,414	**10.07**
12–15	7,074	6,570	13,644	**5.63**
16–24	15,922	15,349	31,271	**12.90**
25–34	17,144	17,082	34,226	**14.12**
35–44	17,131	16,936	34,067	**14.05**
45–54	15,443	15,292	30,734	**12.68**
55–64	13,429	12,612	26,041	**10.74**
65–69	4,678	4,430	9,108	**3.76**
70–74	3,769	3,834	7,603	**3.14**
$>$ 75	5,937	8,418	14,355	**5.92**
Total	**121,829**	**120,577**	**242,406**	**100.00**

Table A.22: **Variation in GMS Cost of Medicines per person (€) 2007, Maximum Midlands and Minimum North–West**

Scenario	**0–5**	**5–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Minimum	76.90	68.45	75.62	176.08	269.64	378.12	604.37	933.96	1133.85	1214.07	1491.67
Mean	104.39	83.99	94.30	247.63	380.55	517.24	833.14	1178.60	1363.82	1385.76	1654.53
Maximum	126.51	106.88	120.95	297.29	444.51	601.32	981.72	1413.87	1578.36	1626.10	1948.21
Variation between Min & Max values (%)	**39**	**36**	**37**	**41**	**39**	**37**	**38**	**34**	**28**	**25**	**23**

Source: (**PCRS**, 2007)

Figure A.1: **Average Regional Variation in GMS cost of Medicines per person (€) 2007**

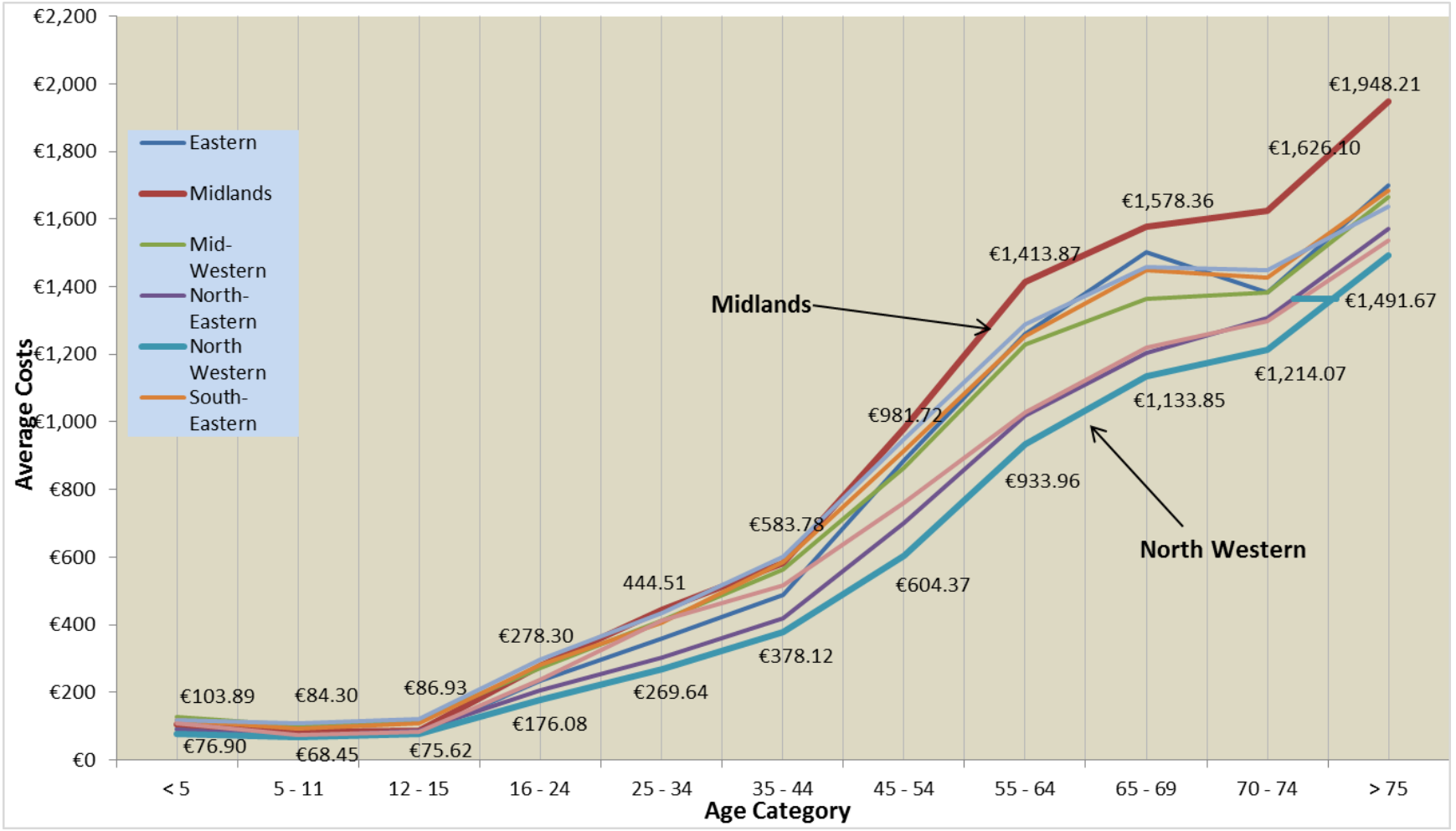


Table A.23: **Average Cost per Claimant by Gender, Age and Region 2007 (€)**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	340.70	526.23	699.58	990.50	1068.39	1529.61	1830.58	1944.42	1659.51	1884.71	**1247.42**
Females	335.74	422.76	497.16	583.24	835.72	1391.44	1587.21	1798.39	1656.34	2101.79	**1120.98**
Midlands											
Males	383.46	526.63	867.35	1310.88	1281.42	1600.47	1842.21	1985.16	2088.70	2253.84	**1414.01**
Females	375.00	376.47	567.59	690.00	1026.93	1360.95	1676.44	1759.30	1976.27	2368.23	**1217.72**
Mid–Western											
Males	473.67	785.42	958.88	1182.14	1430.07	1434.25	1700.76	1743.40	1736.71	1855.32	**1330.06**
Females	432.10	510.40	497.09	748.34	1015.56	1305.22	1643.45	1607.94	1692.36	1984.11	**1143.66**
North–Eastern											
Males	451.81	609.15	859.65	1270.70	1276.09	1447.42	1788.00	1795.59	1875.59	2144.42	**1351.84**
Females	388.21	586.19‘	433.54	671.50	898.59	1298.33	1511.16	1777.87	1789.24	2138.16	**1149.28**
North–Western											
Males	362.06	504.79	662.34	977.47	1161.31	1275.76	1464.13	1571.88	1543.03	1959.05	**1148.18**
Females	365.35	374.71	417.64	550.54	804.19	1088.66	1442.24	1527.07	1564.77	1983.66	**1011.88**
South–Eastern											
Males	426.40	622.35	926.11	1278.76	1325.37	1580.40	1701.19	1800.64	1878.14	2013.15	**1355.25**
Females	322.44	508.25	496.23	592.20	982.93	1453.27	1594.72	1666.03	1714.24	1962.36	**1129.25**
Southern											
Males	460.07	604.36	914.89	1311.79	1321.64	1540.62	1821.50	1949.69	1814.62	1876.65	**1361.58**
Females	450.46	572.32	524.35	735.10	951.01	1426.84	1562.90	1733.53	1739.46	1876.45	**1157.24**
Western											
Males	449.38	564.49	835.16	1301.39	1235.90	1406.51	1607.19	1803.02	1691.33	1966.14	**1286.05**
Females	417.48	419.16	441.20	732.53	968.83	1346.56	1461.06	1610.21	1730.81	1997.09	**1112.49**
Total	**402.15**	**532.09**	**662.42**	**932.94**	**1099.00**	**1405.40**	**1639.67**	**1754.63**	**1759.44**	**2022.82**	**1221.06**

Table A.24: **Claims Rate 2007**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern										
Males	0.52	0.14	0.31	0.39	0.46	0.56	0.69	0.79	0.81	0.89
Females	0.45	0.18	0.50	0.57	0.58	0.65	0.79	0.81	0.86	0.82
Midlands										
Males	0.50	0.18	0.31	0.38	0.45	0.59	0.78	0.82	0.76	0.85
Females	0.50	0.21	0.51	0.57	0.57	0.75	0.83	0.87	0.84	0.83
Mid–Western										
Males	0.51	0.16	0.28	0.37	0.41	0.58	0.72	0.78	0.78	0.90
Females	0.49	0.20	0.55	0.52	0.54	0.68	0.75	0.85	0.83	0.84
North–Eastern										
Males	0.42	0.15	0.26	0.32	0.37	0.56	0.65	0.76	0.72	0.78
Females	0.42	0.16	0.57	0.51	0.53	0.61	0.74	0.73	0.79	0.78
North–Western										
Males	0.45	0.16	0.25	0.27	0.31	0.47	0.63	0.70	0.78	0.75
Females	0.35	0.19	0.44	0.50	0.49	0.55	0.66	0.76	0.78	0.76
South–Eastern										
Males	0.48	0.20	0.26	0.33	0.43	0.56	0.71	0.79	0.74	0.85
Females	0.55	0.18	0.52	0.57	0.55	0.61	0.77	0.85	0.83	0.89
Southern										
Males	0.53	0.21	0.33	0.36	0.47	0.61	0.71	0.76	0.78	0.86
Females	0.46	0.20	0.55	0.54	0.61	0.67	0.82	0.83	0.85	0.88
Western										
Males	0.41	0.17	0.28	0.35	0.43	0.52	0.64	0.69	0.75	0.77
Females	0.44	0.17	0.54	0.50	0.51	0.59	0.71	0.75	0.77	0.79
Total	**0.47**	**0.18**	**0.40**	**0.44**	**0.48**	**0.60**	**0.72**	**0.78**	**0.79**	**0.83**

Table A.25: **Population Weightings for Coverage Parameter**

Region	**Gender**	**<5**	**5–11**
Eastern	Male	0.444765	0.555235
Eastern	Female	0.448114	0.551886
Midlands	Male	0.425506	0.574494
Midlands	Female	0.426549	0.573451
Mid–Western	Male	0.425571	0.574429
Mid–Western	Female	0.424115	0.575885
North–Eastern	Male	0.439684	0.560316
North–Eastern	Female	0.433344	0.566656
North–Western	Male	0.407881	0.592119
North–Western	Female	0.41161	0.58839
South–Eastern	Male	0.422027	0.577973
South–Eastern	Female	0.426775	0.573225
Southern	Male	0.426503	0.573497
Southern	Female	0.423771	0.576229
Western	Male	0.423492	0.576508
Western	Female	0.425721	0.574279

Table A.26: **Three population scenarios by age, gender and region for 2007 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	112,664	33,526	95,760	140,587	103,206	80,654	61,759	20,655	15,955	21,515	**686,280**
Females	106,793	31,504	96,475	138,790	102,732	84,023	64,240	22,685	19,216	36,986	**703,444**
Midlands											
Males	21,727	6,603	15,398	19,268	17,729	15,111	11,397	3.772	3,224	4,715	**118,966**
Females	20,696	6,365	14,585	18,181	17,079	14,074	10,861	3,698	3,370	6,773	**115,682**
Mid–Western											
Males	28,071	8,977	22,635	27,022	24,499	21,409	17,420	5,844	4,708	6,771	**167,355**
Females	26,952	8,431	21,236	25,244	23,399	20,584	16,806	5,870	4,910	10,099	**163,531**
North–Eastern											
Males	34,685	10,086	23,508	31,684	29,155	22,646	17,276	5,485	4,411	6,362	**185,297**
Females	32,700	9,566	22,264	30,840	27,546	21,415	16,391	5,315	4,689	9,795	**180,523**
North–Western											
Males	19,322	6,416	14,441	15,549	15,538	14,006	12,180	4,243	3,419	5,385	**110,499**
Females	18,190	5,959	13,922	15,493	15,361	13,869	11,439	4,018	3,477	7,635	**109,363**
South–Eastern											
Males	37,520	11,813	27,634	33,872	32,088	27,519	22,012	7,962	6,203	8,822	**215,445**
Females	35,772	11,427	26,337	31,978	31,175	26,522	21,336	7,566	6,654	12,893	**211,661**
Southern											
Males	47,166	15,018	37,543	47,696	42,884	36,655	29,451	10,104	8,144	11,664	**286,325**
Females	45,101	14,391	36,501	45,709	41,306	35,636	28,514	10,211	8,908	18,110	**284,387**
Western											
Male	31,451	10,196	26,106	30,736	27,417	24,660	19,830	6,944	5,756	8,888	**191,982**
Females	29,868	9,893	24,895	29,433	26,610	23,860	18,515	6,453	5,732	12,928	**188,188**
Total	**648,676**	**200,170**	**519,242**	**682,084**	**577,725**	**482,644**	**379,427**	**130,825**	**108,795**	**189,342**	**3,918,929**

Table A.27: **Population scenario by age, gender and region for 2007 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	124,216	36,963	105,579	155,003	113,788	88,923	68,092	22,773	17,590	23,721	**756,648**
Females	117,743	34,735	106,367	153,021	113,266	92,638	70,827	25,011	21,187	40,778	**775,573**
Midlands											
Males	23,955	7,280	16,977	21,244	19,547	16,660	12,566	4,159	3,577	5,199	**131,164**
Females	22,818	7,018	16,081	20,045	18,830	15,517	11,975	4,077	3,715	7,467	**127,543**
Mid–Western											
Males	30,949	9,897	24,956	29,793	27,011	23,604	19,206	6,443	5,191	7,465	**184,515**
Females	29,716	9,295	23,414	27,832	25,798	22,695	18,529	6,472	5,413	11,135	**180,299**
North–Eastern											
Males	38,241	11,120	25,918	34,933	32,145	24,968	19,047	6,047	4,863	7,014	**204,297**
Females	36,052	10,547	24,547	34,002	30,372	23,611	18,072	5,860	5,170	10,800	**199,033**
North–Western											
Males	21,303	7,074	15,922	17,144	17,131	15,443	13,429	4,678	3,769	5,937	**121,829**
Females	20,055	6,570	15,349	17,082	16,936	15,292	12,612	4,430	3,834	8,418	**120,577**
South–Eastern											
Males	41,367	13,024	30,468	37,345	35,378	30,341	24,269	8,778	6,839	9,727	**237,536**
Females	39,440	12,599	29,037	35,257	34,372	29,242	23,524	8,342	7,336	14,215	**233,364**
Southern											
Males	52,022	16,558	41,393	52,587	47,281	40,413	32,471	11,140	8,979	12,860	**315,684**
Females	49,725	15,867	40,244	50,396	45,541	39,290	31,438	11,258	9,821	19,967	**313,547**
Western											
Males	34,676	11,241	28,783	33,887	30,228	27,188	21,863	7,656	6,346	9,799	**211,667**
Females	32,930	10,907	27,448	32,451	29,339	26,307	20,413	7,115	6,320	14,254	**207,484**
Total	**715,188**	**220,695**	**572,483**	**752,022**	**636,963**	**532,132**	**418,332**	**144,239**	**119,950**	**208,756**	**4,320,760**

Table A.28: **Population scenario by age, gender and region for 2007 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	138,600	41,244	117,805	172,952	126,965	99,221	75,977	25,410	19,627	26,468	**844,268**
Females	131,377	38,757	118,684	170,741	126,382	103,366	79,029	27,907	23,640	45,501	**865,384**
Midlands											
Males	26,729	8,123	18,943	23,704	21,811	18,589	14,021	4,641	3,991	5,801	**146,353**
Females	25,460	7,831	17,943	22,366	21,011	17,314	13,362	4,549	4,145	8,332	**142,312**
Mid–Western											
Males	34,533	11,043	27,846	33,243	30,139	26,337	21,430	7,189	5,792	8,329	**205,882**
Females	33,157	10,371	26,125	31,055	28,785	25,323	20,675	7,221	6,040	12,424	**201,178**
North–Eastern											
Males	42,670	12,407	28,919	38,978	35,867	27,859	21,253	6,747	5,426	7,827	**227,954**
Females	40,227	11,769	27,389	37,940	33,890	26,345	20,164	6,539	5,768	12,050	**222,081**
North–Western											
Males	23,770	7,893	17,765	19,129	19,115	17,231	14,974	5,220	4,206	6,624	**135,937**
Females	22,377	7,331	17,127	19,060	18,897	17,062	14,072	4,943	4,278	9,393	**134,540**
South–Eastern											
Males	46,157	14,532	33,996	41,670	39,475	33,854	27,079	9,794	7,631	10,853	**265,043**
Females	44,007	14,058	32,399	39,340	38,352	32,628	26,248	9,308	8,186	15,861	**260,388**
Southern											
Males	58,024	18,475	46,186	58,677	52,756	45,093	36,231	12,430	10,019	14,349	**352,240**
Females	55,483	17,704	44,904	56,232	50,815	43,840	35,079	12,562	10,958	22,279	**349,856**
Western											
Males	38,691	12,543	32,116	37,811	33,728	30,336	24,395	8,543	7,081	10,934	**236,178**
Females	36,743	12,170	30,626	36,209	32,736	29,353	22,777	7,739	7,052	15,905	**231,511**
Total	**798,007**	**246,251**	**638,777**	**839,106**	**710,723**	**593,753**	**466,775**	**160,942**	**133,840**	**232,930**	**4,821,104**

Table A.29: **Three population scenarios by age, gender and region for 2011 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	134,088	37,860	92,985	168,814	127,842	96,058	73,121	26,486	19,180	27,191	**803,621**
Females	127,629	35,630	95,624	165,446	122,933	98,219	76,870	28,575	22,322	43,228	**816,477**
Midlands											
Males	25,435	7,689	15,381	23,930	20,964	17,773	13,977	5,032	3,625	5,833	**139,637**
Females	24,017	7,282	14,352	21,959	19,818	16,659	13,107	4,895	3,724	7,774	**133,586**
Mid–Western											
Males	31,984	10,048	23,092	31,696	28,127	24,292	20,332	7,514	5,471	8,301	**190,857**
Females	33,644	9,388	20,883	29,183	26,172	23,559	19,726	7,489	5,668	11,533	**184,226**
North–Eastern											
Males	39,883	11,392	23,498	38,286	34,830	26,473	20,269	7,097	5,171	7,760	**214,659**
Females	37,632	10,797	22,720	36,763	32,004	25,012	19,457	6,731	5,388	11,106	**207,610**
North–Western											
Males	21,597	7,248	14,688	18,885	18,016	16,164	14,209	5,519	3,956	6,456	**126,737**
Females	20,306	8,717	14,455	18,469	17,423	16,189	13,509	5,103	3,973	8,532	**124,675**
South–Eastern											
Males	42,828	13,444	28,545	40,393	37,275	32,378	26,068	9,877	7,439	10,990	**249,236**
Females	40,772	12,710	26,489	37,697	35,217	31,285	24,983	9,926	7,473	15,180	**241,730**
Southern											
Males	53,955	16,701	36,395	55,665	49,436	42,578	34,582	12,821	9,503	14,338	**325,975**
Females	51,270	16,101	35,842	53,777	46,719	41,463	33,518	12,910	10,060	20,939	**322,600**
Western											
Males	35,873	11,253	25,242	38,297	32,490	27,913	23,625	8,704	6,521	10,597	**220,513**
Females	34,327	10,637	25,452	37,341	31,132	27,385	22,475	8,271	6,461	14,247	**217,728**
Total	**752,240**	**224,896**	**515,642**	**816,599**	**680,397**	**563,397**	**449,828**	**166,930**	**125,934**	**224,003**	**4,519,868**

Table A.30: **Population scenario by age, gender and region for 2011 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	139,008	39,249	96,397	175,009	132,533	99,581	75,804	27,458	19,884	28,189	**833,114**
Females	132,313	36,938	99,134	171,518	127,445	101,824	79,691	29,623	23,141	44,814	**846,441**
Midlands											
Males	26,368	7,971	15,945	24,808	21,733	18,425	14,490	5,217	3,758	6,047	**144,762**
Females	24,898	7,549	14,879	22,765	20,545	17,270	13,588	5,075	3,861	8,059	**138,489**
Mid–Western											
Males	33,158	10,417	23,939	32,859	29,159	25,183	21,078	7,790	5,672	8,606	**197,861**
Females	31,769	9,733	21,649	30,254	27,133	24,424	20,450	7,743	5,876	11,956	**190,987**
North–Eastern											
Males	41,346	11,810	24,361	39,691	36,108	27,445	21,013	7,358	5,360	8,044	**222,537**
Females	39,013	11,194	23,554	38,112	33,178	25,929	20,171	6,978	5,586	11,513	**215,229**
North–Western											
Males	22,390	7,514	15,227	19,578	18,677	16,757	14,731	5,721	4,101	6,692	**131,388**
Females	21,051	6,964	14,985	19,147	18,063	16,783	14,004	5,290	4,119	8,845	**129,250**
South–Eastern											
Males	44,400	13,937	29,593	41,875	38,643	33,566	27,025	10,239	7,712	11,393	**258,383**
Females	42,268	13,176	27,461	39,080	36,509	32,433	25,900	10,290	7,747	15,737	**250,601**
Southern											
Males	55,935	17,314	37,731	57,708	51,250	44,141	35,851	13,292	9,852	14,864	**337,938**
Females	53,152	16,692	37,157	55,751	48,434	42,985	34,748	13,384	10,429	21,707	**334,439**
Western											
Males	37,190	11,666	26,168	39,702	33,682	28,937	24,492	9,023	6,760	10,986	**228,606**
Females	35,587	11,027	26,386	38,711	32,274	28,390	23,300	8,576	6,698	14,770	**225,718**
Total	**779,847**	**233,150**	**534,566**	**846,568**	**705,367**	**584,073**	**466,336**	**173,056**	**130,556**	**232,224**	**4,685,743**

Table A.31: **Population scenario by age, gender and region for 2011 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	157,566	44,489	109,266	198,373	150,227	112,876	85,924	31,123	22,538	31,952	**944,334**
Females	149,976	41,869	112,368	194,415	144,459	115,417	90,330	33,578	26,231	50,797	**959,440**
Midlands											
Males	29,888	9,035	18,074	28,120	24,634	20,885	16,424	5,913	4,260	6,854	**164,088**
Females	28,222	8,557	16,865	25,804	23,288	19,576	15,402	5,753	4,376	9,135	**156,977**
Mid–Western											
Males	37,585	11,808	27,135	37,246	33,052	28,545	23,892	8,830	6,429	9,755	**224,275**
Females	36,010	11,032	24,539	34,293	30,755	27,685	23,180	8,777	6,660	13,552	**216,484**
North–Eastern											
Males	46,866	13,386	27,613	44,990	40,929	31,109	23,819	8,340	6,076	9,118	**252,246**
Females	44,222	12,688	26,699	43,200	37,608	29,391	22,863	7,909	6,332	13,050	**243,962**
North–Western											
Males	25,379	8,517	17,260	22,192	21,171	18,994	16,697	6,485	4,648	7,586	**148,929**
Females	23,861	7,893	16,985	21,703	20,474	19,023	15,874	5,996	4,669	10,026	**146,505**
South–Eastern											
Males	50,327	15,798	33,544	47,465	43,802	38,047	30,633	11,606	8,742	12,914	**292,877**
Females	47,911	14,935	31,127	44,297	41,383	36,763	29,358	11,664	8,781	17,838	**284,056**
Southern											
Males	63,402	19,625	42,768	65,412	58,092	50,034	40,637	15,066	11,167	16,848	**383,053**
Females	60,248	18,920	42,117	63,194	54,900	48,723	39,387	15,171	11,821	24,605	**379,087**
Western											
Males	42,155	13,223 ‘	29,661	45,002	38,179	32,800	27,762	10,228	7,762	12,453	**259,125**
Females	40,338	12,499	29,909	43,879	36,583	32,180	26,411	9,720	7,592	16,742	**255,851**
Total	**883,957**	**264,276**	**605,931**	**959,585**	**799,533**	**662,047**	**528,592**	**196,159**	**147,985**	**263,226**	**5,311,290**

Table A.32: **Three population scenarios by age, gender and region for 2016 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	150,883	42,177	94,276	160,485	156,457	110,319	82,169	32,700	24,125	34,186	**887,776**
Females	143,282	40,453	98,905	160,638	147,957	108,891	85,740	35,127	26,889	49,486	**897,368**
Midlands											
Males	27,013	8,391	14,299	23,150	23,951	19,610	15,827	6,231	4,630	6,978	**150,079**
Females	25,344	8,049	12,450	20,818	21,576	18,572	14,786	6,020	4,630	8,586	**140,831**
Mid–Western											
Males	34,758	10,094	23,549	31,102	31,105	26,040	21,859	9,166	6,824	9,993	**204,489**
Females	32,631	9,838	19,314	28,176	28,193	24,871	21,089	9,111	7,034	12,796	**193,052**
North–Eastern											
Males	43,162	12,170	22,958	37,504	40,080	29,704	22,154	8,577	6,505	9,406	**232,220**
Females	40,644	11,647	21,973	36,655	36,440	27,252	21,367	8,366	6,441	12,281	**223,066**
North–Western											
Males	22,597	7,513	14,033	18,935	19,610	17,835	15,250	6,589	4,977	7,681	**135,021**
Females	21,209	6,992	13,417	18,815	18,899	17,425	14,685	6,380	4,730	9,273	**131,826**
South–Eastern											
Males	45,293	14,596	27,764	39,788	41,622	35,490	28,747	11,811	9,024	13,651	**267,787**
Females	42,825	13,873	23,605	36,779	38,340	33,840	27,835	11,617	9,397	17,150	**255,260**
Southern											
Males	58,480	17,495	34,653	51,815	55,467	46,197	37,630	15,520	11,706	17,523	**346,487**
Females	54,437	16,546	34,411	51,272	51,911	44,348	36,573	15,484	12,189	23,257	**341,429**
Western											
Males	39,615	11,963	23,466	37,255	37,835	30,194	25,578	10,724	7,955	12,453	**237,037**
Females	37,871	11,609	23,758	38,600	36,180	29,295	24,912	10,311	7,837	15,384	**235,757**
Total	**821,043**	**243,409**	**502,831**	**791,786**	**785,622**	**619,885**	**496,199**	**203,733**	**154,895**	**260,083**	**4,879,485**

Table A.33: **Population scenario by age, gender and region for 2016 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	157,547	44,040	98,440	167,573	163,367	115,191	85,798	34,144	25,191	35,696	**926,987**
Females	149,611	42,240	103,273	167,733	154,492	113,700	89,527	36,678	28,077	51,672	**937,004**
Midlands											
Males	28,206	8,762	14,931	24,172	25,009	20,476	16,526	6,506	4,834	7,286	**156,708**
Females	26,463	8,405	13,000	21,737	22,529	19,392	15,439	6,286	4,835	8,965	**147,051**
Mid–Western											
Males	36,293	10,540	24,589	32,476	32,479	27,190	22,824	9,571	7,125	10,434	**213,521**
Females	34,072	10,273	20,167	29,420	29,438	25,970	22,020	9,513	7,345	13,361	**201,579**
North–Eastern											
Males	45,068	12,707	23,972	39,161	41,850	31,016	23,132	8,955	6,793	9,822	**242,478**
Females	42,439	12,162	22,944	38,274	38,050	28,456	22,310	8,736	6,726	12,823	**232,918**
North–Western											
Males	23,595	7,844	14,653	19,772	20,477	18,623	15,924	6,880	5,197	8,020	**140,984**
Females	22,145	7,301	14,010	19,647	19,733	18,195	15,334	6,662	4,939	9,682	**137,649**
South–Eastern											
Males	47,294	15,241	28,990	41,545	43,460	37,058	30,017	12,333	9,423	14,254	**279,616**
Females	44,716	14,486	24,648	38,403	40,033	35,335	29,064	12,130	9,812	17,907	**266,534**
Southern											
Males	61,063	18,268	36,184	54,104	57,917	48,237	39,292	16,206	12,223	18,297	**361,791**
Females	57,886	17,277	35,931	53,537	54,204	46,307	38,188	16,168	12,727	24,284	**356,509**
Western											
Males	41,365	12,491	24,502	38,900	39,506	31,528	26,708	11,198	8,306	13,003	**247,507**
Females	39,544	12,122	24,807	40,305	37,778	30,589	26,012	10,766	8,183	16,064	**246,170**
Total	**857,307**	**254,160**	**825,040**	**826,758**	**820,322**	**647,264**	**518,118**	**212,732**	**161,736**	**271,570**	**5,095,004**

Table A.34: **Population scenario by age, gender and region for 2016 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	178,406	49,871	111,473	189,760	184,997	130,443	97,158	38,664	28,526	40,422	**1,049,720**
Females	169,419	47,833	116,947	189,941	174,947	128,754	101,380	41,534	31,794	58,513	**1,061,063**
Midlands											
Males	31,940	9,922	16,908	27,372	28,320	23,187	18,714	7,367	5,474	8,251	**177,456**
Females	29,967	9,518	14,721	24,615	25,512	21,960	17,483	7,118	5,475	10,152	**166,521**
Mid–Western											
Males	41,098	11,935	27,845	36,776	36,779	30,790	25,846	10,838	8,068	11,815	**241,791**
Females	38,583	11,633	22,837	33,315	33,336	29,408	24,935	10,773	8,317	15,130	**228,268**
North–Eastern											
Males	51,035	14,390	27,415	44,345	47,391	35,123	26,195	10,141	7,692	11,122	**274,580**
Females	48,058	13,772	25,981	43,342	43,087	32,223	25,264	9,892	7,616	14,521	**263,757**
North–Western											
Males	26,719	8,883	16,593	22,389	23,188	21,089	18,032	7,791	5,885	9,082	**159,651**
Females	25,077	8,268	15,865	22,248	22,346	20,604	17,364	7,544	5,593	10,964	**155,874**
South–Eastern											
Males	53,556	17,259	32,828	47,046	49,214	41,964	33,991	13,966	10,671	6,141	**316,636**
Females	50,636	16,404	27,911	43,488	45,333	40,013	32,912	13,736	11,111	20,278	**301,823**
Southern											
Males	69,148	20,687	40,975	61,267	65,585	54,624	44,494	18,352	13,841	20,720	**409,692**
Females	65,550	19,564	40,688	60,625	61,381	52,438	43,244	18,309	14,412	27,499	**403,711**
Western											
Males	46,842	14,145	27,746	44,050	44,737	35,702	30,244	12,681	9,406	14,725	**280,277**
Females	44,780	13,727	28,091	45,641	42,780	34,639	29,456	12,191	9,266	18,191	**278,763**
Total	**970,814**	**287,811**	**594,555**	**936,221**	**928,933**	**732,962**	**586,713**	**240,898**	**183,150**	**307,526**	**5,769,583**

Table A.35: **Three population scenarios by age, gender and region for 2021 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	164,612	48,354	104,339	143,205	179,253	132,845	95,482	36,640	30,687	45,318	**980,736**
Females	155,666	46,450	111,285	147,200	170,939	126,457	97,587	39,844	33,765	60,019	**989,213**
Midlands											
Males	27,290	9,018	15,057	18,885	26,923	21,896	17,766	7,244	5,859	9,029	**158,968**
Females	25,685	8,433	12,619	15,964	23,614	20,425	16,783	6,859	5,797	10,303	**146,484**
Mid–Western											
Males	36,130	11,609	24,842	29,174	34,092	28,443	23,801	9,984	8,556	12,906	**219,537**
Females	33,863	10,717	19,591	24,383	30,428	26,296	23,117	9,850	8,752	15,439	**202,436**
North–Eastern											
Males	45,718	13,244	24,411	33,157	45,202	33,871	24,977	9,467	8,074	12,232	**250,352**
Females	43,175	12,591	23,316	33,003	40,994	30,314	24,038	9,174	8,172	14,561	**239,339**
North–Western											
Males	23,336	7,849	14,543	16,622	21,780	19,501	16,840	7,209	6,097	9,885	**143,664**
Females	22,089	7,218	13,684	16,703	20,732	18,776	16,394	6,869	6,035	10,865	**139,363**
South–Eastern											
Males	46,674	15,719	29,643	35,172	45,760	38,908	32,499	13,276	11,027	17,647	**286,375**
Females	43,925	14,674	24,194	30,716	41,889	36,356	31,613	12,875	11,216	20,910	**268,468**
Southern											
Males	61,770	19,222	36,158	43,376	60,472	50,858	42,049	17,080	14,561	22,646	**368,191**
Females	58,034	18,282	35,523	43,745	57,484	47,866	41,134	16,910	14,922	27,688	**361,588**
Western											
Males	43,528	12,936	24,529	31,439	43,521	33,921	27,798	11,766	10,058	15,681	**255,177**
Females	41,533	12,548	24,859	33,967	42,757	32,630	27,374	11,633	9,947	18,066	**255,314**
Total	**873,029**	**268,865**	**538,593**	**696,812**	**885,841**	**699,363**	**559,250**	**226,680**	**193,576**	**323,197**	**5,265,206**

Table A.36: **Population scenario by age, gender and region for 2021 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	170,424	50,061	108,022	148,261	185,582	137,535	98,853	37,934	31,770	46,918	**1,015,360**
Females	161,162	48,090	115,214	152,396	176,974	130,921	101,033	41,251	34,957	62,138	**1,024,136**
Midlands											
Males	28,253	9,336	15,589	19,552	27,874	22,669	18,393	7,500	6,066	9,348	**164,580**
Females	26,592	8,731	13,065	16,528	24,448	21,146	17,375	7,101	6,002	10,667	**151,655**
Mid–Western											
Males	37,406	12,019	25,719	30,204	35,296	29,447	24,641	10,336	8,858	13,362	**227,288**
Females	35,059	11,095	20,283	25,244	31,502	27,224	23,933	10,198	9,061	15,984	**209,583**
North–Eastern											
Males	47,332	13,712	25,273	34,327	46,798	35,067	25,859	9,801	8,359	12,663	**259,190**
Females	44,699	13,036	24,139	34,169	42,441	31,384	24,887	9,498	8,461	15,075	**247,789**
North–Western											
Males	24,160	8,127	15,056	17,209	22,549	20,190	17,435	7,464	6,313	10,234	**148,736**
Females	22,868	7,473	14,167	17,293	21,463	19,439	16,973	7,111	6,248	11,248	**144,283**
South–Eastern											
Males	48,322	16,274	30,689	36,414	47,375	40,282	33,646	13,745	11,468	18,270	**296,485**
Females	45,476	15,192	25,048	31,904	43,368	37,639	32,729	13,330	11,612	21,648	**277,946**
Southern											
Males	63,951	19,901	37,434	44,907	62,607	52,653	43,533	17,683	15,075	23,446	**381,190**
Females	60,083	18,927	36,777	45,289	59,513	49,556	42,586	17,507	15,449	28,666	**374,353**
Western											
Males	45,065	13,393	25,395	32,549	45,057	35,119	28,779	12,181	10,413	16,235	**264,186**
Females	42,999	12,991	25,737	35,166	44,267	33,782	28,340	12,044	10,298	18,704	**264,328**
Total	**903,850**	**278,357**	**557,607**	**721,412**	**917,116**	**724,053**	**578,994**	**234,683**	**200,410**	**334,607**	**5,451,088**

Table A.37: **Population scenario by age, gender and region for 2021 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	188,437	55,352	119,440	163,932	205,198	152,073	109,302	41,943	35,129	51,877	**1,122,683**
Females	178,198	53,173	127,392	168,505	195,680	144,759	111,712	45,611	38,652	68,706	**1,132,387**
Midlands											
Males	31,239	10,323	17,237	21,619	30,820	25,065	20,337	8,293	6,707	10,336	**181,976**
Females	29,403	9,654	14,446	18,275	27,032	23,381	19,212	7,852	6,636	11,795	**167,685**
Mid–Western											
Males	41,360	13,289	28,437	33,397	39,027	32,560	27,246	11,429	9,794	14,774	**251,312**
Females	38,765	12,268	22,427	27,912	34,832	30,102	26,463	11,276	10,019	17,674	**231,736**
North–Eastern											
Males	52,334	15,161	27,944	37,956	51,744	38,773	28,592	10,837	9,243	14,002	**286,587**
Females	49,424	14,414	26,691	37,780	46,927	34,701	27,517	10,502	9,355	16,668	**273,980**
North–Western											
Males	26,713	8,986	16,647	19,028	24,933	22,324	19,278	8,253	6,980	11,316	**164,457**
Females	25,286	8,263	15,664	19,121	23,732	21,494	18,767	7,863	6,908	12,437	**159,534**
South–Eastern											
Males	53,430	17,994	33,933	40,263	52,383	44,540	37,202	15,198	12,680	20,201	**327,823**
Females	50,283	16,798	27,696	35,276	47,952	41,617	36,188	14,739	12,839	23,936	**307,325**
Southern											
Males	70,711	22,005	41,391	49,654	69,225	58,218	48,134	19,552	16,668	25,924	**421,482**
Females	66,434	20,928	40,664	50,076	65,804	54,794	47,087	19,357	17,082	31,696	**413,922**
Western											
Males	49,828	14,809	28,079	35,989	49,820	38,831	31,821	13,469	11,514	17,951	**292,110**
Females	47,544	14,364	28,457	38,883	48,946	37,353	31,336	13,317	11,386	20,681	**292,267**
Total	**999,387**	**307,779**	**616,546**	**797,665**	**1,014,054**	**800,585**	**640,194**	**259,489**	**221,593**	**369,975**	**6,027,288**

Table A.38: **Three population scenarios by age, gender and region for 2026 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	171,133	54,903	115,982	137,696	169,136	162,807	111,091	43,102	34,688	60,443	**1,056,737**
Females	161,417	52,147	122,807	144,953	165,730	153,327	109,695	45,306	38,440	75,266	**1,065,085**
Midlands											
Males	25,695	9,625	16,062	15,828	25,560	24,931	19,793	8,284	6,889	11,917	**163,947**
Females	24,237	9,150	13,306	12,219	22,120	22,284	18,919	7,869	6,642	12,878	**149,023**
Mid–Western											
Males	35,787	12,525	26,707	28,805	33,120	31,577	25,866	11,069	9,400	16,935	**230,905**
Females	33,550	11,505	20,584	21,516	29,230	28,492	24,732	10,786	9,528	19,317	**208,407**
North–Eastern											
Males	46,613	14,486	25,848	30,599	43,619	38,970	28,366	10,656	8,989	16,011	**263,001**
Females	44,032	13,807	24,446	30,448	40,498	34,667	26,519	10,392	8,993	18,171	**250,880**
North–Western											
Males	23,402	8,317	14,890	14,845	21,478	21,256	18,795	7,900	6,732	12,808	**149,843**
Females	22,193	7,763	13,811	14,561	20,850	20,481	17,856	7,764	6,521	13,523	**144,773**
South–Eastern											
Males	45,677	16,838	31,601	32,074	44,523	43,550	36,084	14,952	12,557	22,852	**299,576**
Females	42,948	15,707	25,570	25,350	40,830	39,629	34,671	14,844	12,490	25,872	**277,047**
Southern											
Males	61,360	21,260	38,516	38,388	55,728	57,261	46,221	19,165	16,185	29,563	**382,125**
Females	57,524	19,875	37,352	39,147	54,632	53,484	44,611	19,038	16,363	34,044	**374,643**
Western											
Males	45,391	14,726	26,174	27,284	41,821	39,415	30,470	13,076	11,128	20,231	**268,682**
Females	43,186	14,214	26,226	29,615	43,583	37,929	29,609	13,044	11,281	22,451	**270,067**
Total	**884,145**	**296,848**	**579,882**	**643,330**	**852,457**	**810,261**	**623,298**	**257,247**	**216,826**	**412,372**	**5,554,739**

Table A.39: **Population scenario by age, gender and region for 2026 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	171,133	56,299	118,931	141,198	173,437	166,947	113,916	44,198	35,570	61,980	**1,083,611**
Females	161,417	53,473	125,930	148,639	169,945	157,227	112,484	46,458	39,417	77,181	**1,092,170**
Midlands											
Males	25,695	9,870	16,470	16,231	26,210	25,565	20,296	8,495	7,064	12,220	**168,116**
Females	24,237	9,383	13,644	12,530	22,683	22,851	19,400	8,069	6,811	13,205	**152,813**
Mid–Western											
Males	35,787	12,844	27,386	29,538	33,962	32,380	26,524	11,351	9,639	17,368	**236,777**
Females	33,550	11,798	21,107	22,063	29,973	29,217	25,361	11,060	9,770	19,808	**213,707**
North–Eastern											
Males	46,613	14,854	26,505	31,377	44,728	39,961	29,088	10,927	9,218	16,418	**269,689**
Females	44,032	14,159	25,068	31,222	41,528	35,548	27,193	10,656	9,222	18,633	**257,260**
North–Western											
Males	23,402	8,528	15,269	15,222	22,024	21,796	19,273	8,101	6,903	13,134	**153,653**
Females	22,193	7,960	14,162	14,932	21,381	21,002	18,310	7,961	6,687	13,867	**148,454**
South–Eastern											
Males	45,677	17,266	32,405	32,890	45,665	44,658	37,002	15,332	12,876	23,433	**307,194**
Females	42,948	16,106	26,220	25,995	41,868	40,842	35,553	15,222	12,808	26,530	**284,092**
Southern											
Males	61,360	21,801	39,496	39,364	57,145	58,717	47,396	19,652	16,597	30,315	**391,843**
Females	57,524	20,380	38,302	40,143	56,021	54,844	45,745	19,522	16,779	34,910	**384,170**
Western											
Males	45,391	15,101	26,840	27,978	42,885	40,417	31,245	13,409	11,411	20,838	**275,515**
Females	43,186	14,575	26,893	30,368	44,691	38,894	30,362	13,376	11,568	23,022	**276,935**
Total	**884,145**	**304,397**	**594,629**	**659,690**	**874,136**	**830,866**	**639,149**	**263,789**	**222,340**	**422,859**	**5,696,000**

Table A.40: **Population scenario by age, gender and region for 2026 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	182,274	59,964	126,674	150,390	184,728	177,816	121,332	47,075	37,885	66,015	**1,154,154**
Females	171,925	56,954	134,128	158,316	181,008	167,462	119,807	49,482	41,983	82,205	**1,163,271**
Midlands											
Males	27,368	10,513	17,542	17,288	27,916	27,229	21,617	9,048	7,524	13,016	**179,060**
Females	25,815	9,994	14,532	13,346	24,160	24,339	20,663	8,594	7,254	14,065	**162,761**
Mid–Western											
Males	38,117	13,680	29,169	31,461	36,173	34,488	28,251	12,090	10,266	18,497	**252,191**
Females	35,734	12,566	22,481	23,499	31,924	31,119	27,012	11,780	10,406	21,098	**227,619**
North–Eastern											
Males	49,648	15,821	28,231	33,419	47,640	42,562	30,981	11,638	9,818	17,487	**287,246**
Females	46,898	15,080	26,700	33,255	44,231	37,863	28,964	11,350	9,822	19,846	**274,008**
North–Western											
Males	24,926	9,083	16,263	16,213	23,458	23,215	20,528	8,628	7,353	13,989	**163,656**
Females	23,638	8,479	15,084	15,904	22,772	22,369	19,502	8,479	7,122	14,769	**158,119**
South–Eastern											
Males	48,651	18,390	34,515	35,031	48,627	47,565	39,411	16,330	13,714	24,958	**327,192**
Females	45,744	17,155	27,927	27,687	44,594	43,501	37,868	16,213	13,642	28,257	**302,588**
Southern											
Males	65,355	23,220	42,067	41,927	60,865	62,539	50,481	20,931	17,677	32,289	**417,352**
Females	61,269	21,707	40,795	42,756	59,668	58,414	48,723	20,793	17,871	37,183	**409,179**
Western											
Males	48,346	16,084	28,587	29,799	45,677	43,048	33,279	14,282	12,154	22,195	**293,451**
Females	45,997	15,524	28,644	32,345	47,600	41,426	32,339	14,247	12,321	24,521	**294,963**
Total	**941,703**	**324,213**	**633,339**	**702,636**	**931,042**	**884,955**	**680,758**	**280,962**	**236,814**	**450,387**	**6,066,810**

Figure A.2: **Regional Population Proportions 2011**

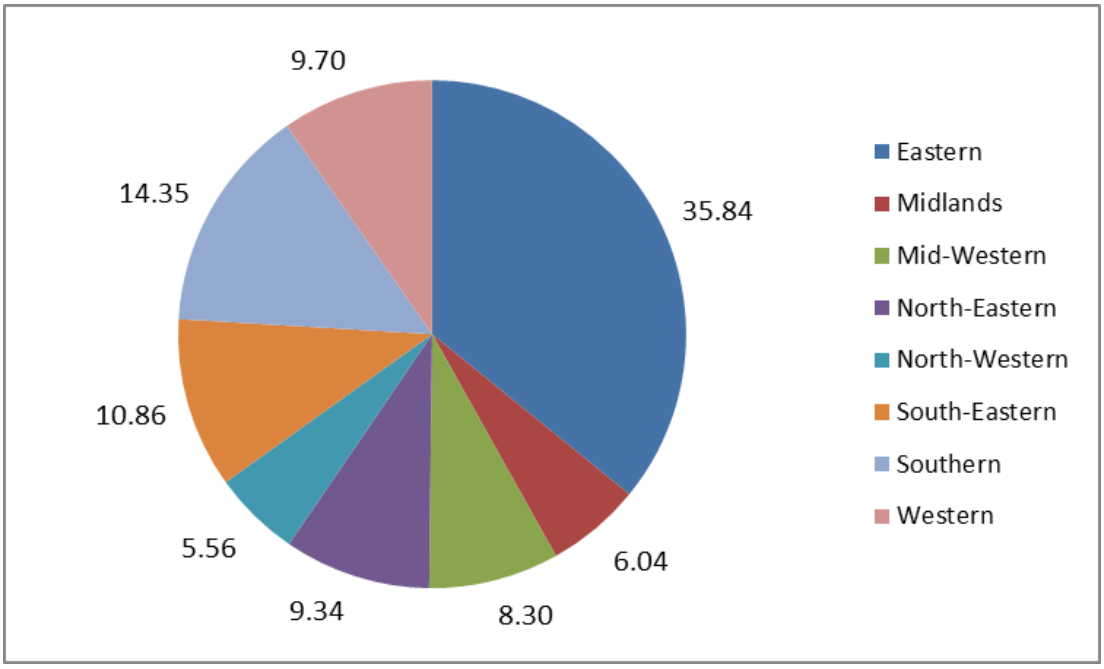


Figure A.3: **Regional Population Proportions 2016**

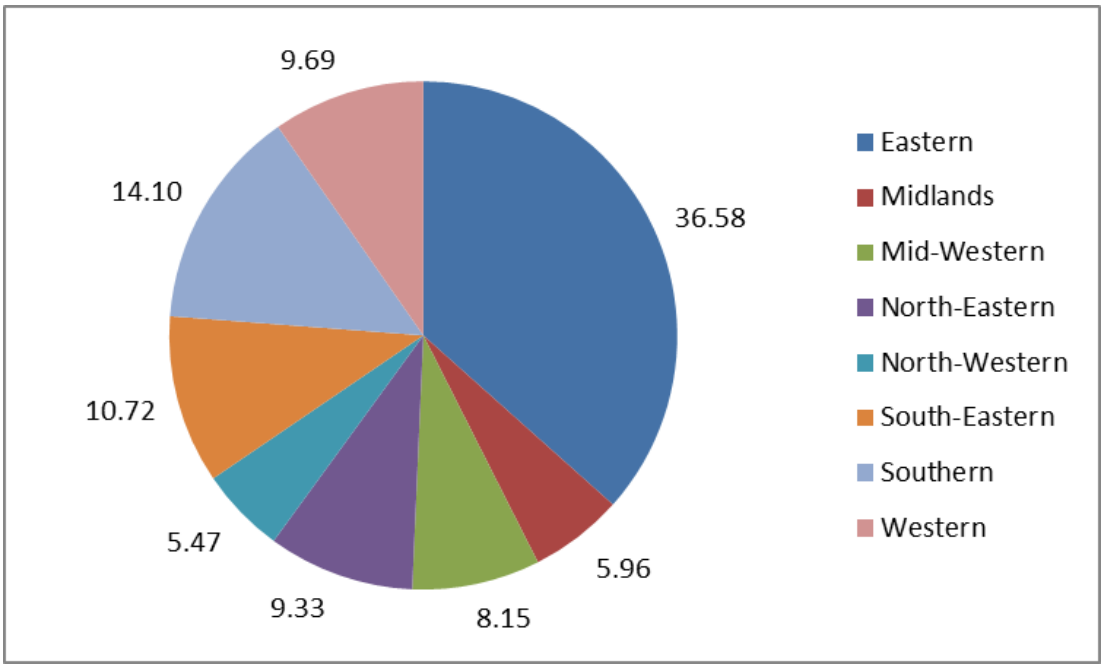


Figure A.4: **Regional Population Proportions 2021**

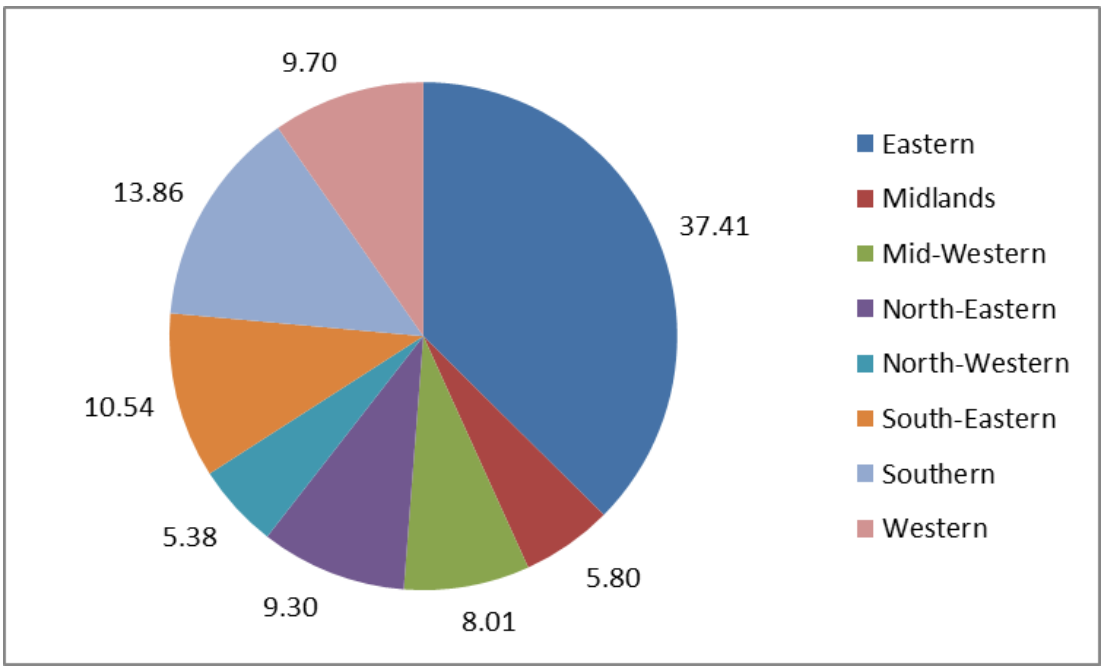


Figure A.5: **Regional Population Proportions compared, 2007 and 2026**

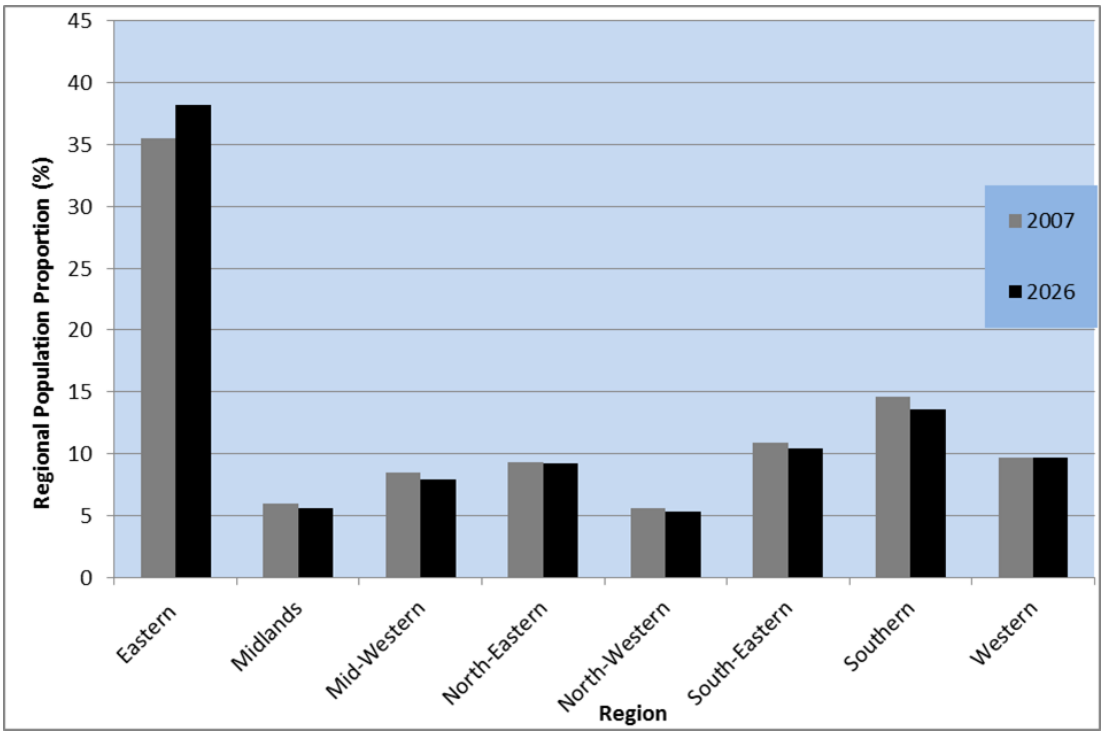


Table A.41: **Three Coverage scenarios by age cohort, gender and region 2007 – Scenario 1: Minimum**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**>70**
Eastern									
Males	0.27	0.25	0.09	0.07	0.12	0.13	0.20	0.33	1.00
Females	0.27	0.25	0.15	0.15	0.17	0.16	0.24	0.41	1.00
Midlands									
Males	0.29	0.29	0.15	0.12	0.16	0.18	0.27	0.43	1.00
Females	0.28	0.29	0.23	0.21	0.22	0.22	0.35	0.54	1.00
Mid–Western									
Males	0.30	0.28	0.17	0.14	0.18	0.20	0.29	0.45	1.00
Females	0.30	0.29	0.24	0.23	0.23	0.23	0.34	0.53	1.00
North–Eastern									
Males	0.25	0.25	0.14	0.11	0.14	0.17	0.26	0.41	1.00
Females	0.25	0.26	0.22	0.18	0.19	0.20	0.32	0.52	1.00
North–Western									
Males	0.41	0.40	0.27	0.22	0.28	0.31	0.42	0.59	1.00
Females	0.40	0.40	0.37	0.33	0.34	0.33	0.46	0.64	1.00
South–Eastern									
Males	0.30	0.29	0.17	0.14	0.17	0.21	0.31	0.47	1.00
Females	0.29	0.29	0.26	0.24	0.23	0.24	0.37	0.57	1.00
Southern									
Males	0.28	0.25	0.15	0.12	0.16	0.19	0.29	0.45	1.00
Females	0.27	0.25	0.20	0.20	0.21	0.22	0.34	0.54	1.00
Western									
Males	0.31	0.31	0.18	0.14	0.20	0.24	0.35	0.51	1.00
Females	0.31	0.32	0.25	0.21	0.25	0.26	0.39	0.60	1.00

Table A.42: **Coverage scenario by age cohort, gender and region 2007 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	>70
Eastern									
Males	0.29	0.26	0.10	0.08	0.13	0.14	0.20	0.34	1.00
Females	0.28	0.26	0.16	0.15	0.18	0.17	0.25	0.43	1.00
Midlands									
Males	0.30	0.30	0.16	0.12	0.17	0.19	0.29	0.45	1.00
Females	0.31	0.31	0.24	0.22	0.23	0.23	0.36	0.56	1.00
Mid–Western									
Males	0.31	0.29	0.18	0.14	0.19	0.20	0.30	0.47	1.00
Females	0.31	0.31	0.25	0.24	0.24	0.24	0.36	0.55	1.00
North–Eastern									
Males	0.26	0.26	0.15	0.11	0.15	0.18	0.28	0.43	1.00
Females	0.27	0.27	0.23	0.19	0.20	0.21	0.34	0.54	1.00
North–Western									
Males	0.43	0.42	0.28	0.23	0.30	0.32	0.43	0.62	1.00
Females	0.42	0.42	0.38	0.34	0.35	0.35	0.48	0.66	1.00
South–Eastern									
Males	0.31	0.30	0.18	0.15	0.18	0.21	0.32	0.49	1.00
Females	0.31	0.30	0.27	0.25	0.24	0.25	0.39	0.60	1.00
Southern									
Males	0.29	0.27	0.15	0.13	0.17	0.20	0.30	0.47	1.00
Females	0.28	0.26	0.21	0.21	0.22	0.23	0.36	0.57	1.00
Western									
Males	0.33	0.33	0.19	0.14	0.21	0.25	0.37	0.53	1.00
Females	0.32	0.33	0.26	0.22	0.26	0.27	0.40	0.63	1.00

Table A.43: **Coverage scenario by age cohort, gender and region 2007 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	>70
Eastern									
Males	0.36	0.33	0.12	0.10	0.16	0.17	0.26	0.43	1.00
Females	0.36	0.33	0.20	0.20	0.23	0.21	0.32	0.55	1.00
Midlands									
Males	0.37	0.38	0.20	0.15	0.21	0.23	0.36	0.56	1.00
Females	0.39	0.39	0.30	0.28	0.29	0.30	0.46	0.71	1.00
Mid–Western									
Males	0.39	0.37	0.22	0.18	0.24	0.26	0.38	0.60	1.00
Females	0.39	0.39	0.31	0.30	0.31	0.30	0.45	0.70	1.00
North–Eastern									
Males	0.34	0.33	0.19	0.14	0.19	0.22	0.35	0.54	1.00
Females	0.34	0.34	0.29	0.24	0.25	0.27	0.42	0.69	1.00
North–Western									
Males	0.54	0.53	0.35	0.29	0.37	0.41	0.55	0.78	1.00
Females	0.53	0.53	0.48	0.43	0.44	0.44	0.61	0.84	1.00
South–Eastern									
Males	0.40	0.38	0.22	0.19	0.23	0.27	0.41	0.62	1.00
Females	0.39	0.38	0.34	0.32	0.30	0.32	0.49	0.76	1.00
Southern									
Males	0.36	0.34	0.19	0.16	0.21	0.25	0.38	0.60	1.00
Females	0.36	0.33	0.26	0.26	0.28	0.29	0.45	0.72	1.00
Western									
Males	0.41	0.41	0.24	0.18	0.26	0.32	0.47	0.68	1.00
Females	0.41	0.42	0.33	0.28	0.32	0.34	0.51	0.79	1.00

Table A.44: **Three Coverage scenarios by age cohort, gender and region 2011 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.26	0.27	0.15	0.10	0.15	0.16	0.19	0.26	0.62	0.62
Females	0.26	0.27	0.17	0.15	0.19	0.17	0.21	0.36	0.65	0.66
Midlands										
Males	0.33	0.32	0.25	0.19	0.23	0.23	0.26	0.35	0.65	0.67
Females	0.34	0.33	0.30	0.26	0.28	0.25	0.30	0.48	0.69	0.71
Mid–Western										
Males	0.30	0.31	0.23	0.19	0.22	0.23	0.26	0.38	0.66	0.68
Females	0.30	0.31	0.27	0.24	0.26	0.24	0.29	0.47	0.70	0.72
North–Eastern										
Males	0.33	0.35	0.27	0.19	0.23	0.24	0.27	0.38	0.68	0.73
Females	0.33	0.35	0.31	0.25	0.28	0.25	0.30	0.50	0.70	0.74
North–Western										
Males	0.39	0.40	0.34	0.28	0.31	0.31	0.34	0.45	0.71	0.77
Females	0.39	0.39	0.36	0.31	0.34	0.30	0.37	0.54	0.72	0.78
South–Eastern										
Males	0.32	0.33	0.25	0.20	0.24	0.24	0.29	0.40	0.68	0.72
Females	0.31	0.32	0.30	0.26	0.27	0.26	0.32	0.49	0.72	0.74
Southern										
Males	0.28	0.28	0.21	0.16	0.20	0.21	0.25	0.36	0.66	0.69
Females	0.28	0.27	0.23	0.21	0.23	0.22	0.27	0.46	0.70	0.73
Western										
Males	0.33	0.35	0.27	0.20	0.24	0.26	0.31	0.42	0.67	0.70
Females	0.33	0.35	0.29	0.23	0.27	0.27	0.32	0.49	0.71	0.74

Table A.45: **Coverage scenario by age cohort, gender and region 2011 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.33	0.34	0.19	0.13	0.19	0.21	0.24	0.33	0.79	0.80
Females	0.33	0.34	0.22	0.19	0.24	0.22	0.27	0.46	0.84	0.85
Midlands										
Males	0.43	0.41	0.31	0.24	0.30	0.29	0.33	0.45	0.82	0.86
Females	0.43	0.42	0.39	0.33	0.35	0.32	0.39	0.61	0.88	0.90
Mid–Western										
Males	0.39	0.39	0.30	0.24	0.29	0.29	0.34	0.48	0.85	0.87
Females	0.38	0.40	0.35	0.31	0.33	0.31	0.37	0.60	0.89	0.92
North–Eastern										
Males	0.42	0.45	0.34	0.25	0.30	0.30	0.34	0.48	0.87	0.90
Females	0.43	0.45	0.39	0.32	0.35	0.32	0.38	0.64	0.89	0.95
North–Western										
Males	0.50	0.51	0.44	0.35	0.40	0.39	0.44	0.58	0.91	0.98
Females	0.50	0.50	0.46	0.40	0.44	0.39	0.48	0.69	0.92	0.99
South–Eastern										
Males	0.40	0.42	0.32	0.26	0.30	0.31	0.37	0.51	0.87	0.92
Females	0.40	0.40	0.38	0.33	0.35	0.33	0.41	0.63	0.92	0.94
Southern										
Males	0.36	0.35	0.27	0.21	0.26	0.26	0.32	0.46	0.85	0.88
Females	0.36	0.35	0.29	0.27	0.30	0.28	0.35	0.59	0.90	0.93
Western										
Males	0.43	0.44	0.35	0.25	0.31	0.34	0.39	0.53	0.85	0.90
Females	0.43	0.44	0.38	0.30	0.35	0.35	0.41	0.63	0.91	0.95

Table A.46: **Coverage scenario by age cohort, gender and region 2011 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.34	0.35	0.20	0.13	0.20	0.21	0.25	0.34	0.82	0.73
Females	0.34	0.35	0.23	0.19	0.25	0.23	0.28	0.48	0.86	0.80
Midlands										
Males	0.44	0.43	0.32	0.25	0.31	0.30	0.35	0.47	0.85	0.78
Females	0.44	0.44	0.40	0.34	0.37	0.33	0.40	0.63	0.91	0.86
Mid–Western										
Males	0.40	0.41	0.30	0.25	0.30	0.30	0.35	0.50	0.88	0.82
Females	0.40	0.41	0.36	0.32	0.34	0.32	0.39	0.62	0.92	0.88
North–Eastern										
Males	0.43	0.47	0.36	0.25	0.31	0.31	0.35	0.50	0.89	0.84
Females	0.44	0.47	0.41	0.33	0.37	0.33	0.39	0.66	0.92	0.88
North–Western										
Males	0.51	0.53	0.45	0.36	0.41	0.41	0.45	0.60	0.94	0.91
Females	0.51	0.52	0.47	0.41	0.45	0.40	0.50	0.72	0.95	0.92
South–Eastern										
Males	0.42	0.43	0.33	0.27	0.31	0.32	0.38	0.52	0.90	0.84
Females	0.41	0.42	0.39	0.34	0.36	0.34	0.43	0.65	0.94	0.92
Southern										
Males	0.37	0.36	0.28	0.22	0.27	0.27	0.33	0.48	0.87	0.81
Females	0.37	0.36	0.30	0.28	0.31	0.29	0.36	0.61	0.93	0.89
Western										
Males	0.44	0.46	0.36	0.26	0.32	0.35	0.41	0.55	0.88	0.82
Females	0.44	0.46	0.39	0.31	0.36	0.36	0.42	0.65	0.94	0.91

Table A.47: **Three Coverage scenarios by age cohort, gender and region 2016 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.22	0.23	0.13	0.09	0.13	0.14	0.16	0.22	0.54	0.54
Females	0.22	0.23	0.15	0.13	0.16	0.15	0.18	0.31	0.57	0.58
Midlands										
Males	0.29	0.28	0.21	0.16	0.20	0.20	0.23	0.31	0.56	0.58
Females	0.29	0.29	0.26	0.22	0.24	0.22	0.26	0.41	0.60	0.61
Mid–Western										
Males	0.26	0.27	0.20	0.17	0.19	0.20	0.23	0.33	0.58	0.59
Females	0.26	0.27	0.24	0.21	0.23	0.21	0.25	0.40	0.60	0.62
North–Eastern										
Males	0.28	0.31	0.23	0.17	0.20	0.20	0.23	0.33	0.59	0.63
Females	0.29	0.31	0.27	0.22	0.24	0.22	0.26	0.43	0.61	0.64
North–Western										
Males	0.34	0.35	0.30	0.24	0.27	0.27	0.30	0.39	0.62	0.67
Females	0.34	0.34	0.31	0.27	0.30	0.26	0.33	0.47	0.62	0.67
South–Eastern										
Males	0.27	0.28	0.22	0.17	0.21	0.21	0.25	0.34	0.59	0.62
Females	0.27	0.27	0.26	0.23	0.23	0.22	0.28	0.43	0.62	0.64
Southern										
Males	0.25	0.24	0.18	0.14	0.18	0.18	0.22	0.31	0.57	0.60
Females	0.24	0.24	0.20	0.18	0.20	0.19	0.24	0.40	0.61	0.63
Western										
Males	0.29	0.30	0.24	0.17	0.21	0.23	0.27	0.36	0.58	0.61
Females	0.29	0.30	0.25	0.20	0.24	0.24	0.28	0.43	0.62	0.64

Table A.48: **Coverage scenario by age cohort, gender and region 2016 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.32	0.33	0.18	0.13	0.18	0.20	0.23	0.32	0.76	0.77
Females	0.31	0.33	0.21	0.18	0.23	0.21	0.26	0.44	0.80	0.82
Midlands										
Males	0.41	0.40	0.30	0.23	0.29	0.28	0.32	0.44	0.79	0.83
Females	0.41	0.41	0.37	0.31	0.34	0.31	0.37	0.59	0.84	0.87
Mid–Western										
Males	0.37	0.38	0.28	0.24	0.28	0.28	0.32	0.46	0.82	0.84
Females	0.37	0.38	0.34	0.30	0.32	0.29	0.36	0.57	0.85	0.88
North–Eastern										
Males	0.40	0.43	0.33	0.24	0.29	0.29	0.33	0.46	0.83	0.90
Females	0.41	0.43	0.38	0.30	0.34	0.31	0.36	0.61	0.86	0.91
North–Western										
Males	0.48	0.49	0.42	0.34	0.38	0.38	0.42	0.56	0.88	0.95
Females	0.48	0.48	0.44	0.38	0.42	0.37	0.46	0.67	0.88	0.95
South–Eastern										
Males	0.39	0.40	0.31	0.25	0.29	0.30	0.36	0.49	0.83	0.88
Females	0.38	0.39	0.37	0.32	0.33	0.32	0.40	0.60	0.88	0.91
Southern										
Males	0.35	0.34	0.26	0.20	0.25	0.25	0.31	0.45	0.81	0.85
Females	0.34	0.33	0.28	0.26	0.29	0.27	0.34	0.57	0.86	0.89
Western										
Males	0.41	0.43	0.34	0.24	0.30	0.32	0.38	0.51	0.82	0.86
Females	0.41	0.43	0.36	0.28	0.34	0.33	0.39	0.61	0.87	0.91

Table A.49: **Coverage scenario by age cohort, gender and region 2016 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.39	0.41	0.23	0.15	0.23	0.24	0.29	0.39	0.94	0.99
Females	0.39	0.40	0.26	0.22	0.28	0.26	0.32	0.55	0.99	0.99
Midlands										
Males	0.51	0.49	0.37	0.28	0.35	0.34	0.40	0.54	0.98	0.99
Females	0.51	0.50	0.46	0.39	0.42	0.38	0.46	0.72	0.99	0.99
Mid–Western										
Males	0.46	0.47	0.35	0.29	0.34	0.35	0.40	0.57	0.99	0.99
Females	0.46	0.47	0.42	0.37	0.39	0.36	0.44	0.71	0.99	0.99
North–Eastern										
Males	0.50	0.53	0.41	0.29	0.35	0.36	0.40	0.57	0.99	0.99
Females	0.51	0.53	0.46	0.38	0.42	0.38	0.45	0.75	0.99	0.99
North–Western										
Males	0.59	0.61	0.52	0.42	0.47	0.46	0.52	0.69	0.99	0.99
Females	0.59	0.59	0.54	0.47	0.52	0.46	0.57	0.82	0.99	0.99
South–Eastern										
Males	0.48	0.50	0.38	0.30	0.36	0.37	0.44	0.60	0.99	0.99
Females	0.47	0.48	0.45	0.39	0.41	0.39	0.49	0.74	0.99	0.99
Southern										
Males	0.43	0.42	0.32	0.25	0.31	0.31	0.38	0.55	0.99	0.99
Females	0.42	0.41	0.34	0.32	0.35	0.33	0.42	0.70	0.99	0.99
Western										
Males	0.50	0.52	0.41	0.30	0.37	0.40	0.46	0.63	0.99	0.99
Females	0.50	0.53	0.44	0.35	0.42	0.41	0.49	0.75	0.99	0.99

Table A.50: **Three Coverage scenarios by age cohort, gender and region 2021 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.24	0.25	0.14	0.09	0.14	0.15	0.18	0.24	0.58	0.58
Females	0.24	0.25	0.16	0.14	0.17	0.16	0.20	0.33	0.61	0.62
Midlands										
Males	0.31	0.30	0.23	0.17	0.22	0.21	0.24	0.33	0.60	0.63
Females	0.31	0.31	0.28	0.24	0.26	0.23	0.28	0.44	0.64	0.66
Mid–Western										
Males	0.28	0.29	0.21	0.18	0.21	0.21	0.25	0.35	0.62	0.63
Females	0.28	0.29	0.25	0.23	0.24	0.22	0.27	0.43	0.65	0.67
North–Eastern										
Males	0.31	0.33	0.25	0.18	0.22	0.22	0.25	0.35	0.63	0.68
Females	0.31	0.33	0.28	0.23	0.26	0.23	0.27	0.46	0.65	0.69
North–Western										
Males	0.36	0.37	0.32	0.26	0.29	0.29	0.32	0.42	0.66	0.71
Females	0.36	0.36	0.33	0.29	0.32	0.28	0.35	0.50	0.66	0.72
South–Eastern										
Males	0.29	0.30	0.23	0.19	0.22	0.23	0.27	0.37	0.63	0.67
Females	0.29	0.29	0.28	0.24	0.25	0.24	0.30	0.46	0.66	0.68
Southern										
Males	0.26	0.26	0.19	0.15	0.19	0.19	0.23	0.34	0.61	0.64
Females	0.26	0.25	0.21	0.19	0.22	0.20	0.25	0.43	0.65	0.68
Western										
Males	0.31	0.32	0.25	0.18	0.23	0.24	0.28	0.39	0.62	0.65
Females	0.31	0.32	0.27	0.21	0.25	0.25	0.30	0.46	0.66	0.69

Table A.51: **Coverage scenario by age cohort, gender and region 2021 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.34	0.35	0.20	0.13	0.20	0.21	0.25	0.34	0.81	0.72
Females	0.34	0.35	0.23	0.19	0.25	0.23	0.28	0.47	0.86	0.79
Midlands										
Males	0.44	0.42	0.32	0.25	0.31	0.30	0.34	0.47	0.85	0.77
Females	0.44	0.43	0.40	0.34	0.36	0.33	0.40	0.63	0.90	0.86
Mid–Western										
Males	0.40	0.40	0.30	0.25	0.30	0.30	0.35	0.49	0.87	0.81
Females	0.40	0.41	0.36	0.32	0.34	0.32	0.38	0.61	0.91	0.87
North–Eastern										
Males	0.43	0.46	0.35	0.25	0.31	0.31	0.35	0.49	0.89	0.83
Females	0.44	0.46	0.40	0.33	0.36	0.33	0.39	0.65	0.92	0.88
North–Western										
Males	0.51	0.53	0.45	0.36	0.41	0.40	0.45	0.60	0.94	0.91
Females	0.51	0.52	0.47	0.41	0.45	0.40	0.49	0.71	0.94	0.91
South–Eastern										
Males	0.42	0.43	0.33	0.26	0.31	0.32	0.38	0.52	0.89	0.84
Females	0.41	0.42	0.39	0.34	0.36	0.34	0.43	0.64	0.94	0.91
Southern										
Males	0.37	0.36	0.27	0.22	0.27	0.27	0.33	0.48	0.87	0.80
Females	0.37	0.36	0.30	0.28	0.31	0.29	0.36	0.61	0.92	0.89
Western										
Males	0.44	0.46	0.36	0.26	0.32	0.35	0.40	0.55	0.88	0.82
Females	0.44	0.46	0.39	0.30	0.36	0.36	0.42	0.65	0.93	0.90

Table A.52: **Coverage scenario by age cohort, gender and region 2021 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.42	0.43	0.24	0.17	0.24	0.26	0.31	0.42	0.99	0.99
Females	0.42	0.43	0.28	0.24	0.30	0.28	0.34	0.58	0.99	0.99
Midlands										
Males	0.54	0.52	0.40	0.30	0.38	0.37	0.42	0.57	0.99	0.99
Females	0.55	0.54	0.49	0.41	0.45	0.40	0.49	0.77	0.99	0.99
Mid–Western										
Males	0.49	0.50	0.37	0.31	0.36	0.37	0.43	0.61	0.99	0.99
Females	0.49	0.51	0.44	0.40	0.42	0.39	0.47	0.76	0.99	0.99
North–Eastern										
Males	0.53	0.57	0.44	0.31	0.38	0.38	0.43	0.61	0.99	0.99
Females	0.54	0.57	0.50	0.40	0.45	0.40	0.48	0.81	0.99	0.99
North–Western										
Males	0.63	0.65	0.55	0.45	0.51	0.50	0.55	0.73	0.99	0.99
Females	0.63	0.64	0.58	0.50	0.55	0.49	0.61	0.88	0.99	0.99
South–Eastern										
Males	0.51	0.53	0.41	0.33	0.38	0.39	0.47	0.64	0.99	0.99
Females	0.51	0.51	0.48	0.42	0.44	0.42	0.52	0.79	0.99	0.99
Southern										
Males	0.46	0.45	0.34	0.27	0.33	0.34	0.41	0.59	0.99	0.99
Females	0.45	0.44	0.37	0.34	0.38	0.36	0.44	0.75	0.99	0.99
Western										
Males	0.54	0.56	0.44	0.32	0.44	0.43	0.50	0.68	0.99	0.99
Females	0.54	0.56	0.48	0.37	0.37	0.44	0.52	0.80	0.99	0.99

Table A.53: **Three Coverage scenarios by age cohort, gender and region 2026 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.25	0.26	0.14	0.10	0.15	0.16	0.18	0.25	0.60	0.60
Females	0.25	0.26	0.17	0.14	0.18	0.17	0.21	0.35	0.63	0.64
Midlands										
Males	0.33	0.31	0.24	0.18	0.23	0.22	0.25	0.34	0.63	0.65
Females	0.33	0.32	0.30	0.25	0.27	0.24	0.29	0.46	0.67	0.69
Mid–Western										
Males	0.30	0.30	0.22	0.19	0.22	0.22	0.26	0.36	0.64	0.66
Females	0.29	0.30	0.27	0.24	0.25	0.23	0.28	0.45	0.67	0.70
North-Eastern										
Males	0.32	0.34	0.26	0.19	0.23	0.23	0.26	0.36	0.66	0.71
Females	0.33	0.34	0.30	0.24	0.27	0.24	0.29	0.48	0.68	0.72
North–Western										
Males	0.38	0.39	0.33	0.27	0.30	0.30	0.33	0.44	0.69	0.75
Females	0.38	0.38	0.35	0.30	0.33	0.30	0.36	0.53	0.69	0.75
South–Eastern										
Males	0.31	0.32	0.24	0.19	0.23	0.24	0.28	0.38	0.66	0.70
Females	0.30	0.31	0.29	0.25	0.26	0.25	0.31	0.48	0.69	0.71
Southern										
Males	0.28	0.27	0.20	0.16	0.20	0.20	0.24	0.35	0.64	0.67
Females	0.27	0.26	0.22	0.20	0.23	0.21	0.27	0.45	0.68	0.71
Western										
Males	0.32	0.34	0.26	0.19	0.24	0.26	0.30	0.40	0.65	0.68
Females	0.32	0.34	0.28	0.22	0.27	0.26	0.31	0.48	0.69	0.72

Table A.54: **Coverage scenario by age cohort, gender and region 2026 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.36	0.37	0.20	0.14	0.21	0.22	0.26	0.36	0.85	0.78
Females	0.35	0.37	0.24	0.20	0.26	0.24	0.29	0.49	0.90	0.86
Midlands										
Males	0.46	0.44	0.34	0.26	0.32	0.31	0.36	0.49	0.89	0.87
Females	0.46	0.45	0.42	0.35	0.38	0.34	0.41	0.66	0.94	0.94
Mid–Western										
Males	0.42	0.42	0.32	0.26	0.31	0.31	0.36	0.52	0.91	0.89
Females	0.42	0.43	0.38	0.34	0.36	0.33	0.40	0.64	0.96	0.96
North–Eastern										
Males	0.45	0.48	0.37	0.26	0.32	0.32	0.36	0.52	0.93	0.97
Females	0.46	0.49	0.42	0.34	0.38	0.34	0.41	0.68	0.96	0.99
North–Western										
Males	0.54	0.55	0.47	0.38	0.43	0.42	0.47	0.62	0.98	0.99
Females	0.54	0.54	0.49	0.43	0.47	0.42	0.52	0.74	0.98	0.99
South–Eastern										
Males	0.44	0.45	0.34	0.28	0.32	0.33	0.40	0.54	0.93	0.95
Females	0.43	0.43	0.41	0.36	0.37	0.36	0.44	0.67	0.98	0.99
Southern										
Males	0.39	0.38	0.29	0.23	0.28	0.28	0.34	0.50	0.91	0.90
Females	0.39	0.37	0.31	0.29	0.32	0.30	0.38	0.63	0.97	0.98
Western										
Males	0.46	0.48	0.38	0.27	0.33	0.36	0.42	0.57	0.92	0.92
Females	0.46	0.48	0.40	0.32	0.38	0.37	0.44	0.68	0.97	0.99

Table A.55: **Coverage scenario by age cohort, gender and region 2026 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.44	0.45	0.25	0.17	0.25	0.27	0.32	0.44	0.99	0.99
Females	0.44	0.45	0.30	0.25	0.32	0.29	0.36	0.61	0.99	0.99
Midlands										
Males	0.57	0.55	0.42	0.32	0.39	0.39	0.44	0.60	0.99	0.99
Females	0.57	0.56	0.52	0.43	0.47	0.42	0.51	0.81	0.99	0.99
Mid–Western										
Males	0.52	0.52	0.39	0.32	0.38	0.39	0.45	0.64	0.99	0.99
Females	0.51	0.53	0.46	0.41	0.44	0.41	0.49	0.79	0.99	0.99
North–Eastern										
Males	0.56	0.60	0.46	0.33	0.39	0.40	0.45	0.64	0.99	0.99
Females	0.57	0.60	0.52	0.42	0.47	0.42	0.50	0.84	0.99	0.99
North–Western										
Males	0.66	0.68	0.58	0.47	0.53	0.52	0.58	0.77	0.99	0.99
Females	0.66	0.66	0.61	0.52	0.58	0.52	0.63	0.92	0.99	0.99
South–Eastern										
Males	0.54	0.55	0.42	0.34	0.40	0.41	0.49	0.67	0.99	0.99
Females	0.53	0.54	0.50	0.44	0.46	0.44	0.55	0.83	0.99	0.99
Southern										
Males	0.48	0.47	0.35	0.28	0.34	0.35	0.42	0.61	0.99	0.99
Females	0.48	0.46	0.39	0.36	0.40	0.37	0.46	0.78	0.99	0.99
Western										
Males	0.57	0.59	0.46	0.34	0.41	0.45	0.52	0.71	0.99	0.99
Females	0.57	0.59	0.50	0.39	0.46	0.46	0.54	0.84	0.99	0.99

Figure A.6: **GMS Coverage Projections (%) 2016 – 2026**

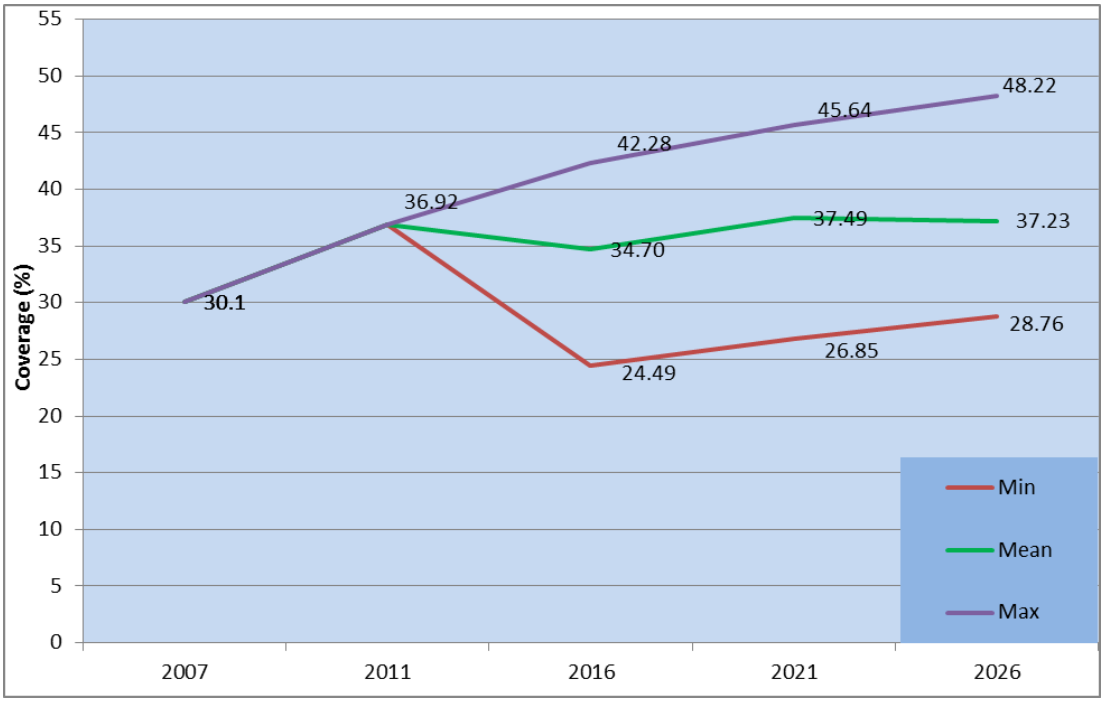


Table A.56: **Comparison of regional average cost per claim totals (€) 2007**

Region	**PCRS Totals (€)**	**Estimated Sample Database Totals (€)**
Eastern	835.14	1184.20
Midlands	930.43	1315.86
Mid–Western	877.64	1236.86
North–Eastern	859.24	1250.56
North–Western	713.16	1080.03
South–Eastern	866.05	1242.25
Southern	918.41	1259.41
Western	855.40	1199.27
National	**856.14**	**1221.06**

Table A.57: **Three Average Cost (€) per Claim scenarios re-estimated by age cohort, gender and region 2007–Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	223.85	342.86	458.84	650.37	704.40	1008.42	1211.25	1284.01	1096.92	1248.82	**821.80**
Females	245.18	309.07	359.02	426.65	612.31	1024.36	1168.08	1325.27	1222.24	1550.32	**822.86**
Midlands											
Males	246.94	335.56	557.19	847.53	829.77	1037.00	1197.80	1291.86	1358.74	1466.2	**915.78**
Females	280.45	283.03	420.47	517.73	772.63	1026.40	1267.79	1331.05	1496.07	1791.15	**917.14**
Mid–Western											
Males	305.14	507.13	616.84	767.23	929.53	934.12	1108.11	1136.54	1133.98	1211.89	**864.48**
Females	324.72	384.56	373.08	564.92	768.45	989.46	1247.64	1222.96	1287.02	1509.14	**866.24**
North–Eastern											
Males	278.61	373.27	534.62	791.15	799.17	907.82	1119.77	1127.69	1178.08	1348.80	**845.16**
Females	282.73	425.30	316.97	493.89	661.59	959.19	1117.54	1316.73	1308.59	1583.43	**847.12**
North–Western											
Males	220.64	305.92	403.22	595.89	709.40	780.71	896.90	964.59	933.88	1203.41	**701.91**
Females	250.22	259.34	287.27	380.29	558.64	756.31	1004.07	1062.61	1079.38	1364.02	**698.53**
South–Eastern											
Males	264.48	389.40	576.45	803.37	832.25	996.39	1073.49	1138.06	1186.64	1272.16	**852.52**
Females	243.16	376.12	371.13	446.94	743.23	1098.17	1210.10	1266.53	1302.75	1491.24	**853.71**
Southern											
Males	303.48	399.51	605.00	865.16	878.35	1024.77	1215.01	1300.59	1210.88	1253.16	**904.66**
Females	348.25	437.70	409.22	573.36	744.73	1119.37	1225.89	1364.15	1368.51	1477.81	**905.99**
Western											
Males	290.12	367.10	544.94	852.22	809.34	922.96	1055.47	1183.45	1112.61	1294.13	**842.54**
Females	313.43	316.08	333.07	553.16	732.06	1022.39	1110.32	1224.42	1318.37	1521.40	**843.36**
Total	**276.14**	**362.63**	**447.46**	**632.45**	**755.17**	**975.37**	**1139.26**	**1221.15**	**1227.25**	**1410.84**	**843.13**

Table A.58: **Average Cost (€) per Claim re-estimated by age cohort, gender and region 2007–Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	228.09	352.31	468.36	663.13	715.28	1024.07	1225.56	1301.78	1111.03	1261.80	**835.14**
Females	250.13	314.96	370.39	434.52	622.62	1036.64	1182.49	1339.82	1233.99	1565.85	**835.14**
Midlands											
Males	252.32	346.52	570.72	862.57	843.18	1053.12	1212.19	1306.25	1374.38	1483.05	**930.43**
Females	286.53	287.65	433.68	527.21	784.65	1039.87	1280.93	1344.24	1510.02	1809.51	**930.43**
Mid–Western											
Males	312.55	518.26	632.72	780.04	943.63	946.39	1122.24	1150.38	1145.96	1224.23	**877.64**
Females	331.60	391.68	381.46	574.27	779.34	1001.62	1261.18	1233.93	1298.71	1522.60	**877.64**
North–Eastern											
Males	287.17	387.18	546.40	807.66	811.09	919.99	1136.46	1141.29	1192.14	1363.01	**859.24**
Females	290.24	438.25‘	324.13	502.04	671.81	970.68	1129.80	1329.20	1337.70	1598.56	**859.24**
North–Western											
Males	224.88	313.54	411.39	607.13	721.31	792.40	909.40	976.33	958.41	1216.81	**713.16**
Females	257.50	264.09	294.35	388.02	566.78	767.27	1016.47	1076.26	1102.82	1398.05	**713.16**
South–Eastern											
Males	272.48	397.70	591.81	817.17	846.95	1009.93	1087.12	1150.66	1200.19	1286.47	**866.05**
Females	247.29	389.64	380.57	454.17	753.83	1114.55	1223.04	1277.73	1314.70	1504.99	**866.05**
Southern											
Males	310.32	407.65	617.11	884.82	891.47	1039.17	1228.63	1315.09	1223.99	1265.83	**918.41**
Females	357.49	454.20	416.13	583.39	754.74	1132.37	1240.35	1375.76	1380.47	1489.19	**918.41**
Western											
Males	298.90	375.46	555.50	865.61	822.04	935.52	1069.00	1199.25	1121.97	1307.75	**855.40**
Females	321.00	322.29	339.24	563.25	744.94	1035.37	1123.41	1238.10	1330.83	1535.57	**855.40**
Total	**283.03**	**372.59**	**458.37**	**644.69**	**767.10**	**988.69**	**1153.02**	**1234.75**	**1240.02**	**1427.08**	**856.14**

Table A.59: **Average Cost (€) per Claim re-estimated by age cohort, gender and region 2007–Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	232.34	361.76	477.88	675.89	726.16	1039.71	1239.87	1319.54	1125.13	1274.77	**848.48**
Females	255.08	320.84	381.76	442.39	632.93	1048.92	1196.89	1354.37	1245.74	1581.39	**847.42**
Midlands											
Males	257.70	357.48	584.25	877.61	856.59	1069.24	1226.58	1320.64	1390.02	1499.97	**945.08**
Females	292.60	292.28	446.90	536.70	796.68	1053.34	1294.07	1357.44	1523.97	1827.87	**943.72**
Mid–Western											
Males	319.97	529.38	648.60	792.84	957.73	958.65	1136.38	1164.22	1157.95	1236.57	**890.80**
Females	338.48	398.80	389.85	583.63	790.22	1013.79	1274.71	1244.90	1310.41	1536.06	**889.04**
North–Eastern											
Males	295.73	401.09	558.18	824.18	823.02	932.16	115316	1154.89	1206.20	1377.23	**873.32**
Females	297.75	451.19	331.29	510.18	682.04	982.16	1142.06	1341.67	1350.60	1613.69	**871.36**
North–Western											
Males	229.13	321.16	419.57	618.37	733.22	804.09	921.90	988.07	969.28	1230.21	**724.41**
Females	264.77	268.84	301.43	395.74	574.93	778.24	1028.86	1089.91	1113.21	1432.08	**727.79**
South–Eastern											
Males	280.49	406.01	607.18	830.97	861.66	1023.47	1100.75	1163.27	1213.74	1300.78	**879.58**
Females	251.41	403.16	390.01	461.40	764.43	1130.94	1235.97	1288.93	1326.64	1518.73	**878.39**
Southern											
Males	317.17	415.79	629.21	904.49	904.59	1053.58	1242.26	1329.59	1237.10	1278.51	**932.16**
Females	366.74	470.71	423.04	593.42	764.75	1145.36	1254.81	1387.37	1392.43	1500.57	**930.83**
Western											
Males	307.68	383.83	566.06	878.99	834.75	948.08	1082.53	1215.05	1137.32	1321.37	**868.26**
Females	328.57	328.51	345.41	573.33	757.82	1048.36	1136.51	125178	1343.28	1549.74	**867.44**
Total	**289.93**	**382.55**	**469.29**	**656.93**	**779.04**	**1002.00**	**1166.77**	**1248.36**	**1252.79**	**1443.32**	**869.15**

Table A.60: **GMS Pharmacy Cost 2007**

Region	**GMS Pharmacy Cost (€)**
Eastern	835.14
Midlands	930.43
Mid–Western	877.64
North–Eastern	859.24
North–Western	713.16
South–Eastern	866.05
Southern	918.41
Western	855.40
National	**856.14**
Standard Deviation	**66.38**

Source: (**PCRS**, 2007)

Table A.61: **Ratios estimated from sample standard deviation 2007 - PCRS database**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	0.33	0.73	0.73	0.98	0.84	1.20	1.10	1.37	1.08	1.00	**1.03**
Females	0.38	0.45	0.87	0.61	0.79	0.94	1.11	1.12	0.90	1.19	**0.94**
Midlands											
Males	0.41	0.84	1.04	1.16	1.03	1.24	1.11	1.11	1.20	1.30	**1.13**
Females	0.47	0.36	1.02	0.73	0.92	1.04	1.01	1.01	1.07	1.41	**1.02**
Mid–Western											
Males	0.57	0.86	1.22	0.98	1.08	0.94	1.09	1.06	0.92	0.95	**1.01**
Females	0.53	0.55	0.64	0.72	0.84	0.94	1.04	0.84	0.90	1.03	**0.88**
North–Eastern											
Males	0.66	1.07	0.91	1.27	0.92	0.94	1.28	1.05	1.08	1.09	**1.08**
Females	0.58	0.99	0.55	0.63	0.79	0.88	0.94	0.96	0.99	1.16	**0.93**
North–Western											
Males	0.33	0.59	0.63	0.86	0.92	0.90	0.96	0.90	0.84	1.03	**0.86**
Females	0.56	0.37	0.54	0.59	0.63	0.84	0.95	1.05	0.80	2.62	**1.12**
South–Eastern											
Males	0.62	0.64	1.18	1.06	1.13	1.04	1.05	0.97	1.04	1.10	**1.04**
Females	0.32	1.04	0.73	0.56	0.81	1.26	0.99	0.86	0.92	1.06	**0.95**
Southern											
Males	0.53	0.63	0.93	1.51	1.01	1.11	1.05	1.11	1.01	0.97	**1.06**
Females	0.71	1.27	0.53	0.77	0.77	1.00	1.11	0.89	0.92	0.87	**0.95**
Western											
Males	0.68	0.64	0.81	1.03	0.98	0.97	1.04	1.21	0.95	1.05	**0.99**
Females	0.58	0.48	0.47	0.77	0.99	1.00	1.01	1.05	0.96	1.09	**0.93**
Total	**0.53**	**0.77**	**0.84**	**0.94**	**0.92**	**1.02**	**1.06**	**1.05**	**0.98**	**1.25**	**1.00**

Table A.62: **Estimated sample standard deviation 2007 - PCRS database (€)**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	48.90	108.77	109.59	146.88	125.30	180.16	164.81	204.57	162.41	149.39	**153.59**
Females	56.94	67.75	130.94	90.64	118.70	141.36	165.89	167.50	135.31	178.84	**141.36**
Midlands											
Males	61.93	126.18	155.77	173.14	154.38	185.60	165.67	165.70	180.10	194.84	**168.62**
Females	69.94	53.24	152.12	109.20	138.46	155.06	151.28	151.95	160.57	211.42	**153.01**
Mid–Western											
Males	85.34	128.09	182.84	147.46	162.36	141.22	162.72	159.38	137.95	142.03	**151.56**
Females	79.21	82.01	96.50	107.76	125.31	140.08	155.84	126.33	134.66	155.00	**131.28**
North–Eastern											
Males	98.57	160.14	135.64	190.13	137.28	140.09	192.21	156.58	161.86	163.67	**162.14**
Females	86.43	148.98	82.43	93.76	117.75	132.22	141.16	143.59	148.51	174.24	**139.53**
North–Western											
Males	48.88	87.74	94.14	129.44	137.14	134.6	143.91	135.16	125.14	154.30	**129.49**
Females	83.78	54.74	81.53	88.98	93.79	126.23	142.69	157.14	119.62	391.83	**168.47**
South–Eastern											
Males	92.20	95.66	176.93	158.86	169.32	155.88	156.95	145.09	156.04	164.73	**155.78**
Females	47.53	155.63	108.72	83.22	122.05	188.67	148.95	128.95	137.54	158.22	**142.10**
Southern											
Males	78.79	93.73	139.37	226.37	151.06	165.89	156.90	166.94	150.92	145.96	**158.37**
Females	106.45	189.99	79.55	115.45	115.27	149.60	166.52	133.64	137.73	131.05	**142.97**
Western											
Males	101.12	96.34	121.56	154.06	146.30	144.59	155.81	181.93	142.29	156.81	**148.10**
Females	87.12	71.54	71.08	116.07	148.29	149.50	150.75	157.53	143.45	163.12	**138.63**
Total	**79.37**	**114.69**	**125.68**	**140.92**	**137.36**	**153.33**	**158.40**	**156.69**	**147.05**	**186.95**	**149.80**

Table A.63: **Standard Deviation rescaled using 2007 Population data (€)**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	21.67	48.20	48.56	65.09	55.53	79.84	73.03	90.65	71.97	66.20	**68.06**
Females	25.23	30.02	58.02	40.17	52.60	62.64	73.51	74.23	59.96	79.25	**62.64**
Midlands											
Males	27.45	55.91	69.03	76.73	68.41	82.25	73.41	73.43	79.81	86.34	**74.72**
Females	30.99	23.59	67.41	48.39	61.36	68.71	67.04	67.34	71.15	93.69	**67.80**
Mid–Western											
Males	37.82	56.76	81.02	65.35	71.95	62.58	72.11	70.63	61.13	62.94	**67.16**
Females	35.10	36.34	42.76	47.75	55.53	62.07	69.06	55.98	59.67	68.89	**58.18**
North–Eastern											
Males	43.68	70.96	60.11	84.26	60.84	62.08	85.18	69.39	71.73	72.53	**71.85**
Females	38.30	66.02	36.53	41.55	52.18	58.59	62.55	63.63	65.81	77.21	**61.83**
North–Western											
Males	21.66	38.88	41.72	57.36	60.77	59.65	63.77	59.60	55.45	68.38	**57.38**
Females	37.13	24.26	36.13	39.43	41.56	55.94	63.23	69.64	53.01	173.64	**74.66**
South–Eastern											
Males	40.86	42.39	78.40	70.40	75.03	69.08	69.55	64.30	69.15	73.00	**69.03**
Females	21.06	68.97	48.18	36.88	54.08	83.61	66.01	57.14	60.95	70.11	**62.97**
Southern											
Males	34.92	41.54	61.76	100.31	66.94	73.51	69.53	73.98	66.88	64.68	**70.18**
Females	47.17	84.19	35.25	51.16	51.08	66.29	73.79	59.22	61.03	58.07	**63.36**
Western											
Males	44.81	42.69	53.87	68.27	64.83	64.08	69.05	80.62	63.05	69.49	**65.63**
Females	38.61	31.70	31.50	51.44	65.72	66.25	66.80	69.81	63.57	72.28	**61.43**
Total	**35.17**	**50.83**	**55.69**	**62.45**	**60.87**	**67.95**	**70.19**	**69.43**	**65.16**	**82.85**	**66.38**

Table A.64: **Three Average Cost (€) per Claim scenarios by age cohort, gender and region 2011 - Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	167.83	254.23	343.24	487.23	530.53	759.44	916.52	969.07	828.91	946.67	**620.37**
Females	183.55	231.71	264.78	320.10	460.35	774.94	883.27	1003.87	927.43	1175.78	**622.58**
Midlands											
Males	144.48	247.16	414.91	636.46	624.39	780.94	906.12	978.36	1028.52	1109.77	**691.11**
Females	209.55	212.93	310.20	388.50	581.83	775.36	961.08	1009.61	1135.64	1358.02	**694.27**
Mid–Western											
Males	227.22	378.78	458.45	576.93	700.34	705.64	837.48	859.59	859.42	918.93	**652.28**
Females	242.77	288.50	278.47	424.87	579.73	748.24	945.22	928.74	977.24	1146.14	**655.99**
North–Eastern											
Males	205.73	273.28	399.26	591.73	602.32	685.54	843.96	853.03	891.20	1022.26	**636.84**
Females	209.92	314.19	236.55	371.49	498.28	725.65	846.52	999.31	1005.10	1201.59	**640.86**
North–Western											
Males	165.37	227.61	301.81	446.84	533.38	588.36	676.83	729.55	717.30	911.38	**529.84**
Females	185.17	194.60	213.81	284.63	421.21	570.32	759.25	803.00	829.05	1014.83	**527.59**
South–Eastern											
Males	195.41	291.07	427.93	603.74	625.04	752.20	811.37	861.96	898.35	963.31	**643.04**
Females	182.78	275.85	275.94	336.31	560.63	827.66	916.97	961.98	989.09	1132.13	**645.93**
Southern											
Males	226.49	299.00	453.01	645.54	661.98	773.20	920.07	984.96	917.40	950.29	**683.19**
Females	258.56	320.26	307.65	430.71	562.35	847.23	927.62	1036.58	1039.58	1124.09	**685.46**
Western											
Males	214.36	273.88	408.37	641.66	609.37	696.79	797.62	893.73	842.64	980.85	**635.93**
Females	233.44	236.78	249.86	415.14	549.85	772.74	840.18	927.25	1000.59	1154.88	**638.07**
Total	**205.79**	**269.99**	**334.01**	**475.12**	**568.85**	**736.52**	**861.88**	**925.04**	**930.47**	**1069.43**	**637.71**

Table A.65: **Average Cost (€) per Claim scenarios by age cohort, gender and region 2011 - Scenario 2: Mean**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**	**Total**
Eastern											
Males	175.19	270.60	359.74	509.34	549.39	786.56	941.33	999.87	853.36	969.16	**641.45**
Females	192.12	241.91	284.49	333.75	478.22	796.22	908.24	1029.09	947.80	1202.70	**641.45**
Midlands											
Males	193.80	266.16	438.36	662.52	647.63	808.88	931.06	1003.30	1055.63	1139.10	**714.64**
Females	220.08	220.94	333.10	404.94	602.68	798.70	983.86	1032.49	1159.82	1389.85	**714.64**
Mid–Western											
Males	240.07	398.06	485.98	599.13	724.78	726.90	861.97	883.58	880.19	940.31	**674.10**
Females	254.69	300.84	293.00	441.09	598.59	769.33	968.68	947.76	997.51	1169.48	**674.10**
North–Eastern											
Males	220.57	297.39	419.68	620.35	622.98	706.63	872.89	876.60	915.66	1046.90	**659.96**
Females	222.93	336.61‘	248.96	385.61	516.01	745.56	867.77	1020.93	1027.46	1227.82	**659.96**
North–Western											
Males	172.73	240.82	315.98	466.32	554.03	608.63	698.49	749.90	736.13	934.61	**547.76**
Females	197.78	202.84	226.08	298.03	435.33	589.33	780.73	826.65	847.06	1073.81	**547.76**
South–Eastern											
Males	209.29	305.47	454.56	627.65	650.53	775.71	834.99	883.80	921.84	988.11	**665.20**
Females	189.94	299.27	292.31	348.84	579.00	856.07	939.39	981.40	1009.79	1155.95	**665.20**
Southern											
Males	238.35	313.11	473.99	679.62	684.72	798.17	943.69	1010.10	940.12	972.26	**705.41**
Females	274.58	348.87	319.62	448.09	579.70	869.75	952.69	1056.69	1060.31	1143.82	**705.41**
Western											
Males	229.58	288.39	426.67	664.85	631.39	718.55	821.08	921.12	864.06	1004.46	**657.02**
Females	246.55	247.55	260.56	432.62	572.17	795.25	862.87	950.96	1022.18	1179.44	**657.02**
Total	**217.39**	**286.16**	**352.07**	**495.17**	**589.20**	**759.39**	**885.61**	**948.39**	**952.43**	**1096.11**	**658.19**

Table A.66: **Average Cost (€) per Claim scenarios by age cohort, gender and region 2011 - Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	182.56	286.98	376.24	531.45	568.25	813.69	966.14	1030.66	877.81	991.65	**662.54**
Females	200.69	252.11	304.20	347.39	496.09	817.50	933.22	1054.30	968.17	1229.62	**660.33**
Midlands											
Males	203.13	285.15	461.81	688.59	670.87	836.82	956.00	1028.25	1082.75	1168.43	**738.18**
Females	230.61	228.95	356.00	421.38	623.52	822.05	1006.63	1055.36	1183.99	1421.67	**735.02**
Mid–Western											
Males	252.91	417.35	513.50	621.33	749.22	748.16	886.47	907.58	900.96	961.69	**695.92**
Females	266.62	313.19	307.52	457.31	617.46	790.41	992.15	966.78	1017.79	1192.81	**692.20**
North–Eastern											
Males	235.41	321.49	440.10	648.97	643.65	727.71	901.83	900.17	940.03	1071.64	**683.09**
Females	235.94	359.04	261.36	399.72	533.73	765.46	889.02	1042.55	1049.81	1254.05	**679.07**
North–Western											
Males	180.09	254.03	330.15	485.81	574.67	628.89	720.16	770.24	754.97	957.83	**565.68**
Females	210.39	211.08	238.36	311.42	449.45	608.33	802.21	850.31	865.06	1132.80	**567.94**
South–Eastern											
Males	223.17	319.87	481.20	651.57	676.02	799.17	858.62	905.64	945.33	1012.91	**687.35**
Females	197.09	322.70	308.68	361.37	597.38	884.47	961.81	1000.81	1030.50	1179.77	**684.46**
Southern											
Males	250.22	327.22	494.97	713.69	707.46	823.14	967.31	1035.23	962.84	994.23	**727.63**
Females	290.61	377.47	331.60	465.47	597.06	892.27	977.76	1076.81	1081.04	1163.55	**725.36**
Western											
Males	244.80	302.89	444.97	688.05	653.42	740.32	844.53	948.51	885.48	1028.06	**678.10**
Females	259.67	258.32	271.26	450.09	594.50	817.75	885.57	974.67	1043.77	1204.00	**675.96**
Total	**228.99**	**302.36**	**370.12**	**515.23**	**609.55**	**782.26**	**909.34**	**971.74**	**974.39**	**1122.79**	**678.68**

Table A.67: **Three re- estimated Claim rate scenarios by age, gender and region 2007 - Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	**0.99**
Females	0.99	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	**0.99**
Midlands											
Males	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	**0.98**
Females	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	**0.99**
Mid–Western											
Males	0.88	0.81	0.84	0.85	0.86	0.89	0.92	0.93	0.93	0.96	**0.89**
Females	0.87	0.82	0.89	0.88	0.88	0.91	0.93	0.95	0.95	0.95	**0.90**
North–Eastern											
Males	0.82	0.75	0.77	0.79	0.80	0.85	0.88	0.91	0.89	0.91	**0.84**
Females	0.81	0.75	0.85	0.84	0.84	0.87	0.90	0.90	0.91	0.91	**0.86**
North–Western											
Males	0.81	0.73	0.75	0.76	0.77	0.81	0.86	0.88	0.91	0.90	**0.82**
Females	0.78	0.73	0.81	0.82	0.82	0.84	0.87	0.90	0.91	0.90	**0.84**
South–Eastern											
Males	0.92	0.89	0.90	0.91	0.92	0.93	0.95	0.96	0.95	0.97	**0.93**
Females	0.93	0.89	0.93	0.93	0.93	0.94	0.96	0.97	0.97	0.97	**0.94**
Southern											
Males	0.94	0.91	0.92	0.92	0.93	0.95	0.96	0.96	0.96	0.97	**0.94**
Females	0.93	0.91	0.94	0.94	0.95	0.95	0.97	0.97	0.97	0.98	**0.95**
Western											
Males	0.80	0.73	0.76	0.78	0.80	0.83	0.86	0.88	0.90	0.90	**0.82**
Females	0.80	0.73	0.83	0.82	0.83	0.85	0.88	0.90	0.90	0.91	**0.84**
Total	**0.88**	**0.84**	**0.88**	**0.88**	**0.89**	**0.91**	**0.93**	**0.94**	**0.94**	**0.95**	**0.90**

Table A.68: **Re- estimated Claim rate scenarios by age, gender and region 2007 - Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Midlands											
Males	1.00	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Mid–Western											
Males	0.93	0.88	0.90	0.91	0.91	0.94	0.96	0.97	0.97	0.99	**0.93**
Females	0.93	0.88	0.93	0.93	0.93	0.95	0.96	0.98	0.98	0.98	**0.95**
North–Eastern											
Males	0.88	0.82	0.85	0.86	0.87	0.91	0.93	0.95	0.94	0.95	**0.90**
Females	0.88	0.82	0.91	0.90	0.90	0.92	0.95	0.94	0.96	0.95	**0.91**
North–Western											
Males	0.87	0.81	0.83	0.83	0.84	0.88	0.91	0.93	0.95	0.94	**0.88**
Females	0.85	0.81	0.87	0.88	0.88	0.90	0.92	0.94	0.95	0.94	**0.90**
South–Eastern											
Males	0.96	0.94	0.94	0.95	0.96	0.97	0.98	0.98	0.98	0.99	**0.96**
Females	0.97	0.94	0.96	0.97	0.97	0.97	0.98	0.99	0.99	0.99	**0.97**
Southern											
Males	0.97	0.95	0.96	0.96	0.97	0.98	0.98	0.99	0.99	0.99	**0.97**
Females	0.97	0.95	0.97	0.97	0.98	0.98	0.99	0.99	0.99	0.99	**0.98**
Western											
Males	0.87	0.81	0.83	0.85	0.87	0.89	0.92	0.93	0.94	0.95	**0.88**
Females	0.87	0.81	0.89	0.88	0.89	0.91	0.93	0.94	0.95	0.95	**0.90**
Total	**0.93**	**0.90**	**0.93**	**0.93**	**0.93**	**0.95**	**0.96**	**0.97**	**0.97**	**0.98**	**0.95**

Table A.69: **Re- estimated Claim rate scenarios by age, gender and region 2007 - Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Midlands											
Males	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Mid–Western											
Males	0.98	0.94	0.96	0.96	0.97	0.99	1.00	1.00	1.00	1.00	**0.98**
Females	0.98	0.95	0.98	0.98	0.98	0.99	1.00	1.00	1.00	1.00	**0.99**
North–Eastern											
Males	0.94	0.90	0.92	0.93	0.93	0.96	0.98	0.99	0.99	0.99	**0.96**
Females	0.94	0.90	0.97	0.96	0.96	0.97	0.99	0.99	1.00	0.99	**0.97**
North–Western											
Males	0.94	0.88	0.90	0.90	0.91	0.94	0.97	0.98	0.99	0.99	**0.94**
Females	0.92	0.89	0.94	0.95	0.95	0.96	0.97	0.99	0.99	0.99	**0.96**
South–Eastern											
Males	1.00	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Southern											
Males	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Western											
Males	0.93	0.88	0.91	0.92	0.94	0.95	0.97	0.98	0.99	0.99	**0.95**
Females	0.94	0.89	0.95	0.95	0.95	0.96	0.98	0.99	0.99	0.99	**0.96**
Total	**0.98**	**0.96**	**0.98**	**0.98**	**0.98**	**0.99**	**1.00**	**1.00**	**1.00**	**1.00**	**0.99**

Table A.70: **Descriptive Analysis of Average Cost per Claimant (€) 2016-2026 (Scenario 1)**

Year	♯ of Simulations	Mean	SE Mean	St. Dev	Min	Q1	Median	Q3	Max
2016	100,000	139.37	0.472	149.32	3.66	52.25	81.75	146.59	810.63
2021	100,000	141.21	0.476	150.61	35.39	50.74	80.95	142.86	764.57
2026	100,000	140.99	0.470	148.60	33.33	48.80	85.83	145.05	704.97

Table A.71: **Descriptive Analysis of Average Cost per Claimant (€) 2016-2026 (Scenario 3)**

Year	♯ of Simulations	Mean	SE Mean	St. Dev	Min	Q1	Median	Q3	Max
2016	100,000	392.58	1.24	393.09	100.94	162.25	250.25	414.14	2036.38
2021	100,000	499.90	1.51	477.82	127.10	205.43	319.54	535.45	2403.96
2026	100,000	637.28	1.87	590.56	156.11	252.35	436.51	697.08	2839.23

Figure A.7: **Histogram of Average Cost per Claimant (€), Scenario 1, 2016**

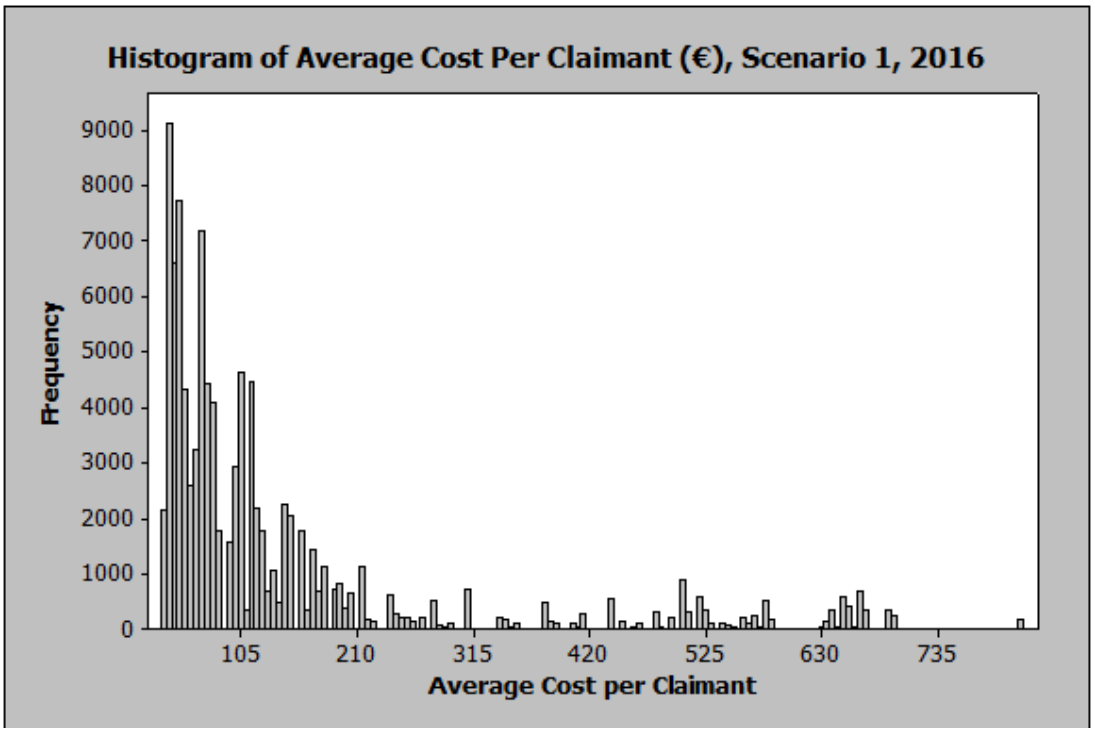


Figure A.8: **Histogram of Average Cost per Claimant (€), Scenario 3, 2016**

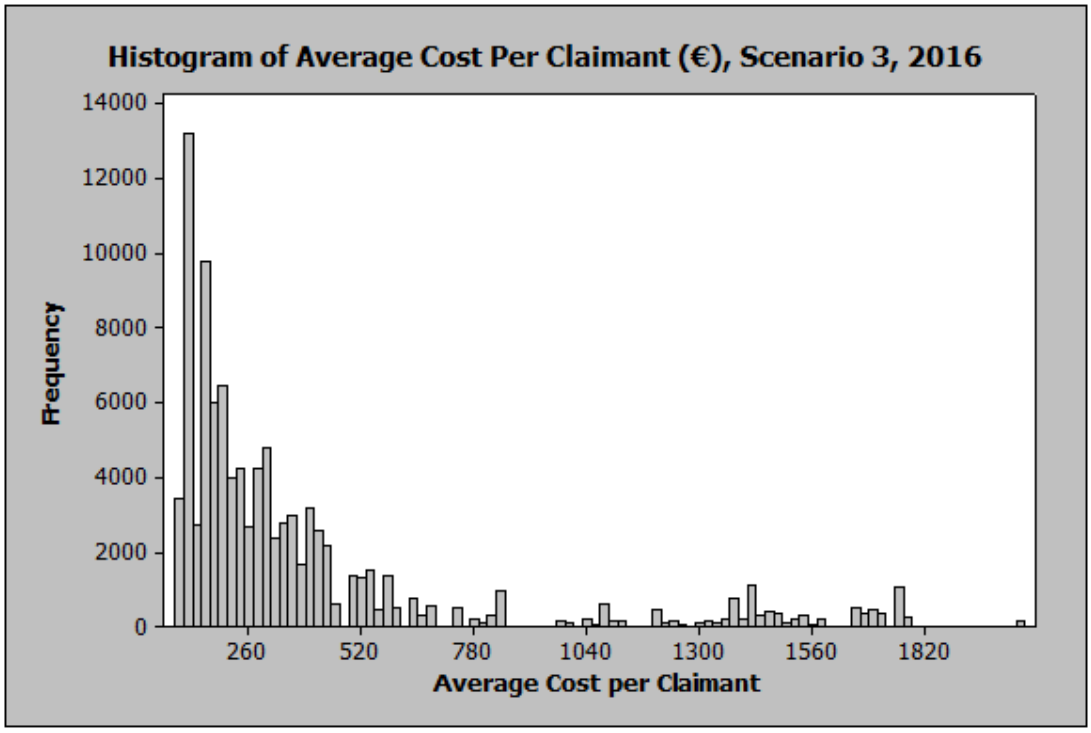


Figure A.9: **Histogram of Average Cost per Claimant (€), Scenario 1, 2021**

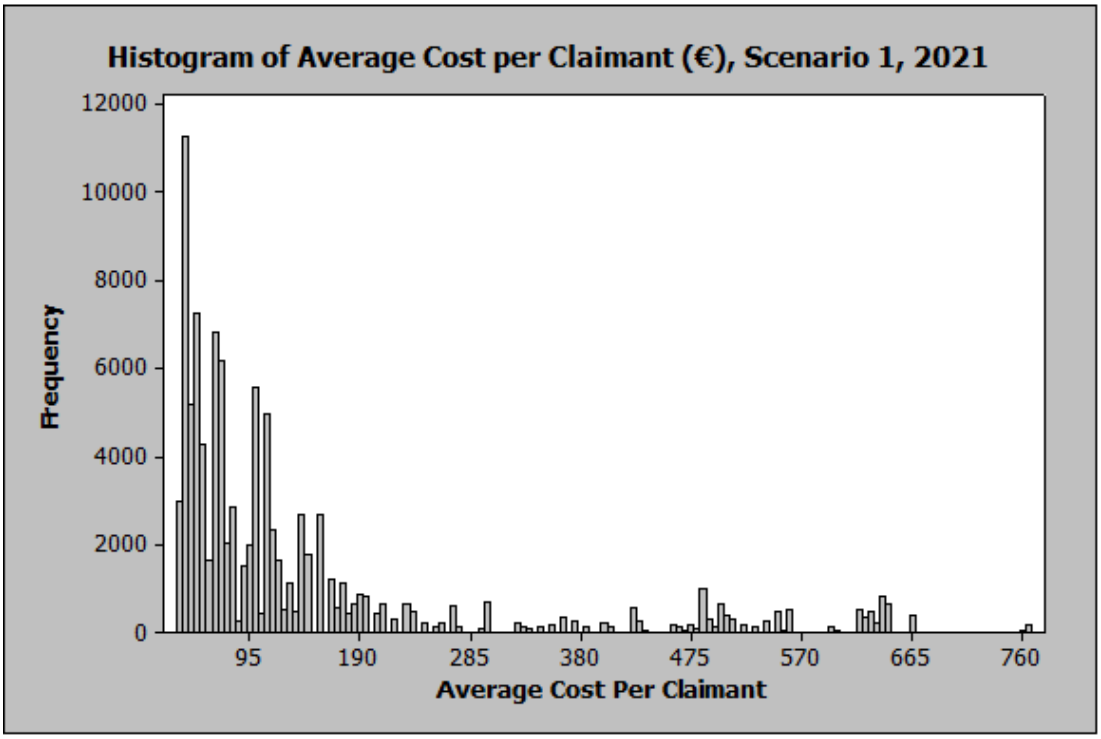


Figure A.10: **Histogram of Average Cost per Claimant (€), Scenario 3, 2021**

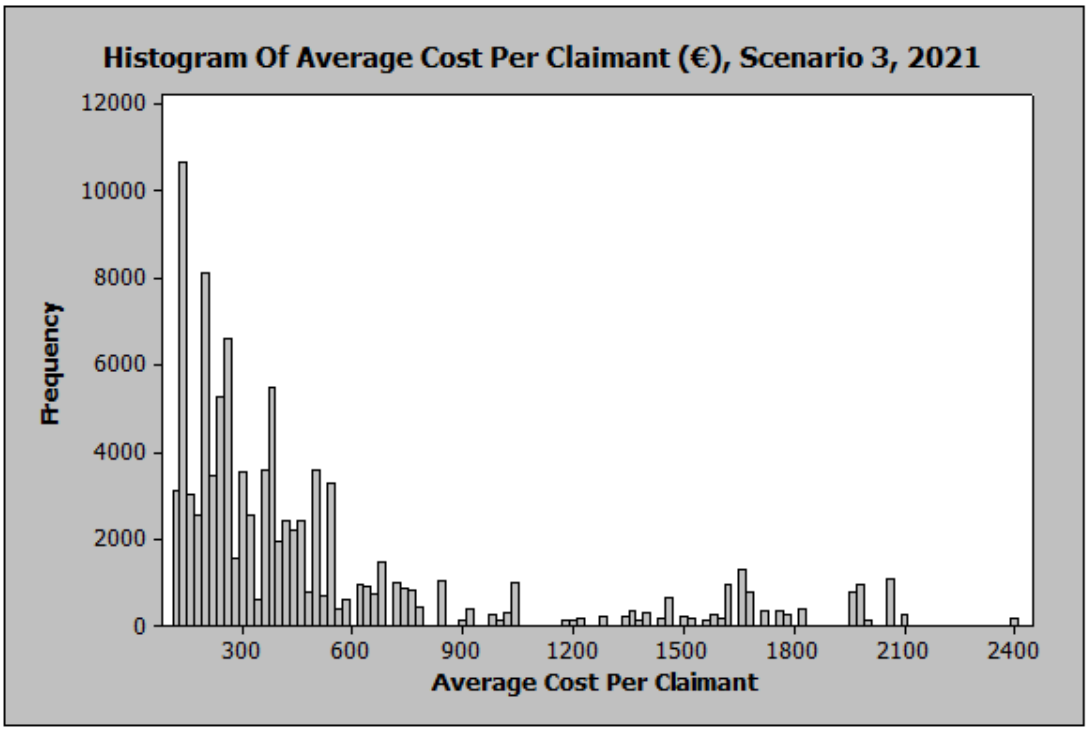


Figure A.11: **Histogram of Average Cost per Claimant (€), Scenario 1, 2026**

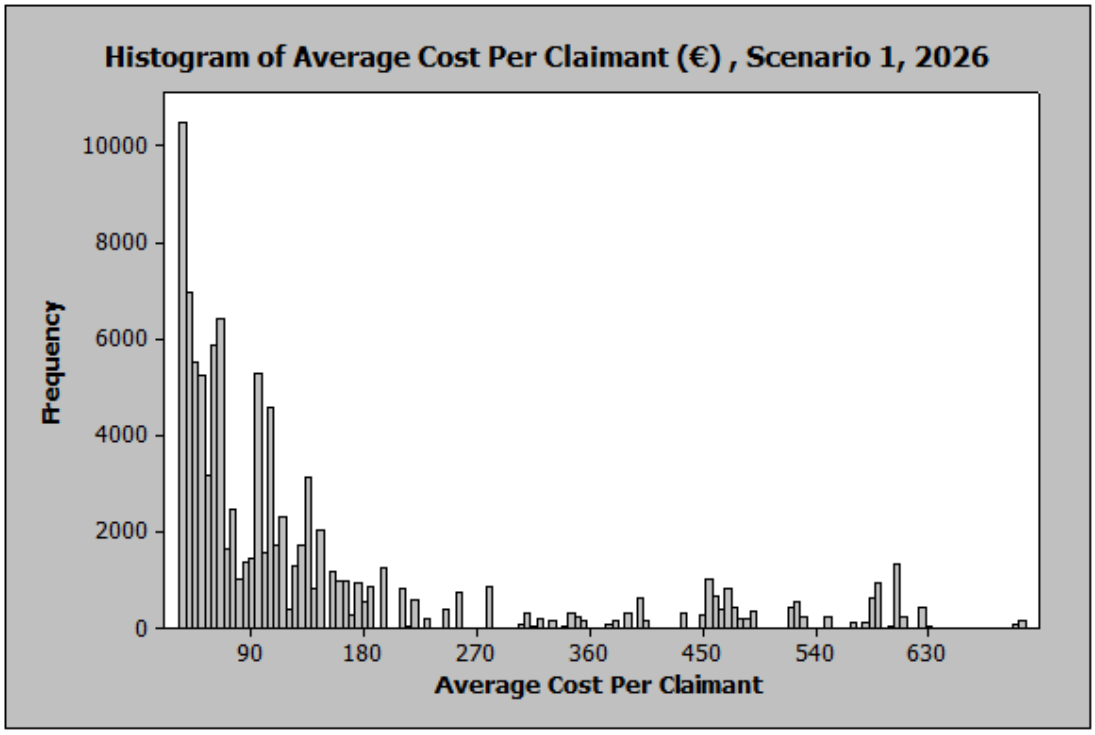


Figure A.12: **Histogram of Average Cost per Claimant (€), Scenario 3, 2026**

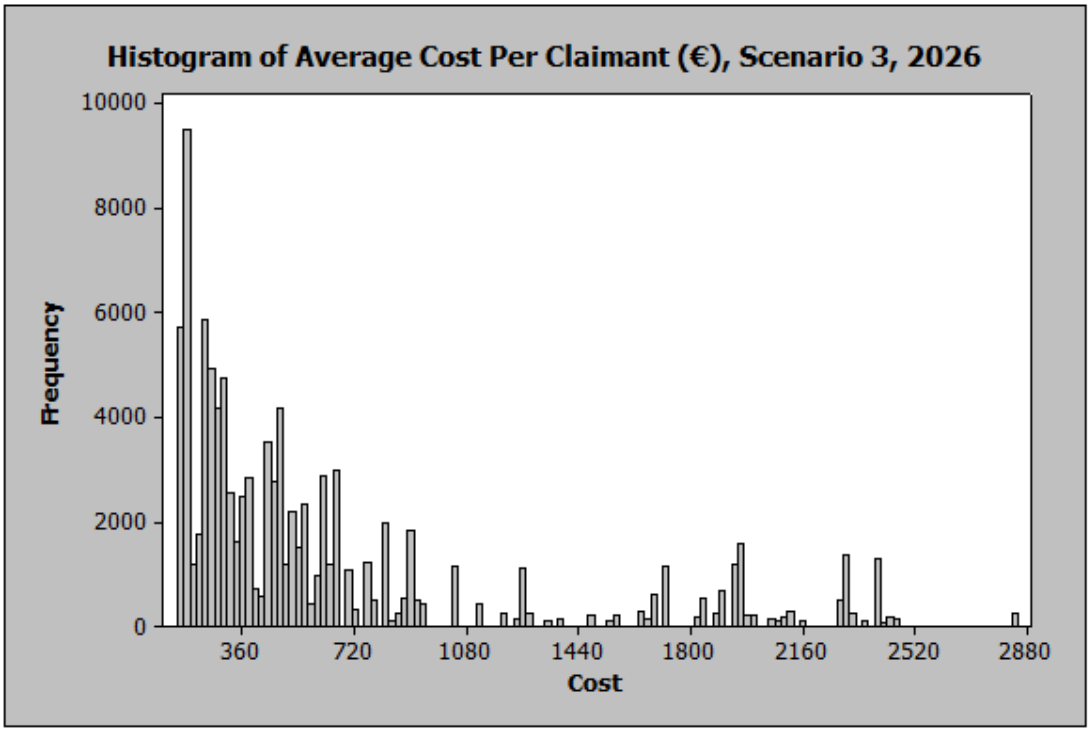


Figure A.13: **Statistical Analysis Scenario 1 – Scenario 3, 2021**

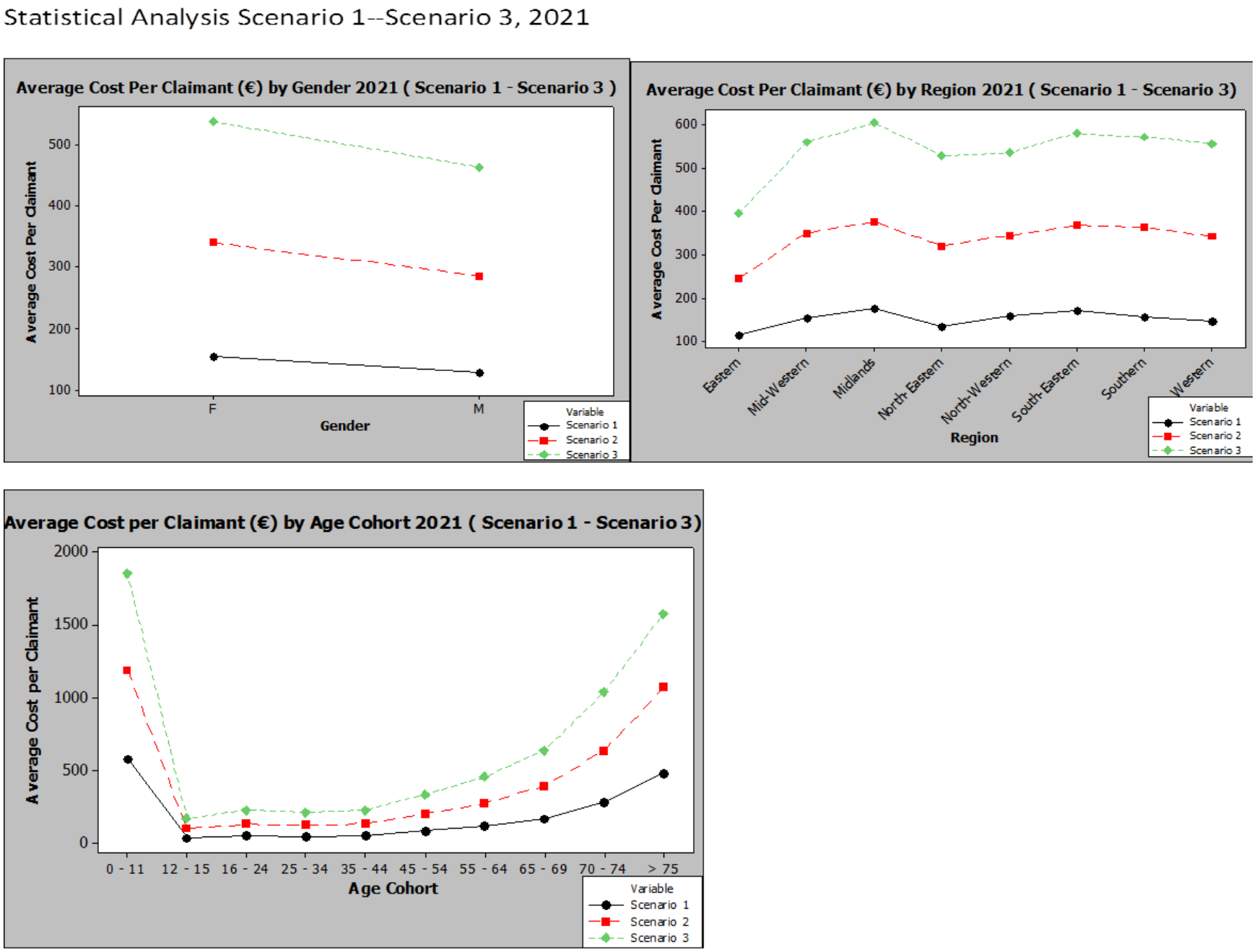


Figure A.14: **Main effects Plot Scenario 1 & Scenario 3, 2016**

Main Effects Plot Scenario 1 and Scenario 3, 2016

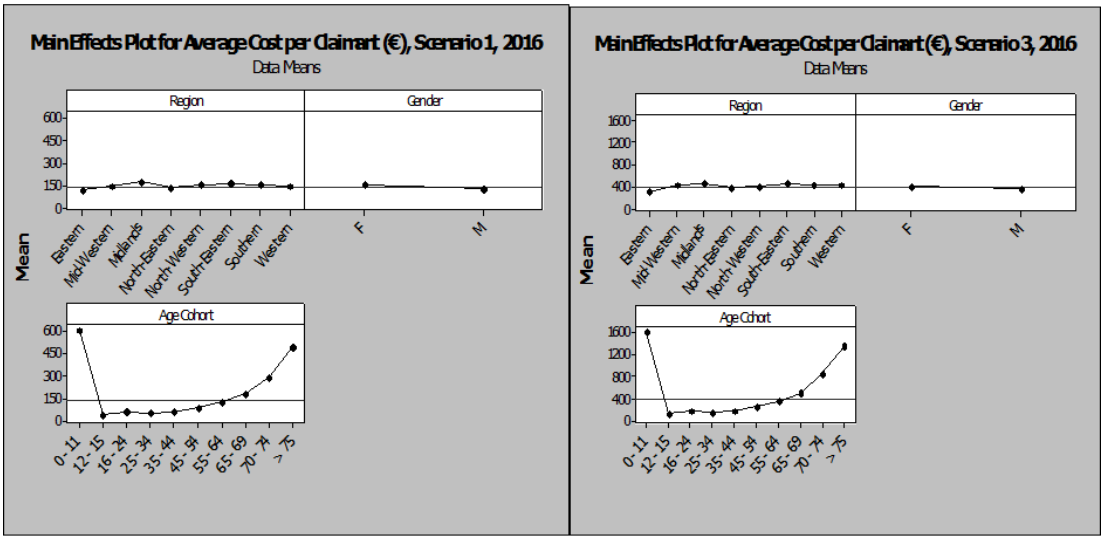


Figure A.15: **Main effects Plot Scenario 1 & Scenario 3, 2021**

Main Effects Plot Scenario 1 and Scenario 3, 2021

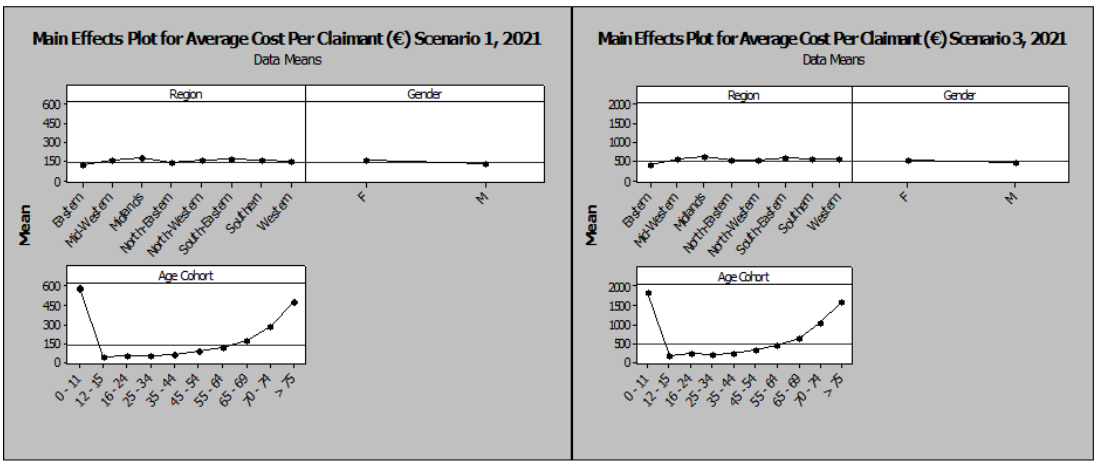


Figure A.16: **Main effects Plot Scenario 1 & Scenario 3, 2026**

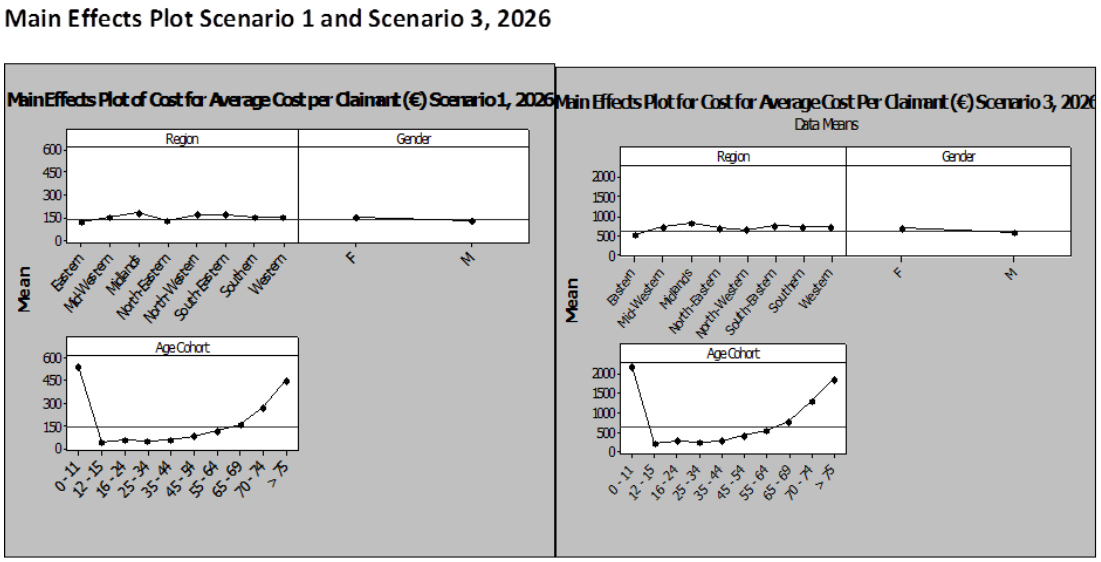


Figure A.17: **Interval Plot of Cost (€) by region, gender & age cohort, Scenario 1, 2016**

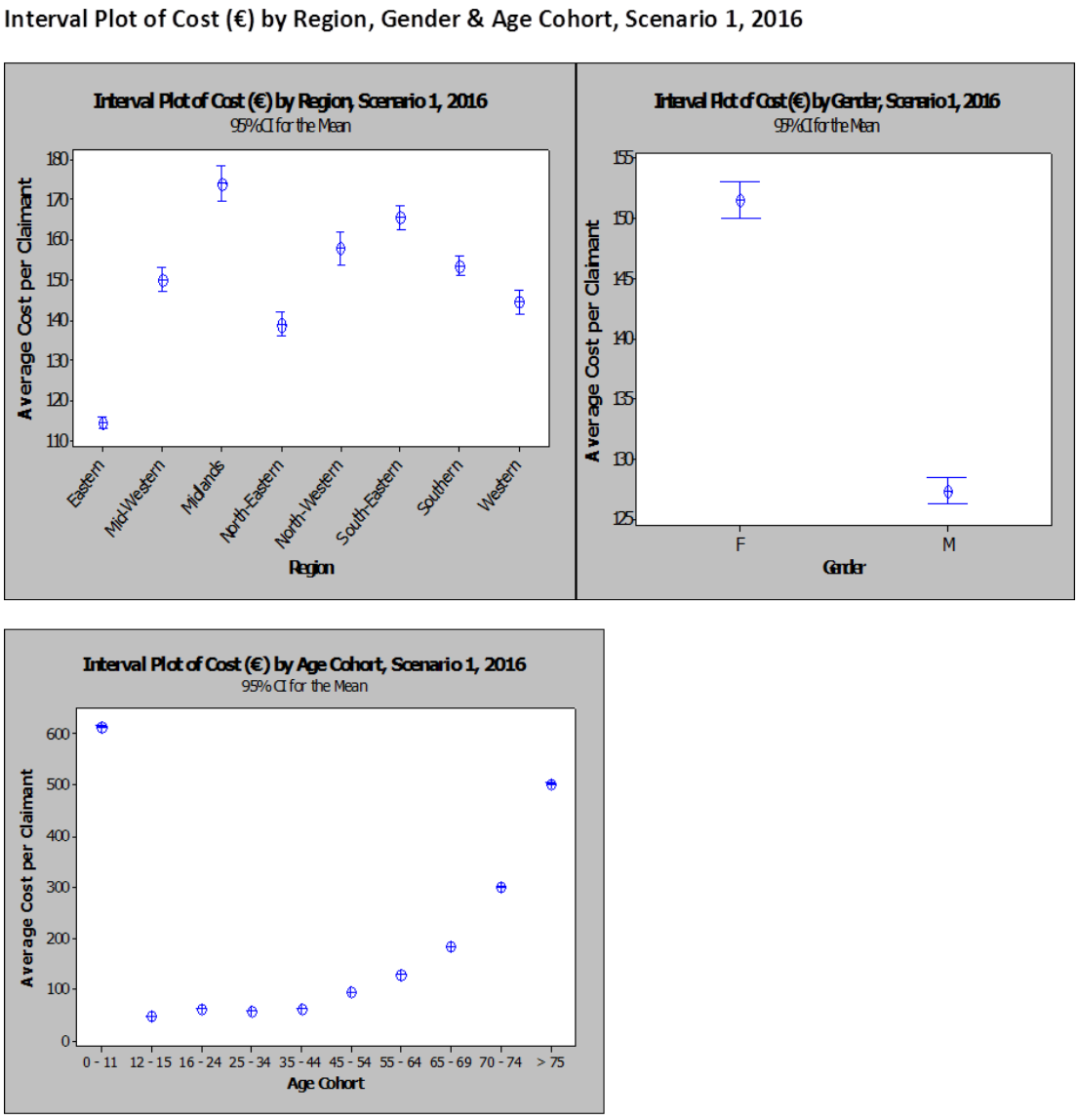


Figure A.18: **Interval Plot of Cost (€) by region, gender & age cohort, Scenario 3, 2016**

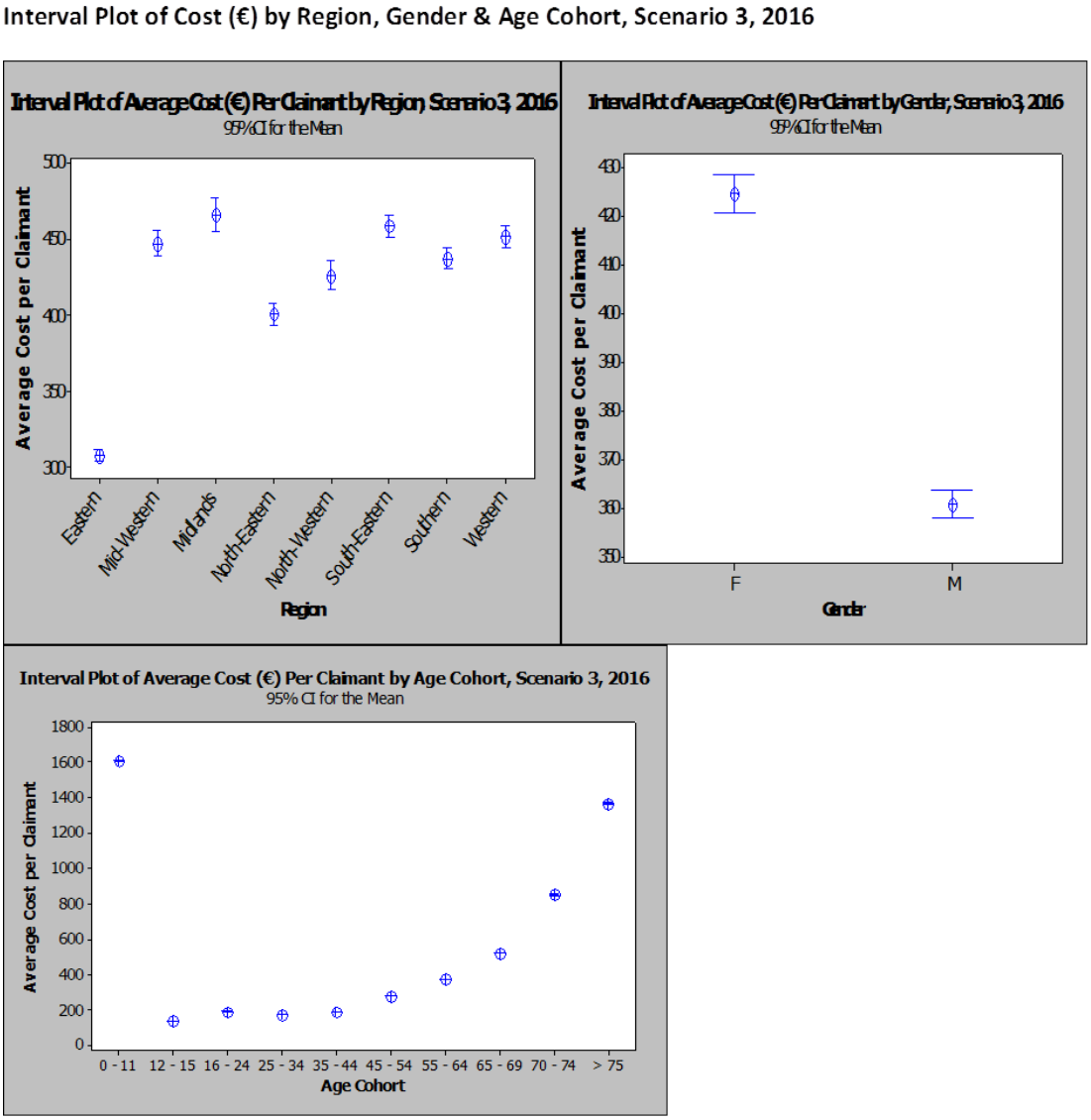


Figure A.19: **Interval Plot of Cost (€) by region, gender & age cohort, Scenario 2, 2021**

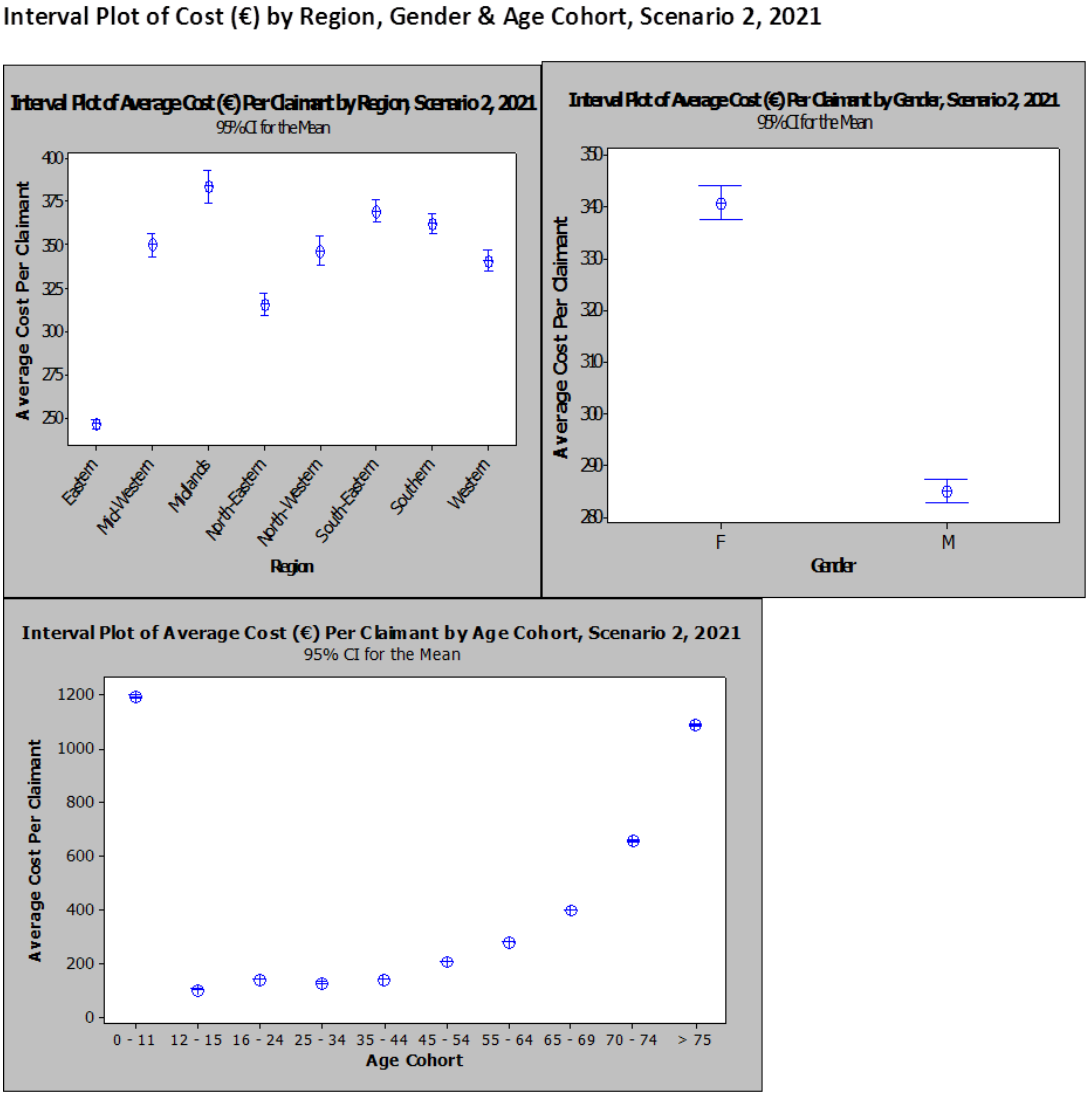
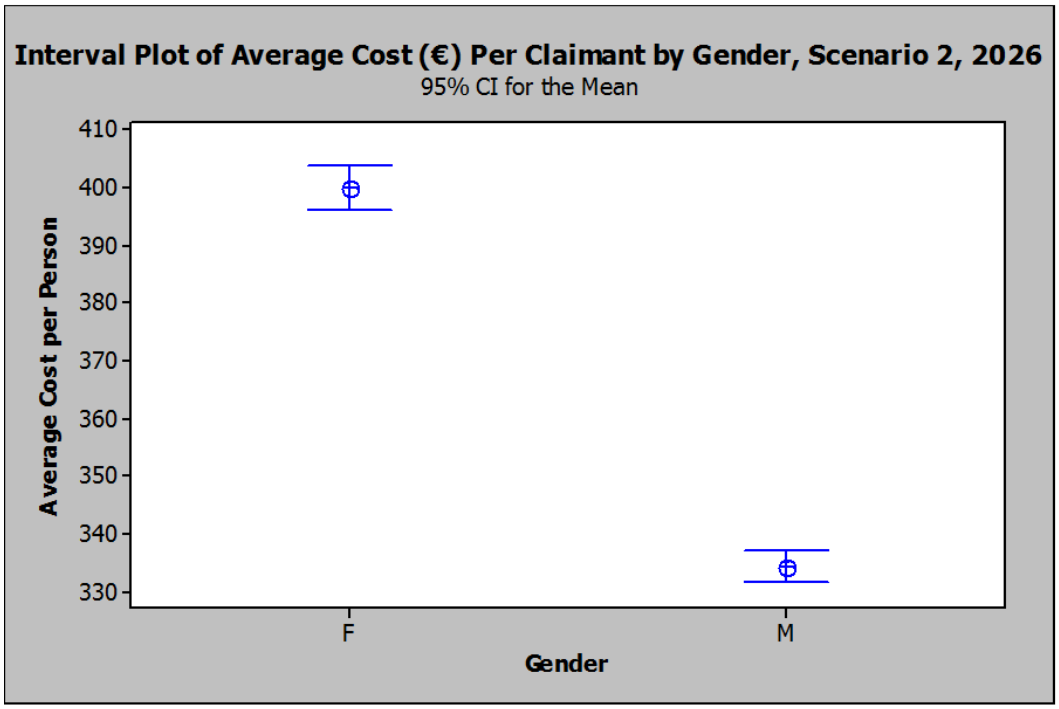
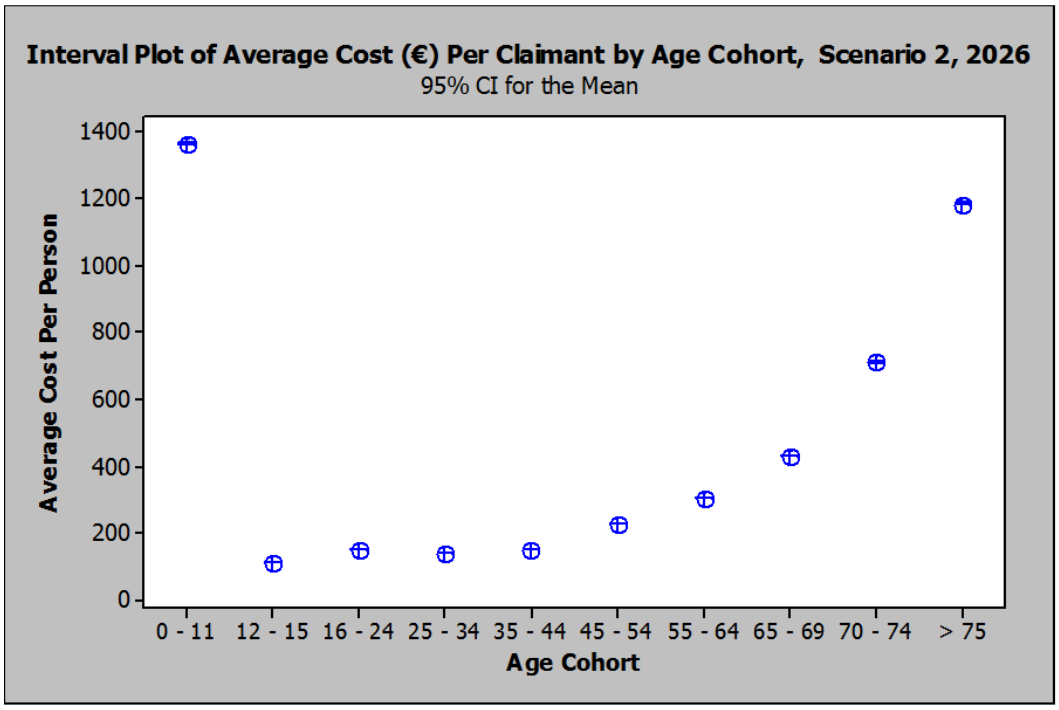


Figure A.20: **Interval Plot of Cost (€) by gender & age cohort, Scenario 2, 2026**

Interval Plot of Cost (€) by Gender & Age Cohort, Scenario 2, 2026





Appendix B

Appendix B (Paper 1)

Conway et al. BMC Health Services Research 2014, 14:477
http://www.biomedcentral.com/1472-6963/14/477

BMC Health Services Research

RESEARCH ARTICLE Open Access

The implications of regional and national demographic projections for future GMS costs in Ireland through to 2026

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Abstract

Background: As the health services in Ireland have become more resource-constrained, pressure has increased to reduce public spending on community drug schemes such as General Medical Services (GMS) drug prescribing and to understand current and future trends in prescribing. The GMS scheme covers approximately 37% of the Irish population in 2011 and entitles them, inter alia, to free prescription drugs and appliances. This paper projects the effects of future changes in population, coverage, claims rates and average claims cost on GMS costs in Ireland.

Methods: Data on GMS coverage, claims rates and average cost per claim are drawn from the Primary Care Reimbursement Service (PCRS) and combined with Central Statistics Office (CSO) (Regional and National Population Projections through to 2026). A Monte Carlo Model is used to simulate the effects of demographic change (by region, age, gender, coverage, claims rates and average claims cost) will have on GMS prescribing costs in 2016, 2021 and 2026 under different scenarios.

Results: The Population of Ireland is projected to grow by 32% between 2007 and 2026 and by 96% for the over 70s. The Eastern region is estimated to grow by 3% over the lifetime of the projections at the expense of most other regions. The Monte Carlo simulations project that females will be a bigger driver of GMS costs than males. Midlands region will be the most expensive of the eight old health board regions. Those aged 70 and over and children under 11 will be significant drivers of GMS costs with the impending demographic changes. Overall GMS medicines costs are projected to rise to €1.9bn by 2026.

Conclusions: Ireland's population will experience rapid growth over the next decade. Population growth coupled with an aging population will result in an increase in coverage rates, thus the projected increase in overall prescribing costs. Our projections and simulations map the likely evolution of GMS cost, given existing policies and demographic trends. These costs can be contained by government policy initiatives.

Keywords: GMS prescribing, Monte carlo simulation model, Regional variation, Scenario analysis

Background

Many of the developed economies, including Ireland, are struggling to contain expenditure on health following the fiscal crisis in the aftermath of the 2008 global economic recession. Expenditure on pharmaceuticals is one of the fastest growing elements of total health spending within the European Union (EU). Pharmaceutical expenditure exceeded €180 billion in 2008 within the EU and accounted, on average, for approximately 17 per cent of EU countries' total expenditure on health [1]. In 2009, Ireland had one of the highest pharmaceutical spends per capita of the Organisation for Economic Co-operation and Development (OECD) countries after the US, Canada and Greece [2]. In Ireland, pharmaceutical expenditure accounted for 16.9 per cent of total health expenditure in 2007 and pharmaceutical spend per capita was €446.37, peaking at 17.9 per cent and €501.48 in 2010 [3]. Community Drugs Schemes (CDS) in Ireland consist of the General Medical Services (GMS), the Long Term Illness (LTI) Scheme, Drug

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Payment Scheme (DPS) and the High Tech Drug Scheme (HTDS). CDS expenditure on medicines accounted for approximately 85 per cent of total drug expenditure in Ireland in 2007 [4]. The annual cost of medicines under community drug schemes in Ireland increased from €564 m in 2000 to €1,961 m in 2009 before falling by an estimated 8 per cent by 2011 following a series of cost containment measures [1].

The focus of this paper is the GMS scheme which is the largest of the schemes with 36.9 per cent of the population eligible in 2011 [5]. Those who are eligible for the GMS scheme (medical card holders) are entitled to free prescription drugs and appliances with a nominal charge per item (€0.50) introduced in budget 2011 . Cost of Medicines on the GMS scheme more than trebled between 2000 and 2009 from approximately €338 million to €1,260 million. Overall, costs of medicines were approximately €1,048 million in 2007 and increased by 15.2 per cent to approximately €1,207 million in 2011.

Following a sharp contraction in the Irish economy in 2008, resulting in mounting fiscal deficits, the sustainability of funding these community drug schemes have come under the spotlight of the EU, International Monetary Fund (IMF) and European Central Bank (ECB) (Troika) who have set stringent targets for reducing drug costs as conditions of the bailout programme. Whilst the troika's main cost containment measure is on the substitution from proprietary to generic prescribing, the challenge for Ireland and many of our EU counterparts in containing expenditure on pharmaceuticals is severely restricted by the growth in the elderly component of our populations, the sub-group with the greatest consumption of prescribed drugs. Projections by the Central Statistics Office (CSO) show the number of elderly people in Ireland will have grown by 200,000 by 2021 [6].

The literature highlights six cost drivers of drug expenditure; population growth, population aging, general inflation, price effects, volume effects and mix of drugs [7]. Whilst Irish drug pricing is substantially higher than our UK counterparts [8], the ESRI identifies population growth and population aging as the key drivers of future drug costs [2]. People in developed economies are living longer, with life expectancy at their highest level and population projections predicting significant increases in the total number of older people. The proportion of people who are very old is growing fastest and this number is expected to almost double by 2030. According to the World Health Organisation, the present and future generations of older people can also expect to live for considerably longer than their predecessors.

This paper assesses the implications of demographic change and policy scenarios on future GMS costs in Ireland from 2007 through to 2026. GMS costs are determined by population, GMS coverage, claims rate and the average cost per claim and assumptions were made around these four variables For this analysis, the coverage rate is defined as the proportion of the population eligible for the GMS scheme and the claims rate is the percentage of those covered who make a claim. The average cost per claim is the total cost of claimants divided by the number of claimants.

Predictions of drug utilisation and costs have been undertaken in several international studies [9,10]. A fixed effects model was used to predict the impact of regulation on pharmaceutical cost in 19 countries from 1992 to 2004, finding that regulations reduce pharmaceutical revenues significantly [9]. A Spanish study investigated the capacity to predict future high-cost patients in Spain through c-statistic, sensitivity and specificity parameters finding that pharmacy-based predictive models can assist administrators and medical directors in planning the health budget and identifying high-cost-risk patients amenable to care management programs [10]. A number of predictive studies have been undertaken in the United States on future health care costs, which also inform future prescribing costs [11-13]. These studies predicted drug expenditures for the Medicare scheme [11] and a veteran health population [12], respectively, and their models included demographic and health status variables. Both [11,12] found combined drug and diagnostic data are superior in predicting total health care costs. A comparison of the predictive performance of diagnosis and drug based models to determine health care costs in the US found drug based models predict future pharmacy costs more effectively than diagnosis based models and a combined drug and diagnostic model is a better predictor of future health care costs than either model alone [13].

In terms of the most relevant studies in Ireland, a linear current use model on 2006 data, and a regression model, was used to project future prescribing for the three community drug schemes [14]. They predicted that ingredient costs are likely to be between €1.5bn and €2.3bn for the three Community drug schemes (GMS, LTI & DPS) by 2020 with the largest increase in the GMS scheme. The ingredient cost incorporates approximately 80 per cent of the total cost of prescriptions. The total cost of prescriptions is comprised of the ingredient cost, dispensing fee and VAT. This paper updates and expands the Bennett et al. (2009) projections for the GMS scheme only. In addition, this paper includes demographic and regional population changes, policy variables and provides a Monte Carlo sensitivity analysis of the results. A regional examination of chronic conditions influencing drug prescribing found that regional factors were highly variable in Ireland and significant [15], whilst an investigation into the prescribing prevalence of insulin dependent and non-insulin dependent diabetes again found a significant variation between regions [16].

Methods

The main source of data is the PCRS Statistical Analysis of Claims and Payments, Annual Reports and a sample 2007 PCRS database. The sample database consists of 192,000 observations extracted from the GMS population claims data. The base year used is 2007 and the geographical area is the former Health Board, of which there are 8. The first 100 observations by gender and age cohort in each monthly file was used in this analysis. For example, 0–5 Eastern male, there are 100 observations. 192,000/100 = 16,000 in each month. The variables in the database include; ingredient cost, VAT, dispensing fee, total cost, number of items and number of forms and are disaggregated by month (12), age cohort (10), gender (2) and region (8). Claims rate and average cost per claim were estimated using the sample PCRS database. For our analysis, the data is disaggregated by 10 age cohorts, 2 genders and 8 regions for each of the four variables. The data used in this paper was granted by the Health Service Executive (HSE) and is anoymised where individuals are not identified, the data does not have a unique user identifier. Therefore, it was unnecessary to seek ethical approval.

Population data was sourced from the CSO Regional Population Projections 2011–2026. Data was detailed by year of age, gender, county and region, taking account of international migration, fertility and inter-regional flows. In order to conform to HSE age cohorts, the CSO data were reconciled into ten age cohorts. The CSO regions (Border, Mid-East, Dublin) were not reconcilable with three of the old health board regions (North-West, North-East, Eastern). An adjustment factor based on the 2006 Census was applied to form the North-West, North-East and Eastern regions to conform to the old health board regions.

Coverage 2007 was estimated from the PCRS annual report and CSO population projections. Medical card coverage was 30.1 per cent (1,276,178 persons) of the population in 2007 [17] increasing to 36.9 per cent (1,694,063) in 2011 [5]. The minimum, mean and maximum 2007 scenarios were calculated based on historical coverage data between 1996 and 2010. Three scenarios were estimated for 2011 based on historical coverage data between 1996 and 2011 to form three coverage scenarios by region, gender and age cohort (RGA).

Coverage projections for 2016, 2021 and 2026 were estimated using 2011 coverage data, as this was the most up to date data available at the time of projections. The projected mean population was used to estimate the coverage and the number of eligible persons for each scenario by RGA in 2016, 2021 and 2026. If the older age cohorts (70–74, >75) for each region and gender exceeded 1.00, an adjustment factor was applied with lambda taking any value between 0 and 0.99. For example, if the projected population for >75 in a given region is 100 but the number of projected GMS eligible persons is 105, GMS coverage rate is 1.05. As this value exceeds 1.00, the adjustment factor below was applied to scale the value below 1.00.

$$\text{Adjustment Factor} = \text{Min}\ (>75 - \lambda(1.00 - \text{70-74 age cohort}))$$

The claims rate was estimated using both the PCRS 2007 annual report and a sample 2007 PCRS database. For this analysis, the claims rate is the proportion of medical card holders who make a claim. Of the 1,276,178 medical card holders in 2007, 1,225,131 made a claim on the card giving a claims rate of 96 per cent in 2007. A 95 per cent confidence interval was applied, establishing a lower bound (minimum scenario) and upper bound (maximum scenario) around the mean claims rate. For this analysis, the claims rate was assumed to remain at the 2007 level throughout the lifetime of the projections . This is borne out by It was found that the introduction of a 50 cent co-payment charge in 2010 did not affect patient demand for drugs [18]. Furthermore, the national claims rate has not changed since the co-payment introduction. 93 per cent of eligible GMS persons availed of services in 2010 and 2011 [5,19].

The average cost (ac) per claim was determined from the sample 2007 PCRS database which is the total cost of claimants divided by the number of claimants. More than 96 per cent of all GMS eligible persons availed of services in 2007 with an average pharmacy cost of €856.14 per person [17]. A 95 per cent confidence interval was applied, establishing a lower bound (minimum scenario) and upper bound (maximum scenario) around the mean cost per claim. Historical ac per claim growth rates were determined and we assumed the historical growth evolution would continue in estimating the ac per claim for 2011 and projections between 2016 and 2026.

The utilisation and expenditure on drugs are difficult to forecast due to uncertainties about the rate of adoption of new medicines and various ongoing health care reforms and activities to improve the quality and efficiency of prescribing. The Monte Carlo Simulation (MCS) model employs statistical sampling to forecast under uncertainty. MCS generates a large number (100,000) of outcomes which is representative of your decision and assesses your decisions and the impact of risk, allowing for better decision making under uncertainty. Taking a large number of simulations as we have done, gives an excellent approximation to the true distribution of projected cost. The equation used for simulations is;

$$\textbf{Probable cost} = \textbf{Expected cost} + \textbf{error}$$

where error is an ensemble for the Monte Carlo simulation, having a normal distribution with zero mean and

standard deviation of 5% of cost. It was found that using an MCS model avoided bias in health economic modelling [20]. The MCS model identifies uncertain variables (explanatory variables) and uncertain functions (dependent variables). The uncertain variables are population, coverage, claims rate and ac per claim and the uncertain function is the total costs of GMS scheme. For this analysis, the MCS model was adopted to forecast GMS costs through to 2026.

Empirical probability (proportion) was determined by each RGA class. The cumulative probabilities were calculated which gives a weight for the occurrence of finding a person in an RGA class. A macro was written in Visual Basic Editor in Microsoft Excel to run the simulations. An MCS with 100,000 iterations was used to propagate the uncertainty in the model. It's important to assign an appropriate probability distribution to uncertain variables in developing a comprehensive MCS model [21]. A Normal distribution was applied to estimate costs to allow for uncertainty in the model. The MCS results were imported into Minitab 16 for statistical analysis. Descriptive and statistical analysis was performed in Minitab for each scenario and an overall analysis was carried out comparing all three scenarios by region, gender and age cohort. Statistical analysis included a histogram of cost, main effects plot, interval plot of cost by region, gender and age cohort.

Results

The population of Ireland is projected to grow rapidly with a sharp increase in both the birth rate and in the elderly population. The total population is projected to grow by 96.3 per cent over the lifetime of the projections. The projections indicate that the population will increase from 4.3 million in 2007 to 5.7 million in 2026 (32.6% increase). The male population is estimated to increase by 33.4 per cent increase and the female population is estimated to increase by 30.2 per cent by 2026. In the 70 to 74 age category, there is an estimated 85.4 per cent increase between 2007 and 2026. The over 75 s shows the largest increase over the lifetime of the projections where the population more than doubles from 208,756 in 2007 to 422,589 in 2026 (102.4%). Over 70s projected population will increase in the first three time periods (2007–2011, 2011–2016 and 2016–2021) and will grow at a slower rate of 22.6 per cent between 2021 and 2026.

In terms of regional population change, the Eastern region constituted 35.5 per cent of the overall population in 2007. That proportion is projected to increase to 38.2 per cent by 2026 whereas the Southern region will decrease from 14.6 per cent in 2007 to 13.6 per cent in 2026. The remaining regions will see a decrease in population apart from the Western region which will remain constant.

We have estimated that coverage will be approximately 34.7 per cent in 2016, 37.5 per cent in 2021 and 37.2 per cent in 2026 (Figure 1). It is estimated that the number of eligible GMS persons will be approximately 1.8 million in 2016, 2 million in 2021 and 2.1 million in 2026. The estimates of the mean claims rate and the ac per claim for 2007 are detailed in Tables 1 and 2.

The MCS model projects total pharmacy cost will rise to €1,317 million in 2016, €1,626 million in 2021 and €1,985 million in 2026 (Figure 2), given the assumptions around the 4 variables. The descriptive analysis of 100,000 simulations for scenario 2 in 2016 projected an average cost per claimant of €272.31. This is projected to be €312.61 in 2021 and €366.81 in 2026 (Table 3). Statistical analysis for the 3 scenarios in 2016 and the main effects plot for scenario 2, 2016 show the effect the three categorical variables have on the average cost per claimant in 2016. The main factors driving

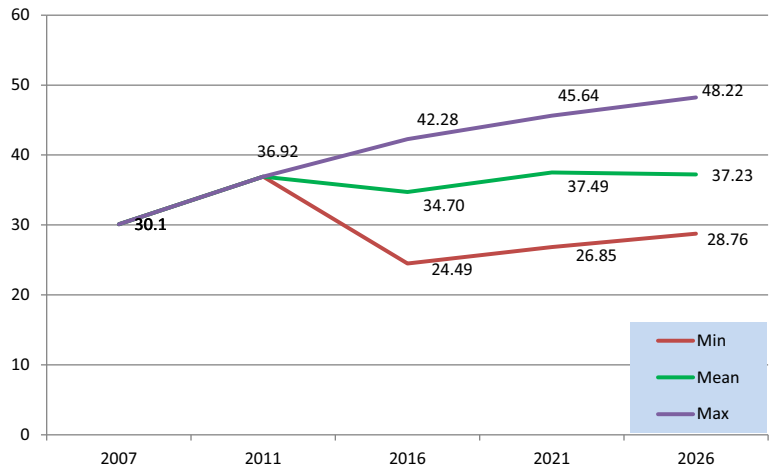


Figure 1 Percentage GMS coverage rate projections, Ireland 2016–2026.

Table 1 Mean scenario claims rate (Claims rate = Number of claimants/GMS population) 2007

Region	0 – 11	12 – 15	16 – 24	25 – 34	35 – 44	45 – 54	55 – 64	65 – 69	70 – 74	>75	Total
Eastern											
Males	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Midland											
Males	1.00	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Females	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Mid-Western											
Males	0.93	0.88	0.90	0.91	0.91	0.94	0.96	0.9	0.97	0.99	**0.93**
Females	0.93	0.88	0.93	0.93	0.93	0.95	0.96	0.98	0.98	0.98	**0.95**
North-Eastern											
Males	0.88	0.82	0.85	0.86	0.87	0.91	0.93	0.95	0.94	0.95	**0.90**
Females	0.88	0.82	0.91	0.90	0.90	0.92	0.95	0.94	0.96	0.95	**0.91**
North-Western											
Males	0.87	0.81	0.83	0.83	0.84	0.88	0.91	0.93	0.95	0.94	**0.88**
Females	0.85	0.81	0.87	0.88	0.88	0.90	0.92	0.94	0.95	0.94	**0.90**
South-Eastern											
Males	0.96	0.94	0.94	0.95	0.96	0.97	0.98	0.98	0.98	0.99	**0.96**
Females	0.97	0.94	0.96	0.97	0.97	0.97	0.98	0.99	0.99	0.99	**0.97**
Southern											
Males	0.97	0.95	0.96	0.96	0.97	0.98	0.98	0.99	0.99	0.99	**0.97**
Females	0.97	0.95	0.97	0.97	0.98	0.98	0.99	0.99	0.99	0.99	**0.98**
Western											
Males	0.87	0.81	0.83	0.85	0.87	0.89	0.92	0.93	0.94	0.95	**0.88**
Females	0.87	0.81	0.89	0.88	0.89	0.91	0.93	0.94	0.95	0.95	**0.90**
Total	**0.93**	**0.90**	**0.93**	**0.93**	**0.93**	**0.95**	**0.96**	**0.97**	**0.97**	**0.98**	**0.95**

costs in 2016 were found to be: age, and in particular those aged 0–11, and those aged 70+, being resident in the midlands region and being female. These key findings were replicated in 2021 and 2026. The main effects plot illustrates age as the most significant driver of cost compared to the other two variables, gender and region (Figure 3). These results show a similar picture for 2021 and 2026 (Figure 4).

Discussion

Population growth, aging population and high fertility rates will be drivers of future health costs in Ireland. Population growth is the effect of changes in the size of the population on total drug spending. Other things being equal, an increase in population size will increase total drug spending. It is well documented in the literature that population is a driver of Irish health care expenditure [22,23]. We estimate that the Irish population will have increased by approximately 33 per cent by 2026. Population aging is the effect of changes in the age distribution of the population on spending. An aging population will result in increased spending as the use and cost of drugs increase with age for the average individual within the population. Furthermore, Ireland has the highest fertility rate (2.05) in the European Union (EU27) as of March 2013. According to Eurostat, Ireland has on average two live births per woman [24]. The CSO recorded 72,225 births in 2012, a 19.3 per cent increase on 2002 births, indicating fertility will be a driver of population growth going forward [25]. This is compounded in our results with the 0–11 age cohort as a key driver of future health care costs. A Canadian study found population growth and population aging had the least effect on drug spending with volume effects and the mix of drugs having the most significant effect of the six cost drivers [7].

It is argued that a shift in the proportion of the population being elderly causes a shift in the health care expenditure in fifteen EU countries [26]. That is, as people are living longer, it represents a shift in expenditure from one age group to another. According to the latest CSO life tables, male life expectancy has increased by

Table 2 Mean scenario average cost per claim (€) by gender, age & region 2007

Region	0 – 11	12 – 15	16 – 24	25 – 34	35 – 44	45 – 54	55 – 64	65 – 69	70 – 74	>75	Total
Eastern											
Males	228.09	352.31	468.36	663.13	715.28	1024.07	1225.56	1301.78	1111.03	1261.80	**835.14**
Females	250.13	314.96	370.39	434.52	622.62	1036.64	1182.49	1339.82	1233.99	1565.85	**835.14**
Midlands											
Males	252.32	346.52	570.72	862.57	843.18	1053.12	1212.19	1306.25	1374.38	1483.05	**930.43**
Females	286.53	287.65	433.68	527.21	784.65	1039.87	1280.93	1344.24	1510.02	1809.51	**930.43**
Mid-Western											
Males	312.55	518.26	632.72	780.04	943.63	946.39	1122.24	1150.38	1145.96	1224.23	**877.64**
Females	331.60	391.68	381.46	574.27	779.34	1001.62	1261.18	1233.93	1298.71	1522.60	**877.64**
North-Eastern											
Males	287.17	387.18	546.40	807.66	811.09	919.99	1136.46	1141.29	1192.14	1363.01	**859.24**
Females	290.24	438.25′	324.13	502.04	671.81	970.68	1129.80	1329.20	1337.70	1598.56	**859.24**
North-Western											
Males	224.88	313.54	411.39	607.13	721.31	792.40	909.40	976.33	958.41	1216.81	**713.16**
Females	257.50	264.09	294.35	388.02	566.78	767.27	1016.47	1076.26	1102.82	1398.05	**716.16**
South-Eastern											
Males	272.48	397.70	591.81	817.17	846.95	1009.93	1087.12	1150.66	1200.19	1286.47	**866.05**
Females	247.29	389.64	380.57	454.17	753.83	1114.55	1223.04	1277.73	1314.70	1504.99	**866.05**
Southern											
Males	310. 32	407.65	617.11	884.82	891.47	1039.17	1228.63	1315.09	1223.99	1265.83	**918.41**
Females	357.49	454.20	416.13	583.39	754.74	1132.37	1240.35	1375.76	1380.47	1489.19	**918.41**
Western											
Males	298.90	375.46	555.50	865.61	822.04	935.52	1069.00	1199.25	1124.97	1307.75	**855.40**
Females	321.00	322.29	339.24	563.25	744.94	1035.37	1123.41	1238.10	1330.83	1535.57	**855.40**
Total	**283.03**	**372.59**	**458.37**	**644.69**	**767.10**	**988.69**	**1153.02**	**1234.75**	**1240.02**	**1427.08**	**856.14**

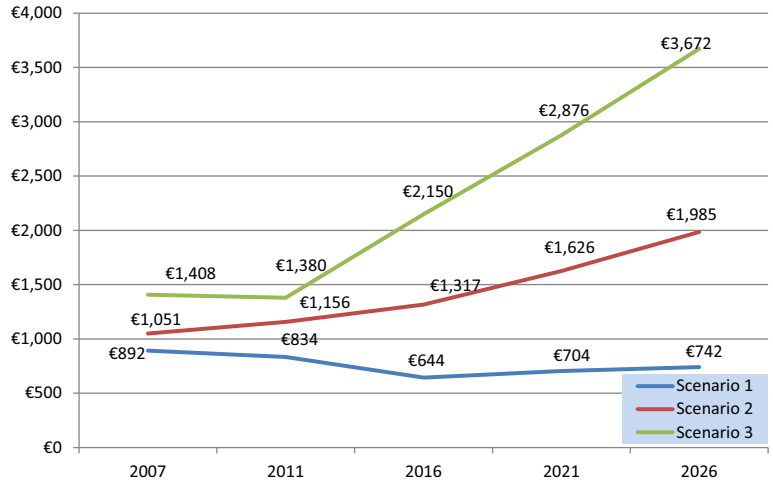


Figure 2 Historical projections and projected pharmacy cost (€'000 m) to 2026.

Table 3 Descriptive analysis of average cost per claimant (€) 2016 – 2026 (Scenario 2)

Year	# of Simulations	Mean	SE Mean	St. Dev	Min	Q1	Median	Q3	Max
2016	100,000	272.31	0.912	149.32	69.63	106.19	167.59	286.14	1541.72
2021	100,000	312.61	0.994	314.45	78.65	121.29	190.43	330.86	1579.73
2026	100,000	366.81	1.18	272.28	86.68	135.56	241.10	371.60	1602.28

5.8 years between 1996 and 2006 and 4.9 years for females [27]. This may justify the addition of a 12th HSE age cohort, the >80s and renaming >75 s to 75–79 to represent a shift in population where people are living longer.

Population growth, aging population and high fertility rates under existing policies will have a knock on effect on future GMS coverage rates. That is, more people will be eligible for medical cards. Since July 2001, everyone over the age of 70 had a free entitlement to a medical card. In 2005, General Practitioner Visit Cards (GPVC) were introduced for persons who did not qualify for a medical card. This card allows one to obtain free general practitioner services subject to eligibility criteria. This initiative was extended to all children under five years of age in the Irish budget, 2014. In 2005, 5,079 people were entitled to a GPVC [28] but by 2011 this increased to 125,657 [5].

In January 2009, eligibility for the GMS scheme changed for the over 70s. New medical card income limits were introduced. A single person with an income of €700 per week (€36,500 per year) or a couple with an income of €1,400 per week (€73,000 per year) were no longer entitled to a free medical card [23]. Budget 2014 reduced the income limits to €500 per week for a single person and €900 per week for a married couple [29]. This policy change will reduce the eligibility rates and reduce overall coverage rates, holding all other factors constant. Since the introduction of this policy change, it is difficult to quantify the impact of this policy as the Irish economy is still in recession with more people eligible for the medical card due to their economic circumstances. Due to the three drivers of future health costs as mentioned above, GMS coverage is likely to increase thus increasing health costs. To counter this increase, the Irish government may need to consider further decreasing the income limits for medical cards or other measures.

The Midlands region is the most expensive and the North-West is the least expensive old health board region

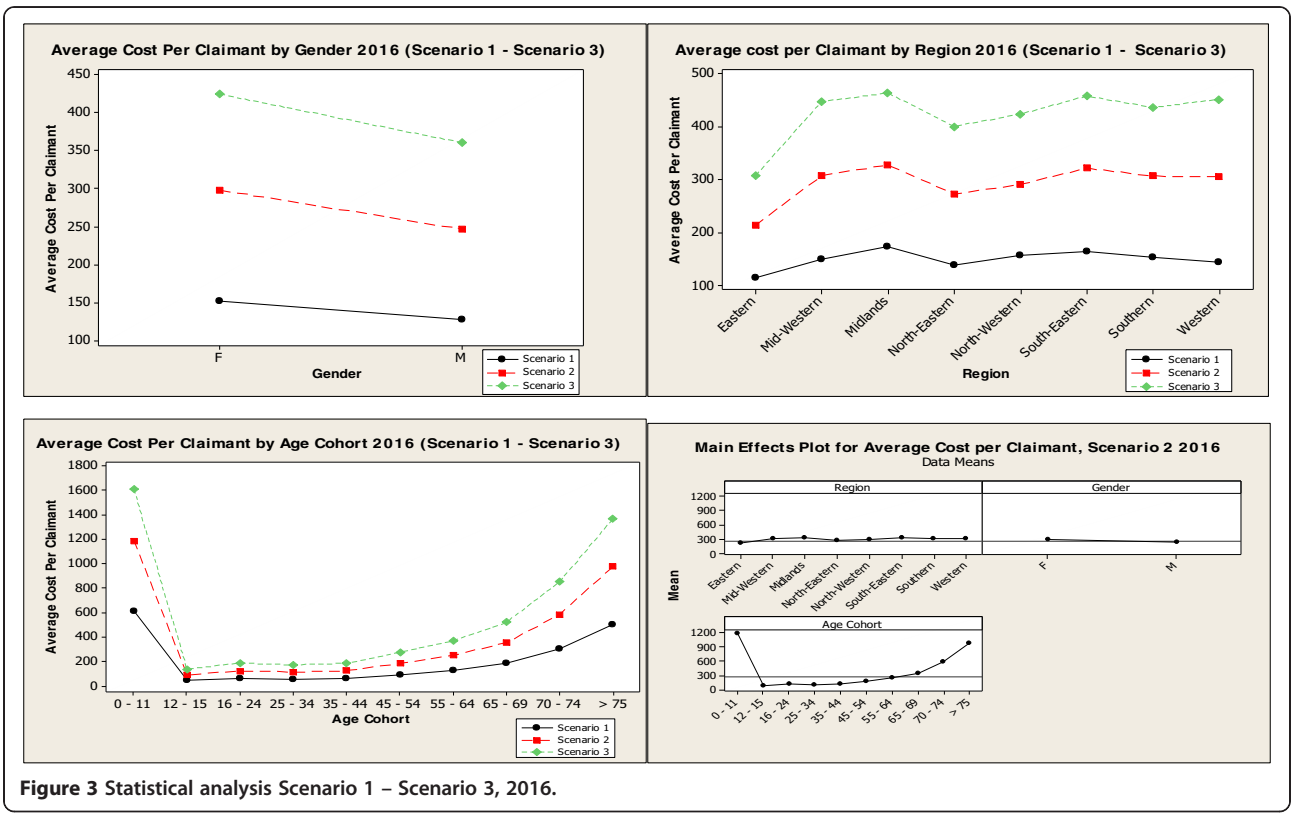


Figure 3 Statistical analysis Scenario 1 – Scenario 3, 2016.

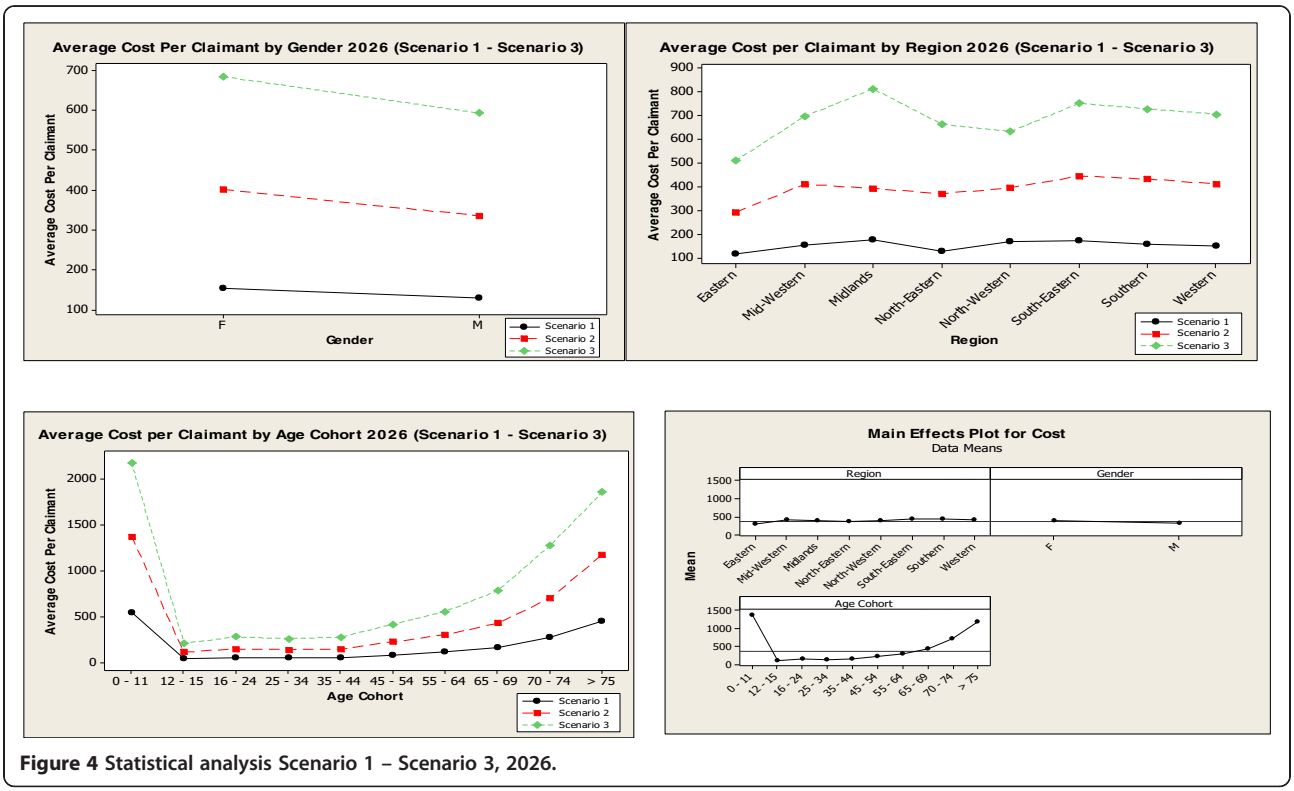


Figure 4 Statistical analysis Scenario 1 – Scenario 3, 2026.

between 2003 and 2009 in terms of the average pharmacy cost per eligible GMS person. The Midlands cost ranged from €649.14 in 2003 to €943.28 in 2009 and the North-West ranged from €521.91 and €787.19 over the same time period [30]. Our results show that this trend is forecasted to continue to 2026. This regional variation in cost may be explained by the following two studies. The distribution of chronic conditions was examined across the old health board regions and it was found the Midlands had the highest prevalence of chronic conditions with the Western and North-Western regions having the lowest [15]. The prescribing prevalence of insulin dependent and non-insulin dependent diabetes was examined across regions [16]. They found the Midlands and the Mid-Western regions had the highest prescribing ratios for both types of diabetes and the North-Western region had the lowest prescribing ratio. It is well documented that females visit doctors more regularly than men, hence prescribing rates are higher for females with a resulting effect of higher health costs. Our results verify this, with females forecasting higher costs than males for all scenarios.

The claims rate, i.e. the proportion who make a claim on a medical card, has been above 90% since 2002. The Irish government introduced a patient co-payment system in October 2010 for medical card holders with a 50 cent per prescription charge, capped at €10 per month and in Budget 2014, this was increased to €2.50 per prescription item, with a monthly cap of €25 [29]. The prescription charge was introduced to reduce the claims rate and the average cost per claim. Research found the 50 cent co-payment charge did not affect patient demand for drugs [18]. No research has been done on subsequent increases in the patient co-payment Irish system. More expensive co-payment charges exist in the UK [31], Italy [32] and Australia [33]. These studies show that an expensive co-payment system can affect the utilisation and demand for drugs. It is well documented in the literature that co-payment charges can reduce the utilisation of both essential and non-essential medicines in vulnerable populations such as the poor, elderly and chronically ill [34,35]. Therefore the Irish government needs to be mindful of the ill-effects of future increases in prescription charges as these groups comprise the GMS population in Ireland.

Limitations of Data: It is important to note the limitations of this research. The PCRS sample data lacked a unique user identifier. There is a possibility of some data appearing twice in the dataset as we can't identify individual claims, but the influence of such cases is small given the size of the sample database (192,000). The old health board regions (8) are no longer comparable to the current HSE regional structure (4), which was changed in 2010. Further research with more recent data and cost projections using the current regional structure would prove very useful.

Conclusions

Over the next decade, Ireland's population will experience rapid growth. This growth coupled with an aging population will result in an increase in both the coverage rate and the claims rate, thus the projected increase in overall prescribing costs. However, these costs can be contained by government policy initiatives. A downward adjustment of the income eligibility limits can be used to curtail the coverage rates and upward adjustments to the co-payment patient prescription charges can be utilised to reduce the claims rate, thus curbing the overall average cost per claim. Age (youngest and oldest), females and the Midlands region were found to have the most significant effect on future drug costs in Ireland. These projections remain subject to substantial uncertainty given the variable nature of future economic trends and policy decisions.

Abbreviations

GMS: General medical services; PCRS: Primary care reimbursement service; CSO: Central statistics office; EU: European union; OECD: Organisation for economic co-operation and development; CDS: Community drug scehemes; LTI: Long term illness; DPS: Drug payments scheme; HTDS: High tech drug scheme; IMF: International monetary fund; ECB: European central bank; HSE: Health service executive; RGA: Region, gender, age cohort; AC: Average cost; MCS: Monte Carlo simulation; GPVC: General practitioner visit card.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AC conducted data analysis and drafted the manuscript. NW, AT, MK and MR advised on data analysis and revised manuscript. All authors read and approved the final manuscript.

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Appendix C

Appendix C (Chapter 4 Appendices)

Table C.1: **Estimated Population 2012**

Age Category	**Males**	**Females**	**Total**
0–5	185,325	177,354	362,679
5–11	229,507	218,653	448,160
12–15	123,150	116,725	239,874
16–24	252,276	247,006	499,281
25–34	357,708	377,413	735,120
35–44	349,906	348,394	698,300
45–54	292,101	294,467	586,567
55–64	234,072	233,831	467,903
65–69	90,045	90,827	180,872
70–74	64,207	68,302	132,510
$>$ 75	96,062	139,060	235,122
Total	**2,274,357**	**2,312,031**	**4,586,388**

Table C.2: **Estimated Population 2016**

Age Category	**Males**	**Females**	**Total**
0–5	186,413	177,680	364,093
5–11	251,805	239,589	491,394
12–15	129,355	123,560	252,915
16–24	240,406	230,798	471,204
25–34	301,780	322,493	624,273
35–44	359,539	369,682	729,221
45–54	312,373	313,957	626,330
55–64	249,772	253,377	503,149
65–69	101,894	103,796	205,690
70–74	76,737	81,001	157,738
$>$ 75	109,443	151,340	260,783
Total	**2,319,517**	**2,367,273**	**4,686,790**

Table C.3: **Estimated Population 2021**

Age Category	**Males**	**Females**	**Total**
0–5	162,669	155,122	317,791
5–11	266,416	253,946	520,362
12–15	144,615	137,587	282,202
16–24	274,686	264,216	538,902
25–34	266,174	271,655	537,829
35–44	342,450	369,664	712,114
45–54	337,028	340,150	677,178
55–64	275,814	282,301	558,115
65–69	110,555	115,057	225,612
70–74	93,251	98,364	191,615
$>$ 75	136,637	178,011	314,648
Total	**2,410,295**	**2,466,073**	**4,876,368**

Table C.4: **Estimated Population 2026**

Age Category	**Males**	**Females**	**Total**
0–5	143,237	136,596	279,833
5–11	240,966	229,549	470,515
12–15	156,883	149,547	306,430
16–24	308,137	297,023	605,160
25–34	285,374	285,051	570,425
35–44	296,909	322,549	619,458
45–54	356,130	369,725	725,855
55–64	303,107	308,245	611,352
65–69	123,101	128,915	252,016
70–74	102,328	109,722	212,050
$>$ 75	173,655	217,145	390,800
Total	**2,489,827**	**2,554,067**	**5,043,894**

Table C.5: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2012 - Scenario 1**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	107.80	121.00	191.17	347.64	485.27	812.67	1,175.33	1,410.83	1,316.77	1,581.34	**769.68**
Females	93.86	108.84	179.84	285.25	448.41	805.16	1,147.67	1,308.58	1,361.03	1,652.97	**746.32**
Midlands											
Males	112.83	122.24	191.77	355.67	492.40	833.23	1,269.48	1,524.30	1,444.32	1,667.44	**795.26**
Females	106.04	108.67	204.46	321.94	516.94	867.94	1,292.77	1,437.01	1,481.95	1,773.54	**799.03**
Mid–Western											
Males	140.16	193.54	219.44	388.15	543.73	824.32	1,180.10	1,355.82	1,282.50	1,505.02	**756.55**
Females	127.35	128.28	217.41	343.36	507.88	824.57	1,187.00	1,309.90	1,364.47	1,579.09	**747.37**
North–Eastern											
Males	116.46	126.99	185.00	321.00	431.81	744.97	1,137.29	1,365.50	1,315.37	1,596.55	**740.57**
Females	100.13	109.52	195.46	283.02	410.02	739.88	1,082.91	1,283.94	1,382.95	1,667.80	**728.09**
North–Western											
Males	113.73	132.36	173.25	300.66	432.23	654.38	989.92	1,208.03	1,228.36	1,463.26	**681.21**
Females	93.24	102.48	160.76	271.72	408.80	631.06	990.11	1,199.72	1,239.20	1,546.88	**669.13**
South–Eastern											
Males	140.19	149.04	234.36	403.81	541.22	854.75	1,220.91	1,406.56	1,317.40	1,497.94	**772.94**
Females	119.26	141.34	228.15	346.48	523.39	876.30	1,216.33	1,339.95	1,365.46	1,552.89	**759.92**
Southern											
Males	118.75	146.72	203.06	353.24	480.32	815.71	1,166.30	1,390.44	1,349.70	1,595.74	**761.18**
Females	96.42	109.27	197.55	294.11	466.34	807.94	1,152.86	1,339.43	1,395.08	1,661.77	**746.42**
Western											
Males	124.03	128.69	198.61	355.30	497.08	762.21	1,064.77	1,284.11	1,291.10	1,491.69	**718.63**
Females	107.64	113.38	190.25	319.05	459.35	754.02	1,062.21	1,202.32	1,306.77	1,594.91	**704.25**
Total	**113.62**	**127.65**	**198.16**	**330.65**	**477.82**	**788.07**	**1,146.00**	**1,335.40**	**1,340.15**	**1,589.30**	**743.53**

Table C.6: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2012 - Scenario 3**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	119.15	133.74	211.30	384.24	536.35	898.21	1,299.05	1,559.34	1,455.37	1,747.80	**850.70**
Females	103.74	120.30	198.77	315.27	495.61	889.91	1,268.48	1,446.32	1,504.29	1,826.97	**824.88**
Midlands											
Males	124.70	135.11	211.95	393.11	544.23	920.94	1,403.11	1,684.76	1,596.35	1,842.96	**878.97**
Females	117.20	120.11	225.98	355.83	571.35	959.30	1,428.85	1,588.27	1,637.94	1,960.23	**883.14**
Mid–Western											
Males	154.91	213.91	242.54	429.01	600.96	911.10	1,304.32	1,498.54	1,417.50	1,663.45	**836.18**
Females	140.75	141.78	240.29	379.51	561.34	911.37	1,311.95	1,447.78	1,508.10	1,745.31	**826.04**
North–Eastern											
Males	128.72	140.36	204.47	354.78	477.26	823.39	1,257.01	1,509.23	1,453.83	1,764.61	**818.53**
Females	110.67	121.05	216.03	312.82	453.17	817.76	1,196.90	1,419.09	1,528.53	1,843.36	**804.73**
North–Western											
Males	125.70	146.29	191.48	332.31	477.73	723.27	1,094.12	1,335.20	1,357.66	1,617.29	**752.92**
Females	103.05	113.27	177.68	300.33	451.83	697.49	1,094.34	1,326.01	1,369.65	1,709.71	**739.57**
South–Eastern											
Males	154.94	164.73	259.03	446.32	598.19	944.72	1,349.43	1,554.62	1,456.07	1,655.62	**854.30**
Females	131.81	156.21	252.16	382.95	578.48	968.54	1,344.36	1,481.00	1,509.19	1,716.35	**839.91**
Southern											
Males	131.25	162.16	224.44	390.43	530.88	901.57	1,289.07	1,536.81	1,491.77	1,763.71	**841.31**
Females	106.57	120.77	218.34	325.07	515.43	892.99	1,274.22	1,480.42	1,541.93	1,836.69	**824.99**
Western											
Males	137.09	142.23	219.52	392.70	549.41	842.44	1,176.86	1,419.28	1,427.00	1,648.71	**794.27**
Females	118.97	125.32	210.28	352.64	507.71	833.40	1,174.03	1,328.88	1,444.33	1,762.79	**778.38**
Total	**125.58**	**141.08**	**219.02**	**365.46**	**528.12**	**871.02**	**1,266.63**	**1,475.97**	**1,481.22**	**1,756.60**	**821.80**

Table C.7: **Scenario 1, Claims Rate 2012**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern										
Males	0.74	0.52	0.61	0.66	0.70	0.76	0.83	0.90	0.91	0.95
Females	0.67	0.52	0.70	0.74	0.74	0.78	0.86	0.87	0.90	0.88
Midlands										
Males	0.91	0.86	0.88	0.89	0.90	0.92	0.95	0.95	0.95	0.96
Females	0.90	0.85	0.90	0.91	0.91	0.93	0.94	0.95	0.94	0.94
Mid–Western										
Males	0.89	0.81	0.84	0.86	0.87	0.91	0.94	0.95	0.95	0.98
Females	0.87	0.81	0.88	0.88	0.88	0.91	0.93	0.95	0.95	0.95
North–Eastern										
Males	0.82	0.74	0.77	0.79	0.80	0.86	0.89	0.92	0.91	0.92
Females	0.79	0.72	0.84	0.82	0.83	0.85	0.89	0.89	0.90	0.90
North–Western										
Males	0.83	0.76	0.78	0.79	0.80	0.84	0.88	0.90	0.92	0.91
Females	0.79	0.75	0.82	0.83	0.83	0.84	0.87	0.90	0.90	0.90
South–Eastern										
Males	0.86	0.77	0.79	0.81	0.84	0.88	0.93	0.95	0.94	0.97
Females	0.85	0.74	0.84	0.86	0.85	0.87	0.92	0.94	0.94	0.95
Southern										
Males	0.91	0.85	0.88	0.88	0.90	0.93	0.95	0.96	0.96	0.98
Females	0.89	0.84	0.91	0.90	0.92	0.93	0.96	0.96	0.96	0.97
Western										
Males	0.82	0.75	0.78	0.80	0.83	0.85	0.88	0.90	0.91	0.92
Females	0.81	0.74	0.84	0.83	0.83	0.85	0.88	0.89	0.90	0.90
Total	**0.83**	**0.75**	**0.82**	**0.83**	**0.84**	**0.87**	**0.91**	**0.92**	**0.93**	**0.94**

Table C.8: **Scenario 3, Claims Rate 2012**

Region	**0–11**	**12–15**	**16–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65–69**	**70–74**	**>75**
Eastern										
Males	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Females	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Midlands										
Males	1.00	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Females	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mid–Western										
Males	0.93	0.88	0.90	0.91	0.91	0.94	0.96	0.97	0.97	0.99
Females	0.93	0.88	0.93	0.93	0.93	0.95	0.96	0.98	0.98	0.98
North–Eastern										
Males	0.88	0.82	0.85	0.86	0.87	0.91	0.93	0.95	0.94	0.95
Females	0.88	0.82	0.91	0.90	0.90	0.92	0.95	0.94	0.96	0.95
North–Western										
Males	0.87	0.81	0.83	0.83	0.84	0.88	0.91	0.93	0.95	0.94
Females	0.85	0.81	0.87	0.88	0.88	0.90	0.92	0.94	0.95	0.94
South–Eastern										
Males	0.96	0.94	0.94	0.95	0.96	0.97	0.98	0.98	0.98	0.99
Females	0.97	0.94	0.96	0.97	0.97	0.97	0.98	0.99	0.99	0.99
Southern										
Males	0.97	0.95	0.96	0.96	0.97	0.98	0.98	0.99	0.99	0.99
Females	0.97	0.95	0.97	0.97	0.98	0.98	0.99	0.99	0.99	0.99
Western										
Males	0.87	0.81	0.83	0.85	0.87	0.89	0.92	0.93	0.94	0.95
Females	0.87	0.81	0.89	0.88	0.89	0.91	0.93	0.94	0.95	0.95
Total	**0.93**	**0.90**	**0.93**	**0.93**	**0.93**	**0.95**	**0.96**	**0.97**	**0.97**	**0.98**

Table C.9: **Population Weightings for Coverage Parameter**

Region	**Sex**	**<5**	**5–11**
Eastern	Male	0.462947371	0.537052629
Eastern	Female	0.463567094	0.536432906
Midlands	Male	0.437800834	0.562199166
Midlands	Female	0.436041083	0.563958917
Mid–Western	Male	0.441812013	0.558187987
Mid–Western	Female	0.436505228	0.563494772
North–Eastern	Male	0.441924222	0.558075778
North–Eastern	Female	0.449205238	0.550794762
North–Western	Male	0.423576073	0.576423927
North–Western	Female	0.428054754	0.571945246
South–Eastern	Male	0.434129262	0.565870738
South–Eastern	Female	0.433216229	0.566783771
Southern	Male	0.444482546	0.555517454
Southern	Female	0.448557235	0.551442765
Western	Male	0.436259237	0.563740763
Western	Female	0.435169787	0.564830213

Table C.10: **Three population scenarios by age, sex and region for 2012–Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	130,254	36,873	82,549	133,885	115,654	89,255	68,354	25,701	18,451	26,638	**727,614**
Females	124,810	34,387	81,439	142,541	116,517	93,938	72,873	27,543	21,320	42,079	**757,446**
Midlands											
Males	25,753	7,559	14,277	19,132	19,973	17,051	13,419	5,001	3,468	5,605	**131,236**
Females	24,585	7,293	13,988	20,118	19,593	16,466	12,775	4,964	3,584	7,495	**130,860**
Mid–Western											
Males	30,850	9,728	19,505	24,532	25,945	22,932	19,344	7,519	5,310	7,855	**173,520**
Females	29,595	9,254	18,717	25,082	25,463	22,474	18,870	7,538	5,546	10,986	**173,523**
North–Eastern											
Males	40,930	11,692	21,667	29,737	32,463	25,973	19,846	7,385	5,075	7,427	**202,194**
Females	38,849	11,153	21,238	31,809	32,110	25,178	19,017	7,221	5,112	10,725	**202,411**
North–Western											
Males	21,677	7,035	13,092	15,352	17,024	15,379	13,503	5,592	3,925	6,187	**118,766**
Females	20,354	6,628	12,654	16,068	16,995	15,501	13,130	5,211	3,879	8,247	**118,668**
South–Eastern											
Males	42,223	13,025	25,028	31,869	34,323	30,636	24,903	9,813	7,274	10,613	**229,707**
Females	39,989	12,453	24,620	33,761	33,918	30,647	24,093	9,843	7,302	14,435	**231,060**
Southern											
Males	53,553	16,280	32,962	44,646	46,263	40,432	32,842	12,763	9,095	13,694	**302,529**
Females	51,200	15,651	32,954	47,570	45,594	39,951	32,066	12,796	9,728	19,896	**307,406**
Western											
Male	35,660	10,885	22,559	29,295	29,640	26,549	22,714	8,906	6,357	10,185	**202,750**
Females	34,232	10,358	21,192	29,592	29,706	26,225	21,880	8,281	6,246	13,822	**201,533**
Total	**744,512**	**220,252**	**458,440**	**674,988**	**641,179**	**538,586**	**429,629**	**166,077**	**121,670**	**215,889**	**4,211,222**

Table C.11: **Population scenario by age, sex and region for 2012 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	141,858	40,158	89,903	145,813	125,957	97,207	74,444	27,991	20,095	29,011	**792,435**
Females	135,929	37,451	88,694	155,240	126,897	102,307	79,365	29,996	23,219	45,828	**824,925**
Midlands											
Males	28,047	8,232	15,549	20,836	21,752	18,570	14,614	5,446	3,777	6,104	**142,927**
Females	26,775	7,943	15,234	21,910	21,338	17,933	13,913	5,406	3,903	8,163	**142,518**
Mid–Western											
Males	33,598	10,595	21,243	26,717	28,256	24,975	21,067	8,189	5,783	8,555	**188,978**
Females	32,231	10,078	20,384	27,316	27,731	24,476	20,551	8,210	6,040	11,965	**188,982**
North–Eastern											
Males	44,576	12,733	23,598	32,386	35,355	28,287	21,614	8,043	5,527	8,089	**220,207**
Females	42,310	12,147	23,130	34,642	34,971	27,421	20,712	7,864	5,567	11,680	**220,444**
North–Western											
Males	23,608	7,662	14,258	16,720	18,540	16,749	14,706	6,090	4,275	6,738	**129,347**
Females	22,168	7,218	13,781	17,500	18,509	16,882	14,299	5,676	4,224	8,982	**129,239**
South–Eastern											
Males	45,984	14,185	27,258	34,708	37,381	33,365	27,122	10,687	7,922	11,559	**250,171**
Females	43,551	13,562	26,813	36,769	36,940	33,377	26,239	10,720	7,952	15,721	**251,644**
Southern											
Males	58,324	17,730	35,898	48,623	50,384	44,034	35,768	13,900	9,905	14,914	**329,480**
Females	55,761	17,045	35,890	51,808	49,656	43,510	34,923	13,936	10,595	21,668	**334,792**
Western											
Males	38,837	11,855	24,569	31,905	32,281	28,914	24,737	9,699	6,923	11,092	**220,812**
Females	37,282	11,281	23,080	32,228	32,352	28,561	23,829	9,019	6,802	15,053	**219,487**
Total	**810,839**	**239,874**	**499,281**	**735,120**	**698,300**	**586,567**	**467,903**	**180,872**	**132,510**	**235,122**	**4,586,388**

Table C.12: **Population scenario by age, sex and region for 2012 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	153,462	43,443	97,257	157,740	136,260	105,158	80,534	30,280	21,739	31,384	**857,257**
Females	147,048	40,514	95,949	167,938	137,278	110,675	85,857	32,450	25,119	49,576	**892,404**
Midlands											
Males	30,341	8,905	16,821	22,540	23,531	20,089	15,809	5,891	4,086	6,603	**154,618**
Females	28,965	8,593	16,480	23,702	23,083	19,400	15,051	5,848	4,222	8,831	**154,176**
Mid–Western											
Males	36,346	11,462	22,981	28,902	30,567	27,018	22,790	8,859	6,256	9,255	**204,436**
Females	34,867	10,902	22,051	29,550	29,999	26,478	22,232	8,882	6,534	12,944	**204,441**
North–Eastern											
Males	48,222	13,775	25,528	35,035	38,247	30,601	23,382	8,701	5,979	8,751	**238,220**
Females	45,771	13,140	25,022	37,476	37,831	29,664	22,406	8,508	6,022	12,635	**238,476**
North–Western											
Males	25,539	8,289	15,425	18,088	20,057	18,119	15,909	6,588	4,625	7,289	**139,927**
Females	23,981	7,809	14,908	18,931	20,023	18,263	15,469	6,140	4,570	9,717	**139,811**
South–Eastern											
Males	49,745	15,345	29,488	37,547	40,439	36,094	29,341	11,561	8,570	12,505	**270,635**
Females	47,113	14,671	29,006	39,777	39,962	36,107	28,385	11,597	8,602	17,007	**272,228**
Southern											
Males	63,095	19,180	38,834	52,600	54,505	47,636	38,694	15,037	10,715	16,134	**356,431**
Females	60,322	18,439	38,826	56,046	53,718	47,069	37,780	15,076	11,462	23,440	**362,178**
Western											
Males	42,014	12,825	26,579	34,515	34,922	31,279	26,760	10,492	7,489	11,999	**238,874**
Females	40,332	12,204	24,968	34,864	34,998	30,897	25,778	9,757	7,358	16,284	**237,441**
Total	**877,165**	**259,496**	**540,123**	**795,253**	**755,421**	**634,548**	**506,178**	**195,667**	**143,349**	**254,354**	**4,961,555**

Table C.13: **Three population scenarios by age, sex and region for 2016 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	151,331	42,387	83,149	120,428	132,706	104,674	79,070	31,360	23,395	32,870	**801,369**
Females	144,772	40,426	80,333	128,312	137,031	108,558	84,988	33,923	26,559	49,427	**834,329**
Midlands											
Males	28,555	8,718	14,762	17,606	21,409	19,535	15,684	6,079	4,565	6,689	**143,602**
Females	27,042	8,539	14,301	19,016	21,981	19,201	14,991	6,068	4,742	8,692	**144,574**
Mid–Western											
Males	34,680	10,200	20,982	22,000	27,325	25,391	21,656	9,101	6,834	9,649	**187,818**
Females	32,623	10,106	19,301	22,681	27,601	25,238	21,220	9,169	7,157	12,835	**187,931**
North–Eastern											
Males	46,044	13,188	21,468	26,379	35,401	30,148	22,598	8,994	6,622	9,034	**219,877**
Females	43,662	12,601	20,553	28,833	36,287	28,989	22,091	9,023	6,485	12,415	**220,939**
North–Western											
Males	23,202	7,736	13,480	13,732	17,569	17,521	15,103	6,598	5,146	7,351	**127,439**
Females	21,770	7,224	13,027	14,844	18,334	17,656	15,041	6,398	4,945	9,371	**128,612**
South–Eastern											
Males	46,679	14,606	26,554	29,121	37,014	34,408	28,447	11,787	9,046	13,158	**250,820**
Females	44,098	13,865	25,410	32,228	37,801	34,536	28,180	11,689	9,412	17,113	**254,333**
Southern											
Males	60,428	18,016	32,978	39,526	49,499	45,467	37,226	15,367	11,610	16,654	**326,770**
Females	58,230	16,842	34,112	45,285	51,506	45,098	37,128	15,370	12,279	23,261	**339,111**
Western											
Male	39,411	12,176	22,705	27,555	32,145	29,607	25,494	10,774	8,138	12,067	**220,070**
Females	37,562	11,733	19,606	25,488	32,487	29,029	25,176	10,288	7,964	15,502	**214,833**
Total	**840,088**	**248,363**	**462,722**	**613,036**	**716,095**	**615,056**	**494,092**	**201,988**	**154,899**	**256,089**	**4,602,428**

Table C.14: **Population scenario by age, sex and region for 2016 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	154,105	43,163	84,673	122,635	135,138	106,592	80,519	31,935	23,824	33,473	**816,058**
Females	147,426	41,167	81,806	130,664	139,543	110,548	86,546	34,545	27,045	50,333	**849,623**
Midlands											
Males	29,078	8,878	15,033	17,929	21,801	19,893	15,971	6,190	4,649	6,812	**146,234**
Females	27,538	8,696	14,563	19,365	22,384	19,553	15,266	6,179	4,829	8,851	**147,224**
Mid–Western											
Males	35,316	10,387	21,367	22,403	27,826	25,856	22,053	9,268	6,959	9,826	**191,261**
Females	33,221	10,291	19,655	23,097	28,107	25,701	21,609	9,337	7,288	13,070	**191,376**
North–Eastern											
Males	46,888	13,430	21,862	26,863	36,050	30,700	23,012	9,159	6,743	9,200	**223,908**
Females	44,462	12,832	20,930	29,362	36,952	29,521	22,495	9,188	6,604	12,643	**224,988**
North–Western											
Males	23,627	7,877	13,727	13,984	17,891	17,843	15,380	6,719	5,240	7,486	**129,775**
Females	22,169	7,356	13,266	15,116	18,670	17,979	15,317	6,515	5,036	9,543	**130,969**
South–Eastern											
Males	47,535	14,874	27,041	29,655	37,692	35,039	28,968	12,003	9,212	13,399	**255,418**
Females	44,906	14,119	25,876	32,819	38,494	35,169	28,697	11,903	9,585	17,427	**258,995**
Southern											
Males	61,536	18,346	33,582	40,251	50,406	46,300	37,908	15,649	11,823	16,959	**332,760**
Females	59,297	17,151	34,737	46,115	52,450	45,925	37,809	15,652	12,504	23,687	**345,327**
Western											
Males	40,133	12,399	23,121	28,060	32,734	30,150	25,961	10,971	8,287	12,288	**224,104**
Females	38,250	11,948	19,965	25,955	33,082	29,561	25,637	10,477	8,110	15,786	**218,771**
Total	**855,487**	**252,915**	**471,204**	**624,273**	**729,221**	**626,330**	**503,149**	**205,690**	**157,738**	**260,783**	**4,686,790**

Table C.15: **Population scenario by age, sex and region for 2016 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	158,065	44,273	86,849	125,787	138,611	109,332	82,588	32,756	24,436	34,333	**837,031**
Females	151,215	42,225	83,908	134,022	143,129	113,389	88,771	35,433	27,740	51,627	**871,458**
Midlands											
Males	29,825	9,106	15,419	18,390	22,361	20,404	16,381	6,349	4,768	6,987	**149,992**
Females	28,246	8,919	14,937	19,863	22,959	20,056	15,658	6,338	4,953	9,078	**151,008**
Mid–Western											
Males	36,224	10,654	21,916	22,979	28,541	26,520	22,620	9,506	7,138	10,079	**196,176**
Females	34,075	10,555	20,160	23,691	28,829	26,362	22,164	9,577	7,475	13,406	**196,294**
North–Eastern											
Males	48,093	13,775	22,423	27,553	36,977	31,489	23,603	9,395	6,917	9,437	**229,662**
Females	45,605	13,162	21,468	30,116	37,902	30,280	23,074	9,424	6,774	12,968	**230,771**
North–Western											
Males	24,234	8,080	14,080	14,343	18,351	18,301	15,775	6,892	5,375	7,679	**133,110**
Females	22,739	7,546	13,607	15,505	19,150	18,441	15,711	6,683	5,165	9,789	**134,335**
South–Eastern											
Males	48,757	15,256	27,736	30,417	38,661	35,940	29,712	12,311	9,449	13,743	**261,982**
Females	46,060	14,482	26,541	33,662	39,483	36,073	29,435	12,209	9,831	17,875	**265,651**
Southern											
Males	63,117	18,817	34,445	41,285	51,701	47,490	38,882	16,051	12,127	17,395	**341,312**
Females	60,821	17,592	35,630	47,300	53,798	47,105	38,781	16,054	12,825	24,296	**354,202**
Western											
Males	41,164	12,718	23,715	28,781	33,575	30,925	26,628	11,253	8,500	12,604	**229,863**
Females	39,233	12,255	20,478	26,622	33,932	30,321	26,296	10,746	8,318	16,192	**224,393**
Total	**877,473**	**259,415**	**483,314**	**640,317**	**747,962**	**642,427**	**516,080**	**210,976**	**161,792**	**267,485**	**4,807,241**

Table C.16: **Three population scenarios by age, sex and region for 2021 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	151,592	47,842	100,153	104,253	130,631	117,420	89,354	34,013	28,739	41,153	**845,149**
Females	144,977	46,035	102,196	104,172	140,960	120,539	95,519	37,988	32,399	57,995	**882,780**
Midlands											
Males	27,260	9,578	15,762	15,455	20,080	20,711	17,233	6,942	5,550	8,247	**146,818**
Females	25,973	9,123	14,529	16,294	21,809	20,788	16,992	6,763	5,738	10,243	**148,252**
Mid–Western											
Males	33,323	11,547	23,796	20,713	24,576	26,426	22,917	9,629	8,267	11,993	**193,187**
Females	31,395	10,633	20,338	19,949	25,754	26,414	22,771	9,758	8,637	15,231	**190,881**
North–Eastern											
Males	43,902	14,681	24,288	23,133	33,233	32,250	24,839	9,659	7,901	11,254	**225,140**
Females	41,849	13,933	23,417	24,450	35,657	31,236	24,524	9,831	7,945	14,347	**227,190**
North–Western											
Males	21,106	8,518	14,665	12,157	15,758	18,072	16,294	7,041	6,040	9,133	**128,784**
Females	20,069	7,807	13,872	12,996	17,249	18,608	16,560	6,849	6,073	10,745	**130,828**
South–Eastern											
Males	45,170	15,981	28,789	26,188	34,114	35,798	31,082	12,753	10,738	16,308	**256,921**
Females	42,988	14,860	25,308	29,003	37,102	36,105	31,599	12,786	11,056	20,447	**261,255**
Southern											
Males	59,693	19,700	36,128	33,287	44,939	47,360	40,670	16,441	14,002	20,679	**332,900**
Females	57,032	19,236	36,593	39,747	51,505	47,739	41,001	16,850	14,527	27,151	**351,383**
Western											
Male	36,955	13,368	24,651	24,733	31,073	31,070	26,944	11,479	9,823	14,659	**224,754**
Females	35,171	12,727	21,754	18,660	30,940	30,727	26,700	11,527	9,677	17,669	**215,552**
Total	**818,456**	**275,570**	**526,238**	**525,190**	**695,379**	**661,264**	**544,999**	**220,310**	**187,112**	**307,254**	**4,761,773**

Table C.17: **Population scenario by age, sex and region for 2021 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	155,240	48,994	102,563	106,762	133,774	120,246	91,504	34,831	29,430	42,143	**865,488**
Females	148,466	47,142	104,655	106,679	144,352	123,440	97,818	38,902	33,179	59,391	**904,024**
Midlands											
Males	27,916	9,809	16,141	15,827	20,563	21,209	17,648	7,109	5,684	8,445	**150,351**
Females	26,598	9,343	14,879	16,686	22,334	21,288	17,401	6,926	5,876	10,489	**151,820**
Mid–Western											
Males	34,125	11,825	24,369	21,211	25,167	27,062	23,468	9,861	8,466	12,282	**197,836**
Females	32,151	10,889	20,827	20,429	26,374	27,050	23,319	9,993	8,845	15,598	**195,475**
North–Eastern											
Males	44,958	15,034	24,873	23,690	34,032	33,026	25,437	9,891	8,091	11,525	**230,558**
Females	42,856	14,268	23,980	25,038	36,515	31,988	25,114	10,068	8,137	14,692	**232,657**
North–Western											
Males	21,614	8,723	15,017	12,450	16,137	18,507	16,686	7,210	6,185	9,353	**131,883**
Females	20,551	7,995	14,206	13,309	17,664	19,056	16,959	7,014	6,219	11,004	**133,976**
South–Eastern											
Males	46,257	16,366	29,482	26,818	34,935	36,660	31,830	13,060	10,996	16,700	**263,104**
Females	44,023	15,218	25,917	29,701	37,995	36,974	32,359	13,094	11,322	20,939	**267,542**
Southern											
Males	61,130	20,174	36,997	34,088	46,020	48,500	41,649	16,837	14,339	21,177	**340,911**
Females	58,405	19,699	37,474	40,704	52,744	48,888	41,988	17,256	14,877	27,804	**359,839**
Western											
Males	37,844	13,690	25,244	25,328	31,821	31,818	27,592	11,755	10,059	15,012	**230,163**
Females	36,017	13,033	22,278	19,109	31,685	31,466	27,343	11,804	9,910	18,094	**220,739**
Total	**838,153**	**282,202**	**538,902**	**537,829**	**712,114**	**677,178**	**558,115**	**225,612**	**191,615**	**314,648**	**4,876,368**

Table C.18: **Population scenario by age, sex and region for 2021 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	164,105	51,791	108,419	112,858	141,413	127,112	96,729	36,820	31,111	44,550	**914,908**
Females	156,944	49,834	110,631	112,770	152,595	130,488	103,403	41,123	35,073	62,782	**955,644**
Midlands											
Males	29,510	10,369	17,063	16,731	21,737	22,420	18,656	7,515	6,009	8,927	**158,936**
Females	28,117	9,876	15,729	17,639	23,609	22,504	18,395	7,321	6,212	11,088	**160,489**
Mid–Western											
Males	36,074	12,500	25,760	22,422	26,604	28,607	24,808	10,424	8,949	12,983	**209,132**
Females	33,987	11,511	22,016	21,595	27,880	28,595	24,651	10,564	9,350	16,489	**206,637**
North–Eastern											
Males	47,526	15,893	26,293	25,043	35,976	34,912	26,889	10,456	8,554	12,183	**243,723**
Females	45,303	15,083	25,349	26,468	38,600	33,815	26,548	10,643	8,601	15,531	**245,942**
North–Western											
Males	22,848	9,221	15,875	13,161	17,059	19,564	17,639	7,622	6,538	9,887	**139,414**
Females	21,725	8,451	15,017	14,069	18,673	20,144	17,927	7,415	6,574	11,632	**141,627**
South–Eastern											
Males	48,898	17,300	31,165	28,349	36,930	38,753	33,647	13,806	11,624	17,654	**278,127**
Females	46,537	16,087	27,397	31,397	40,165	39,085	34,207	13,842	11,968	22,135	**282,819**
Southern											
Males	64,621	21,326	39,110	36,034	48,648	51,269	44,027	17,798	15,158	22,386	**360,377**
Females	61,740	20,824	39,614	43,028	55,756	51,680	44,386	18,241	15,726	29,392	**380,386**
Western											
Males	40,005	14,472	26,685	26,774	33,638	33,635	29,168	12,426	10,633	15,869	**243,305**
Females	38,074	13,777	23,550	20,200	33,494	33,263	28,904	12,478	10,476	19,127	**233,343**
Total	**886,012**	**298,316**	**569,673**	**568,539**	**752,776**	**715,845**	**589,983**	**238,494**	**202,556**	**332,614**	**5,154,809**

Table C.19: **Three population scenarios by age, sex and region for 2026 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	138,292	55,445	116,934	116,526	113,978	132,053	102,296	39,388	31,977	53,393	**900,282**
Females	131,967	53,405	122,484	117,489	122,418	138,374	106,996	43,280	37,033	71,641	**945,087**
Midlands											
Males	24,300	10,021	17,324	15,357	17,738	21,431	19,092	7,898	6,494	10,555	**150,211**
Females	23,298	9,527	15,465	15,493	19,596	22,278	19,194	7,852	6,516	12,665	**151,884**
Mid–Western											
Males	29,982	12,412	26,574	24,498	21,305	26,731	24,528	10,571	8,960	15,354	**200,915**
Females	28,328	11,470	21,255	21,362	22,225	27,276	24,585	10,585	9,377	18,909	**195,374**
North–Eastern											
Males	39,359	15,450	27,317	25,077	28,886	33,948	27,721	10,724	8,697	14,393	**231,572**
Females	37,537	14,836	26,350	26,245	31,269	33,804	27,061	11,167	8,816	17,648	**234,734**
North–Western											
Males	18,586	8,248	16,079	12,882	13,644	17,982	17,859	7,602	6,606	11,592	**131,081**
Females	17,739	7,721	14,929	13,450	15,271	19,214	18,084	7,764	6,629	13,189	**133,990**
South–Eastern											
Males	41,499	16,829	31,534	27,264	29,820	37,076	33,786	14,238	11,900	20,627	**264,573**
Females	39,618	15,887	26,613	27,703	34,356	38,384	34,590	14,648	12,332	25,128	**269,259**
Southern											
Males	54,692	21,634	40,258	33,871	38,066	48,947	44,083	18,255	15,360	26,442	**341,607**
Females	52,173	20,773	40,726	40,939	46,665	52,024	44,499	18,920	16,236	33,006	**365,961**
Western											
Male	31,460	14,382	27,280	25,419	28,810	32,371	28,983	12,492	10,727	18,573	**230,495**
Females	29,736	13,581	24,538	17,895	25,684	32,566	28,396	12,675	11,060	21,549	**217,679**
Total	**738,568**	**301,619**	**595,659**	**561,469**	**609,733**	**714,459**	**601,754**	**248,059**	**208,721**	**384,664**	**4,964,705**

Table C.20: **Population scenario by age, sex and region for 2026 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	140,498	56,329	118,799	118,384	115,796	134,160	103,928	40,016	32,487	54,245	**914,642**
Females	134,072	54,256	124,437	119,363	124,371	140,582	108,703	43,970	37,623	72,784	**960,162**
Midlands											
Males	24,688	10,181	17,600	15,602	18,021	21,773	19,397	8,024	6,598	10,723	**152,607**
Females	23,670	9,679	15,712	15,740	19,909	22,633	19,500	7,977	6,620	12,867	**154,307**
Mid–Western											
Males	30,460	12,610	26,998	24,889	21,645	27,157	24,919	10,740	9,103	15,599	**204,120**
Females	28,780	11,653	21,594	21,703	22,580	27,711	24,977	10,754	9,527	19,211	**198,490**
North–Eastern											
Males	39,987	15,697	27,752	25,477	29,346	34,490	28,163	10,895	8,835	14,622	**235,265**
Females	38,135	15,073	26,771	26,663	31,767	34,344	27,493	11,345	8,957	17,930	**238,478**
North–Western											
Males	18,883	8,379	16,336	13,088	13,861	18,269	18,144	7,723	6,711	11,776	**133,171**
Females	18,022	7,844	15,167	13,665	15,515	19,521	18,372	7,888	6,735	13,399	**136,127**
South–Eastern											
Males	42,161	17,097	32,037	27,699	30,296	37,667	34,325	14,465	12,090	20,956	**268,793**
Females	40,250	16,140	27,037	28,145	34,904	38,996	35,142	14,882	12,529	25,529	**273,554**
Southern											
Males	55,564	21,979	40,900	34,411	38,673	49,728	44,786	18,546	15,605	26,864	**347,056**
Females	53,005	21,104	41,376	41,592	47,409	52,854	45,209	19,222	16,495	33,532	**371,798**
Western											
Males	31,962	14,611	27,715	25,824	29,270	32,887	29,445	12,691	10,898	18,869	**234,172**
Females	30,210	13,798	24,929	18,180	26,094	33,085	28,849	12,877	11,236	21,893	**221,151**
Total	**750,348**	**306,430**	**605,160**	**570,425**	**619,458**	**725,855**	**611,352**	**252,016**	**212,050**	**390,800**	**5,043,894**

Table C.21: **Population scenario by age, sex and region for 2026 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	147,987	59,331	125,131	124,694	121,968	141,310	109,467	42,149	34,219	57,136	**963,393**
Females	141,218	57,148	131,070	125,725	131,000	148,075	114,497	46,314	39,629	76,663	**1,011,339**
Midlands											
Males	26,004	10,724	18,538	16,434	18,982	22,934	20,431	8,452	6,950	11,295	**160,741**
Females	24,932	10,195	16,549	16,579	20,970	23,839	20,539	8,402	6,973	13,553	**162,532**
Mid–Western											
Males	32,084	13,282	28,437	26,216	22,799	28,604	26,247	11,312	9,588	16,430	**215,000**
Females	30,314	12,274	22,745	22,860	23,784	29,188	26,308	11,327	10,035	20,235	**209,070**
North–Eastern											
Males	42,118	16,534	29,232	26,835	30,910	36,328	29,664	11,476	9,306	15,402	**247,805**
Females	40,168	15,876	28,197	28,085	33,460	36,174	28,958	11,950	9,434	18,886	**251,189**
North–Western											
Males	19,889	8,826	17,207	13,785	14,600	19,243	19,111	8,135	7,069	12,404	**140,269**
Females	18,983	8,262	15,975	14,393	16,342	20,561	19,352	8,308	7,094	14,113	**143,383**
South–Eastern											
Males	44,408	18,008	33,745	29,175	31,911	39,675	36,155	15,236	12,734	22,073	**283,120**
Females	42,395	17,000	28,478	29,645	36,764	41,074	37,015	15,675	13,197	26,890	**288,134**
Southern											
Males	58,526	23,150	43,080	36,245	40,734	52,379	47,173	19,535	16,437	28,296	**365,554**
Females	55,830	22,229	43,581	43,809	49,936	55,671	47,619	20,247	17,374	35,319	**391,615**
Western											
Males	33,666	15,390	29,192	27,200	30,830	34,640	31,014	13,367	11,479	19,875	**246,653**
Females	31,820	14,533	26,258	19,149	27,485	34,848	30,387	13,563	11,835	23,060	**232,938**
Total	**790,342**	**322,763**	**637,415**	**600,829**	**652,475**	**764,543**	**643,937**	**265,448**	**223,352**	**411,630**	**5,312,734**

Table C.22: **Coverage scenarios by age cohort, sex and region 2012 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.36	0.38	0.26	0.18	0.24	0.24	0.26	0.35	0.78	0.78
Females	0.36	0.38	0.31	0.24	0.27	0.25	0.29	0.48	0.84	0.84
Midlands										
Males	0.45	0.46	0.39	0.32	0.34	0.33	0.35	0.46	0.84	0.89
Females	0.44	0.46	0.45	0.38	0.38	0.35	0.39	0.61	0.89	0.91
Mid–Western										
Males	0.41	0.41	0.37	0.32	0.32	0.32	0.35	0.48	0.85	0.90
Females	0.41	0.42	0.41	0.37	0.36	0.33	0.38	0.58	0.89	0.92
North–Eastern										
Males	0.41	0.45	0.38	0.30	0.33	0.32	0.34	0.47	0.86	0.95
Females	0.42	0.45	0.42	0.36	0.37	0.33	0.38	0.60	0.92	0.97
North–Western										
Males	0.49	0.53	0.49	0.41	0.42	0.42	0.44	0.55	0.92	0.98
Females	0.50	0.50	0.52	0.45	0.44	0.41	0.47	0.68	0.90	0.96
South–Eastern										
Males	0.44	0.46	0.42	0.36	0.36	0.35	0.39	0.51	0.86	0.92
Females	0.44	0.45	0.46	0.41	0.39	0.36	0.43	0.64	0.91	0.95
Southern										
Males	0.38	0.38	0.33	0.27	0.29	0.29	0.34	0.46	0.83	0.89
Females	0.37	0.38	0.35	0.32	0.32	0.30	0.36	0.59	0.89	0.93
Western										
Males	0.43	0.46	0.41	0.33	0.34	0.36	0.40	0.52	0.85	0.89
Females	0.43	0.46	0.47	0.38	0.37	0.36	0.41	0.64	0.91	0.93

Table C.23: **Three Coverage scenarios by age cohort, sex and region 2012 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.38	0.40	0.27	0.19	0.25	0.26	0.28	0.37	0.82	0.66
Females	0.38	0.40	0.32	0.25	0.29	0.26	0.31	0.51	0.88	0.82
Midlands										
Males	0.47	0.48	0.40	0.34	0.36	0.35	0.37	0.48	0.88	0.88
Females	0.47	0.48	0.47	0.40	0.40	0.36	0.41	0.64	0.93	0.92
Mid–Western										
Males	0.43	0.43	0.38	0.34	0.34	0.33	0.36	0.50	0.89	0.89
Females	0.43	0.44	0.43	0.39	0.37	0.34	0.40	0.61	0.93	0.94
North–Eastern										
Males	0.44	0.47	0.39	0.32	0.34	0.33	0.36	0.50	0.90	0.95
Females	0.44	0.47	0.45	0.38	0.38	0.35	0.40	0.63	0.96	0.99
North–Western										
Males	0.51	0.55	0.51	0.43	0.44	0.44	0.46	0.58	0.96	0.99
Females	0.52	0.52	0.55	0.48	0.47	0.43	0.49	0.71	0.95	0.98
South–Eastern										
Males	0.46	0.48	0.44	0.37	0.37	0.37	0.41	0.54	0.90	0.92
Females	0.46	0.47	0.49	0.43	0.41	0.38	0.45	0.67	0.95	0.97
Southern										
Males	0.40	0.40	0.34	0.29	0.31	0.31	0.35	0.49	0.88	0.87
Females	0.39	0.39	0.37	0.34	0.34	0.32	0.38	0.62	0.93	0.94
Western										
Males	0.46	0.48	0.43	0.35	0.36	0.38	0.42	0.55	0.89	0.88
Females	0.45	0.48	0.49	0.40	0.39	0.38	0.44	0.67	0.95	0.96

Table C.24: **Coverage scenario by age cohort, sex and region 2016 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.27	0.28	0.19	0.13	0.17	0.18	0.19	0.26	0.57	0.57
Females	0.26	0.28	0.22	0.17	0.20	0.18	0.21	0.35	0.61	0.61
Midlands										
Males	0.33	0.33	0.28	0.23	0.25	0.24	0.26	0.34	0.61	0.65
Females	0.33	0.33	0.33	0.28	0.28	0.25	0.29	0.45	0.65	0.67
Mid–Western										
Males	0.30	0.30	0.27	0.23	0.24	0.23	0.25	0.35	0.62	0.65
Females	0.30	0.30	0.30	0.27	0.26	0.24	0.28	0.42	0.65	0.67
North–Eastern										
Males	0.30	0.33	0.27	0.22	0.24	0.23	0.25	0.34	0.62	0.69
Females	0.31	0.33	0.31	0.26	0.27	0.24	0.28	0.44	0.67	0.70
North–Western										
Males	0.36	0.38	0.36	0.30	0.30	0.30	0.32	0.40	0.67	0.71
Females	0.36	0.36	0.38	0.33	0.32	0.30	0.34	0.50	0.66	0.70
South–Eastern										
Males	0.32	0.33	0.30	0.26	0.26	0.26	0.29	0.37	0.62	0.67
Females	0.32	0.33	0.34	0.30	0.28	0.26	0.31	0.46	0.66	0.69
Southern										
Males	0.28	0.28	0.24	0.20	0.21	0.21	0.25	0.34	0.61	0.65
Females	0.27	0.27	0.25	0.23	0.23	0.22	0.27	0.43	0.65	0.68
Western										
Males	0.32	0.33	0.30	0.24	0.25	0.26	0.29	0.38	0.62	0.65
Females	0.31	0.33	0.34	0.28	0.27	0.26	0.30	0.46	0.66	0.68

Table C.25: **Coverage scenario by age cohort, sex and region 2016 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.30	0.32	0.21	0.15	0.20	0.20	0.22	0.29	0.65	0.65
Females	0.30	0.32	0.25	0.20	0.23	0.21	0.24	0.40	0.70	0.70
Midlands										
Males	0.37	0.38	0.32	0.27	0.28	0.27	0.29	0.38	0.70	0.74
Females	0.37	0.38	0.38	0.32	0.32	0.29	0.33	0.51	0.74	0.76
Mid–Western										
Males	0.34	0.34	0.30	0.27	0.27	0.26	0.29	0.40	0.71	0.75
Females	0.34	0.35	0.34	0.31	0.30	0.27	0.32	0.48	0.74	0.77
North–Eastern										
Males	0.35	0.38	0.31	0.25	0.27	0.26	0.29	0.39	0.71	0.79
Females	0.35	0.37	0.35	0.30	0.30	0.28	0.32	0.50	0.76	0.80
North–Western										
Males	0.41	0.44	0.41	0.34	0.35	0.35	0.37	0.46	0.76	0.81
Females	0.42	0.42	0.44	0.38	0.37	0.34	0.39	0.57	0.75	0.80
South–Eastern										
Males	0.37	0.38	0.35	0.30	0.30	0.29	0.33	0.43	0.71	0.77
Females	0.36	0.37	0.38	0.34	0.32	0.30	0.36	0.53	0.75	0.79
Southern										
Males	0.32	0.31	0.27	0.23	0.24	0.24	0.28	0.39	0.69	0.74
Females	0.31	0.31	0.29	0.27	0.27	0.25	0.30	0.49	0.74	0.77
Western										
Males	0.36	0.38	0.34	0.28	0.29	0.30	0.33	0.43	0.71	0.74
Females	0.36	0.38	0.39	0.32	0.31	0.30	0.35	0.53	0.75	0.78

Table C.26: **Coverage scenario by age cohort, sex and region 2016 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.39	0.41	0.28	0.20	0.25	0.26	0.28	0.38	0.84	0.99
Females	0.39	0.41	0.33	0.25	0.29	0.27	0.31	0.52	0.90	0.99
Midlands										
Males	0.48	0.49	0.41	0.34	0.36	0.35	0.38	0.49	0.90	0.99
Females	0.48	0.49	0.48	0.41	0.41	0.37	0.42	0.65	0.95	0.99
Mid–Western										
Males	0.44	0.44	0.39	0.34	0.35	0.34	0.37	0.51	0.91	0.99
Females	0.44	0.45	0.44	0.40	0.38	0.35	0.41	0.62	0.95	0.99
North–Eastern										
Males	0.45	0.48	0.40	0.33	0.35	0.34	0.37	0.51	0.92	0.99
Females	0.45	0.48	0.45	0.39	0.39	0.36	0.41	0.65	0.98	0.99
North–Western										
Males	0.53	0.57	0.52	0.44	0.45	0.45	0.47	0.59	0.98	0.99
Females	0.54	0.54	0.56	0.49	0.48	0.44	0.50	0.73	0.97	0.99
South–Eastern										
Males	0.47	0.49	0.45	0.38	0.38	0.38	0.42	0.55	0.92	0.99
Females	0.47	0.48	0.50	0.44	0.41	0.38	0.46	0.68	0.97	0.99
Southern										
Males	0.41	0.40	0.35	0.29	0.31	0.31	0.36	0.50	0.89	0.99
Females	0.40	0.40	0.37	0.34	0.34	0.32	0.39	0.63	0.95	0.99
Western										
Males	0.47	0.49	0.44	0.36	0.37	0.39	0.43	0.56	0.91	0.99
Females	0.46	0.49	0.50	0.41	0.40	0.39	0.44	0.68	0.97	0.99

Table C.27: **Coverage scenario by age cohort, sex and region 2021 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.28	0.32	0.21	0.13	0.18	0.20	0.22	0.29	0.65	0.68
Females	0.28	0.32	0.24	0.18	0.22	0.21	0.24	0.39	0.70	0.73
Midlands										
Males	0.34	0.39	0.33	0.22	0.28	0.28	0.29	0.38	0.70	0.76
Females	0.34	0.40	0.40	0.31	0.33	0.30	0.33	0.51	0.76	0.79
Mid–Western										
Males	0.31	0.35	0.28	0.22	0.26	0.26	0.29	0.40	0.72	0.75
Females	0.31	0.36	0.34	0.28	0.31	0.27	0.32	0.49	0.75	0.79
North–Eastern										
Males	0.32	0.41	0.31	0.21	0.26	0.27	0.30	0.41	0.73	0.80
Females	0.32	0.40	0.36	0.27	0.32	0.29	0.33	0.54	0.77	0.82
North–Western										
Males	0.38	0.45	0.39	0.30	0.35	0.35	0.37	0.47	0.79	0.83
Females	0.38	0.43	0.42	0.35	0.38	0.34	0.40	0.58	0.78	0.84
South–Eastern										
Males	0.34	0.38	0.33	0.25	0.29	0.29	0.33	0.43	0.72	0.78
Females	0.33	0.38	0.39	0.32	0.33	0.31	0.36	0.53	0.77	0.80
Southern										
Males	0.29	0.32	0.27	0.20	0.24	0.24	0.28	0.39	0.69	0.74
Females	0.29	0.32	0.29	0.25	0.27	0.26	0.31	0.49	0.75	0.79
Western										
Males	0.34	0.39	0.33	0.22	0.27	0.30	0.34	0.45	0.72	0.76
Females	0.33	0.39	0.36	0.26	0.31	0.30	0.35	0.54	0.77	0.81

Table C.28: **Coverage scenario by age cohort, sex and region 2021 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.32	0.33	0.22	0.16	0.20	0.21	0.23	0.31	0.68	0.67
Females	0.32	0.33	0.26	0.20	0.24	0.22	0.25	0.42	0.73	0.72
Midlands										
Males	0.39	0.40	0.33	0.28	0.29	0.29	0.30	0.40	0.73	0.77
Females	0.39	0.39	0.39	0.33	0.33	0.30	0.34	0.53	0.77	0.79
Mid–Western										
Males	0.36	0.35	0.32	0.28	0.28	0.28	0.30	0.41	0.74	0.78
Females	0.36	0.36	0.36	0.32	0.31	0.28	0.33	0.50	0.77	0.80
North–Eastern										
Males	0.36	0.39	0.33	0.26	0.28	0.27	0.30	0.41	0.74	0.82
Females	0.37	0.39	0.37	0.31	0.32	0.29	0.33	0.52	0.79	0.84
North–Western										
Males	0.43	0.46	0.42	0.36	0.36	0.36	0.38	0.48	0.79	0.85
Females	0.43	0.43	0.45	0.39	0.38	0.35	0.41	0.59	0.78	0.83
South–Eastern										
Males	0.38	0.39	0.36	0.31	0.31	0.30	0.34	0.44	0.74	0.80
Females	0.38	0.39	0.40	0.35	0.33	0.31	0.37	0.55	0.78	0.82
Southern										
Males	0.33	0.33	0.28	0.24	0.25	0.25	0.29	0.40	0.72	0.77
Females	0.33	0.32	0.30	0.28	0.28	0.26	0.32	0.51	0.77	0.80
Western										
Males	0.38	0.40	0.35	0.29	0.30	0.31	0.34	0.45	0.73	0.77
Females	0.38	0.40	0.40	0.33	0.32	0.31	0.36	0.55	0.78	0.81

Table C.29: **Coverage scenario by age cohort, sex and region 2021 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.41	0.42	0.29	0.20	0.26	0.27	0.29	0.39	0.72	0.99
Females	0.41	0.43	0.34	0.26	0.31	0.28	0.32	0.54	0.82	0.99
Midlands										
Males	0.50	0.51	0.43	0.36	0.38	0.37	0.39	0.51	0.81	0.99
Females	0.50	0.51	0.50	0.43	0.42	0.39	0.44	0.68	0.91	0.99
Mid–Western										
Males	0.46	0.46	0.41	0.36	0.36	0.36	0.39	0.53	0.83	0.99
Females	0.46	0.46	0.46	0.42	0.40	0.36	0.42	0.65	0.90	0.99
North–Eastern										
Males	0.47	0.50	0.42	0.34	0.36	0.35	0.38	0.53	0.84	0.99
Females	0.47	0.50	0.47	0.40	0.41	0.37	0.43	0.67	0.94	0.99
North–Western										
Males	0.55	0.59	0.54	0.46	0.47	0.46	0.49	0.62	0.93	0.99
Females	0.56	0.56	0.59	0.51	0.50	0.46	0.52	0.76	0.95	0.99
South–Eastern										
Males	0.50	0.51	0.46	0.40	0.40	0.39	0.44	0.57	0.85	0.99
Females	0.49	0.50	0.52	0.45	0.43	0.40	0.48	0.71	0.94	0.99
Southern										
Males	0.43	0.42	0.36	0.31	0.33	0.33	0.37	0.52	0.81	0.99
Females	0.42	0.42	0.39	0.36	0.36	0.34	0.41	0.65	0.90	0.99
Western										
Males	0.49	0.51	0.46	0.37	0.38	0.40	0.44	0.58	0.84	0.99
Females	0.49	0.51	0.52	0.43	0.42	0.40	0.46	0.71	0.94	0.99

Table C.30: **Coverage scenario by age cohort, sex and region 2026 – Scenario 1: Minimum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.29	0.30	0.20	0.14	0.18	0.19	0.21	0.28	0.62	0.61
Females	0.29	0.30	0.24	0.19	0.22	0.20	0.23	0.38	0.66	0.66
Midlands										
Males	0.35	0.36	0.30	0.25	0.27	0.26	0.27	0.36	0.66	0.70
Females	0.35	0.36	0.35	0.30	0.30	0.27	0.31	0.48	0.70	0.72
Mid–Western										
Males	0.32	0.32	0.29	0.25	0.25	0.25	0.27	0.37	0.67	0.70
Females	0.32	0.33	0.32	0.29	0.28	0.26	0.30	0.45	0.70	0.73
North–Eastern										
Males	0.33	0.35	0.29	0.24	0.26	0.25	0.27	0.37	0.67	0.74
Females	0.33	0.35	0.33	0.28	0.29	0.26	0.30	0.47	0.72	0.76
North–Western										
Males	0.39	0.41	0.38	0.33	0.33	0.33	0.35	0.43	0.72	0.77
Females	0.39	0.39	0.41	0.36	0.35	0.32	0.37	0.53	0.71	0.76
South–Eastern										
Males	0.35	0.36	0.33	0.28	0.28	0.28	0.31	0.40	0.67	0.72
Females	0.35	0.35	0.36	0.32	0.30	0.28	0.34	0.50	0.71	0.75
Southern										
Males	0.30	0.30	0.26	0.22	0.23	0.23	0.26	0.36	0.65	0.70
Females	0.30	0.29	0.27	0.25	0.25	0.24	0.29	0.46	0.69	0.73
Western										
Males	0.35	0.36	0.32	0.26	0.27	0.28	0.31	0.41	0.67	0.70
Females	0.34	0.36	0.37	0.30	0.29	0.28	0.33	0.50	0.71	0.73

Table C.31: **Coverage scenario by age cohort, sex and region 2026 – Scenario 2: Mean**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.33	0.34	0.23	0.16	0.21	0.22	0.24	0.32	0.70	0.70
Females	0.33	0.34	0.27	0.21	0.25	0.22	0.26	0.43	0.75	0.75
Midlands										
Males	0.40	0.41	0.34	0.29	0.30	0.30	0.31	0.41	0.75	0.80
Females	0.40	0.41	0.40	0.34	0.34	0.31	0.35	0.55	0.80	0.82
Mid–Western										
Males	0.37	0.37	0.33	0.29	0.29	0.29	0.31	0.43	0.76	0.80
Females	0.37	0.37	0.37	0.33	0.32	0.29	0.34	0.52	0.79	0.83
North–Eastern										
Males	0.38	0.40	0.34	0.27	0.29	0.28	0.31	0.42	0.77	0.85
Females	0.38	0.40	0.38	0.32	0.33	0.30	0.34	0.54	0.82	0.86
North–Western										
Males	0.44	0.47	0.44	0.37	0.37	0.37	0.40	0.49	0.82	0.88
Females	0.45	0.45	0.47	0.41	0.40	0.37	0.42	0.61	0.81	0.86
South–Eastern										
Males	0.40	0.41	0.37	0.32	0.32	0.31	0.35	0.46	0.77	0.82
Females	0.39	0.40	0.41	0.36	0.35	0.32	0.38	0.57	0.81	0.85
Southern										
Males	0.34	0.34	0.29	0.25	0.26	0.26	0.30	0.42	0.75	0.79
Females	0.34	0.34	0.31	0.29	0.29	0.27	0.33	0.52	0.79	0.83
Western										
Males	0.40	0.41	0.37	0.30	0.31	0.32	0.36	0.46	0.76	0.80
Females	0.39	0.40	0.42	0.34	0.33	0.32	0.37	0.57	0.81	0.84

Table C.32: **Coverage scenario by age cohort, sex and region 2026 – Scenario 3: Maximum**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75
Eastern										
Males	0.43	0.44	0.30	0.21	0.27	0.28	0.30	0.41	0.76	0.99
Females	0.42	0.44	0.35	0.27	0.32	0.29	0.34	0.56	0.86	0.99
Midlands										
Males	0.52	0.53	0.44	0.37	0.39	0.38	0.40	0.53	0.85	0.99
Females	0.52	0.53	0.52	0.44	0.44	0.40	0.45	0.70	0.95	0.99
Mid–Western										
Males	0.48	0.47	0.42	0.37	0.37	0.37	0.40	0.55	0.87	0.99
Females	0.48	0.48	0.48	0.43	0.41	0.38	0.44	0.67	0.94	0.99
North–Eastern										
Males	0.48	0.52	0.43	0.35	0.38	0.37	0.40	0.54	0.87	0.99
Females	0.49	0.51	0.49	0.41	0.42	0.38	0.44	0.70	0.98	0.99
North–Western										
Males	0.57	0.61	0.56	0.48	0.48	0.48	0.51	0.64	0.97	0.99
Females	0.58	0.58	0.61	0.52	0.51	0.47	0.54	0.78	0.99	0.99
South–Eastern										
Males	0.51	0.52	0.48	0.41	0.41	0.41	0.45	0.59	0.89	0.99
Females	0.51	0.52	0.53	0.47	0.45	0.41	0.49	0.73	0.98	0.99
Southern										
Males	0.44	0.44	0.38	0.32	0.34	0.34	0.39	0.53	0.85	0.99
Females	0.44	0.43	0.40	0.37	0.37	0.35	0.42	0.68	0.94	0.99
Western										
Males	0.51	0.53	0.47	0.39	0.40	0.42	0.46	0.60	0.88	0.99
Females	0.50	0.53	0.54	0.44	0.43	0.42	0.48	0.74	0.98	0.99

Figure C.1: **No. of Eligible Persons Projections Updated 2016 – 2026**

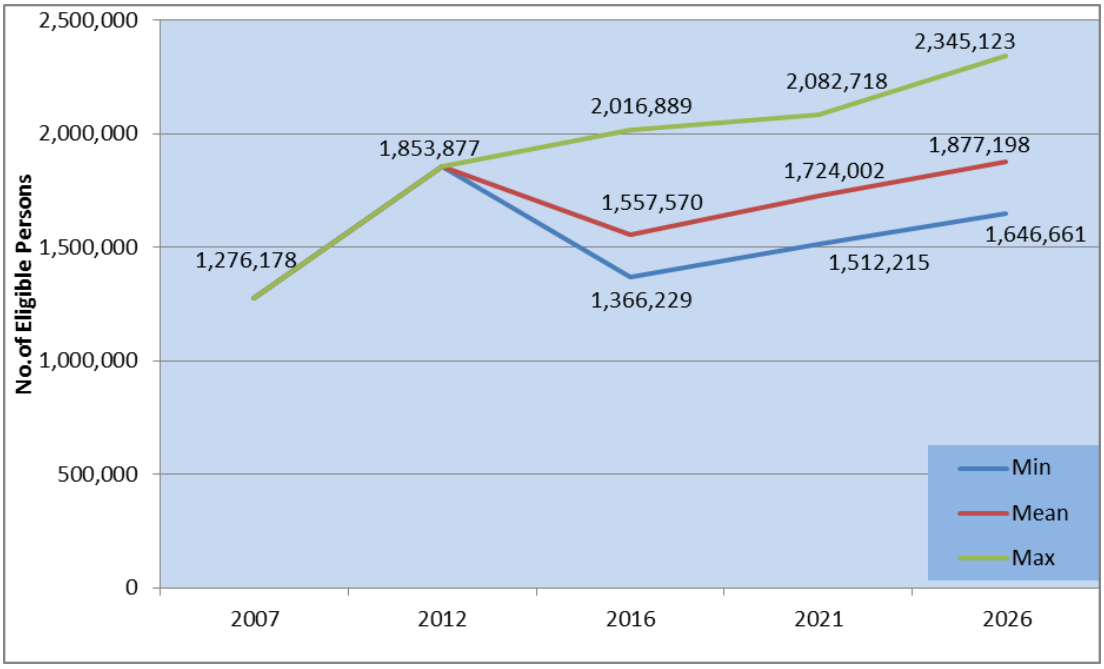


Table C.33: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2016 - Scenario 1**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	116.69	130.98	206.93	376.30	525.27	879.66	1,272.22	1,527.13	1,425.31	1,711.70	**833.13**
Females	101.60	117.81	194.66	308.76	485.37	871.53	1,242.28	1,416.44	1,473.22	1,789.23	**807.84**
Midlands											
Males	122.13	132.32	207.58	384.99	532.99	901.92	1,374.13	1,649.96	1,563.37	1,804.89	**860.81**
Females	114.78	117.63	221.31	348.48	559.55	939.49	1,399.34	1,555.47	1,604.11	1,919.73	**864.90**
Mid–Western											
Males	151.71	209.49	237.53	420.14	588.55	892.27	1,277.38	1,467.58	1,388.22	1,629.09	**818.91**
Females	137.85	138.85	235.33	371.67	549.75	892.54	1,284.85	1,417.87	1,476.94	1,709.26	**808.98**
North–Eastern											
Males	126.06	137.46	200.25	347.46	467.41	806.38	1,231.04	1,478.06	1,423.80	1,728.16	**801.62**
Females	108.38	118.55	211.57	306.35	443.81	800.87	1,172.17	1,389.78	1,496.95	1,805.28	**788.10**
North–Western											
Males	123.10	143.27	187.53	325.44	467.86	708.33	1,071.52	1,307.62	1,329.62	1,583.88	**737.36**
Females	100.92	110.93	174.01	294.12	442.50	683.08	1,071.73	1,298.62	1,341.35	1,674.40	**724.29**
South–Eastern											
Males	151.74	161.33	253.68	437.10	585.84	925.21	1,321.55	1,522.51	1,425.99	1,621.42	**836.65**
Females	129.09	152.99	246.96	375.04	566.53	948.53	1,316.59	1,450.41	1,478.02	1,680.90	**822.56**
Southern											
Males	128.54	158.81	219.80	382.36	519.91	882.95	1,262.44	1,505.06	1,460.96	1,727.28	**823.93**
Females	104.37	118.28	213.83	318.36	504.78	874.54	1,247.90	1,449.84	1,510.07	1,798.75	**807.95**
Western											
Males	134.25	139.29	214.98	384.59	538.06	825.04	1,152.55	1,389.96	1,397.53	1,614.65	**777.86**
Females	116.51	122.73	205.93	345.35	497.22	816.18	1,149.78	1,301.43	1,414.49	1,726.38	**762.30**
Total	**122.98**	**138.17**	**214.49**	**357.91**	**517.21**	**853.03**	**1,240.47**	**1,445.48**	**1,450.62**	**1,720.31**	**804.82**

Table C.34: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2016 - Scenario 2**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	122.83	137.87	217.82	396.11	552.92	925.95	1,339.18	1,607.51	1,500.33	1,801.79	**876.98**
Females	106.95	124.01	204.91	325.01	510.91	917.40	1,307.66	1,490.99	1,550.76	1,883.40	**850.36**
Midlands											
Males	128.55	139.28	218.50	405.25	561.04	949.39	1,446.45	1,736.80	1,645.66	1,899.89	**906.12**
Females	120.82	123.82	232.96	366.82	589.00	988.93	1,472.99	1,637.33	1,688.53	2,020.77	**910.42**
Mid–Western											
Males	159.70	220.52	250.03	442.26	619.52	939.24	1,344.61	1,544.82	1,461.28	1,714.83	**862.01**
Females	145.10	146.16	247.72	391.23	578.68	939.52	1,352.47	1,492.50	1,554.68	1,799.22	**851.55**
North–Eastern											
Males	132.70	144.70	210.79	365.74	492.01	848.82	1,295.83	1,555.85	1,498.74	1,819.11	**843.81**
Females	114.09	124.79	222.71	322.48	467.17	843.02	1,233.87	1,462.92	1,575.74	1,900.30	**829.58**
North–Western											
Males	129.58	150.81	197.40	342.57	492.48	745.61	1,127.92	1,376.44	1,399.60	1,667.25	**776.17**
Females	106.23	116.77	183.17	309.60	465.79	719.04	1,128.14	1,366.97	1,411.95	1,762.52	**762.41**
South–Eastern											
Males	159.73	169.82	267.03	460.11	616.67	973.90	1,391.11	1,602.64	1,501.05	1,706.76	**880.69**
Females	135.89	161.04	259.95	394.78	596.35	998.45	1,385.89	1,526.75	1,555.81	1,769.36	**865.85**
Southern											
Males	135.30	167.17	231.37	402.48	547.28	929.42	1,328.89	1,584.28	1,537.85	1,818.19	**867.29**
Females	109.87	124.50	225.09	335.11	531.35	920.57	1,313.57	1,526.14	1,589.55	1,893.42	**850.47**
Western											
Males	141.32	146.62	226.30	404.83	566.38	868.46	1,213.21	1,463.12	1,471.08	1,699.63	**818.81**
Females	122.64	129.19	216.77	363.53	523.39	859.14	1,210.29	1,369.93	1,488.94	1,817.24	**802.42**
Total	**129.46**	**145.44**	**225.78**	**376.74**	**544.43**	**897.93**	**1,305.75**	**1,521.56**	**1,526.97**	**1,810.85**	**847.18**

Table C.35: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2016 - Scenario 3**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	128.97	144.77	228.71	415.91	580.56	972.25	1,406.14	1,687.88	1,575.34	1,891.87	**920.83**
Females	112.29	130.21	215.16	341.26	536.46	963.27	1,373.04	1,565.54	1,628.30	1,977.57	**892.88**
Midlands											
Males	134.98	146.25	229.43	425.52	589.10	996.86	1,518.77	1,823.64	1,727.94	1,994.88	**951.42**
Females	126.86	130.01	244.60	385.16	618.45	1,038.38	1,546.64	1,719.20	1,772.96	2,121.81	**955.94**
Mid–Western											
Males	167.68	231.55	262.53	464.37	650.50	986.20	1,411.84	1,622.06	1,534.35	1,800.57	**905.11**
Females	152.36	153.47	260.10	410.79	607.62	986.50	1,420.10	1,567.12	1,632.41	1,889.18	**894.13**
North–Eastern											
Males	139.33	151.93	221.33	384.03	516.61	891.26	1,360.63	1,633.64	1,573.67	1,910.07	**886.00**
Females	119.79	131.03	233.84	338.60	490.53	885.17	1,295.56	1,536.07	1,654.53	1,995.31	**871.06**
North–Western											
Males	136.06	158.35	207.27	359.70	517.11	782.89	1,184.31	1,445.26	1,469.58	1,750.61	**814.98**
Females	111.54	122.61	192.32	325.08	489.08	754.99	1,184.54	1,435.32	1,482.55	1,850.65	**800.53**
South–Eastern											
Males	167.72	178.31	280.38	483.11	647.50	1,022.60	1,460.66	1,682.77	1,576.10	1,792.10	**924.72**
Females	142.68	169.09	272.95	414.52	626.17	1,048.38	1,455.18	1,603.08	1,633.60	1,857.83	**909.15**
Southern											
Males	142.07	175.53	242.94	422.61	574.64	975.89	1,395.33	1,663.49	1,614.74	1,909.10	**910.66**
Females	115.36	130.73	236.34	351.87	557.92	966.60	1,379.25	1,602.45	1,669.03	1,988.09	**892.99**
Western											
Males	148.39	153.96	237.61	425.07	594.70	911.89	1,273.87	1,536.28	1,544.64	1,784.61	**859.75**
Females	128.78	135.65	227.61	381.71	549.56	902.09	1,270.80	1,438.42	1,563.39	1,908.10	**842.54**
Total	**135.93**	**152.71**	**237.07**	**395.58**	**571.66**	**942.83**	**1,371.04**	**1,597.64**	**1,603.32**	**1,901.40**	**889.54**

Table C.36: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2021 - Scenario 1**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	128.84	144.61	228.47	415.47	579.94	971.21	1,404.63	1,686.08	1,573.66	1,889.85	**919.84**
Females	112.17	130.08	214.93	340.90	535.89	962.24	1,371.57	1,563.87	1,626.55	1,975.46	**891.92**
Midlands											
Males	134.84	146.09	229.18	425.06	588.47	995.79	1,517.15	1,821.69	1,726.09	1,992.75	**950.41**
Females	126.73	129.87	244.34	384.75	617.79	1,037.27	1,544.98	1,717.36	1,771.06	2,119.54	**954.91**
Mid–Western											
Males	167.50	231.30	262.25	463.87	649.80	985.14	1,410.33	1,620.33	1,532.70	1,798.64	**904.14**
Females	152.19	153.30	259.82	410.35	606.97	985.44	1,418.58	1,565.45	1,630.67	1,887.16	**893.17**
North–Eastern											
Males	139.18	151.77	221.09	383.62	516.05	890.31	1,359.17	1,631.89	1,571.99	1,908.03	**885.05**
Females	119.66	130.89	233.59	338.24	490.01	884.22	1,294.17	1,534.43	1,652.76	1,993.18	**870.13**
North–Western											
Males	135.91	158.18	207.05	359.31	516.55	782.05	1,183.04	1,443.71	1,468.00	1,748.74	**814.11**
Females	111.42	122.47	192.12	324.73	488.56	754.18	1,183.28	1,433.78	1,480.96	1,848.67	**799.68**
South–Eastern											
Males	167.54	178.12	280.08	482.60	646.81	1,021.51	1,459.10	1,680.97	1,574.41	1,790.18	**923.73**
Females	142.53	168.91	272.66	414.07	625.50	1,047.26	1,453.63	1,601.37	1,631.85	1,855.84	**908.17**
Southern											
Males	141.92	175.34	242.68	422.16	574.03	974.85	1,393.84	1,661.71	1,613.02	1,907.05	**909.68**
Females	115.24	130.59	236.09	351.49	557.32	965.57	1,377.78	1,600.74	1,667.24	1,985.97	**892.04**
Western											
Males	148.23	153.79	237.36	424.62	594.06	910.91	1,272.50	1,534.63	1,542.98	1,782.70	**858.83**
Females	128.64	135.50	227.37	381.30	548.97	901.13	1,269.45	1,436.88	1,561.72	1,906.06	**841.64**
Total	**135.78**	**152.55**	**236.82**	**395.16**	**571.04**	**941.82**	**1,369.57**	**1,595.93**	**1,601.60**	**1,899.36**	**888.59**

Table C.37: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2021 - Scenario 2**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	135.62	152.22	240.49	437.33	610.46	1,022.33	1,478.56	1,774.82	1,656.48	1,989.32	**968.25**
Females	118.08	136.92	226.24	358.84	564.09	1,012.88	1,443.76	1,646.18	1,712.16	2,079.43	**938.86**
Midlands											
Males	141.93	153.78	241.24	447.43	619.44	1,048.20	1,597.00	1,917.56	1,816.94	2,097.63	**1,000.43**
Females	133.40	136.71	257.20	405.00	650.30	1,091.86	1,626.30	1,807.75	1,864.28	2,231.10	**1,005.17**
Mid–Western											
Males	176.32	243.47	276.05	488.29	684.01	1,036.99	1,484.56	1,705.61	1,613.37	1,893.31	**951.73**
Females	160.20	161.37	273.50	431.95	638.91	1,037.31	1,493.24	1,647.84	1,716.49	1,986.48	**940.18**
North–Eastern											
Males	146.51	159.76	232.73	403.81	543.21	937.17	1,430.70	1,717.78	1,654.73	2,008.45	**931.63**
Females	125.96	137.78	245.89	356.04	515.80	930.76	1,362.29	1,615.18	1,739.74	2,098.08	**915.93**
North–Western											
Males	143.07	166.51	217.94	378.23	543.74	823.21	1,245.31	1,519.70	1,545.27	1,840.77	**856.96**
Females	117.29	128.92	202.23	341.83	514.27	793.87	1,245.55	1,509.24	1,558.91	1,945.97	**841.76**
South–Eastern											
Males	176.35	187.49	294.83	507.99	680.85	1,075.27	1,535.90	1,769.44	1,657.28	1,884.40	**972.35**
Females	150.03	177.80	287.01	435.87	658.42	1,102.37	1,530.13	1,685.65	1,717.74	1,953.52	**955.97**
Southern											
Males	149.39	184.57	255.45	444.38	604.24	1,026.15	1,467.20	1,749.17	1,697.91	2,007.42	**957.56**
Females	121.30	137.46	248.52	369.99	586.65	1,016.39	1,450.29	1,684.99	1,754.99	2,090.49	**938.99**
Western											
Males	156.03	161.89	249.85	446.97	625.33	958.85	1,339.48	1,615.40	1,624.19	1,876.53	**904.03**
Females	135.41	142.63	239.34	401.37	577.86	948.56	1,336.26	1,512.51	1,643.91	2,006.38	**885.94**
Total	**142.93**	**160.58**	**249.28**	**415.96**	**601.10**	**991.39**	**1,441.66**	**1,679.93**	**1,685.90**	**1,999.33**	**935.36**

Table C.38: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2021 - Scenario 3**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	142.40	159.83	252.52	459.20	640.99	1,073.44	1,552.49	1,863.56	1,739.31	2,088.78	**1,016.67**
Females	123.98	143.77	237.55	376.78	592.30	1,063.52	1,515.95	1,728.49	1,797.77	2,183.40	**985.81**
Midlands											
Males	149.03	161.47	253.30	469.80	650.41	1,100.61	1,676.85	2,013.44	1,907.79	2,202.51	**1,050.45**
Females	140.07	143.54	270.06	425.25	682.82	1,146.45	1,707.61	1,898.14	1,957.49	2,342.65	**1,055.43**
Mid–Western											
Males	185.13	255.65	289.86	512.70	718.21	1,088.84	1,558.78	1,790.89	1,694.04	1,987.97	**999.32**
Females	168.21	169.44	287.17	453.54	670.86	1,089.17	1,567.90	1,730.23	1,802.32	2,085.81	**987.19**
North–Eastern											
Males	153.84	167.74	244.36	424.00	570.38	984.03	1,502.24	1,803.67	1,737.46	2,108.87	**978.22**
Females	132.26	144.66	258.18	373.84	541.59	977.30	1,430.40	1,695.94	1,826.73	2,202.99	**961.72**
North–Western											
Males	150.22	174.83	228.84	397.14	570.93	864.37	1,307.58	1,595.68	1,622.53	1,932.81	**899.81**
Females	123.15	135.37	212.34	358.92	539.98	833.57	1,307.83	1,584.71	1,636.85	2,043.27	**883.85**
South–Eastern											
Males	185.17	196.87	309.57	533.39	714.90	1,129.03	1,612.69	1,857.91	1,740.14	1,978.62	**1,020.97**
Females	157.53	186.69	301.36	457.66	691.34	1,157.49	1,606.64	1,769.93	1,803.62	2,051.20	**1,003.77**
Southern											
Males	156.86	193.80	268.22	466.59	634.45	1,077.46	1,540.56	1,836.63	1,782.81	2,107.80	**1,005.44**
Females	127.37	144.33	260.94	388.49	615.98	1,067.20	1,522.81	1,769.24	1,842.74	2,195.02	**985.94**
Western											
Males	163.83	169.98	262.34	469.32	656.59	1,006.80	1,406.45	1,696.17	1,705.40	1,970.36	**949.23**
Females	142.18	149.76	251.30	421.44	606.76	995.99	1,403.07	1,588.14	1,726.11	2,106.70	**930.23**
Total	**150.08**	**168.61**	**261.75**	**436.75**	**631.15**	**1,040.96**	**1,513.74**	**1,763.92**	**1,770.19**	**2,099.30**	**982.13**

Table C.39: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2026 - Scenario 1**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	142.25	159.66	252.25	458.71	640.30	1,072.30	1,550.83	1,861.57	1,737.45	2,086.55	**1,015.58**
Females	123.85	143.61	237.29	376.38	591.66	1,062.39	1,514.33	1,726.64	1,795.85	2,181.06	**984.75**
Midlands											
Males	148.87	161.30	253.03	469.30	649.71	1,099.43	1,675.05	2,011.29	1,905.74	2,200.15	**1,049.33**
Females	139.92	143.39	269.77	424.79	682.09	1,145.23	1,705.78	1,896.10	1,955.40	2,340.14	**1,054.30**
Mid–Western											
Males	184.94	255.37	289.55	512.15	717.44	1,087.68	1,557.12	1,788.97	1,692.23	1,985.85	**998.25**
Females	168.03	169.26	286.87	453.06	670.14	1,088.01	1,566.23	1,728.38	1,800.39	2,083.58	**986.14**
North–Eastern											
Males	153.67	167.56	244.10	423.55	569.77	982.97	1,500.63	1,801.74	1,735.61	2,106.62	**977.17**
Females	132.12	144.51	257.91	373.44	541.01	976.25	1,428.87	1,694.13	1,824.78	2,200.63	**960.69**
North–Western											
Males	150.06	174.65	228.60	396.71	570.32	863.44	1,306.18	1,593.98	1,620.80	1,930.75	**898.84**
Females	123.02	135.22	212.11	358.53	539.40	832.68	1,306.43	1,583.01	1,635.10	2,041.08	**882.91**
South–Eastern											
Males	184.97	196.66	309.24	532.82	714.13	1,127.83	1,610.97	1,855.93	1,738.28	1,976.50	**1,019.87**
Females	157.36	186.49	301.04	457.17	690.60	1,156.25	1,604.92	1,768.04	1,801.69	2,049.00	**1,002.70**
Southern											
Males	156.69	193.59	267.93	466.10	633.77	1,076.31	1,538.91	1,834.66	1,780.90	2,105.54	**1,004.36**
Females	127.23	144.18	260.66	388.08	615.32	1,066.06	1,521.18	1,767.34	1,840.77	2,192.67	**984.88**
Western											
Males	163.65	169.80	262.06	468.81	655.89	1,005.72	1,404.95	1,694.36	1,703.58	1,968.25	**948.21**
Females	142.03	149.60	251.03	420.98	606.11	994.92	1,401.57	1,586.44	1,724.26	2,104.45	**929.24**
Total	**149.92**	**168.43**	**261.47**	**436.29**	**630.48**	**1,039.84**	**1,512.12**	**1,762.04**	**1,768.30**	**2,097.05**	**981.08**

Table C.40: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2026 - Scenario 2**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	149.73	168.07	265.52	482.85	674.00	1,128.73	1,632.45	1,959.54	1,828.89	2,196.37	**1,069.03**
Females	130.37	151.17	249.78	396.19	622.80	1,118.30	1,594.03	1,817.51	1,890.37	2,295.86	**1,036.58**
Midlands											
Males	156.71	169.78	266.35	494.00	683.91	1,157.30	1,763.21	2,117.14	2,006.05	2,315.95	**1,104.55**
Females	147.28	150.94	283.97	447.15	717.99	1,205.50	1,795.56	1,995.90	2,058.31	2,463.31	**1,109.79**
Mid–Western											
Males	194.67	268.81	304.79	539.11	755.20	1,144.92	1,639.07	1,883.13	1,781.29	2,090.37	**1,050.79**
Females	176.88	178.17	301.97	476.91	705.41	1,145.27	1,648.66	1,819.35	1,895.14	2,193.24	**1,038.04**
North–Eastern											
Males	161.76	176.38	256.95	445.84	599.75	1,034.71	1,579.61	1,896.57	1,826.95	2,217.49	**1,028.60**
Females	139.07	152.12	271.48	393.10	569.48	1,027.63	1,504.08	1,783.29	1,920.82	2,316.45	**1,011.26**
North–Western											
Males	157.96	183.84	240.63	417.59	600.33	908.89	1,374.92	1,677.87	1,706.10	2,032.36	**946.15**
Females	129.50	142.34	223.28	377.40	567.79	876.50	1,375.19	1,666.33	1,721.16	2,148.51	**929.38**
South–Eastern											
Males	194.71	207.01	325.51	560.87	751.72	1,187.18	1,695.75	1,953.61	1,829.77	2,080.53	**1,073.55**
Females	165.64	196.31	316.88	481.23	726.95	1,217.11	1,689.39	1,861.10	1,896.52	2,156.84	**1,055.47**
Southern											
Males	164.94	203.78	282.04	490.63	667.13	1,132.96	1,619.91	1,931.22	1,874.63	2,216.36	**1,057.22**
Females	133.93	151.77	274.38	408.50	647.71	1,122.17	1,601.24	1,860.36	1,937.65	2,308.07	**1,036.72**
Western											
Males	172.27	178.73	275.86	493.49	690.41	1,058.65	1,478.89	1,783.54	1,793.24	2,071.84	**998.12**
Females	149.50	157.48	264.25	443.14	638.01	1,047.28	1,475.34	1,669.93	1,815.01	2,215.21	**978.14**
Total	**157.81**	**177.29**	**275.23**	**459.25**	**663.66**	**1,094.57**	**1,591.71**	**1,854.77**	**1,861.37**	**2,207.42**	**1,032.71**

Table C.41: **Average Cost per Claimant (€) by Region, Sex and Age Cohort 2026 - Scenario 3**

Region	0–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Eastern											
Males	157.22	176.47	278.80	506.99	707.70	1,185.17	1,714.07	2,057.52	1,920.33	2,306.18	**1,122.48**
Females	136.89	158.73	262.27	416.00	653.94	1,174.22	1,673.73	1,908.39	1,984.88	2,410.65	**1,088.41**
Midlands											
Males	164.54	178.27	279.67	518.70	718.10	1,215.16	1,851.37	2,223.00	2,106.35	2,431.75	**1,159.78**
Females	154.64	158.48	298.17	469.51	753.89	1,265.78	1,885.34	2,095.69	2,161.23	2,586.48	**1,165.28**
Mid–Western											
Males	204.40	282.25	320.03	566.06	792.96	1,202.17	1,721.02	1,977.29	1,870.36	2,194.88	**1,103.33**
Females	185.72	187.08	317.06	500.75	740.68	1,202.53	1,731.09	1,910.32	1,989.90	2,302.90	**1,089.94**
North–Eastern											
Males	169.85	185.20	269.80	468.13	629.74	1,086.45	1,658.59	1,991.40	1,918.30	2,328.36	**1,080.03**
Females	146.02	159.72	285.05	412.75	597.95	1,079.02	1,579.28	1,872.46	2,016.86	2,432.28	**1,061.82**
North–Western											
Males	165.86	193.03	252.66	438.47	630.35	954.33	1,443.67	1,761.76	1,791.41	2,133.98	**993.46**
Females	135.97	149.46	234.44	396.27	596.18	920.33	1,443.95	1,749.64	1,807.22	2,255.93	**975.84**
South–Eastern											
Males	204.44	217.36	341.79	588.91	789.30	1,246.54	1,780.54	2,051.29	1,921.26	2,184.55	**1,127.23**
Females	173.93	206.12	332.73	505.29	763.30	1,277.97	1,773.86	1,954.15	1,991.35	2,264.69	**1,108.24**
Southern											
Males	173.18	213.97	296.14	515.16	700.49	1,189.61	1,700.90	2,027.78	1,968.36	2,327.18	**1,110.08**
Females	140.62	159.36	288.10	428.93	680.10	1,178.28	1,681.30	1,953.38	2,034.54	2,423.48	**1,088.55**
Western											
Males	180.88	187.67	289.65	518.16	724.93	1,111.59	1,552.84	1,872.71	1,882.90	2,175.43	**1,048.02**
Females	156.98	165.35	277.46	465.30	669.91	1,099.65	1,549.10	1,753.43	1,905.76	2,325.97	**1,027.05**
Total	**165.70**	**186.16**	**288.99**	**482.21**	**696.85**	**1,149.30**	**1,671.29**	**1,947.51**	**1,954.44**	**2,317.79**	**1,084.35**

Figure C.2: **Pie Chart of Cost (€), Scenario 2 2021**

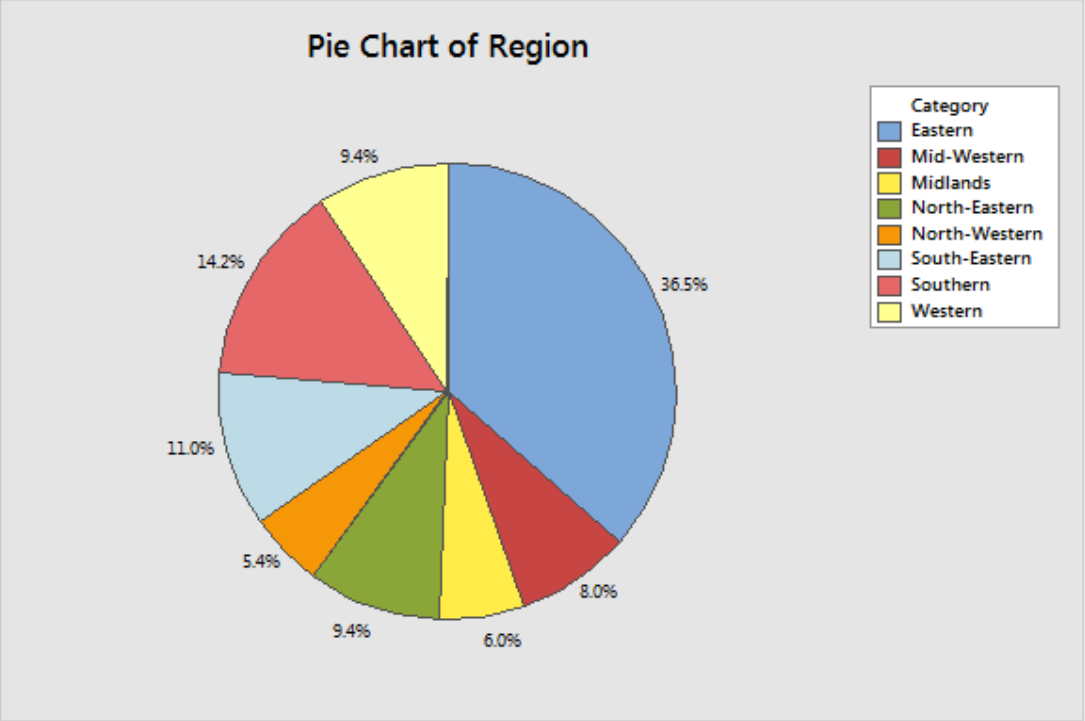


Figure C.3: **Pie Chart of Cost (€), Scenario 2 2026**

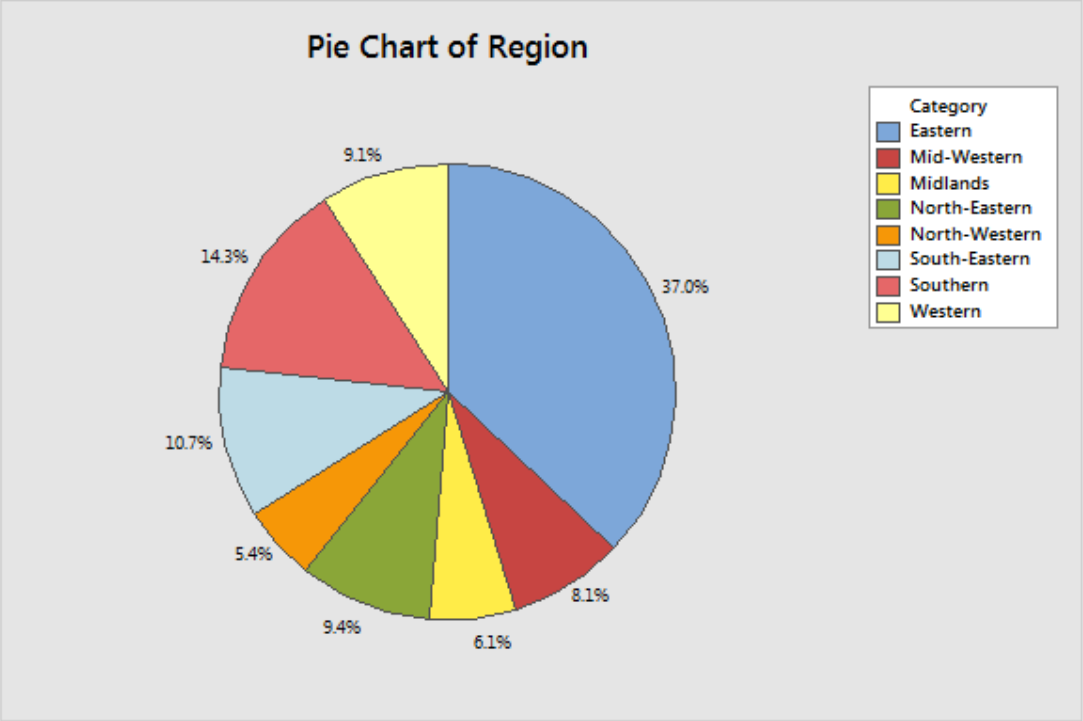


Figure C.4: **Histogram of Cost (€), Scenario 2 2021**

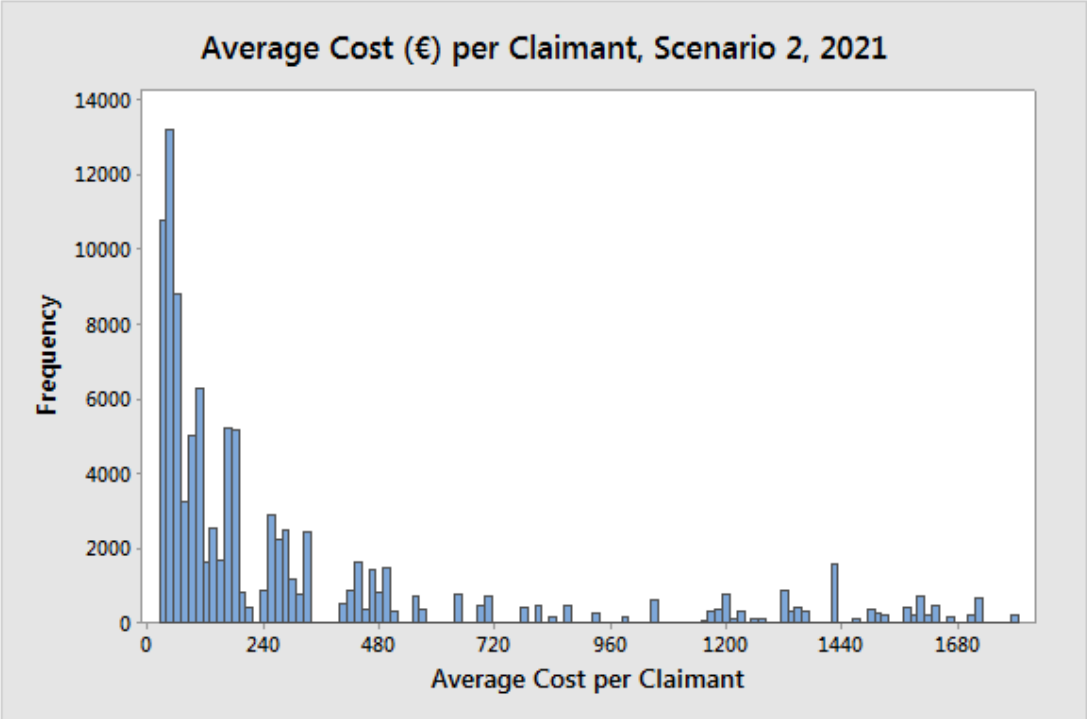


Figure C.5: **Histogram of Cost (€), Scenario 2 2026**

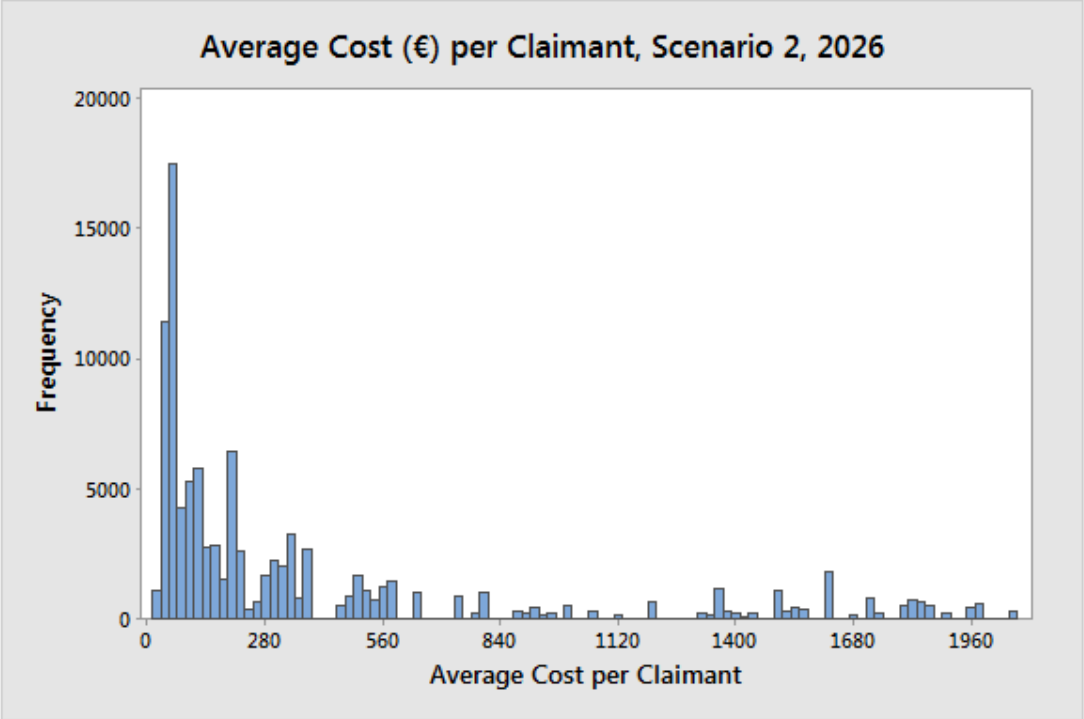


Figure C.6: **Interval Plot of Cost by Region, Scenario 2 2021**

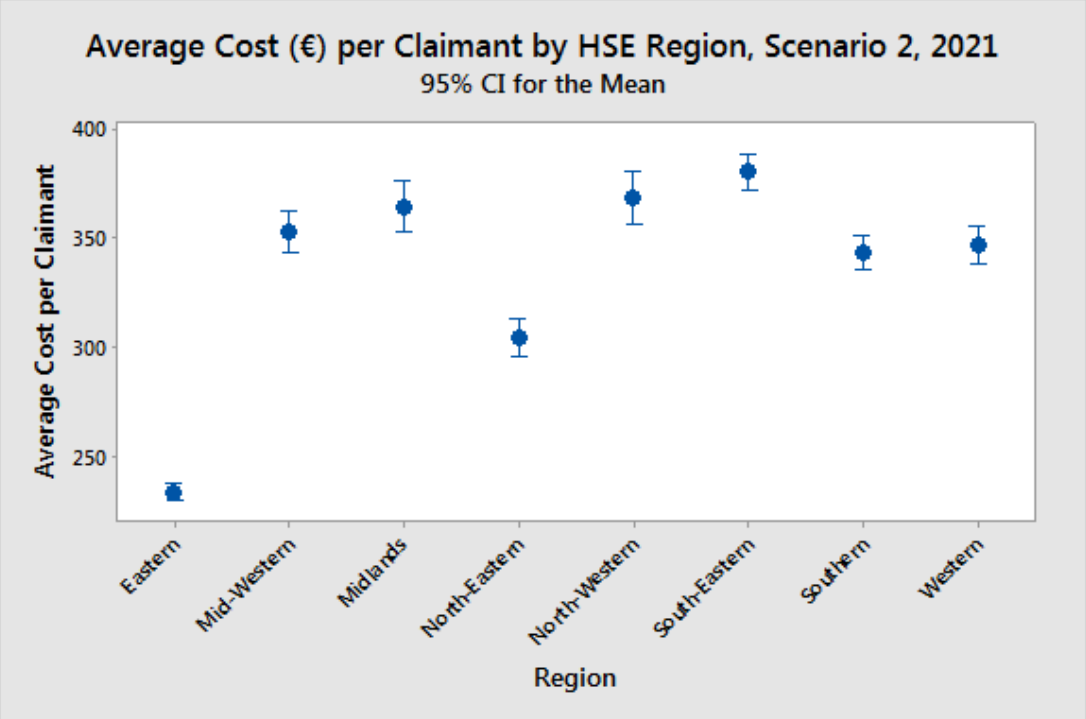


Figure C.7: **Interval Plot of Cost by Region, Scenario 2 2026**

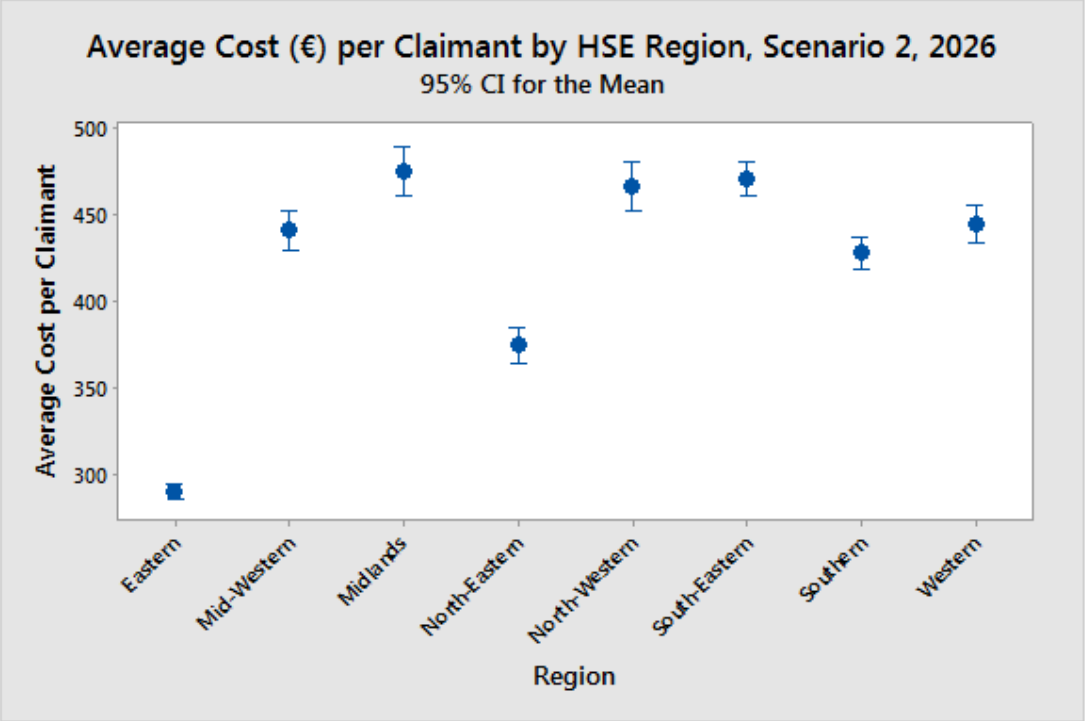


Figure C.8: **Interval Plot of Cost by Age Cohort, Scenario 2 2021**

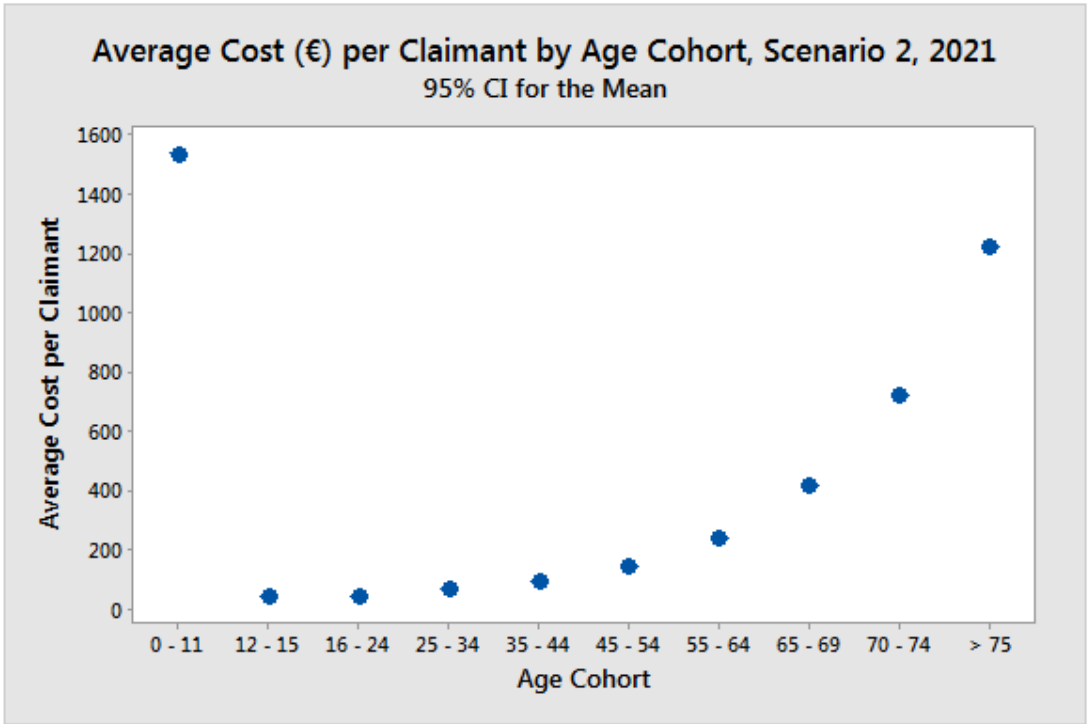


Figure C.9: **Interval Plot of Cost by Age Cohort, Scenario 2 2026**

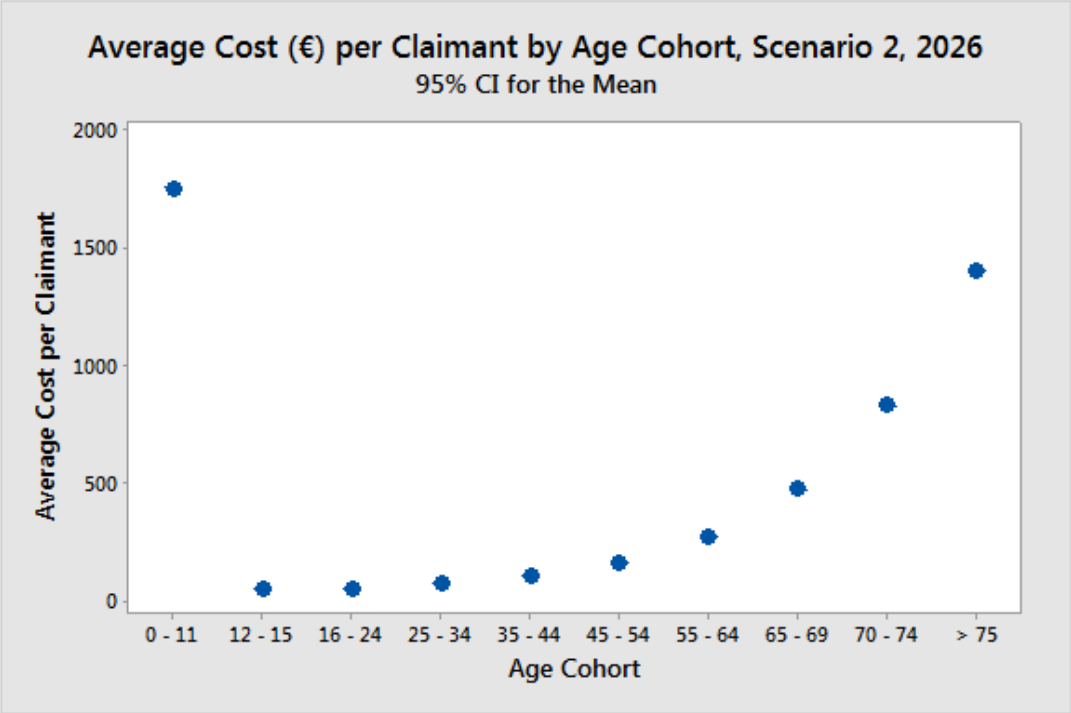


Figure C.10: **Interval Plot of Cost by Sex, Scenario 2 2021**

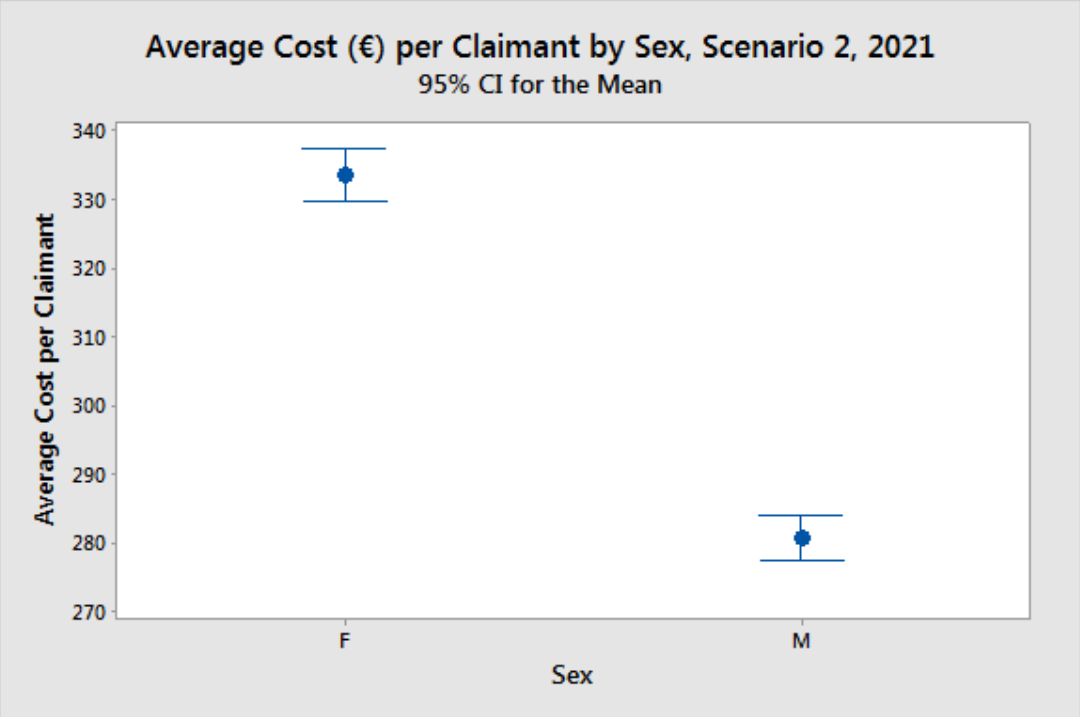


Figure C.11: **Interval Plot of Cost by Sex, Scenario 2 2026**

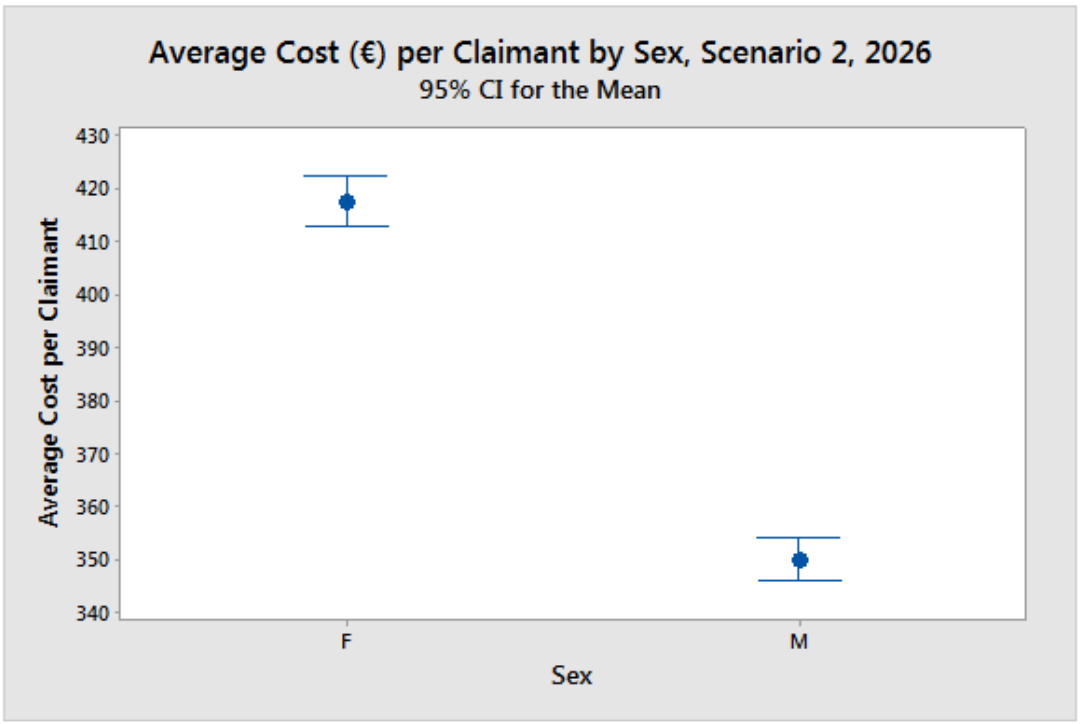


Figure C.12: **Main Effects Plot 0–11, Scenario 2 2026**

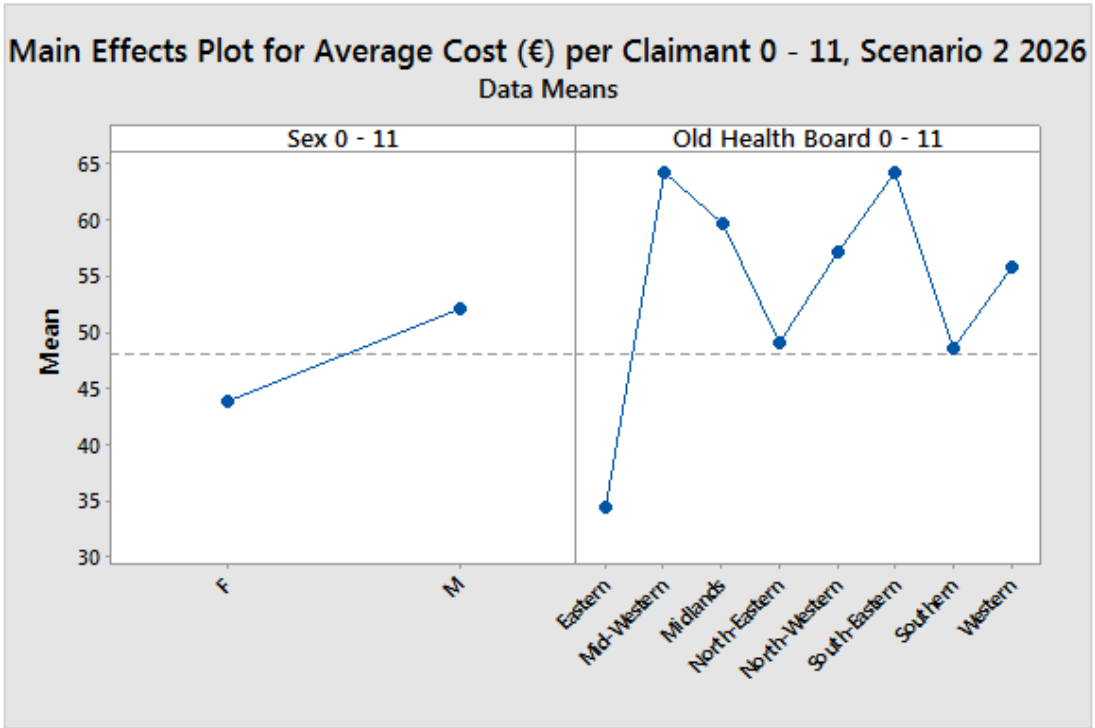


Figure C.13: **Main Effects Plot 0–11, Scenario 2 2021**

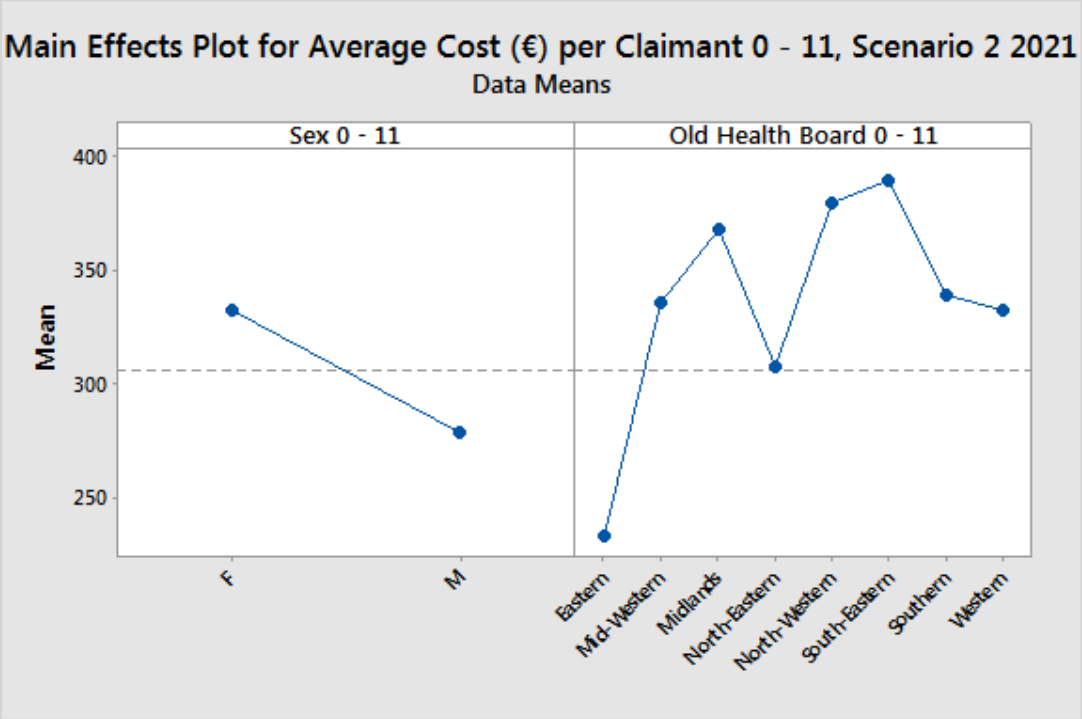


Figure C.14: **Main Effects Plot >70, Scenario 2 2026**

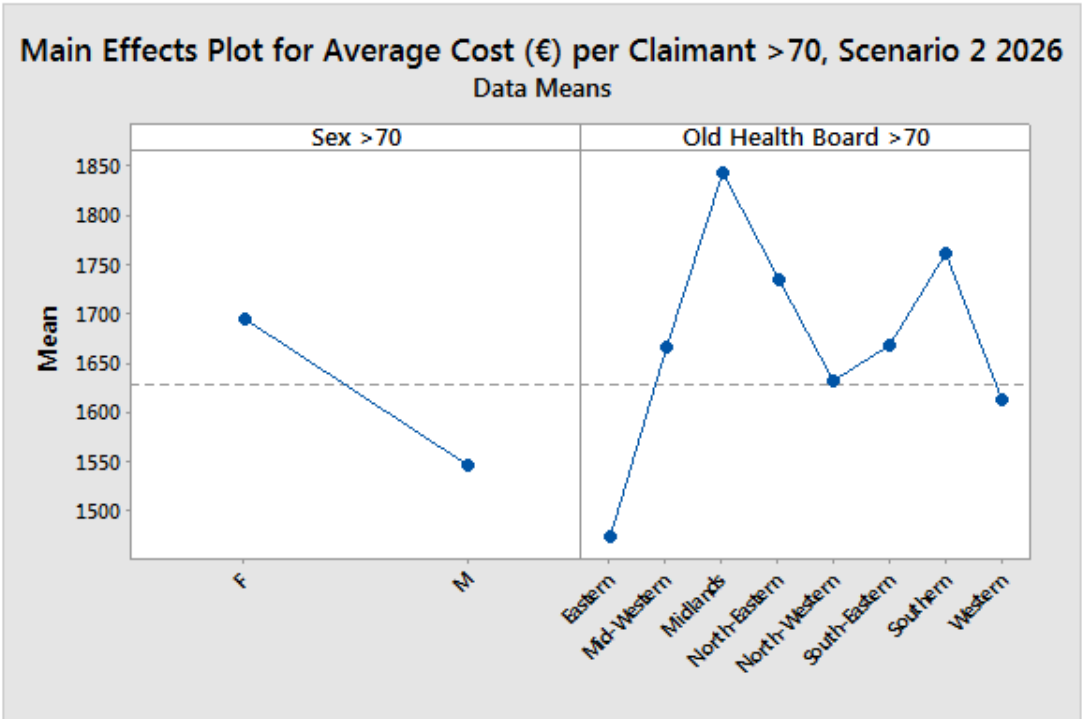


Figure C.15: **Main Effects Plot >70, Scenario 2 2021**

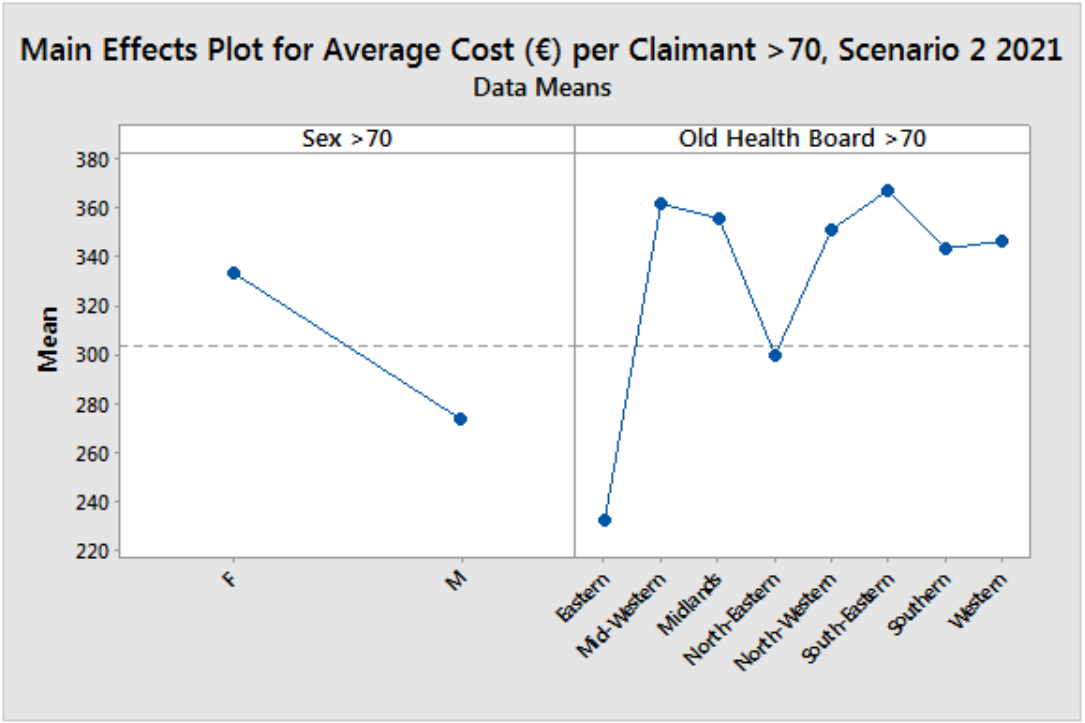
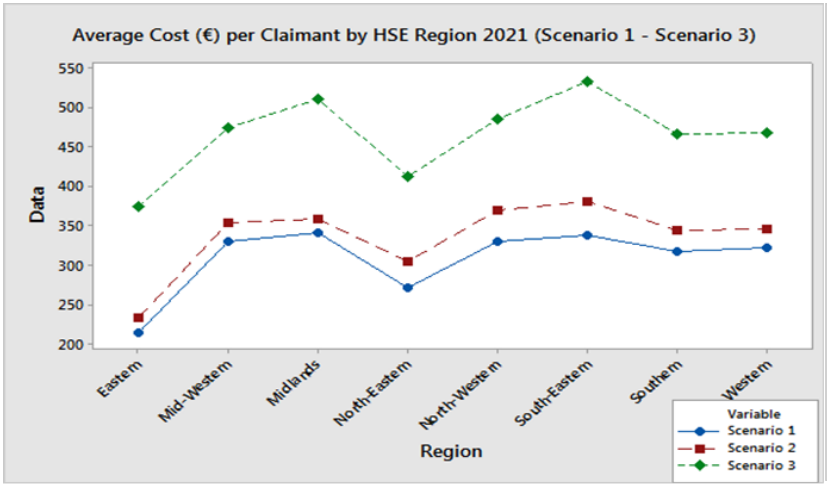
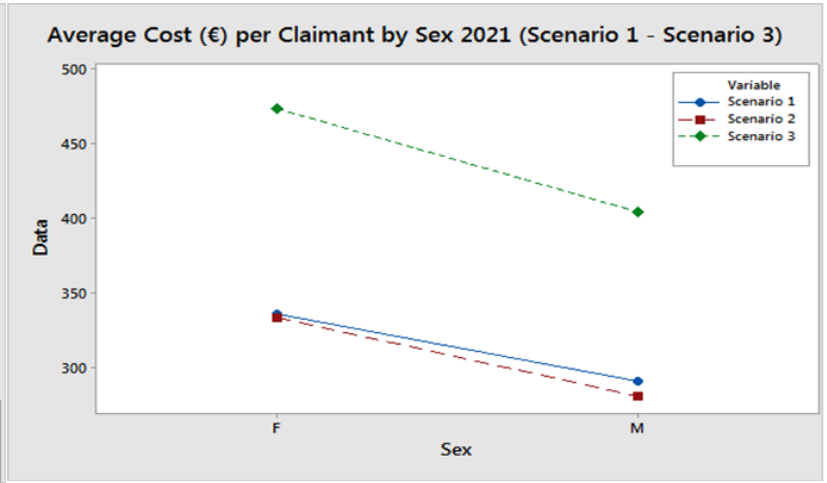


Figure C.16: **Average cost per Claimant (€) by old health board region, sex & Age cohort, Scenario 1 - Scenario 3 2021**





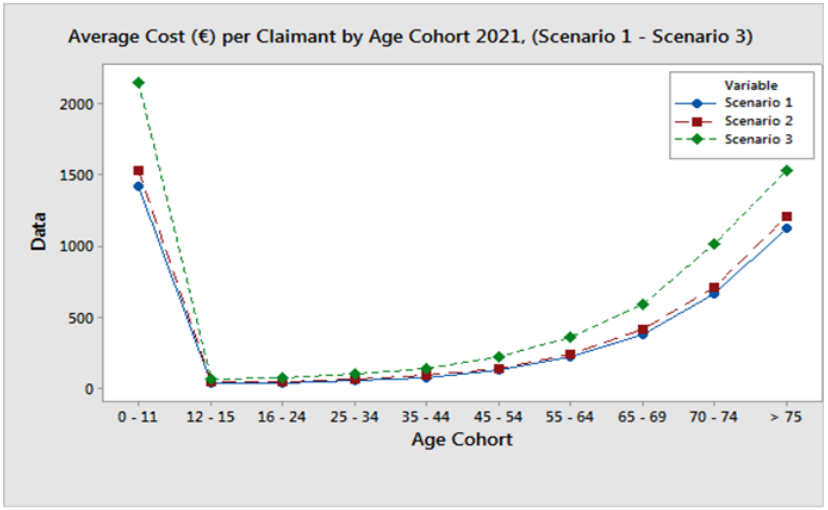
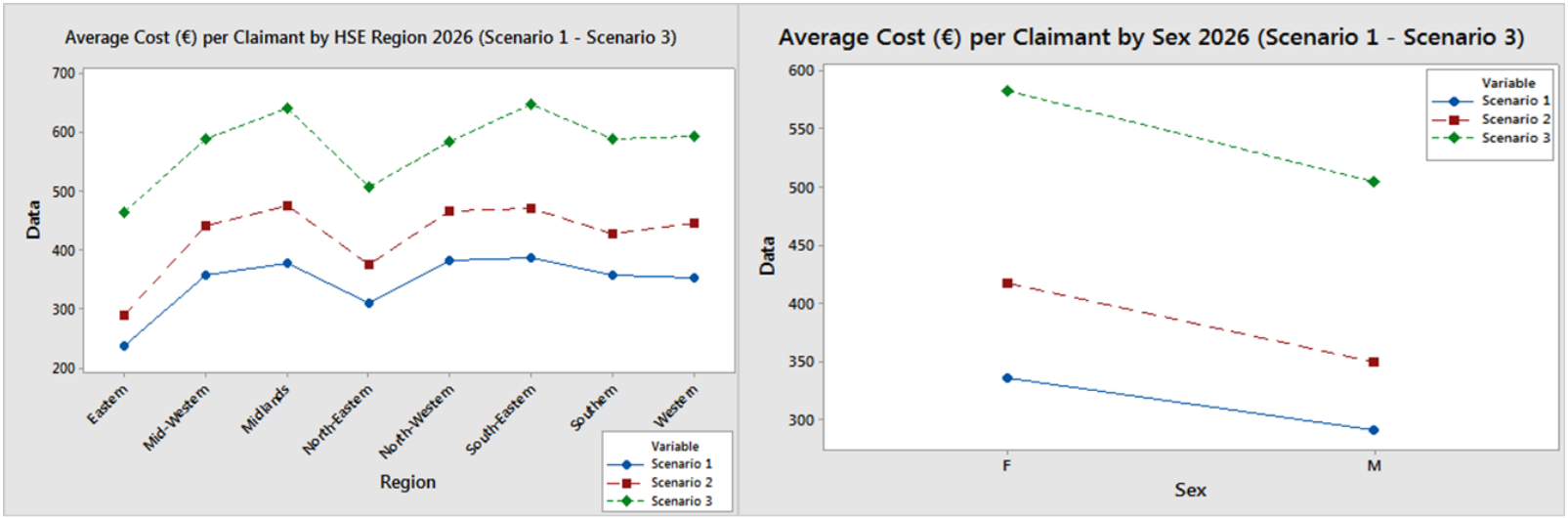
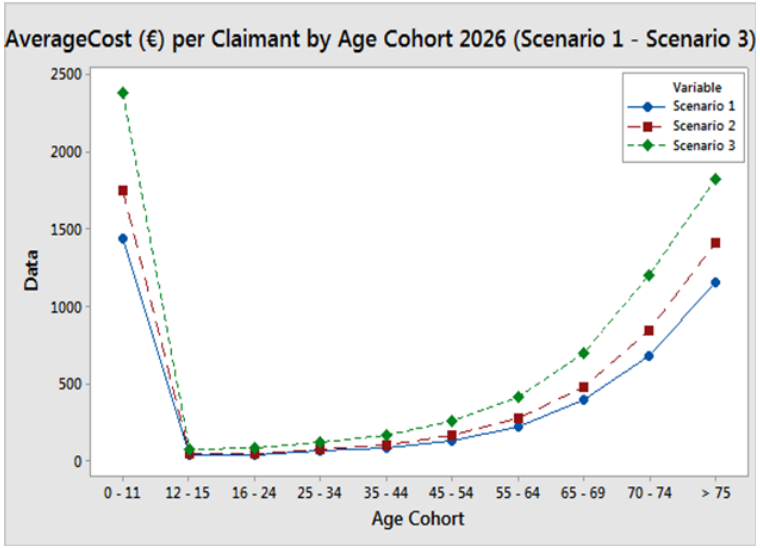


Figure C.17: **Average cost per Claimant (€) by old health board region, sex & Age cohort, Scenario 1 - Scenario 3 2026**





Appendix D

Appendix D (Paper 2)

Irish population and GMS coverage projections by health board region, sex and age cohort out to 2026.

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Irish population and GMS coverage projections by health board region, sex and age cohort out to 2026.

Abstract

This paper projects population and GMS coverage rates and is disaggregated by old health board region, sex and age cohort in five year time intervals between 2016 and 2026. Data is drawn from the Primary Care Reimbursement Service (PCRS) and the Central Statistics Office (CSO). 2012 is the base year for projections and three scenarios are estimated for each projected year; mean scenario, lower bound scenario and an upper bound scenario. The Irish population is estimated to grow by approximately 10% between 2012 and 2026, whereas the over 70s are expected to grow by 64%. The Eastern region is expected to grow at the expense of the other regions. 37% of the population is estimated to live in the Eastern region in 2026. GMS coverage is estimated to lie between 33% and 46% in 2026. Increased coverage rates are likely given an increase in population and the over 70s living longer.

Keywords population projections, GMS projections, Ireland, regions

Introduction

This paper details the methodology used and the assumptions made in deriving population and coverage projections for five year intervals between 2016 and 2026 disaggregated by the old heath board region, age cohort and sex. Central Statistics Office (CSO) population data form the basis of the population projections for this paper (CSO, 2013). The population projections are used in conjunction with the Primary Care Reimbursement Service (PCRS) data to build General Medical Services (GMS) coverage rates by the old heath board region, age cohort and sex in Ireland. GMS coverage is the proportion of the population who are eligible for a medical card. The analysis is based on 2011 CSO census data and 2012 PCRS data and the projection years include 2016, 2021 and 2026. Population and coverage rates are estimated under three scenarios; minimum (scenario 1), mean (scenario 2) and maximum (scenario 3). Current CSO population projections are not suitable for this research as the data is provided by CSO region. Population projections by the old health board regions is required for GMS coverage projections. Therefore, this research uses the CSO population data and develops population projections by the old health board region, age cohort and sex. This is the main contribution of this paper. The old health board regions will be referred to as HSE regions for the remainder of the paper. The paper is structured as follows. The background section provides a brief description of population projection models and the GMS scheme in Ireland. The methodology section discusses the principal data sources and methods used. The results are summarised in the results sections and the discussion section analyses the findings and policy implications. The final section concludes.

Background

In terms of the existing literature, the CSO has been the main source of Irish population projections and research data. Blackwell & Associates (2001) were commissioned by the Department of the Environment and Local Government to produce population forecasts, labourforce and housing demand forecasts for the national spatial strategy. Projections were based on CSO data (1999 – 2000) and forecasts were produced in five year intervals out to 2030 by CSO regions. Twelve models were developed in total, some of which were used for sensitivity analysis. Connell & Pringle (2004) developed four forecasts (A1-A4) around the assumptions of births, deaths, net migration, marital status and living alone in five year intervals out to 2021 by county. This report compares population projections produced in 1995 for the National Council for the Elderly with actual population using Census 2002 and census 2006 data. Morgenroth (2009) developed population projections for 27 Irish counties using 2006 census data as a starting point and made assumptions around mortality, fertility and migration. Previous research has focused on national and county trends. Conway et al (2014) assessed the implications of demographic change and policy scenarios on future GMS costs in Ireland from 2007 through to 2026. Their estimated population projections using CSO regional population projections 2011 – 2026 and census 2006 data. They projected

GMS coverage rates from 2007 to 2026. This research adds value as it produces population and GMS coverage projections in five year intervals between 2016 and 2026 by the old health board region, sex and Health Service Executive (HSE) age cohorts. No previous research has published population and GMS coverage projections by these three variables using CSO Regional Population Projections 2016-2031 and Census 2011 data. These projections will facilitate further research in determining the effect of population and GMS coverage changes on future GMS costs.

The GMS scheme is the largest of the community drug schemes in Ireland with 40.40% of the population (1,853,877 persons) eligible in 2012, the highest it has been since data was published in 1998 (1,252,385, 34.54%) (PCRS Annual reports, 1998 & 2012). This represents an increase of 48% between 1998 and 2012. Those who are eligible for the GMS scheme (medical card holders) are entitled to free prescription drugs and appliances. This paper focuses on persons who are eligible for a full medical card. In 2012, Ireland spent 14% of total government expenditure on health which is comparable with the European Union (EU) average, EU28. Irish health spending accounted for 8.9% of Gross Domestic Product (GDP), just above the EU28 average of 8.7% (OECD, 2014). Since the economic crisis began in 2008, the number of persons eligible for medical cards increased. A person may apply for a medical card if they fall within certain eligibility criteria. 1,352,120 persons were eligible for the GMS scheme in 2008 and this increased to 1,853,877 in 2012, an increase of 37.11%. This augmented pressure on the Irish health budget at a time when contractionary fiscal measures were being implemented. According to the WHO report (2014), 26.1% (€16,156m) of the total government budget was spent on health in 2008 and this fell to 25.9% (€14,469m) in 2012. This report also finds that government health spending between 2008 and 2012 fell by 10.4%. Thomas et al (2012) reported more than €2 billion in cuts to the public health system between 2010 and 2012. During this time period, the total cost of GMS medicines increased by 12.5% from €1,145m in 2008 to €1,288m in 2012 (PCRS, 2008 & 2012).

As detailed in table 1, health care prices increased between 2008 and 2012. Ireland experienced a deflationary period between 2009 and 2010 as indicated in table 1 but health price inflation increased during this time. In 2009 and 2010, hospital and dental services were driving health price inflation and hospital services have a high expenditure weighting in the index (CSO, 2012a). According to the WHO report (2014), Irish health inflation was the highest except for the Netherlands amongst 15 EU countries between 2005 and 2012. Public spending on health was reduced during this recessionary period, with a backdrop of rising health inflation, population growth and growth in entitlements for community drug schemes e.g. GMS scheme.

Table 1: Consumer Price Index (CPI) (All items, health items) 2008 – 2012, Ireland

(Base Dec2011 = 100)

Year	**2008**	**2009**	**2010**	**2011**	**2012**
All Items	102.4	97.9	96.9	99.4	101.1
Annual % Change In CPI	4.1	-4.5	-1.0	2.5	1.7
Health Items	92.9	96.2	96.8	100.0	100.5
Annual % Change In CPI	6.0	3.5	0.6	3.4	0.5

Source: (CSO, 2012a)

From July 2001, any person over the age of 70 was entitled to a free medical card. Due to health budget cutbacks, this automatic entitlement was removed. In January 2009, any person over 70 earning more than €700 per week or €1,400 for a married couple were no longer automatically entitled to a free medical card. These income limits were reduced further in 2013 to €600 for a single person and €1,200 per week for a married couple and to €500 for a single person and €900 for a married per week since the 1st of January 2014. The Irish government has generated further savings in the cost of medicines during this time period due to some drugs coming off patent and the substitution from proprietary to generic prescribing (Conway et al, 2014).

Methodology

CSO national and regional population projections and PCRS annual statistical reports were used for this research. Data management and analysis was carried out in Microsoft Excel 2010. The CSO Regional Population Projections 2016-2031 provided population projections based on the 2011 Irish census. Data was detailed by year of age, sex, county and region, taking account of mortality, international migration (M2, M3), fertility (F2) and internal migration (Recent, Traditional & Modified) assumptions between regions. The national mortality assumption was applied across all regions. The national mortality rate for men will decrease by 3.5% and 2.5% for women per annum. Under the M2 scenario, CSO project population growth across all regions, whereas under the M3 scenario, the CSO forecast net negative international migration between 2011 and 2031 and varying regional population growth, where some regions will not envisage any growth. The fertility assumption (F2) represents a decrease in the Total Fertility Rate from 2.1 in 2010 to 1.8 by 2026 and remain constant thereafter. The CSO identified three internal migration scenarios; recent, traditional and modified. The traditional scenario which is used in this research refers to a gradual

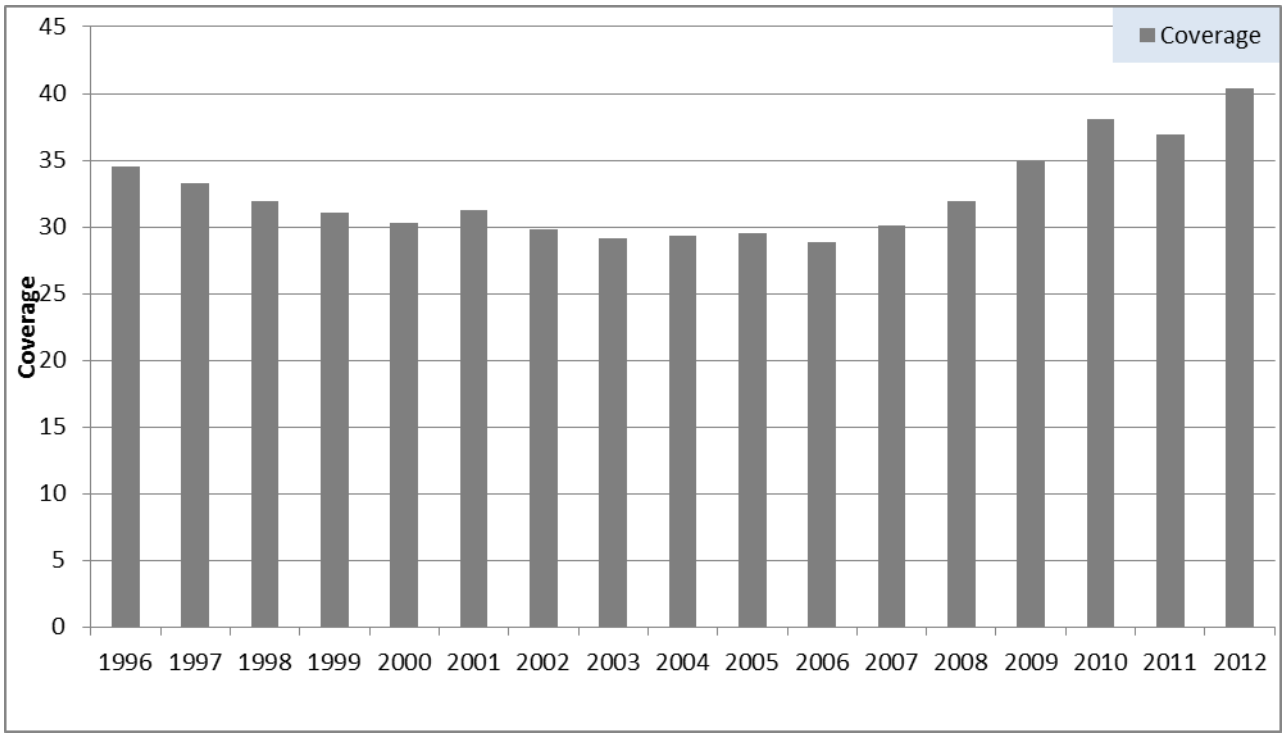
reversal to the 1996 pattern of inter-regional flows to 2021 and will remain constant thereafter. The CSO developed six scenarios for their regional population projections (CSO, 2013). The M2F2T scenario was used to develop the population projections for this research. This was deemed the most appropriate[1] scenario to use at the time of population projections. The data was initially aggregated by sex and age cohort. The population data was aggregated into eleven HSE age cohorts ranging from the under 5s to the over 75s. An adjustment factor based on the 2011 census was applied as three of the CSO regions (Border, Mid-East, Dublin) did not conform to three of the HSE regions (North-West, North-East, Eastern).

For example, to estimate the HSE Eastern region (Dublin, Kildare and Wicklow), the 2012 CSO Mid-East (Meath, Kildare and Wicklow) and Dublin data was aggregated. From the 2011 CSO census, the number of persons in the counties of Meath, Kildare, Wicklow and Dublin were aggregated by age cohort and sex. County Meath was expressed as a proportion of the total region to form a weighting by age cohort and sex. This weighting was multiplied by the Eastern region 2012 to estimate Meath 2012 by age cohort and sex. Meath values were subtracted from the Eastern region to estimate the HSE Eastern region (Dublin, Kildare & Wicklow) 2012. The same methodology using the 2011 census data was applied to estimate the HSE North-West and North-East regions. Regional and national population projections were estimated for 2016, 2021 and 2026 by age cohort, sex and HSE region. We also developed a lower and upper bound scenario. The CSO M3F2T scenario was used to develop projections for the lower bound scenario. An upper bound scenario was estimated as follows; (M2F2T – M3F2T) + M2F2T. The adjustment factor was applied in both scenarios for the relevant regions to form projections between 2016 and 2026.

GMS coverage is the proportion of the population who are eligible for the GMS scheme. 2012 coverage rates were estimated using the PCRS Statistical Analysis of Claims and Payments annual report and the estimated population projections generated through this research. The mean coverage rate is the number of eligible GMS persons (table 7, 2012 PCRS report) divided by the estimated population for 2012. 2012 minimum, mean and maximum coverage rates by the HSE regions, sex and age cohort were estimated. Minimum and maximum 2012 coverage rates were estimated using historical data (national coverage rates) between 1996 and 2012. The national coverage rates are illustrated in figure 1.

[1] Personal Communication: A conversation took place between a CSO population statistician and the researcher to confirm the M2F2T was the most appropriate scenario to use.

Figure 1: National Coverage rates (%) between 1996 and 2012



Source: Various PCRS Reports 1996 - 2012

The historical yearly coverage percentage change was determined between 1996 and 2012 and the minimum, mean and the maximum yearly percentage rate were calculated. The mean coverage rate was scaled down by the minimum yearly percentage rate and scaled up by the maximum yearly percentage rate to formulate scenario 1 and scenario 3, 2012 coverage rates by HSE region, sex and age cohort. In the over 75 age category, some of the values exceeded 1.00 so an adjustment factor was applied, with lambda taking any value between 0 and 0.99. For example, if the projected population for >75 in a region is 100 but the number of GMS eligible persons is 105, GMS coverage rate is 1.05. As this value exceeds 1.00, the adjustment factor below was applied to scale the value below 1.00.

$$\textit{Adjustment Factor} = \textit{Min}\ (>75 - \lambda\ (1.00 - \textit{70-74 age cohort})) \qquad (1)$$

Coverage projections 2016 through to 2026 were based on the reference year 2012 as this was the most up to date data available at the time of projections. In order to project coverage 2016, three scenarios; minimum, mean and maximum were calculated based on the historical coverage data between 1996 and 2012. The minimum value (0.2885) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,352,139. The difference between the total number of eligible persons, 2012 (1,853,877) and 2016 (1,352,139) was derived and expressed as a proportion (0.729357). This value was uniformly multiplied by coverage 2012 to generate scenario 1 coverage 2016 by HSE region, gender and age cohort. Coverage 2016

was multiplied by population 2016 to determine the number of eligible persons, 2016 (scenario 1) by HSE region, gender and age cohort.

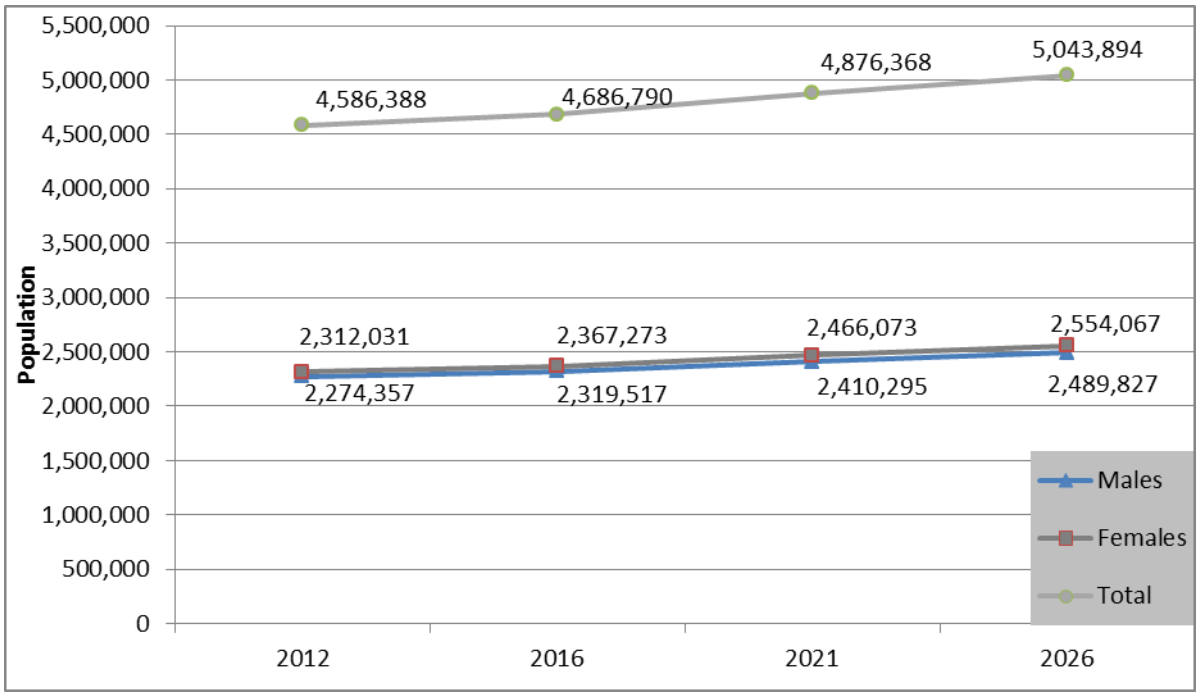
The mean value (0.3243) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,519,926. The difference between the total number of eligible persons, 2012 (1,853,877) and 2016 (1,519,926) was derived and expressed as a proportion (0.819863). This value was uniformly multiplied by coverage 2012 to generate scenario 2 coverage 2016 by HSE region, gender and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons, 2016 (scenario 2) by HSE region, gender and age cohort.

The maximum value (0.404) was multiplied by the projected total population for 2016 (scenario 2, the most likely population) of 4,686,790. This generated an estimated number of eligible persons of 1,893,463. The difference between the total number of eligible persons, 2012 (1,853,877) and 2016 (1,893,463) was derived and expressed as a proportion (1.021353). This value was uniformly multiplied by coverage 2012 to generate scenario 1 coverage 2016 by HSE region, gender and age cohort. Coverage 2016 was multiplied by population 2016 to determine the number of eligible persons, 2016 (scenario 3) by HSE region, gender and age cohort. Coverage 2012 formed the basis of projections for 2021 and 2026. The same methodology for 2016 coverage rates was applied for 2021 and 2026 coverage projections. Three scenarios were calculated for each year. 2021 and 2026 coverage projections were based on the most likely projected population of 4,876,368 and 5,043,894 respectively.

Results

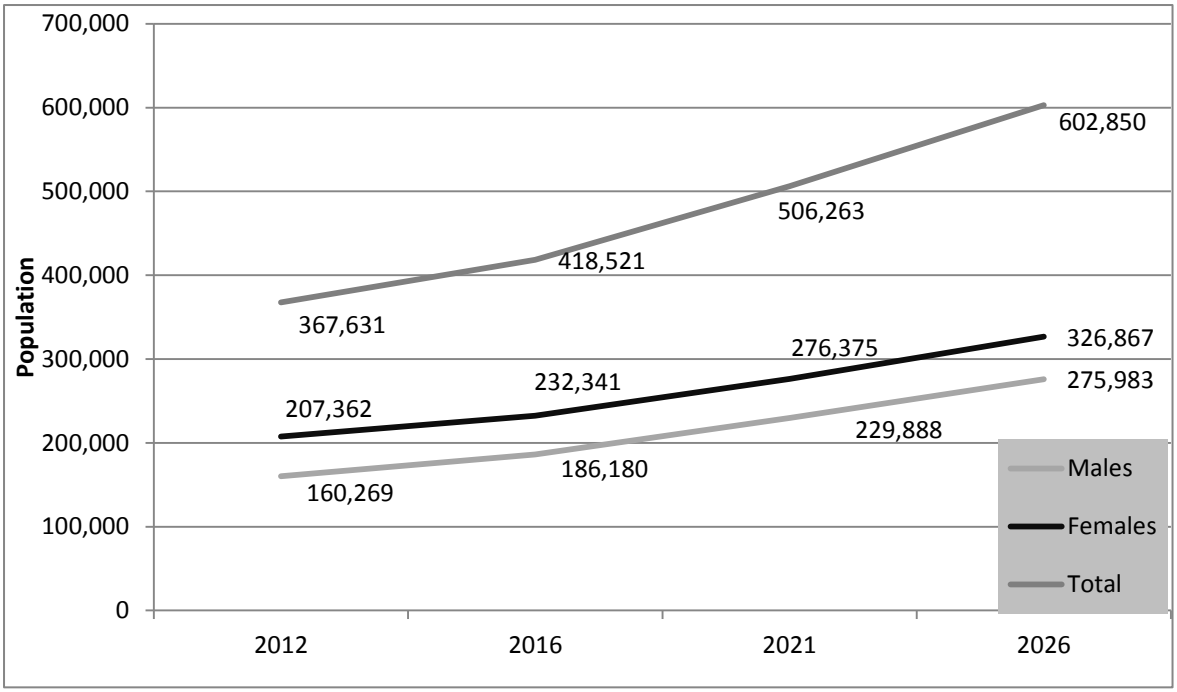
The population of Ireland is projected to grow significantly over the lifetime of the projection period. The following results are based on the most likely population scenario, M2F2T. Figure 2 estimates the population of Ireland will increase from 4,586,388 in 2012 to 5,043,894 in 2026, an estimated increase of 9.47%. The male population is estimated to increase from 2,274,357 in 2012 to 2,489,827 in 2026, an increase of 9.98%. The female population is estimated to increase from 2,312,031 in 2012 to 2,554,067 in 2026, an increase of 10.47%. The female population is increasing at a marginally faster rate than the male population as illustrated in Figure 2. The male and female population will increase by 3.91% and 4.17% between 2016 and 2021. Post 2021, both the male (3.30%) and female (3.57%) population increase at a decreasing rate. The national population is estimated to increase by 4.04% between 2016 and 2021 and by 3.43% between 2021 and 2026.

Figure 2: Irish Population Estimates and Projections, 2012 - 2026



The over 70s population is of particular interest for this research as they are entitled to a free GMS card subject to eligibility criteria. The over 70s includes two age cohorts; 70-74 and >75. These two age cohorts were summed together for the purpose of this analysis. Figure 3 shows that the total over 70s population is projected to grow by 63.98% over the lifetime of the projections. The male population is expected to grow at a higher rate of 72.20% compared to the female population, which is expected to grow by 57.63% between 2012 and 2026.

Figure 3: >70 Irish Population Estimates and Projections, 2012 - 2026



Regional population is expressed as a proportion of total national population. The Eastern region will see an increase in population and the Western region will remain relatively constant over the lifetime of the projections. The six other regions will see a reduction in population between 2012 and 2026. The Eastern region is projected to grow from 35.26% in 2012 to 37.17% of the population in 2026 as illustrated in figure 4. This increase is at the expense of all other regions except the Western region. The Western region experiences the largest decrease over the lifetime of the projection period from 9.60% in 2012 to 9.03% in 2026.

Figure 4: Regional Population Proportion (%) 2012 and 2026

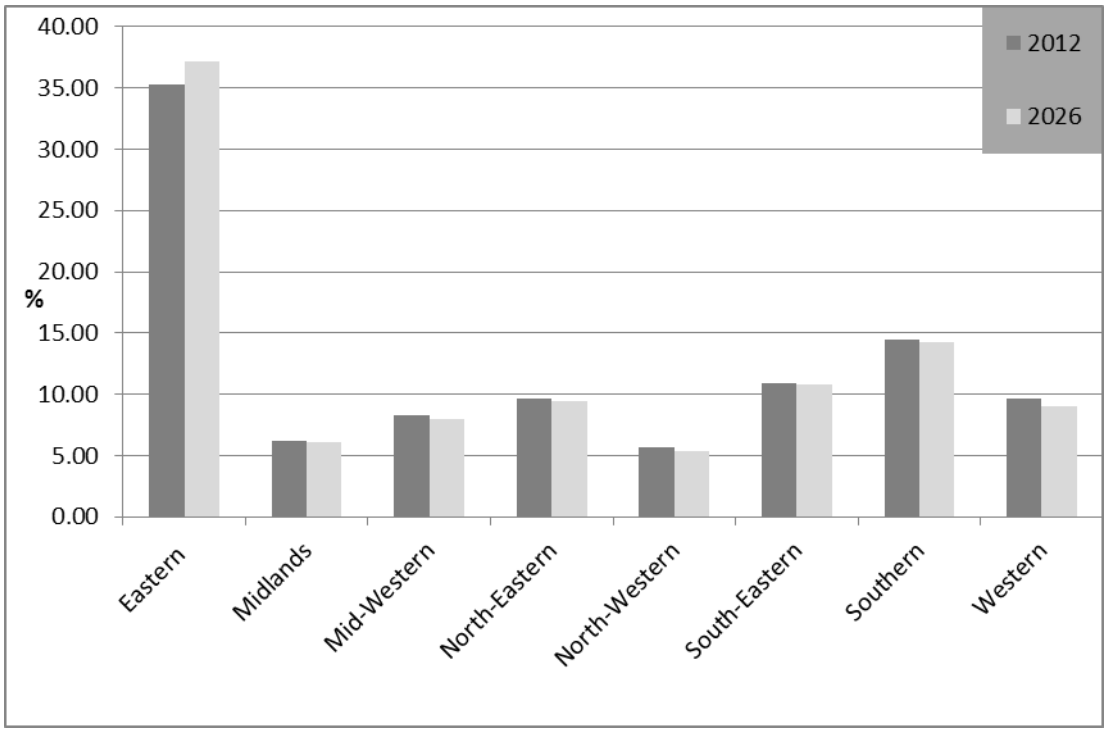


Table 2 shows the 2026 population projections by age cohort, sex and HSE region. This table shows the most likely scenario for 2026. Three scenarios were estimated in this format for 2016, 2021 and 2026.

Table 2: National and Regional Population Projections 2026 by old health board region, Sex and Age Cohort

Region	< 5	5 – 11	12 – 15	16 – 24	25 – 34	35 – 44	45 – 54	55 – 64	65 – 69	70 – 74	>75	Total
Eastern												
Males	53,461	87,037	56,329	118,799	118,384	115,796	134,160	103,928	40,016	32,487	54,245	**914,642**
Females	50,800	83,273	54,256	124,437	119,363	124,371	140,582	108,703	43,970	37,623	72,784	**960,162**
Midlands												
Males	9,071	15,617	10,181	17,600	15,602	18,021	21,773	19,397	8,024	6,598	10,723	**152,607**
Females	8,707	14,963	9,679	15,712	15,740	19,909	22,633	19,500	7,977	6,620	12,867	**154,307**
Mid-Western												
Males	11,336	19,124	12,610	26,998	24,889	21,645	27,157	24,919	10,740	9,103	15,599	**204,120**
Females	10,778	18,002	11,653	21,594	21,703	22,580	27,711	24,977	10,754	9,527	19,211	**198,490**
North-Eastern												
Males	15,004	24,984	15,697	27,752	25,477	29,346	34,490	28,163	10,895	8,835	14,622	**235,265**
Females	14,458	23,678	15,073	26,771	26,663	31,767	34,344	27,493	11,345	8,957	17,930	**238,478**
North-Western												
Males	6,907	11,976	8,379	16,336	13,088	13,861	18,269	18,144	7,723	6,711	11,776	**133,171**
Females	6,597	11,426	7,844	15,167	13,665	15,515	19,521	18,372	7,888	6,735	13,399	**136,127**
South-Eastern												
Males	15,752	26,409	17,097	32,037	27,699	30,296	37,667	34,325	14,465	12,090	20,956	**268,793**
Females	15,082	25,168	16,140	27,037	28,145	34,904	38,996	35,142	14,882	12,529	25,529	**273,554**
Southern												
Males	20,817	34,747	21,979	40,900	34,411	38,673	49,728	44,786	18,546	15,605	26,864	**347,056**
Females	19,835	33,170	21,104	41,376	41,592	47,409	52,854	45,209	19,222	16,495	33,532	**371,798**
Western												
Males	10,889	21,073	14,611	27,715	25,824	29,270	32,887	29,445	12,691	10,898	18,869	**234,172**
Females	10,340	19,870	13,798	24,929	18,180	26,094	33,085	28,849	12,877	11,236	21,893	**221,151**
Total	**279,833**	**470,515**	**306,430**	**605,160**	**570,425**	**619,458**	**725,855**	**611,352**	**252,016**	**212,050**	**390,800**	**5,043,894**

Number of eligible persons and coverage projections are presented in Table 3.

Table 3: GMS Coverage & Eligible Persons Projections, 2016-2026

Scenario	Year	No.of Eligible Persons	Population	Coverage (%)
Minimum	2016	1,366,229		29.15
Mean		1,557,570	4,686,790	33.23
Maximum		2,016,889		43.03
Minimum	2021	1,512,215		31.01
Mean		1,724,002	4,876,368	35.35
Maximum		2,082,718		42.71
Minimum	2026	1,646,661		32.65
Mean		1,877,198	5,043,894	37.22
Maximum		2,345,123		46.49

In table 3, coverage rates are based on the most likely population level for each year. It is estimated that the number of eligible GMS persons will lie between 1.4 million and 2.0 million in 2016, 1.5 million and 2.0 million in 2021 and 1.6 million and 2.3 million in 2026. Coverage is estimated to be approximately 33.23% in 2016, 35.35% in 2021 and 37.22% in 2026 as illustrated in Figure 5.

Figure 5: GMS Coverage (%) Projections 2016 - 2026

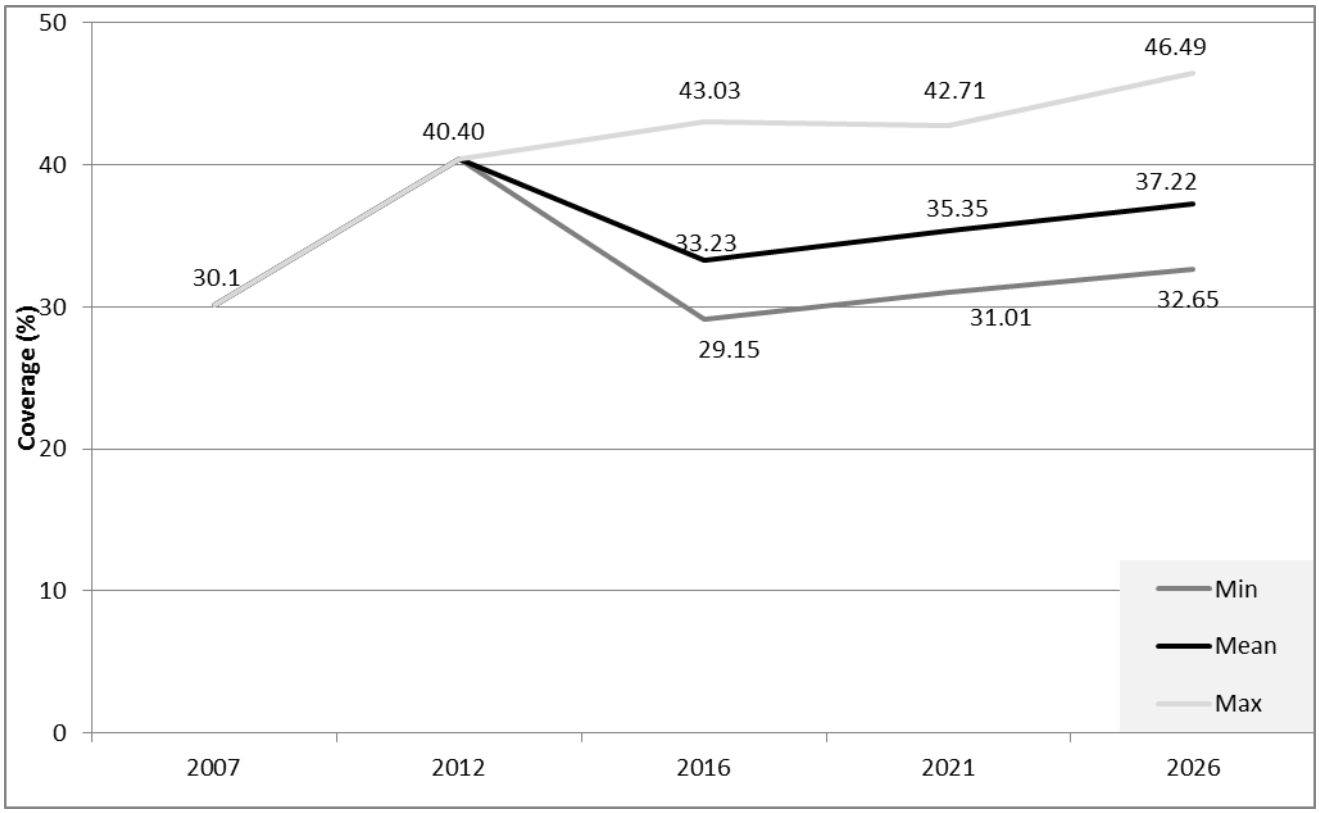


Table 4 illustrates the 2026 coverage rate projections by age cohort, sex and HSE region. The Eastern region is projected to have the lowest coverage rates in 2026 and the North-Western region is projected to have the highest coverage rates for all eleven age cohorts. The older age cohorts (70-74, >75) have higher coverage rates in comparison to the younger age cohorts as frequency of medical cards increases with age. We estimate the majority of people over 70 will retain their medical card which is based on 2012 data.

Table 4: Coverage rate projections by age cohort, sex and old health board region, 2026 - Scenario 2: Mean

Region	< 5	5 - 11	12 – 15	16 – 24	25 – 34	35 – 44	45 – 54	55 – 64	65 – 69	70-74	>75
Eastern											
Males	0.28	0.37	0.34	0.23	0.16	0.21	0.22	0.24	0.32	0.70	0.70
Females	0.28	0.36	0.34	0.27	0.21	0.25	0.22	0.26	0.43	0.75	0.75
Midlands											
Males	0.35	0.43	0.41	0.34	0.29	0.30	0.30	0.31	0.41	0.75	0.80
Females	0.35	0.43	0.41	0.40	0.34	0.34	0.31	0.35	0.55	0.80	0.82
Mid-Western											
Males	0.33	0.39	0.37	0.33	0.29	0.29	0.29	0.31	0.43	0.76	0.80
Females	0.33	0.39	0.37	0.37	0.33	0.32	0.29	0.34	0.52	0.79	0.83
North-Eastern											
Males	0.33	0.40	0.40	0.34	0.27	0.29	0.28	0.31	0.42	0.77	0.85
Females	0.33	0.41	0.40	0.38	0.32	0.33	0.30	0.34	0.54	0.82	0.86
North-Western											
Males	0.39	0.47	0.47	0.44	0.37	0.37	0.37	0.40	0.49	0.82	0.88
Females	0.40	0.48	0.45	0.47	0.41	0.40	0.37	0.42	0.61	0.81	0.86
South-Eastern											
Males	0.36	0.42	0.41	0.37	0.32	0.32	0.31	0.35	0.46	0.77	0.82
Females	0.35	0.42	0.40	0.41	0.36	0.35	0.32	0.38	0.57	0.81	0.85
Southern											
Males	0.30	0.37	0.34	0.29	0.25	0.26	0.26	0.30	0.42	0.75	0.79
Females	0.30	0.37	0.34	0.31	0.29	0.29	0.27	0.33	0.52	0.79	0.83
Western											
Males	0.34	0.43	0.41	0.37	0.30	0.31	0.32	0.36	0.46	0.76	0.80
Females	0.34	0.42	0.40	0.42	0.34	0.33	0.32	0.37	0.57	0.81	0.84

Discussion

Ireland experienced population growth of 2.24% between 2008 and 2012, despite the recession. The population increased from 4,485,100 in 2008 to 4,585,400 in 2012, an increase of 100,300 persons (CSO 2012b). A lot of research has been done in Ireland on the factors driving population increases and population projections. Table 5 compares population projections where time intervals are comparable. Blackwell & Associates (2001) and Morgenroth (2009) were not included in this table as time projection intervals were not comparable to this research.

Table 5: Population Projections 2016 – 2026

Projection Model	2016	2021	2026
Connell & Pringle A1	4,441,002	4,569,854	-
Connell & Pringle A2	4,544,518	4,701,365	-
Connell & Pringle A3	4,594,138	4,750,639	-
Connell & Pringle A4	4,675,912	4,913,637	-
CSO M2F2 Traditional	4,687,000	4,876,000	5,044,000
CSO M2F2 Recent	4,687,000	4,875,000	5,043,000
CSO M2F2 Modified	4,687,000	4,875,000	5,043,000
CSO M3F2 Traditional	4,669,000	4,778,000	4,853,000
CSO M3F2 Recent	4,606,000	4,764,000	4,884,000
CSO M3F2 Modified	4,669,000	4,778,000	4,853,000
Conway et al – Min (CSO M2F1 Traditional)	4,879,485	5,265,206	5,554,739
Conway et al – Mean (CSO M2F1 Traditional)	5,095,004	5,451,088	5,696,000
Conway et al – Max (CSO M2F1T Traditional)	5,769,583	6,027,268	6,066,810
Conway & Woods – Min (CSO M3F2 Traditional)	4,602,428	4,761,773	4,918,805
Conway & Woods – Mean (CSO M2F2 Traditional)	4,686,790	4,876,368	5,043,894
Conway & Woods – Max (CSO MF2T – M3F2T) +M2F2T	4,807,241	5,154,809	5,372,251

Connell & Pringle (2001) results range from their lowest scenario (A1) to their highest scenario (A4). Their projections lie between 4.4 million and 4.6 million for 2016. The CSO population estimates for 2016 are approximately 4.6 million for all 6 scenarios, whereas our population projections are estimated to lie between 4.6 million and 4.8 million. Connell & Pringle (2001) estimate the national population will lie between 4.5 million and 4.9 million in 2021 where our estimates lie between 4.7 million and 5.1 million and CSO projections lie between 4.7 million and 4.8 million. 2026 projections will lie approximately between 4.9 million and 5.3 million, whereas CSO projections will lie between 4.8 million and 5.0 million. Our current population projections are more conservative across all three scenarios than Conway et al (2014) projections. Conway et al (2014) project Irish population will grow by 32.6% between 2007 and 2026 whereas this research projects the total population will grow by approximately 10% between 2012 and 2026. Table 6 compares regional proportional projections for the year, 2021. Connell & Pringle (2001) analysis is based on CSO regions where our research is based on the old health board regions.

Table 6: Regional Population Projections 2021 (% of population in each old health board region)

Model	Border	Dub	ME	M	MW	SE	SW (S)	W	E	NE	NW
Connell & Pringle A1 2021	11.4	23.6	13.1	6.8	8.2	11.9	14.8	10.2			
Connell & Pringle A2 2021	11.3	23.9	13.2	6.7	8.2	11.7	14.7	10.3			
Connell & Pringle A3 2021	11.2	24.1	13.2	6.7	8.2	11.7	14.6	10.3			
Connell & Pringle A4 2021	11.0	24.4	13.4	6.7	8.3	11.5	14.5	10.3			
Conway et al 2021 (CSO M2F1 Traditional)				5.80	8.0	10.5	13.9	9.7	37.4	9.3	5.4
Conway & Woods 2021 (CSO M2F2 Traditional)				6.2	8.1	10.9	14.4	9.2	36.3	9.5	5.4

The CSO South-West region is comparable to the HSE Southern region, which is comprised of counties Cork and Kerry. Our research estimates that 6.2% of the national population will live in the Midlands region, 8.1% in the Mid-West, 10.9% in the South-East region, 14.4% in the Southern region and 9.2% in the Western region in 2021 which are lower than Connell & Pringle estimates. Comparing previous (Conway et al, 2014) and current research, current regional projections have higher proportions except for the East and Western regions which are projected to have 37.4% and 9.2% of the population respectively. The North-Western region is projected to have the same proportion of 5.4% of the population of Ireland under both projection models as presented in table 6.

Comparing Conway et al (2014) coverage projections with current research in table 7, current coverage projections are tighter around the most likely annual coverage rate. Conway et al (2014) estimates coverage projections will lie between 24.49% and 42.28% in 2016, whereas current research estimates between 29.15% and 43.03%. Previous research estimates 2021 coverage rates will lie between 26.85% and 45.64% compared to current research estimates of 31.01% and 42.71%. 2026 coverage projections were estimated to lie between 28.76% and 48.22% compared to current research estimates of 32.65% and 46.49%. This variation may be explained by conservative population projections using census 2011 in this research. This research may become redundant if a single-tier health service supported by universal health insurance is introduced in Ireland. In 2011, free medical care to all was a key objective for the current government (GOI, 2011). In budget 2015, the Irish government went partially towards meeting this objective, by announcing free General Practitioner (GP) care for all children under 6 years of age. A limitation of this research is that the population and coverage projections are produced in the format of the old health board regions. The old health board regions (8) are no longer comparable to the current HSE regional structure (4), which was changed in 2010. Personal communication took place between researchers and a CSO population statistician, but were advised the population data was not available at local health office level but by county level only. If population data was available in this format, this would prove beneficial for future GMS coverage and cost projections.

Table 7: Coverage Projections (%) Comparisons 2016 – 2026

Projection Model	2016	2021	2026
Conway et al – Min	24.49	26.85	28.76
Conway et al – Mean	34.70	37.49	37.23
Conway et al – Max	42.28	45.64	48.22
Conway & Woods – Min	29.15	31.01	32.65
Conway & Woods – Mean	33.23	35.35	37.22
Conway & Woods – Max	43.03	42.71	46.49

Conclusion

This paper has estimated population by the old health board regions, sex and age cohort and the likely effect an increasing population will have on future GMS coverage rates between 2016 and 2026 under various scenarios. The Irish population is estimated to grow by 10% between 2016 and 2026 whereas the over 70s population is estimated to grow by 64% during this projection period, compounding the pressure on GMS coverage rates. Coverage rates are projected to lie between 33% and 46% in 2026. Population growth combined with increased coverage rates will add additional pressure to future health costs.

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Appendix E

Appendix E (Paper 3)

Pharmacoeconomics

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Irish GMS Cost Projections and Its Implications between 2016 and 2026

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Abstract

Introduction: Ireland had one of the highest pharmaceutical spends per capita in the EU in 2012. The General Medical Services (GMS) scheme is the largest community drug scheme in Ireland with approximately 40% of the population eligible for free drugs and appliances in 2012. The total cost of GMS prescriptions increased by 414% between 1998 and 2012. This paper projects Irish GMS cost from 2016 to 2026 and examines the implications of the estimated impact on GMS expenditure.

Method: Central Statistics Office (CSO) population projections (2013) and HSE-PCRS GMS population prescription data (2012) were used to develop four variables; population, GMS coverage, average cost per claimant and claims rate. A Monte Carlo Simulation (MCS) model simulated the effect of these four variables on GMS costs, by health board region, age cohort and sex.

Results: Irish population is projected to grow by approximately 10% between 2012 and 2026. The over 70s population is estimated to grow by 64% with the proportion of males growing by 72%. GMS expenditure is estimated to increase by 64%, from €1.1 billion in 2016 to €1.8 billion by 2026. Age is a key driver of GMS expenditure, specifically those aged under 11 and over 70. The MCS results project that males, the Mid-Western and South-Eastern regions are driving GMS costs in the under 11s. Females, Midlands and Southern regions are driving GMS costs in the over 70s.

Conclusion: Population growth coupled with an aging population will impact future GMS costs. Targeted GMS policy changes such as co-payment charges, reference pricing, and generic substitution can help to contain future GMS expenditure.

Keywords: Monte carlo modelling; Drug prescribing; Pharmaceutical expenditure; GMS

Introduction

In 2012, Ireland spent 14% of total government expenditure on healthcare which is comparable with the European Union (EU) average, EU28. The Netherlands had the highest proportion at 20% and Cyprus had the lowest proportion at 8%. Irish health spending accounted for 8.9% of Gross Domestic Product (GDP), just above the EU28 average of 8.7%. Netherlands recorded the highest value at 11.8% and Romania the lowest at 5.6% [1]. According to a 2015 Organisation for Economic Co-Operation and Development (OECD) report, Ireland spent 1.3% less on health between 2007 and 2013 [2]. Irish pharmaceutical expenditure per capita relative to other OECD countries has increased significantly since 2000. Ireland's position has moved from 20th highest of 27 countries in 2000 to 3rd highest of 25 countries in 2010. In 2010, Irish per capita spending on pharmaceuticals was the highest in the EU and was 34% above the EU average [3]. The Irish government has introduced cost containment measures during the economic crisis to combat this trend such as co-payment charges for patients, GMS eligibility criteria, reference pricing and generic substitution promotion [4]. Despite these cost containment measures, Irish pharmaceutical spending per capita in 2012 was the third highest amongst EU countries at €500, 40% above the EU average (€350) [1].

There are eleven community drug schemes in Ireland, where a person has entitlement to free or subsidised healthcare. The four most expensive schemes are the General Medical Services Scheme (GMS), Drug Payments Scheme (DPS), High Tech Drug Scheme (HTDS) and Long Term Illness (LTI) scheme. The GMS scheme is the largest community drug scheme in Ireland. 40.40% of the population (1,853,877 persons) were eligible for the GMS (also known as medical card scheme) in 2012, the highest it has been since data was published in 1996 (1,252,385-34.5%) [5]. Any eligible GMS person is entitled to free medicines and appliances. Eligibility is determined by income guidelines and persons who are affected by certain medical conditions. The GMS scheme is financed by the state with a contribution from each GMS eligible person. Since October 2010, each person on the scheme incurred a €0.50 charge for every prescription item dispensed up to a maximum of €10 per family per month. This was subsequently increased to €1.50 in 2013 and is currently €2.50 per prescription item up to a maximum of €25 per family per month.

GMS coverage rates (proportion of the population who has a medical card) peaked in 2012 and have fallen to 1,849,380 (40.3%) in 2013 and to 1,804,376 (39.3%) in July 2014. This decrease may be partly attributed to a reduction in the number of discretionary medical

cards issued, which decreased from 63,126 in 2012 to 50,294 in 2013 [6]. Discretionary medical cards are awarded when significant medical costs are incurred as a result of illness and are unable without undue hardship to arrange GP medical and surgical services for themselves [7]. The total cost of GMS prescriptions has increased from €249 million in 1998 to €1.28 billion in 2012, a 414% increase (various annual PCRS Reports – 1998-2012). GMS prescription expenditure rose rapidly after 2000. It increased by 290% from approximately €328 million in 2000 to €1.28 billion in 2012. GMS expenditure accounted for 9% of the overall health budget in 2012 [8]. There are number of factors identified in the literature that influence drug expenditure; population, population aging, inflation, price effects, volume effects, mix of drugs, sex and age [9-12].

Modelling health and drug expenditure varies considerably internationally. A number of studies on health expenditure projections based on historical trends have been carried out in the US [13-15]. The three studies estimated national health expenditure based on assumptions around economic (varying levels of economic growth) and demographic variables for a 10 year period. Another US study developed projections on drug expenditure and incorporated historical trends in drug expenditure and expected changes in the drugs market that may influence drug expenditure in 2015 [16]. A French study forecasted national drug expenditure based on demographic and epidemiological factors out to 2029, using a Markovian micro-simulation model [17]. A Swedish study forecasted drug expenditure in the region of Stockholm over a two year period, 2010-2011. They used a linear regression analysis and applied it to historical drug sales between 2006 to 2009 [18]. Based on expert opinion and a review of the literature, a Monte Carlo Simulation (MCS) was deemed to be the most appropriate model to use.

A 2014 study by Conway et al [19] projected GMS costs for Ireland in five year intervals to 2026, using 2008 Central Statistics office (CSO) population projections. This study estimated that GMS expenditure is estimated to increase from €1.1 billion in 2011 to €1.9 billion by 2026. The conclusions drawn were that age (<11 and >70), females and the Midlands region were found to have the most significant effect on future GMS costs in Ireland. Since then, the CSO [20] has revised its population projections downwards and following the onset of the financial crisis, the Irish government has introduced cost containment measures. This paper adds to the literature by utilising updated CSO population projections and 2012 GMS population prescription data.

The aim of this paper is to project Irish GMS cost from 2016 to 2026 and to examine the implications of the estimated impact on GMS expenditure.

Method

To estimate GMS costs to 2026, we used a MCS model to simulate various scenarios, using the latest CSO population projections and 2012 Health Service Executive-Primary Care Reimbursement Service (HSE-PCRS) population GMS prescription data. From this data, four variables were developed; population, GMS coverage rates, claims rate and average cost per claimant. Three scenarios were formulated for each variable; low variable growth (best case scenario - minimum), average variable growth (most likely scenario - mean) and high variable growth (worst case scenario - maximum).

CSO population data

The CSO regional population projections 2016-2031 [20] provided updated projections based on the 2011 Irish census. Data was detailed by year of age, sex, county and region, incorporating assumptions around mortality, fertility, international and internal regional migration. The revised downward CSO population projections are mainly driven by a fall in fertility. We aggregated the population data into ten HSE cohorts so comparisons can be made with earlier research [19]. An adjustment factor based on the 2011 census was applied as three of the CSO regions (Border, Mid-East, Dublin) did not conform to three of the old health board regions (North-West, North-East, Eastern). There are eight regions (Eastern, South-Eastern, Southern, Western, Mid-West, Midlands, North-West and North-East) within the old health board structure in Ireland.

GMS coverage rates

GMS coverage rates are the proportion of the population who have a medical card. 2012 mean coverage rates by the old health board region, sex and age cohort were estimated using the 2012 PCRS annual report and CSO population projections. The minimum, mean and maximum coverage rates were estimated using historical data between 1996 and 2012. These three scenarios formed the basis of projections for 2016, 2021 and 2026. The projected mean population was used to estimate the coverage rates and the number of eligible persons for each scenario in 2016, 2021 and 2026.

GMS HSE-PCRS database

HSE-PCRS population GMS dataset (2009-2012) and N=60 million for each year. The data is detailed per prescription item (observation). There are 40 variables in the database, of which seven are specific to this research. These include; HSE Local Health Office (LHO) number, year of age, sex, dispense number and total cost (ingredient cost, Value Added Tax (VAT) and dispensing fee). Any person can register with their LHO (32 offices) to determine eligibility for the GMS scheme. A unique dispense number is allocated to each GMS claimant for all prescription items in an individual year. A claimant is a person who has a GMS medical card and makes a claim on that card. If a claimant is issued a replacement medical card within any specific year, they will be allocated a new dispense number. The data was aggregated and analysed by the old health board region (8). The data was cleaned as some data had no sex or age. The year of age variable was aggregated into the eleven HSE age cohorts ranging <5's to the >75's. For the purpose of comparison, the age cohorts, <5 and 5-11 were summed together for the four variables. Data management and analysis was carried out in Microsoft Excel and R-Studio version 2.15.3. HSE-PCRS population GMS dataset (2009-2012), combined with the annual 2012 PCRS report [5] was used to formulate the average cost per claimant and claims rate variables.

Claims rate

The claims rate is the proportion of the GMS population who make a claim. 1,853,877 held medical cards in Ireland in 2012, of which, 1,649,950 made a claim (claims rate=89%). Historical national and regional claims rates were calculated to determine lower and upper bound values around the mean claims rate. Between 2005 and 2012, the lowest national claims rate was 88% and the highest national claims rate was 95% (2007 levels) and these formed the minimum and maximum scenarios respectively. The mean claims rate in 2012 was

scaled by the minimum national and regional claims rate values to determine the lower bound claims rate scenario 2012 by region, sex and age cohort. 2007 claims rate values by region, sex and age cohort were taken as the upper bound scenario for 2012 [19]. For this analysis, the claims rate was assumed to remain at 2012 estimated levels (3 scenarios) over the lifetime of the projections.

Average cost per claimant

The average cost per claimant is the total cost of claimants divided by the number of claimants and this was calculated using the 2012 HSE-PCRS population dataset. The average cost per claimant variable was updated using HSE-PCRS 2009 to 2012 population data and this formed the basis of our projections whereas the previous research [19] was based on a sample 2007 HSE-PCRS GMS database. Historical average cost per claimant data was determined from the HSE-PCRS population database between 2009 and 2012. There is considerable variation in the data year on year. The minimum, mean and maximum growth rates between 2009 and 2012 were calculated by age cohort and sex. This variation may be explained by the Irish economic crisis, an increase in GMS eligibility rates and health expenditure cuts. Therefore, a four year average cost per claimant between 2009 and 2012 was deemed appropriate given the variability in the data and this formed the most likely scenario for 2012 and the base for projections of this variable. Upper bound and lower bound 2012 scenarios were estimated around the mean cost per claimant. Initially, various percentiles and the inter-quartile range were determined, but showed significant variation in the data. Therefore, we estimated lower and upper bounds for 2012 around the mean cost per claimant (mean ± 5%).

The four year average cost per claimant ± 5% formed the basis of projections between 2016 and 2026. For average cost per claimant projections, the minimum, mean and maximum annual growth rates were determined between 2009 and 2012. As the historical data showed significant variation between 2009 and 2012, projections based on these growth rates were not deemed appropriate. A four year average of the health inflation rate between 2009 and 2012 was calculated (2%) and this was applied annually between 2012 and 2026 [21]. The minimum 2012 average cost per claimant (scenario 1) values by region, sex and age cohort were uniformly increased by 2% to determine 2016 scenario 1 average cost per claimant by region, sex and age cohort. For example, a male in the Eastern region in the 0-11 age cohort has an average cost per claimant value of €107.80 in 2012. This value was increased annually by 2% up to 2016 to estimate the average cost per claimant of €116.69 for 2016. The following formula (Eq1) was applied to each of the 160 cells (age cohorts (10), sex (2) and regions (8));

Min ac per claimant 2016=min ac per claimant 2012 (1+0.02)4 (1)

This methodology was applied to all three scenarios to determine three 2016 scenarios. Using the same methodology average cost per claimant 2016 (3 scenarios) and 2021 (3 scenarios) was increased by 2% uniformly across region, sex and age cohort to determine average cost per claimant 2021 and 2026 respectively.

The Cost projection model (Eq 2) is as follows;

Total Cost=f (Population, GMS Coverage, AC per Claimant, Claims Rate) (2)

MCS model was employed due to the uncertainty around the input parameters. The input parameters are population, coverage, claims rate and average cost per claimant based on 2012 data. MCS was employed to propagate the parameter uncertainty through 100,000 iterations. Each input variable is comprised of age cohorts (10), sex (2) and regions (8) giving a total of 160 cells to be modelled for each variable. The dependent variable is the projected total GMS cost for 2016, 2021 and 2026. Taking a large number of simulations (100,000), gives an approximation to the true distribution of projected cost. The equation (Equation: 3) used for simulations is;

Probable cost=Expected cost+error (3)

In order to prepare the data for Monte Carlo Simulations, the probability and cumulative probability of finding a person within each region, sex and age cohort class were calculated. A macro was written in Visual Basic Editor in Microsoft Excel to run the simulations. It's important to assign an appropriate probability distribution to uncertain variables in developing a comprehensive MCS model [22]. A normal distribution was applied to estimate costs to allow for uncertainty in the model. The Central Limit Theorem was applied, which states that the sum of random variables will be approximately distributed [23]. The MCS results were imported into Minitab for analysis. All statistical analyses were performed using Minitab statistical package (Minitab 17).

Results

This section includes a descriptive analysis followed by an empirical analysis.

National population projections

The population of Ireland is estimated to grow from 4.6 million to 5.0 million, an increase of almost 10% between 2012 and 2026 in Figure 1. The female population is estimated to grow by 10.5%, whereas the male population is estimated to grow by 9.5%. The updated population projections in Table 1 are more conservative than the Conway et al. [19] projections.

Year	Current Projections	Conway et al (2014) Population Projections
2012	4.6	4.7
2016	4.7	5.1
2021	4.9	5.4
2026	5.0	5.7
Source: [19]		

Table 1: Comparison current population projections (Million) with Conway et al (2014) Projections.

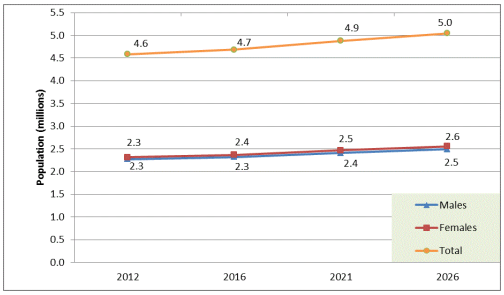


Figure 1: Estimated Population Growth 2012–2026.

The elderly population is those aged 65+ but this paper focuses on the over 70's population as this age group is entitled to free medical care on the GMS scheme. The over 70's include two age cohorts, 70-74 and >75's. The over 70s population is estimated to grow by 64% between 2012 and 2026 in Figure 2. The male population is estimated to grow by 72.2% and the female population is expected to grow by 57.6%[1].

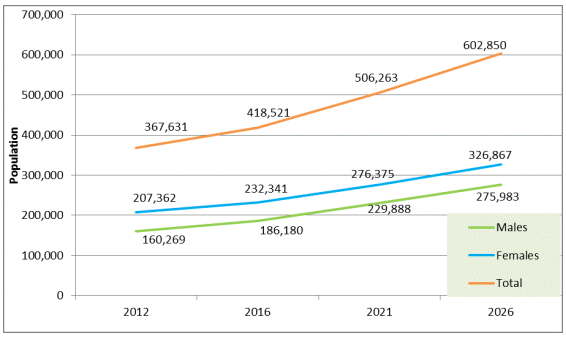


Figure 2: Estimated Population Growth for those aged 70 and over, 2012–2026.

The dependency ratio (ratio of population aged 65+ to the population aged 18-64) indicates the likely impact of population aging. The dependency ratio is estimated to increase from 0.21 in 2016, to 0.24 in 2021 and 0.27 in 2026. The inverse (ratio of population aged 18-64 to the population aged 65+) shows those of working age who support the older population of 65+. It decreases from 4.54 in 2016, to 3.95 in 2021 to 3.49 in 2026.

Regional population projections

Regional population is expressed as a proportion of the national population[2]. In 2012, we estimated that 35.3% of the population live in the Eastern region but this is projected to increase to 37.2% by 2026. Three regions, Midlands, North-West and the South-East region are estimated to grow slightly between 2012 and 2016 and decrease thereafter. The remaining four regions are forecasting a population decrease over the lifetime of the projections.

GMS coverage projections

GMS coverage projections were produced by old health board region, sex, age cohort and three scenarios in five year intervals between 2016 and 2026[3]. Figure 3 estimates GMS coverage rates will lay between 29% and 43% in 2016, 31% and 43% in 2021 and 33% and 46% in 2026. Coverage rates are estimated to be lower in 2016 due to slower population growth. The 2012 estimates of the mean claims rate and the average cost per claimant are available in the supplementary information file. The 2012 average cost per claimant for a male and female in the >75 age category is 15 and 18 times the average cost per claimant of a male and female in the 0-11 age category in the Eastern region, highlighting the variation in cost by age cohort.

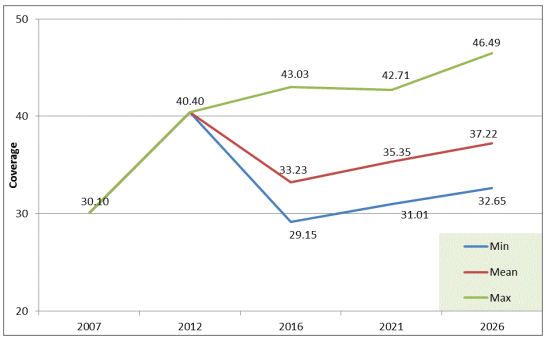


Figure 3: GMS Coverage Projections (%) 2016–2026.

GMS cost projections

GMS cost projections are estimated to be €1.1 billion in 2016, €1.4 billion in 2021 and €1.8 billion in 2026 (most likely scenario) as illustrated in Figure 4. Lower CSO population projections based on lower fertility rates contributed to more conservative GMS cost projections.

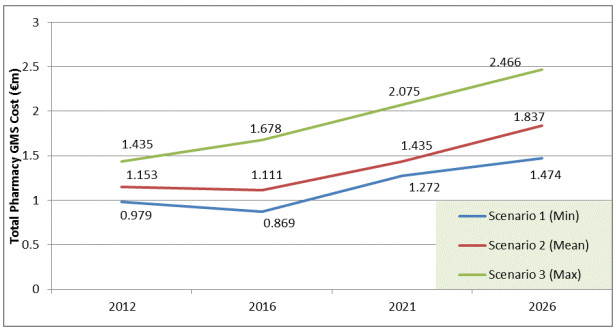


Figure 4: GMS Cost (€m) Projections 2016–2026.

[1] Personal Communication: with a CSO population Statistician advised that males are experiencing higher growth rates than females in older age cohorts, as there more males than females in earlier age cohorts.

[2] See Supplementary Information file for region (population proportion - %) Population Projections 2012 – 2026

[3] See Supplementary Information file for 2026 GMS projections, most likely scenario.

Monte carlo simulation results - descriptive and statistical analysis

The descriptive analysis of 100,000 simulations for 2016, 2021 and 2026 is detailed in Table 2. There is considerable variation in the cost results with 25% of the data lying below €46.02 and 75% of the data lying above €253.43 in 2016. The average cost per claimant is estimated to be €249.96 with the median estimated to be €106.22. The histogram plots the distribution of cost with a higher frequency of claimants having a lower average cost per claimant as illustrated in Figure 5.

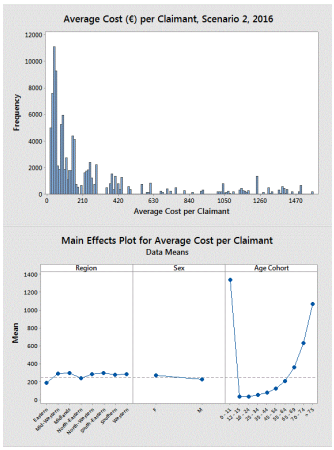


Figure 5: Histogram of Cost and Main effects Plot, Mean Scenario, 2016.

The histogram reiterates the descriptive analysis in Table 2, there is significant variation in cost with the lowest claim of €21.25 and the highest claim of €1573.57 in 2016. In Figure 5, the main effects plot examines the differences between the three categorical variables; old health board region, sex and age cohort. Sex is showing no main effect with all regions showing some effect except Eastern and North-Eastern. Age cohorts show the greatest response, especially under 11s, 65-69 and over 70s. Researchers further analysed these age groups and found that males, Mid-Western and South-Eastern regions are driving costs in the under 11s age group as illustrated in Figure 6.

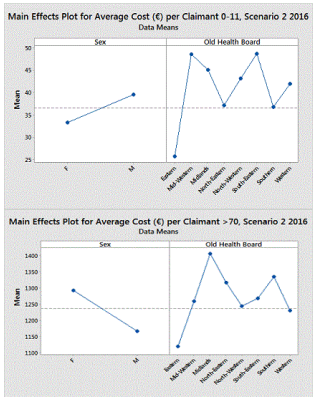


Figure 6: Main effects Plot by Sex and Old Health Board Region <11 and >70, Mean Scenario, 2016.

In Figure 6, females, the Midlands and Southern regions are driving costs in the over 70s. These results were also found in 2026.

Year	# of Simulations	Mean	St. Dev	Min	Q1
2016	100,000	249.96	348.24	21.25	46.02
2021	100,000	307.45	418.28	24.58	53.49
2026	100,000	384.13	508.22	28.14	62.3

Table 2: Descriptive Analysis of Average Cost per Claimant (€) 2016–2026 (Scenario 2- most likely scenario).

Average cost per claimant (€) by sex and region – Scenario 1-Scenario 3

In Figure 7, the Midlands and the Southern regions are the most expensive and the Eastern and Western regions are the least expensive regions for all three scenarios. Females are driving costs more than males for all three scenarios. The under 11s and increasing age are driving costs for all three scenarios. Similar trends were found for sex and age cohort in 2021 and 2026. In 2021 and 2026, the South-Eastern and the Midlands regions are estimated to be the most expensive and the North-Eastern and Eastern regions are estimated to be the least expensive regions.

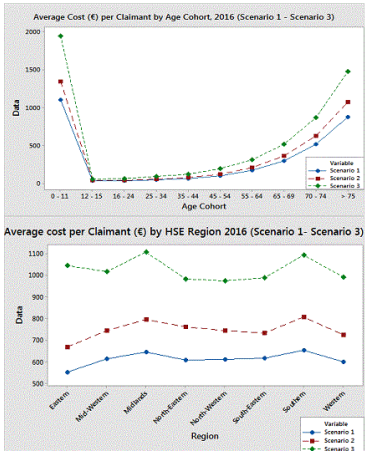


Figure 7: Average Cost per Claimant by Age Cohort, Region and Sex, and Scenarios 1-3 2016.

Discussion

The key findings of this research are; population growth, significant growth in the over 70s population, age, sex and region and the implications they will have in fuelling GMS costs. Irish population is projected to grow by approximately 10% between 2012 and 2026. The over 70s population is estimated to grow by 64% with males over 70 estimated to grow by 72% over the projection period. A combination of falling rates of fertility and mortality produces a greater proportion of older people in society.An aging population will significantly contribute to overall GMS costs and has the potential to cause an increase in GMS coverage rates, claims rates and average cost per claimant. According to a WHO report, a key driver of health care costs is growth in the overall size of the population. Population aging is also

a driver of health care costs, but not to the same extent [24]. An Irish study on aging reported that the dependency ratio was 0.18 in 2011 rising to 0.23 in 2021 [25]. Our estimates for 2021 show a similar finding, with a dependency ratio of 0.24. This Irish study argued the inverse of the dependency ratio was more informative and they estimated a value of 5.7 in 2011 falling to 4.4 in 2021 [25]. In our study, the inverse is estimated to be 3.95 in 2021. An aging population, leading to an increased dependency ratio, will put financial pressures on future health costs. A French study found an increase in aging population and changes in health status will increase French drug expenditure annually by between 1.1% and 1.8% for the over 25s [17].

A US study estimated health spending will grow on average by 5.8% annually to $2.4 trillion between 2012 and 2022 based on a sluggish economic recovery in 2013 coupled with an expansion in coverage due to the Affordable Care Act and an aging population [13]. Two US studies projected drug expenditure and one study projected 12% to 14% increases in US total drug expenditures in clinics, and 5% to 7% increases in hospitals [16]. The other study predicted drug expenditure (ambulatory and hospital) would increase by 2% in 2010 and 4% in 2011 [18]. The current GMS cost projections are more conservative than the previous Irish projections [19]. Previous research estimated GMS cost projections will rise to €1.3 billion in 2016, €1.6 billion in 2021 and €1.9 billion in 2026. This research estimated GMS cost projections will rise to €1.1 billion in 2016, €1.4 billion in 2021 and €1.8 billion in 2026 [19].

This research [19] found that females, age (≤ 11 and ≥ 70) and the Midlands region were driving GMS costs out to 2026. This paper confirms those findings and contributes the following; males, the Mid-Western and South-Eastern regions are driving GMS costs in the under 11s in 2016. Females, Midlands and Southern regions are driving GMS costs in the over 70s in 2016. Our results show that younger male children (≤ 11 years) are a driver of GMS costs in Ireland. This may be explained by a higher incidence of drug prescribing amongst male children. An Irish study investigating prescribing antibiotics trends in a paediatric sub-population found that male participants (0-4 age cohort) were more likely to receive an antibiotic prescription than female participants [26]. A Spanish study examined how gender and age influenced prescription drug use and found a higher prevalence of prescription drugs in males aged 0-4 and 5 to 14 years of age [11]. A Swedish study found more drugs were dispensed amongst males under 10 years [27]. In 2011, a new government was formed in Ireland with an objective of implementing a single-tier health service through the introduction of universal health insurance with free medical care for all [28]. In Budget 2015, the Irish government partially met this objective, by announcing free General Practitioner (GP) care for all children under 6 years of age. As this is one of the most expensive age groups, the Irish government may have been better advised to implement this policy in a less expensive age group such as adolescents as a pilot measure. Females over 70 years are driving GMS costs in Ireland. In Spain [11], Sweden [27] and British Colombia [29], there is a higher incidence of prescribing amongst females compared to males. The Spanish study found drug prescribing is 23% higher in females than males and that age is statistically more significant than sex ($P<0.05$) [11]. In British Colombia, they found that population aging only explained 1 point of the observed annual drug expenditure growth [29]. The drug expenditure growth is largely explained by the increase in the age/sex specific numbers of prescriptions filled per patient and mix of products selected per prescription.

The Midlands region is the most expensive region and the Eastern region is the least expensive region for GMS costs. Upon further investigation at age cohort level, GMS costs differ across the eight regions. The Mid-Western and South-Eastern are the most expensive regions for the under 11s, the Midlands for the over 70s and the Eastern region is the least expensive region for both age cohorts. A high prevalence of chronic conditions in the Midlands region [30] coupled with Usher et al. [31] findings that the Midlands and the Mid-Western regions had the highest prescribing rates for type 1 and type 2 diabetes may explain high GMS expenditure in this region.

In terms of policies on cost containment, in November 2012, a three year agreement was formulated between the Irish Pharmaceutical Healthcare Association (IPHA), the Department of Health and the HSE. The agreement applies to medicines prescribed and reimbursed on the community drugs scheme, including the GMS. This agreement led to reductions in the cost of in-patent and off-patent pharmaceuticals [32]. It was widely reported that this agreement would yield over €400 million for the Irish state over three years. The Irish government estimated €16 million in drug savings in 2012 across all community drug schemes[4], €116 million in 2013, €136 million in 2014 and €150 million in 2015 [33]. According to a recent WHO report [4], the agreement resulted in actual savings of €190 million. Co-payments were introduced as a revenue raising measure. Two Irish studies found both co-payments (€0.50 and €1.50) were associated with larger reductions in adherence to less--essential medicines than essential medicines, with anti-depressant and anxiolytic/hypnotic medicines being the exception [34,35]. In 2013, a number of cost containment measures were introduced. GMS eligibility income criteria were lowered, co-payment charges were increased and new legislation was enacted on reference pricing and generic substitution. These policy changes will reduce future GMS expenditure.

Limitation

The researchers investigated the possibility of developing estimates of the variables by the current regional HSE structure, which incorporates four regions (Dublin Mid-Leinster, Dublin North-East, and West and South). However, this was not possible for the Population variable[5]. Further research investigating the 2013 policy changes and the impact of the IPHA agreement on GMS expenditure would be very useful.

Conclusion

Growth in population and population aging will contribute to future GMS expenditure through the channels of increased average cost per claimant, GMS coverage and claims rates. However, cost containment measures; co-payment charges, generic substitution, reference pricing and GMS eligibility criteria can decelerate the pace of GMS expenditure growth. Co-payment charges are likely to reduce claims rates. Reference pricing and generic substitution are likely to reduce average cost per claimant and eligibility criteria will lower GMS

[4] Minister for Health, James Reilly stated a breakdown in projected savings was not available by community drug scheme.

[5] Personal Communication: with a CSO population Statistician and we were advised that the population data was only available by county but we required further disaggregation. For example, North Tipperary resides in HSE West and South Tipperary resides in HSE South. Therefore the research was based on the 8 old health board regions when further disaggregation was not available.

coverage rates. The health sector in Ireland has a rapidly changing policy environment and this research went in some way to address these changes given the data that was at our disposal.

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Appendix F

Appendix F (Chapter 5 Appendices)

Figure F.1: **Log of Total Cost, non–linear relationship with age**

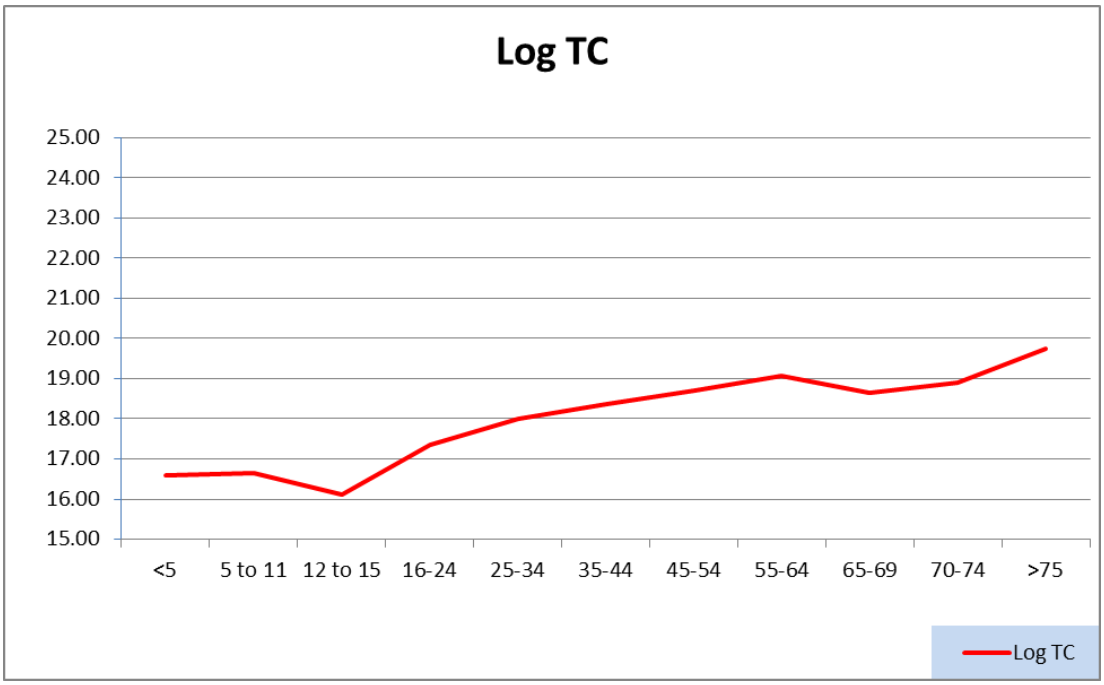


Figure F.2: **Model 1: Test for Normality, Histogram**

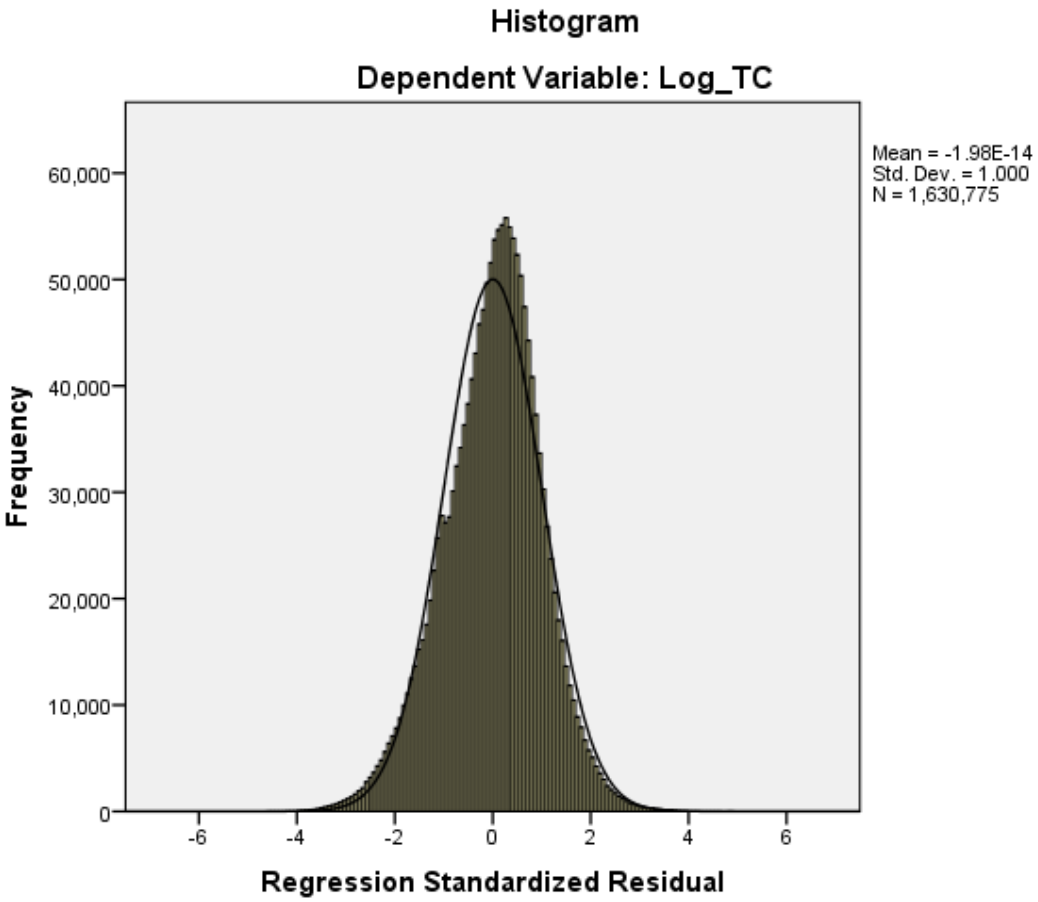


Figure F.3: **Model 2: Test for Normality, Histogram**

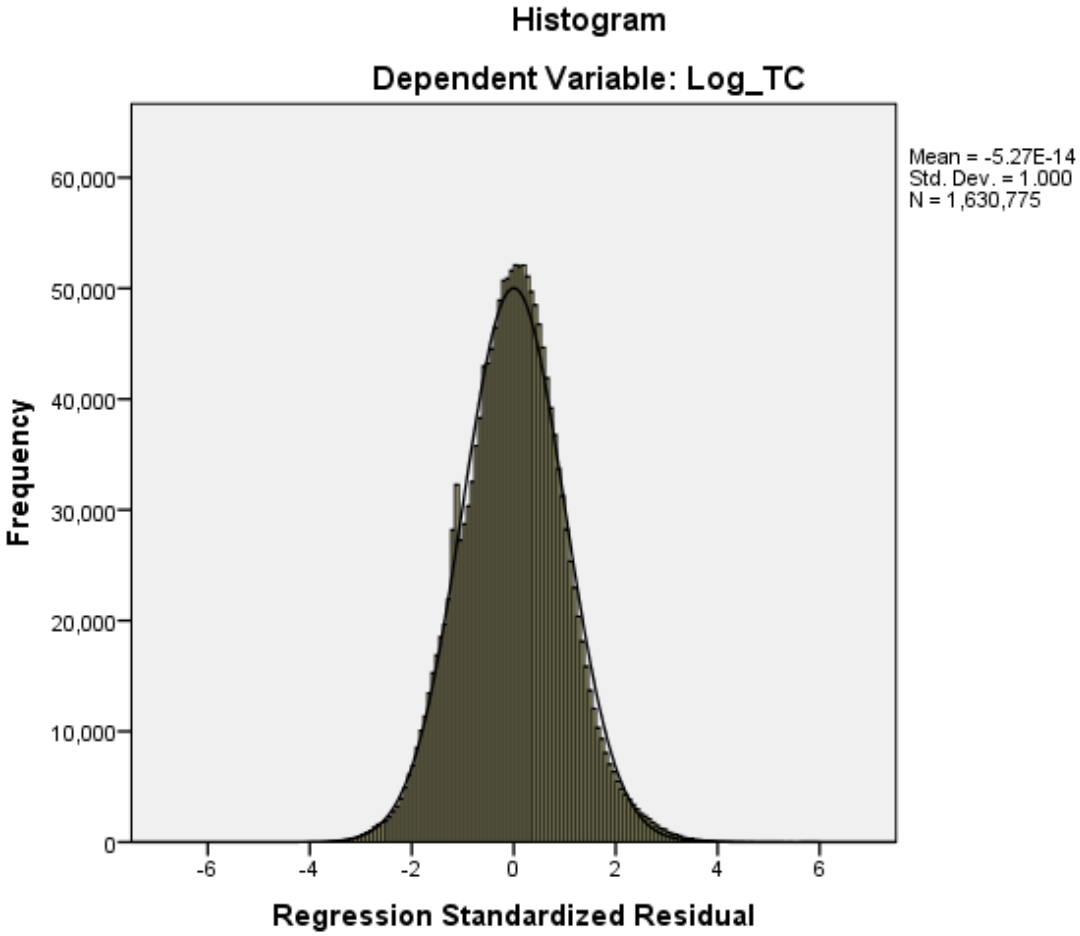


Figure F.4: **Model 3: Test for Normality, Histogram**

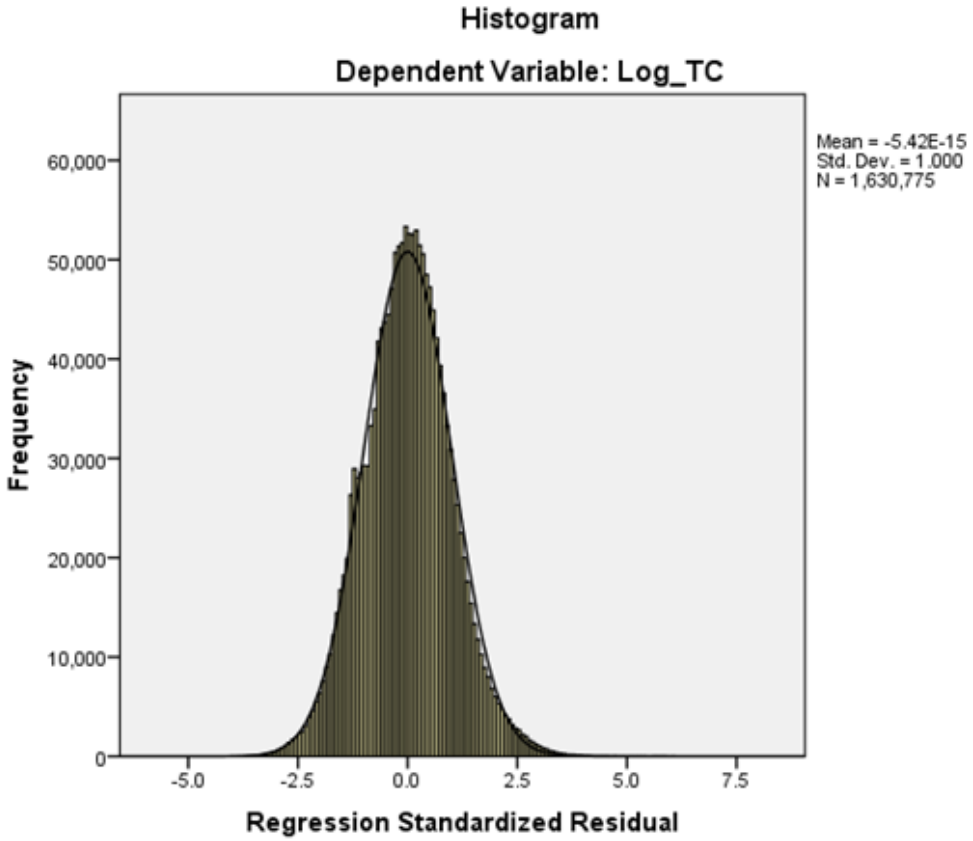


Figure F.5: **Model 1–3: Test for Linearity, Normal Probability Plot**

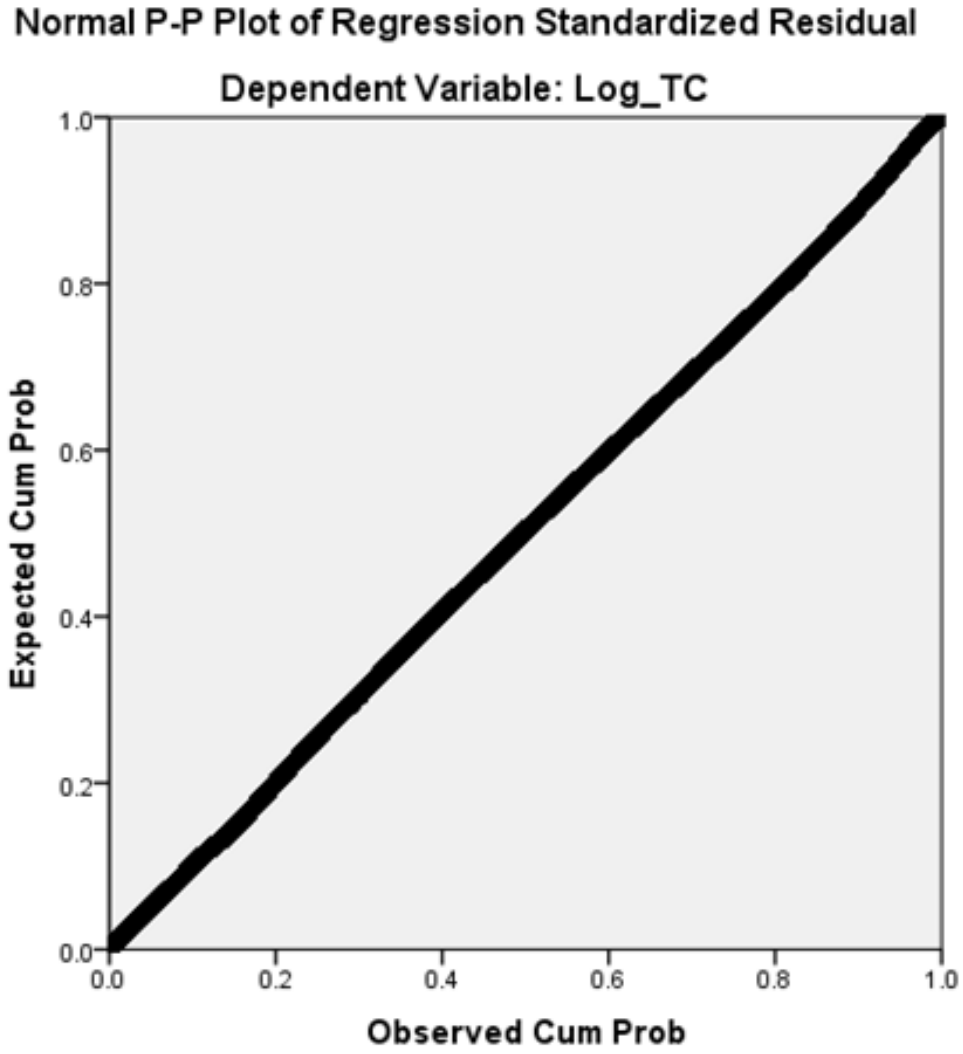


Figure F.6: **Model 1: Test for Homoscedasticity, Scatter Plot**

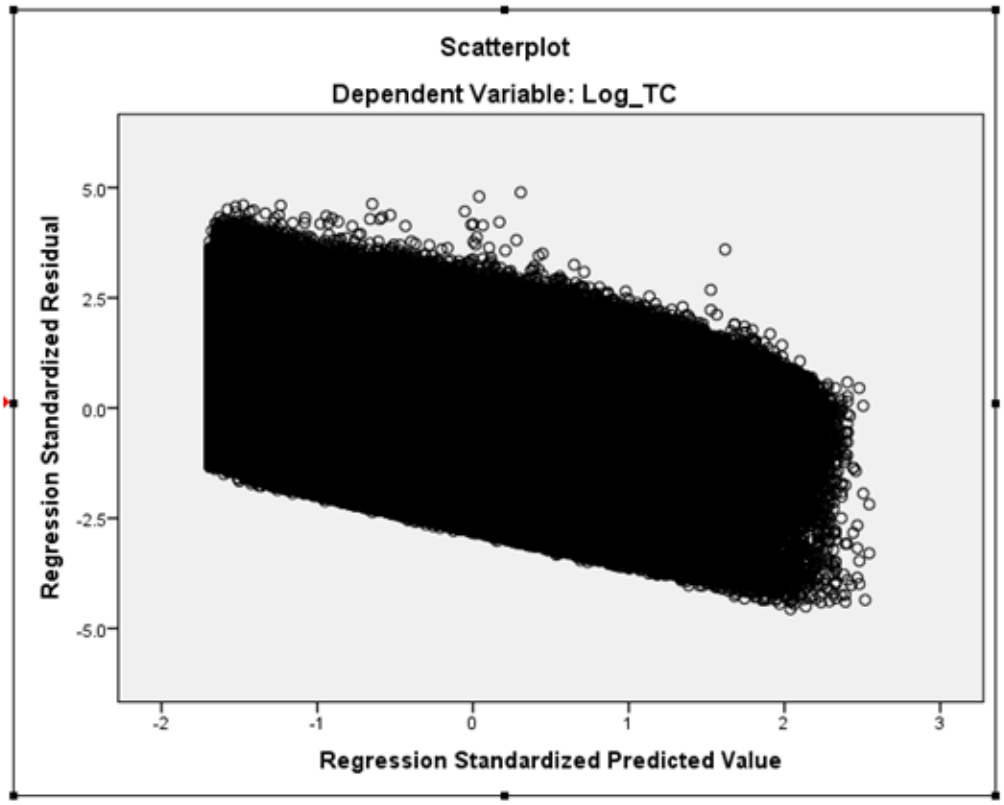


Figure F.7: **Model 2: Test for Homoscedasticity, Scatter Plot**

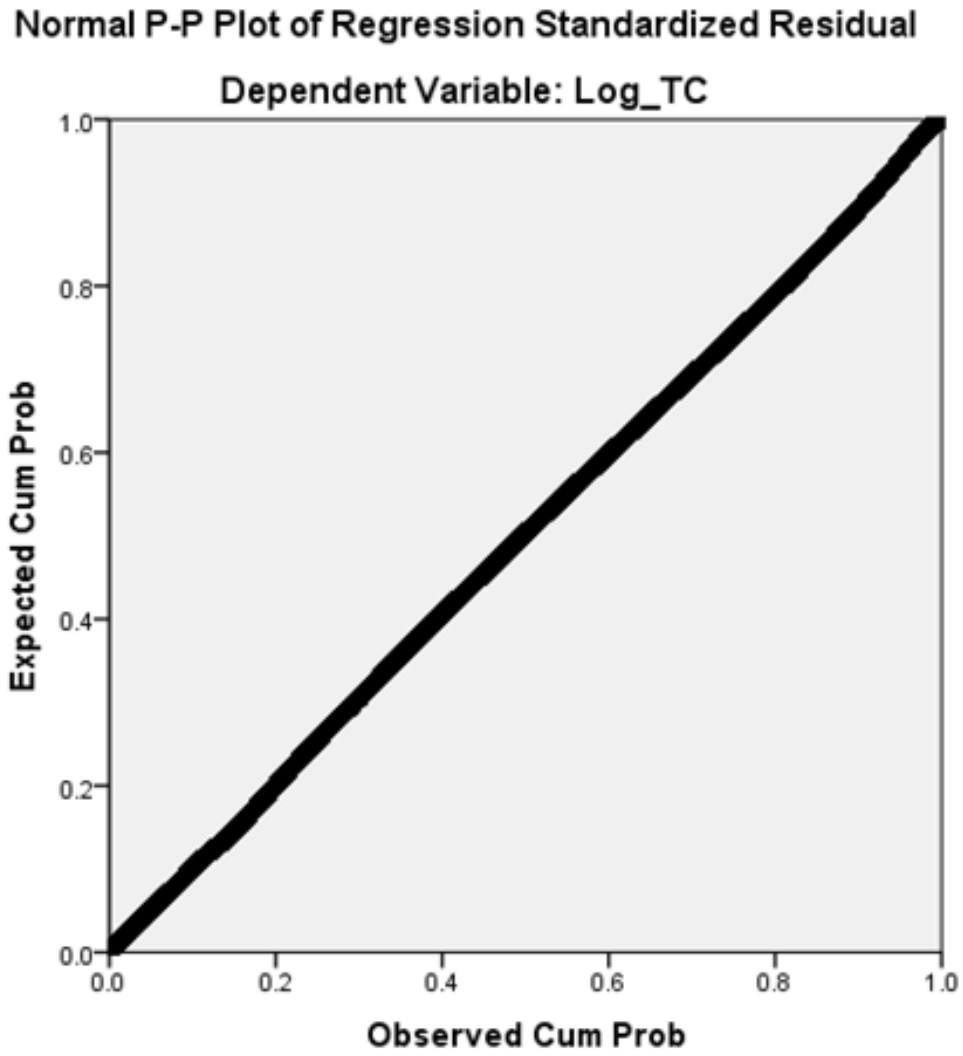


Figure F.8: **Model 3: Test for Homoscedasticity, Scatter Plot**

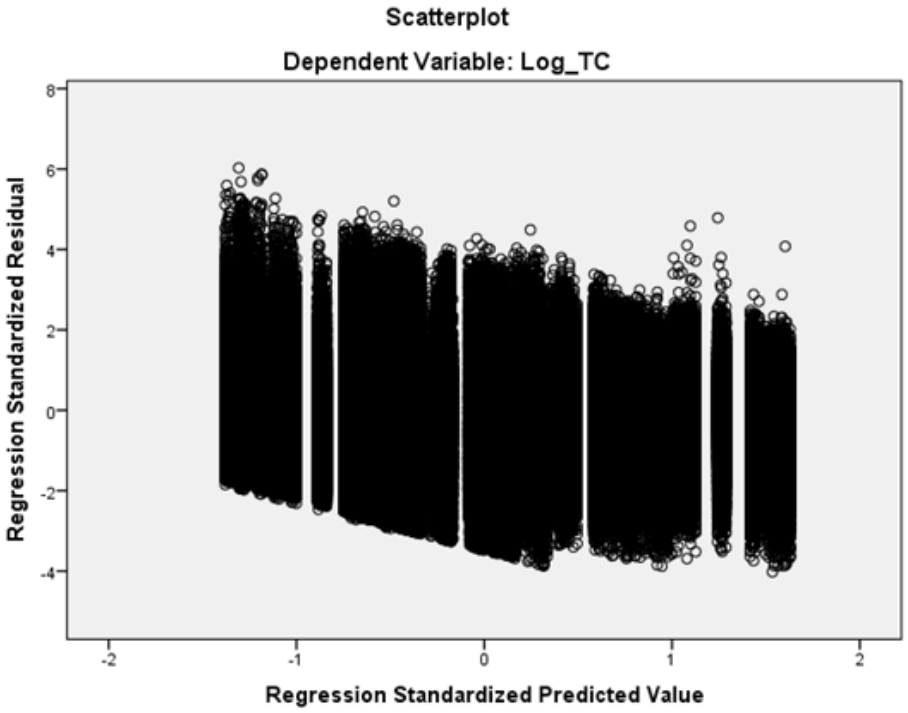


Table F.1: **Respiratory GMS Expenditure (€) by Region and Sex, 0–15**

Region	Total Cost	Female	Male
(Under 5)			
Dublin ML	490,104 (24%)	194,707 (24%)	295,397(25%)
Dublin NE	**385,862 (19%)**	**154,078 (19%)**	**231,784(19%)**
West	505,946 (25%)	195,501 (24%)	310,445(26%)
South	**626,880 (31%)**	**261,969 (32%)**	**364,911 (30%)**
Total	2,008,792	806,255	1,202,537
(5–11)			
Dublin ML	1,046,911 (24%)	417,999 (24%)	628,912 (24%)
Dublin NE	**831,261 (19%)**	**326,158 (19%)**	**505,103 (19%)**
West	1,149,931 (27%)	455,184 (27%)	694,747 (27%)
South	**1,302,602 (30%)**	**517,314 (30%)**	**785,288 (30%)**
Total	4,330,705	1,716,656	2,614,050
(12–15)			
Dublin ML	538,298 (25%)	202,551 (24%)	335,747 (26%)
Dublin NE	**361,847 (17%)**	**147,628 (17%)**	**214,218 (16%)**
West	588,265 (27%)	232,378 (27%)	355,887 (27%)
South	**665,464 (31%)**	**263,584 (31%)**	**401,880 (31%)**
Total	2,153,874	846,141	1,307,733

Table F.2: **Nervous System GMS Expenditure (€) by Region and Sex, 16–44**

Region	Total Cost	Female	Male
(16-24)			
Dublin ML	2,280,228 (24%)	1,196,155 (25%)	1,084,073 (24%)
Dublin NE	**1,590,883 (17%)**	**863,657 (18%)**	**727,226 (16%)**
West	2,584,789 (28%)	1,296,588 (27%)	1,288,201 (28%)
South	**2,864,634 (31%)**	**1,438,294 (30%)**	**1,426,340 (32%)**
Total	9,320,534	4,794,694	4,525,839
(25-34)			
Dublin ML	7,377,677 (27%)	3,867,736 (28%)	3,509,941 (27%)
Dublin NE	**5,063,062 (19%)**	**2,737,957 (19%)**	**2,325,105 (18%)**
West	6,608,161 (24%)	3,389,633 (24%)	3,218,528 (25%)
South	**8,061,683 (30%)**	**4,053,397 (29%)**	**4,008,286 (31%)**
Total	27,110,583	14,048,723	13,061,860
(35-44)			
Dublin ML	10,360,932 (26%)	5,763,904 (27%)	4,597,028 (25%)
Dublin NE	**7,498,266 (19%)**	**4,187,232 (19%)**	**3,311,034 (18%)**
West	10,190,016 (26%)	5,355,278 (25%)	4,834,738 (27%)
South	**11,783,437 (30%)**	**6,406,327 (30%)**	**5,377,110 (30%)**
Total	39,832,651	21,712,741	18,119,910

Table F.3: **Nervous System GMS Expenditure (€) by Region and Sex, 45–64**

Region	Total Cost	Female	Male
(45-54)			
Dublin ML	12,010,286 (26%)	6,894,640 (27%)	5,115,646 (25%)
Dublin NE	**8,215,300 (18%)**	**4,796,099 (18%)**	**3,419,201 (17%)**
West	11,815,477 (26%)	6,457,822 (25%)	5,357,655 (27%)
South	**13,991,055 (30%)**	**7,782,006 (30%)**	**6,209,049 (31%)**
Total	46,032,118	25,930,567	20,101,551
(55-64)			
Dublin ML	12,268,141 (26%)	7,096,581 (27%)	5,171,560 (26%)
Dublin NE	**7,749,063 (17%)**	**4,481,581 (17%)**	**3,267,482 (16%)**
West	12,130,746 (26%)	6,810,817 (26%)	5,319,929 (27%)
South	**14,177,364 (31%)**	**7,948,561 (30%)**	**6,228,803 (31%)**
Total	46,325,314	26,337,540	19,987,774

Table F.4: **Cardiovascular GMS Expenditure (€) by Region & Sex, 65+**

Region	Total Cost	Female	Male
(65-69)			
Dublin ML	7,573,354 (24%)	4,104,470 (25%)	3,468,884 (23%)
Dublin NE	**5,844,488 (19%)**	**3,186,472 (19%)**	**2,658,016 (18%)**
West	8,295,246 (26%)	4,204,591 (25%)	4,090,655 (27%)
South	**9,874,051 (31%)**	**5,152,926 (31%)**	**4,721,125 (32%)**
Total	31,587,139	16,648,459	14,938,680
(70-74)			
Dublin ML	11,144,503 (26%)	5,729,760 (26%)	5,414,743 (25%)
Dublin NE	**9,063,055 (21%)**	**4,696,475 (21%)**	**4,366,580 (20%)**
West	10,400,332 (24%)	5,159,332 (23%)	5,241,000 (24%)
South	**13,006,557 (30%)**	**6,531,322 (30%)**	**6,475,235 (30%)**
Total	43,614,447	22,116,889	21,497,558
(>75)			
Dublin ML	24,722,360 (26%)	14,583,086 (27%)	10,139,274 (26%)
Dublin NE	**18,711,796 (20%)**	**10,867,735 (20%)**	**7,844,061 (20%)**
West	23,719,404 (25%)	13,521,598 (25%)	10,197,806 (26%)
South	**26,817,007 (29%)**	**15,374,622 (28%)**	**11,442,385 (29%)**
Total	93,970,567	54,347,041	39,623,526

Table F.5: **Respiratory System usage by Sex and Age Cohort**

Age Cohort	Female	Male
<5	21,341	**26,322**
5–11	26,236	**32,790**
12–15	13,093	**15,133**
16–24	31,046	22,510
25–34	37,944	22,331
35–44	40,189	26,358
45–54	35,906	24,721
55–64	38,886	27,831
65–69	23,667	16,101
70–74	26,165	21,834
>75	58,316	40,947
Total	**352,789**	**276,878**

Table F.6: **Cardiovascular System usage by Sex and Age Cohort**

Age Cohort	Female	Male
<5	713	**797**
5–11	643	**901**
12–15	529	**541**
16–24	5,296	3,033
25–34	12,315	7,431
35–44	19,796	18,008
45–54	32,489	32,114
55–64	54,388	48,959
65–69	40,062	30,189
70–74	49,341	44,522
>75	114,761	77,140
Total	**330,333**	**263,635**

Table F.7: **Nervous System usage by Sex and Age Cohort**

Age Cohort	Female	Male
<5	6,751	**7,899**
5–11	4,046	**5,433**
12–15	8,231	7,593
16–24	41,657	26,878
25–34	64,761	40,938
35–44	68,275	49,679
45–54	59,848	46,143
55–64	61,868	47,230
65–69	36,823	23,804
70–74	43,240	31,994
>75	107,607	62,286
Total	**503,107**	**349,877**

Table F.8: **Total GMS Cost (€000), Number of Claimants and Average GMS cost per Claimant**

Region	0–5	5–11	12–15	16–24	25–34	35–44	45–54	55–64	65–69	70–74	>75	Total
Total GMS Cost (€000)												
Dublin ML	3,790	4,277	2,466	8,281	17,163	25,127	34,797	49,597	31,221	41,406	107,27	**325,395**
Dublin NE	3,155	3,491	1,914	6,076	12,419	18,673	24,342	32,294	22,931	32,573	78,097	**235,965**
West	3,878	4,575	2,855	9,041	15,995	23,315	32,847	48,765	32,774	38,633	101,990	**314,670**
South	4,370	4,826	2,926	9,688	18,398	26,245	38,277	55,740	36,699	44,677	106,990	**348,838**
Total	15,194	17,169	10,161	33,086	63,975	93,361	130,263	186,397	123,625	157,289	394,347	**1.225**
No. of Claimants												
Dublin ML	34,417	37,073	18,665	42,508	50,425	50,053	40,837	40,286	22,219	30,569	60,205	427,257
Dublin NE	27,476	29,133	14,245	31,225	38,637	40,150	29,940	27,227	16,458	22,783	42,190	**319,464**
West	31,334	34,686	18,906	45,301	47,895	48,720	43,637	45,722	25,694	29,560	60,521	**431,976**
South	33,723	36,525	19,383	44,545	51,525	51,968	45,786	46,684	26,974	32,719	62,246	**452,078**
Total	126,950	137,417	71,199	163,579	188,482	190,891	160,200	159,919	91,345	115,631	225,162	**1.631**
Average Cost per Claimant												
Dublin ML	110.12	115.36	132.10	194.81	340.37	502.02	852.10	1,231.14	1,405.15	1,354.50	1,781.74	**761.59**
Dublin NE	114.84	119.85	134.34	194.58	321.42	465.09	813.03	1,186.10	1,393.31	1,429.70	1,851.08	**738.63**
West	123.78	131.89	151.03	199.58	333.96	478.56	752.73	1,066.56	1,275.56	1,306.93	1,685.20	**728.44**
South	129.59	132.14	150.97	217.49	357.07	505.02	836.00	1,193.99	1,360.52	1,365.49	1,718.83	**771.63**
Total	119.69	124.94	142.71	202.27	339.42	489.08	813.13	1,165.57	1,353.38	1,360.27	1,751.39	**751.10**

Appendix G

Appendix G (Paper 4)

ConwayLenihan et al. Health Economics Review (2016) 6:13
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Health Economics Review

RESEARCH Open Access

Factors influencing the variation in GMS prescribing expenditure in Ireland

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Abstract

Background: Pharmaceutical expenditure growth is a familiar feature in many Western health systems and is a real concern for policymakers. A state funded General Medical Services (GMS) scheme in Ireland experienced an increase in prescription expenditure of 414 % between 1998 and 2012. This paper seeks to explore the rationale for this growth by investigating the composition (Anatomical Therapeutic Chemical (ATC) Group level 1 & 5) and drivers of GMS drug expenditure in Ireland in 2012.

Methods: A cross-sectional study was carried out on the Health Service Executive-Primary Care Reimbursement Service (HSE-PCRS) population prescribing database (n = 1,630,775). Three models were applied to test the association between annual expenditure per claimant whilst controlling for age, sex, region, and the pharmacology of the drugs as represented by the main ATC groups.

Results: The mean annual cost per claimant was €751 (median = €211; SD = €1323.10; range = €3.27–€298,670). Age, sex, and regions were all significant contributory factors of expenditure, with gender having the greatest impact (β = 0.107). Those aged over 75 (β =1.195) were the greatest contributors to annual GMS prescribing costs. As regards regions, the South has the greatest cost increasing impact. When the ATC groups were included the impact of gender is diluted by the pharmacology of the products, with cardiovascular prescribing (ATC 'C') most influential (β = 1.229) and the explanatory power of the model increased from 40 % to 60 %.

Conclusion: Whilst policies aimed at cost containment (co-payment charges; generic substitution; reference pricing; adjustments to GMS eligibility) can be used to curtail expenditure, health promotional programs and educational interventions should be given equal emphasis. Also policies intended to affect physicians' prescribing behaviour include guidelines, information (about price and less expensive alternatives) and feedback, and the use of budgetary restrictions could yield savings in Ireland and can be easily translated to the international context.

Background

Pharmaceutical expenditure is a considerable and growing cost to health care systems in Western European Union (EU) countries, including Ireland. Consequently, it is important to identify the factors influencing this rise in expenditure so as to ensure the sustainability of health systems going forward. Information on pharmaceutical expenditure trends is necessary to facilitate informed decision making about efficient resource allocation, optimum budget allocation, and future policy decisions.

Pharmaceutical expenditure growth is not a recent phenomenon as it has been growing faster than Gross Domestic Product (GDP) in all European countries since the 1980s [1]. A systematic review of the factors influencing pharmaceutical expenditure identified that drug utilisation; drug therapies; price; and new drugs; are the main drivers of pharmaceutical expenditure [2], and population growth and aging have been found to be additional factors in Ireland [3]. In 2012, Ireland spent 14 % of total government expenditure on health which is comparable with the EU average (EU 28 average). Irish health spending accounted for 8.9 % of GDP, just above the EU28 average of 8.7 % [4].

Approximately 14 % of public health expenditure in Ireland was spent on pharmaceuticals in 2012 [5]. Irish pharmaceutical expenditure per capita relative to other Organisation for Economic Co-Operation and Development (OECD) countries increased significantly from 20th

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highest of 27 countries in 2000 to 3rd highest of 25 countries in 2010 [6]. In 2012, the state accounted for €2.6 billion (19 %) of overall health expenditure (€13.71bn) in Ireland through its publicly funded Community Drug Schemes (CDS). There are eleven CDS schemes. The General Medical Services (GMS) scheme accounted for €1.28 billion, 50 % of community drug expenditure, the High Tech Drugs scheme accounted for 385 million (15 %) and the Drug Payments scheme accounted for 126 million (5 %). This paper focuses on the GMS scheme, the largest community drug scheme [7].

The most significant contributor to pharmaceutical expenditure in Ireland is the GMS (medical card) scheme. This is a community drug scheme, whereby drugs, medicines and appliances supplied under the Scheme are provided through retail pharmacies. All GMS claims are processed and paid by the Primary Care Reimbursement Service (PCRS). The scheme is means tested and eligibility is based on income. Persons who are affected by certain medical conditions are also eligible for the scheme. Those who are unable without undue hardship to arrange general practitioner medical and surgical services for themselves and their dependants are eligible to receive free general medical service under the scheme and are issued with a medical card. The scheme is financed by the state with a co-payment from each eligible person introduced in 2010. Since October 2010, each person on the scheme has incurred a €0.50 charge for every prescription item dispensed. This was subsequently increased to €1.50 in 2013 and is currently €2.50 per prescription item up to a maximum of €25 per family per month. Between July 2001 and December 2008, all persons over 70 were granted a free medical card. Due to the economic crisis, eligibility criteria were introduced on the 1st of January 2009 so that all persons ≥70 were means tested.

Since 2000 GMS expenditure on pharmaceuticals has been rising rapidly, as illustrated in Fig. 1. The government introduced cost containment measures during the economic crisis to combat this trend such as co-payment charges for claimants,[1] adjustments to GMS eligibility criteria, reference pricing and the promotion of generic substitution [8]. Despite these measures, Irish pharmaceutical spending per capita in 2012 was the third highest amongst EU countries at €500, 40 % above the EU average (€350) [4]. The total cost of GMS prescriptions has increased from €249 million in 1998 to €1.24 billion in 2009 (400 % increase) as illustrated in Fig. 1. GMS expenditure accounted for 9 % of the overall health budget in 2012 [9].

The total cost of GMS prescriptions decreased in 2010 and 2011, due to government cut backs and the introduction in cost containment measures, before increasing again to €1.28 billion in 2012, at a time when GMS coverage rates[2] increased from 35 % of the population in 1998 to over 40 % in 2012. A study of projected GMS costs for Ireland found that GMS expenditure could rise to €2.5 billion by 2026 [10].

Between 1998 and 2012, between 67 % and 70 % of total annual GMS expenditure has been accounted for by four of the Anatomical Therapeutic Chemical (ATC) groups; Nervous (N) system, Cardiovascular (C) system, Alimentary Tract and Metabolism (A) system and Respiratory (R) system (Annual (PCRS) Reports, 1998–2012). In 2012, €872 million of total GMS expenditure (€1288.82 million) was recorded across the four ATC groups equating to 68 % of GMS expenditure [7]. Table 1 reports the findings of previous studies.

The objective of this research is to investigate the significant drivers of GMS expenditure whilst controlling for age, gender, regional disparities, and the main therapeutic use of the main active ingredient of medicinal

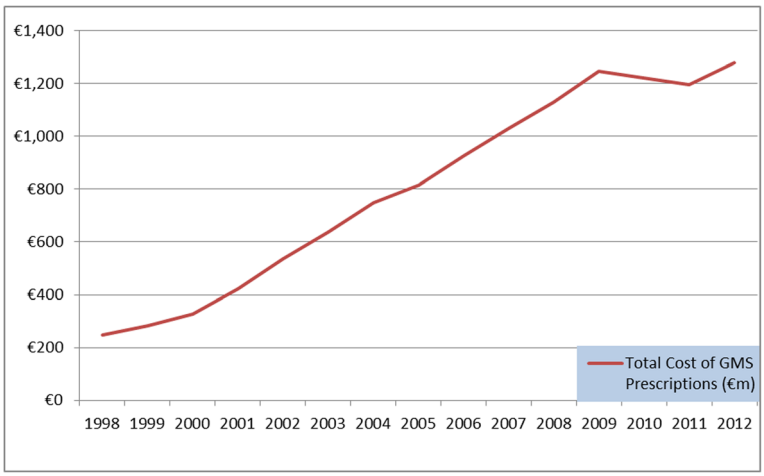


Fig. 1 Total Cost (€m) of GMS Prescriptions between 1998 and 2012

Table 1 Previous Studies

Country	Author	Findings
British Colombia (2006)	Morgan [24]	A population study on drug expenditure in 1996 and 2002 found 75 % of total drug costs were accounted for by 5 ATC groups in descending order of expenditure, 'C', 'N', 'A', 'G' (Genito Urinary System & Sex Hormones) and 'J' (Anti-infectives for Systemic Use).
Sweden (1998)	Gerdtham et al. [34]	This study identified ATC group 'N' contributed the most to drug expenditure.
Sweden (2004)	Gerdtham & Lundin [35]	This study identified ATC groups 'N', 'C' 'and 'A' contributed the most to drug expenditure.
Sweden (2003)	Klarin et al. [36]	A study carried out on an elderly population (84+) found 'C', 'N' and 'A' were the most commonly prescribed drugs.
Spain (2011)	Vivas et al. [13]	This study reported the cost of drugs used to treat hyperlipidemia (from ATC 'C'), respiratory illnesses, asthma (from ATC 'R') and diabetes (from ATC 'A') represents 37 % of total pharmaceutical expenditure on chronic conditions in Valencia.
Ireland (2006)	Naughton et al. [21]	A study based on an elderly Irish population (≥70 years) found that Cardiovascular Disease (CVD) is the most prevalent condition across all regions using a 2006 PCRS pharmacy database.
Various Studies	[3, 10, 20, 26, 30, 37]	A number of studies have identified age as a factor influencing pharmaceutical spending.
United States (1997)	Mueller et al. [30]	A study in the United States found the elderly (65+) accounted for 34 % of total pharmaceutical expenditure, children (≤17) accounted for 9 %, and those aged (18–64) accounted for the remaining 57 %. Of total drug expenditure, 41 % was spent on cardiovascular and renal drugs and 14 % on respiratory tract drugs.
3 European Countries (2008)	Sturkenboom et al. [20]	This study found that respiratory drugs were the most prescribed drugs and cardiovascular drugs were the least prescribed drugs for children (≤18).
Spain (2008)	Fernandez et al. [26]	A study in Catalonia, investigated how age influenced drug utilisation and found drug use was highest among infants (0–4) and those aged 55 and older.
Ireland (2015)	Conway et al. [10]	A recent study identified children (≤11) and the over 65 s as the two key drivers of future GMS costs in Ireland.
Various Studies	[2, 13, 23, 37]	Several studies have reported that females are more likely to utilise drugs than males.
United States (2000)	Steinberg et al. [37]	Males aged 65 and over were 50 % more likely not to be prescribed any drugs.
Sweden (2013)	Loikas et al. [23]	This study examined gender differences in drug prescribing and found 59 % of men and 76 % of women were dispensed at least one drug. Females were found to be prescribed more nervous drugs and males more lipid lowering (cardiovascular) drugs.
Various Studies	[12, 14, 15]	Geographical location is also considered in international studies as a predictor of pharmaceutical expenditure.
United States (2003)	Wrobel et al. [12]	A Medicare study examined the predictability of drug expenditure and found demographic variables (age, sex, disability & geographic location), explained only 5 % of the variation in drug expenditure. The inclusion of health status measures improved the explanatory power considerably.

products i.e., ATC groups. The main contribution of this paper will identify the ATC groups by gender, age and region generating the highest level of cost. It will identify the ATC Level 5 i.e., specific drug within the ATC group that are generating the highest cost. We make recommendations on what policies that can be introduced to reduce cost and generate savings. These policies that will reduce cost can be translated internationally and would yield savings in the international context.

Methods

Study design and data

A cross-sectional study was carried out on the Irish Health Service Executive (HSE)-PCRS pharmacy claims database for the year 2012 ($n = 1.63$ million claimants). Each GMS claimant is identified by a unique dispense number. There are approximately 60 million observations in the database and the data was aggregated to create one observation per claimant. There are 40 variables in the database, of which seven are included in this research. These include demographic information (age, sex, region), cost data (ingredient cost, Value Added Tax (VAT), dispensing fees) and ATC group. For the purpose of this analysis, total annual cost is the sum of ingredient cost, VAT and dispensing fees for 2012. The pharmacology is coded using the World Health Organisation (WHO) ATC classification system[3] [11]. The analysis of the pharmacology is undertaken at the 1st level of the ATC classification system.

Modelling health and drug expenditure varies internationally [2]. A number of studies have used Ordinary Least Squares (OLS) to model the variation in drug and health costs [12–18]. Following a review of the literature and expert opinion, the OLS regression model was deemed the most appropriate model to use.

Empirical analysis

Three models were developed to investigate the association between the total annual GMS cost per claimant and the independent variables. The cost data is positively skewed (skewness = 16.140) and a log transformation was applied to normalise the data. This approach has been previously used [17, 19]. In the first model we estimate the impact on the log of annual total cost per claimant using OLS regression whilst controlling for age, sex, and the 4 HSE regions (Dublin Mid-Leinster (ML), Dublin North East (NE), South and West). The square and cube of age were considered as age has a non-linear relationship with the log of total cost. The inclusion of these two variables does not add to the explanatory power of the model and were excluded.

In the first model we estimate the impact of age, sex and region on the log of total cost.

$$LogTC = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_5 X_5 + \varepsilon$$

where β_0 is the constant, X_1 = age, X_2 = female, X_3 = Dublin ML, X_4 = West and X_5 = South, (Reference category = Dublin NE, Male).

In the second model in addition to the demographic variables, we estimate the impact of pharmacology on the log of total cost by including the main ATC groups.

$$LogTC = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_8 X_8 + \varepsilon$$

where X_1 = age, X_2 = female, X_3 = Dublin ML, X_4 = West, X_5 = South, X_6 = 'A' ATC group, X_7 = 'C' ATC group and X_8 = 'N' ATC group (Reference category = Dublin NE, 'R' ATC, Male).

In the third model in addition to the demographic and pharmacological variables, we estimate the model using 11 age categories, to ascertain the impact of age categories on cost.

$$LogTC = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_{17} X_{17} + \varepsilon$$

where X_1 = female, X_2 = Dublin ML, X_3 = West, X_4 = South, X_5 = 'A' ATC group, X_6 = 'C' ATC group and X_7 = 'N' ATC group, plus 10 dummy variables for age cohort (X_8-X_{17}). (Reference category Age = 12–15, Dublin NE, 'R' ATC group, Male)

The models were estimated by OLS regression. Each model was tested for normality, homoscedasticity and linearity. The Variance Inflation Factor (VIF) and tolerance factors were obtained to test for multicollinearity. All statistical tests were two-sided at the 5 % significance level. Aggregation by GMS claimant was carried out in R Studio version 2.15.3. Statistical Analysis was performed using SPSS 22.

Results

Statistical analysis

The mean annual cost per claimant was €751 (median = €211; SD = €1323.10; range = €3.27–€298,670). As regards age, 14 % were 75 or over, with 4 % between 12 and 15. Over 55 % of claimants were female. In terms of their regional distribution, 28 % were located in the Southern region, 26 % in both Western and Dublin ML, and 20 % in Dublin NE. With reference to pharmacology, 52 % were prescribed an 'N' prescription item, 45 % an 'A' item, 39 % an 'R' item and 36 % a 'C' prescription item. In 2012, 19 % of claimants were prescribed items from ATC groups other than 'A' 'C' 'N' or 'R'accounting for almost €19 million of the total annual cost.

The following descriptive analysis is based on claimants (n = 1,313,825) who were prescribed an 'N', 'C', 'A' or 'R' prescription item. Table 2 presents GMS expenditure (€) by claimants categorised by age category and ATC group.

Table 2 shows that 51 % of claimants in the under 5's were prescribed 'R' prescription items, whereas just 2 % were prescribed 'C' items. Of those aged 25–34, 42 % were prescribed 'N' items, whereas 8 % were prescribed 'C' items. For those aged 75 and over, 30 % were prescribed 'C' items with 16 % prescribed 'R' items. Analysis of expenditure by ATC level 2 identified that respiratory drugs, principally for the treatment of obstructive airway diseases such as asthma, recorded the highest proportion of claimants and total expenditure for those up to the age of 15. Nervous system drugs predominantly for the treatment of depression, anxiety, psychotic conditions, and epilepsy, recorded the highest proportion and expenditure for those between 16 and 64 years. Cardiovascular drugs, particularly statins, recorded the highest proportion and expenditure for those over 65.

Of overall expenditure in 2012, 55 % was due to prescribing claims by females with the proportion of nervous system items (31 %) the major component of this expenditure (Table 3). There was a higher proportion of male claimants up to age 15 in ATC groups 'R', and a higher proportion up to age 11 for ATC 'N'.

Table 4 shows that the South region contributed over €240 m (29 %) to the overall prescribing expenditure in 2012 and was the most expensive region across the four ATC groups. Drugs for the treatment of the nervous system records the highest proportion across the four regions. Dublin ML and Dublin NE record the highest percentage of claimants for the nervous and respiratory system and the West and South record the highest percentage of cardiovascular claimants. Of the 427,257 claimants in Dublin ML, incorporating Dublin City, 31 % were prescribed nervous system items, whereas just 20 % were prescribed cardiovascular items, largely explained by a relatively younger population in Dublin ML.

Table 2 Percentage of GMS Claimants & Expenditure Euro million (€m) by ATC group and Age Category (2012)

Age Cohort	N		C		A		R		Total (€m)	Total GMS
	%	(€m)	%	(€m)	%	(€m)	%	(€m)	N,C,A,R	Cost (€m)
<5	16	0.57	2	0.35	32	0.88	**51**	**2.01**	3.81	12.35
5–11	10	1.78	2	0.29	24	1.13	**64**	**4.33**	7.53	9.46
12–15	28	1.87	2	0.11	20	0.97	**50**	**2.15**	5.10	4.76
16–24	**40**	**9.32**	5	0.52	25	3.44	31	3.91	17.20	17.12
25–34	**42**	**27.11**	8	1.80	26	7.29	24	5.32	41.52	23.69
35–44	**39**	**39.83**	13	6.83	26	12.39	22	7.62	66.68	28.19
45–54	**34**	**46.03**	21	19.31	26	19.79	19	11.32	96.45	35.65
55–64	**29**	**46.33**	27	40.68	26	29.53	18	18.56	135.11	55.41
65–69	26	23.58	**30**	**31.59**	26	19.27	17	13.06	87.49	37.30
70–74	26	27.10	**32**	**43.61**	26	23.28	16	15.22	109.21	51.13
>75	27	79.32	**30**	**93.97**	27	54.78	16	31.85	259.92	119.79
% of Total	36	302.85	29	239.06	21	172.76	14	115.34	830.01	394.86

N Nervous System, *C* Cardiovascular System, *A* Alimentary Tract & Metabolism, *R* Respiratory System
The most expensive age category by ATC group is highlighted in bold

Results of empirical analysis

In Table 5 the results of the empirical analysis are presented based on estimates from three models. Model 1 shows that whilst age, sex and regions are all significant drivers of expenditure, gender (female) had the greatest impact (β = 0.107). Additional claimants in the South region will have greatest cost increasing impact. However, when the ATC groups were included in model 2, the impact of gender was diluted, with cardiovascular prescribing most influential (β = 1.229) and the explanatory power of the model increases from 40 % to 60 %. The inclusion of age dummies in model 3 expectedly shows those aged over 75 (β =1.195) added most to GMS costs. Multicollinearity was not violated as VIF values did not exceed ten, Tolerance values were greater than 0.1. Mahalanobis and Cook's distances tests were carried out to check for outliers. For the residuals output, the max value for Cook's distances did not exceed 1 and the max value for Mahalanobis distances did not exceed the critical χ^2 value.

Discussion

Our investigation identified significant factors [age, sex, region and pharmacology of the drugs] influencing mean GMS expenditure per claimant in Ireland for 2012. This research also identified the drugs (ATC level 5) that incur the highest level of expenditure by age group. The impact of age on expenditure followed a similar pattern as observed in the literature, highest expenditure on respiratory drugs for those under 15, highest on nervous system drugs for those between 16 and 64, and highest on cardiovascular drugs for those aged 65 and over. A recent study reported that children (0–11) and the elderly (70+) will be a key driver of future drug costs in Ireland [3]. A three country study (UK, Italy & Netherlands) found the respiratory system to be one of 3 ATC groups with the highest prevalent rates in children [20]. A study in Ireland found that cardiovascular disease is the most prevalent condition in an elderly population aged 70 and over, indicating the trend has continued between 2004 and 2012 [21]. However, a study in Denmark found treatment intensity and prevalence contributed to drug expenditure costs rather than population aging [22].

In terms of gender differences in prescribing, females account for more than half of GMS claimants in 2012, and were found to be more expensive across the 4 ATC groups with the highest expenditure for nervous system drugs and the smallest for cardiovascular. A study on a Swedish population in 2010 concurs with our findings, which found a greater proportion of men were prescribed cardiovascular drugs whilst a greater proportion of women

Table 3 Percentage of GMS Claimants & GMS Expenditure (€m) by ATC group and Sex (2012)

Sex	N		C		A		R		Total (€m)	Total GMS
	%	(€m)	%	(€m)	%	(€m)	%	(€m)	N,C,A,R	Cost (€m)
Females	31	**178.02**	20	**125.31**	27	**96.23**	22	62.80	**462.37**	687.12
Males	29	124.82	22	113.75	25	76.53	23	52.54	367.64	537.74
% of Total	36	302.85	29	239.06	21	172.76	14	115.34	830.01	1224.86

N Nervous System, *C* Cardiovascular System, *A* Alimentary Tract & Metabolism, *R* Respiratory System
The most expensive group (females) is highlighted in bold The underlined data in Table 3 shows the highest prescribing frequency for females (N,A) and males (C,R)

Table 4 Percentage of GMS Claimants and Expenditure (€m) by ATC group and HSE Region (2012)

Region	N		C		A		R		Total
	%	(€m)	%	(€m)	%	(€m)	%	(€m)	(€m)
Dublin ML	31	79.85	20	61.18	26	46.26	23	31.39	218.67
Dublin NE	31	56.05	21	46.45	26	33.05	23	22.46	158.01
West	30	78.91	22	60.38	26	44.25	22	29.36	212.91
South	30	**88.04**	22	**71.05**	26	**49.20**	22	**32.13**	240.42
% of Total	36	302.85	29	239.06	21	172.76	14	115.34	830.01

N Nervous System, *C* Cardiovascular System, *A* Alimentary Tract & Metabolism, *R* Respiratory System
The most expensive group (South) is highlighted in bold

were prescribed nervous system drugs [23]. A higher female per capita expenditure was reported for nervous and alimentary tract and metabolism drugs in a study in British Colombia with males highest expenditure on cardiovascular drugs [24]. Coronary artery disease was more common in men over 60 than females in Sweden [25]. We reported that males under 11 years were prescribed more prescription items than female which concurs with higher drug usage in adolescent males compared to females in both Catalonia and Sweden [23, 26].

In terms of regional variation, the South region recorded the highest prescribing expenditure and Dublin NE the lowest. Dublin ML recorded the highest proportion of nervous prescription items and Dublin ML recorded the lowest for cardiovascular items. Two Irish studies [27, 28] found variations for Ischaemic heart disease and diabetes respectively, in prescribing by old health board regions.[4] They found high prescribing rates in the Midlands and Eastern regions and low prescribing rates in the Western and North-Western regions. Furthermore, an Irish study found variation in projected drug costs by old health board regions where the Midlands region was the most expensive region which is now part of the Dublin ML region [3]. Research on prescribing in Canada reported that individual characteristics and living environment affect prescription use and may explain regional variations in prescription use. For example, area level measures of population health and socioeconomic status affected the likelihood of prescription use [29].

In examining the factors driving expenditure, we also investigated the most costly prescription items. Drugs for the treatment of the nervous system were the greatest contributor to prescribing expenditure in 2012. An important finding of this paper identified the most

Table 5 Estimates from Multivariate Regression Models 1–3

Variables	Model 1			Model 2			Model 3		
	β	C1 95 %	t-stat	β	C1 95 %	t-stat	β	CI 95 %	t-stat
Constant	3.339			3.288			3.324		
Sex (F)	0.107	(0.103;0.112)	[a]47.84	0.018	(0.015;0.022)	[a]10.07	0.025	(0.021;0.029)	[a]13.66
Age	0.044	(0.044;0.045)	[a]1043.44	0.015	(0.015;0.015)	[a]306.74			
Dublin ML	0.026	(0.019;0.032)	[a]7.76	−0.003	(−0.008;0.002)	[a]-1.16	−0.003	(−0.009;0.002)	−1.20
West	−0.017	(−0.024;-0.011)	[a]-5.16	0.008	(0.003;0.014)	[a]3.07	0.009	(0.003;0.014)	[a]3.21
South	0.056	(0.050;0.063)	[a]17.08	0.038	(0.033;0.043)	[a]14.21	0.037	(0.032;0.043)	[a]14.00
Alimentary				0.911	(0.907;0.915)	[a]440.64	0.903	(0.899;0.907)	[a]436.51
Cardiovascular				1.229	(1.224;1.234)	[a]478.42	1.193	(1.188;1.198)	[a]452.28
Nervous				0.927	(0.923;0.931)	[a]456.61	0.947	(0.943;0.951)	[a]454.63
<5							0.117	(0.106;0.128)	[a]21.57
5–11							0.103	(0.092;0.113)	[a]19.23
16–24							0.237	(0.227;0.247)	[a]45.55
25–34							0.370	(0.360;0.381)	[a]72.09
35–44							0.475	(0.465;0.485)	[a]92.06
45–54							0.706	(0.696;0.717)	[a]131.29
55–64							0.957	(0.946;0.968)	[a]172.64
65–69							1.071	(1.059;1.083)	[a]173.49
70–74							1.126	(1.114;1.137)	[a]189.07
>75							1.195	(1.184;1.206)	[a]215.44
Adjusted R^2		0.402		0.604			0.605		

[a]Statistically significant at 5 % level
The dependent variable was the logarithim of annual total GMS cost (€) per claimant
Baseline - Males, age category 12–15, Dublin NE and ATC 'R'. (least cost variables)

expensive drugs in each ATC group by age cohort. Escitalopram which treats depression and anxiety accounts for the highest expenditure (€0.74 m; 1 % of 'N') for 16 to 24 year olds and Olanzapine which treats psychotic conditions such as schizophrenia and bipolar disorder accounts for the highest expenditure (€2.48 m; 1 % of 'N') for 25 to 34 year olds. Expenditure on Pregabalin (€16.95 m; 10 % of 'N') in 35 to 64 year olds for the treatment of conditions such as epilepsy contributed to 10 % of prescription items for ATC 'N'.

Respiratory drugs was the main contributor to GMS drug expenditures in children up to the age of 15 and this is corroborated by the literature [26, 30]. With an increasing incidence of asthma in developed countries, it's not surprising that drugs for the treatment of obstructive airway diseases, such as Montelukast (€2.4 m; 29 % of 'R'), and inhalers such as Salbutamol and Beclometasone are amongst the greatest contributors to expenditure for ATC group 'R'. A childhood study in Ireland reported that cigarette smoke, atopy, and the presence of certain furry pets, are determinants of respiratory symptoms in children [31].

Cardiovascular prescription expenditure in 2012 was mainly influenced by the prescribing of statins (Atorvastatin, Rosuvastatin, Pravastatin, Simvastatin and Fluvastatin) [7]. Atorvastatin has since come off patent, which should help reduce costs associated with high cholesterol. The greater promotion of generic prescribing for these drugs would lead to cost savings.

Expenditure on Esomeprazole (€31.25 m; 18 % of 'A'), a Proton Pump Inhibitor (PPI) which is used to treat certain stomach and oesophagus conditions, such as ulcers and acid reflux, contribted 18 % of expenditure on alimentary tract and metabolism items. In 2012, PPI's were the second most expensive group of medicines after statins [7]. An Australian study investigated the utilisation of PPI's and found Esomeprazole to be the second most prescribed PPI and the second most expensive group of medicines after statins [32]. An Irish study on the GMS scheme investigated whether cost savings could be made by changes in prescribing practice. They found if Esomeprazole was substituted with a less expensive alternative, it would create savings of approximately €3.3 million [33].

Our analysis highlighted a significant difference between the mean expenditure per claimant and the median. This is explained by high cost users of prescription items in our population. The characteristics of high cost users need further investigation. An important strength of this study is that it provides a population based overview of drug utilisation and expenditure across four ATC groups.

This study is subject to certain limitations. The HSE-PCRS has pre-defined age cohorts, therefore making it difficult to re-construct age cohorts to make comparisons. The age band widths are not equal across the 11 HSE age cohorts. The HSE-PCRS database lacks a unique health identifier, which precludes the link between pharmacy data and other health data such as mortality data. The analysis is limited to the HSE-PCRS database which relates to public patients only.

Conclusion

All European countries have common concerns about growing drug expenditures. The growing proportion of the elderly, the increase in the incidence and duration of chronic diseases, the continuing development of health technologies, and the increase in health expectation of society, are common factors across all countries. Our research indicates that growth in the proportion of elderly claimants and associated levels of cardiovascular prescribing, particularly for statins, will present difficulties for Ireland in terms of cost containment. The primary prevention of CVD is dependent on the effective reduction of the major risk factors, particularly tobacco control and a healthier diet. Policies aimed at population-wide CVD prevention, such as legislating for smoke-free public spaces, banning dietary transfats, or halving daily dietary salt intake are generally effective and cost saving. Based on prevalence rates and related prescribing costs of asthma among children up to the age of 15, it is imperative that public health resources and educational efforts are targeted to improve asthma control and reduce the disease burden on both the healthcare system and society. Expenditure on nervous system drugs in Ireland are highest for those aged between 16 and 64, in particular, drugs for the treatment of anxiety and depression. The treatment of anxiety and depression is vitally important with the growth in suicidal related deaths in Ireland. Whilst pharmacological treatments are often necessary, changes in prescribing practice combined with psychological therapies, cognitive methods, and self-help strategies, can yield cost savings. Since October 2013, a generic substitute for Esomeprazole is now available which could generate substantial savings in alimentary tract prescribing. Whilst policies aimed at cost containment such as co-payment charges, generic substitution, reference pricing, and adjustments to GMS eligibility can be used to curtail expenditure, health promotional programs and educational interventions should be given equal emphasis.

Furthermore, policies intended to affect physicians' prescribing behaviour include guidelines, information (about price and less expensive alternatives) and feedback, and the use of budgetary restrictions could also yield significant savings.

Endnotes

[1]A claimant is a person who is eligible for a GMS card and makes a claim.

[2]GMS coverage refers to the proportion of the population who have a medical card.

[3]In the Anatomical Therapeutic Chemical (ATC) classification system, the active substances are divided into different groups according to the organ or system on which they act and their therapeutic, pharmacological and chemical properties. Drugs are classified in groups at five different levels. The drugs are divided into fourteen main groups (1st level), with pharmacological/therapeutic subgroups (2nd level).

[4]The 8 Health Service Executive (HSE) regions were restructured to 4 Regions (Dublin ML; Dublin NE; South; West) in 2010.

Abbreviations

A: Alimentary; ATC: Anatomical Therapeutic Chemical; C: Cardiovascular; CDS: Community Drug Schemes; CVD: Cardiovascular Disease; EU: European Union; G: Genito urinary system & sex hormones; GDP: Gross Domestic Product; GMS: General Medical Services; HSE: Health Service Executive; J: Anit-infectives for systemic use; ML: Mid-Leinster; N: Nervous; NE: North-East; OECD: Organisation for Economic Co-operation and Development; OLS: Ordinary Least Squares; PCRS: Primary Care Reimbursement Service; PPI: Proton Pump Inhibitor; R: Respiratory; VAT: Value Added Tax; VIF: Variance Inflation Factor; WHO: World Health Organisation.

Competing interests

The authors declare they have no competing interests.

Authors' contributions

ACL conducted data analysis and drafted the manuscript. NW, SA, SM, JC advised on data analysis and revised manuscript. All authors read and approved the final manuscript.

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Appendix H

Appendix H (PhD Research Dissemination)

Table H.1: **Published papers**

Year	Reference
2014	Conway, A., Kenneally, M., Woods, N., Thummel, A., and Ryan, M. The implications of regional and national demographic projections for future GMS costs in Ireland through to 2026. BMC Health Services Research 14:477 October 2014
2015	ConwayLenihan, A., Woods, N. Cost Projections and its Implications between 2016 and 2026 Pharmacoeconomics 1:101 November 2015
2016	ConwayLenihan, A., Ahern, S., Moore, S., Cronin, J., Woods, N. Factors influencing the variation in GMS prescribing expenditure in Ireland Health Economics Review 6:13 March 2016

Table H.2: **Papers Under Review**

Year	Reference
2015	ConwayLenihan, A., Woods, N. Irish population and GMS coverage projections by health board region, sex and age cohort out to 2026 Irish Business Journal

Table H.3: **Presented Research**

Year	Research
2014	National and Regional GMS Community Drug Costs in Ireland to 2026: Analysis, Projections and Policy Simulations ESRI Research Seminar Series, Dublin 06^{th} December 2012

Table H.4: **Conference Presentations**

Year	Title & Conference
2013	The implications of demographic change projections for GMS costs in Ireland through to 2026 Poster Presentation at ISPOR 16th Annual European Congress, Dublin 5th November 2013
2014	The Impact of Increased Coverage Rates on GMS Costs in Ireland Conference Presention at IHEA/ECHE 10th World Congress, Dublin 16th July 2014
2015	The Implications of demographic change for GMS costs in Ireland through to 2026 Conference Presentation at University College Cork 13th February 2015
2015	Regional Variation in Irish GMS expenditure by ATC classification Conference Presentation at 44th Annual Regional Science Association International - British and Irish Section, Dublin 17th August 2015

Table H.5: **Conference Publication**

Year	Title & Conference
2013	The Implications of demographic change for GMS costs in Ireland through to 2026. The Journal of the international society of Pharmaeconomics and outcomes research, Value in Health Published abstract number PH66 16(7) November 2013

Appendix I

Appendix I (PhD Education and Training)

Table I.1: **List of Training Courses undertaken during course of PhD**

Year	**Course**
2011	Endnote Training Course University College Cork.
2011	Literature Review Session University College Cork.
2012	Latex Course Department of Computer Science, University College Cork.
2012	Statistics & Data Analysis for Postgraduate Research Students ST6013 (10 credits) Department of Statistics, University College Cork.
2013	Decision Analytic Modelling for Economic Evaluation – Advanced Course Centre for Health Economics, University of York.
2013	Introduction to Modelling & Meta–Analysis ISPOR 16th Annual European Congress, Dublin.
2013	Systematic Literature Review ISPOR 16$^{\text{th}}$ Annual European Congress, Dublin.

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