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Evidence and the micro-foundations of economic growth[1]

Michael Joffe[2]

Abstract: A theory for a phenomenon needs to explain its main empirical features. In the case of modern economic growth, these include the times and places where it has occurred, its magnitude, the distinction between cutting-edge and catch-up growth, and the uniformity of the growth process despite major cultural and institutional heterogeneity. I summarise the historical record to characterise the *explanandum*, then review the main theoretical perspectives. I find that most leading theories fail to explain the main observed features of modern economic growth. In particular, the magnitude of growth and other key characteristics suggest the need for a systems analysis. An implication is that the economy is driven by interacting *economic* forces, rather than being merely reactive to external non-economic influences such as preferences and technology.

Keywords: economic growth; catch-up growth; micro-foundations; the capitalist firm; capitalist growth; systems; feedback; arms race; evidence-based economics; economic methodology.

JEL codes: O10, O40, N10, O57, F43, P17, B41.

Introduction

Transformation, uniformity and heterogeneity in modern economic growth

Modern economic growth has transformed the world in unprecedented ways since the process started, a little over 200 years ago. The explanation of this phenomenon needs to accord with the evidence on when and where it has occurred – it is far from being a universal human phenomenon. In particular, it needs to be able to account for the magnitude of the transformation in the leading industrial countries, beginning in the 19th century with the "great divergence", and in a handful of economies in East Asia that have made the tran-

[1] Article received 24 July 2017, accepted 20 August 2017.

[2] Imperial College, Department of Epidemiology & Biostatistics, St Mary's Campus, Norfolk Place, London W2 1PG, United Kingdom, m.joffe@imperial.ac.uk.

sition from poor to rich country more recently. This implies also the need for a distinction between cutting-edge and catch-up growth. Typically, the growth trajectory has been close to exponential in form. Any theory of "micro-foundations" of the macro phenomenon of modern economic growth needs to be compatible with these characteristics.[3]

Such a theory also needs to explain why some features were similar across space and time, whereas others were very different. There was a basic similarity of the growth process: the emergence and rapid spread of factories and industrialisation, on the basis of firms with "capitalist" characteristics – the ability of the firm to buy in all its inputs, including labour. In most instances, the process began with labour-intensive production (generally in textiles), with many small firms. As time passed, competition led to concentration in market structure, together with diversification into a range of different industries.

Nevertheless, this homogeneity coexisted with a high degree of heterogeneity in important features of the relevant societies. They have been highly heterogeneous culturally (e.g. 19th-century England vs. Germany vs. the US; more recently, East Asia vs. Europe). They have also had diverse institutions, not only between different countries, but also across time. For example, limited liability was introduced relatively late during the 19th-century rise of Britain; oligopoly developed in many economies as competition favoured the strong; more recently there has been a rise in routinized R&D. These changes did not have any large impact on the growth rate.

I will argue that these features of the empirics of growth can best be explained in terms of a "causal system": the basic similarity of the growth pattern corresponds to the endogenous causal processes that are common to all the instances where modern economic growth has occurred. The diversity results from other causal relationships that exist in each particular case, both with respect to how the system became established, and to the other characteristics of that economy and society. This raises the question, what is a causal system? The general nature of causal systems will first be outlined, locating the analysis in the philosophical literature on causal mechanisms.

The new philosophy of causation

For much of the 20th century, the concept of causation was largely deemed to have a place in science that was secondary to the mathematical laws of physics, or even "a relic of a bygone age" (Russell, 1913). However, towards the end of the century, philosophers began to explore the meaning and implications of causality. One important recent focus has been on the concept of a mecha-

[3] In this paper, growth is given the conventional meaning, despite its acknowledged problems, of (*per capita*) GDP. I do not have the space to distinguish growth from development, nor to discuss issues concerning demographic changes or human capital. There is also no assumption here that growth is necessarily "good".

nism (Machamer, Darden, & Craver, 2000; Glennan, 2002; Bechtel, 2006; Illari & Williamson, 2012). This has brought the philosophy of science into better alignment with scientists such as biologists, who regularly use the term "mechanism" to indicate the way that a phenomenon is brought about. This has involved analysis of sciences beyond physics, especially that aspect of biology that seeks to understand how the bodies of organisms work.

Another strand in the new literature on causation has been "difference making", the study of causation of a phenomenon from the viewpoint of the study of its properties, as demonstrated e.g. by statistical analysis.[4] The two approaches are best regarded as complementary (Russo & Williamson, 2007; Joffe, 2013a).

Mechanisms and systems

Causal systems are combinations of individual causal links (Joffe, *mimeo*). Each of these components has its own mechanism, which brings about its specific phenomenon. There are three basic types of system. The simplest is merely a sequence of causal processes, possibly with branching, the properties of which result from the summation of its component links – it has no additional system properties. In contrast, the second and third types both have specific system properties.

The second type is characterised by feedback: it has a looped structure – variables are both causative of and caused by other variables in the system. This means that with each iteration of the causal loop, the value of each variable is updated in a systematic manner (Joffe, *mimeo*). Feedback systems are readily understood in causal terms, and their properties can be simulated using appropriate software packages. The two basic kinds of feedback are balancing (negative) and reinforcing (positive) feedback, and feedback systems frequently contain more than one loop (Sterman, 2000). In reinforcing feedback, values increase by the same proportional amount with each iteration (like compound interest), leading to exponential growth; over a period of time, this can generate very large changes.

The third type of causal system involves complexity, and as its name suggests, its specific system properties are more complicated than feedback systems; this makes them more difficult to comprehend causally. Some complex systems exhibit the particular property of selforganization. In this paper, I focus especially on feedback systems.

Systems with feedback

Because the properties of feedback systems are generated by their loop structure, their behaviour is typically rather independent of initial conditions (Forrester, 1970; Lane, 2007). These system properties can be regarded as the *endogenous*

[4] An example is the evidence on rates of lung cancer, comparing them between e.g. smokers and non-smokers. Together with causal inference (whether this correlation can be interpreted causally), it suggests that cigarette smoking causes lung cancer.

or *system* causes. One of the hallmarks of causal systems (except in the case of self-organization) is that these endogenous or system causal processes are distinct from those that are responsible for the existence of the system. The latter can be called *generative* and *maintaining* causes, which respectively bring the system into being and promote its survival (Joffe, *mimeo*) – see Figure 1.

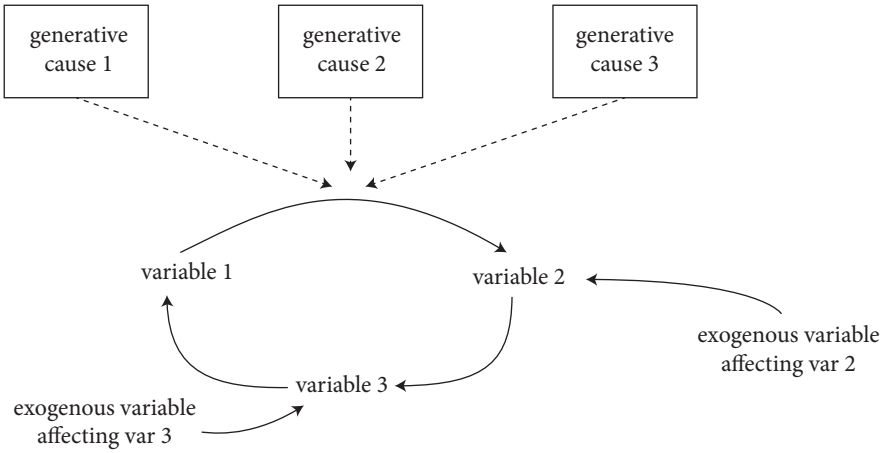

Figure 1. Endogenous system causes, exogenous causes, and generative causes

The arrows between variables 1, 2 and 3 are the endogenous causes that make up the system. There are also exogenous causes that influence variables 2 and 3. These are all indicated by solid arrows. In addition, the system exists because it has been brought about by prior generative causes, indicated by broken arrows.[5] In addition, it is important to recognise that the social world (including the economy) is characterised by multiple causation. This means that in addition to generative or maintaining causes and endogenous causes, other causal influences are likely to be operating in any particular case.

Economic systems

The economy can be seen as being composed of the three types of causal system described above. Here we maintain the focus on feedback systems.[6] A system with its own endogenous causal processes does not respond in a linear or auto-

[5] For example, the system that maintains human body temperature is a group of systems that includes sweating: over-heating leads to sweating, and sweating involves loss of latent heat and thereby promotes cooling. Those two processes are the endogenous causes. The generative cause is that evolution has produced this system. An example of an exogenous cause is the effect of infection in causing a fever.

[6] The case that parts (at least) of the economy should be analysed as a complex system has also been made (see e.g. Ormerod, 1998; Mandelbrot & Hudson, 2008; Gabaix, 2009; Holt, Rosser, & Colander, 2010; Kirman, 2011; Arthur, 2013).

matic way to exogenous, non-economic variables. It is not a stimulus-response model, but rather a largely self-driven one. This analysis is therefore distinct from the notion that economic phenomena are ultimately driven by non-economic, exogenous factors such as preferences or technology.

And because we are often dealing with more than one causal link, i.e. "causes of causes", there are indirect effects – in the context of the social world these would be termed unintended consequences. So, another way of saying that a particular group of causal links has system properties is that (some of) the unintended consequences are *structured*. The idea that societal phenomena can be the result of the successive updating of the values of variables with each iteration is not a new one. It was embodied in a model by Schelling (1978), which demonstrated that a mild preference for living near people similar to oneself can eventually generate a racially segregated city.

Thus, the use of systems concepts is a method of aggregation that is an alternative to the use of the representative agent. It emphasises the interaction between agents that may be heterogeneous, and avoids the fallacy of composition. It is not new to economics: the "price mechanism" is an example of balancing (negative) feedback (Sterman, 2000). And reinforcing (positive) feedback has been proposed, e.g. to explain bubbles (Shiller, 2005). There are likely to be others (Joffe, 2018). In another sense, too, the focus on feedback systems follows established tradition in economics. The force that propels the system is that people tend to respond to incentives (Joffe, 2018).

Evidence and systems

For a causal relationship, evidence can be adduced (a) for the phenomenon, and (b) for the mechanism (Russo & Williamson, 2007). Ideally they correspond. The more diverse the types of evidence, the more secure is the inference in favour of a specific mechanism being in operation. In addition, there may be evidence for other causes that happen also to be operating.

Similarly, for a feedback system, evidence is ideally available (a) for characterising the system phenomenon, in this case modern economic growth, (b) for each of the component mechanisms, and (c) for the way that they fit together (Joffe, *mimeo*). Again, there may be evidence for additional causal processes. In this paper, I first examine the issue of aggregation, in the form of the prevalent idea that macroeconomic phenomena should be understood in terms of their "micro-foundations" (Section 1). I then characterise the system phenomenon, by reviewing the features of growth in the various times and places where it has occurred (Section 2). Section 3 is an overview of the main theories that have attempted to explain growth, along with an analysis of how well each fits with the empirical observations.

The literatures covering the topics of Sections 2 and 3, in particular, are vast. In order to keep the task manageable, I have needed to be extremely concise.

I have tried to avoid being selective in the sense of introducing distortion, but I leave it to others to judge how successful I have been in this.

1. Micro-foundations

1.1. The compatibility of macro and micro theory

Traditionally, economic theory has been derived by considering what economic agents are likely to do in different situations, a bottom-up approach. This has been given apparent rigour by assuming that the agents optimize, that they are motivated by self interest, and that they are rational in a tightly specified sense. However, in the 1930s, largely under the influence of Keynes, a different theory arose that was at the aggregate – implicitly national – level, that did not have explicit roots in standard micro theory, and that contained elements which conflicted with the more traditional approach. In particular, Keynes proposed that an equilibrium was possible that was characterised by involuntary unemployment, which conflicted with the traditional assumption that all markets rapidly clear, including the labour market. Keynes' view was made plausible by the mass unemployment and extreme lack of vacancies during the 1930s, which did not sit well with the orthodox idea that non-frictional unemployment is due to the reluctance of potential workers to offer themselves for work at the currently prevailing wages (Lucas, 1978).

At around the same time, econometrics was developing rapidly. One of the macro observations that attracted attention was the "Phillips curve", the trade-off between unemployment and inflation that was apparent in the data of several countries for many decades leading up to the late 1950s. However, this statistical relationship began to break down, and was decisively rejected by the occurrence of stagflation in the 1970s. The orthodox response (Lucas, 1976) was that the use of historical correlations – even when they work well for short-term forecasting – is an insecure basis for policy, because variables become unreliable when they become targets for economic policy. This became known as the "Lucas critique", and was important in arguing for a return to traditional economic theory, in what became known as the micro-foundations project.

1.2. The micro-foundations project

One conclusion was that traditional theory would provide a better analysis, because it provides structural, policy-invariant parameters. An analysis based on such "deep parameters", relating to preferences, technology and resource constraints, would be able to predict what individuals would do, taking account

of the policy change. It could be aggregated up, to predict the macroeconomic consequences of the policy change.

This was the fundamental concept of the "micro-foundations" project: the idea that macro models should be founded on the traditional basis of individuals' rational decisions under conditions of constrained optimization (see the review by Janssen, 2008). In practice, this has usually involved the use of the representative agent methodology, in which it is assumed that the macroeconomy can be analysed as if it were an individual with preferences that mirror those observed at the macro level. This methodology has been effectively criticised, e.g. by Kirman (1992).

The methodological literature on micro-foundations has generally focused on such topics as the business cycle, unemployment and inflation, not on economic growth. The standard Solow-Swan growth model (Section 3.1) has analogous issues: it is based on the idea of an aggregate production function, which has also been criticised both theoretically and empirically, notably by Shaikh (1974).

In this paper, I address a more fundamental aspect of the micro-foundations project: the idea that the economy is driven by external, non-economic "deep parameters", i.e. preferences, technology and resource constraints. The implication of this view is that economic forces as such play no important part in the economy – rather, what we see is an economic response to these exogenous factors. The concept of a causal system with its own endogenous causal processes, as previously outlined, is fundamental to my critique.

In Section 2, I review the evidence on modern economic growth, and demonstrate that its features are best understood by analysing it as such a system, in which there is a commonality between the *endogenous* causal processes operating across the range of dynamic economies in different places and times. The *generative* causes, by contrast, are specific to place and time. In addition, multiple causation operates, in the sense that numerous other causal processes may play an important although incidental role in some of the economies, and/or at specific times, but not others. Before reviewing the evidence on growth, I briefly consider how the traditional view of economic theory relates to the available evidence (Section 1.3), and what type of theory could, in principle, explain a phenomenon such as modern economic growth that is not a universal in human history (Section 1.4).

1.3. Traditional microeconomic theory, causation, and the evidence

In his critique of the use of historical econometric correlations, Lucas (1976) was clearly correct that such correlations are not necessarily stable – they may change over time. However, his reliance on standard economic theory was not explicitly justified; it was merely referred to as a "rightly respected tradition". In addition, he provided two purposes for economic theory: short-

term forecasting and policy evaluation. It may be implicit in the latter that causal understanding is also an important aim, but it is neither explicit nor prominent.

In the methodological literature on causation in traditional economic theory, one prominent contribution has been that of Friedman (1953), who argued that "as if" explanations are satisfactory. In terms of the philosophy of causation literature discussed in the Introduction, this means that the mechanism postulated by a model can be different from that which actually operates in the real world. For example, a billiard player uses Newton's equations of motion while playing, even though s/he is not directly aware of those equations. The important thing is not causal understanding (or indeed realistic assumptions), but rather that the predictions are correct – although Friedman does not mention the evidence for correct predictions in the economic literature, nor does he appear to be aware of the need for this evidence.

More recent work in economic methodology has shifted towards the view that explanations are more likely to be successful if they represent the actual causal processes (Alexandrova & Northcott, 2013; Grüne-Yanoff, 2013; Rol, 2013) This is also true of some practicing economists (e.g. Rodrik, 2015). It is certainly more achievable now than in the past, given the increased availability of rich datasets and the development of improved methods of causal inference.

Nevertheless, much economics – including empirical work, which now dominates the work of academic economists – continues to rely on the assumption of rationality and the use of constrained optimization as fundamental. It is not because there is good evidence for rationality or for optimization. There is a large literature giving empirical grounds for criticising the rationality assumption, and although there is less written about optimization, it is clear that this is an idealization of human behaviour, and is not intended to be an accurate description. They continue to be used for pragmatic reasons, including their suitability for the conventional type of mathematical analysis.

As convenient modelling assumptions, they may be justifiable for many purposes. For example, if one assumes optimization and then conducts a statistical analysis on that basis, unless the model were able to explain 100 percent of the variance (which never happens), the interpretation would be that the behaviour that was modelled as optimal is in fact only a tendency, one causal force in a world of multiple causation. It would be harmless, as long as this were made explicit.

The important issue is not whether rationality and optimization occur in the actual economy. It is clear that they do not. More important is that this focus has tended to obscure the need for an empirically-based account of the causal processes that are operating in the economy. The accumulating evidence, much of it causally sound, needs to be used as the basis of causal theory; whether or not this corresponds with the traditional body of modelling and theory is ir-

relevant. In the literature, attention is often directed at trying to explain the *discrepancy* of empirical findings from what is expected (or "typical") in standard theory rather than the phenomenon itself (see for example Joffe, 2017a). In natural sciences such as biology and geology, which study a reality that is complicated and open-ended just like the economy, successful causal theories have been developed by combining multiple types of evidence – as diverse as possible – with causal ideas derived from description, generalisation and explanation, and/or from imaginative leaps (Joffe, 2017b). It is argued here that economics could use a similar methodology, and that this would produce a better account of how the economy works.

1.4. The necessary features of a theory that explains a non-universal phenomenon

As we have seen, the micro-foundations project seeks to ground macroeconomic analysis in parameters that are invariant. There is an empirical question of whether such "deep" parameters actually exist, with the qualities of permanence that are desired. However, even if they do exist, here we are concerned with understanding modern economic growth, which has had a particular spatio-temporal distribution – it is far from universal in human experience. It could not, even in principle, be explained on the basis of unchanging deep parameters. A more important question is, therefore, how best to understand the cause(s) of something that is spatially and temporally contingent? To put this as the counter-factual, suppose micro-foundations of modern growth were universal, for example a feature of human nature or of economic behaviour in general or in the abstract. Then economic growth would be evenly spread across human history and across different places and types of economy.

There are two caveats here. First, if there were demonstrable impediments in some economies that prevent the "natural" working out of the forces described by the micro theory, then it is possible that a universally present cause could have its effects only on the occasions that such impediments were absent. Obvious candidates could be the neoclassical assumption of a "competitive market", or the idea of property rights. It will become clear in the later discussion that neither of these fits with the evidence.

Secondly, the universally-present cause could interact with some other causal force that is specific to certain places and/or times. The phenomenon of interest, economic growth, would then depend on the presence of both. In such a situation, the specific factor would (also) be a cause of growth. Indeed, the status of the universal cause would then be merely as a background cause, or possibly a necessary condition. The primary focus of scientific attention would be the specific cause.

2. The evidence on modern economic growth

2.1. "Modern" growth and earlier growth episodes

Economic growth as such is not a purely modern phenomenon. Episodes of growth in GDP *per capita*, of a sizeable magnitude, have occurred previously in e.g. China, northern Italy, Japan, the Netherlands, and Britain before the industrial revolution. In some of these cases, the growth episode was followed by decline in absolute terms (Italy) or stagnation (China) (Fouquet, & Broadberry, 2015; Maddison, 2007). In some cases, it appears to have resulted from the growth of trade and specialization – the division of labour, as analysed by Adam Smith (1776) – and has thus been called "Smithian growth" by some economic historians (e.g. Kelly, 1997). However, in other cases, such as Chinese growth during the Song dynasty (960-1279), it was mainly due to a one-off transition from an economy based on wheat and millet to one based on rice, accompanying the major population shift to the south. The denser settlement reduced transport costs, and the higher agricultural productivity released labour for handicraft production (Maddison, 2007). This was a time of expansion of education, with increased meritocracy, and vibrant trade involving joint-stock companies (Ebrey, 1999); many peasants owned their own land (Ebrey, 1999, p. 155).

Yet it remains essentially true that "Average growth rates for about one and a half *millennia* before the Industrial Revolution are estimated to have been approximately *zero*, and, although there was undoubtedly some growth (…) [earlier], it proceeded at a snail's pace by modern standards" (Baumol, 2002). An estimate of the extent of growth since the industrial revolution is that the economy has expanded 16-fold on a *per capita* basis during that time, in the rich parts of the world (McCloskey, 2010). But this is probably a substantial underestimate, because it neglects the way that product innovation can transform the situation. The classic case is lighting: it is not just that candles have become cheaper; they have been supplanted in turn by gaslight, various types of cheap and effective oil lamp, and then by electric light (Nordhaus, 1997). The cost of a lumen hour in terms of labour hours has reduced more than 10,000-fold. Clearly, in modern times the economy has developed dynamic system properties that were absent before.

2.2. The industrial revolution in England

From the mid-17th century, *per capita* GDP in England started to increase. At that stage, Holland, northern Italy and Sweden were still more prosperous (Fouquet & Broadberry, 2015). During the 18th century, some transformation of production began to be evident, e.g. in ironwork, ceramics, etc.

However, the real impetus to growth came at the end of the 18th century, as the industrial revolution got underway, with a massive expansion in such in-

dustries as cotton thread, textiles and clothing. Similar developments quickly spread across a wide range of economic activities. Figure 2 illustrates this economic transformation in terms of builders' wages, starting in 1209. It shows relatively small fluctuations for several centuries, with no overall trend, followed by a structural break around 1800, after which annual growth became a routine occurrence. Data on *per capita* GDP show a similar pattern, although estimates of the date of the structural break vary, and it is likely that living standards did not rise until some decades after the industrial revolution.

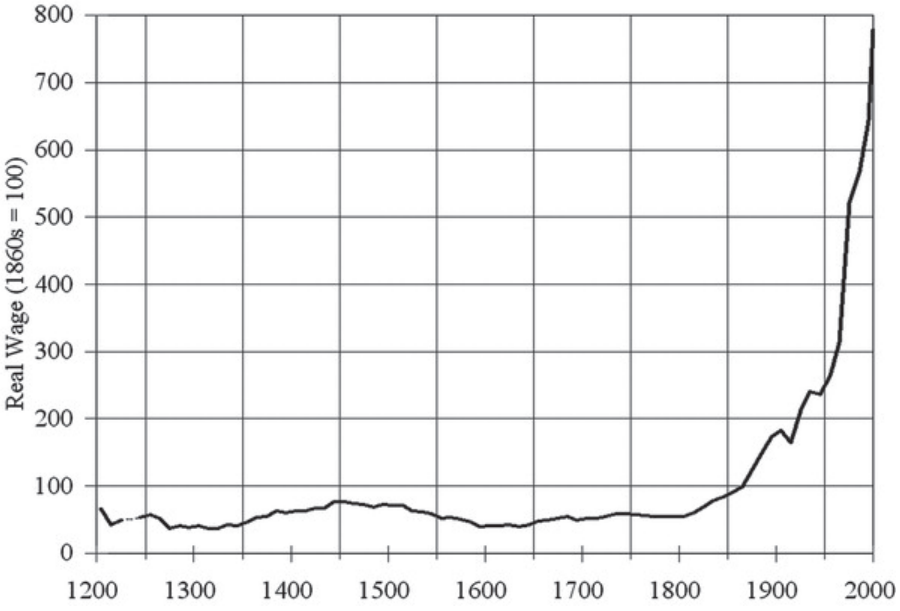

Figure 2. Builders' real day wages, 1209-2004
Taken with permission of University of Chicago Press from Clark (2005)

Britain thus became "the workshop of the world". By 1851, the year of the Great Exhibition, British wealth was unparalleled anywhere in the world. This period saw the establishment of a new legal basis for the firm, which was necessary to meet the needs of the new type of industrialists. The primary innovation was entity shielding, which established the firm as an entity and protected it not only from the state and those who might sue, but also from its own shareholders (Blair, 2003; Hansmann, Kraakman, & Squire, 2006). This is the mirror image of limited liability, which is much better known, and which emerged only later in response to lobbying by *rentiers* (Ireland, 2010).

2.3. The spread of growth and industrialisation among European populations

Britain's international economic dominance started to become eroded in the last third of the 19th century, with the rise of the United States and Germany. Many features were similar to the British experience, notably the spread of industrialisation and factories, underpinned by the legal changes that facilitated them. On the other hand, there were important differences. America's economy remained largely rural at first, and transportation improvements meant a rapid rise in the scale and diversity of food exports to Europe, along with the traditional cotton for Lancashire. The scarcity of labour meant that wages were relatively high, providing a strong incentive for labour-saving innovation. Industrialisation started mainly on the basis of multiple small firms, but the situation changed radically towards the end of the century, with the rise of the "robber barons". Germany's rise included science-based industries such as chemicals, and independent small firms were less in evidence, with cartels playing an important role (Chandler, 1990). Whereas US *per capita* GDP surpassed that of Britain in the early years of the 20th century (according to Maddison's figures), that of Germany continued to be some 25 percent lower in those terms, despite its growing industrial might. The growth of industry was not confined to these large economies. Industrialisation came early to other parts of Europe, such as Belgium. France and the rest of north-western Europe also developed increasingly prosperous industrial economies, and this subsequently spread elsewhere in Europe.

Prosperity spread rapidly to Australia and New Zealand, and later to Canada – areas of European colonisation often referred to (along with the US) as "Western offshoots" (Maddison, 2006) – as well as to Argentina and Uruguay. Their European populations also expanded hugely due to mass immigration. This was largely on the basis of agricultural and pastoral activities, relying on the buying power of Britain and other industrialising countries, plus some local manufacturing.

2.4. Cutting-edge growth and catch-up growth

The economic transformation wrought by the industrial revolution was cutting-edge growth, defined as new methods of production and/or new products. The rise of English cotton goods to global dominance was mainly based on process innovation; whilst cotton-based production was new to England, it had been long established elsewhere e.g. Bengal. Other industries were completely new, notably the railways.

As industrialisation grew, and especially as it spread internationally, much of the consequent growth was catch-up rather than cutting-edge growth. The distinction is not clear-cut. The growth of the horseless carriage in the late 19th century was a product innovation. It was soon accompanied by major process

innovations, notably those of Henry Ford starting in 1908. These are clearly cutting-edge growth. So too, arguably, is the emergence of General Motors in the 1920s under Alfred P Sloan, with the introduction of brand architecture, annual model change and planned obsolescence. However, it could be argued that the subsequent imitations of the methods of the pioneers were merely catch-up. If this were accepted, much if not most growth would really be catch-up growth, even within a highly innovative society such as the US.

In deciding what is catch-up growth, it is probably preferable to resort to the national level. This is in line with concept of convergence in the Solow/Swan growth model, which suggests that relatively poor countries will catch up with the rich nations. This at least provides a relatively clear classification, even if it can be criticised on the basis that adoption of imported foreign technology requires the domestic ability to adapt to it, as well as on the already-mentioned grounds that much rich-country growth is not truly innovative. It would mean that, for example, one might classify all Japanese growth as catch-up, even though some of it became innovative in the late 20th century.

One should also bear in mind a third category. Periods of dramatic industrialisation in one part of the world, e.g. industrial-revolution England or China more recently, are accompanied by a secondary growth impulse elsewhere. This results from a boom in the demand for commodities, with a consequent price rise. We have already seen that this occurred in the British dominions during the 19th century. The recent China-driven boom in manufacturing had a similar but now waning impact in such countries as Australia, Brazil, and parts of sub-Saharan Africa.

2.5. The spread of economic dynamism beyond European populations

Episodes of rapid growth have not been uncommon in many parts of the world, but the region where sustained high growth rates have been most transformative is East Asia. It began with the rapid industrialisation of Meiji Japan in the late 19th century, which led to a military capability sufficient to defeat Russia in 1904-1905, and to the colonisation of Taiwan, Korea and Manchuria. Economic growth was, however, relatively modest (2.6-fold) until 1950. *Per capita* GDP then increased a further 10-fold between 1950 and the mid-1990s, with many Japanese corporations becoming world leaders in their field.

At first, it appeared that Japan was the only country with a non-European population to achieve transformative growth. But a series of reforms, in 1950s Taiwan and then 1960s South Korea, set them on a similar upward path. In addition, the city-states, Hong Kong and Singapore, followed an even more rapid trajectory.

The dynamic economies of East Asia have, for the most part, developed according to a different pattern from the various European countries, including

the offshoots. Aside from Hong Kong, the state has played a dominant role (especially marked in Singapore). The process of industrialisation has been strongly guided by the state, starting with Japan, and continuing in the other countries – albeit with important variations in how this was done. In particular, capital flows were controlled by the state in accord with its strategic aims. For example, the South Korean reforms of the early 1960s began with the nationalisation of the banks. The second important feature has been openness to international competition. The state incentives have been largely directed to export success. Thus, industry in these countries has been subjected to the discipline of global competition, but in a way diametrically opposed to the "free market"; in some instances, prices were deliberately "wrong" in terms of conventional economics (Amsden, 1989). In most cases, the early industrialisation was based on labour-intensive manufacture such as textiles and clothing, in which the low unit cost (cost relative to productivity) made it internationally competitive. Each has then established itself in other industries, including technology-intensive sectors (Amsden, 1989; Wade, 1990; Studwell, 2014).

More recent has been the rise of China. Although its *per capita* GDP "only" rose a little over 5-fold between the beginning of the reforms in 1978 and 2003, its global impact has been immense owing to its size. Much of its growth has been attributable to low unit costs, together with an undervalued exchange rate, enabling its manufacturers to undercut world prices across the whole range of types of industry. Much heavy industry remains in the hands of State-Owned Enterprises (SOEs), and the banking system is state controlled. However, there has been a large element of FDI (foreign direct investment) in export industries, especially where the need for foreign technological input has been large.

2.6. Unsuccessful capitalist economies

To avoid the selection bias involved in discussing only the economies that showed transformative dynamism, a brief word is necessary on the economies that were capitalist in structure but which experienced only moderate or intermittent growth. The prime example is 20th-century Latin America. Some growth occurred, but it was sporadic, and the economies were prone to periodic crises. This is often attributed to government policies that set out to protect industry from international competition, so that the firms never became globally competitive. Equally plausible is that most firms never had the potential to compete internationally, and that government policy was just recognising this fact. Both ideas may contain some truth.

2.7. Summary of the main features

Since the advent of modern economic growth, it has become customary to expect that a successful economy will have positive GDP growth in most years. It has often been the case that a particular economy has a characteristic pro-

portional growth rate, and this gives rise to a near-exponential growth curve. For example, US GDP has had a form that is very close to exponential since the early 19th century, apart from episodes of instability.

Most rapidly industrialising countries, although not Britain or America, have had an authoritarian government in the early decades of their growth. Germany was the star economic performer in late 19th-century Europe, and in the era of "social imperialism" had a government that was highly autocratic by west European standards. The East Asian countries have mostly had dictatorial regimes during their early decades of growth. It is of course also true that most of the authoritarian governments in the world have not presided over rapid economic growth.

The state has played a central role economically. The Royal Navy's domination of the seas was pivotal during the industrial revolution (O'Brien, 2004). Protectionist policies were followed in almost all these countries, until they had developed far enough for their industries to be able to compete internationally (Chang, 2003; Allen, 2014). The state fostered human capital improvements, especially education (Lindert, 2004). It built infrastructure to complement industry's products, e.g. roads for cars. And in some places, it has supported basic research plus applied R&D, and has also acted entrepreneurially, taking on risk, and created and shaped markets (Mazzucato, 2013).

3. Overview of the growth literature

3.1. Neoclassical growth theory

A fundamental tenet of orthodox textbook theory is that competitive markets provide an optimal solution to problems of distribution. This theoretical argument, however, does not provide a good basis for the explanation of modern economic growth, which has proved equally compatible with other market structures, e.g. ones dominated by oligopoly. The notion that this growth results from a transition to more competitive markets in the dynamic economies does not withstand even a cursory confrontation with the evidence. Schumpeter even argued that some insulation from competitive forces provided an incentive to innovate.

It has often been remarked that the "price mechanism" facilitates convergence, but does not have the capacity to generate growth. Whilst true, it remains possible that relatively unimpeded market economies are more dynamic. If so, the argument needs to be made explicitly, and to include the distinction between the distribution of what already exists from the production of new goods and services. The fundamental issue here is that if exchange is seen as a human universal, or even as very ancient and also widespread, then it can-

not be used to explain something as historically and spatially contingent as modern economic growth.

The neoclassical tradition contains models of growth as well as of markets. Notably, in 1956, a model of long-run economic growth within the neoclassical framework was proposed (Solow, 1956; Swan, 1956). Based on the standard aggregate production function, it decomposed growth into three components: capital accumulation (as well as its depreciation), labour force growth, and increase in productivity. Capital was assumed to be subject to diminishing returns. The conclusion was that the rate of long-run *per capita* growth is equal to the growth in Total Factor Productivity (TFP), and depends entirely upon it. This so-called "Solow residual" is what is left over once the contributions of capital and labour have been deducted from the actual growth rate; Solow himself commented that it is "a measure of our ignorance".

One prediction was that poorer countries should have higher growth rates. This is because their lower capital stock implies a higher return on capital, in accord with the diminishing returns assumption. However, it could equally well occur because later arrivals are able to import the methods, ideas and technology that have already been developed in the rich world. Evidence for convergence (catch-up growth faster than cutting-edge growth) could therefore support either mechanism, or a combination of both.

Econometric analysis shows that if sufficient account is taken of savings rates and human capital growth, there is some evidence for convergence that is conditional on these factors (Barro & Sala-i-Martin, 2004). However, this work has been criticised on the grounds that it too readily accepts correlations as evidence for causation with growth as the outcome, as well as a closed-economy assumption (Acemoglu, 2009). It is also important to note that it applies only to the period since World War II, when the actual divergence in *per capita* GDP was relatively small, not to the great divergence of the 19th century (Acemoglu, 2009). Nor does it explain the evidence from the comparative economic history of the period since catch-up growth started 150 years ago; this shows a degree of heterogeneity that cannot be explained in terms of the variables involved in this econometric work, as I have tried to summarise in Section 2. A distinction between these proximate causes and more fundamental ones is required, and this requires a richer conception of the interacting causal influences.

Further models have been developed since the mid-1980s, with the intention of making growth endogenous – at least in a modelling sense, with a plausible "story", if not grounded in evidence for causation. These "endogenous growth" models have, for example, focused on spillovers involving investment, technology, human capital or knowledge, which counteract the effect of the assumption of diminishing returns (Romer, 1986; Lucas, 1988). These models have been extended in various ways, for example to include imperfect markets, open economies and R&D (Aghion & Howitt, 1998). However, they have various drawbacks (Sach & Warner, 1997; Parente, 2001), including that they involve permanently

different growth rates for each country, and therefore predict an ever-expanding world distribution, which is incompatible with the evidence since World War II. They are also irrelevant to catch-up growth (Acemoglu, 2009).

3.2. Invention

In line with the Solow-Swan model, growth can be seen as resulting from invention – a source of productivity growth, and indeed also of product innovation, that is outside the economic system as such. This is usually proposed in the context of the history of the English industrial revolution or other cutting-edge growth (Mokyr, 2002, 2009, 2017), and/or in attempting to answer the questions why that occurred when it did (Mokyr, 2002) or where it did (Lipsey, Carlaw, & Bekar, 2003; Mokyr, 2009, 2017, especially pp. 339 ff.). If it were true, it would imply that the capitalist economic system has no intrinsic dynamic attributes; it merely responds to external technological "shocks".

There is a general sense in which process and product innovations have made the difference between today's world and that of 300 years ago. But one needs to be able to answer the questions, "why does this type of economic system generate so many inventions?" And, "why are they the sort of inventions that lead to growth?

In any case, the spatio-temporal distribution of invention is quite different from that of transformative growth. For one thing, it applies only to cutting-edge growth. Catch-up growth, on the other hand, relies on importing existing technology – there is no role for invention, other than that required to adapt something that already exists to a particular situation. Usually if the new location has any benefit over the place where the technology is already in use, it is because it facilitates a competitive advantage. Often this is low unit costs, because of cheaper labour without proportional loss of productivity.

In addition, it is well recognised that there have been highly inventive societies in other places and times, such as medieval Islam and Imperial China. These did not display either modern economic growth or a rise in living standards for the majority of the population. Why not? One reply is that science, and the Enlightenment more generally, became central to (implicitly cutting-edge) growth after 1870, even though it played only a small part in the original industrial revolution (Mokyr, 2009). Lipsey et al. (2003, Chapter 8) discuss why these highly inventive civilisations did not develop mechanistic science. These explanations are difficult to assess, because they rely on historical accidents as the most important causes. A further problem for the idea that science and/or invention more generally underlie economic dynamism is that the Soviet Union's economy is universally agreed to have been sluggish in comparison with that of the West, despite a high level of scientific and technical expertise. There does seem to be something specifically dynamic about the capitalist system.

3.3. Situation-specific factors

Economic historians have suggested causes for particular key transformations. It would take us too far afield to compile a list, and I will focus on two interrelated ideas that appear to be most relevant. Pomeranz (2000) has proposed that the ecological constraints faced both by western Europe and by east Asia (Japan and China) were resolved in a different way, and that this had far-reaching consequences. Increasing population density led to more labour-intensive production in Asia, whereas a different solution was possible in Europe, especially England, due to coal and colonies. Moving to coal from charcoal, which required a great deal of land, both economised on land and stimulated technological development. Control of the colonies, especially the plantations based on slave labour, again eased the pressure on the land, by allowing imports of agricultural products.

Allen (2006, 2009) has argued that Britain's endowments were relevant in a different, albeit related, way: factor prices. Domestic wages were high, so labour was expensive. But energy was cheap, due to the relatively large coal industry – and its size made it worth investing in mining technology, notably the steam engine for drainage. There were thus strong incentives for British entrepreneurs to invest in technology that substituted coal for labour. It meant that an invention that was profitable in Britain would be loss-making in e.g. France, where the savings on labour costs would be far too small and the energy costs too high. An important rider to this argument is that once the impetus towards labour-saving technology had developed further, it could become so low-cost that it might become profitable even in France. Ideas of this kind are probably relevant to questions about the location, and perhaps also the timing, of the English industrial revolution. However, they are irrelevant to most of the other economies that subsequently embarked on sustained growth (with the important exception of labour costs in the US). They are addressing the question of generative causation, but not of system causation.

3.4. The entrepreneur

It has often been pointed out that the dynamic of markets is convergence towards a static equilibrium (balancing feedback), not the creation of something new; and relatedly, that orthodox theory lacks a role for uncertainty or agency, because optimization methodology guarantees a unique outcome. In the early 20th century, Schumpeter proposed the brilliant metaphor "creative destruction", to describe how an economy could be transformed: it "incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter, 1992). He contrasted this with the orthodox static model.

There are two problems that prevent this being a satisfactory answer to the question addressed in this paper. One is that although he stated, "This process

of Creative Destruction is the essential fact about capitalism" (Schumpeter, 1992), he denied that sustained *per capita* growth is specific to capitalism, providing a 14-page account of equivalent processes occurring under a simple exchange economy, an isolated manorial estate, and an isolated communist society (Schumpeter, 1983).

The second is more fundamental: there is no causal account. On the one hand, he remarked that capitalism creates the tendency to think in certain ways, e.g. to generate innovations, but only specified this in vague terms. On the other, his main emphasis was on "the entrepreneur" as a person who produces new combinations that lead to new products, new production methods, etc. By specifying a type of person, he obscured the need for a causal analysis. One would need to be able to answer, "why does this particular type of economic system generate entrepreneurs?" And secondly, "why should the resulting innovations be of such a kind that one result is growth?" (Joffe, 2013b). Without a satisfactory answer, we are left with a brilliant description, but no causal understanding.

In addition, Schumpeter confused two senses of the term "entrepreneur" (Joffe, 2013b). His image was of a dynamic newcomer who transforms things, which ignores the observation that innovation frequently arises in existing firms. But it also meant that the term came to mean someone who is "their own boss", i.e. self-employed, a confusion that is still widely prevalent. In fact, the evidence is that entrepreneurs in this sense have far lower productivity than capitalist firms (e.g. GERA, 2017).

3.5. Evolutionary economics

Evolutionary economics analyses the processes of economic change, as manifest in the transformation of firms and industries, employment, production and trade (Nelson & Winter, 1982; Witt, 2008). Although much of its original motivation was based on an analogy with biological evolution, emphasising "adaptation", and taking "routine" and "innovation" as analogues of genetic inheritance and mutation, its contributions are not limited by this analogy.

For example, empirical research in the evolutionary tradition has documented the great heterogeneity of economic agents, especially firms (Bartelsman & Doms, 2000; Grazzi, 2012). It shows that even with the same technology, there is a two-fold range in productivity in each sector. This is correlated with wages, export success, technology usage, output growth and probability of firm survival. Input intensities also vary greatly, and the distributions of efficiency, innovativeness and indicators of profitability are highly skewed. All these characteristics are consistent across the definition of a sector, i.e. whether three-, four- or five-digit level, and are highly persistent over time (Grazzi, 2012). Evolutionary economics is not so much a theory of growth, in the sense of attempting to explain why and when it occurred, as a study of the internal

dynamics of the process. It is therefore highly relevant to the perspective proposed in this paper, and has a complementary role to the systems perspective.

3.6 Institutional economics

There has been increasing focus on the institutional underpinnings of the economy, including their possible impact on growth and development, in the past two decades. There is no doubt that they are important, although it remains unclear exactly which institutions have which economic consequences. One influential tradition has been New Institutional Economics, with its emphasis on transaction costs (Coase, 1937; Williamson, 1985). However, this is probably not important in explaining economic growth. As Williamson himself has stated (in Hodgson & Gindis, 2007), innovation and the entrepreneurial firm both pose "special challenges"; "another generation of economists is going to have to come up with the answers".

Another perspective within New Institutional Economics is a focus on property rights (Acemoglu, Johnson, & Robinson, 2005; Besley & Ghatak, 2009). It is argued that well-enforced property rights provide incentives for individuals to participate in economic activities, such as investment, innovation and trade, which lead to a more efficient market. Economic prosperity is one result, especially if there is equality of opportunity. And importantly, rulers are far less likely to be able to expropriate private owners of property. In addition, the property rights perspective has been applied to many specific areas, e.g. the firm (Hart & Moore, 1990).

However, the situation is not as clear-cut as that analysis may suggest. In China, property rights have been extremely unclear under the Communist regime, and this did not alter with the reforms that started in 1978. Some changes have been made in the direction of European-style property rights, but expropriation remains common, often with minimal compensation. This is especially true in the rural areas, but it also affects firms: "it is often unclear whether a "private" enterprise is really owned by individuals or by a local government or party unit. Conversely, some "collective" or "state" enterprises operate in ways indistinguishable from the private interests of their bosses" (*The Economist*, 2007). This has not prevented the spectacular growth of the Chinese economy. Thus, whilst secure property rights may have been an important factor in European growth, they cannot be considered a necessary condition more generally.

Another strand of this argument has emphasised *intellectual* property rights. Patents may have increased the returns to inventing, and therefore acted as an incentive to innovate. However, patents are also widely acknowledged to have been used as much to protect an existing technology, and therefore to delay innovation, as to promote it. And the role of English patent law in the industrial revolution may have been overstated: as Allen (2006) has argued, "the English patent law was enacted in 1624 and attracted little interest for much

of the 17th century, so the explanation of the inventions of the 18th turns on the greater incentive to invent rather than on a change in law that met an existing, latent demand for patenting".

Other institutional hypotheses include the "reversal of fortune" idea, that European colonies that were prosperous in the early stages of colonisation failed to develop economically, whereas the initially poor colonies eventually became extremely rich (Acemoglu & Robinson, 2012). The main contrast is Latin America as against North America. Their explanation is that in the former case, "extractive" institutions were introduced, whereas the settler pattern of North America developed "inclusive" institutions. While this may possibly apply to the Americas, despite the extremely long period involved, and therefore the neglect of other forces that could have intervened, it has been criticised for being incompatible with historical experience elsewhere, for example Germany, East Asia, and sub-Saharan Africa (see e.g. Austin, 2008). In particular, it ignores the role of highly authoritarian governments in the early decades of many dynamic economies.

One further institutional idea is that it is misleading to analyse capitalism solely as a market system; it also contains subsystems of production, governance, etc (Hodgson, 2015). In particular, the state has a constitutive role. This accords with the above observations on the supportive and complementary role of the state.

3.7 The financial sector and capital accumulation

Financial-sector development is often cited as a central feature of capitalist growth. However, the evidence is unclear. Banking systems were developed in northern Italy and Flanders in the middle ages. The first stock exchange was established in early 17th century Amsterdam. Yet the first example of specifically capitalist growth did not emerge until the late 18th century, some distance away in Britain. Financial institutions were not sufficient to trigger it in earlier continental Europe.

At a micro level, studies of sources of finance show that start-ups in new industries often rely on local financial networks (O'Sullivan, 2007) and venture "angels" (Bhidé, 2006) in a large variety of times and places, and that established companies tend to use retained profits for investment (O'Sullivan, 2007). It is true that industrialists have often borrowed from banks, etc, e.g. using collateralizable property (Hodgson, 2015). But in America, investment in industry during the 19th century was not primarily funded by formal financial institutions (Lamoreaux, 1985). They are not a necessary condition.

More recently, the dissemination of capitalism has largely occurred using foreign direct investment, brought about by expanding real-economy firms. This has played a major role in bringing about catch-up growth, through its role in the diffusion of technology, management methods, etc. The rise of East Asia

also provides a substantial counter-argument to the view that the financial sector has been crucial to all capitalist growth. The state itself and/or state-owned banks have been responsible for channelling capital to businesses. In particular, China's financial sector was relatively undeveloped in the early decades of its phenomenal growth trajectory following the reforms that started in 1978.

3.8. Baumol's "free-market innovation machine" view

In his book *The free-market innovation machine*, Baumol (2002) posed the question of modern growth very clearly; his description of its uniqueness was quoted earlier, in Section 2.1. He set out to discover how this works. His answer to this question involves (a) the free market, but oligopolistic not "perfect" competition; (b) continuing innovation, seen as far more important than price and the static efficiency properties that are stressed by standard welfare economics – indeed it is often a matter of life and death to firms. Another key feature is (c) routinized R&D.

Unfortunately, none of these features fits well with the empirical record of growth. For (a), it ignores the observation that in a large proportion of countries, including Britain, America and most catch-up growth countries, oligopoly was rare during the early stages of growth. With (b), it is not specified why pre-capitalist firms should not also have needed to innovate to survive; he is probably correct about the contrast, but the basis is unclear. In the case of (c), it is only in recent decades and in cutting-edge-growth countries that R&D has been routinized in this way. In sum, it is another theory that takes no account of catch-up growth, and even for cutting-edge growth its correspondence with the evidence is patchy.

3.9. McCloskey's idea of "bourgeois dignity"

McCloskey has demonstrated that the scale of economic growth is far too large to be explained by any of the existing "materialist" theories. Even all of them taken together could, at most, only account for a small fraction of the actually-observed phenomenon (McCloskey, 2010). Her conclusion is that the transformation in the economy was due to the social acceptance of the emerging industrialist class – the bourgeoisie were accorded "dignity". It would be difficult to establish this definitively, because one would need to be able to show that the social acceptance came before the transformation, which is necessary for it to have been causal, and is inherently problematic. This does not mean that the theory is wrong, only that this would be difficult to demonstrate empirically.

Furthermore, the theory would need to apply not only to England and other cutting-edge economies, but also to those that experienced substantial catch-up growth. In addition, countries with non-dynamic capitalist economies should have accorded less dignity to their business people. The most that can currently be said is that these wider features have not yet been demonstrated.

One may also doubt the plausibility that such a large effect could be the result of such a subtle cause.

Probably the most important shortcoming of this work is that McCloskey neglects the possibility of reinforcing (positive) feedback. The underlying assumption behind the argument about magnitudes is that the economy responds in a one-off manner to whatever impinges upon it – a stimulus-response notion. This is not necessarily true, if one allows that a feedback process can produce a change that is progressively greater with each iteration. This generates the exponential functional form, typical of reinforcing (positive) feedback, that is close to what is usually observed empirically.

3.10. Arms-race competition between "capitalist" firms

During the industrial revolution, the factory system became dominant. Its main features were that the firm owned and controlled not only the premises where production took place, but also all the means of production – machinery, materials, etc. It evolved into the capitalist firm, which can buy in all its inputs, including labour. This meant that it is no longer limited by its capacity for (e.g. family) labour, but only by managerial capacity (Penrose, 1959). It opens up the possibility of taking over substantial amounts of market share from one's competitors, which could be called "economic conquest" (Joffe, 2011). Such firms have been introduced in one country after country as industrial capitalism has spread; in England, the legal underpinning was initially a response to the needs of business people, but in most of the follow-on countries the relevant legislation has been introduced in a top-down fashion.

Competition between such firms is an arms race, a form of reinforcing (positive) feedback. Over time, such competition leads to process innovation that lowers unit costs in each sector, and thence also prices. This has led to dramatic falls in the quantity of work time necessary to buy a large number of products, especially manufactures (Cox & Alm, 1997). The consequent raising of the buying power of customers has been a primary source of economic growth (Joffe, 2011). A similar dynamic has applied to product innovation – ever more new products becoming affordable as buying power increased – and this is responsible for much of the remainder. One implication is that the growth performance of an economy depends on how good its component firms are at competing. This hypothesis is consistent with the spatial and temporal distribution of growth. It is applicable equally to cutting-edge and catch-up growth, and to various types of market structure. It does not depend on culture, except that it requires that economic relationships are formed between strangers, not just within a family or clan grouping.

Conclusions

There are many perspectives on economic growth. In this paper, I have provided a brief overview of the most important theories, with the over-riding criterion that they should be able to account for the most basic empirical features of modern economic growth as it has actually occurred. The conclusion reached is that scarcely any of them are able to fulfil this basic requirement.

This is not the result one might expect from the philosophy of science literature, where a major problem is considered to be the "underdetermination of scientific theory by evidence" – the problem that any given body of evidence can be explained by numerous hypotheses. This would mean that it is difficult to determine which is correct (Stanford, 2016).

In most cases, the reason is the *a priori* methodology that dominates economic theorising. The result is that many theories have been developed that are highly ingenious and brilliant, but methodologically this approach provides no systematic link between the theory and the actually-existing world. In economics, it is unusual – although not impossible – to find a theory that is derived from a systematic consideration of the various types of evidence, as is the norm in natural sciences such as biology and geology (Joffe, 2017b). With the large increase in the availability of statistical datasets, comparative economic history data and methods of causal inference in recent decades, it would now be possible for economic theory to be based on evidence (Joffe, 2014). This paper is intended as a contribution to that aim.

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