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Dichotomous Impacts on Social and Environmental Sustainability: Competitiveness and Development Levels Matter

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ABSTRACT

Whereas in developed countries, sustainability primarily focuses on environmental topics, in developing countries the issues of poverty, development and equity are equally, if not more, important. This paper applies measures of social and environmental sustainability to assess sustainable development across a sample of 94 countries for which relevant data are available for the period 2005 to 2015. A mix of more- and less-developed countries is included. Using the index-based approach introduced by the World Economic Forum (WEF) in its Global Competitiveness Project, a range of indicators are collected for estimating trends in *both* social and environmental sustainability. For the panel of data identified, a dynamic panel data estimator method is applied to the dataset constructed. The paper presents the empirical results identifying key competitiveness factors related to social and environmental sustainability (separately and combining both aspects in a comprehensive sustainability framework). Performance impacts are found to differ substantially across two groups of countries depending on their development level. This highlights the challenges in shaping and achieving sustainable development goals.

Keywords: Social Sustainability, Environmental Sustainability, Global Competitiveness Index, Sustainable Development.

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1 Introduction

This paper engages with challenges inherent in sustainable development, a multi-faceted concept embodying social, environmental *and* economic elements. Sustainability is now widely embedded in policy and research aligned with such concepts as 'circular economy' and 'inclusive growth' that identify the need for consumption and production systems that are in harmony with society and the environment (Corrigan et al. 2014; Piketty & Goldhammer, 2014).

A trade-off between environmental quality and economic growth that previously dominated the development narrative has been amended; now simultaneous targets are increasingly being identified for growth, environmental sustainability *and* societal development (Ambec et al., 2013; Porter & Van der Linde, 1995). For policy, efforts are directed at decoupling economic growth from environmental degradation while leveraging innovation and skill upgrading to foster prosperity for all, especially the most vulnerable (e.g. European Commission, 2010).

However, traditional economic indicators (i.e. GDP, CO^2 emissions) offer limited insight on sustainability (Stiglitz, Sen, & Fitoussi, 2009). Instead, comprehensive integrated and holistic approaches to signal pitfalls and opportunities for policy interventions are required. Effective metrics to measure pathways to sustainable development assist transition to greener and more inclusive performance, highlighting current achievements and areas requiring improvement, to better inform policy. This paper addresses this transition, with perspectives of relevance for less-developed and more-developed perspectives.

This paper addresses the metrics gap by generating estimates of cross-country impacts on economic performance measured as 'global competitiveness' of environmental and social sustainability. A set of adjustments to competitiveness are used following a once-off approach applied by the World Economic Forum (WEF) in its Global Competitiveness Index (Schwab,

2015). Extending the analysis period to a2005-2015 relative to the WEF's focus on one year is one contribution of this study. This research is also novel in examining the intersections between economic competitiveness *and* environmental *and* social sustainability addressing an identified research gap. In addition, the paper investigates the most important competitiveness pillars focusing on both strengths and weaknesses in sustainable competitiveness.

A further consideration is the distinction between countries at different stages of economic development with differential impacts identified in terms of sustainability and competitiveness performances. Many studies have addressed the 'north-south' divide in terms of globalisation debates (Stiglitz 2002), development and learning (McFarlane, 2006), and poverty (Kacowicz, 2007). Here the challenge is presented in terms of 'superstars' of economic competitiveness – the most advanced economies - benefitting most from sustainability adjustments.

In *Section 2,* approaches to defining and measuring Sustainable Competitiveness are set out. *Section 3* sets out the model used and methods followed in empirical analysis. The construction of our dataset for social and environmental sustainability variables (from 2005 to 2013 to align with the WEF approach introduced in 2014) is outlined. In *Section 4* the results from our measurement of sustainable competitiveness are provided. Estimates of the impact on economic performance of environmental and social sustainability are provided, broken down into a range of theoretically-grounded aspects. Comparisons of performance for countries at different levels of development are undertaken that reveal dichotomous performance for those countries at the highest levels of development. *Section 5* concludes with a discussion of the implications.

2 Sustainable Competitiveness: Definition, Concepts & Measurement

A trade-off between environmental quality and economic growth no longer dominates research or policy narratives and simultaneous targets are identified for growth, sustainability and societal development (Ambec et al., 2010; Porter & Van der Linde, 1995).

Environmental sustainability has received much attention within sustainability debates, especially for more developed countries, and the general understanding is that economic development must be decoupled from intensive use of natural resources to avoid surpassing the carrying capacity of the natural environment (United Nations, 2002). Greater activity of companies in developed countries around environmental practices is to be expected (Gardberg and Fombrun, 2006; FiBL et al., 2011) relative to a growth focus in less-developed economies.

Within economic growth research, increasing emphasis on human development, polarization and inequality prevails (Karabarbounis & Neiman, 2013; Piketty & Goldhammer, 2014). While much of this work focuses on developing nations, where economic growth is expected to significantly reduce poverty (Commission on Growth and Development, 2008), increased emphasis on social injustice and inequality have become more evident (post-crises) in mainstream public policy across more advanced economies (Schwab, 2015). For policy, efforts are directed at decoupling economic growth from environmental degradation while leveraging innovation and skill upgrading to foster prosperity for all, especially the most vulnerable (see for example European Commission, 2010).

While the sustainability narrative binds the three key elements of sustainable development - economic, environmental and social – the environmental and social elements of sustainable development are often studied entirely separately to economic growth. The sustainable

competitiveness concept targets this gap, acknowledging that sustainability aspects of the social and the environmental are deeply interwoven.

In this context, the WEF in 2015 extended its definition of competitiveness to encompass sustainability, defining *sustainable* competitiveness as the set of institutions, policies, and factors that make a nation productive over the longer term while ensuring social and environmental sustainability (Schwab, 2015).

2.1 Measuring Competitiveness

A starting point for measurement is those factors that make a nation competitive. The productivity-based approach to competitiveness has evolved from an agreed theoretical background that views productivity as central to the prosperity of nations (Delgado et al., 2012; Krugman, 1994; Porter, 1990). The productivity-based approach focuses on fundamental factors enabling a location-based generation of wealth and prosperity, with specific drivers of productivity presented in Table 1.

Table 1: Drivers of Competitiveness: A Productivity-Based Approach

Traditional Drivers	Recently Identified Drivers	Complex Drivers
• Rules and regulation	• Company sophistication and firm heterogeneity	• Individuals: Culture and trust
• Financial Markets	• Economic geography: Urbanization and clusters	• Institutions: Quality and capacity
• Physical Infrastructure	• Economic composition: 'Economic Complexity'	• Social capital and linkages
• Macroeconomic Policy	• (Creative) skills and locational attractiveness	
• Institutions and Geography	• Different levels of geography (within a nation)	
• Size of the economy		

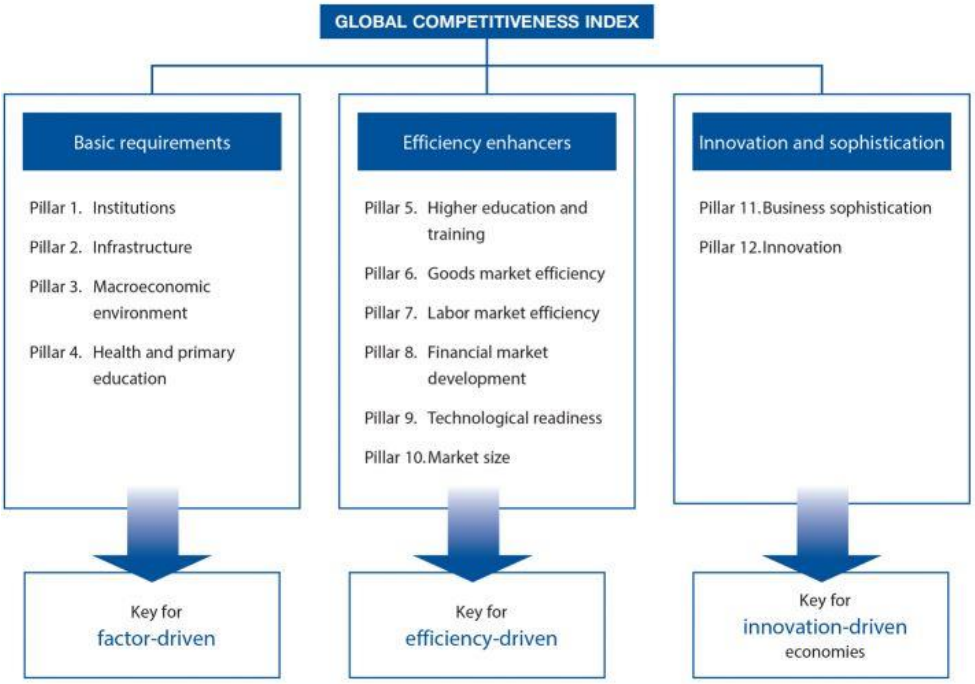
Source: Authors' own, after Ketels (2016).

Drivers are categorized as traditional, recently identified, and more complex, i.e. that have not yet been fully understood (Delgado et al., 2012; Ketels, 2016; Porter et al., 2009). Approaches based

on these drivers includle (i) *The Global Competitiveness Index*[1] (GCI) produced by the World Economic Forum (WEF), (ii) Institute for Management Development's (IMD) *World Competitiveness Ranking*[2] (WCR), and (iii) the *European Competitiveness Index*[3] (ECI) published by the European Commission., with European coverage only.

The GCI published annually between 2005 and 2017 was reported using the format presented in Figure 1[4]. The GCI identifies *twelve competitiveness pillars* driving productivity, organized into three sub-indexes (Basic requirements: Efficiency enhancers; Innovation and sophistication) outlined in Figure 1.

Figure 1: Competitiveness Pillars



[1] http://reports.weforum.org/global-competitiveness-report-2015-2016/
[2] http://www.imd.org/wcc/news-wcy-ranking/
[3] http://www.cforic.org/pages/european-competitiveness.php
[4] While some changes were made to the GCI over that period 2015-2017, comparability across individual indicators and the overall Index is possible across this period. Since 2018, however, a new categorization was introduced with substantial differences that do not support comparability of the GCI pre and post 2018. Hence the focus in this paper GCI consistent with its 2005 construction.

Source: World Economic Forum Global Competitiveness Report 2015-2016.[5]

The extent to which pillars and sub-indexes impact on productivity depends on the *stage of development* of an economy (see Appendix Table). It is increasingly recognized that at different levels of development, locations face different competitiveness challenges and the relative importance of dimensions of microeconomic and macroeconomic competitiveness changes(Porter, 1990: Porter et al., 2008; Delgado et al., 2012).[6]

The approach, while not without criticism (Fougner, 2008; Lall, 2001) is widely used and recognized as the most theoretically grounded approach available, having evolved from an agreed theoretical background that views productivity as central to the level of prosperity of nations (Delgado et al., 2012; Krugman, 1994; Porter, 1990). Its construction by pillar, by sub-index, and in aggregate allows for the identification of vulnerabilities and strengths in national competitiveness. Development debates focus on what *specific* policies are best applied to support productivity growth and to diagnose strategies to close gaps (Ketels, 2006).[7] Thus, the GCI-productivity approach is associated with sound policies like skill upgrading, infrastructure investment, research and innovation investment that are widely-accepted contributions to development.

For this research, preference is given to using the internationally comparable and theoretically-grounded approach found in the WEF's GCI[8] as data are not limited to Europe, and a

[5] Report available from http://reports.weforum.org/global-competitiveness-report-2015-2016/methodology

[6] In measuring the GCI for countries at different stages of development, different weightings of the 3 sub-indexes are applied, with increased weighting towards Sub-Index 3 (innovation-related) for the most advanced countries. The weights were established based on analysis of the underlying data.

[7] It regularly reports on benchmarking aspects of Irish performance relative to peers.

[8] The National Competitiveness Council (NCC, 2016) in Ireland has developed a bespoke competitiveness framework, detailed in Ketels (2016). There are advantages and disadvantages of operating a bespoke model: selected features can relate to those most pertinent to the specific context and experience, however, ability to use cross-country data-sets in a more comprehensive manner is limited.

comprehensive range of data, hard data (66%) and data gathered through business surveys (34%) are used to measure 114 indicators (feeding into pillars) resulting in one GCI score per country.

2.2 To Sustainable Competitiveness

A plethora of separate environmental and social sustainability approaches that have contributed much to each specific field make an integrated assessment of sustainability an intricate task. Traditional indicators (i.e. GDP, CO^2 emissions) present a narrow view of what sustainable development should achieve, highlighting the need for more comprehensive, integrated and holistic approaches (Stiglitz et al., 2009).

Ecologically speaking, environmental sustainability focuses on the natural environment´s bio-geo-physical aspects e.g. maintaining or improving the integrity of the earth's life-supporting systems (Moldan, et. al., 2012). Assessing environmental sustainability should concern *what* is happening to the state of the environment; *why* is it happening; and *what* is being done? (Hammond et al., 1995). Questions such as *if* and *how* efforts for sustainable development achieve decoupling, and what are the reciprocal effects between human influence on the natural environment and economic growth are also high on the research agenda (Patil, 1994).

The social domain is the least theorized and explored pillar of sustainable development and the most complex to operationalise (Colantonio, 2009; Littig & Grießler, 2005; Murphy, 2012). Although a range of analytical approaches to assess socio-economic development exist, they largely failed to align the social domain with sustainability before the 1990s (Colantonio & Lane, 2007; Magis, 2010).

Social sustainability approaches at the national level leverage traditional themes on social development (i.e. income, inequality, etc.) and emerging themes of Quality of Life, the environment as socially defining, and health of communities. Analytical frameworks for social

sustainability usually focus on regional or community levels, rather than the nation (Magee et al., 2012; Woodcraft, 2012).[9]

Here, we select the WEF's research-grounded approach to include sustainability adjustments, for both social and environmental elements, to competitiveness pillars. As the adjustments were made by the WEF for 2015 only this paper applies similar sustainability adjustments for both environmental and social sustainability elements to data extended to the ten-year period 2005-15.

2.2.1 Accounting for Social Sustainability

Social sustainability focuses on enabling maximum health, participation, and security experiences (Bilbao-Osorio et al., 2013). The three elements that comprise the social sustainability adjustment are: access to basic necessities; vulnerability to shocks; and social cohesion and indicators for each element are provided in Table 2.

Table 2: Indicators for Social Sustainability Adjustment

Access to Basic Necessities	Vulnerability to Shocks	Social Cohesion
• Access to sanitation	• Vulnerable employment	• Income Gini index
• Access to improved drinking water	• Extent of informal economy*	• Social mobility*
• Access to healthcare*	• Social safety net protection*	• Youth unemployment

Source: Bilbao-Osorio et al. (2013): * denotes data from EOS of WEF.

As no quantitative data exist for some indicators, survey data (from the Executive Opinion Survey of the WEF) are used for Access to healthcare; Extent of informal economy; Social safety net protection; and Social mobility.

Data are aggregated to generate estimates of each element and these are combined (each element equally weighted) to obtain a national Social Sustainability score. This represents an additional pillar – social sustainability - within the competitiveness framework (Figure 1).

[9] An exception is the social progress index published only since 2013 (Porter, Stern, & Green, 2016).

2.2.2 Accounting for Environmental Sustainability

Environmental sustainability relates to efficient management of resources with both current and future considerations (Bilbao-Osorio et al., 2013 p.58). The environmental sustainability adjustment of the GCI consists of three elements namely, environmental policy, use of renewable resources and degradation of the environment: see Table 3. Survey data (from the Executive Opinion Survey of the WEF) are used for the following indicators: Stringency of environmental regulations: Quality of the natural environment.

Table 3: Indicators for Environmental Sustainability Adjustment

Environmental Policy	Use of Renewable Resources	Degradation of the Environment
• Environmental regulations (stringency and enforcement)*	• Agricultural water intensity	• Level of particulate matter concentration
• Number of ratified international environmental treaties	• Forest cover change	• CO2 intensity
• Terrestrial biome protection	• Fish stocks' overexploitation	• Quality of natural environment*

Source: Bilbao-Osorio et al. (2013); * denotes data from EOS of WEF.

A similar approach of aggregation is carried out to generate a national Environmental Sustainability Score.

This represents an additional pillar – environmental sustainability - within the competitiveness framework (Figure 1).

A national sustainability score is found by averaging the Social and Environmental Sustainability score for each country (Corrigan et al., 2014) to generate a sustainability-adjusted GCI, or ***SGCI***. In line with the approach adopted in the GCI, the SGCI is reported on a scale of 1-7 (all data normalized to this scale) where country scores close to 7 are the 'best' i.e. most competitive or most sustainability competitive.

3 Dataset and Estimation

To understand sustainable competitiveness requires studying interconnected past and present relationships between macro-economic and micro-economic factors that drive economic, environmental and socially sustainable competitiveness. The twelve competitiveness pillars (Figure 1) plus the social and environmental sustainability adjustment pillars capture these various dynamics.

To consider dynamics over the period 2005-2015 a panel of 94 countries was constructed using data from the *Global Competitiveness Index* (GCI).[10] While substantial re-organization of the pillars was carried out in 2009 to better align it with economic development theory (Porter et. al., 2009), the approach followed since 2005 allows for robust comparison from 2005-2015.[11,12] Data for the twelve main pillars were based on individual measures across 114 variables (derived from hard statistical data from several sources and perception-based data gathered in an Executive Opinion Survey carried out by the WEF).[13,14] The contribution of each sub-index (Basic requirements; Efficiency enhancers; Innovation and sophistication) is determined by the stage of development of each country, proxied by its level of GDP per capita: weights are provided in Table 4.

[10] Data available at http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/. Data was retrieved in June 2016.
[11] Most changes after 2009 focused on data sources and on the addition of more countries to the index rather than on the approach.
[12] While the Global Competitiveness Report has been published since 1979 it is only since 2005 that it appears in its current format, or formats compatible with editions to 2015.
[13] For Survey information see http://reports.weforum.org/global-risks-2015/executive-opinion-survey-2014/
[14] Detail on the methods used is provided in http://reports.weforum.org/global-competitiveness-report-2014-2015/methodology/.

Table 4: Weights Applied According to Stage of Development of Nations in GCR

Factors/Stages	Stage of Development				
	Stage 1 (Factor-Driven)	**Transition from Stage 1 to Stage 2**	**Stage 2 (Efficiency-Driven)**	**Transition from Stage 2 to Stage 3**	**Stage 3 (Innovation-Driven)**
GDP per Capita (US$) Thresholds	**< 2000**	**2000 - 2999**	**3000 - 8999**	**9000-17000**	**< 17000**
Weight for Basic Requirements	60%	40-60%	40%	20-40%	20%
Weight for Efficiency Enhancers	35%	30-50%	50%	50%	50%
Weight for Innovation and Sophistication	15%	5-10%	10%	10-30%	30%

Source: World Economic Forum Global Competitiveness Report 2015-2016. Available at: http://reports.weforum.org/global-competitiveness-report-2015-2016/appendix-methodology-and-computation-of-the-global-competitiveness-index-2015-2016/#view/fn-g

To extend the data to cover social- and environmental-sustainability indicators across the ten-year period (2005-15), comparable data was generated for social and environmental sustainability pillars to those identified for the GCI dataset in 2015. Relevant literature was explored to identify comparable social and environmental sustainability indicators to those provided in the GCI. For the purposes of estimation, the aim was to construct a balanced panel with the GCI data from 2005 to 2015 (t=10). This was possible for 94 countries only. Countries that featured in at least 6 annual waves of the GCI were included.

Since the Executive Opinion Survey was used to generate some variables (see Tables 2 and 3), replacements had to be identified for some variables. Techniques to address missing data in constructing composite indexes are discussed by the OECD (2008) where data are missing at random. Since gaps in our data were systematic (i.e. missing for all countries for specific years) and where data was available for most of the period but had missing observations for periods in-between, the research team completed the dataset using the nearest data point in the dataset.

In those cases, weightings of 50 per cent of the 2015 value were used with the remaining 50 per cent generated using comparable hard data from available sources to assure data consistency[15] [16] (appendix Table A2 lists indicators used for sustainability adjustments, and their sources).

The econometric technique used was the Arellano and Bond (1991) Dynamic Generalised Method of Moments Panel Data Estimator. This technique addresses the dynamism that has been identified in the process of developing the foundations of sustainable competitiveness while efficiently dealing with potential issues such as fixed-effects (idiosyncratic, country-specific factors playing a confounding role in estimations) and endogeneity (factors not accounted for that cannot be estimated without introducing bias).

To examine the related features of interest, we formalize their relationship according to the following model:

1. $y_{it} = \alpha_{it} + \beta Z'_{it} + \beta y_{-1} + \mu_{it}$

In Equation 1, the level of sustainable competitiveness (SGCI) is denoted y for country i in year t and is determined by the effect of our parameters of interest that represents a group of vectors $\beta\{z_{it} \ldots . z_{in}\}$ and the error term μ_{it}. In this case, the terms Z' correspond to the 12 competitiveness pillars i.e. their component indicators. The parameter α_{it} represents the fixed-effects, or country-specific characteristics that enable nations to develop different foundations for competitiveness.

Developing the foundations for competitiveness, however, is a slow and evolving process where the level of competitiveness a nation achieves today is largely dependent on its previous

[15] This was the case for the following variables: *Access to Health Care Services* and *Social Safety Nets*..

[16] No time series of variables were identified for *Extent of Informal Economy; Social Mobility; Quality of Natural Environment*. (Arguably in the case of the latter variable, this is indicated by the variables across this entire pillar). The inclusion of the 2015 values for these variables in the analysis means there is no time invariance in the variables across the period considered.

developments (Delgado et al., 2012). Thus, the competitiveness level of a nation at any one point in time is determined by past (or lagged) moments of y (which is determined by past moments of Z'). This is captured by the term βy_{-1}.

Using the AB estimator requires transforming the model into its first differences. This eliminates the individual effects from the model as their presence is the cause of the endogeneity problem. Therefore, the transformed model enables the lagged variable y_{it-2} and their predecessors to be used as valid instruments. These instruments can be used in a GMM approach to obtain an asymptotically efficient estimator of β.

4 Empirical Results

4.1 Adjusting Competitiveness for Social and Environmental Sustainability

Adjusting competitiveness for social and environmental sustainability enables identification of the best and worst performers in sustainable-competitiveness terms. Some specific examples of the adjustments are provided in Figure 2 relative to GCI, with wide variations evident. The mean impact of the aggregate adjustment (i.e. social plus environmental adjustment) is an increase equivalent to 1.7 percent (SD=7.4 percent) with important variation across the sample.

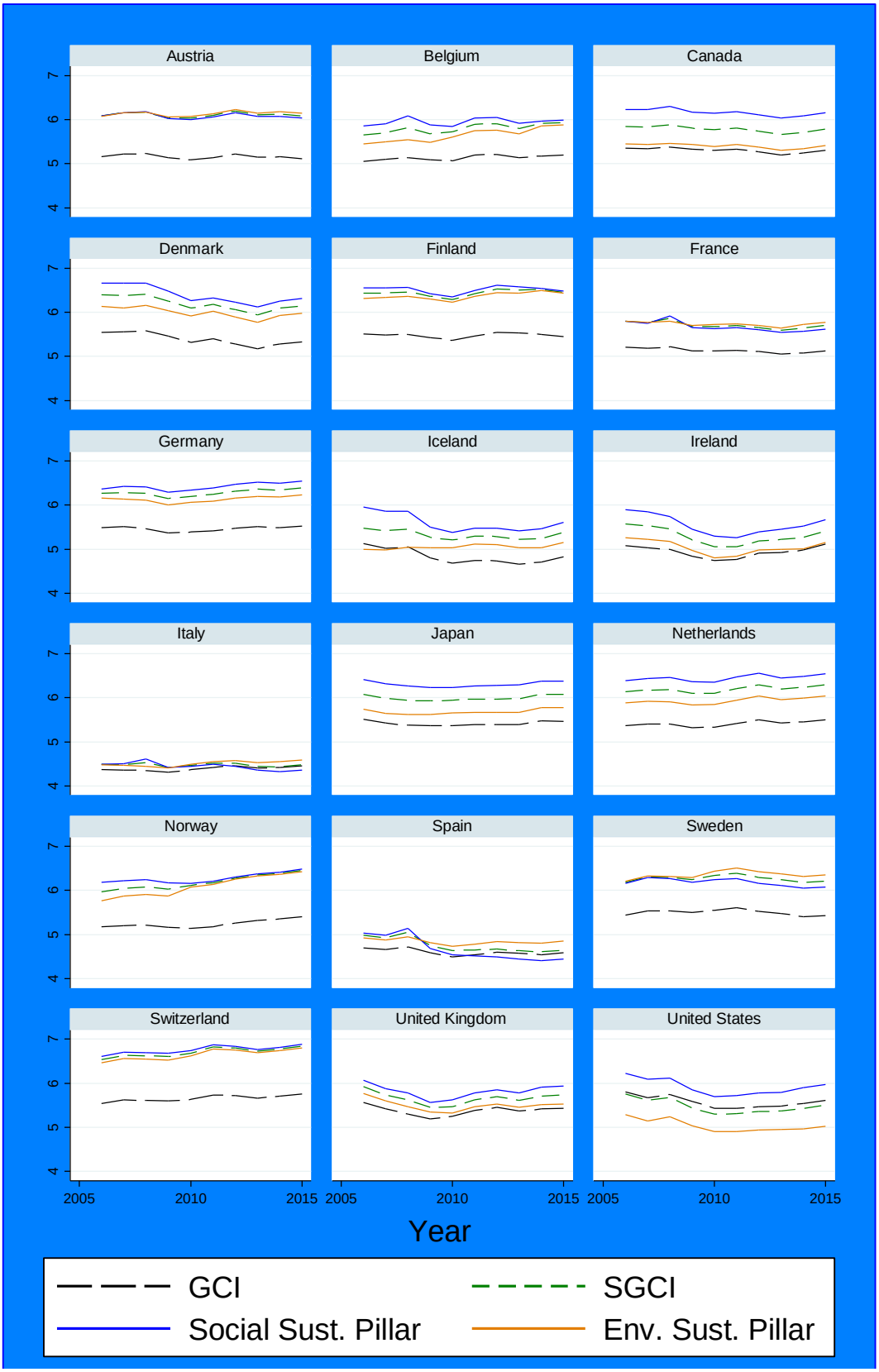
Countries may be classified into three groups according to comparisons between the sustainability-adjustment and the GCI measures.

- Group 1: countries where the adjustment generates a significant *reduction* in performance i.e. SGCI score < GCI score (lower quartile of the sample distribution). Adjusted scores are between -0.27 to -0.7 points lower (i.e. -14 to -6.5 percentage change).
    - In this category countries exhibit a *worse* sustainable competitiveness than *pure* competitiveness score.

- Group 2: for these countries the sustainability adjustment produces a change in the range of -0.1 to 0.3 points, equivalent to -3 to 6.5 percent change. SGCI and GCI scores are approximately similar. Fifty percent of the countries are in this category.
- Group 3: countries for which sustainability adjustment produces a positive change, i.e. SGCI > GCI, of between 0.28 to 1 point (between 6.5 and up to 19 percent).

The top-ten country group benefitting most from the sustainable competitiveness adjustment is dominated by European countries, particularly Scandinavian countries (Finland ranks second, Norway third, Sweden sixth and Denmark seventh) with Japan in ninth place as the only non-European nation. Switzerland ranks, on average, as the most sustainable competitive country during the period 2005 to 2015. The remaining countries in the top 10 are Germany, Belgium, Luxembourg and Austria. The bottom-ten group of countries for which the adjustment has the largest negative impact is dominated by developing economies. These are in Africa: South Africa, Namibia, Lybia and Algeria; the Middle East: Saudi Arabia and Turkey; Latin America: Argentina; the Caribbean: Guyana and Jamaica, and one South Asian Country, Pakistan.

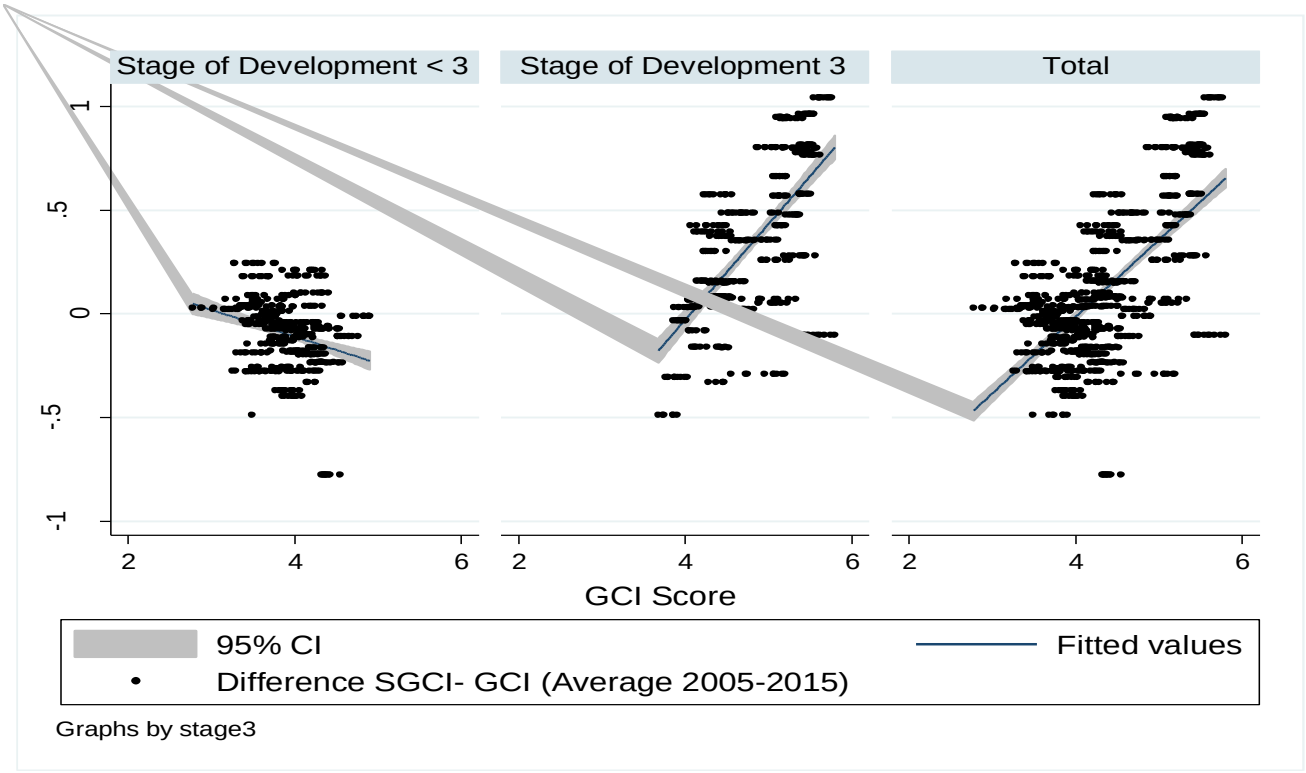
Figure 2: SGCI - Sample of Countries



4.2 Dichotomy of Development Levels

Figure 3 illustrates the relationship between the GCI and the SGCI scores for two samples. Countries with a per capita GDP of at least US$ 17,000 are considered at the highest (stage 3) level of development. For simplicity, we group all other countries below stage 3.

Figure 3: Relating SGCI and GCI: Country Groups



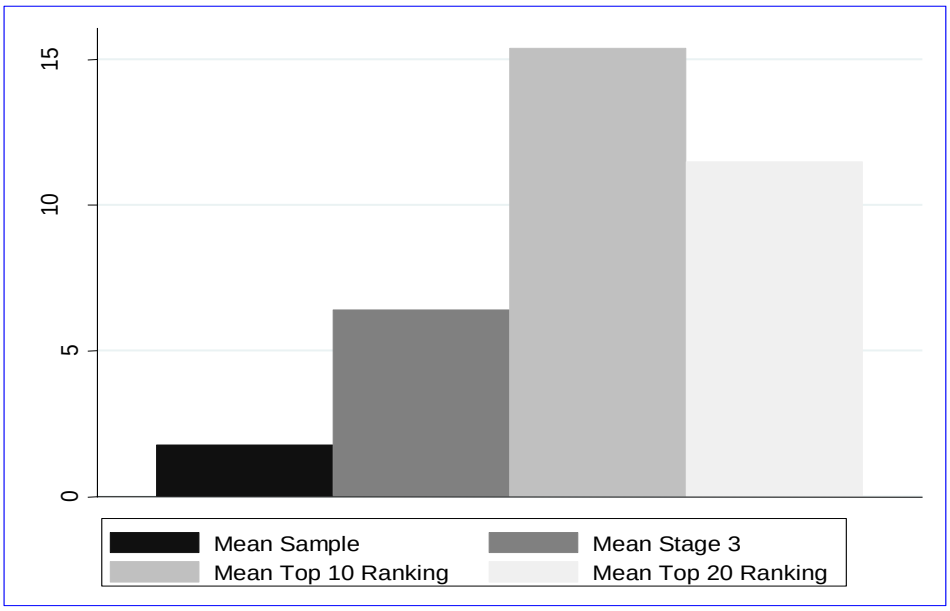
Source: Authors' estimations.

A positive relationship is evident between the economic and sustainability adjusted competitiveness scores for countries at stage 3 (Figure 3: middle panel). The most *economically* competitive countries are also the most *sustainably* competitive. In contrast, countries below this level display a negative relationship between these two indicators. A simple comparison of means suggests that countries in stage 3 of development benefit by approximately 10 percent from the

sustainability adjustment than other economies (Standard Error .018). Thus, more advanced economies also lead the field in sustainable competitiveness.

Figure 4 presents the average gain from the sustainability adjustment for the total sample, for countries in stage 3 of development and countries in the top 10 and to 20 of the SGCI respectively.

Figure 4: Average Impacts of Sustainability Adjustments: Country Groups



Source: Authors' estimations.

Countries in the top 20 gain almost twice as much from adjusting competitiveness for social and environmental sustainability than the broader group of countries at stage 3. Countries in the top 10 gain almost 3 times this amount.

Table 5 displays the contribution each element of sustainability to the SGCI. Column 2 presents coefficients for the overall sample, Column 3 for most competitive economies (stage 3) and Column 4 for the remainder. Coefficients are interpreted as the average contribution of each to changes in annual sustainable competitiveness (SGCI).

Table 5: Contributions of Economic and Sustainability Pillars to SGCI

	SGCI (All)	SGCI (Stage 3)	SGCI (Below Stage 3)
L.SGCI	0.020***	0.011	0.013**
	(0.007)	(0.011)	(0.006)
Economic GCI	1.001***	1.056***	0.981***
	(0.007)	(0.012)	(0.007)
Environmental GCI	0.280***	0.294***	0.253***
	(0.008)	(0.008)	(0.013)
Social GCI	0.319***	0.334***	0.299***
	(0.006)	(0.010)	(0.010)
Observations	744	346	387
arm1	-1.360	-1.687	-1.561
arm2	-2.381	-1.409	-1.004
chi2	24315.407	15931.742	28304.393
N_g	94.000	47.000	51.000
df_m	4.000	4.000	4.0
rss	0.042	0.015	0.012
Robust Standard errors in parentheses * p<0.10 ** p<0.05 *** p<0.01			

The standard economic element ('Economic GCI') is associated with the largest proportion of the changes to SGCI across the sample, by development level with a higher coefficient exhibited for more advanced economies.

The social element is the second largest element, however, its magnitude is significantly lower than the economic element, at around one third of the former. The influence of the social element is most pronounced for more advanced economies. The environmental element is the least influential element with coefficients between 0.25 (less-advanced countries) and 0.29 for the most advanced. Relatively lower coefficients on social and environmental sustainability may be expected since the time-frame (10 years) is narrow within such slowly changing processes, however, rationale for the importance of social relative to environmental sustainability is not clear *a priori*.

4.3 Strengths and Roadblocks to Sustainable Competitiveness

Given interdependence of social and environmental elements of sustainable competitiveness with the economic element, identifying key strengths and roadblocks to sustainable competitiveness provides insights for potential policies impacting on sustainability-adjusted competitiveness. Table 6 reports the contribution of each competitiveness pillar to the overall change (annual average) in SGCI. Results are reported for the entire sample (col.2), for most advanced economies (col. 3), and for less advanced economies (col. 4).

For the entire sample, pillars in the Basic Requirements sub-index suggest that macroeconomic stability and the level of education of the population (primary level) are important determinants of sustainable competitiveness. The level of infrastructure and the institutional environment also matter, but to a lesser extent, and *not* for the most advanced economies. The impact of these pillars is both significant and more pronounced in the less advanced group relative to the overall sample. The effect of the macroeconomic environment is most pronounced for the less developed group. Health and education (primary) are similarly important for both country groups.

Hence, adverse macroeconomic, infrastructural and institutional environments are more detrimental to sustainable competitiveness *outside* the most developed economies. Having developed quality institutions and infrastructure, these factors have no *direct* impact on SGCI for countries at the highest levels of development and we see resilience in SGCI for the most advanced countries. Recognizing that it is other less advanced countries that are worst affected by environmental and climate impacts (Nanda, 2009; Stern, 2006) due to dependence on climate sensitive sectors, specific policies to be developed across all pillars in Basic Requirements can be identified in terms of e.g. food security, poverty reduction and generating adequate living standards. Education is key in generating widespread information both on challenges *and*

mechanisms to address them, and so is a central channel for delivering appreciation of the context necessary for new policy development and implementation (Nath and Behera, 2011: Karlsson, 2002).

Table 6: Contributions of Economic Pillars to SGCI

	SGCI (Full sample)	**SGCI** (Stage 3)	**SGCI** (Below Stage 3)
L.SGCI	-0.126	0.104	0.086
	(0.111)	(0.097)	(0.110)
Basic Requirements Pillars:			
Pillar 1: Institutions	**0.050*** **	0.016	**0.083*** **
	(0.016)	(0.019)	(0.019)
Pillar 2: Infrastructure	**0.070*** **	0.020	**0.093*** **
	(0.013)	(0.023)	(0.013)
Pillar 3: Macroeconomic Environment	**0.107*** **	**0.071*** **	**0.134*** **
	(0.008)	(0.011)	(0.008)
Pillar 4: Health and Primary Education	**0.100*** **	**0.120*** **	**0.117*** **
	(0.016)	(0.040)	(0.013)
Efficiency Enhancing Pillars:			
Pillar 5: Higher Education and Training	**0.100*** **	**0.104*** **	**0.082*** **
	(0.013)	(0.026)	(0.014)
Pillar 6: Goods Market Efficiency	**0.107*** **	0.042	**0.096*** **
	(0.025)	(0.038)	(0.023)
Pillar 7: Labour Market Efficiency	**0.070*** **	**0.085*** **	**0.065*** **
	(0.012)	(0.023)	(0.016)
Pillar 8: Financial Market Development	**0.078*** **	**0.082*** **	**0.052*** **
	(0.015)	(0.022)	(0.016)
Pillar 9: Technological Readiness	**0.097*** **	**0.105*** **	**0.062*** **
	(0.011)	(0.015)	(0.013)
Pillar 10: Market Size	**0.056** **	-0.026	0.025
	(0.022)	(0.046)	(0.026)
Innovation & Sophistication Pillars:			
Sub_Pillar_3	**0.186*** **	**0.331*** **	**0.103*** **
	(0.024)	(0.037)	(0.028)
Observations	744	346	387
arm1	-0.231	-1.515	-1.988
arm2	-1.182	-0.391	0.144
chi2	2896.637	3524.549	5628.204
N_g	94.000	47.000	51.000
df_m	18.000	18.000	18.000
rss	1.490	0.700	0.659

Standard errors in parentheses * p<0.10 ** p<0.05 *** p<0.01
Notes: Coefficients in b**old** indicate statistical significance. Coefficients **underlined** denote sub-sample coefficients higher than the full-sample coefficient.

Pillars in the second sub-index exhibit larger coefficients for more advanced nations. The importance of four of the six pillars increases with economies' competitiveness, emphasizing challenges for less developed countries (Tol et. al, 2004). Not only are developed countries less dependent on climate sensitive sectors, e.g. agriculture, but they have greater resources to invest in adaptation, enjoy more flexible economies and financial markets permitting greater resilience potential (Grasso, 2004; Hallegatte et.al, 2006).

Finally, the Innovation and sophistication sub-index features the most important pillars driving sustainable competitiveness for the entire sample and most advanced economies.[17] The differential impact is largest across all pillars – the coefficient is over three times larger for developed countries. This is consistent with the understanding that innovation is *not* a 'low hanging fruit' and it is largely affected by resources and capabilities in firms and also by the national (and regional) innovation systems (Shrolec, 2011; Farinha et al, 2018). While less advanced nations are not at a stage where the interaction of multiple elements yields an adequate environment for strong innovation systems to develop, a positive relationship is evident between this pillar and sustainable competitiveness. In this country-group, sustainable competitiveness is more dependent on macro-economic environment, and health and primary levels of education attainment.

[17] Pillars within this sub-index exhibited high collinearity (correlation coefficient 0.92) and were combined (equally weighted) for estimation purposes.

5 Discussion and Conclusions

The paper makes two key contributions. It first explores how sustainable competitiveness offers a comprehensive assessment of the inter-related dynamics of the social, the environmental and economic building blocks of sustainable development simultaneously. It also identifies discrepancies between more- and less-developed economies in terms of their sustainability outcomes and how these are impacted by elements of their economic performance.

Sustainable competitiveness is determined by the capacity of nations to generate economic prosperity within an efficient economic system, supported by strong institutional foundations and normative behaviours (Solvell, 2015). Understanding sustainable competitiveness requires studying the interconnected past and present relationships between macro-economic and micro-economic factors that drive economic, environmental and socially sustainable competitiveness. While calls for greater integration of economic, social and environmental elements of sustainable development, evident in policy, have been directed towards decoupling economic growth from environmental degradation such integration has been less pronounced in research, especially in terms of a focus on social aspects.

Addressing this gap, our first area of focus is on data collection for measurement, so that comparable baseline data across countries are considered (Esty, 2002). Analysis reveals that sustainability is not in opposition to economic competitiveness, contributing to the modern paradigm viewing economic development and sustainability as mutually reinforcing (Porter and van der Linde, 1995; Ambec and Barla, 2006). We find that more competitive countries (in GCI terms) also feature strong sustainability features. However, a substantial challenge arises from our finding that only the most advanced countries enjoy a positive relationship between traditional

economic competitiveness pillars and sustainability adjustments (Figure 4). A ceiling on positive economic/sustainability effects is measured.

In fact, this finding echoes the debate relating performance and environmental regulation and the mixed findings identified (see Jaffe and Palmer, 1997; Brunnermeier and Cohen, 2003; Horbach, 2008; Walker et al., 2008). For example, what Porter and van der Linde (1995) identified as 'innovation offsets' that systemically increase competitiveness in response to more stringent (costly) regulation are not found to be universally enjoyed.

Recent research into innovation determinants in developing countries and the wide distribution of innovation within this group is relevant here: approximately 25% of firms in A (see Schrolec, 2011 and for the figures that follow). Firm level capabilities are essential for innovation, increasing the probability of innovating by 75% for the most capable firms. A link to the current research is evident in the estimated relationships between innovation and national economic impacts where the 'average' firm in Armenia had a 60% probability of innovating as the country enjoys the most favourable national conditions: the comparable probability was 19% for Morocco.

In terms of future research greater appreciation of the interaction effects between national 'pillar' conditions and firm innovation activities would increase understanding of the relationship between these separate features and sustainable competitiveness both within developing countries as a group and across the country groups of less- and more-advanced countries. Furthermore, based on our productivity-focussed definition of competitiveness, that builds up from firm-level activities, it is crucial to integrate understanding of this level of activity into the picture that emerges at national level in future research. Dominant features of divergence and heterogeneity across national features within world economic development, highlighted in Cimoli et. al, (2009),

make identifying simple approaches to the dichotomy extremely challenging, and pointing to the need for detailed qualitative research to accompany quantitative analyses.

We would agree that 'simple' goals such as increasing public expenditure on research would be blunt and ineffective as a route to innovation-based growth in developing countries (Gaillard, 2008: Schrolec, 2011). Instead focus on improving generic conditions are more liable to reap benefits including as we find here for sustainability-focused goals.

Greater collaboration has been identified as a need within research circles to address the north-south divide in research relevant to climate change policy (Blicharska et al, 2017: Karlsson, 2002). Without system-level changes, however, necessary changes in collaboration patterns that elicit change will likely not be achieved. Research (investments) should shift towards those issues where the burdens were highest - requiring re-orientation from 'northern' interests. Local 'southern' research needs would drive the research agenda, rather than orienting limited southern research resources to priorities emphasized in the North. Southern research systems would be supported to develop the necessary resources to appreciate local contexts and identify available solutions. Business research has followed a similar theme with e.g. Khavul and Bruton (2013) arguing that to deliver sustainability-enhancing innovations in developing countries requires a design with local customers and the local business ecosystem in mind. In this regard researchers' responsibility, north and south, may lie increasingly in shaping multi-disciplinary debates that target business research and its resources towards social and environmentally impactful business interventions and analyses of those local features that support or hinder them.

Appendix

Table A1: Countries Included in Analysis

Albania	Guatemala	Panama
Algeria	Guyana	Paraguay
Argentina	Honduras	Peru
Armenia	Hungary	Philippines
Australia	Iceland	Poland
Austria	India	Portugal
Azerbaijan	Indonesia	Romania
Bangladesh	Ireland	Russian Federation
Belgium	Italy	Saudi Arabia
Bolivia	Jamaica	Senegal
Brazil	Japan	Serbia
Bulgaria	Kazakhstan	Slovak Republic
Cambodia	Kenya	Slovenia
Cameroon	Kyrgyz Republic	South Africa
Canada	Latvia	Spain
Chile	Libya	Sri Lanka
China	Lithuania	Sweden
Colombia	Luxembourg	Switzerland
Costa Rica	Malaysia	Tanzania
Croatia	Mauritius	Thailand
Cyprus	Mexico	Trinidad and Tobago
Czech Republic	Mongolia	Turkey
Denmark	Morocco	Ukraine
Dominican Republic	Mozambique	United Arab Emirates
El Salvador	Namibia	United Kingdom
Estonia	Nepal	United States
Ethiopia	Netherlands	Uruguay
Finland	New Zealand	Vietnam
France	Nicaragua	Zambia
Georgia	Nigeria	Zimbabwe
Germany	Norway	
Greece	Pakistan	

Note: Shading indicates countries at the top stage of development.

Table A2: Variables and Sources: Social and Environmental Sustainability Adjustments

Social Sustainability Adjustment	**Source**
Gini Index*	World Development Indicators, accessed June 2016
Youth Unemployment*	World Development Indicators, accessed June 2016
Access to Sanitation*	World Development Indicators, accessed June 2016
Access to Improved Drinking Water*	World Development Indicators, accessed June 2016
Access to Health Care Services**	50% from 2014-2015 value in WEF data. Remaining 50% from indicators of WDI: Births attended by skilled health staff (% of total); Community health workers (per 1,000 people); Hospital beds (per 1,000 people).
Social Safety Nets	50% from 2014-5 value in WEF dataset. Remaining 50% from the following indicators from WDI database: Active contributors to an old age contributory scheme as a percent of labour force; Public Social Protection Expenditure on benefits as a percent of GDP; Share of population above statutory pensionable age receiving an old age pension (%); Share of unemployed receiving regular periodic social security unemployment benefits (%).
Informal Economy	No Replacement Found – 2015 value used.
Social Mobility	No Replacement Found – 2015 value used.
Vulner.Employment*	World Development Indicators, accessed June 2016
Environmental Sustainability Adjustment	**Source**
Stringency of Environmental Regulation*	Variable for 2014-2015 used for all years. Data obtained from World Economic Forum, Executive Opinion Survey, multiple years.
Enforcement of Environmental Regulation*	Variable for 2014-2015 used for all years. Data obtained from World Economic Forum, Executive Opinion Survey, multiple years.
Terrestrial Biome Protection*	Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network. Available at: http://epi.yale.edu/data
Number of Ratified Environmental Treaties*	The International Union for Conservation of Nature (IUCN), Environmental Law Centre ELIS Treaty Database
Baseline water stress *	Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network. Available at: http://epi.yale.edu/data
Waste Water Treatment*	Yale Center for Environmental Law & Policy (YCELP) and the Centerfor International Earth Science Information Network. Available at: http://epi.yale.edu/data
C02 intensity*	Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network. Available at: http://epi.yale.edu/data
Fish Stock Depletion*	Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network. Available at: http://epi.yale.edu/data
Forest Cover Change*	Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network. Available at: http://epi.yale.edu/data
Particulate Matter Concentration	World Development Indicators, accessed June 2016
Quality of Natural Environment	No Replacement Found- 2015 value used.
* Variables used are the same as WEF in the construction of the SGCI. ** Variables include those used by WEF in construction of the SGCI weighted at 50 percent; remaining 50 per cent incorporates variables not used in the SGCI.	

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