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Finance past, Finance future

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Abstract

As we work our way through the latest financial crisis, politicians seem both powerless to act convincingly and unable to craft from the welter of diverse and antagonistic narratives a coherent and convincing vision of the future. In this paper, we argue that a temporal lens brings clarity to such confusion, and that thinking in terms of time and reflecting on privileged temporal structures helps highlight underlying assumptions and distinguish different narratives from one another. We begin by articulating our understanding of temporality, and we proceed to apply this to the evolution of financial practice during different historical epochs as recently delineated by Gordon (2012). We argue that the principles of finance were effectively in place by the 18th Century and that consequent developments are best conceptualised as phases in which one particular aspect is intensified. We find that in different historical periods, the temporal intensification associated with specific models of finance shifts, over history, from the past to the present to the future. We argue that a quite idiosyncratic understanding of the future has been intensified in the present phase, what we refer to as *proximal future*, and we explain how this has come to be. We then consider the ethical consequences of privileging an intensification of proximal future before mapping an alternative model centred on intensifying distal future, highlighting early signs of its potential emergence in the shadows of our present.

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Our Time

As we write this in Europe, for the first time since the Second World War, it seems that most of our children's generation will face a harsher economic future than their parents. Recession, stagnation, depression and decline have replaced growth, progress and opportunity. Politicians seem both powerless to act, with the financial levers of action now wrenched from their grasp and their comforting economic models broken and discarded, and unable to craft from the welter of diverse and antagonistic narratives a coherent and convincing vision of the future. In this paper, we argue that a temporal lens brings clarity to such confusion, and that thinking in terms of time and reflecting on privileged temporal structures helps highlight underlying assumptions and distinguish different narratives from one another. Shifting understandings of time can also provide a way of framing evolving conversations over history (which, of course, brings its own temporal frame).

Time is probably the most taken-for-granted of all social concepts. One measure of this is that time is invariably depicted on the x-axis in graphs, regardless of what other variables are being considered. It is, it seems, the most independent of independent variables. However, there is a substantial literature on the sociology and social construction of time that makes the compelling argument that time is just another (socially) constructed category (see Hassard (1990) for a collection of seminal works). For instance, Gurvitch (1964) has identified eight kinds of social time, while Zerubavel (1981) has explored the 'hidden rhythms' of time in social life, reminding us that (commonsensical) clock time is but one, relatively recent, way of thinking about time.

Notwithstanding this substantial literature, the field of finance has largely escaped a specifically temporal analysis (Esposito (2011) is a notable exception). This is surprising because concepts that are inherently temporal – such as the idea of the new – are routinely leveraged to explain current problems. For instance, in the breathless and confused accounts of the causes and consequences of the financial crisis, there is often the suggestion that it was the new (and misunderstood because of its newness) that played a significant part in the crisis. The language and purpose of derivatives and structured products such as Collateralized Debt Obligations (CDOs) and Credit Default Swaps seemed utterly opaque, representing a financial system ceaselessly reinvented by ever younger Young Turks (Lewis 1989) to the extent that it became incomprehensible to those of older sensibilities. However, in this paper we argue that the essential financial machinery that, once unfettered, would run out of control, was in place centuries before. To contextualise the recent crisis, we examine how different temporal aspects of finance have been intensified at different times. We do this through exploring the temporal dimensions of organizational and financial history (and, in places, the history of financial thought). We begin the paper by

articulating our understanding of temporality, and we proceed to apply this to the evolution of financial practice during different historical epochs as recently delineated by Gordon (2012). What we find is that in different historical periods, the temporal intensification associated with specific models of finance shifts, over history, from the past to the present to the future. We argue that a quite idiosyncratic understanding of the future has been intensified in the present phase, what we refer to as *proximal future*, and we explain how this has come to be. We then consider the consequences, especially the ethical consequences, of privileging an intensification of proximal future. Finally, we map out an alternative model that is centred on intensifying *distal future* and we highlight evidence of a potentially new paradigm.

Performing Time

The philosopher J. L. Austin has used the term 'performative' to describe utterances that *do* something. For instance, 'if I say "I apologize," or "I name this ship the Queen Elizabeth," or "I bet you sixpence it will rain tomorrow," then "in saying what I do, I actually perform the action"' (Austin 1970: 235). Whether or not an utterance is *actually* performative depends on the social conditions: for instance, just because I say, 'I have walked from the moon', doesn't make this so, nor does it mean that I will be believed. Thus, performative statements only make sense within a self-referring system of practices and beliefs that are mutually validating and sustaining (Barnes 1988; Luhmann 1995). Money is a good example of such a system, in that our collective belief that some pieces of paper are 'money' is sustained and validated by the practices that inform that belief, while, at the same time, the belief self-referentially enables and sustains the practices, so that a monetary transaction can be performed when I say, 'I'll give you 5 euros for that toy'.

And so too it is with time. When I say, 'the time is two o'clock' or 'the French revolution occurred in 1789', I am making a performative utterance that sustains a particular understanding of time. In this paper, we see time as an emergent, interpretative phenomenon of self-referring socio-material systems – that are constituted by objects, beliefs and practices – wherein meaning is ascribed to the past, present and future.

Much work must be done to sustain or create any particular temporality: for instance, our basic unit of time, the second, does not 'exist' out there; rather, it is a property of a complex entanglement of humans, artifacts, machines and practices that allows it to be defined as the 'duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom' (Organisation intergouvernementale de la Convention du Mètre 2006:133). Time, like money, is an emergent property of a particular self-referential system (while Latour (1988: 198) asserts

that ‘the notion of system is of no use to us’, we like Luhmann’s (1995) understanding of the term system). Just as we can have distinct currency systems – that are not wholly separate – we also have distinct temporal systems. The similarity between time and money – as emergent phenomena in self-referential systems – can be usefully understood through comparing the ‘standardisation of time’ that took place in the 19th century (Zerubavel 1982) with the creation of the euro and the eurozone in the late 20th century. And just as the perceived value of one currency is imputed within a wider network of currency systems, time systems can also be ‘calibrated’ against one another. For instance, the ‘time’ spent waiting for a delayed bus might be calibrated as the same amount of ‘clock time’ as the ‘time’ spent watching an exciting game of hurling, even though the subjective experience of ‘time’ might be quite different in both cases.

Systems can be differentiated from one another in terms of how the past, present and future are conceptualised, interpreted and privileged. For instance, the temporality of ‘clock time’ can be imposed on other systems, as happens when a spectator at a game uses a clock – connected to a much wider temporal system – to ‘check the time’. The power of ‘clock time’ is that it provides a standard against which time in other systems can be partly calibrated. However, it is also possible to construct time within a system, having no reference to ‘clock time’.

Within any given system, the system’s ‘chronology’ – a temporal arrangement of events – can be distinguished from the system’s ‘time’, even though both are deeply implicated in one another. They are self-referring in so far as chronology is a set of utterances through which ‘time’ is performed, while, conversely, chronology only makes sense within a particular temporal frame (time) that is collectively believed.

Temporal *horizons* – how the distant or near past (or future) is conceptualised – can also differ between systems, and indeed a temporal horizon only makes sense when horizons in different systems are compared to one another. A few examples will illustrate this important point. The CEO of a Japanese corporation once visited a recently opened subsidiary in a small town in Ireland. As part of the visit, he asked the Irish management to present their long-term plan for the plant. The management duly presented their seven-year plan, but were taken aback when the Japanese CEO said, ‘That’s fine, but can you show me your long-term plan?’ He proceeded to explain that what he wanted was their vision of what the factory and town would look like when the *children* of the current workers were company employees. Here, we see systems with two different temporal horizons, one Irish and one Japanese, bumping up against one another.

Another example. In 1802, the Christian Brothers was founded as a religious community within the Catholic Church dedicated to working with young people and the poor. The community expanded rapidly in the first half of the 20th century, especially in Ireland where it had a significant involvement in second-level education. However, numbers declined from the 1970s onwards and by 1997 there was only one novice preparing for final vows in Ireland. Around that time, a Catholic priest was asked why the Christian Brothers weren't marketing themselves or actively recruiting new members. His response was that the conditions that obtained in the early 19th century no longer existed and so there was no compelling reason why the community should continue. While most people might see 200 years as a long time for an organisation to exist, he dismissed this as a relatively short period when contextualised within a Church history of some 3000 years. A similar example of different temporal horizons is to be found in Naughton's (2013) story about the Google Books project, which planned to digitise all of the world's printed books. At a meeting with the librarian of one of the universities who had signed up for the plan, the two co-founders of Google were stunned when the librarian suddenly asked, 'What happens to all this stuff when Google no longer exists'. What these stories illustrate is how different systems can contain, not only different understandings of the past and future – different times – but also different ways of calibrating the temporal horizon.

Time in Finance

It is possible to sketch out economic and financial history in terms of revolutions. For example, Gordon (2012) suggests that we might see economic growth in terms of three industrial revolutions: the first starting in 1750 based on steam and spinning, the second from 1870 with the inventions of the internal combustion engine, electricity and indoor plumbing, with the third (the digital) beginning in the 1960s. For Gordon, the repercussions of the first two revolutions took a century to work through, while the third was already starting to ebb by the turn of the millennium. His analysis is interesting in that he suggests that prior to 1750 economic growth was negligible and that we might, in retrospect, come to see the period 1750-2010 as but a blip, as growth 'sputters out' (p. 21) and settles back to its historical negligible norm. (There may, of course, be further revolutions, though Gordon warns that there are substantial headwinds blowing against this possibility). His analysis is essentially American and centred on an industrial history – it thus ignores different histories in other countries and downplays the importance of the financial crisis suggesting that, 'all of these [headwind] problems [preventing the next industrial revolution] were already evident in 2007' (p. 2). By relegating finance to a sideshow, constantly present but essentially

dependent upon industry, Gordon is able to highlight industrial development but ignores how different aspects of finance have shaped industry.

Certainly it is clear that finance and accounting pre-existed Gordon's first revolution and, indeed, were necessary for it. Weber, for example, famously suggests that, 'The modern rational organization of capitalistic enterprise would not have been possible without … rational book-keeping' (Weber 1930/1995: 21-22) which can be traced back to the double-entry systems developed in 15th century Italy. A similar origin to finance is suggested by Poitras (2009) (see also Poitras and Jovanovic (2007)) who suggests that the roots of 'modern' finance can be found in Renaissance mathematics. (Other histories demonstrate that the principles of accounting and finance can be seen in Sumeria 7,000 years ago (Schmandt-Besserat (1999), Schmandt-Besserat and Hays (1999)) and in feudal Japan.) Following this line, we argue that the principles of finance were effectively in place by the 18th Century and that consequent developments are not revolutions but instead phases (in the sense in which Simondon (1980) uses the term) where one particular aspect is intensified. We use the idea of intensification to show that while one aspect accrues greater significance at a particular time, the other aspects are still important but of lesser significance and visibility.

The initial intensification phase of finance was centered on joint stock companies. These were already in existence by the 17th century, but were commonplace during the first industrial revolution (1750-1870) as the favored way of managing the demand for large capital that was required for railroads and factories. Two signal features of this mode of finance and accounting were centered on the past. First, these joint stock companies were typically created through the pooling of *historically* acquired resources.

For instance, the first joint stock companies, set up in the early 17th century, were usually formed for a single venture, such as a trade voyage to Asia, and were liquidated once the enterprise was complete. The second temporal aspect relates to the accounting practices of joint stock companies, which were based on the historic cost convention where only events that have happened can be recorded. Thus, we argue that this phase of finance strongly emphasised the *past*. This can be seen in the etymology of capital (and subsequently capitalism): Braudel (1979: 232-3) notes that, '*Capitale* (a late Latin word based on *caput* = head) emerged in the twelfth or thirteenth century in the sense of funds, stock of merchandise, sum of money, or money carrying interest […] The word gradually came to mean the *money* capital of a firm of a merchant.' Accounting, of course, allows the demonstration of capital accumulation, a prerequisite for Marx's definition of capital as a means of production.

Needless to say, this story needs to be fleshed out a little, for we would not wish to imply that there is no consideration of the future at work here. From a different perspective that emphasizes the importance of debt obligations in human history, Graeber (2011) suggests that:

> [W]hat we see at the dawn of modern capitalism is a gigantic financial apparatus of credit and debt that operates – in practical effect – to pump more and more labor out of just about everyone with whom it comes into contact, and as a result produces an endlessly expanding volume of material goods. (p346)

Accounting, as it always has been, whether through clay tokens, tally sticks, pen and ink or bits and bytes, is the means of recording these credit and debt obligations. Debt obligations, at their simplest, encompass a particular way of considering the future, as something that will be paid, and accounting, when applied to the joint stock corporation, shows the obligation of the company to its shareholders, both in terms of the original stake and by way of subsequent profits. That such future profits can be imagined as far greater than may materialize is, through the South Sea Bubble, proved early in this story.

We also ride (in part) with Gordon when looking at the second phase of finance. This we might suggest is seen as a period where the corporation is seen as a 'going concern', managed perhaps by Chandler's (1977) 'Visible Hand.' Money is generated within the company, retained, invested and used to grow the organization (unlike an earlier period when past monies were used to finance specific, stand-alone ventures). In line with this reorientation, key management accounting practices such as standard costing achieved their limited apogee at that time. Chandler's research indicates that up until the mid-19th century, most small firms operated simple double-entry book-keeping procedures that had changed little since they were first codified in the 15th century by the Franciscan friar, Luca Pacioli. While such practices were adequate for tracking the 'external' transactions of traders, they did not provide manufacturing firms with data on 'internal' transactions involving the transformation of raw materials into finished goods. Thus, modern costs accounting methods emerged in the latter part of the 19th century as more complex production processes and large scale organisation came to be in the railroad, steel, chemical and metal-working industries. These new methods provided reliable cost data which could be used to determine prices, to assess the results of operations, and to evaluate technological investments (Johnson 1972; Chatfield 1974). What is perhaps most interesting is that, while the historic model still runs, the temporal change associated with such new practices is that the emphasis has shifted to organization in the *present*.

These accounting methods, which emerged in the late 19th century, continued to be central to accounting practice up until the 1960s (which Gordon sets as the start of the third industrial revolution), providing a coherent basis for addressing the accounting problems of industrial enterprise, through various techniques of cost accounting and analysis for decision-making, auditing and budgeting. During the third industrial revolution, these practices were displaced from their central position as they were overtaken by the notion of strategy in directing the corporation.

Unsurprisingly then, the third phase is the future, albeit a peculiar understanding of the future. Before exploring this third phase, we need to contextualise and clarify our understanding of the future. Our first point is that we are not saying that the concept of the future was unknown prior to the 1960s, but rather that the contemporary, commonsensical understanding of the future is relatively young and can perhaps be seen as originating in the extraordinary set of changes retrospectively captured by the notion of 'the Renaissance', which provided the intellectual space for a new set of practices and ideas out of which capitalism would emerge. One important element in this set was the theory of probability, whose roots can be found in the mid–17th century correspondence between Pierre de Fermat and Blaise Pascal. If mathematical puzzle-solving was not in the *zeitgeist* of the time, slowly, but surely, the future came more into focus for the general populace. In particular, work by Halley, Jacob and Daniel Bernoulli, De Moivre and Bayes in the early 18th century provided the mathematical foundations for practices that became central to the emerging insurance and finance industries. Notwithstanding these developments, it is still important to highlight that rather ordinary mathematical concepts and techniques, which are now routinely taught in second-level education, are relatively recent innovations in the practice of finance. For instance, the mathematical concepts of correlation, regression to the mean, and hypothesis testing were developed by Galton and Pearson as recently as the late 19th and early 20th centuries. Importantly for our purposes, up to the mid-20th century, the various statistical techniques tended to privilege the past, in so far as an analysis of past events provided the basis for predictions and depictions of the future.

But this understanding of the future as an extension of the past came to be criticised during the 20th century. As early as 1921, Frank Knight (1921/2006) had highlighted the difference between risk and uncertainty, which was all-important in predicting the future: 'risk' refers to a situation where the probability of an outcome can be determined (and therefore the outcome insured against), while 'uncertainty' refers to an event whose probability cannot be known. In a clear departure from earlier statisticians like Bayes, Knight was dubious about what can be learned from empirical evaluations of the frequency of past occurrences. He argued that

> any high degree of confidence that the proportions found in the past will hold in the future is still based on *a priori* judgement of indeterminateness. Two complications are to be kept separate: first, the impossibility of eliminating all factors not really indeterminate; and, second, the impossibility of enumerating the equally probable alternatives involved and determining their mode of combination so as to evaluate the probability by *a priori* calculation (Knight 1921/2006: 221).

He proceeded to distinguish three different types of probability: '*a priori* probability'; 'statistical probability' and 'estimates'. The first is akin to the logic of mathematics, as in the mathematical probability of rolling a six on a die. Statistical probability depends upon the 'empirical evaluation of the frequency of association between predicates' and on 'the empirical classification of instances' (p. 225). When there is '*no valid basis of any kind* for classifying instances' (p. 225, original emphasis) then only estimates can be made (in other words, such data that do exist do not lend themselves to statistical analysis). And for Knight, the last case is most interesting and most relevant to the world of business.

Writing in the same year, John Maynard Keynes (1921/2007) was equally sceptical of both statistical and *a priori* probability. Drawing especially on Hume's criticism of argument by induction – inference from past particulars to future generalisations – Keynes heaped scorn on the practical merits of various statistical techniques such as Bernoulli's Law of Great Numbers. He also drew on the work of Henri Poincaré whose contributions to pure and applied mathematics in the early 20th century provided the basis for what we now know as chaos theory. More broadly, the effect of uncertainty on decision-making was an important theme running through influential research in finance theory during the second half of the twentieth century, most notably Von Neumann and Morgenstern's (1944) work on game theory, Arrow's (1951/1963) impossibility theorem, and Markowitz's (1952) writings on portfolio selection.

It took some time for these mathematical contemplations to percolate into the practices that constitute financial markets, but as they did the nature of finance changed profoundly. Hacking (1990) and Ewald (2002) identify the late 1960s as the watershed moment, not too far from the early 1960s that Gordon identified as the start of the third industrial revolution. The revolution in finance was both within the academy and in practice. Prior to this, the study of finance was largely descriptive (MacKenzie 2006:5) and thus mirrored the descriptive function of accounting. Advocates of change, such as Jensen and Smith (1984) derided this approach, suggesting that, 'Dewing (1953) the major corporate finance textbook for a generation, contains much institutional detail but little systematic analysis' (1984:1). By contrast, they argued, the mathematization of finance was presented as offering the possibilities of 'positive theories' that would 'provide the scientific basis for the formation and

analysis of corporate policy decisions' (1984:2). The wave of new visualizations of finance and the corporation, including Efficient Markets Hypothesis and Agency Theory, swept all before them within the academy and were just as enthusiastically adopted by finance practitioners. One notable example is that of option pricing. Over the last 40 years there has been an unprecedented and prodigious increase in the trade of a whole range of investments, such as options, swaps, futures and derivatives that allowed punters to bet on the future without incurring a large outlay of funds in the present. While derivatives, which are essentially bets on people taking bets, had existed for centuries (Poitras 2009), market regulators were deeply suspicious of them even as late as the 1960s. Importantly, the massive increase in derivative trading from the 1970s can be almost solely attributed to advanced probabilistic techniques (MacKenzie and Millo 2003), the calculations for which were often trialed on university computers. One result of this sea-change was that the exchange value of a firm came to be no longer just the exchange value of the firm's assets, nor even the calculable extrapolation of current income streams, but rather the sum of a collection of bets on the firm's *future* profitability. One repercussion arising from this was that the function of accounting became devalued as a means of evaluating company performance: the reports produced were only interesting in terms of their impact on the market price (i.e. what they were able to reveal about extant bets). Indeed, Eugene Fama (2008) is able to joke that accounting is, 'Assets equal liabilities and then event studies[1].'

Another important feature of the latter part of the 20th century was the development of electronic trading platforms. Trading now takes place via 'matching engines' which are computer systems that execute a trade if they can match a buy and sell order. Separate from this is algorithmic trading (also called automated trading) which involves software algorithms that use advanced mathematical models to make transaction decisions in financial markets. By 2010, algorithms accounted for more than half of all US share trading, with a genus of algorithms emerging to either avoid losing money while trading ('execution algorithms'), to make money by trading ('electronic market-making'), to seek out transient disturbances in price patterns ('statistical arbitrage'), or to prey on other algorithms ('algo-sniffing') (MacKenzie 2011). Milliseconds matter in this elaborate and high stakes game between real-time mathematical models, and so it makes sense to situate the computer systems on which the algorithms run as close as possible to the data centres that host the matching engines.

And the computer models became more sophisticated, more data-hungry and more complex. Crucially, these models did more than simply analyse markets, they also worked

[1] Event studies are where the impact of an event (here, the publication of financial statements) is measured in terms of the share price.

to alter them. Models are not akin to cameras, passively recording the environment; rather they are more like engines, actively transforming, altering and constituting the world of which they form an increasingly important part (Callon 1998; MacKenzie 2006b). Perhaps the most important model in the story is the Black-Scholes (or Black-Scholes-Merton) model, if we are to give weight to Taleb's (1998) observation that, "Most everything that has been developed in modern finance since 1973 is but a footnote on the BSM [Black-Scholes-Merton] equation" (p. 35). The problem that Black-Scholes addressed is how to estimate the price that a stock would have at maturity. The general approach to this problem that emerged in the 1960s was to assume that change in the price of a stock followed a 'random walk' - i.e., it could be viewed as a random (probabilistic) variable, the distribution of which in any given time period was independent of its changes in the past. Black and Scholes (1973) (and subsequently Merton) asserted that, if all market traders behave rationally, the price of options will be pushed down to the risk-free interest rate. Thus,

> it was possible to construct a portfolio of an option and a continuously adjusted position in the underlying asset and lending/borrowing of cash that was riskless: changes in the value of the option would be cancelled out exactly by changes in the value of the position in the asset and cash. Since this perfectly hedged portfolio was riskless, it must earn exactly the riskless rate of interest. If not, there would be an opportunity for arbitrage: a way of making a profit that demands no net outlay of capital and involves no risk of loss. Such an opportunity could not persist: option prices would adjust so that it disappeared (MacKenzie 2006a: 33).

MacKenzie (2006b) shows how the performative loop between (finance) theory and reality was established, through detailed mapping of the translation of the BSM formula, using material artefacts, into the daily practices of traders. Initially (between 1973 and 1976) there were significant differences between the values imputed by the model and the observed option prices, but from 1976 to mid-1987 there was an excellent fit, with a discrepancy again emerging after the 1987 crash. In effect, use of the model in the practical work of traders, especially through their use of data sheets sold by Black, helped create a reality in which the model itself was 'substantially confirmed' (2006b:166). For MacKenzie, the BSM model was 'performative in an especially strong sense: that its use brought about a state of affairs of which it was a good empirical description' (MacKenzie 2006a:41). Following Callon (1998), MacKenzie was especially interested in the role of 'market devices' such as the data sheets sold by Black, that worked to make option pricing theory 'performative'. In contrast, our focus is on time and the way time, as well as theory, is performed through such practices.

Compressing Time

The idea and practice of calculating potential future risks is an important part of modernity, and the application of rational techniques of forecasting, risk management and insurance is central to modernist ideals about protecting citizens from misfortune (Beck 1986/1992; de Goede 2005; Luhmann 1993; Arnoldi 2009). For Arnoldi, this modern cultural narrative, in which the future features prominently, takes different forms, one being that the uncertain future creates an opportunity and need for play – as epitomised by gambling and edgework (Lyng 1990) – that allow the illusion that one's actions can influence the future. Thus, the Black-Scholes equation may be understood as just one technique within a large toolkit of quantitative models of financial markets, which, in turn, is symptomatic of wider cultural reorientations around time and risk. The power of the Black-Scholes equation is that it can create an illusion of knowing the future, at least in the short term.[2] Of course, this illusion is due to more than just the Black-Scholes formula (indeed Haug and Tassib (2011) have argued that the 'formula' predates Black and Scholes' paper and that option traders have developed and used a wide range of similar heuristics over the last century). Value at Risk (VaR) is another key risk management tool that emerged after the stock market crash of 1987, and it has been severely criticised along similar lines to the criticisms of Black-Scholes (Kolman and Taleb 1997; Einhorn 2008; Haldane 2009).

The Black-Scholes option-pricing equation is:

$$\frac{\partial w}{\partial t} = rw - rx\frac{\partial w}{\partial x} - \frac{1}{2}\sigma^2 x^2 \frac{\partial^2 w}{\partial x^2}$$

where *w* is the option price, *x* is the stock price, *t* is time, *r* is the riskless rate of interest (i.e. the rate of interest paid by a borrower that creditors are certain will not default) and σ is the volatility of the stock price. The first important point to make about this equation is that it will work regardless of the system's temporal frame. To better understand this, consider Lotka's mathematical model for population growth:

$$\frac{dP}{dt} = rP\left(1 - \frac{P}{K}\right)$$

where *P* represents population size, *t* is time, *r* is the growth rate and *K* is the carrying capacity of the environment. While the unit of measure along the x-axis (time) may vary, the

[2] Black and Scholes, in their original paper, hold out the possibility of something even more than that, in that the capital asset pricing model, from which their equation is derived, is "originally stated as a single-period model. Extending it to a multi- period model is, in general, difficult. Fama (1970), however, has shown that if we make an assumption that implies that the short-term interest rate is constant through time, then the model must apply to each successive period in time" (Black and Scholes 1973:645).

shape of the projected population growth curve will be the same whether we are predicting growth of yeast in a petri dish (days), algae in a pond (weeks), or humans on a planet (decades or centuries).

The Black-Scholes model makes a number of assumptions; in particular it assumes that the short-term interest rate is known and is constant through time, and that the stock price follows a 'random walk' in continuous time. Such assumptions do not hold over the 'longer' term, and so the equation works to privilege a shorter time horizon, both retrospectively into the past and prospectively into the future. In addition, humans exhibit a psychological propensity to focus on the near past (and near future). Andrew Haldane, Executive Director for Financial Stability at the Bank of England, terms this 'disaster myopia':

> an agent's propensity to underestimate the probability of adverse outcomes, in particular small probability events from the distant past … The longer the period since an event occurred, the lower the subjective probability attached to it by agents (the so-called "availability heuristic"). And below a certain bound, this subjective probability will effectively be set at zero (the "threshold heuristic") (Haldane 2009: 6).

Haldane speculates that perhaps ten years is the 'threshold heuristic' for risk managers because 'the last three truly systemic crises – October 1987, August 1998 and the credit crunch which commenced in 2007 – were roughly separated by a decade' (ibid, p. 7).

An important point we make is that because of the performative nature of the Black-Scholes equation, the temporality infused within the equation is also performative. In other words, the equation works to create a particular temporal structure in the 'real' world, wherein a *proximal future* is privileged (the notion of a proximal future only makes sense through interpreting one temporal structure relative to another). Moreover, the future is determined solely by the present state of affairs, or at least those affairs in the *proximate past*. This temporality derives directly from the 'random walk' assumption in Black-Scholes: that an object's position at time $t+1$ is determined solely by its present position at time t without any reference to the manner in which that position was reached. In mathematics, this concept of the future depending only on the present is formalised as a 'Markov chain' – i.e. a process consisting of a finite number of states and some known probabilities p_{ij}, where p_{ij} is the probability of moving from state j to state i. The children's game of *Snakes and Ladders* manifests the idea quite well: at each turn, the player starts in a given state (a specific square) from which there are defined odds of moving to certain other states (squares), while a more complicated game might have the odds changing for some or all of the states (squares). A Markov process is 'memoryless' or *ahistorical* in that knowledge of the sequence preceding the present state is not required to predict the future state. Moreover,

the gaming paradigm that underpins the mathematical models of financial markets puts an interesting spin on the three different types of probability – *a priori* probability, statistical probability and estimates – identified by Knight (1921/2006: 221). While we might follow Knight and see 'estimates' as most relevant to business, the performative effect of the mathematical models works to create a world where *a priori* probability (one that is akin to probability theory in mathematics) comes to be dominant (at least for a while).

Overall, we use the term *compressed time* to describe a temporal structure that is, firstly, ahistorical, and secondly, privileges the proximate future and the present.

Calibrating Time

Our analysis is based on the idea the economic models are performative, and that the temporal structures inherent in these models seep into 'the world' through the same performative processes. In a real sense, these models work to change the fabric of time. But neither the economic models nor the temporal structures are fixed; the fabric of time can be continually reshaped. Here, Mirowski and Nik-Khan's (2007) critique of Callon's project is important because it reminds us that Callon's performative approach to economics might come to be a 'pact with neoclassical economics' (p. 191), or 'might even end up as a prettified neoliberalism decked out in new rags' (p. 217). Hence, perhaps the first step is to recognise the effect of, and problems with, the models, although this has already been well documented, most especially by Nassim Taleb, who has has highlighted the disproportionate role of 'Black Swans' – rare and hard to predict events, that, crucially, fall outside the time horizons of the mathematical models (Taleb 2007). Such events are almost invariably excluded from mathematical models of financial markets, not least because to include them would overwhelm the model, making them impractical to use. Similarly, a major problem with the bank stress tests was that they were too heavily influenced by a relatively short time horizon, well contained within the so-called Golden Decade – October 1988 to June 2007 – when banks' share prices increased by almost 60% and their balance sheets rose more than threefold. However, this time period was 'most unusual from a macroeconomic perspective' (Haldane 2009: 7), which Haldane illustrates through a whole series of historical data. Haldane's conclusion is that these 'risk management models have during this crisis proved themselves wrong in a more fundamental sense. They failed Keynes' test – that it is better to be roughly right than precisely wrong. With hindsight, these models were both very precise and very wrong' (Haldane 2009: 2).

Returning to time, a fundamental issue with its compression in finance theory and practice is that it arguably utterly eclipses ethics. Sometimes this appears deliberate – as when those

that are now seen as the theoretical forefathers of modern, forward-looking finance have their texts re-translated to fit the modern idiom. (In the case of Bernoulli (1738/1954), this involves striking out the 'moral' element of analysing risk in favour of 'utility'[3].) More generally, ethics has been largely evacuated from modern finance theory – when it is considered at all it becomes wrapped up as part of the price (see, for example, Smith 1992, Smith, Brickley & Zimmerman 1994 or Smith, Brickley & Zimmerman 2003) – which is not unrelated to finance theory's peculiar temporal structure. Thus, the summary of bets on probabilities of future performance that the market price is seen to represent both compresses time and etiolates the possibility of consideration of outcomes not solely dependent on (short-term) price. One implication of privileging the present and proximate future is that it works to exclude those that will inhabit the distal future from decisions that affect them, or even of consideration of how those decisions will affect them. While they have no voice in today's market, they are nonetheless the unwitting recipients of market externalities and consequences that are 'kicked down the road'. 'Our' time is indeed a selfish time.

Part of the solution may be to recast our fabric of time to incorporate a much stronger emphasis on long-term historical structures rather than present events, as captured by the concept of the *longue durée* (as understood by the French *Annales* school to historians (Braudel 1958)), or Kondratiev's concept of 'long waves' in economic and technological cycles (Freeman and Perez 1988). The so-called 'Long Now' is one small attempt to do this, as it works to 'creatively foster long-term thinking and responsibility in the framework of the next 10,000 years' (http://longnow.org/):

> Civilization is revving itself into a pathologically short attention span. The trend might be coming from the acceleration of technology, the short-horizon perspective of market-driven economics, the next-election perspective of democracies, or the distractions of personal multi-tasking. All are on the increase. Some sort of balancing corrective to the short-sightedness is needed-some mechanism or myth which encourages the long view and the taking of long-term responsibility, where 'long-term' is measured at least in centuries. (*ibid*)

Such thinking also provides a novel and insightful way of looking at some of our favoured research methods. For instance, ethnomethodology emerged in the 1960s largely in opposition to the positivist ideas that were popular at the time, but it still retained the same fetish for presentness.

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[3] The translator, Louise Sommer, thanks 'Mr William J Baumol, Professor of Economics, Princeton University, for his valuable assistance in interpreting Bernoulli's paper in the light of modern econometrics'. (23*n*1)

Concluding comments

In this paper, we have illustrated how time may be conceptualized in different ways, and how different conceptualizations of time can give a different perspective to 'revolutions' in economic and industrial history. In particular, when looking at finance, we show how it is possible to see the emphasis moving from past, to present, to future, leaving open questions as to what the next future might hold. There are possibilities in striving for a different conceptualization that breaks with bringing the proximate future into the here and now in order to pay attention to a distal future, and our responsibilities (rather than our rights) to it. But, just as we would see all the essential components of contemporary finance already in place by the 1700s, is there any possibility in re-interrogating the roots of finance to find where the next turn may be?

Perhaps so. Historical practice and writing on finance and economics (and debt, as Graeber 2011 shows) was often couched in terms of morality, as McCloskey (2006) also highlights. This 'normative' element was explicitly attacked in the revolution in academic finance in the 1960s and 1970s, and largely written out of the contemporary discipline (and would have formed a strange interjection in the centres of finance capitalism at the end of the twentieth century). For McCloskey this process of etiolisation of matters moral and ethical has a somewhat longer history, deriving from what she sees as post 1848 romanticisms' reactions to, and curious enrolment of, both Bentham's utility and Kant's pure reason. But ethics and morality have never been completely excised from consideration in the commercial world, and the movements in behavioral finance, for example, although currently trending towards severely limited models of human action, implicitly carry with them the idea that behavior is normative, is moral. Moreover, as McCloskey notes, more implicit moral and ethical ideals abound whenever we narrate the activities of our commercial (elite) coordinators, for all our stories carry traces of our values and their imputations.

For McCloskey, the appropriate response is to revalorize the balancing of that system of virtues – encompassing both pagan and 'Christian' varieties – that her heroes, Aquinas and Smith, have previously mobilized. For as long as we have transcendent goods as sacred ends (variants of faith, hope and love) to which we aim, our more profane concerns with justice, courage, temperance and prudence are apparently not only suitably trammeled so that they can be recognized as virtuous in their own right but also thus enabled to deliver the benefits to wider society that their recognition entails. Most obviously, in a commercial world, this relates to a valorization of prudence. Not the elevated prudence – prudence alone – of a unifold utility; rather the prudence that takes its place and stakes its claim within a broader system of virtues. The societal benefits of buy low, sell high are seen by McCloskey to be central here, enabling her to reassert the ethical and moral benefits of accurate pricing in

markets for a maximizing of the benefits to society of informed resource allocations. Where extant pricing is inadequate, due to existing market imperfections or to potential changes that could be engineered, the special virtue of the 'alert' (Kirzner, 1973), assuming suitable entrepreneurial rewards for its deployment, can apparently be relied upon to produce a better price and thus better allocations. But whilst Kirzner's alertness does allow at least some theorization of the entrepreneurial function, we are less than convinced that its deployment is always an unalloyed good (Lilley and Lightfoot, 2013), even when we allow sufficient time to pass for markets to adjust to meeting new needs as old ones are dissipated. The development of such 'alertness' seems itself hard won and can appear to be to the detriment of character of those who have learned to wield it. And where such profane concerns appear to necessitate near complete immersion in market matters for alertness to be continually deployed, it becomes difficult to see how more sacred concerns can continue to deliver the trammeling of excess required to prevent particular, privileged pagan virtues becoming pre-eminent and unbalancing the whole.

In such circumstances calls for balanced bourgeois virtues may not be enough, for they too may deliver little more than the 'prettified neoliberalism decked out in new rags' that Mirowski and Nik-Khan's (2007: 217) see as a potential outcome of consideration of Callon's performative approach to economics. It may well be that in the world of the proximal future that we describe here, there is simply insufficient time for sacred virtues to trammel the profane from the outside of the market, particularly when market participants are endlessly reminded about the risks of the outside for perfection of their performances (Lilley and Lightfoot, 2013). When that is the case, sacred concerns would need to be present as and when prudent decisions are arrived at, not as a point of later or earlier comparison. Production of a finance that recognizes a moral debt to the future in the timescape that we increasingly inhabit would entail sacred concerns being there in the financial numbers themselves, at the point of the decision. Such a system remains hard to envisage, but it is certainly worth striving for if we still seek to be virtuous in the times of today.

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