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A Common Misunderstanding about Capitalism and Communism Through the Eyes of Innovation

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Abstract

This paper argues that theories of communism and capitalism should not be considered as opposites or alternatives, but rather systems that satisfy different stages of humanity's technological development. The argument derives from Maslow's hierarchy of needs, and a focus on the role of innovation within systems. Some argue that capitalism focuses on the lower, and communism on the higher, layers of the hierarchy – which lays the basis for their inability to compete in different periods.

Keywords: capitalism, innovation, communism, Maslow, development of economic thought

JEL-Codes: B14, O15

1. Introduction

This paper's objective is to show that communism and capitalism should not be seen as competing systems, but rather as economic systems for potentially successive periods in human development. The analysis takes a different path from the usual argument that communism is only possible if socialism changes the human tendency towards selfishness. In this paper, socialism is understood to be that which Marx called the lower stage of communism (Marx, 2010). We argue that capitalism, as a system whose core purpose it is to provide services and material goods to satisfy material and basic Maslowian needs, is a system that fails to support the will and ability of persons to strive to satisfy their higher Maslowian needs. The second layer of needs, that of security, is disrupted by continuous changes and the constant generation of new needs. New needs that derive from humanity's technological development, which capitalism advances consistently by a self-supporting loop of need creation and need fulfilment. So, most stakeholders in the system would promote emerging – or uphold mature – innovations. Any capitalistic system can harness the energy of individuals for innovative purposes, but it also keeps the population focused on satisfying their lowest layer of Maslowian needs. In present-day capitalistic systems in the 'developed' and economically strong parts of the world, scarcity of most goods is an artificial construct derived from the creation of desires and needs. The question this paper asks is: what happens if almost all human labour – even the innovation process – is automated? Would such a society be sustainable in the long run if the largely unemployed population were unable to satisfy even their lower level needs because they are unable to work? *Capitalism with an unemployed, bored, impoverished population without prospects is not sustainable*. The hypothesis of this paper is that capitalism is a great economic system for the 'self-

development phase' of humanity, while communism is more suitable for a phase in which humans are not preoccupied with continuous innovation as their lower level needs are already satisfied.

The authors do not endorse any of the systems. The first objective of this paper is to show that communism and capitalism are suitable for fundamentally different phases in human technological development, and that these systems are not able to compete in different development phases because each has an important – yet fundamentally different – role in humanity's technological development. Second, the authors believe that complete automation of work is not necessarily a desirable objective, as work is also a way to attain self-worth. Labour can possess an intrinsic value for the individual that should not be trivialised. However, the current drive towards minimising human labour and increasing technological potential leads to the conclusion that computers will be better than humans at doing everything at some point in time. Work in general, for this paper, is used in a positivistic way – in that labour or work is seen as neither good nor bad.

To proceed with the paper, interpretations of two basic concepts must be clarified. First, any need is subjective; it is a product of the time, social status and culture of the particular person. This interpretation is adapted from Maslow (1943) and Doyal and Gough (1984). This is also the case for human wants. Here, it is enough to understand wants as a softer and weaker form of needs, that are not accounted for by actual needs.

2. Maslow's Theory of Human Motivation

Maslow's theory of human needs and motivation has echoed through the decades. It describes a hierarchical system where the lower and basic needs must be fulfilled first to enable development to the higher stages, or as Maslow put it, '…basic human needs are organised into a hierarchy of relative prepotency' (Maslow, 1943, p. 6). The basic layer of needs encompasses physiological needs that ensure our survival and physical well-being. These needs are not urges and appetites, as these are spontaneous indications of a certain lack of chemicals, or a response to addictive substances, like sugar. Basic needs are not limited to nutritional factors. They include activity, sleep, sexual desire and parental behaviour. Maslow states that it is senseless to provide a conclusive list of basic needs, as they are numerous. Needs also evolve not only subjectively for an individual, but also for the individual's social group, which adapts to standards, technology and social development (Doyal and Gough, 1984).

The second level of needs is the need for safety. This layer is triggered if the previous layer is mostly satisfied (which does not need to be for an extended period). It focuses on matters such as peace, order, health, predictability, organisation and safe conditions as well as external influences such as extreme weather conditions or criminal activity. One outcome derived from satisfying this layer is insurance. This layer also leads to the evolutionary preference for the known above the unknown. It can trigger the search for a protector or strong leader, often the case if intangible fear is apparent in a society.

The third and middle layer consists of the need for love and belonging, and develops when safety is mostly provided. Friendship, sticking by your family, nurturing children and having a partner, are all ways in which this need is satisfied. It represents the level of intimacy and connection.

The fourth is the esteem layer. It consists of two components. One pertains to self-esteem and self-confidence, self-worth, strength, capability and the perception of usefulness; the other pertains to the respect of others, reputation, prestige and need to be unique. The

fifth and last layer represents self-actualisation. It is related to the final striving towards happiness. Maslow writes, 'A musician must make music, an artist must paint, a poet must write, if he is to be ultimately happy. What a man can be, he must be' (Maslow, 1943, p. 10). Every person defines each layer individually, but the top layer is particularly individual, as some aspire athletically, others philosophically or artistically. Some may focus on inventions, writing, creativity, or being a brilliant parent; people choose whatever focus they deem fit. This layer represents a striving for experience, spontaneity, meaning and inner potential.

Humans can get lost in all the layers; they can be endless and unfulfillable. Progressing up the hierarchy of needs fulfilment is a highly individual process, but it can be hugely facilitated or tremendously complicated by a supportive or contradictory economic system – as it is only possible to focus on the satisfaction of higher needs if the lower needs are provided in that moment. To better understand the theory, one should define self-actualisation in the way it is understood in psychology, and not in economic terms. Self-actualisation is defined as 'being a mature, fully human person in whom the human potentialities have been realised and actualised' (Mittelman, 1991, p. 116). 'This tendency might be phrased as the desire to become more and more what one idiosyncratically is, to become everything that one is capable of becoming' (Maslow, 1954, p. 46), or, in more general terms, 'The process of development which does not end.' The self-actualising person has also been defined as one 'who is eager to undergo new experiences and learn new ideas and skills' (Heylighen, 1992, pp. 41-43). A more precise description of self-actualisation is provided by Friedman and Schustack (2004) as a congenital tendency towards spiritual growth and actualisation of the individual potential.

3. Innovation

Generally, the conscious process of business-driven innovation is focused on needs represented by Maslow's lower layers, as most consciously-driven innovation is focused on time-saving services and services that increase safety, comfort or the availability of material goods. There are other innovations, like those oriented towards societal security, but there are also those that target the higher layers. These are social innovations that engage a large share of the population, and they do not necessarily occupy all of an individual's time. Today, there are mixed forms such as the approaches of sustainable or responsible innovation that try to merge pure innovation with aspects of environmental protection or health concerns.

Innovation is the central concept on which this paper builds its thesis. Thus, there is a need to explain the difference between manual innovation and automated innovation. Manual innovation includes all active, human-driven innovation processes. Automated innovation includes all innovation processes that humans are no longer involved in as substantial and active actors. Manual innovation is one of the most fundamental parts of a capitalist economic system; it is also one of the hardest parts to automate. The difference between automated and manual innovation is important, because in a society in which even innovation processes are automated, labour is almost necessarily surplus to requirement. Hence, income from work is not necessarily available to a large share of the workforce, making such a system inherently instable. If an economy's entire production and service creation is automated, but the innovation process is still conducted by humans, labour will still play an important role in the lives of most people. If the innovation process is also automated, only then will labour really disappear for almost the entire population.

3.1 Innovation in Capitalism

The first economist to emphasise that innovation is an endogenous and crucial part of the capitalist economic process was Schumpeter (1939) in his milestone work *Business Cycles*. For Schumpeter, innovation, or the term he coined 'creative destruction', is the means by which economic players surpass their competitors in costs or efficiency, and it alters the prior equilibrium forever. However, Schumpeter was not the first to emphasise the importance of innovation in capitalism. Schumpeter's cycle theory includes short-, medium- and long-term cyclical development (Schumpeter, 1939). The short-term cycle is of little importance for this paper as it mostly shows the psychological state of the economy and current investment behaviour (A'Hearn and Woitek, 2001). The cycle time is too short to represent larger innovation. The medium business cycle, according to Juglar ([1862] 2014), focuses on excessive speculative behaviour and the provision of credit. His theory was later reinterpreted by Schumpeter as innovation and investment for innovation (Legrand and Hagemann, 2007).

The long-term cycle, which usually takes between 50 and 70 years, is known because of Kondratiev ([1925] 1984), who wrote that all major manual innovations develop in waves. In this case, 'waves' is another names for cycles. The idea behind long-term innovation waves is that innovation processes accumulate over time, and at a certain point a critical volume of knowledge is provided, and the technological development spikes. These spikes are the major drivers of technological and economic change, but they are also the major source of crises, as each new wave is not yet strong enough to cope with the growth of the fully-developed former wave. This idea is articulated by Perez's structure of innovation waves or paradigms (Perez, 2002). The paradigms describe a change in industries, both in the way of doing business and in the mind-sets of the people of the time. The emphasis here lies in the observation that these big waves of manual innovation are not bound to one industry only; they impact all industries and our social lives. They impact our way of life and the way we think about and perceive the world. This happened not only in the current information and communication technologies (ICT) paradigm, but also in the first industrial revolution, when industrial production initially arose. It also happened in the paradigm of steam and railways, the paradigm of steel, electricity and engineering and the paradigm of oil, automobile and mass production. It has, therefore, happened in all five big innovation waves (Perez, 2002). The idea of fundamental social changes – not only business changes, adds a new and important dimension to the already-established concept of innovation cycles. Since 1776, five paradigms or fundamental innovation waves have changed human development tremendously (Christopher and Louca, 2001; Perez, 2002). The concept is not without criticism, but it helps explain how innovation develops. Each paradigm improved living conditions in the long run. Not every paradigm led to a 'golden age' – a period in which most people benefitted from the economic benefits of growth produced by the paradigm. Each paradigm provided the economic and social basis for the next paradigm to grow. Some paradigms, like the current one, were helped along the way by state-sponsored innovation, but neither the initiation nor the surge in the type of innovation would have been possible without different markets.

Innovation determines everything; it substantially alters our social lives. In a capitalistic system, systemic change through innovation is always backed by the high involvement of financial markets. At first, banks generally hesitate to invest in new technologies, as risk cannot yet be calculated. Market share is covered mostly by venture capitalists. After the first phase of introducing a new wave of technologies, such as ICT, more investors see the potential. According to the life cycle theory, the profitability of products from

the older paradigms decrease and lose attractiveness for investors compared to the processes and products developed under the new paradigm (Kregel, 2007; Perez, 2009).

Crises in general stem from the fact that development can create some divergence between ongoing innovation and supposedly robust financial structures (Papadimitriou and Wray, 2008), which means that innovations renew the composition and behavioural patterns within a market. Thus, the supervising entities and regulations remain the same while the market and technology develop around them, which leads to a situation that cannot be sustained in the long run. Hence, regulations need to be timely and technologically adequate (Hodgson, 2001) to stabilise innovation, development and growth. Minsky (1992, p. 8) described the process of destabilisation by saying, 'prolonged prosperity transits from financial relations that make for a stable system to financial relations that make for an unstable system'. Times of 'prolonged prosperity' create opportunities for profit making and innovation in the markets, which can be destabilising Alternatively, as Minsky described, '….innovations result from profit opportunities' (Minsky, 1986, p. 359). This drive towards profit lets market players innovate, regardless of whether it is in developing new products, structures or forms of market interaction. Innovations always depend on their particular time. Today, for example, speculation in foreign exchange markets is seen as a common form of business, but in the interwar period, it was seen as a destabilising factor (Nurkse, 1944). Companies rightly develop new ways as established products and ways of doing business lose profitability through increased competition. Accordingly, accumulation of these small developments and internal market innovations develop over time.

Capital is crucial for technological development and, consequently, economic development. This claim was supported both by Schumpeter and Keynes (Pecchi and Piga, 2008). However, the generation of economists that included Keynes and Schumpeter was not the first to talk about technical development and economic growth. They were the first to emphasise the importance of innovation in capitalist economies, but the implicit importance was already present in classics like *The Wealth of Nations* (Smith, 1776). Smith started the chapter 'Of the Division of Labour' early in the book with the famous example of efficiency gained in the pin-making business through the division of labour. This represented a testimonial to process innovation. It emphasised the role of different forms of innovation for the capitalist system. A more Darwinian approach to innovation was asserted by Hayek (1960), who proposed the theory of cultural evolution. He claimed that our habits and problem-solving methods are a product of evolutionary processes developed by humans experimenting. This focus on innovation, however, makes capitalism inherently unstable. There is no such thing as continuous, stable innovation or growth in the long run. System-changing innovation leaps forward and slows down again, as humans must get used to the innovation paradigm before the next wave can even begin to develop. Such development can only be changed by a fully-automated innovation process; this is the exact condition that sets the current innovation paradigm apart from the paradigms of the past. An automated and increasingly self-automating system requires ever-decreasing external and manual input from humans. Therefore, labour will be become a marginal input in the innovation and production process at some point in time and with that, income distribution and the ability to influence future innovations will be increasingly difficult for a growing share of the population.

Almost all major schools of thought in economics have their own approach and understanding of innovation. The importance of innovation to capitalist theory and capitalist society cannot be denied. However, one question that arises from the ICT-based innovations of the recent years is whether 'Baumol's cost effect' is still accurate. Under this premise, a rise in manufacturing productivity generates a rise in income and a heightened demand for labour-intensive services. The claim is that automation is uneven, and complete automation

will never occur. While the Baumol effect accounts for innovations of mechanical nature, it does not always account for ICT-based innovation (Triplett and Bosworth, 2006) and will not account for the growing influence of Artificial Intelligence-(AI)-based innovations (Barrat, 2013; Scherer, 2016). Over time, self-learning systems will diminish the number of jobs available to humans. This does not mean that the ability to work or do voluntary work will evaporate. However, computers, as they do not have desire and do not need to rest, can work more effectively, efficiently and in social jobs even more emphatically than humans. Computers can see what a human requires in a situation from the data creation of the last and current generations. AI changes all, which means that such an algorithm with access to big data-based information should be able to predict future social innovations as well.

In summary, we can say that the capitalist system is dependent on innovation, which is why society today can sustain so many inhabitants on the planet with current living conditions. The history of capitalism, on the other hand, emphasises the unrest and instability that is a product of continuous innovation, though this continuous innovation is what keeps the capitalist system alive.

3.2 Innovation in Communism

Karl Marx stated that communism would be a positive resolution to the alienation that humans experience because of the private ownership of means of production. It would allow humans to reclaim their humanity. This process would, therefore, be a conscious and complete return of man to himself as a social being, and be rendered possible by the already-created wealth from earlier human developments (Marx, 1844). This implies that Marx saw, at least in that moment, that communism would not be conducive to fast technological development to which innovation is central. The transition to communism would imply that another set of factors would shift into the focus of society; innovation is not at the core of communist theory: 'The only force that brings them together and puts them in relation with each other, is the selfishness, the gain and the private interests of each' (Marx, 1887, p.110). Later, the adaptation of communism was advanced by other scholars: 'Communism is utopian as long as man is what capitalism has made him: we need socialism to reshape man, to get rid of his selfishness, or as he said: '*Selbstsucht*', and to turn him into the altruistic person communism requires', and 'Communism is bound to fail under conditions of scarcity: we need socialism to develop the productive powers of humankind and thus create the state of abundance in which alone communism can flourish' (van der Veen & Van Parijs, 1986, p. 653). The two statements show ideological conflict between capitalism and communism, which implies that they are two approaches to humanity's technological and societal development, and that communism could only work if humans focussed on a more socialistic perception of the world. This might be possible if there was no capitalistic competition (as the capitalistic competition would be more efficient in innovating and providing lower layer needs, thus keeping communism from reaching its full potential).

This paper argues that communism cannot work solely with a shift to a less egoistic ideology. It can only theoretically function within a state of almost full economic automation, so production, services and innovation must be automated to a large extent. The extent of automation must be significant enough so that capitalism is not sustainable for development anymore. For the population, such a society would, of course, be one of post-scarcity. This is an argument advanced in the *Critique of the Gotha Programme* (Marx and Engels, 1875) where there is a future where citizens can work or innovate if they so choose, but they do not have to do so, as their basic needs are already taken care of. In such a system, a human workforce is not necessary on a mass scale anymore; full employment is a utopia. It is in

opposition to a system that needs people to focus on consumption and on satisfying the lower layers of Maslow's pyramid. A concomitant feature of consumerism is the proliferation of jobs that workers feel are purposeless (see Bregman, 2017). In theory, a communist system could only work in such a situation if everybody could work on whatever they felt like doing on a particular day, or not work if they chose not to, which is also close to original Marxian thought (Marx, 1844). Schumpeter and Hilferding came close to making similar arguments (Hilferding, 1910; Schumpeter, 1942).

The high Maslowian-level-oriented system of communism is not directly linked with innovation, as the act of innovating itself is not necessarily an activity that can be accounted for at the higher levels. Innovating can have many motivations, and only a few of them are linked to higher motivational levels. Therefore, voluntary innovation will always occur, but it is not the essence that is needed for system survival. We argue that a Marxian communist system is incapable of generating high levels of manual innovation, when the workforce is occupied trying to satisfy the first layer of needs. The social system, in contrast to its inhabitants, focusses on a higher level of needs – personal development and self-worth. This dissonance leads to the inevitable collapse of a not-significantly-automated communist system. Firstly, the difference between what the system delivers, and what the populace want, damages the relationship between the latter and their leadership, especially if the economic situation does not improve, which may well be the case, as not every year is equally fertile or free of crises. Secondly, planning errors are, in the long run, only human. Thirdly, surrounding capitalist systems progress economically and technologically faster, and this can affect people's satisfaction with their own system. The lack of innovation impacts the system from multiple sides, and makes it unsustainable in the long run.

In conclusion, communism can innovate, but innovation is not in the essence of a communistic system.

4. The Conflict Between the Two Systems

The analysis above shows that the two systems are not focussed on the same objectives. They are fundamentally different; hence, their ability to further societal development is also fundamentally different. Capitalism is mainly focused on manual innovation and the satisfaction – and creation – of basic needs in Maslow's scheme. Manual innovation is not a continuous, proportionally growing process, but rather an eruptive one (Perez, 2002). These continuous but spontaneous changes are more fitting to a capitalistic system. The system occupies not only the creators, but also the consumers – with constant innovations in almost all fields. The system's stability has its origins in the pure number of innovations that occupy people and create new desires and needs at a material level. The majority of our world today is still occupied most of the day with acquiring what is needed for the two basic layers. In a society in which these layers are provided for, if the individual is satisfied with affordable goods, then less labour needs to be invested. Hence, a voluntary decrease in labour hours and an increase in focus on the higher layers could be observed (Kallis et al., 2013). Of course, in today's societies, these developments are still marginal but growing quickly (Evans, Lippoldt and Pascal, 2001; Hamermesh and Stancanelli, 2015). The full automation of labour is very much in its early stages.

A communist society, on the other hand, cannot develop materially as fast as a capitalist one, since the system is not focused on innovation. Communist theory focusses more on the higher layers of needs, and is built for stability, harmony and internal development – providing that the basic layers are fulfilled. The system cannot compete with

the fast materialistic development of a capitalistic system, as the innovation of new goods and services leads to the growth of new needs and desires. Capitalism thrives on its capacity to create desires; keeping the populace in a cycle of desiring and acquiring new goods is essential to the survival of each company – and capitalism itself. The various forms of capitalism, like statist, corporatist or neoliberal capitalism, have different abilities to create and fulfil desires, but, for most of the population, this is happening at the lower Maslowian levels (Gough, 1994). If these created desires are not fulfilled, individuals can only partially develop and fulfil their higher needs. Therefore, if the systems compete, the communistic system would not be able to develop its strengths, as it would have to endeavour to keep up with the needs developed by, and satisfied in, the neighbouring capitalistic system. In a capitalist society, despite the relentless generation of new needs, it is at least possible that, for short periods of time, lower level needs are satisfied, thus freeing the population to focus on higher level aspirations. This is much less likely for individuals within a communist society, as the efficiency of their capitalistic neighbours could not be matched, so they are unlikely to progress from Maslow's lowest layers.

Additionally, occasional mis-planning could exacerbate the situation, leading to a shortage of material goods. There is not enough development and innovation to keep people occupied, and the lower needs are not sufficiently provided for to allow a focus on the higher layers of human aspiration. Thus, communism cannot succeed in a stage of technological development in which society is still actively occupied with the development of material living conditions. This does not mean that communist systems will only necessarily occur after a period in which basic needs have been fulfilled, rather it means that a communist system can only excel if basic needs are already taken care of, or, at the very least, do not absorb most of people's time. In history, this never has been the case. The view that communism and capitalism are concerned with the same issues and are dealing with the same development stage in human history – simply because they have been rival economic systems – is not correct.

Maslow's hierarchy of needs emphasises the impossibility of communism being successful in its current or any former development stage. The basic layers will always trump the higher levels. A system focussed on emotional and immaterial development cannot function if its people do not have enough to eat or the material means to fulfil a sufficient percentage of their other basic needs. Such a system can never play out its strengths in this type of environment. A system with a lower-layer focus, on the other hand, can develop its strengths perfectly in such an environment.

The environment changes fundamentally if the production and innovation processes are automated. In a society where automated machines provide for the physiological needs of society, individuals have ample leisure time. The automation of supplementary labour is simpler than that of labour directly focussed on innovation. However, by the end of the automation process, all necessary human labour may be automated, so while voluntary labour may still have a role to play in society, the core and necessary parts of the economic system are automated (Hemous and Olsen, 2013; Frey and Osborne, 2015). Thus, if the lowest layer of the hierarchy is satisfied automatically, and humans are not continuously forced to think about providing the lower two or more material layers for themselves and their families, they have the freedom to strive for higher layers. However, this presupposes that, with automation, most people can still get access to the goods produced by machines. If their income is limited due to a lack of access to paid work, then the social system could start to break down. It would create a situation like the one described by Akerlof and Shiller:

> 'Consider fairness. As in the 1890s, the Depression of the 1930s led to an intense feeling of unfairness in employment relations and a surge of labour disputes worldwide. Communism emerged into its heyday, as intellectuals around the world began to see it as the solution to the exploitation of working people and the failures of the macro economy. A sense of instability in business institutions developed, with fears that the social contrast would be changed unpredictably' (Akerlof and Shiller, 2009, p. 68).

In this case, a capitalist system could not prevail, as the system would not generate the economic means by which people could function. Unwanted interest in higher needs will be triggered if the population is provided with sufficient food and other basic needs without the constant creation of new desires. If the focus on higher needs cannot proceed, or if, because of automation, there is no chance of new income, social unrest would certainly be triggered, as unsatisfied citizens – with lots of time on their hands and little prospects – are not a sustainable basis for any system. Hence, capitalism, in its purest forms, could not be sustained in such a situation. A communistically-influenced system, with a focus on developing the higher layers of its subjects, on the other hand, would thrive under such conditions, as the basic layers are provided and are no longer a concern for society and its members. Individuals would be free to focus on the higher layers of Maslow's needs, and a sustainable system would support them. Schumpeter arrived at a similar conclusion. 'As a matter of fact, capitalist economy is not and cannot be stationary. Nor is it merely expanding in a steady manner. It is incessantly being revolutionised from within by new enterprise…' (Schumpeter, 1942, p. 31).

Schumpeter's long-term evaluation of the prospects for a capitalistic system are summarised in the second part of his book, *Capitalism, Socialism and Democracy*, 'Can capitalism survive?' He begins, 'No I do not think it can' (Schumpeter, 1942, pp. 59, 61). His perception of a socialist system can be seen in part three, 'Can socialism survive?' to which he replies, 'Of course it can' (Schumpeter, 1942, p. 167). His main argument for why socialism may work is that it inspires people to strive for higher things and nobler means than within a capitalistic society. The intrinsic and long-term motivation is higher if the means defined by Maslow are continuously fulfilled.

Labour, in capitalist systems, is directly or indirectly connected to innovation, supporting those who innovate or who promote innovation. The pursuit of fulfilling material needs is often portrayed as the pursuit of money, but it has also repeatedly been shown that money does not enhance individuals' happiness in general. It enhances individuals' ability to provide for their basic needs, but if that level is reached, money does not impact on happiness anymore. Interestingly, the relationship seems to be the other way around, meaning that happiness makes it more likely for a person to achieve an increase in income. Individuals with material objectives in life tend to be unhappy if they are not wealthy. Indeed, the systemic economic growth of the last decades in developed economies has not coincided with a similar increase in systemic happiness (Diener and Biswas-Diener, 2002).

Schumpeter (1934) claimed that the end of capitalism would be the result of innovation being captured within a corporate structure. The rise of such a corporate system could empower leaders to stunt and control innovation if such actions were needed to advance profits. However, Schumpeter also stated that such a system could survive for a long time, which fits with the argument of this paper. While corporate leadership would be empowered to stunt innovation, they would not necessarily do so if the markets developed into an oligopolistic or even monopolistic structure. However, the paradox is that if innovation is controlled by a few, then capitalism has surpassed its purpose, which is to innovate as

much and as fast as possible. Profit, however acquired, is the overarching systemic imperative. Schumpeter described it as the line in the sand that represented the latest stage of a system that has surpassed its purpose. Another purpose is needed at that stage.

A transition to a more social and equitable society is needed for peaceful co-existence. Where people are provided with all necessary goods and have time to develop their own interests, which is one core argument in the discussion about a universal basic income or alternatives, like a right to labour. This merged form of capitalism and socialism would be one possible path to follow. However, regardless of the exact design of a future system, it is crucial to mention that such a system would be economically stable in the long run, as humans are occupied with whatever they like, and most of the system runs on autopilot. A capitalist system operating on a similar technological basis would be less sustainable as production inevitably became ever more concentrated. Such a system would lead to extreme inequality in income and wealth, with all the social instability that this would entail. For this reason, we do not consider unfettered capitalism to be sustainable when automation renders labour redundant.

To keep the paper focused, we do not delve into the nuances of different mixed systems. Also, we do not want to make any claims about the rise of, or transition to, communism. We just endeavour to show that particular initiatives – like a universal basic income – could represent a transitional phase, where the economy exhibits capitalist and socialist features.

An important feature of this paper is its focus on theories in their pure form. Real-world applications have never been, and most probably never will be, the pure form of either system. Still, these purely theoretical utopias have their purpose in motivating humankind (Hodgson, 1995a). The perception that innovation is only driven by private entities in a capitalistic system, for example, is incorrect. Initially, fundamental innovations, and those that require a long time to achieve profitability, are often not driven by private companies' profit motives. Many of these innovations are the product of long-lasting investment programmes that the private sector is often not willing to support. In various cases, public investment enables the first stage of developing such fundamental innovations until the markets can take over, as the risk is more predictable. This is the development phase, what Perez (2002) calls the 'surge'. Fundamental technological innovations leading to the rise of a new technological age are often initiated by public entities and public funding. One famous example of that from the recent paradigm is public funding for innovations leading to the iPhone, for which the internet, basic touchscreen technology, GPS and 13 fundamental components in total were publicly funded (Mazzucato, 2013). These public innovations were then provided to the private sector, enabling the rise of the most valuable company in the world. Hence, a purely private sector innovation is not the case – even in the most developed countries of the world.

These tendencies show that real-world applications of capitalistic systems have communist elements (Hodgson, 1995b). Another socialistically-influenced form of economic design is the classical German approach to the Social Market Economy (Drechsler, 1997). Modern developments, like shared usage models, social entrepreneurship and green economics, are newer additions to the broader field of adaptations. A mixture of systems has always been in place, and our economy is in a constant process of transition between the competing systems' nuances. Similarly, real-world applications of Marxist thought in human history (Leninism, Stalinism, Titoism, Hoxhaism, Maoism) were not pure expressions of the communist economic system. All systems suffered after some time because of scarcity and too little innovation. Fitting with our argument, one could say that scarcity kept the population focused on trying to acquire basic goods, while the systems failed to provide sufficient incentives to individuals to innovate. The systems were either eliminated or had to adapt

substantially to survive. These cases are also a partial confirmation of our thesis that communism and capitalism should have never competed in the first place.

5. Conclusion

The central claim of this paper is that capitalism and communism are not and never should have been treated as competitors, as they are not focused on the same issues and not even on the same period in humanity's development. The mixed forms, however, are very much able to compete, and their use shows the perceived developmental stage of society that employs the particular form. Pure and theoretical systems have different objectives and different appropriate times of usage. All economic systems exist to satisfy human needs. Human needs can be differentiated into layers, and different economic systems focus on different layers in the hierarchy. Capitalism focuses on innovating material goods and services through continuous innovation and competition. The system persists through constant change and occupation for the population. Occupation in this instance refers to both working and having the mind filled up with other things. The system also engages the population by the creation of needs through the constant creation of new products and services. Communism, on the other hand, focuses on higher-layer development of its citizens. Communism mostly ignores the lower layers. It does not focus as much attention on innovation and is a system focused on post-scarcity periods. Theoretically, we would not expect the innovation rate to be as high as in a capitalist system, and to be different in type.

The paradigms that systemically push important innovations have changed over the years. The current ICT-focused paradigm differs from previous innovation waves. Critically, it automates an ever-increasing share of jobs in society, and it has the potential to create a state of Artificial General Intelligence, in which machines will be able to perform almost any intellectual task more efficiently than humans. Such a state is not around the corner, but neither is it an illusion. It is a fact that society is moving inexorably towards that state. In a society where the need for human labour no longer exists , capitalism is not at its strongest as income is required to fulfil needs. If these needs cannot be fulfilled, then the system becomes unstable. Communism, in its classical theoretical form, on the other hand, cannot compete if the lower layers are not provided automatically or externally. However, if those layers are provided automatically, then it can show its strengths and enable individuals to focus on higher layers of needs.

The authors do not wish to speak for or against either system. The argument is only that communism and capitalism should not be seen as competing, and it was an error to do so. Each system has its own purpose and applications. Capitalism builds implicitly on the basic desires of humans, while communism focuses implicitly on higher layers of human desire. The paper also discusses mixed forms that draw on aspects of both systems and how these social systems may be appropriate for a particular developmental stage. Tendencies such as shared, green, social, sustainable and post-growth economies are such partially mixed forms in our current time, which can be seen as a response to the growing automation of labour.

Whether any system will dominate a post-scarcity society depends largely on the design of the system. It is possible that technologically-driven development manages to maintain current capitalist economic systems, through the relentless generation of new wants. On the other hand, increasing inequality could be the catalyst for a systemic change. Both are possible and will most probably lead to mixed forms of the practical adaptation of the two most famous economic systems, but to discuss these developments requires another paper.

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Cherchez la Firme: Redressing the Missing – *Meso* – Middle in Mainstream Economics

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Abstract

Aristotle warned against a 'missing middle' in logic (Gk *Mesos* – middle; intermediate). This paper submits that one of the reasons why there has been no major breakthrough in macroeconomics since the financial crisis of 2007-08 has been a missing middle in mainstream micro-macro syntheses, constrained by partial and general equilibrium premises. It maintains that transcending this needs recognition that large and dominant multinational corporations between small micro firms and macro outcomes – while also influencing both – merit the conceptual paradigm of mesoeconomics. Drawing on a range of uses of the concept, it relates this to reasons for 'too big to fail' and suggests implications for policies to gain accountability of big business, including how a meso dimension to input-output could yield transparency on risk-prone financial transactions by banks, and of corporations contributing to climate change. It also critiques misrepresentation of Walras and Pareto, as well as suggesting areas for research which could address, and potentially redress, 'missing middles' in mainstream micro-macro syntheses.

Key words: meso, global, governance, environment, accountability

JEL as yet has no classification for meso rather than micro and macroeconomics. The already wide range of literature cited in this paper suggests that it should.

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1. Introduction

In an address in October 2016, when still heading the US Federal Reserve, Janet Yellen observed that the 1930s Depression motivated new ways of thinking about economic phenomena, and questioned why a Great Recovery in economic thought has proved elusive since the 2007-08 financial crisis (Yellen, 2016). In May 2018, Thomas Ferguson and Robert Johnson of the Institute for New Economic Thinking submitted to the G20's Global Solutions Summit in Berlin, that the hold of orthodoxy on the economics profession hurts not only research, but also people and societies subjected to discredited economic policies (Ferguson and Johnson, 2018). We agree in particular that,

> 'one of the central problems in this regard has been fixation on economic models emphasising full or nearly complete information and the presumption of tendencies for economies either to be always in equilibrium or heading there, not just in the present but into the indefinite future' (Ferguson and Johnson, 2018, p. 2).

We also recognise with Ferguson and Johnson (Ferguson and Johnson, 2018,, p. 7) that: 'Possible reforms of economics have stimulated widespread discussion, but produced a wide dispersion of views'. Yet suggest that there is already an increased interest by a range of institutional, evolutionary and environmental economists in meso as a 'missing middle' between micro and macroeconomics which, if gaining higher profile and a sustained research agenda, could synergise and reinforce more heterodox economic critiques.

While there also recently has been increasing openness to alternatives from mainstream institutions – such as the European Central Bank (ECB), the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD) and the National Bureau of Economic Research (NBER). As cited below, the ECB, while not overtly deploying the meso concept, has shifted from intending to scrutinise all of some 6,000 banks and credit institutions in the EU, to focus on only the 130 or so which are transnational – since it is they that dominate macro financial outcomes. Under the direction of Olivier Blanchard, the IMF Research Department has challenged deflationary theories of 'structural adjustment'. The OECD has done the same in questioning 'structural reforms', as has Benoit Cœuré, French executive director of the ECB. The NBER has published a series of papers highlighting the increased dominance of markets in the US by both banks and corporations, and linking this to rising inequality.

Yet, although significant, we suggest below that such institutional openness has not as yet redressed a 'missing middle' in mainstream economic thinking. Such as Samuelson following Ricardo by excluding capital mobility from his model of comparative advantage, which Heckscher and Ohlin had not. Thereby unconsciously ignoring that it was foreign direct investment, rather than comparative advantage, that drove post-war trade, but without the presumption that comparative advantage would maximise global welfare. As in aiding China to industrialise but, inversely, de-industrialising much of the US. Which helped Donald Trump gain the White House, and then repeal NAFTA whereas Hillary Clinton did not effectively address the issue.

In addition, misplaced pre-Keynesian macroeconomics such as rigidly rule-based *Ordoliberalismus* which, in the case of the 1992 deflationary Maastricht debt and deficit criteria, has condemned much of Europe to austerity in the single currency area of the Eurozone. Which also has challenged EU rhetoric claiming to be concerned with democratic values, such as denying anti-austerity majorities in a general election and referendum in Greece in 2015. While austerity policies also have provoked electoral support for populisms across Europe that, while deplorable where their rhetoric and intent may be racist, in key cases have grounds in disillusion with neoliberal policies that have damaged confidence in the post-war European project and, not without justification, have encouraged claims to return decision-making to national levels (Etzioni, 2018; Habermas, 2018).

2. Redressing Micro-Macro Syntheses

When Janet Yellen questioned in her address to the Boston Fed in 2016 why there had been a lack of rethinking in economic theory since the financial crisis, she cited a host of macroeconomic analyses yet did not even refer to 'too big to fail'. Whereas one of the reasons for seeking to redress the missing middle in mainstream economics relates to the increased concentration of banks in the US since the repeal of the Glass-Steagall Act in 1999 that not only aided the 2007-08 financial crisis, but has increased since it occurred (Grullon, Larkin and Michaely, 2017). Which also has been paralleled by ongoing concentration in global industry, with 100 corporations now representing half of world manufacturing output

(UNCTAD, 2016) while 100 of them source over 70%, and 25 over 50% of global carbon emissions (CDP, 2017).

Not that the meso concept, if still under-recognised, is new. It has been deployed and supported in a wide range of literature for decades. Featuring, for example, in both regional and international economics since the 1970s (Holland, 1974ff; Amoroso, 1996; 1998) as well as in conceptualising nations within a contiguous area as meso regions (Papadaskalopoulos, Karaganis and Christofakis, 2005). Such as Sub-Saharan Africa, persistently rent by both drought and poverty, the southern Mediterranean, penalised by austerity policies, or East Asia, still thriving. A mesoregion also may be between the size of a city or district and that of a nation, as in Brazil, where its use both is commonplace and part of national accounts (Roth and Brunnbauer, 2009). Rasmussen, Friis-Hanse and Funder (2018) have shown how meso-level institutions, between a central state and local levels, can facilitate responses to climate change.

While it by now may be commonplace that alleged market reforms in collapsing the Soviet Union led to both concentrated oligopoly, and oligarchy, Kleiner (2001; 2011) has extensively evidenced this in terms of meso dynamics. Zezza and Llambí (2002) have deployed meso in terms of policy reforms and rural poverty in Latin America. Kristjanson, Maren, Baltenweck, Ogutu and Notenbaert (2005) have shown how mapping poverty can be enhanced by a meso level analysis in Africa. Much of Hodgson's major long-term achievement in gaining support for institutional economics has been in showing that this spans the gap between micro and macroeconomics (Hodgson, 2000; 2007; 2013).

In parallel, in management theory, Hedström and Swedberg (1998) have evidenced how meso institutions can bring about both intended – and unintended – macro-level outcomes. Claude Ménard (2014) has suggested that a meso dimension can enhance understanding both of authoritarian hierarchies and countering them by hybrid forms of governance. In challenging command-and-control models of allegedly 'new' public management in health services Oliveira and others (Oliveira *et al*, 2016, 2017) have supported the case for relative autonomy at meso levels such as health authorities and hospitals, to gain both economic efficiency and social efficiency in terms of the wellbeing of health professionals and welfare of the public.

Liljenström and Svedin (2005) have extensively analysed meso-level relevance in the domains of physics, chemistry, ecology and social analysis, including economics, while recognising differences in how the natural and social sciences tend to deal with scaling issues. In parallel, in addressing problems from aggregation in economic, social and environmental studies, Radej (2011) has submitted that only a meso approach can address, and redress, their conceptual challenge.

In a paper with the well merited title of 'Hidden in Plain Sight', the main aim of Kim, Wennberg and Croidieu (2016) is to demonstrate gains from introducing meso-level institutions more explicitly into both economic and social theory and policies. While recognising that meso structures are now widely studied independently they also propose, with supporting evidence, that more can be gained from integrating them into multi-level micro-meso-macro analysis.

2.1 Micro-Meso-Macro

In deploying the meso concept in relation to economics and institutions we therefore are not alone. In economics, Ng has done so extensively (Ng, 1986; 1992; 1998; 1999; Ng and Wu, 2004), as have Dopfer, Foster and Potts (Dopfer, 2005; 2006; 2012; Foster, 2005; Dopfer, Foster and Potts, 2004; Dopfer and Potts, 2014). Yet some of their work has been concerned

to reconcile it with partial and general equilibrium, whereas we are concerned to show that it profoundly qualifies them. Our approach is closer to that of Elsner (2010; 2013; 2015; 2016) and his work with a younger generation of economists (Elsner and Heinrich, 2009; Elsner, Heinrich and Schwardt, 2014; Elsner and Schwardt, 2015), including their readiness to relate the meso concept to precedents in the history of economic thought and to critique fictitious financial capital. As with Kim, Wennberg and Croidieu, we also share their view that institutional meso-micro level cooperation can enable pro-social outcomes.

Some of those recognising the meso concept have sought to do so in terms of 'rules' and 'axioms', of which we are sceptical, and for which Dopfer has been criticised on methodological grounds by others (e.g. Juniper, 2009). We also submit that some principles that have been assumed to be axiomatic in macroeconomic theory are profoundly qualified by the market power of major corporations. Such as the alleged interest rate sensitivity of investment, assumed in Hicks-Hansen IS-LM investment-savings and liquidity-money models, in that they fail to distinguish the different significance of borrowing costs for micro and meso firms, which can be high to penal for the former, yet insignificant for many of the latter when these can self-finance. More radically we maintain that foreign direct investment by multinational corporations not only qualifies the assumption that comparative advantage will maximise global welfare, but also the presumption of Keynes, and many Keynesians, that exchange rate changes necessarily can balance global trade outcomes.

The paper outlines several policy alternatives in terms of accounting and accountability of financial institutions, aiming to redress tax avoidance by multinational companies and tracing their carbon footprints. *Inter alia,* it does so on the basis of meso dimensions to input-output analysis, i.e. a focus on the few multinational firms that tend to represent the major share of output and trade at national and global levels. In the 1990s, proposals for this gained the interest of Delors and Leontief, and the then head of Eurostat, but were not followed through. Yet which now could inform how a Tobin tax introduced for such corporations could be effective without concerning all international transactions. As well as proposing several areas for further research within a meso conceptual framework that could yield more realism than mainstream micro-macro syntheses.

2.2 The – Meso – Representative Firm

What we centrally submit is that 'representative firm', at a global level, is not a price-taking, small enterprise subject to consumer sovereignty, but typically, a large multinational corporation with price-making power. Stiglitz (2016) has deemed this 'monopoly', which happens to be consistent with Marx's use of the term even if, with reason, Stiglitz qualifies it. In line with our own approach Ozawa (1999) has submitted that such firms are more typical of concentrated oligopoly – and that this can gain in explanatory power from a meso analytic approach.

As well known, and frequently referred to, in seeking to achieve more realism than the perfect competition assumptions of neoclassical micro theory, Chamberlin and Joan Robinson, in the same year (1933), proposed the concepts of monopolistic and imperfect competition. But in their respective analyses they both stayed within a partial equilibrium framework of limits to the market share of firms. With the outcome that they could be regarded as an add-on to mainstream micro theory. Which was assumed by Keynes of Robinson's imperfect competition concept, when he wrote in the Concluding Notes of *The General Theory* on the social philosophy to which it might lead that:

> 'if we have dealt otherwise with the problem of thrift, there is no objection to be raised against the modern classical theory as to the degree of consilience between private and public advantage in conditions of perfect and imperfect competition respectively'(Keynes, 1936, chapter 24, Part III).

Yet, as recognised by Kalecki (1943; 1954), big business can gain a decisive influence on macroeconomic outcomes and macro financial policy. Sraffa's recognition of increasing returns was published by Keynes in *The Economic Journal* in 1926, but then by and large, disregarded. That oligopoly, through scale economies, could dominate markets was recognised by Bain (1954), by Galbraith (1967), by Averitt (1968), by Sylos-Labini (1969) and, notably, by Eichner (1976). But their arguments, although justified, did not dislodge mainstream micro-macro assumptions. While even Eichner, who impressively demonstrated how corporations with market power could qualify macro outcomes, subtitled his 1976 *Megacorp* as *The Micro Foundations of Macro Dynamics.*

An exception to mainstream micro-macro analysis was François Perroux (1955; 1961; 1964; 1965) who was powerfully influential in post-war economic theory and policy in France, Belgium and Italy as well as in Latin America (Holland, 1987c). He already related big business domination of markets to its role in globalisation while his analysis of 'domination' was within a dynamic *champ des forces* rather than equilibrium outcomes. His concept of leading firms or *firmes motrices* in interregional and international polarisation was similar to Myrdal's (1957) concept of asymmetric circular and cumulative causation but with more emphasis on the role of dominant firms in driving it. While influencing also the decision of French planners in the 1960s to focus on policies to gain accountability of, and macro leverage from, leading firms (Holland, 1974b).

Another exception was Stephen Hymer (1968; 1972). Extending Marx's case that capital would draw on reserve armies of labour wherever it could when these were at or near subsistence levels, Hymer realised the relevance of this to foreign direct investment by multinational capital and that it had major implications for uneven rather than balanced global development. He had outlined this in his 1960s PhD which, though only published later, strongly influenced Kindleberger (1976; 1984) as well as Dunning and others (Dunning, 1978; 1988; 1998; Dunning and Rugman, 1985). But Hymer's breakthrough was otherwise neglected in mainstream economic literature while, tragically, he died prematurely in a road accident in 1974 when only 30, and did not live to follow through on his initial insights.

2.3 Meso Dominance and Macro Dynamics

Black and Dixon have submitted that, as a class, rather than individual firms within it, the global dominance of multinational companies has been persistent, and evidenced this (Black, 2016; Black and Dixon, 2016). Grullon, Larkin and Michaely (2017) have found that more than 75% of US industries had experienced an increase in product market concentration levels since the financial crisis. Firms with the largest increases in product market concentration had enjoyed higher profit margins, higher stock returns and more profitable mergers and acquisition deals, while enforcement of antitrust laws by the Department of Justice and the Federal Trade Commission waned during the administrations of both George W. Bush and Barack Obama.

Research by the OECD (2017) has found that a 100 'frontier' firms across the world have been able to increase their productivity, whereas this for the rest (the 'laggards') has been low or falling. 'Frontier' firms thereby are increasing their earnings and can increase pay substantially, whereas 'laggard' firms can find it difficult to do so. In a study for the NBER

Gutiérrez and Philippon (2017) have found that leading firms have been increasing concentration and decreasing competition in many industries since 2000, and that the gap is primarily driven by industry leaders who show higher profit margins but lower investment and lower capital formation.

In another NBER study Autor, Dorn, Katz, Patterson and Van Reenen (2017) have found that 'superstar' firms account for an increasing share of industry output. Yet also agree with Jones and Philippon (2016) who submit that the US capital stock was 5% to 10% lower than it could have been by 2012 if competition had remained at its level of 2000.

2.4 Meso Accelerators – and Decelerators

We suggest that this has implications for both recovering and qualifying what used to be a mainstream concept in macro theory – the accelerator – and recognising that under-investment by meso corporations in an economy may outcome in a macro 'decelerator', and employment and other multipliers, at a national level.

With some exceptions (e.g. Arestis and Gonzalez-Martinez, 2016), combined accelerator-multiplier models have fallen out of fashion. But were encouraged by Keynes' *General Theory* and, in some cases with capital stock adjustment principles, gained attention through to the 1950s from leading economists at the time, such as Tinbergen (1938), Samuelson (1939), Harrod (1939, 1948) and Hicks (1951), as well as Goodwin (1951), Chenery (1952) and Eckhaus (1953).

Some of their models were linear. Others such as Harrod's were not, as in his drawing on Keynes' – psychological – concept of the marginal efficiency of capital and conceptualising accelerators in terms of 'warranted growth', i.e. that rate of investment that entrepreneurs would deem to be justified in term of their judgement – right or wrong – of the prospective rate of growth of demand.

In his 1951 *Contribution to a Theory of the Trade Cycle,* Hicks posed the question of why combined negative accelerator and multiplier effects would not mean that an economy could keep going down and 'hit the floor'. Answering that there would be a difference between shorter- and longer-term investment and that the upward trend of the latter, which he illustrated as a rising 'lower equilibrium line', would reverse a short-term downwards trend.

This thereafter happened to coincide with the rising post-war share of public expenditure and investment until 1974, when OECD governments jointly restrained spending and investment to reduce domestic demand, and thus imports, to make way for the higher price of oil and inflation, following the September 1973 OPEC price hikes. Which ended the Keynesian era while by enabling Milton Friedman to claim that governments should limit themselves to controlling money supply, even if this entirely contradicted his earlier assertion that 'inflation starts in one place and one place only, national treasuries' (Holland, 1987b).

Yet such pre-war and post-war analyses of combined accelerator and multiplier effects assumed that these were within national economies. Which since has been overtaken by globalisation in that multinational companies in hitherto advanced economies now not only may be disposed to 'adjust' their stock of capital by outsourcing, but reduce it by investing abroad. Not least as leading US, European and Japanese multinationals have found it 'warranted' in Harrod's sense of an accelerator, to invest in a China that was managing sustained double digit growth from the 1980s, as well as elsewhere in East Asia.

But with inverse decelerator effects, especially in the US, the UK and Japan, with foreign direct investment substituting for exports and thereby reducing national export multipliers, to which, with supporting evidence, we return.

2.5 Unequal Competition and Deregulation

In his analysis of barriers to new competition, Bain (1954) had recognised that an oligopoly could deploy 'no entry pricing' by temporarily reducing price below what would be the variable costs of a potential entrant to a market such as that, if it entered, it could not even pay its wage bill. There is also the concept of 'elimination pricing' (Holland, 1987a) whereby, if an oligopoly is faced by a new entrant with less market power than itself, it could reduce price on a longer-term basis so that the challenger, once entered, then risked going insolvent. Such dynamics represent a challenge for antitrust and competition authorities – since lowering, rather than raising, price is not *prima facie* an abuse of market power.

Yet while the US has had a 15% rule of thumb for non-financial institutions, and the 1890 Sherman Antitrust Act was sufficient to break up Standard Oil, it has none for banks. As Robert Reich (2018) has submitted, as a result of consolidations brought on by the Wall Street crash, the biggest banks today are more dominant than ever, and their shareholders can assume that they will be bailed out if they get into trouble.

That major financial institutions have been able to persuade successive administrations in the US – and the Blair-Brown New Labour government in the UK – that they should not be closely regulated has been a confirmation of Kalecki's 1943 warning that big business could gain a decisive influence on macroeconomic policy. Which was not unrelated to both the US and UK economies facing a decline in their industrial base which increased pressure to enlarge the scope for profit by deregulating finance and privatising public assets and services. Or, as Galbraith (2008; 2014) has forcefully put it, to predate on them.

2.6 Dualisms, Income and Wealth

Ciarli, Lorentz, Savona and Valente (2010) have observed that much analysis of links between economic growth and distributional change has been confined to macro levels. But their findings, as well as those by Brennan (2016), Temin (2015; 2016) and Lazonick (2016; 2017) suggest that the rise of practices such as stock buybacks by leading firms not only has shifted finance away from investment in production, but centrally promoted inequality in both income and wealth.

Temin (2015; 2016) has related this in the US to an increasingly dual economy. The primary or core economy of successful firms, with less than a third of employees, is dominated by finance, technology and electronics – yet includes both the very rich and a rapidly shrinking middle class. The secondary or peripheral economy includes low-skilled workers in more traditional sectors. The outcome of which is that the chances for most Americans to enjoy a middle-class standard of living, are negligible and shrinking.

Lazonick (2016; 2017) has analysed how managers and technical workers in older firms could reasonably look forward to careers within them. By contrast, paralleling Brennan, he found that within what he calls 'New Economy' firms, managers offered stock options on a vast scale to increase personal wealth, while dismantling older career ladders. Such firms cut back on R&D. Whereas federal agencies – synergising pure research in academic or other institutions and sponsoring major innovations – (Lazonick, 2016; 2017; Block and Keller, 2011; Mazzucato, 2011; 2013) have enabled some firms to leap from micro start-ups to global giants. Such as promoting Google's algorithm, the GPS with its myriad positive and more contested applications, touch screen displays as well as more than a dozen of the key components for Apple's iPhone and related apps.

In effect, a key factor in the concentration of wealth since the end of the Keynesian era, as identified by Piketty (2014), is explained not only by his stress on the reduction of progressive taxation, but also by the difference in a dual economy between meso corporations whose chief executives can afford high incomes and bonuses for themselves and for their own high flyers, albeit with Icarus-like risks, and micro firms whose employees receive a shrinking share of income and many of which now are struggling for survival.

Drawing on Temin and Lazonick, the effects of dualism in the US also have been submitted by Ferguson, Jorgensen and Chen (2018) to have implications for understanding why for millions of people in the US the 'American Dream' has become a nightmare in terms of not only lack of social mobility, but also marginalisation and social exclusion.

3. The Dangers of Systems Thinking

It has been recognised in philosophy, sociology and other social theory, rather than economics, that David Hume greatly influenced his younger fellow Scot, Adam Smith. For example, Hume castigated a 'passion for hypotheses and systems', warning that they were a common source of 'illusion and error' (Hume, 1751, pp. 173, 175). Drawing on this, Smith observed that those disposed to systems thinking 'attempt, to no purpose, to direct, by precise rules, what it belongs to feelings and sentiments only to judge of', submitting that 'their frivolous accuracy almost necessarily betrayed them into dangerous errors' (Smith, 1759, pp. 499-450).

What we submit below is that such systems thinking at macro levels has displaced recognition of the dominance of global investment and trade by multinational capital. As in an alleged Heckscher-Ohlin-Samuelson theorem which neither was Heckscher's nor Ohlin's but Samuelson's, compounded by Samuelson's error in assuming that mathematics can reveal economic 'truths'. Also we suggest that the axiomatic hold of general equilibrium in mainstream economics has traduced Walras who stressed that this was only a conceptual device that he had not managed to dynamise to gain more realism.

Also we suggest, in terms of the meso concept, that mainstream economics has neglected not only that Walras had a 'theory of the firm', but also recognised that monopoly and cartels already dominated smaller enterprise and needed to be countervailed either by mutual societies or outright public ownership and control. Besides disregarding his stress that such social and public ownership should be not only on economic but also on *moral* grounds.

3.1 Traducing Walras

There appear to be as many economists who have routinely referred to Walras on general equilibrium as never have read him. With the irony, and error, that they disregard that he stressed that this was theoretical rather than realistic. Thus, in his 1898 *Studies in Applied Political Economy,* he recognised that he had not managed a dynamic theory of equilibrium, only a comparison of static equilibria, and that this was a major limit to any analysis of production, distribution and exchange, and needed to be overcome. As he put it:

> 'All aspects of social wealth, other than land, are subject to constant movement, of appearance and disappearance. But for my equations of production, as in my *Elements of Pure Political Economy*, I supposed the movement of economic production and consumption stopped for an instant in order to consider the conditions for an equilibrium' (Walras, 1898, p. 336).

Then adding that:

> 'In working this way I have done what mathematicians do who, to rationalise mechanics, elaborate the static *before* the *dynamic*. If there are savants who have found a way to reverse this in economics, one can only wish that they decide, before too long, to include us in their remarkable discovery' (Walras, 1898, p. 336, his italics).

But, since him, the savants of neoclassical economics neither have made such a discovery nor can do so – as long as they stay trapped within comparative static analyses of equilibrium. Against which Pareto (1909) also warned – on the grounds that any such comparisons would need to be very short term, since otherwise technical progress would falsify them.

Further, there is virtually no reference in any introduction to economics, whether Keynesian, monetarist or otherwise, to Walras opting to work for years in the cooperative movement before becoming an academic and strongly advocating the merits of mutual societies, rather than limited liability companies whose shareholders were not individually liable for failure (Walras, 1865). Nor that he presciently warned that banks with limited liability could be driven by competition to heighten shareholder value by speculating with, and losing, depositors' funds.

There also has been a lack of awareness that Walras was an advocate of public ownership of land, other public infrastructure and utilities including water, gas and electricity, in a manner which later would come to be known as a social or mixed economy. Thus he claimed that competitive private rail transport, rather than a single integrated public system, would raise user costs since needing to generate profits for shareholders, imply external diseconomies if companies with different efficiencies used the same track, and be suboptimal (Walras, 1875). Little of which was taken into account in the privatising of rail transport in the UK, yet which confirmed him to be correct (The *Guardian*, 2017).

Besides which, recognising the already evident trend to monopoly in his own time, with trusts in the US and cartels in Germany, Walras made the case for 'moral monopolies' and 'public economic monopolies' which would be both socially responsible and non-profit:

> '[I]n the case of a moral monopoly run by the state for the benefit of the community, the products which are public services can and often must be given away free while, in the case of [public] economic monopolies… it is enough for products to be sold at cost and not at a profit maximising price' (Walras, 1875, p.85).

Next to none of this has been recognised by the mainstream. Thus of 75 papers in two volumes totalling some 1,270 pages edited by David Walker (2001), only three directly address Walras on social economy rather than his general equilibrium theory. *The International Encyclopaedia of the Social Sciences* (1968) merely mentions his 464 page 1896 *Études d'Économie Sociale* in one line without giving any indication of what it is about. Even as distinguished an economist centrally concerned with social justice and welfare as Amartya Sen (1977) has not been immune, as in his contrasting the value-based ethical approach of Adam Smith in his 1759 *Theory of Moral Sentiments* with what he claimed to be the 'technique focused economic engineering' of Walras.

3.2 Ricardo, Samuelson and Myths of Comparative Advantage

Paul Romer has indicated that his early work was motivated primarily by observation that, in the broad sweep of history, classical economists like Malthus and Ricardo came to conclusions that were completely wrong about prospects for growth (Romer, 1983; 1986, 1994). But Ricardo not only was wrong in this regard, but also entirely misleading in his claims on comparative advantage. Such as that, in asserting mutual gains from trade between England and Portugal (Ricardo, 1817), he needed to assume no capital mobility, admitting that otherwise lower cost Portugal would have an advantage in both cloth and wine.

Yet this was a deceit, since it was English capital that had developed the main wine trade from Portugal – in port – through companies such as Churchill's, Croft, Dow, Gilbey, Graham, Offley, Taylor and Warr, whose brands still dominate it. Which Ricardo would have known since his family for generations had been based in Portugal and because port was well recognised as both the addiction – and affliction – of the English upper classes of which, by then, he was part. While free access to Portugal for British cloth since the Methuen Treaty of 1703 was already causing many Portuguese textile producers to relocate to lower cost Brazil (Serrão, 1975). Which was not evidence of comparative advantage without capital mobility, but of nascent multinational capital (Holland, 2015b).

Capital mobility also profoundly qualifies the alleged HOS Heckscher-Ohlin-Samuelson theorem of comparative advantage, which is neither Heckscher's (1919; 1950), nor Ohlin's (1933) but Samuelson's (1948; 1949) – and entirely unrealistic in not recognising such mobility.

Heckscher and Ohlin assumed a factor proportion basis for trade with countries specialising in capital- or labour-intensive goods on the basis of whether they were capital or labour abundant. But Heckscher, who originally published in Swedish in 1919, and only by 1950 in English, had been making his case from data in a colonial era before WW1, when some less-developed countries either lacked manufactures or, as in the case of India, were forbidden to export them. Ohlin was also well aware of differences in capital and labour mobility and realised that, with inhibitions on labour migration, factor flows would be asymmetric and that comparative advantage therefore would not necessarily maximise global welfare. As well as presciently observing that foreign direct investment and production could substitute for exports from a country of capital outflow.

In an article in the *New York Times* in 2004, Samuelson allowed that the economies of China and India can combine low wages, increasingly skilled workers and rapidly improving technology. He put his case in terms of a labour market 'clearing wage' that has been lowered for all countries by globalisation, and observed that: 'If you don't believe this changes the average wages in America, then you believe in the tooth fairy' (Samuelson, 2004b).

Yet it was Samuelson's expositions of comparative advantage, over decades, that gave such a tooth fairy wings. He had displaced both mounting US FDI outflow to Asia since WW2, and that half of China's technology-related exports by the time he wrote this were from foreign direct investment (Yadev, 2010; McKinsey, 2010). Which, at much lower labour costs, was yielding Smith's absolute advantage – rather than Ricardian comparative advantage. For, as Smith (1763) presciently had put it in his Glasgow Lectures:

> '[t]he cotton and other commodities from China would undersell any made with us were it not for the long carriage, and other taxes that are laid upon them' (Smith, 1763, in Napoleoni, 1975, p. 141).

Krugman gained more realism in comparative advantage by allowing for economies of scale within a Chamberlin monopolistic competition premise (Krugman, 1979a; b; 1980; 1981). This was evidence-based at the time – in that the expansion of trade up to that point since WW2 had mainly been between the triad of the US, Europe and Japan (Ohmae, 1982) and thus between countries with similar factor endowments – rather than those which were more capital or labour intensive. In this he showed that product differentiation could account for how similar, though not identical, products could attract consumers in different countries with comparable levels of income, and that their producers, thereby, gain from increased economies of scale in a larger international market.

Yet Ohmae, in his 1982 study *Triad Power,* was wrong in assuming that this was *The Coming Shape of Global Competition*, as he claimed in its subtitle, since trade from the 1980s increasingly was to be between countries with different factor endowments and in which foreign direct investment through the capital mobility – that Ricardo denied and Samuelson displaced – was to enable labour-intensive China to gain Smith's absolute, rather than Ricardian comparative advantage.

3.3 Stripping Out Psychology

Akerlof and Shiller (2009) have, rightly, related Keynes' animal spirits to the reasons for the 2007-08 financial crisis. Yet well before the rise of monetarism and the demise of Keynesianism, Samuelson had stripped psychology and uncertainty from Keynes. In a paper in 1942 on economic theory and mathematics, and in his 1947 *Foundations of Economic Analysis,* he claimed that just as progress in mathematics had advanced physics, similar advances in mathematics could advance economics as a science (Samuelson, 1942, p. 1; 1947, p. 284).

This proved highly influential, despite Samuelson's *Foundations* at the time meeting mixed reviews, including from some of those who were to be among the most eminent of post-war economists. Criticism was focussed on three main areas: that he had assumed that instability, if it occurs, will be transient and less typical than stable equilibrium; that he focused on mathematics, with very little economic content; and that he paid no attention to the uncertainty in expectations that Keynes had stressed in chapter 12 of *The General Theory*. Yet, in citing this, and recognising that Samuelson remained sceptical of much of the neoclassical orthodoxy that emerged in the 1960s and 1970s, Backhouse has observed that 'his *Foundations* provided a toolbox for those who developed that orthodoxy' (Backhouse, 2015, p. 36). Not least, in Samuelson's presumption in his *Foundations* that economics could reveal 'truths'. Which he thereafter made in his highly influential *Economics* textbook in multiple editions from 1948. Thus, at the time that Minsky (1975) was warning that Keynes without psychology and uncertainty, was Hamlet without the Prince, Samuelson was claiming that:

> 'The first task of modern political economy is to describe, to analyse, to explain, and to correlate the behaviour of production, unemployment, prices and similar phenomena… To be significant, descriptions must be more than a series of disconnected narratives. They must be fitted into a systematic pattern - i.e., constitute true analysis' (Samuelson, 1976, p.7).

Samuelson had based this on an assertion in his *Foundations* that that logic in language and mathematics were identical:

> 'Mathematics is language. I mean this quite literally… For in deepest logic – and leaving out all tactical and pedagogical considerations – the two media are strictly *identical'* (Samuelson, 1947, p. 40, his emphasis).

This is precisely what Wittgenstein had assumed in the algebraic 'truth functions' and claims for 'logical atomism' in language in his *Tractatus* (1922), which also had a parallel in the claims for 'atomistic competition' in neoclassical microeconomics. Which, after challenge from Sraffa (Malcolm, 1958), Wittgenstein then abandoned in seminars at Cambridge that were to be published posthumously as his *Philosophical Investigations* (1953) and other later work (Wittgenstein, 1958; 1980; 1982). Which then influenced the evolution of post modernisms in philosophy, sociology, other areas of social analysis (Sluga, 1999; Summerfield, 1999) and in law (Patterson, 2004), while Keynes already had been influenced by the later Wittgenstein before he completed *The General Theory* (Coates, 1996; Davis, 1993; 1996).

Yet there has been no similar post-war evolution in an economics mainstream that, with Samuelson, has presumed that economics is a science, similar in its analytical and predictive power to physics. Which has been compounded by many graduates in mathematics, or physics, being recruited by economics faculties with no grounding either in philosophy, the history of economic thought or economic history.

3.4 Irrational Expectations – and Pareto's Pangloss Warning

Key reasons for 'too big to fail' not only were pressures that leading financial institutions brought to bear on the US Treasury to reduce capital reserves, and on Congress to repeal the Glass-Steagall Act, but also that this was encouraged by Nobel benedictions for theorists of 'efficient markets' and 'rational expectations' (Fama, 1965; Fama and French, 1992; Lucas, 1972; 1976; 1996: Merton, 1973; 1997; Scholes, 1997).

There have been many critiques of how such theories opened the gates to the flood of toxic financial derivatives, fictitious capital, and the greatest financial crisis of the western world since 1929. One of their deepest flaws was in presuming perfect information for individual agents – not only in their own, but all markets, with an omniscience normally reserved only for deities, and not even for those already all too human, such as in Greek mythology. While rational expectations had also leapt from being an assumption in micro theory (Muth, 1961) to macroeconomics without demonstrating evidence for any bridge between them.

This was initially criticised less by economists than by several management theorists (e.g., Cyert and March, 1963; Edwards and Tversky, 1967; Vroom and Yetton, 1974). Simon (1978; 1979) stressed that the theory was normative and lacked evidence on how decisions in business environments were actually made, while he claimed that decision-makers do not sum weighted probabilities of all possible outcomes but 'satisfice' with the first that either fits or fits well enough (Simon, 1987). Which gained widespread resonance thereafter in management theory – but not in the economics mainstream, despite Simon gaining an economics Nobel and also being published in the *American Economic Review* (Simon, 1979).

Moreover, in projecting strings of past prices into the future, the theorists of rational expectations and allegedly efficient markets neglected that Pareto had warned that to presume that the past could be projected into the future could be a significant displacement of risk. Thus, in chapter 1 of his *General Principles of Social Evolution* (1909) he allowed that we tend to equate current utility with what was previously useful to us, which we know from experience. But that projecting this into what we expect from the future, is different for two

main reasons. First, no individual actually can foresee the consequences of a present decision; second, that:

> 'something that risks being bad in the future is not represented with sufficient intensity in consciousness to balance what may be good in the present' (Pareto, 1909, p. 46).

He then commented that this can lead to ungrounded optimism that 'ends by resembling that of Dr Pangloss in Voltaire's *Candide*' (Pareto, 1909). Voltaire's most famous claim for Pangloss, surveying the ruins of Lisbon after the earthquake of 1755, was his insistence to Candide that he still was convinced that 'all is for the best in the best of all possible worlds'. This both savagely, if unfairly, parodied Leibniz, yet was to be paralleled in the survival of rational expectations and efficient market theories – even after the collapse in 1998 of the Long-Term Capital Management (LTCM) hedge fund, a decade before the subprime fiasco, and which had already required a major bailout organised by the Federal Reserve to avoid a systemic financial crisis. And again, the 2013 Economics Nobel awarded to Eugene Fama – even though he was still supporting theories that paved the path to the crisis of 2008.

Further, while Pareto reasoned in terms of derivatives as in calculus, and used it, he stressed that such derivatives are not facts but a 'conceptual scheme of the mind' (Pareto, 1909). He also extended the concept of derivatives beyond calculus to what may be derived from commonality in what people say and the beliefs that they hold, i.e. precisely the 'narratives' that Samuelson disdained, which is the method that has since become known as discourse analysis in grounded theory (Charmaz,1994; Shah and Corley, 2006). Which is consistent with Hayek's claim that finding that different people: 'perceive different things in a similar manner… must be regarded as a significant datum of experience which must be the starting point in any discussion of human behaviour' (Hayek, 1942, p. 37).

4. Regaining Realities

What follows in terms of regaining realties stresses that it is foreign direct investment – neglected by both Ricardo and Samuelson – that has driven post-war trade, both promoting uneven global development and qualifying exchange rate changes for countries with high ratios of foreign investment relative to exports, such as the US. It outlines meso qualifications of investment-savings liquidity-money IS-LM theory and the disavowal of this by Hicks as early as the 1960s. While stressing the initially successful role of meso level credit institutions in financing industry in Europe and the US before banks and hedge funds sought to make money from speculative derivatives, and the success of such institutions for decades in Asia. It also seeks to deconstruct macro fiscal policy, and draws unduly-neglected lessons from public finance through bonds in the Roosevelt New Deal, with implications now for bonds to finance both social and environmental investments and higher levels of employment in the EU.

4.1 Foreign Investment, Not Comparative Advantage, Drives Trade

Consistent evidence from the United Nations Conference on Trade and Development (UNCTAD, 1973; 1991; 2009; 2011; 2013) shows that it has been foreign direct investment (FDI) by multinational companies – rather than comparative advantage – that has driven post-war global trade. Further, while Keynes was right on key issues such as effective demand,

and the role of psychology, he was wrong in assuming – like Keynesians such as Kaldor – that trade was between different companies in different countries (Holland, 1987a; 2015b; 2017a). But with as yet, still under-recognised implications. Since asymmetric outcomes from FDI, such as recognised by Hymer, not only challenge HOS theories of comparative advantage, but also question whether balance in international trade can be achieved by the managed exchange rate changes that underlay Keynes' proposals for the Bretton Woods system – for three main reasons.

1. There will be an 'export substitution' effect if companies which had been exporting from one country then invest in, produce and export from others.
2. If companies are producing in other countries and then export to the country of investment outflow, this will tend to increase its imports, with an 'import promotion' effect.
3. For such companies to follow through a devaluation or depreciation of a currency with lower prices in others would be to compete against themselves or an 'own competitor' effect (Holland, 2015b).

The 'own competitor' effect from foreign direct investment was suggested in findings decades ago, from the devaluation of sterling in 1967 which signalled the beginning of the end for the managed exchange rate system of Bretton Woods. For, at the time, foreign production by leading UK firms was more than double visible exports, whereas that for Germany or Japan was only two fifths of exports (UNCTAD, 1973).

Two analyses in the 1970s of the effects of the 1967 sterling devaluation, including a study of the top 220 exporters which accounted for two thirds of British visible exports, found that none of them had chosen to lower export prices because of the devaluation, and that where some of them had done so, it was for other reasons – such as price strategies either to gain foreign market entry or to deter new entrants (Hague, Oakeshott and Strain, 1974; Holmes, 1978).

Export substitution and import promotion effects from FDI explain, in large part, long-standing post-war US trade deficits. Since for decades, it has been the most multinational of all economies, with foreign production by its firms more than four times its visible exports. Robert Lipsey and Irving Kravis showed that, by the early 1980s, exports from the US by American multinationals had fallen to less than half their exports from other global locations (Lipsey and Kravis, 1985).

Such effects also give more explanatory power to the slowdown in growth of the Japanese economy than the alleged Heckscher-Ohlin-Samuelson theorem. In a survey of 3,200 subsidiaries of 1,250 companies in Japan in the early 1980s for the Japanese Ministry of International Trade and Industry, it was found that 78% of them had located abroad to replace exports. They had done this by direct investment in the US to avoid the risk of protection, or, in less-developed Asian economies, to access lower-cost labour, thereby reducing exports from, and export multipliers within, Japan (Kono, 1984).

This is not to claim that exchange-rate changes are unimportant. They are vital for countries with little foreign direct investment, and denying devaluation as a means of adjusting trade imbalances has been a critical disadvantage for Greece and other economies of southern Europe (Varoufakis and Holland, 2010; 2011; 2012). But, while deserving further research, the evidence so far is that the effects are asymmetric for companies with a high degree of foreign direct investment

Thus the revaluation or appreciation of a currency will tend to reduce export competitiveness. A devaluation or depreciation will, in principle, increase it for micro firms – although they may hesitate to increase export volume for a range of reasons, including lack of capacity or of sufficient representation in foreign markets or simply opting to increase cash

flow. But it will not necessarily do so for an economy with a high degree of outward foreign direct investment by its corporations, such as the US, since to lower prices in foreign markets in which they already are producers and sellers, would be to compete against themselves.

4.2 Not by Interest Rates Alone: IS-LM and Quantitative Easing

A meso perspective also qualifies the presumption for decades in monetary theory of an alleged Hicks-Hansen IS-LM investment-savings and liquidity-money model (Hicks, 1950; Hansen, 1953) which, at the height of its influence, was described, in a paper for the Federal Reserve Bank of St Louis as the cornerstone of most macroeconomics courses taught throughout the western world (Carlson and Spencer, 1975). IS-LM also was integral to one of the few post-war textbooks to compete with Samuelson's *Economics* by Stanley Fischer and Rudiger Dornbusch, later to be joined by David Begg (Begg, Fischer and Dornbusch, 1987). But this made no distinction between bigger firms with market power and smaller firms without it – and wrongly presumed that investment decisions for all firms were interest rate sensitive.

Whereas Hicks (1980-81) not only later repudiated claims ascribed to him for IS-LM, but already had done so in 1965, at one of his last seminars as Drummond Professor at Oxford, in which one of us was a graduate student. When an American Rhodes Scholar attributed IS-LM to him, Hicks put his head in his hands and said 'Stop, please stop'. The hapless Rhodes Scholar responded 'I'm sorry Professor, have I got this wrong?' To which Hicks replied 'I don't know whether you have got it wrong or right, but do not attribute it to me', protesting that all he had done at the end of his *Contribution to the Theory of the Trade Cycle* (1951) was to suggest such a relationship *if* investment were interest rate sensitive – which it might not be.

While, also, although IS-LM fills reams of literature, next to no attention has been paid to one of the main implications of the case made by Hicks in his *Contribution,* i.e. that cutting long-term investment will lower the floor to which an economy can sink.

In parallel with this we submit that a distinction between interest rate sensitivity for micro firms and little to none for meso firms, where these can self-finance, qualifies the effectiveness of quantitative easing. QE has injected liquidity into banks, but not recovered private sector investment to its pre-crisis trends on a sustained basis in either the US or Europe. The programme has been a major exercise of about €2 trillion and successful in avoiding a further financial crisis. Yet the real economy impact on investment has been minimal (Gros, 2018).

Not least since private sector banks have used the money to recapitalise or, also, in offering it to finance investment, have done so at interest rates which have been prohibitive for small or medium firms yet irrelevant for bigger business which by and large can self-finance investment yet hesitates to undertake it since misguided policies of 'structural adjustment' and alleged 'structural reforms' have been depressing demand.

While, as Knibbe (2017) has well stressed, zero or even negative interests are of no use to pension funds which, on such a basis, cannot meet their statutory obligations. Both they and sovereign wealth funds have lacked adequate private sector investment outlets since the financial crisis. The China Investment Corporation, the biggest sovereign fund in Asia, lost a fortune by still investing in private equities in the three to four years after the crisis, and then declared in 2012 that it was looking for more reliable and longer-term public investment projects (Business News, 2012).

Which is not to say that the ECB, at the highest level, has presumed that QE will recover the European economy. Senior members of the bank have recognised that this alone, rather than a bond-funded public investment programme – such as along the lines of the

Delors White Paper *Growth, Competitiveness Employment* (COM, 1993) – may not do so. Yet have submitted that governments, rather than they, needed to lead on it since bonds are 'fiscal policy' and not their remit (Holland, 2015a; 2016).

4.3 Deconstructing Fiscal Policy

Yet there also are problems from compounding differences within the two words 'fiscal policy'. Thus this can mean changes in taxation, or public expenditure or public investment. Each of which is different in their claims on resources and their economic and social impact. Thus lower personal taxes may mainly increase wealth for those who have it. Lower corporate taxes may only increase retained earnings for corporations and shareholders. Similarly, lower interest rates may increase a propensity to consume, but also encourage unsustainable investment in property – as they did in the run up to the subprime crisis.

It also has been less-than-widely recognised that multipliers from public expenditure and investment also tend to be significantly higher than those from fiscal policy – in the sense of tax cuts. For example, the 2009 Obama American Recovery and Reinvestment Act was undertaken on the basis of a multiplier of close to unity for such cuts, and of 1.6 for public expenditures. Yet the multipliers from public investment projects can be up to double or treble these. Those from European Investment Bank projects range from 2.5 to 3.00, whereas fiscal multipliers tend to range from 1.1 to 1.8 (Blot, Creel, Rifflart and Schweisguth, 2009; Holland, 2015a).

Fournier (2016) has shown that, in a typical advanced economy, government allocating a larger share of total expenditure to good quality public investment, tends to boost growth and productivity over the long term. Fournier and Johansson (2016) also have found that households in many countries could experience income gains of up to a seventh by a shift from current public spending towards public investment.

Yet if public spending or investment is cut, this not only means direct loss of jobs and incomes, as well as loss of direct and indirect taxation, but also reduction of the multipliers which otherwise could sustain the private sector. As has been the case in Europe resulting from misguided theories of 'structural adjustment' and alleged 'structural reforms' which, as indicated at the outset, have been well criticised in research by the OECD (2017). Benoit Cœuré (2014; 2015), French executive director of the European Central Bank, has directly criticised claims for structural reforms as amounting too often to rhetoric, and called for further research rather than just assertion concerning them. A series of studies in papers from the research department of the IMF, under the direction of Olivier Blanchard (Blanchard and Leigh, 2013; Abiad, Furceri and Topalova, 2015; IMF, 2015), also have criticised the neglect of negative multipliers from misguided deflationary policies of structural adjustment.

Whereas public investment, or even fiscal policy in a more general sense, is hardly analysed in the academic mainstream. In a Lionel Robbins Memorial Lecture in 2009, Paul Krugman illustrated this well by citing that of some 7,000 articles published by the National Bureau for Economic Research in the US since 1980, only five referred to any form of fiscal policy (Krugman, 2009a).

Yet fiscal policy also needs more than simply returning to Keynes' concept of effective demand to restore growth, whether by running deficits, or public spending and investment. What now is needed is to meet *latent* demand for more equitable societies, for individual and collective wellbeing, sustainable environments and an institutional framework for governance based on mutual advantage rather than reliance on comparative advantage. Which is implicit in protests against inequality such as 'one per cent' and against a

globalisation in which people serve markets rather than markets serve people, to which we return later in this paper.

4.4 Credit, Debt and Finance

In his *Finance Capital* (1910), Hilferding analysed not only monopoly trends in German industry and finance but also how German banks, with government backing, were directly financing big business – and cartels – both by credit and direct shareholdings on a long-term basis, rather than relying on the short-term dependence on stock markets.

This also was the case in Italy, and has been typical of credit and finance in Japan's – meso – conglomerate *keiretsu* and South Korea's *Chaebol.* While, since the Deng Xiao Ping reforms, China's major state owned banks – of which three, since the financial crisis, have been the largest in the world – sustained high macro-investment rates through credit to state enterprise and local governments which, even while generating great inequalities in wealth, has lifted some six hundred million people out of poverty (Wong, 2018).

By contrast with Hilferding, and commenting on the 'amnesia' of modern monetary economics, Adair Turner (2013) has contrasted this with credit and stock market finance in the UK and US and how these have funded almost anything other than productive investment. Suggesting, for example, that probably no more than 15% of lending by the UK banking system had, for years, been financing new investment. While also stressing the negative macroeconomic outcomes of major banks funding debt-on-debt on a massive scale.

4.5 The New Deal – and Bond Finance

It is remarkable that in her address to the 2016 conference organised by the Boston Fed, Janet Yellen made no reference to the 1930's New Deal, despite her concern being to understand *The Elusive 'Great Recovery': Causes and Implications for Future Business Cycle Dynamics*. Whereas, by contrast, Minsky (1986) had paid extensive credit to it in his *Stabilizing an Unstable Economy.* Moreover, the multiple 'alphabet agencies' that enabled the success of the New Deal were not 'micro' with no macro significance, but institutionally meso in the sense of in between micro small and medium firms in crisis, major meso corporations in stasis, and more positive macro outcomes.

Being public and concerned to recover investment and employment, rather than speculating in finance, the New Deal agencies were big enough to succeed rather than too big to fail. Nor was this Keynesian deficit spending. The average fiscal deficit of the US from 1933 to the outbreak of war was only 3% – coincidentally, but also significantly, the target rate of the inversely deflationary Stability and Growth pact of the EU. While Keynes himself was initially remiss on the New Deal. In *The General Theory* his early observations were that it probably would destabilise financial markets rather than recover them.

None of which has been aided by Milton Friedman asserting that government investment and expenditure 'crowds out' the private sector (Friedman, 1953; 1957; 1962) nor that public spending increases necessarily will be viewed by consumers as adding only to transitory income, and thereby claiming that a Keynesian marginal propensity to consume from such spending is zero (Friedman and Meiselman, 1963). Yet he and Meiselman (either wilfully or otherwise) disregarded that the those from bond-financed public investment in civil and environmental projects during the US New Deal were crucial in reducing unemployment from over 20% in 1933 to under 10% by 1940, even if it was only wartime rearmament and military expenditures that reduced this further (Smiley, 1983).

Some economists seeking to support Friedman and Meiselman (e.g. UCLA, Edu., 2004) have done so on the basis of claiming that government-generated employment, such as in the New Deal, does not represent 'real jobs' – which only can be created on and by 'free' markets. Whereas if New Deal employment generation has been deemed unreal by them or others since, it was not for millions in the US in the 1930s, who not only gained jobs but also, thereby, recovered faith in American democracy (Schlesinger, 1958).

4.6 Eurobonds

The relevance of the US New Deal for Europe underlay the case for 'Eurobonds' to be issued by a European Investment Fund – EIF – which was proposed to Delors in 1993 (Holland, 1993), agreed in December that year by the European Council, set up in 1994 and, since 2000, has been part of the European Investment Bank - EIB - Group. EIB bonds do not count on the debt of member states of the EU, any more than US Treasury bonds count on the debt of member states of the American Union, such as California or Delaware, and EIF Eurobonds need not do so. But whereas the management psychology and practice of the EIB has been project-based, the design aim of the EIF was macro – both to offset the deflationary debt and deficit conditions of Maastricht and to recycle global surpluses (Varoufakis and Holland, 2010; 2011; 2012; Varoufakis, Holland and Galbraith, 2013).

In 2012 Eurobonds were overtly opposed by Angel Merkel who declared that they would be introduced 'over her dead body' (Ottens, 2012). Yet without any evidence that she actually understood what bond finance was about. Any more than Helmut Kohl who, when Antonio Guterres in 1996 proposed that bonds issued by the European Investment Bank should be extended to investments in health, education, urban regeneration and protection of the environment opposed this and declared that 'the German taxpayer has paid enough' (Holland, 2015).

But then, when briefed that EIB bonds did not count on German debt, nor needed German guarantees, nor servicing by German taxpayers, Kohl (in 1997) agreed to such an extension of the EIB's investment remit which enabled it in the following decade to quadruple its investment finance and overtake that of the World Bank. Further, despite opposition to Eurobond issues to fund a European recovery by Angela Merkel, these have been supported by Emmanuel Macron (Holland, 2016; 2018). Whether their wider role in enabling a European New Deal could follow the departure of Merkel (Ryan, 2018) and that already of German finance minister Wolfgang Schäuble is open to question. But the institutions in the case of both the EIB and EIF already exist, and issuing Eurobonds does not need a Treaty revision rather than political decision (Holland, 2018).

5. Psychological and Institutional Barriers

It already has been more than a century since Veblen in 1898 asked why economics is not an evolutionary science. To which the barriers may be political – as, in the McCarthy era, with the risks in the US of appearing to be Marxist – or institutional or, in part, psychological. As in how the 'systems thinking' against which Smith warned in his *Theory of Moral Sentiments* relates to Wittgenstein's warning in his *Philosophical Investigations* of being trapped by 'language games' without being aware of, or displacing the unreality of, doing so.

5.1 Displacement, Denial and Projective Identification

These barriers may range deeper in terms of what Melanie Klein (1932; 1952; 1961) conceptualised as not only of displacement and denial but also 'splitting' and 'projective identification'. Klein developed this from her studies of paranoid-schizoid behaviour in disturbed children. Her conceptual framework nonetheless was seen by many psychologists and psychoanalysts to be relevant to everyday life and psychologists influenced by her such as such as Schneider (1975) and Richards (1989) then related it to behaviour in markets. As did Dinnerstein (1978) in submitting that:

> 'the realm of sensuous experience embodied by the mother is rejected in favour of rational worldly activity. Hence the splits between heart and head, feeling and reason, private and public' (Dinnerstein, 1978, p. 130).

Which also is relevant to projective identification of 'pure theory' as if this either is, or should be, how markets actually work. Thereby not only displacing Walras on how theory and practice differ, and warnings from Pareto on risks from projecting past trends into an assumed future. But also is relevant to errors in rational expectations theory in which there was a projection of an 'idealised good' in terms of assuming that decision-makers not only were rational but also had 'perfect' information. While splicing of mortgages that were rated as prime because they were serviced by borrowers who had regular incomes, with those that were subprime, on the basis of projected rather than actual income streams, discplacing that this might be toxic for both. The splitting also had another dimension. It split lenders from needing to know borrowers since the commissions on selling the derivatives were paid 'up front' and then sold on to others, such as European banks, on the assumption that efficient market and rational expectations theories could accurately project future outcomes.

5.2 Institutional Barriers

Bourdieu had reason in his *Homo Academicus* (1984) to cite how hierarchies resist either entry or preferment to those whose views challenge their own, thereby echoing the neglected case of Pareto (1909; 1935) that elites tend to exclude non-elites. While, although neoclassical economics has premised free entry to markets, this has proved less so for new thinking in economics. As Krugman (2008) frankly recounts, his earlier efforts to get published were rejected by established journals such as *The Quarterly Journal of Economics.*

In parallel, Ferguson and Johnson (2018) have highlighted that a problem for a more realistic economics is from 'risk-averse' editors in leading US journals who 'can drive up their impact factors by snapping up guaranteed blockbusters produced by brand names and articles that embellish conventional themes' (Ferguson and Johnson, p. 4). While, even if the case for recovering realities either are accepted for or are reviewed in such journals, they may make no impact on the mainstream.

For example, *The American Economic Review*, in 1994 published an authoritative paper by Bürgenmeier on 'The Misperception of Walras', but without displacing the dominant perception of Walras as an advocate both of 'pure theory' and general equilibrium. Similarly, a concern to distinguish meso from micro economics, and stress the macroeconomic dominance of meso firms, was elaborated in some depth in two volumes some three decades ago (Holland 1987a; 1987b). Where there were mainstream reviews, they were favourable, including in *The Economic Journal* (Singer, 1989) and a double-column, two-and-a-half-page lead review in the *Journal of Economic Literature* which claimed that: 'In scope,

comprehensiveness, accessibility and insight, these books have no equal. Economists, especially teachers of economics, are in his debt' (Elliott, 1990, p. 67). Which was not to be the case.

5.3 Timing

One comment was that such rethinking was too early at a time when many economists, including some who considered themselves Keynesians, were being seduced by rational expectations and efficient markets, as also submitted by Krugman (2009a). There as yet had been no financial crisis nor assumptions of 'too big to fail', nor a return of 'depression economics' (Krugman, 2009b).

Nor, in Europe at the time, austerity such as was to be imposed in the Eurozone on pre-Keynesian assumptions of *Ordoliberalismus* and which Blyth (2015), with reason, has deemed a 'dangerous idea' for democracy. Nor how democracy was to be denied in Greece when finance ministers in the Eurogroup – with no basis in any Treaty nor reporting to any parliament – refused to recognise the outcome of both the January 2015 election of a government proposing alternatives to austerity and the July referendum rejecting it.

Nor, in the 1980s, had there been heightened public awareness of the emergence of gross inequalities of wealth and income giving rise to 'one per cent' protest movements and highlighted by Piketty in relation to the decline in progressive taxation. Nor widespread evidence of the precarity of employment, of which Standing (2011) also has warned of dangers. Nor, at the time, a now widespread concern that a neoliberal paradigm of globalisation was not bringing the mutual gains from comparative advantage that hitherto had been assumed to be axiomatic. Nor increasing evidence of a loss of confidence by electorates in mainstream institutions and mainstream policies such as have encouraged calls to end 'ever closer union' in the EU and restore the right of national electorates to elect parties and governments with alternatives to austerity, including the vote in the UK for Brexit (Habermas, 2018; Etzioni, 2018)

6. Alternatives

We already have cited a wide range of alternatives to the mainstream in institutional, evolutionary, heterodox – and mesoeconomics. In what follows, we propose: feasible means for gaining accounting and accountability of meso corporations, banks and other finance; institutional and governmental means for achieving mutual advantage between states rather than relying on assumptions that comparative advantage necessarily will maximise global welfare; and the case for meeting latent demand for liveable and sustainable environments rather than only recovering effective demand.

6.1 Accounting and Accountability

Part of this process concerns rethinking – and extending – national accounts. There are well-recognised limits within these in a concept such as GDP which fails to account for negative externalities from economic growth or to recognise human and social dimensions to wellbeing (Stiglitz, Sen and Fitoussi, 2008). Yet these have not seriously been revised since the 1930s when they mainly measured what Keynes thought important. And, since, have stayed within a macro framework at national levels which has masked the increasing dominance of supply – and finance – by multinational capital.

For such reasons, as well as the inability of governments to foresee or then adequately deal with banks deemed 'too big to fail', we submit the case for a meso dimension to both national and international accounting. For example, while the theoreticians of rational expectations had premised their models on perfect information, when the credit crunch came in August 2007, no one knew how much money had been lost or was at risk for whom or where. The dilemma was how to address an information deficit (Tett, 2007), not least since the Fed had not been concerned to track what major banks, hedge funds or an insurer, such as AIG, had been doing.

At the time of the credit crunch traders in financial markets referred to a 'correlation crisis' between credit and risk (Scholtes, Mackenzie and Ishmael, 2007), despite the Nobel awards to Lucas, Merton and Scholes having been based on claims of being able to correlate them with precision. It then took four years, until 2011, for the European Banking Authority to be able to publish 'stress tests' on 91 banks after which nine that passed them promptly failed. Since when is has committed itself to try once more to determine which actually were solvent or insolvent (Finch, Martinuzzi & Penty, 2011) but without, as yet, transparent success.

6.2 Meso Accounting – and Input-Output

Two decades before the financial crisis and 'too big to fail', it had been proposed that there should be a meso dimension to national – and international – accounts, tracing the multinational reach of banks and big business, and that this could be informed by a meso dimension to input-output (Holland, 1987a, chapter 9). The project was supported by Jacques Delors when he was President of the European Commission, by Yves Franchet, the then head of Eurostat, and also gained the interest of a still very alert Leontief, who recognised that it could enhance input-output by tracing most activity through only some – rather than all – banks or enterprise (Holland, 2015a).

In Europe, there also was, and still is, an institutional basis for doing this in terms of the remit of the Competition Directorate General of the EU Commission which, since the provisions of articles 85 and 86 of the Rome Treaty, has had extensive powers to require information from any enterprise that could, *prima facie*, be abusing a 'dominant position' in a market. Which is the case when multinational corporations both dominate sales and, through transfer pricing and tax havens, pay little or no tax. And could be actionable on the basis that, unless they pay taxes in final markets, in Europe, or the US, or elsewhere, they cannot sell there.

This meso accounting proposal lost momentum after Delors retired from the Commission. However, without using the concept, in seeking to implement the EU proposal for a banking union, the ECB *de facto* is not seeking to gain detailed information from all some 6,000 financial institutions in Europe, but from the 130 or so that dominate macro financial outcomes (Holland, 2015a). And which could be informed by a meso dimension to input-output.

One of the limits of input-output modelling has been that, since seeking to analyse a whole economy, it takes time to collate all available data, correlate it and then project findings several years ahead on fixed coefficients, by which time much of it is out-of-date. Yet this can be overcome not only by advances in computing, but by gaining such data from the few meso firms that dominate outcomes rather than whole sectors. While a meso dimension to fiscal policy is relevant to the feasibility of a Tobin Tax in that this could be introduced for transfers by multinational corporations rather than all international financial transactions.

This could also have political significance in that by gaining both accounting and accountability of bigger business and banks, governments need not subject all enterprise, or all individuals, to Orwellian intrusive scrutiny. Thereby countering Hayek's (1944) claim that any intervention in or to control or to supplement markets would be the road to serfdom. Which itself displaced that Roosevelt had done so, extensively, thereby not only recovering faith in the US in democratic institutions but giving Truman and the post-war US Congress the confidence, from his success, to endorse the post-war Marshall Plan which was crucial in not only gaining European economic recovery, but also a similar recovery of support for democracy.

6.3 Meso and the Environment

One of the challenges that outstrips even another financial crisis is existential in the prospect that asymmetric climate change may be irreversible within 30 to 40 years, or less, that environmental protection through new technologies alone will not deliver a 'technological fix', and that what it needed is to 'take out' carbon both from current emissions and those accumulated from the past.

A UN climate change report of October 2018 (UN, 2018) has warned that to achieve the goal of limiting warming to 2.5 degrees would require the reduction of carbon dioxide emissions to 45 percent of their 2010 levels by 2030, and their elimination completely by 2050. Among environmentalists who already have voiced such warnings, Tim Jackson not only has been one of the most vocal, but also has factored the need for this into a Keynesian macroeconomic model (Jackson, 2009). In which he has recognised both the case for input-output analysis, and for it to map carbon emissions and resource implications at different levels and compositions of aggregate demand.

For which, again, a meso dimension helps. Thus, as cited at the outset of this paper, the Carbon Disclosure Project (CDP, 2017) has shown that 100 corporations have been sourcing over 70%, and 25 over 50% of global carbon emissions.

One of the implications of this comes from Richard Heede (2014) who, as with the CDP report, has designated 90 such corporations as 'carbon majors'. But whose case and findings coincide with what we are forwarding as mesoeconomic analysis. As he does in his suggestion to focus attention on a 'manageable number of entities', rather than only on countries. Thus the United Nations Framework Convention on Climate Change accounts for emissions at national levels. Yet 40 of Heede's 90 'carbon majors' are state firms and 50 are investor-owned corporations. On such a basis the United Nations Environment Programme – UNEP – could in principle adopt and pursue a meso dimension to environmental accounting and accountability. Some countries – and companies – would be opposed. But others seeking to be green in their national strategies, or claiming to be so in their corporate profiles, could cooperate. If UNEP were to adopt such an accounting proposal, and report progress in it on an annual basis to the General Assembly, it could raise the issues concerned to a global political level.

6.4 Funding Carbon Reduction

One of the cases that Tim Jackson makes to counter climate change is for Green Bonds to fund major carbon reduction programmes. Yet he recognises that if these were to be national they would be unlikely to be able to address the scale of the challenge. This is realistic where bond finance counts on national debt – which is limited in principle for EU member states by

the Maastricht debt and deficit conditions – and, in practice, in many other countries, constrained by competing claims on national borrowing.

However, US Treasury bonds do not count on the debt of the member states of the American Union. One of the central cases made earlier in this paper and endorsed by employers', trades unions' and civil society representatives on the Economic and Social Committee of the EU (EESC, 2012), has been that bonds issued by the European Investment Bank Group, including the European Investment Fund, either do not, or need not, do so.

Since the Essen European Council of 1997, the EIB has had a specific remit to fund both investments protecting and enhancing the environment and green technologies. This type of funding also can meet the need to recycle under-invested surpluses in pension funds and sovereign wealth funds. Such as in the lament in 2013 of Bill Gross of the PIMCO pension fund – one of these world's largest – that he could not finance pensions with near-to-zero interest rates, which abetted his demise shortly after as its CEO. Paralleled by the earlier-cited 2012 declaration of the China Investment Corporation that it was looking for longer-term public investment projects (Reuters, 2014; Business News, 2012).

6.5 Meso-Cities and Green Demand

There also is another meso dimension to the environment which is not national – cities. And which has implications for generating green production which does not depend on macro demand management

In the spring of 1998, as part of the British presidency of the European Council, and advised by one of us, the Deputy Prime Minister of the incoming Labour Government, John Prescott, launched an *Alternative Traffic in Towns – Alter* project which managed, within months, to gain commitment from over 120 European cities including London, Paris, Berlin, Rome, Lisbon and Athens (with interest also from New York and Moscow) – to introduce low emission zones. On the rationale that if they did so this would give a message to major – meso – vehicle producers that there would be a macro demand shift to 'green'. Which, already, Volvo (involved in the original project) has recognised by now producing only low- or zero-emission vehicles.

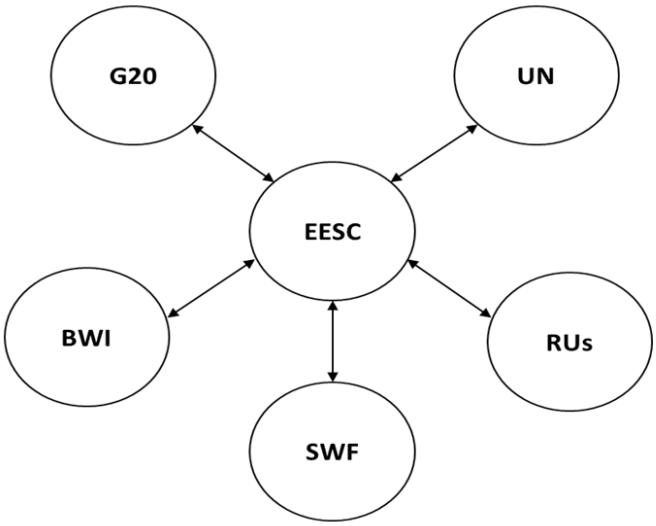
Initially the project stalled. In part, because the EU Commission, in a classic case of inertial institutional logic, claimed that it could not fund more than three cities in an environmental safeguard project. While the EIB had not yet got its act together to bond finance environmental protection on its new 1997 remit. But by now there are more than 200 active or planned low emission zones in Europe, even if their impact varies depending on the design and size of the zone, as well as its enforcement (BUND 2015; Obrecht, Rosi and Potric, 2017). Also, and encouragingly, there is increasing commitment to introduce such zones in China (WRI, 2016).

Low-emission zones reinforce the meso concept, in terms of both pro-social civic institutions and their ability to countervail the market power of corporations. For example, a city such as São Paulo has a population in its greater urban area the size of that of Benelux. Its strategic master plan (São Paulo, 2014) is admirably concerned with both social development and enhancing its metropolitan environment. Yet its measures are mainly remedial, such as treatment of contaminated land and recommending more use of public transport. If it were progressively to introduce, and then widen, a central area low-emission zone, it would not be in the interest of any auto major to seek to sell any vehicles in Brazil that were not low emission. And it could initiate this without waiting for the federal government to introduce legislation.

6.6 Meso Institutions and Global Governance

While allowing exceptions, such as how cities can generate green demand, much of what we have proposed begs the question: whether and how there could be more effective global governance? Which we suggest implies a shift from a global trade model based on comparative advantage to one that can achieve mutual advantage in addressing issues of economic and environmental security. With a synergic framework for an institution such as the G20 which, while meso in the sense of between all nation states and global outcomes, currently lacks even an effective permanent secretariat.

Figure 1. An economy and environment security council



UN - UN Agencies, BWI – Bretton Woods Institutions, RUs – Regional Unions, SWF - Sovereign Wealth Funds

Which, as stylised in the above figure, could be the governments of the G20 nominating the governing body of an Economy and Environment Security Council. This would parallel the UN Security Council. Yet, while the Security Council mainly is reactive, in the sense of crisis management, an EESC should be able address economic and environmental issues in a proactive manner.

Such a Council would be more representative than the G7 and could liaise on its working groups with UN agencies such as UNCTAD, UNEP, UNDP, WHO and the ILO which currently report to the General Assembly but otherwise are advocates rather than actors in global decision-making. To enhance this a representative of the Secretary General of the UN could be a member, if non-voting, of its governing body.

An EESC would liaise with the IMF and the World Bank but not depend only on them nor on further protracted renegotiation of voting rights within them. For several reasons. Despite the openness of Blanchard and others in the research department of the IMF, the senior management of the Fund still is devoted to a neoliberal ideology and a catechism of deflation and deregulation. While the Bank, although having made nominal concessions to intervention in markets, such as industrial policy, still is tending to mirror the interests of the US Treasury and Wall Street, as cited from his own experience by Stiglitz (2003).

Whereas East Asia has been open to more plural forms of economic governance such as was submitted by Wade (1990) against strenuous efforts by the Bank to prevent publication of his *Governing the Market.* Paralleled by the more recent work of Paul De

Grauwe (2017) on the need to govern markets. Besides which the Fund and the Bank lack the resources needed to promote sustainable development – or counter climate change – at a global level. Sovereign wealth funds such as those of China, the Middle East, Norway and, to a lesser extent, Brazil have the resources yet are not institutionally linked with either the Fund or the Bank or the G20.

The decision-making of an EESC, if not unanimous, could be on an enabling basis between states willing to act, similar to that of 'enhanced cooperation' in the EU (Holland, 2003; 2015). But, unlike voting weighted by population in the EU, this could be on the basis of one nation one vote which still would give greater weight to bigger member states in terms of their global significance and greater resources. In the event of one or more governments declining to join, it could be initiated by a G19, or less. Yet if not endorsed by, for example, a Trump administration in the US, but proposed by a major EU member state such as Germany or France, or by China, or Japan, it could gain support from others in the G20.

7. Implications

In line with others cited earlier in this paper, we have suggested that a concept such as meso can synergise commonality in several heterodox approaches as well as informing synergies between institutions and policy outcomes. We therefore invite responses to and suggestions in areas such as those below – while recognising, and welcoming, that there may well be others.

- Post Keynesian Analysis

Analysing meso-macro dynamics by moving beyond Keynes' presumption that the supply side of an economy could be left to perfect or imperfect competition. Recognising that Keynes' marginal efficiency of capital, as well as accelerator-decelerator and capital stock adjustment principles, is no longer national but global for transnational corporations. Matching his concern to recycle global surpluses yet shifting fiscal policy from deficit finance to generate effective demand to recognising and meeting latent demand for social and environmental investments through regional and global bond finance.

- Post Marxian and Kaleckian Perspectives

Confirming a Marxian perspective such as Hymer's on the now global role of a reserve army of labour as a lever of capital accumulation, but qualifying assumptions of declining rates of profit for meso firms with multinational reach and price-making power. Relating 'too big to fail' to crisis theory in terms of declining rates of profit in traditional sectors in advanced economies, and to both the pressures and incentives for speculative finance with deregulation. Critiquing the commodification of labour and social services as capital seeks to privatise social institutions in health and education, and other public services. Updating Kalecki's perception that oligopoly not only qualifies neoclassical micro theory, but also compromises key principles in mainstream macro theory.

- Monetary Policy and Credit

Qualifying IS-LM theory by evidencing to what extent meso corporations are influenced – or not influenced – in their investment decisions by interest rates. Analysing the role of credit policies by either public or private major financial institutions, in either 'real' or 'fictitious' financial investments, and their related welfare, or negative social, effects.

- Fiscal Policy and Financial Transactions
Sampling estimations of the fiscal loss for different countries from transfer pricing by given categories of meso corporations. Analysing the feasibility of a Tobin style financial transactions tax for meso, rather than all, international financial transactions.

- Exchange Rate Policy
Assessing the degree to which multinational corporations follow through the devaluation or depreciation of the dollar with lower prices in their exports, or do not do so due to an 'own competitor effect'.

- Foreign Direct Investment and Trade
Evaluating export substitution effects from multinational FDI (as submitted by Ohlin) but neglected in mainstream comparative advantage theory. Assessing import promotion effects from multinational FDI (importing back to the country of FDI outflow from lower cost global locations). Estimating the share of exports from China and other East Asian economies from US companies locating and producing there, and the degree to which this may compromise both economic and political support for protection against them.

- Accounting and Accountability
Evaluating and potentially enhancing the decision of the European Central Bank to directly assess only 130 meso banks rather than the 6,000 financial institutions in the EU, and modelling their influence in terms of meso-micro matrices in input-output analyses.

- ***Public and Social Multipliers***
Evaluating public and social sector investment, employment and income multipliers – in the sense that construction of a hospital or high speed rail link with public funds generates private sector contracts, jobs and income – including fiscal multipliers from both direct and indirect taxes generated by such public and social sector multipliers.

- ***Bond Finance and Crowding-In***
Estimating the crowding-in effects of bond-issuing public financial institutions, both in the EU (such as the EIB) and in individual European countries (such as with the KfW in Germany, the Caisse des Depôts et Consignations in France and the Cassa Depositi e Prestiti in Italy) as well as the BNDES in Brazil.

- Bond Finance and the Environment
Assessing the scale on which bond finance by meso financial institutions such as the EIB Group and Brazil's BNDES can meet the green funding challenge posed by Jackson not only for environmental protection, but also to 'take out' carbon.

- Carbon Majors and the Environment
Reinforcing the work and findings of the Carbon Majors Report in the 2017 Carbon Disclosure Project by deploying input-output to trace the carbon footprints of meso corporations to inform policies on environmental protection and, especially, carbon reduction.

- Cities and the Environment
Evaluating how cities such are reducing carbon emissions by their introduction of low-emission zones, and the degree to which a major urban area such as São Paulo could do so with demand generation for zero- or low-emission vehicles.

- Social Economy

Relating the meso concept to analysis and management of social institutions whether in less or least developed countries and in countering command-and-control hierarchies in health, education and social services in the more developed. Doing so in terms of how this can gain from a distinction of macro institutional, meso organisational and micro operational levels, while assessing the case for greater relative autonomy for hybrid management at intermediate and lower levels

- The G20 and Global Governance

Assessing a meso institutional approach for more effective global governance, such as a G20-nominated Economy and Environment Security Council, with an enabling, rather than binding, decision-making procedure. Allowing that this might need to be a G19, in the event that a US administration did not support such an initiative. Yet recognising that a G19, or less. could include most of the world economy and that decisions by many of its members could register significant global outcomes.

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The Lucas Critique: A Lucas Critique

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Abstract

The Lucas critique has been – and continues to be – the cornerstone of modern macroeconomic modelling. In this note we apply the Lucas critique to macroeconomic modelling using deep rational expectations. In conclusion, we point out that Lucas's critique reveals a fundamental flaw in Lucas's own, popular 'solution', i.e., the so-called forward-looking rational expectations models. Heeding Lucas's call for model-consistent policy advice eventually requires an ontological shift in economics – which throws the door wide open to an exciting, hardly-explored field of economic research.

Keywords: Lucas critique, deep rational expectations, ontology

JEL classification: B4, C5, E2

1. Introduction

In 1976, Robert Lucas mounted an influential attack on the then common approach to macroeconometric modelling, by pointing out that the econometric models then *en vogue* lacked what is commonly called internal consistency. Put simply, model forecasts and rational choice were at odds with each other.

Lucas's critique henceforth gave rise to a new class of macro models which are built on rational decision making on the micro level, and deliver results on the macro level that are consistent with individual choices. Today, the so-called 'real business cycle', 'new classical' and 'new Keynesian' models claim to heed the call for model-consistent expectations in order to analyse alternative macroeconomics policies. Currently, the dynamic stochastic general equilibrium (DSGE) variant of these model types, represent the most popular approach.

In this note, we apply Lucas's critique to the choice of these models. It will be shown that contemporary macroeconomic modelling strategies are in obvious contradiction to rational choice and, therefore, by Lucas's standards – rather useless for actual policy analysis.

2. Lucas's Influential Criticism

Lucas (1976) famously took issue with the dominant econometric approach of the 1960s and 1970s, which was to use one and the same model for describing both the working of the economy, as well as for analysing the outcomes of alternative economic policies – without paying due attention to how people would react to those policies. Ignoring these reactions is a mistake, Lucas claimed, because they would, in fact, impact the model on which they are based. In Lucas's (1976) own words:

> '[. . .] given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models' (Lucas, 1976, p. 41).

Arguably, Lucas was not the first to recognise an inherent contradiction between giving policy advice for achieving a certain goal on the one hand, and assuming that nothing else of importance would change in due course on the other. In fact, as early as 1944, Haavelmo raised the problem of econometric stability and identifiability of model coefficients, and independently, as well as concurrently with Lucas, Goodhart (1975) came up with what was later dubbed 'Goodhart's law' – stating that the implementation of a certain policy which is based on some statistical regularity, will unavoidably change this regularity.

Lucas's unease with the assumption of stable coefficients was further matched by the views of others who also expressed their doubts – more or less along the lines of the above quote.[1] In contrast, however, Lucas not only criticised the implausible assumption, but also made a suggestion of how to overcome this problem. This second part of the Lucas critique eventually caught the imagination of many economists, and became the cornerstone of modern macroeconomic methodology.

In order to resolve the inconsistency problem, Lucas first introduced a new function that relates the state variables, parameters and shock to the policy variable, and then integrates this policy function into the model. The model parameters, thus, turn into functions of the policymaking process. Finally, Lucas argues, economic agents are able to understand the interrelatedness of policy conduct, and to predict the relevant model outcomes giving rise to so-called rational expectations solutions to macromodels.

In view of the fact that Lucas not only outlines a specific criticism, but also a remedy, reveals that the 'Lucas critique' is in fact a composite concept with two distinct parts. The first part is made up of the fairly well established issue of lack of parameter invariance in econometric modelling when considering deliberate policy action building on the very model. This part of the Lucas critique we may simply refer to as its positive part. The second component, which turned out to define macroeconomics for several decades to come, however, is normative by nature as it devises a remedy to the inconsistency problem.

The composite nature of the Lucas critique can be shown to be at the heart of the internal inconsistency of the critique itself when applying the positive analysis to its normative prescription.

3. Deep Rational Expectations

In the aftermath of Lucas' papers a whole new literature on models that achieve consistency between model-based expectations and the models themselves emerged. This 'Lucas-proof' modelling approach turned out to be so (seemingly) successful (Smets and Wouters, 2003; Smets and Wouters, 2007, for example) that in 2003, Lucas declared:

> 'that macroeconomics [. . .] has succeeded: Its central problem of depression prevention has been solved, for all practical purposes, and has in fact been solved for many decades to come' (Lucas, 2003, p. 1).

[1] Lucas explicitly mentions Jacob Marschak and Jan Tinbergen (Lucas, 1976, p. 20, footnote 3).

From Lucas's 2003 perspective, a long and challenging mission had seemingly been accomplished. Back in 1976, Lucas had observed that contemporaneous models were doing a good job in short-term forecasting but 'are meaningless' (Lucas, 1976, p. 24) when it comes to long-term forecasting.

However, immediately after Lucas's initial publication several econometricians were able to show that this claim was very far-fetched, to put it mildly. For example, Klein (1985) found that inflation in the early 1970s was mainly due to exogenous shocks, yet not due to policy shocks as Lucas had claimed.[2] Eckstein (1983) likewise concluded that changes in policy regimes were only minor sources of structural change in the economy and of forecasting failures. Using the concept of super exogeneity, Favero and Hendry (1992) argued that some of Lucas's behavioural parameters did indeed not change in response to policy shocks - which is in obvious contradiction to Lucas.

These statistical arguments against the Lucas critique were accompanied by several other issues raised against it. For example, the stability of Lucas's 'deep parameters' (preferences and technology) have been questioned (Solow, 1978) as well as the way in which Lucas advocated the 'microfoundation' of macroeconomics (Summers, 1986; Syll, 2016; Murray, 2016) or the ability of agents to obtain and process the necessary amount of information for expectation formation (Klamer, 1984; Tobin, 1981). One may add the fact that the aggregation of individual utilities obtains anything but stable aggregate demand or supply schedules (Debreu, 1974; Sonnenschein, 1972; Mantel, 1974) and several other objections which are too numerous to cover in due detail.

Furthermore, Lucas's and his disciples's 'success' narrative of the Lucas critique now co-exists with an alternative interpretation tradition that focusses on alternative responses to the Lucas critique's positive part. Most prominently among them certainly is Lawson's (1997) transcendental realism that calls for the comparison of rival theories, all of which are necessarily fallible, but one may nevertheless discriminate between them based on empirical evidence.[3]

In the wake of the 2007/2008 financial crisis, Lucas's (1976, p. 42) claim that this newer class of models would systematically outperform traditional models that are not based on micro-founded rational expectation came under attack again (Stanley, 2000; Edge and Gurkaynak, 2010) and lost some of its appeal at large. The question thus re-emerges: what makes the 'Lucas-proof' model class vulnerable to challenges posed by the developments in the real economy and by competing models that lack model consistent expectations?[4]

All mentioned and not-mentioned alternative suggestions notwithstanding, one answer is Lucas's account of the benefits of introducing rational expectations. As has been shown before, Lucas rightfully emphasises that rational individuals will realise the consequences a policy choice has *according to a given model,* and hence this model must consistently account for the predictable effects of such policy moves. However, this notion leaves unexplained the actual *choice of the model*. In other words, before formulating model consistent expectations, an individual must choose a model to build expectations on in the first place. It is only reasonable to assume that rational individuals do also choose their model rationally.

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[2] See also Blinder (1988) on this issue.

[3] Goutsmedt, Pinzon-Fuchs, Renault and Sergi (2016) offer a discussion of several alternative reactions to the Lucas critique's positive part.

[4] Smets and Wouters (2003, 1151) argue that their model is 'very close to that of the best VAR models. This implies that the DSGE model does at least as good a job as the VAR models in predicting [. . .] over the period 1980:2 to 1999:4'.

Therefore, the question arises what would be a rational model choice. Again, Lucas (1976) provides a useful hint. Referring to the standard econometric practice of his day, he notes:

> 'No one, surely, expected the initial parametrizations of [the traditional] models to stand forever' (Lucas, 1976, p. 24).

By simple analogy, a rational individual would not have expected in 1976, or any time before or after, that the most popular (benchmark) micro-founded, 'Lucas-proof' model at any given point in time would 'stand forever'. The consequences are, again, far reaching. A rational individual would not only make up his mind about the consequences of a certain policy measure within a given model, he or she would also account for the fact that this very model would sooner or later be replaced by a better one that might yield different implications of the same policy. We may call this additional layer of rationality 'deep rational expectations'.

Owing to the transitory nature of any economic model, an individual would therefore *rationally* choose not to place too much weight on the implications of any given model.[5] Exactly how much weight he or she does place remains *prima facie* unknown. What can be safely said, nonetheless, is that it is pretty unlikely that an individual would expect that the implied consequences of a particular given model will fully surface. By backward induction, he or she will hence not consider the rationally optimal solution of this particular model to offer a sound basis for decision making.[6]

Consider Leeper, Traum and Walker (2017) as a case in point. The authors describe their approach in the following way: 'We augment a monetary DSGE model from the class that Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2007) develop with a rich set of fiscal details ...' (Leeper et al., 2017, p. 2409). With three models mentioned in one sentence the key question now obviously becomes what model is the 'right' one for building expectations and policy simulations.

In Christiano, Eichenbaum and Evans's (2005) paper the 'right' model apparently was Christiano et al.'s (2005) model, while in Smets and Wouters's (2007) it was theirs. In both these models the rational agents maximise their respective objective functions over an infinite time horizon (Smets and Wouters, 2007[7]), while being at the same time unaware of the fact that their employed models would be outdated in no less than two or ten years respectively. This ignorance is, of course, in obvious contradiction to Lucas's admonition that no one should expect a model's initial parametrisation 'to stand forever'.

Therefore, Leeper et al. (2017) do not only invalidate Christiano et al.'s (2005) and Smets and Wouters's (2007) approaches, but they repeat their fundamental mistakes. All their agents possess the amazing skill to optimise over infinite time horizons without actually being able to look further than two years into the future. What tastes somewhat like the proverbial plank in one's eye has significant implications.

To see this, one might consider a positive fiscal policy shock. Most rational expectations models – especially of the real business cycle type – have it that the long-run effect of this shock will be no change in output, but a rise in the price level. By virtue of these models, the rationally optimal individual policy response is to raise prices immediately, thus driving the output effect to zero – even in the short-run. In light of the Lucas critique and deep rational expectations, raising prices may not be the truly rational, optimal response, however. This is simply because a rational agent would expect that newer and better models of the

[5] Alternatively, one might say that the Lucas critique requires to make the model choice to become part of the model of a rational agent.
[6] A similar idea has been developed by Frydman and Goldberg (2011, p.63).
[7] See pp. 1–3 in the online model appendix: https://assets.aeaweb.org/assets/production/articles-attachments/aer/data/june07/20041254_app.pdf)

economy will sooner or later emerge that might propose, for instance, that the best response could be not to raise prices or even to lower them.

Consequently, there is only one situation in which relying on any given model truly is the rational choice. This situation arises when the ultimate, unanimous 'true' model is at hand. Such a situation is, however, for pretty obvious reasons – neither plausible nor desirable to ever occur.[8] If the 'true' model was known, ingenious researchers like Smets, Wouters, Eichenbaum, Blanchard, Lucas, Leeper and all future generations of economists, would stop amending existing models or coming up with new ones to account, for example, for new developments such as the financial crisis. The alternative to this rather unrealistic prospect would be to, once and for all, restrict the universe of potential models to a set of models with agreed-upon properties. This alternative would, however, mean putting research in a straitjacket which would signify the end of economics as a science. Therefore, the ultimate model is not available, neither now, nor in the future.

4. Lucas-proof Squared

Deep rational expectations require that models must not only feature model-consistent expectations, but also take into account the transitory nature of the model itself. Rationality, therefore, does not only require rational expectations to be applied to the model, but also to the model choice. A model has thus to cover rational expectations within the model, as well as rational expectations with respect to model selection. This requirement adds yet another layer to the well-known Lucas critique. The problem remains, however, how to achieve that goal?

To the best of my knowledge, research has not yet produced an answer – though it is possible to tell what approaches do not work. One of those infeasible approaches is (Bayesian) model averaging, for example. Model averaging does not work because it does not solve the problem of not knowing what future, superior models will imply. So far, model averaging has only be applied and analysed with respect to known models, or known classes of models. Averaging should, however, be applied to as yet not-knowable models which is, of course, impossible.

Likewise mainly empirical models, like vector-autoregression models, may produce 'useful' forecasts, even in the presence of structural or policy shifts, but they, too, can merely serve as an approximation and tentative guide to policy analysis and optimal decision making. Their advantage might be, however, that they trade in some of the first layer Lucas critique for the second, because they tend to encompass many possible models (Sims, 1982; Lütkepohl, 2005) while not building on model consistent expectations.

It is also possible to identify two potential ways to make models truly 'Lucas-proof'. One either has to give in on rationality, or one should consider uncertainty.

The first option does not appear very attractive because it is not plausible to assume that individuals would systematically act against their own interests. Other roads, such as bounded rationality or rational inattention, also have their problems. Bounded rationality, for example, is haunted by the discomfort of assuming that a superior researcher can distinguish between complete and incomplete rationality, but an economic agent cannot. Likewise, in as far as that lack of rationality is owed to rational inattention, the item under consideration may not be interesting (enough) for the agent to bother much, so no one else should bother either.

[8] Among the less significant implications we would conclude that many economic journals would instantly cease publishing because everything that could be said about macromodels would have already been said.

The concept of (fundamental) uncertainty, however, is potentially able to reconcile rationality, model consistent expectations and the Lucas critique. Fundamental uncertainty, following the definition of Keynes (1937), emphasises the possibility of not-knowable events and hence not-knowable models. And because these events and models are not knowable, they cannot follow a probability distribution function, and it is neither possible to apply expected utility maximisation, nor Bayesian learning or averaging.[9]

Fundamental uncertainty would imply that no matter how hard we try, no economic model would ever come close enough to the true underlying fabric of the economy, simply because no such true fabric exists. Therefore, fundamental uncertainty finally elevates the Lucas critique to an as yet, not widely discussed dimension – although Goodhart (1975; 1983) already offered some clues.

'Godhart's law' may be seen as a more general formulation of the Lucas critique's positive part, because Goodhart does not only consider changes to the model triggered by private agents actions, but also changes due to shifts in the institutional environment (Chrystal and Mizen, 2001, p. 12). The key questions then become: what is the source and motivation for private or public sector action and what can be expected from them? Interestingly, both questions are tightly related as both, at a very basic level, inquire about human imagination and creativity. To the extent that it is impossible to know all possible motives and ideas humans may come up with, is it impossible to imagine all potential ways in which the resulting actions feed back into the economy. This impossibility is at the heart of Christiano et al.'s (2005) and Smets and Wouters's (2007) inability to incorporate all future amendments to their own models from the very beginning, and the consequential inconsistency between optimisation horizon and durability of their respective models.

The message of the Lucas critique is, therefore, an ontological one. It signifies the shift from the quest for some given truth, to the quest for understanding human behaviour in an environment in which humans constantly create, amend, destroy and re-create social relationships without ever arriving at invariant social laws that govern human life. This latter world view is quite obvious in contrast to the traditional ontology that assumes some underlying truth waiting to be discovered, dating back to Mill (1844), and which is also referred to by Chrystal and Mizen (2001, p. 13) in their tribute to 'Goodhart's law'.

When rejecting objective truth, the way is cleared for fundamental uncertainty – because fundamental uncertainty builds on the not-knowable, whereas rational expectations rest on assuming an underlying, objective foundation that can be discovered, or sufficiently closely approximated, provided that enough resources are invested. If, however, the relationships to be modelled do not even exist, or emerge from creative, non-predictable processes, fundamental uncertainty is the concept of choice. Therefore, the Lucas critique must eventually be regarded a trigger and motivation for a research agenda that aims at integrating fundamental uncertainty into economic analysis.

For the time being, standard rational expectation modelling should be understood as a means of facilitating decisions in the face of otherwise paralysing fundamental uncertainty. In the medium and long run, however, individual decision making under fundamental uncertainty still awaits a systematic investigation. The Lucas critique should be taken as a strong reminder to shed light on this, as yet, unexplored problem.

[9] In order to avoid confusion one should note that fundamental uncertainty must not be mistaken for Knightian uncertainty (Knight, 1921). Knight deals with known events for which probability functions exist but whose parameters are unknown and not-knowable. In contrast to that, Keynesian uncertainty deals with unknown events for which (consequently) no probability function can be given. Knightian uncertainty is, in principle, accessible to econometric analysis (Schorfheide, 2000, for example) whereas Keynesian uncertainty has not yet be shown to be accessible.

5. Conclusions

The Lucas critique has pointed out the necessity of incorporating optimal, individual decision making in economic model building. A thorough analysis of this demand shows that only deep rational expectations – which also take into account the transitory nature of all human knowledge and hence of economic models – can truly inoculate against Lucas's criticism.

Although it is still too early to fully understand the impact of deep rational expectations, a preliminary inspection of the available options seems to suggest that Lucas's critique must be understood as an urgent call for seriously acknowledging fundamental uncertainty in economic analysis and policy advice.

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Quantum Economics

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Abstract

A decade after the financial crisis, there is a growing consensus that the neoclassical approach to economics has failed, and that new approaches are needed. This paper argues that economics has been trying to solve the wrong problem. Economics sees itself as the science of scarcity, but instead it should be the science of money. Just as physicists' ideas about quantum matter were formed by studying the exchange of particles at the subatomic level, so economics should begin by analysing the properties of money-based transactions, which like quantum entities have a fundamentally dualistic nature. By building on ideas from quantum money, quantum finance and quantum social science, this paper shows that the economy is an archetypal example of a quantum social system, complete with its own versions of measurement uncertainty, entanglement, and so on. This leads to a proposal for a quantum economics, which is to neoclassical economics what quantum physics is to classical physics.

Keywords: money, quantum social science, quantum finance, quantum economics

JEL: A12, B41, B50, E40, G01

1. Introduction

It is now widely accepted that, by nature of their design, the models developed by neoclassical economists to simulate the economy – from models of financial risk used by banks, to the macroeconomic models used by policy makers – failed to predict, or even properly explain, the events of the 2007/8 financial crisis. In fact they even contributed to the crisis by creating a false sense of security. This paper argues that the reason these economic models broke down is because neoclassical economics – whose 19th-century founders were inspired by classical physics – had failed to heed the teachings and insights of quantum physics, which revolutionised physics in the early 20th century. This does not mean that economics should directly mimic quantum physics, or that all modellers need to literally adopt the formalism of quantum mechanics. Instead, the economy should be viewed as a quantum social system on its own terms, with its own versions of duality, measurement, uncertainty, entanglement and so on.

A number of papers and books have been written that suggest different versions of a quantum economics. In his 1978 paper 'Quantum Economics', the mathematician Asghar Qadir pointed out that quantum mechanics seems a better fit than classical mechanics to modelling the vaguaries of economic behaviour, given that it was developed to handle situations where a variable does not have a single 'true' state (Qadir, 1978). The fields of quantum cognition (Aerts and Aerts, 1994) and quantum social science (Haven and Khrennikov, 2013) indeed show how our decision-making, at the individual or societal level, follows a kind of quantum logic, similar in spirit to that which applies at the subatomic realm. Many (but not all) authors take pains to distance themselves from the idea that the human

brain – like a wet version of a quantum computer – itself employs quantum cognitive processes, though this question is not settled (Wendt, 2015, p. 30). A number of authors working in the area known as quantum finance, meanwhile, have shown that, for certain topics, it is possible to translate existing theorems used in quantitative finance into the formalism of quantum mechanics (e.g. Shubik, 1999; Schaden, 2002; Baaquie, 2007).

This paper takes a somewhat different or complementary approach, which is to follow the lead of quantum physicists and start with the idea of quantum (Latin for 'how much') but applied to money instead of energy. It then reconnects with the more general area of quantum social science by considering how people and institutions interact with money. Comparisons are made with neoclassical economics throughout. The aim is not to provide a survey of the quantum approach in related fields, but to show that, by building on findings from these areas, quantum economics provides a genuine alternative to the neoclassical approach.

The plan for the paper is as follows. Section 2 discusses how money effectively went missing from mainstream economics, and Section 3 introduces the quantum approach. Sections 4 and 5 go into more detail about money's roles in measurement and entanglement, and Section 6 explores the process of money creation. Section 7 discusses the relationship between quantum money and quantum social science, Section 8 considers how the quantum view of the economy differs from that presented by neoclassical economics, and finally Section 9 summarises the key results. An appendix presents some of the relevant mathematical tools.

2. The Science of Money

Economics is commonly known as the 'science of scarcity' after the English economist Lionel Robbins, who wrote in 1932 that 'Economics is a science which studies human behaviour as a relationship between ends and scarce means which have alternative uses' (Robbins, 1932, p. 15). But it seems more natural to define economics as the study of transactions that involve money – even if the topic plays a surprisingly small role in mainstream theory.

In standard textbooks, money is usually treated as an inert chip, or as a kind of metric, rather than as a substance with special properties. This goes back at least to Adam Smith, who argued that money was a distraction from what really counted, which was the exchange of goods (Smith, 1776). The economist Jean-Baptiste Say, who popularised Smith's work in France, summed this up in his statement that 'money is a veil'. Or as Paul Samuelson later put it, 'if we strip exchange down to its barest essentials and peel off the obscuring layer of money, we find that trade between individuals and nations largely boils down to barter' (Samuelson, 1973, p. 55).

Key to this assumption was that money was not a force in itself, but only a measure of some other quality. For Smith, it was the labour that had been used to produce a good; for neoclassical economists, it was defined as utility (Jevons, 1957, p. 1). In either case, since money had no important qualities of its own, one consequence was that it could be safely omitted from models. For example, the famous Arrow-Debreu model from the 1950s, sometimes known as the 'invisible hand' model because it showed that an idealised market would attain a kind of optimal equilibrium, excluded money and the financial sector altogether (Arrow and Debreu, 1954). Modern dynamic stochastic general equilbrium (DSGE) models follow this example (Keen, 2017), as do standard risk models used in quantitative finance (Wilmott and Orrell, 2017). The economy is viewed as a giant barter system, where money and finance play no central role. Nowhere is this more true than in the pivotal topic of credit

creation by banks, which – as discussed below – was ignored by most economists until very recently.

The failure of this approach was brought home during the crash, when models which did not include money or credit could not predict, or even understand, the effect of a credit crunch. Quantum economics argues, however, that money is much more than just an inert chip; instead it is a dynamic substance with complex dualistic properties that feed into, and in many ways define, the economy. Recognising this fact promises to have a similarly disruptive impact on neoclassical economics, as quantum physics did on the orthodoxy of its day.

3. Quantum Money

Neoclassical economics was explicitly based on mechanistic, classical physics. Economists such as Irving Fisher tried to show how individuals mapped to particles, utility to energy, and so on (Fisher, 1892). The central idea was that rational economic man, through the magic of Smith's invisible hand, would guide prices to a stable equilibrium which represented the optimal result for society. Quantum economics, in contrast, treats the economy as a quantum social system in its own right. Just as quantum physics grew out of studies of energy transactions between particles, quantum economics starts by examining the complex properties of money objects.

As discussed in previous works (Orrell, 2016; 2017; Orrell and Chlupatý, 2016), money objects – be they coins or bitcoins – combine the properties of abstract numbers, with the properties of objects. The fact that numbers and objects are very different – for example, you can own an object, but you can't own a number – means that money is fundamentally dualistic, and has properties not unlike those of quantum matter.

It is often said that quantum physics is highly counterintuitive. Quantum entities, such as photons, sometimes present as virtual waves, sometimes as real objects. Particles don't move continuously, like normal objects, but in sudden jumps. Quantities, such as position or momentum, are fundamentally uncertain – and their values are, in a sense, determined during the measurement procedure. Particles can be entangled so that a measurement on one instantly determines the state of the other. They can magically appear out of nowhere, and then disappear back into the void. Quantum physics, at first glance, seems to present a universe that is utterly alien to our way of thinking.

However, these properties only seem strange when we think of things like objects moving in space. When we talk about money, they are completely natural and obvious. For example, money can present as real objects, like coins, or as a kind of virtual transmission, as when we tap a credit card at a store. It is has become something of a cliché to say that 'money is not an object' but its properties certainly resemble those of a quantum entity, which has both wave and particle attributes, and for which neither description is complete. The historic argument over whether money obtains its value because of its link to precious metal (the theory known as bullionism), or because its value is based on virtual credit that is backed by the state as in chartalism (Knapp, 1924, p. 32) resembles the debate stretching back to the ancient Greeks over whether light is made of real particles or virtual waves, and which was only settled in the early 20th century when it was found that it was both.

The quality known as value is intrinsically fuzzy and indeterminate, and only takes on a fixed and settled amount at the time of a monetary transaction (you don't know exactly how much your house is worth until you sell it). Money, therefore, acts as a kind of measurement device, that puts a number on the concept of value, just like the observation process in quantum physic. Money also acts as an entanglement device, for example, between debtor

and creditor. And like elementary particles, money objects can be created out of the void – for example, when banks create money by issuing loans, but can also be annihilated and removed from the system. Money objects are our contribution to the quantum universe. The next three sections go into their properties in more detail.

4. Transactions as a Measurement Process

In neoclassical economics, price is said to be determined by the intersection of supply and demand curves, which are assumed to exist as fixed and independent entities. In practice, however, supply and demand curves can never be observed – all we have is plots of price for particular combinations of supply and demand, so the separate curves are not identifiable from the data (McCauley, 2004, p. 25). Also, given that supply and demand are dynamic and affect one another, there is no reason to believe that these curves generally exist. In quantum economics, prices are determined by the exchange of money objects, just as the position or momentum of a particle can only be determined through a measurement process which affects the particle.

As an illustrative example, consider the purchase of something like an artwork at auction. When the owner first decides to sell the piece, they will only have a fuzzy idea of how much it is worth. The price will depend on sales of works by the same artist, sales by similar artists, trends in the marketplace, the mood during the auction, the nature and quality of the particular piece, whether it captures the eye of a wealthy investor, and so on. But there will be no exact 'correct' or 'intrinsic' value – the painting doesn't come with a price tag on the back. Instead the price will be discovered during the auction process. The fundamentally indeterminate value of the artwork will therefore 'collapse' down to a single number, just like the measurement process in quantum physics, where the wave function describing the location of a particle collapses to a single number.

Of course, many things do come with a (temporarily) fixed price tag; but even here, the transaction acts to confirm the price. You might try to order a plane ticket at a particular price, only to find that by the time you have submitted your credit card details the price is no longer available. And even supposedly fixed prices are usually open to change at short notice.

Just as in quantum physics, this measurement process also has an effect on the system being measured. In physics, measuring the position of an electron by bouncing photons off it imparts momentum to the electron, so the more accurately position is known, the more uncertainty there is in the momentum (Wheeler and Zurek, 1983, p. 64). (More generally, Heisenberg's uncertainty principle states that it is impossible to know both position and momentum perfectly, not because of technical limitations, but because these quantities are indeterminate until measured.) In the same way, the purchase of something like an artwork provides a new data point for similar works, which in turn affects future prices.

As shown by the area of quantum finance, a similar effect is seen in stock markets, where uncertainty in price is resolved only at the exact time of a transaction (see Appendix A.2). More generally, it is possible to use the formalism of quantum mechanics to model hypothetical markets and deduce an explicit equation for the uncertainty. For example, Baaquie shows that under certain conditions the uncertainty in price, multiplied by uncertainty in momentum, is greater than, or equal to half, the variance (Baaquie, 2007, p. 99). However this formula relies on the idealised assumption that the price data follows a random walk with constant variance (see discussion of this assumption in Wilmott and Orrell, 2017, p. 53). One

advantage of the quantum finance approach is that it allows a degree of flexibility to relax assumptions such as perfect information (Haven and Khrennikov, 2013, p. 223).

5. Entanglements

Because mainstream economists see money as an inert chip, it pays little attention to the concept of debt. The traditional view, as summarised by Bernanke, was that debt is 'no more than a redistribution from one group (debtors) to another (creditors)' (Bernanke, 1995). In this linear view of the economy, debts and credits cancel out in the aggregate (Krugman, 2012, p. 112). As Keen points out, this is one reason central banks have been content to allow debt levels to reach unprecedented heights (Keen, 2017, p. 110). In 2017 global debt was estimated at $217 trillion, up $50 trillion over the past decade (Institute of International Finance, 2017).

In quantum economics, however, money acts as an entanglement device. In quantum physics, two particles can become entangled so that a measurement of one acts as a measurement on the other, even if the two particles are separated by vast differences – a phenomenon which Einstein famously called 'spooky action at a distance' (Einstein, Born and Born, 1971, p. 158). The field of quantum thermodynamics shows that whenever particles interact, they become entangled to a degree, effectively sharing their wave functions, which has implications for things like entropy (Linden, et al. 2009). In the same way, financial instruments such as loans, bonds or investments, act as contracts between two parties, which means that a change in one, instantly affects the other (see Appendix A.3). The debt/credit relationships in the economy, therefore, act to create an intricate web of entanglements.

These entanglements are not just numeric things which cancel out in the aggregate, but represent a power structure in the economy, which can be mapped using techniques from complexity science. One 2011 study by scientists from the Swiss Federal Institute of Technology (Vitali, Glattfelder and Battiston 2011), for example, analysed the direct and indirect ownership links between 43,000 transnational corporations, and found that fewer than 1 per cent of the companies controlled 40 per cent of the network. Another type of power relationship is that between debtor and creditor. A basic feature of debt is that it is governed by mathematical rules, such as compound interest. Being on the wrong side of this has historically been a major cause of people falling into slavery or peonage (Graeber, 2010, p. 8). Financial derivatives, such as options or credit default swaps, create another layer of financial entanglements, whose complexity defies analysis.

What distinguishes these entanglements from classical network links, is that they represent ties between abstract numbers and real assets. A debt owed on a house grows exponentially, but the house itself is located in the real world, and is subject to things like depreciation and decay. This tension between the virtual debt and the entangled real asset, and between number and the fuzzy concept of value, scales up the inherent quantum tension between the real and virtual sides of money (Orrell, 2016).

6. Money Creation

The entanglement process is seen most clearly at the moment that money is created. As a graphic example, consider the tally sticks that were a main form of payment in e.g. medieval England. This consisted of a wooden stick that was notched to indicate an amount, and then split down the middle. One part, known as the stock, was held by the state, and represented a

credit. The other part, known as the stub or foil, was given to a tax collector, and represented a debt that needed to be paid. If the state wanted to pay a supplier, it could give them the stock, which granted the holder the right to collect the debt. Tallies therefore began to circulate as money objects. But because they came in two parts, they directly entangled the debtor and the creditor; if, for example, a stock was lost or destroyed, then so was the record of the debt.

In neoclassical economics, there is little attention paid to how money is created. The main focus tends to be on quantity theory, which says that money supply should be tuned to reflect economic growth. In the conventional picture, the money supply is controlled by a central bank using fractional reserve banking: the central bank creates money by, for example, buying a government bond using made-up money. This money then goes out into the economy and ends up being deposited in private banks, which can then lend out more money, subject to a reserve requirement.

In this picture, the central bank is seen as a kind of central command node, consistent with a mechanistic viewpoint. In recent years, however, there has been a reassessment of how the process really works. The Bank of England wrote in 2014: 'The reality of how money is created today differs from the description found in some economics textbooks… the central bank does not fix the amount of money in circulation, nor is central bank money "multiplied up" into more loans and deposits' (McLeay, Radia and Thomas, 2014). Adair Turner similarly noted that 'Economic textbooks and academic papers typically describe how banks take deposits from savers and lend the money on to borrowers. But as a description of what banks actually do this is severely inadequate. In fact they create credit money and purchasing power' (Turner, 2014). The economist Richard Werner performed an empirical analysis and concluded that 'The money supply is created as "fairy dust" produced by the banks individually, "out of thin air"' (Werner, 2014).

Today, indeed, the vast majority of money (in the UK, about 97 percent) is created by private banks lending money for things like mortgages on houses (Werner, 2005; McLeay, Radia and Thomas, 2014). The money is created in the same manner as tally sticks: money is deposited in the account of the seller, but the bank retains a record granting it title over the property (the difference here is that the money is the thing which acts as the stock, while the title represents the debt that needs to be paid). Because these are of equal but opposite value, they cancel out in the aggregate, but the entanglement remains. If the mortgage holder goes bankrupt, the status of the bank's loan is instantaneously changed – even if it doesn't find out until later.

The flip side of money creation is money destruction. Money that is created from debt is destroyed when the debt is repaid, like a particle colliding with its anti-particle. One implication is that if new debts are not constantly being created, the money supply will shrink, leading to recession. Money creation and destruction are therefore at the heart of the business cycle.

Of course, it is not necessary to adopt a quantum viewpoint to refute the neoclassical picture of money creation, since other people have long made exactly the same points. The banking expert H.D. MacLeod wrote in 1856 that 'the business of banking is not to lend money, but to create Credit' (MacLeod, 1856, p. 338). Schumpeter wrote in 1954: 'It is much more realistic to say that the banks "create credit", that is, that they create deposits in their act of lending, than to say that they lend the deposits that have been entrusted to them' (Schumpeter, 1954). However, the quantum version, by focussing on the role of money, naturally draws attention to the way that money is created and destroyed; and its ideas and formalism offer a coherent alternative to the dominant neoclassical orthodoxy, which has long dominated our understanding of the economy, to the exclusion of other approaches.

7. Quantum Economic Person

Neoclassical economics was originally based on the idea that people act rationally to optimise their own utility, or expected utility, when outcomes are uncertain (von Neumann and Morgenstern, 1944). In recent years this picture has been extended somewhat using the insights of behavioural economics, however, the caricature of rational economic man can still be found in many of the models routinely used by economists, and is still taught at university-level courses (Earle, Moran and Ward-Perkins, 2016).

The field of quantum social science offers a very different conception of how people and institutions behave. While a summary of this field is beyond the scope of this paper, the basic insight is that the decision-making process is analogous to the wave function collapse of a quantum system, where the system encompasses the decision maker's mind (e.g. prior beliefs and biases) and their environment. Something like answering a survey question, or accepting a gamble, is therefore a probabilistic process similar to quantum measurement, and can be modelled using the quantum methodology (see Appendix A.1). Prior to their response, people are seen as being in a superposition of states. The measurement process selects a particular state, but also changes the system. This can be seen by the fact that, just as a measurement of a particle's position affects its momentum, so the answers to certain survey questions are affected in a predictable way by the order in which they are asked (Wang et al., 2014). Similarly, the likelihood of accepting a new gamble depends on whether a previous gamble was won or lost (Busemeyer, Wang and Shiffrin, 2015). It might appear that respondents are being inconsistent, but in fact they are following a kind of quantum logic instead of classical logic.

Decisions are also affected by context, and by entanglement. One illustration, which is very relevant for economics, is the well-known psychological experiment called the ultimatum game (Güth, Schmittberger and Schwarze, 1982). Two subjects are offered an award of say ten dollars, but are given an ultimatum: one must decide how to split the money, and the other has to decide whether to accept the offer. If the offer is rejected, all the money is returned, so they both lose. Standard theory, based on rational utility maximising behaviour, would imply that any offer would be accepted, no matter how low, because it is better than nothing. However the game has been performed in many countries around the world, and the results consistently show that people reject an offer that is overly cheap, just to stop the offerer making an unfair profit. Most offers are near to five dollars, and the typical minimum acceptable offer is around three dollars. Viewed from the perspective of quantum social science, which accounts for things like entanglement and context, this result seems less surprising, since any degree of entanglement between the two players means that the offerer can no longer 'maximize her utility' by offering the other person zero (Mendes, 2005).

Further empirical evidence for the quantum approach lies in interference effects, which occur as the result of incompatible concepts. An example is preference reversal, where subconscious preferences – such as risk aversion – interfere with the decision-making process in a manner that depends on context (Tversky and Thaler, 1990). As Yukalov and Sornette (2015) wrote: 'It is the appearance of interference terms that makes the structure of quantum expressions richer than the related classical ones and that allows one to explain those psychological phenomena that, otherwise, are inexplicable in classical decision making.'

Behavioural economists have uncovered a long series of such traits, which are generally viewed as examples of 'bounded rationality', and have devised tweaks to models in order to incorporate them. As Wendt notes, however, this idea of bounded rationality remains rooted in classical decision theory, and reflects a modified version of rational utility

maximisation. The quantum approach, in contrast, can be viewed as 'a kind of super – or "unbounded" rationality' in that it transcends classical limits by taking into account effects such as entanglement, interference and context (Wendt, 2015, p. 167). Furthermore, while any model can always be adjusted to fit the data by adding extra variables, the quantum formalism is, in fact, quite parsimonious and robust (Busemeyer, Wang and Shiffrin, 2015) and has the appealing advantage of allowing for a consistent model which can be applied to a range of situations (Wendt, 2015, p. 164). Money can be viewed as a social technology which extends this notion of mental wave function collapse to the societal idea of value.

8. The Quantum Economy

Quantum economics is, therefore, a composite of quantum money, quantum finance and quantum social science – which were developed independently, but together provide a direct alternative to the traditional neoclassical approach. It also makes very different predictions about how the economy should behave.

To summarise the vision presented by neoclassical economics, it sees the economy as being made up of a large number of independent agents, each of whom have roughly similar power, so that it is possible to concentrate on aggregates. It assumes that people make (roughly) rational choices in order to optimise their own utility, and that economic growth will therefore lead to greater societal happiness (Aldred, 2009, p. 22). Prices are represented as the intersection of supply and demand curves, which are further assumed to be fixed (for a time) and independent of one another.

Money is assumed to be an inert chip, and the financial sector is an intermediary. Models, therefore, usually exclude these, along with debt and credit, and treat the economy as an inherently stable barter system. Not only is credit creation by banks not usually modelled, it was only accepted as an empirical fact in 2014 (Werner, 2016). Such models are incapable of simulating things like financial crashes.

The economy is assumed to be fundamentally fair, with rewards roughly proportional, at least on average, to success in the marketplace. Questions of distribution are tackled only by distorting the model, and there is no settled way on how to do this. As Paul Krugman noted in 2016, 'we really don't know how to model personal income distribution' (Krugman, 2016). Olivier Blanchard wrote in the same year, that the derivation of distributional effects 'depends on the way distortions are introduced in the model. And, often, for reasons of practicality, these distortions are introduced in ways that are analytically convenient but have unconvincing welfare implications' (Blanchard, 2016).

The economy is treated as being separate from the environment, and effects such as pollution are handled as 'externalities'. To summarise, then, neoclassical economies predicts an economy which, if freed from 'frictions' such as over-regulation, monopolies and so on, will optimise happiness, is inherently stable, is fundamentally fair and can be viewed to most practical purposes as a closed system. It also lacks the tools to properly explore topics such as financial instability, inequality and environmental damage.

Quantum economics, by drawing attention to the quantum powers of money, draws a very different picture. Instead of rational economic man, we have quantum economic person – interacting with quantum money and other quantum economic people. There is no isolated 'utility function' to be optimised, instead we make choices that reflect complex entanglements. It is not possible to simply aggregate over people's emotions. The questions of happiness and economic growth are therefore separate issues, which are only loosely connected.

Money is assumed to be a substance that is active both psychologically – conflating as it does the properties of rational number and feelings of ownership – and in terms of its own dynamics. Its distinguishing property is that it provides a way of attaching number to the fuzzy concept of value. It acts as both a measurement device, and an entanglement device, which links debtors and creditors in a complex web of relationships.

The financial sector is not merely an intermediary, it is a uniquely important part of the world economy. Unlike most businesses, banks can create money anew by making loans. This is an extraordinary privilege, and one which is highly lucrative, since the money they create through debt is interest bearing. This special role also makes banks immensely powerful. It is no accident that many governments are dominated by people who came out of the financial sector; or, for that matter, that the economics profession has shown a blind eye to the process of money creation, given its own significant entanglements with the financial sector (Carrick-Hagenbarth, 2012; Häring, 2013).

The business cycle is driven, in large part, by the creation and destruction of money during financial booms and busts. Any realistic model of the financial system, therefore, needs to take these factors into account. Quantum economics puts money at the centre of its approach, instead of treating it as a 'veil' which obscures the true nature of trade. Financial bubbles are not anomalies, but expected features of the system.

Quantum economics anticipates the problem of inequality, because the economy is not a barter system and money does not flow to people on merit alone. Money has its own dynamic – in that money makes more money through compound growth and power relationships. (As Benjamin Franklin put it, 'Money is of a prolific generating Nature. Money can beget Money, and its Offspring can beget more, and so on.') On a societal level, it therefore tends to cluster, rather than spread evenly. The reason eight men now control as much wealth as half the world's population does not come down to merit (Oxfam, 2017).

Quantum economics notes that the economy, as currently maintained, is fundamentally incompatible with environmental limits. Our debt-based money system means that new money must constantly be created in order to pay the interest on the old money. This implies the need for permanent economic growth – and the easiest way to make money out of the world is to extract resources and sell them. The conflict between our economy and the environment is, therefore, as fundamental as the conflict inherent in money, between numeric price and real value. The answer is not to attempt to put numbers on nature, but instead to view the economy as a separate human institution, whose limits are ultimately determined by natural forces outside its domain.

Finally, quantum economics recognises that the economy is a reflexive system, so that theories of the economy affect the economy, just as a measurement affects the system being measured. In particular, a theory which views the economy as inherently stable will lead to its exact opposite, by creating a false sense of security, and leading to cutbacks of safeguards and protective regulations.

9. Conclusions

As seen above, quantum economics starts from assumptions that are radically different from those of neoclassical economics, and comes to equally different conclusions. Neoclassical economics is based on a fundamentally reductionist approach which attempts to derive economic models from so-called micro-foundations. The image is of the economy as an intricate machine with many moving parts. However, it achieves this by aggregating over a large number of individuals, so, for example, a country or sector might be simulated through

the use of a single representative agent, and prices determined through estimates of average supply and demand curves.

With quantum economics, concepts, such as representative agents or aggregate demand curves, are not very meaningful. It may not, therefore, be appropriate to try to build a model up from micro-foundations, any more than a weather forecaster would base their model on the quantum physics of water molecules. Instead, it makes more sense to take a complexity approach. Prices are not measuring some unique and stable quality such as utility, instead they emerge from financial transactions. A model which is appropriate at the level of individuals, cannot simply be scaled up to the macro level. Rather than attempt to build a reductionist mathematical model of the economy, it is better to take an agile approach which builds smaller models for particular situations (Orrell, 2017). Just as Heiesenberg argued, that physicists should focus on what can be observed, rather than speculate on what goes on inside an atom (Kumar 2008, p. 231), so economists should limit their use of model parameters as far as possible to those that can actually be measured.

In neoclassical economics, so-called 'market failures' such as economic inequality, financial instability and environmental degradation are treated as aberrations or externalities. Quantum economics sees all of these as intrinsic properties of the economic system, that are caused, in large part, by our use of debt-based money. To tackle these issues, we therefore need to examine the money system in more detail and see how it can be improved. One solution which has been proposed by a variety of economists, for different reasons, is that of full-reserve banking, where money is created debt-free by the state (Soddy, 1926). Barring that, private banks should be viewed as money creators rather than financial intermediaries, and regulated accordingly – so that credit is directed towards productive uses, rather than asset bubbles (Werner, 2016).

Because neoclassical economics treats the economy as a mechanistic system, there has been little role for ethics – either as they relate to decision-making in economics, or to the profession itself (DeMartino and McCloskey, 2016). Quantum economics, in contrast, sees the economy as an entangled living system where individuals and institutions have broader responsibilities to each other, and to society. Finally, quantum economics is inherently pluralistic in the sense that, because it does not see the economy as a utility-optimising machine, it is open to different ideas about the kind of choices that will lead to the good society. The aim is not to further mathematicise the subject, or replace the classical mechanics mimicked in neoclassical economics with a quantum version. Instead, it is to treat the economy as a kind of quantum social system in its own right, with modelling tools adapted for its needs.

This paper has only presented the core ideas of quantum economics, and putting these into practice will obviously be a major project. Techniques such as DSGE models will not be compatible with the quantum approach, but there are plenty of suitable options, such as agent-based models (where the agents may be quantum, see Orrell, 2018, p. 201), network models, and nonlinear dynamics models (Bruno, Faggini and Parziale, 2016). In principle at least, the success of the theory will depend on its ability to make accurate predictions. Physicists initially adopted quantum theory, not for its theoretical appeal, or because they could directly observe how subatomic particles behaved, but because they were compelled to do so by its ability to simulate a number of puzzling experimental results. In economics, the situation is much simpler because we *can* directly observe how money behaves (we invented it), and see its effects scale up through money creation and financial entanglement. Instead of deducing the laws of nature from experiments, we are deciding on the correct mathematical framework for a designed social technology or institution. The

empirical evidence for something like entanglement through a loan, lies not in subtle statistical signals, but in the wording of the contract.

Empirical backing for quantum cognition, meanwhile, is provided by experimental evidence for things like the order effect. In his 1978 paper – written before behavioural economics had even been founded as a field – Qadir posited that a consumer's choice 'will depend, among other things, on the order in which his requirements for various commodities are found out'. Some 36 years later, an *Economist* article on tests of quantum cognition (whose author was apparently unaware of Qadir's article) could confirm: 'what is clear is that the kind of judgments we make when responding to a survey are not simply read out of our memory, but are dependent on our cognitive state (which may be highly uncertain) and the context in which it is operating (which can be influenced by question ordering, among other factors). In other words, the cognitive equivalent of those puzzling phenomena that led physicists to develop quantum theory in the first place more than a century ago' (Anonymous, 2014).

Of course, factors such as the difficulty of making controlled experiments, mean that the role of prediction is a little different in the social sciences; neoclassical economics has remained in place for a century and a half, without much of a predictive track record to boast of, and failed completely during the recent crisis – which suggests that prediction isn't really the test. Instead a theory is likely to be accepted if it tells a story which benefits a powerful constituency, either within the profession or outside it (e.g. the government, the financial sector). For quantum economics, its natural constituency is perhaps similar to that which fuelled the anti-nuclear protests: people who have lived through the recent financial crisis, and want to prevent it from happening again.

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Appendix: Overview of the mathematics of quantum economics

A.1. The Hilbert Space and Quantum Cognition

This appendix gives a brief introduction to some of the mathematical techniques related to topics discussed in the paper, including quantum cognition, quantum finance and entanglement through debt.

Perhaps the most basic mathematical tool in quantum theory is the concept of the Hilbert space, which is named for the German mathematician David Hilbert (1862-1943). A Hilbert space *H* is a type of vector space whose elements, denoted $|u\rangle$, have coefficients that can be complex numbers. The dual state $\langle u|$ is the complex conjugate of the transpose of $|u\rangle$. The inner product between two elements $|u\rangle$ and $|v\rangle$ is denoted $\langle u|v\rangle$, and is analogous to the dot product in a normal vector space, with the difference that the result can again be complex. The outer product is denoted $|u\rangle\langle v|$, and is like multiplying a column vector by a row vector, which yields a matrix. The magnitude of an element $|u\rangle$ is given by $\sqrt{\langle u|u\rangle}$, and two elements are orthogonal if $\langle u|v\rangle = \langle u|v\rangle = 0$. The Hilbert space can therefore be viewed as a generalisation of Euclidean space, with the difference that there can be an infinite number of

dimensions (though conditions apply), the basis need not be simple column vectors, and coefficients can be complex.

An operator $\hat{A}$ is a map which sends one element $|u\rangle$ of *H* to another element $\hat{A}|u\rangle$ of *H*. For example, the projection operator is defined as $\hat{P}_u = |u\rangle\langle u|$, and $\hat{P}_u|v\rangle = |u\rangle\langle u|v\rangle$ gives the projection of *v* onto *u*. Operators $\hat{A}$ and $\hat{B}$ do not generally commute, so $\hat{A}\hat{B} \neq \hat{B}\hat{A}$. A state $|u\rangle$ is an eigenvector of $\hat{A}$ if $\hat{A}|u\rangle = \lambda|u\rangle$ where λ is the associated eigenvalue. For example, $\hat{P}_u|u\rangle = |u\rangle\langle u|u\rangle = \lambda|u\rangle$, so $|u\rangle$ is an eigenvector of $\hat{P}_u$ with eigenvalue $\lambda = \langle u|u\rangle$. The expectation value of a linear operator $\hat{A}$ in the state $|u\rangle$ is given by $\langle u|\hat{A}|u\rangle$, i.e. the scalar product of $\langle u|$ with $\hat{A}|u\rangle$.

A key feature of quantum theory is that observables, such as a particle's position or momentum, are represented by Hermitian operators, which have real eigenvalues.[1] Instead of being passive elements, as in classical theory, they are operators that ask a question of the system. During a measurement of an observable, the system state $|S\rangle$ collapses to one of the eigenvectors of the associated operator, with a probability given by the square of the projection of the state $|S\rangle$ on that eigenvector.

To see the difference between the classical and quantum approaches, in the context of human cognition, suppose that a person has a choice between a certain number of possible options. In classical probability theory, each choice *u* would be treated as a subset of the set *U* consisting of all choices. A person's cognitive state is represented by a function *p* with the probability of choosing *X* given by *p*(*u*). As a simple example, *U* could consist of two choices *u* and *v*, with respective probabilities *p*(*u*) and *p*(*v*), that satisfy *p*(*u*) + *p*(*v*)= 1.

In quantum cognition, a choice in response to a particular question is treated instead as an element (e.g. vector) $|u\rangle$ of a Hilbert space *H*, and a person's cognitive state is represented by an element $|S\rangle$, both of length 1. (The state $|S\rangle$ is sometimes called a wave function, although here it is static rather than time-varying.) Here the associated operator $\hat{P}_u$ is the one that projects vectors onto the vector $|u\rangle$. The probability of the answer to the question being $|u\rangle$ is then given by the magnitude of the projection squared, which is $|\langle u|S\rangle|^2$.

This shift, from sets of elements to geometric projections, allows for more complicated probabilistic effects such as non-commutativity and interference, which are characteristic of human cognition. For example, projecting onto $|u\rangle$, and then onto $|v\rangle$, may not give the same result as when the order is reversed, which compares with the 'order effect' in surveys.[2] The Hilbert space therefore appears to be the natural framework for simulating cognitive phenomena, and researchers have amassed a considerable number of empirical findings to back up that claim (Bruza et al., 2015).

A.2. The Quantum Market

In the same way that a person's cognitive state can be simulated as a member of a Hilbert space, so we can do something similar for the economy as a whole, and model it as a collection of interacting particles in a Hilbert space. As a starting point, we will consider a simplified financial market. Following (Schaden, 2002), suppose that the market consists of a collection of agents (investors) *j* = 1, 2, ..., *J* who buy and sell assets of types *i* = 1, 2, ..., *I*. Each agent holds cash (or debt) x^j. The market can be represented as a Hilbert space *H*, with the basis

[1] A Hermitian operator is one which equals its Hermitian conjugate, which for a matrix operator is defined as the complex conjugate of the transpose, so $A = A^\dagger \equiv (A^T)^*$.

[2] For the 2-D case the coefficients can be assumed to be real rather than complex, see (Moreira & Wichert, 2017). For a worked example, see the web application available at https://david-systemsforecasting.shinyapps.io/ordereffect/.

$$B := \{|x^j, \{n_i^j(s) \geq 0, i = 1, .., I\}, j = 1, .., J\rangle\}.$$

Here $n_i^j(s)$ is the number of assets *i* with a price of *s* dollars that are held by investor *j*.

An individual basis state represents a market where the price of every security, and the cash position of each agent, is known precisely. The basis states are orthogonal in the sense that if the market is in the state $|m\rangle$ then it cannot be in a different state $|n\rangle$, so if $m \neq n$ then the inner product $\langle m|n\rangle = 0$. In general the market state (wave function) *M* is never known this accurately and is instead represented by the linear superposition of basis states $|n\rangle$ in *B*:

$$|M\rangle = \sum_n A_n |n\rangle$$

where the A_n are complex numbers, and $w_n = |A_n|^2$ is the probability that the market is in the state $|n\rangle$. The phases of the A_n are left unspecified at this stage, but are key to understanding effects such as interference.

If we define the ground state $|0\rangle$ to be a market where agents hold no assets including cash, then we can build up a real market by transferring cash and assets to agents. The approach is the same as that used in many-body quantum mechanics to simulate the behaviour of a collection of bosons, so shares are added or removed from an agent's account by the use of the so-called creation operator $\hat{a}_i^{\dagger j}(s)$ and the annihilation operator $\hat{a}_i^j(s)$. Money creation is handled using a translation operator of the form

$$\hat{c}^{\dagger j}(s) = \exp\left(-s\frac{\partial}{\partial x^j}\right)$$

which increases the amount of cash held by agent *j* by *s* currency units. Similarly the Hermitian conjugate operator $\hat{c}^j(s) = \hat{c}^{\dagger j}(-s)$ lowers the cash holding of agent *j* by the amount *s*.

We can build up an arbitrary market state from the vacuum state by using these operators to successively transfer cash and securities to each agent. To study how the market wave function evolves with time, we write

$$|M\rangle_t = \hat{U}(t, t_0)|M\rangle_{t_0}$$

where $\hat{U}(t, t_0)$ is a unitary linear operator. The dynamical behaviour of the system is driven by a Hamiltonian $\hat{H}(t)$, which as in classical physics represents the total energy of the system. This satisfies the Schrödinger equation

$$i\frac{\partial}{\partial t}|M\rangle_t = \hat{H}(t)|M\rangle_t.$$

It is then possible to develop Hamiltonians for things like cash flow, the trading of securities, and so on. As shown by Schaden and other researchers, these in turn can be used to derive statistical properties of markets (see the original paper for details).

The variables of the system can be loosely interpreted in terms of physical analogies. The price *s* of an asset (or more correctly its logarithm) is like position. As in physics, there is an uncertainty relation involving asset price, and the momentum of the price change. The creation of money or assets adds energy (as measured by the Hamiltonian) to the total

energy of the system. The same techniques used to study many-body quantum systems can then be applied to make predictions about market behaviour, either in closed form or by explicitly modelling each agent.

As a simple example of a Hamiltonian in finance, consider the case of a savings instrument containing an initial amount of cash x_0 which accumulates at an interest rate *r*. The classical Hamiltonian for this system is

$$H = rxp$$

where (in classical notation) *p* is the conjugate variable of *x*.[3] We then have

$$\frac{dx}{dt} = \frac{\partial H}{\partial p} = rx$$
$$\frac{dp}{dt} = -\frac{\partial H}{\partial x} = -rp.$$

Solving then gives

$$x = x_0 e^{rt}$$
$$p = p_0 e^{-rt}$$

which implies that the Hamiltonian is constant in time:

$$H = rxp = rx_0 e^{rt} p_0 e^{-rt} = rx_0 p_0.$$

Note that changing p_0 doesn't affect the result for *x*, so we can set $p_0 = 1$ which means that $p = e^{-rt}$ is the value of one unit of currency discounted to time $t = 0$.

To quantise the system, we replace the Hamiltonian *H* and classical variables *x* and *p* with operators. Because the Hamiltonian must be Hermitian, we need to write it in a symmetric form as

$$\hat{H} = \frac{r}{2}(\hat{x}\hat{p} + \hat{p}\hat{x}).$$

Standard techniques can then be used to show that the probability distribution of the cash holdings matches that expected from the classical case (as Schaden notes, the quantum approach only comes into its own when future returns are uncertain). In the case of a single cash transfer of a quantity *s* at time $t = t_0$, the Hamiltonian becomes $\hat{H}(t) = s\delta(t - t_0)\hat{p}(t)$ where the delta function $\delta(t - t_0)$ has the value 1 at $t = t_0$ and 0 at other times.

The cash flow model treats the account as a black box which magically produces money at a fixed rate *r*. There are no inputs or outputs, which is why the Hamiltonian remains constant even as the nominal amount of money increases indefinitely. While such isolated systems do not exist in reality, the simple model is instructive about how inflation occurs in something like a housing market. As emphasised in quantum economics, money is created by private banks every time they issue a mortgage. If we assume mortgage lending continues at a steady rate, then the money supply will grow at some constant rate *r*. If this money is then used to bid up the supply of houses, then house price growth will track money supply growth, even if the real value of homes remains unchanged.[4]

[3] See e.g. (Bensoussan, Chutani and Sethi, 2009).
[4] As an example, Figure 3 of (Orrell, 2018) shows that both house prices, and a broad measure of the Canadian money supply, grew at an annual rate of about 6.5 percent in the period 1999 to 2017.

An important difference between cash and a security is that while money is a conserved quantity during transactions, a security once bought evolves into a superposition of states, each of different prices, with amplitudes specifying the probability of selling at that price. If markets are assumed to be large and nearly efficient, then the results generally approximate those produced by the classical approach. (Indeed, researchers have so far largely tended to respect classical assumptions such as efficiency, in an attempt to replicate known results.) However quantum effects become more important for markets that are thinly traded, and the quantum approach can also be used to describe markets driven by investor sentiment, where there is a significant degree of entanglement between market participants.

A.3. Entanglement

As discussed in the paper, a key advantage of the quantum approach in economics is that it provides a natural framework for thinking about financial entanglement through loans and derivatives. To first motivate the discussion, consider the physical example of a pair of entangled electrons, denoted 1 and 2, each of which has spin ½ when measured along a particular axis, but in opposite directions. The spin part of their wave function can be written as a superposition of two states:

$$|S\rangle = \frac{1}{\sqrt{2}}\,|1\uparrow\rangle|2\downarrow\rangle - \frac{1}{\sqrt{2}}|1\downarrow\rangle|2\uparrow\rangle$$

where the arrow indicates the direction of spin of each electron.

The wave function tells us nothing about the direction of spin for either electron, only that they are opposite, so the total spin is zero. Now, suppose that we measure the spin for electron 1. We would expect an equal chance of getting a positive or negative result. If it is the former, then the system must have collapsed to an eigenstate with positive eigenvalue, so is of the form

$$|S\rangle = |1\uparrow\rangle|2\downarrow\rangle$$

A measurement of particle 2 can now yield only a negative result. The reason is that the wave function describes the system, including both particles, so a measurement on one is equivalent to a measurement on the system as a whole.

The financial version of entanglement can be expressed using a similar formalism. Instead of two entangled electrons, consider two people entangled by a loan contract; and instead of spin direction, we will use loan status (i.e. 'default' or 'no default'). As in quantum cognition, the debtor is modelled as initially being in a superposition of two states, with a decision acting as a measurement event. The loan status can therefore be expressed by a wave function of the form:

$$|S\rangle = \alpha\,|1\uparrow\rangle|2\downarrow\rangle - \beta|1\downarrow\rangle|2\uparrow\rangle$$

Here α^2 and β^2 add to 1, and give the probability of default $|1\uparrow\rangle|2\downarrow\rangle$ and no default $|1\downarrow\rangle|2\uparrow\rangle$ respectively, so reflect the debtor's propensity to default at a particular moment. If the debtor decides to default on the loan, that acts as a measurement on the system as a whole. At any time after that, if the creditor decides to assess the state of the loan, the result can only indicate default. The two parties are thus entangled.

Of course, systems can be correlated without any need to invoke quantum effects.[5] However the key point is that we are treating the debtor's state regarding the loan as being in a superposition of the two states 'default' and 'no default'. The state of the loan is therefore indeterminate (we don't know whether the debtor will default) yet still correlated, which is the essence of entanglement.

Another possible objection is that, after one of a pair of entangled particles has been measured, the second doesn't need to check with the first to find out what its state is; while with a loan the creditor does. However the wave function equation applies to the loan agreement, which is an abstract thing that encompasses both parties. So from the point of view of that wave function (which again is what we are modelling) the state does change instantaneously; it is only measurements that take time. The difference between the physics version, and the financial version, then reduces to a question of the nature and reality of such wave functions, which would depend on one's interpretation of quantum theory, and is a topic of debate for both physicists and social scientists.[6] But from a mathematical modelling perspective the two are the same.

One feature of the system is that, unlike for electrons, there is now only one axis of measurement. This means that the behaviour of a loan agreement is much less subtle than the physical version (though some social scientists do argue for rich versions of mental entanglement based on physical principles); and also that it is not possible to reproduce Bell-type experiments, where entanglement is tested by changing the orientation of the axis. However Bell's experiments do not define entanglement, but were devised as a way to tease out entanglement for systems that cannot be queried more directly. For loans, the entanglement is encoded by the terms of the agreement. Again, the equation applies only to the loan agreement, so default may for example be followed by a complex negotiation, but the same is true in a physical system where other forces can also come into play.

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[5] For example, suppose I have two beads, one red and one blue, and I give one to a friend without looking. Then if I check and find that I have the red one, I know that my friend has the blue one.

[6] A widely discussed example is whether Xantippe, the wife of Socrates, became a widow the instant her husband was forced to commit suicide, or only when she found out later. See Wendt, 2015, p. 194.

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Computational Agents, Design and Innovative Behaviour: *Hetero Economicus*

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Abstract

For too long, a majority of economic stories speak of perfectly informed, fully rational optimisation within a purely materialistic world – leaving a lack of evidence and explanation regarding human decision makers and entrepreneurs revolutionising the decision space. Strands like game theory and institutional economics have already adopted a more practical view. Evolutionary and behavioural economics were finally able to establish the necessary links to other disciplines – like psychology and informational science. This paper recaps selected parts of the literature that favour a conceptional view of computational agents. Firstly, we invite economic modellers to question the microfoundation of their assumptions with regard to the individual or to an aggregate level of human behaviour that they truly refer to. Secondly, we illustrate the potential, as well as the limitations, that computational agents exhibit – with regard to the incorporation of creativity as the main source of innovative behaviour. Thirdly, this rather superficial collection of ideas serves as a position paper for future approaches.

Keywords: computational economics, *hetero economicus*

JEL classification: D01, D90, B91

1. Introduction

Arguments in favour of agent-based modelling often relate to corresponding critiques of other, more common, approaches in economic science. To benefit from the advances provided by agent-based models, therefore, we need a fundamental change in perspective – not least on economic agency. According to Jason Potts (2001, p. 111), engendering 'a plausible and scientifically interesting model of economic agency' is what 'orthodox microeconomics' has never accomplished. His attempt to substitute the one-dimensional *homo economicus* with his scheme of *hetero economicus* certainly requires a new evolutionary perspective. But with regard to its formalisation and representation, it still suffers from the constraints of economics.

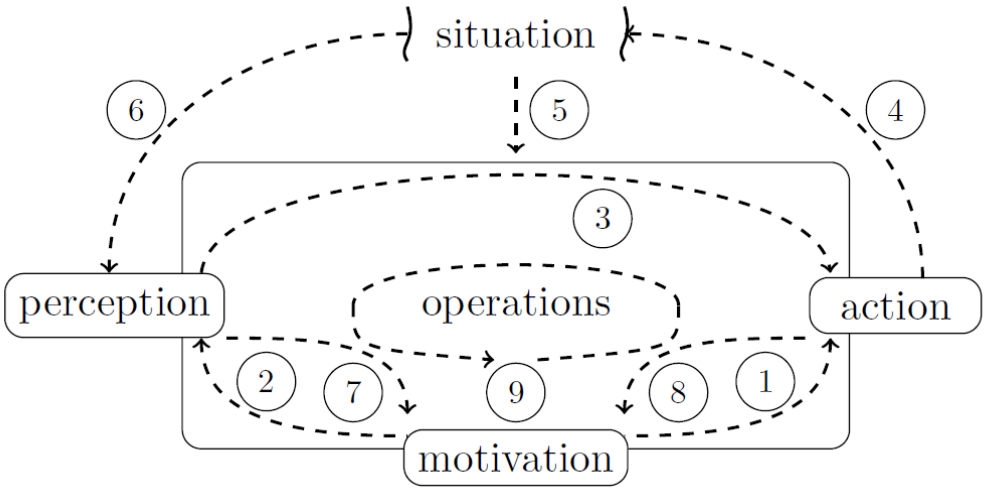
Fifteen years before Potts, Herbert Simon (1976a, p. 66) indicated that a real change in perspective implies that 'an economist should acquaint himself with the psychological literature on human cognitive processes or human choice'. Now, fifteen years since Potts and thirty years since Simon, I intentionally do not tie in with their formalities, nor do I directly aim for a new, formal description of economic agency. Instead, I allow myself to step outside existing boxes and remain conceptional: to pick up some ideas from other disciplines and sketch their potential relevance for agent-based models. I capture and name considerations that modellers may – or at least should – have in mind when they design computational agents representing socio-economic entities (see section 2). It may help to critically question the extent of individual or aggregate human behaviour that a certain model can truly capture, and which assumptions it explicitly, or – especially by neglect – implicitly, refers to. Because

creativity is one of the key features that differentiates artificial intelligence from the human mind, I add some considerations with regard to the potential (and limitations) of incorporating innovative behaviour (see section 3). The whole paper can be seen as a hint about how far the economic discipline will, in the future, incorporate computational agents, design and innovative behaviour. My focus on computational agents is based on the belief that simulations are the most important way to model the complexities arising from adopting more realistic assumptions about human behaviour (cf. Novarese, 2004, p. 23), which must form the basis of economic agency.

2. The Agent's Design

Agents, in agent-based models, are confronted with decisions and solve them according to certain rules and procedures. Describing an agent, therefore, requires more than an itemisation of its final choices. Especially with regard to economic behaviour, the visible, end choices probably represent just the final steps within a more comprehensive series of considerations. According to Simon (1976b, p. 130) we must carefully consider the deliberation process that the agents perform in order to make their decisions, before making assumptions and related explanations.

Figure 1 The operating structure of an agent



In 1974, Wersig (pp. 55–57) suggested a corresponding idea for agent design by applying Stachowiak's (1964; 1965) approach for a cybernetic model of the human organism. Neither Wersig nor Stachowiak had an economic focus, but implicitly identified the importance of an operating structure as the central point of contact (see figure 1). Picking up and just slightly adapting this so-called Kybiak-model, internal operations have to process individual perception in order to prepare autonomous actions. This is one kind of operation – internal to the agent (①②③⑦⑧⑨) – to be discussed later. The term 'operation' thereby captures different procedural connections within the agent's operating structure. One human decision maker is just one subsystem of an economy formed by many. Further operations, therefore, have to be considered that deal with the interaction and interdependency among them (④⑤⑥). They link the individual agent to the situation of the world an agent is embedded in,

and part of. External feedback can affect both the situation collectively shared within the agent's environment, and the situation as it is individually perceived. So far this suggests an intelligent agent, situated in an environment, perceiving and acting 'in order to achieve its delegated objectives' (Wooldridge, 2013, pp. 4–5). It is these delegated objectives that underline that there has to be a guiding reason for perceiving and acting in a certain way: the agent's *motivation.*

In order to avoid any confusion of terms, I will refer to several particles of information available, recorded and processed in a model, and thereby in the operating structure, as 'informational elements'. The selection of informational elements to be considered for the set of an agent's perception, motivation, operations and action space – depends on the individual model.

2.1 Motivation – Roots, Renunciation and Recurrence

As Wersig (1974, p. 56) himself stated, the consideration of motivation as a term is not least founded on psychological theories. Probably the most important theory of motivation available in those days was the hierarchy of needs by Maslow (1943; 1954; 1969). Treating needs as key motives at that point seemed adequate – not only for psychologists. A corresponding connection to economics was identified even earlier in time by Brentano ([1908/1924] 2003) and, probably more famously, by Gossen (1854). Unfortunately the latter is remembered in mainstream economic theory nearly exclusively with regard to utility and maximisation. It is utility maximisation also that represents the sole motivation – as well as operation – of an agent called *homo economicus*. At least implicitly, this agent is the main actor in mainstream microeconomic teaching. The narrowness of its operating structure may be shown by a simplified, but typical example with regard to the previously mentioned design (see figure 1): facing resources and market characteristics ⑥; restricted to the choice of output level ①; endowed with the goal of profit maximisation ②; calculating the optimal amount to produce ③; providing it in favour of aggregate supply ④.

Whether it is profits, utility or welfare that the agent of interest tries to maximise, the rather deceptive conclusion remaining says: microeconomics is about the optimal use of scarce resources (cf. Estrin, Laidler, and Dietrich, 2008, p. 1; Snyder and Nicholson, 2008, p. 6; Pindyck and Rubinfeld, 2009, p. 27). This conclusion is in no way wrong, but its exclusivity disclaims several strands of specialisation within the economic discipline. Focussing soley on optimisation refuses to acknowledge the roots of economics in general. As it is still written in introductory literature today, economics – and thereby economic science – deals with those human activities that serve the satisfaction of needs (Wöhe and Döring, 2008, p. 1). This is the fundamental level where microeconomics has to step in.

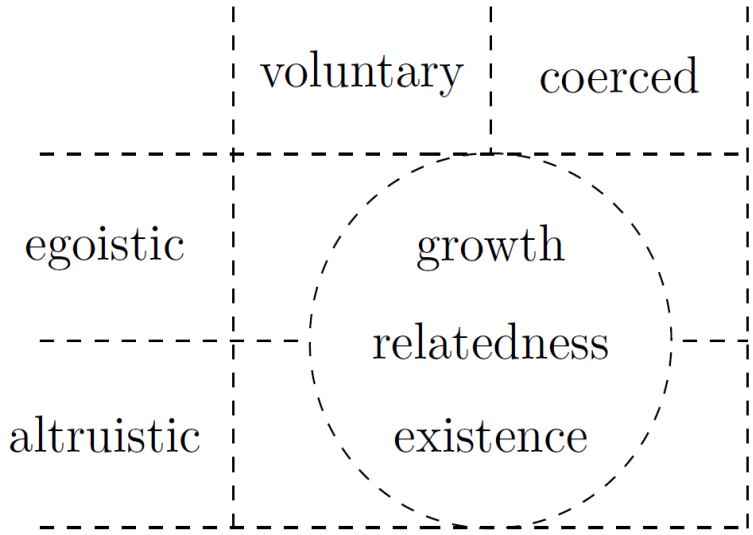
An economic agent's motivation is therefore best described by its key motive: the satisfaction of needs – the distinctive and delegated objective of Potts' (2001, p. 113) *hetero economicus*. It heralds the renunciation of the one-dimensional utility framework. It is not that all modern textbooks totally neglect the existence of needs, other than a person's own material ones (cf. Burda and Wyplosz, 2009, p. 109, Gibbons, 1992, p. 130). However, assuming that all kinds of needs and preferences are transformable into one dimension implicitly assumes that they can all be totalled – as well as substituted. This perspective risks missing the fact that different needs may be of different urgency and require different mechanisms to satisfy them – and that they may even exclude one another. It, therefore, is the consideration of complementary categories of needs that helps us understand the spectrum of motivation by true heterogeneity. Heterogeneous and complementary needs are what the entertainment industry has applied to their computational agents for some time now

(The Sims, Tamagotschi, etc.) – so social and economic science should at least try to close the gap.

When it comes to the categorisation of different needs, another psychologist, Alderfer (1972), refers to three hierarchically ordered types: existence, relatedness and growth. They provide a still-simplified, but thereby feasible, guide for approaching a higher level heterogeneity of motives in economic models (see figure 2). To emphasise the need for such heterogeneity, just think of fundamental economic variables – like final demand and labour supply, or even savings and investment. Accumulation of wealth and the expansion of a business may be suggested by books, or be driven by an individual's desire for power, or just self-actualisation. A job may allow for identification with an occupation and colleagues, or may not; it may allow for individual fulfilment or may not; it may provide a long-term perspective or just be terminable. Consumption also partly serves to define who we are and what social groups we belong to (cf. Giddens, Fleck, and Egger De Campo, 2009, pp. 216, 298, 308, ..., 711, 741–749). Economic decisions are far-reaching and cover the whole spectrum – from existential needs to needs of relatedness and growth.

Speaking of the previous examples, the goods purchased, the amount of hours spent working in a job, and the size of a business – may not be a choice made from an indefinite and continuous decision space. This suggests that we consider the possibility that not all decisions are completely voluntary, and they may not be purely egoistic. Motivational structures are not necessarily restricted to self-interest and free will, but also take the form of altruism, or even coercion (cf. Kasper and Streit, 2005, pp. 61–63). It all helps determine microeconomic behaviour based on certain levels of needs (see fig. 2). Microeconomics, therefore, is more than the derivation of optimal consumption bundles, production levels and corresponding equilibria in markets. The theoretical discussion should, in fact, start with the question – why to produce and consume in the first place.

Figure 2 Exemplary categories of needs and motivational structure



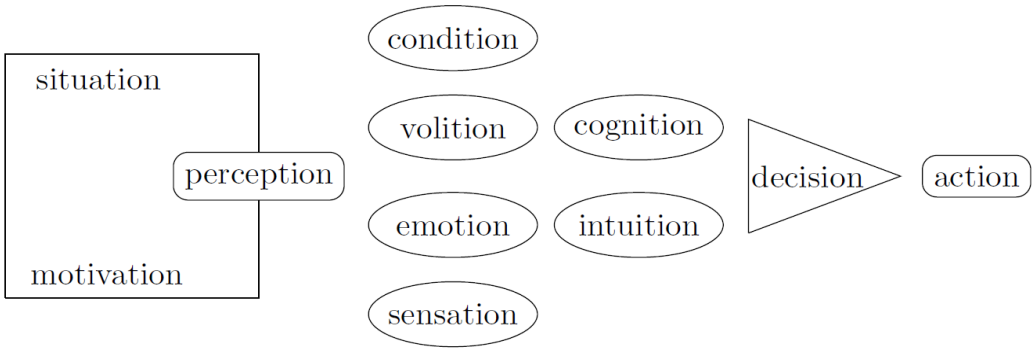
2.2 Operations – Dependencies and Behaviour

Given the motivation of an agent, the determination of an agent's behaviour has to be defined. Again I refer to the operating structure of the suggested design (see figure 1). The first challenge is to consider that an intrinsic motivation may pass some *transduction* or

transformation on its way to the agent's perception ②. The agent might perceive some vague state rather than a distinct and numbered dissatisfaction of needs. For example, the agent might just sense hunger instead of identifying the exact amount of calories to eat. Speaking of rudimentary motivation systems, as well as *sensation*, the importance of *emotion* cannot be neglected. Applying Murray's (1938) model of human behaviour, the emotion is determined by the combined effects of personal needs and environmental pressure. Emotions then are considered as the interface between those two forces (Heckhausen and Heckhausen, 2010, p. 59). Both sensation and emotion, as well as their partly unsettled evolution over time, are almost never considered in economic models.

Considering sensation and emotion as something feeding the perception of the agent, I am tempted to say that many economic models simply set in one step later. Populated with elaborated and rational agents, these models dare to focus just on the the main task of a human decision maker and thereby represent the intelligent agent: decision making ③ – both reactive and proactive (cf. Wooldridge, 2013, p. 8). According to a common evolutionary perspective, the decision process may be separated according to three principles: the *categorisation* of the perceived and accessed elements, the *prediction* of possible outcomes based on potential decisions, and finally the *selection* of an action (Lesourne, Orléan, and Walliser, 2006, p. 39). All these steps, and maybe more, have to be considered when trying to apply the phenomenon of choice mentioned by Potts (2001, pp. 116–117) in order to describe his *hetero economicus* as an algorithmic man. However, decisions can be made in different ways and be based on different intensities of deliberation. Linking psychology with behavioural economics, Kahneman (2003, p. 1451) provides a useful perspective on human rationality. He suggestions decisions may be based on intuition on the one hand, and reasoning on the other. Intuitive decisions are rather fast, automatic and emotional responses, while reasoning occurs comparatively slowly and with more control. Similarly, but in a little more detail, Rubinstein (2007, p. 1245) differentiates between cognitive reasoning, instinctive behaviour and reasonless action based on random processes. A model of a human decision maker, therefore, must consider both *intuition* as well as *cognition* (see figure 3) to allow the model to build a complete picture of personal typologies based on psychology (cf. Jacobi, 1987, p. 21). Accepting the ability for cognitive reasoning also requires the model to represent the complexity and reflexivity of the agent it implies. The operational structure described so far is not just a one-way, check-in / check-out system. Instead, the psychology of human decision allows for *volition*. This means that the agent is able to form its own intermediate goals – and can perceive and pursue them. In addition, the agent is able to reflect on what they perceive. At least implicitly assumed in economic models and theories (cf. Davis, 2016, p. 2), the complex and reflexive way of processing input is a key feature of human decision makers and their economic behaviour in the aggregate. In order to emphasise this interlinkage between internal and external input, as well as the spectrum from emotion to cognition, models of education and pedagogy also mention social and societal *conditions* (cf. Illeris, 2006, pp. 30–31). While the agent is a complex system of its own, it is highly dependent on the systems surrounding it, and vice versa.

Figure 3 Dimensions addressed by internal operations on the way from perception to action



Many have considered this interdependence as important and suggested ways to identify the ineradicable social element in the economy (cf. Arrow, 1994, p. 2). It is obvious that interaction – like exchange – is an ineradicable social element in market economies, however, there are many more. Market economies are built on institutions like every other social and economic system, and these institutions are highly relevant for the decision process. Some even say that 'rational deliberation is not possible except through interaction with the fabric of social institutions' (cf. Hodgson, 2003, p. 163). So from perception to action – and even motivation, the social framing of the agent is determinant. Simple examples for this interdependency may be given by fundamental laws and norms that an agent is aware of, and confronted with, when it is deciding about its behaviour (cf. Fishbein and Ajzen, 2010, pp. 120–123). These norms and institutions may not just be *perceived*, but over time even *adopted* as an intrinsic, and thereby even motivational, value ⑦. The agent's operating structure then may exhibit some explicit or implicit value system consistent with its set of motives, that directly affects its decision making and corresponding action ①. A practical example may be that some need for relatedness can exclude the execution of some condemnable deeds. And so corresponding operations might derive a set of actions that is consistent with permissions and obligations taken as given. They determine a pre-selection of decision nodes and actions (cf. Dignum and Padget, 2013, pp. 73–77). With regard to the step-by-step complexity of cognitive processes, such dominant tendencies might point to the *will* and *beliefs* of an agent. The operating structure must also consider examples where the decision in favour of an action alone may provide some satisfaction, independent of its actual impact on the situation – ⑧ thereby affecting the motivational state of the agent.

Another category of operations must address the case where the system integrity of the agent is questioned. The agent's design must consider a possible lack of immunity of the operating structure itself against external situational influences ⑤. Such influences may affect several operations internal to the agent, as well as several sets of informational elements – distorting the perception, restricting the practicability of actions or even triggering special needs and thereby motivation. This type of operation could be labelled as *manipulation*. With regard to human decision makers, a colourful example is given by drugs or other dependencies. Other stress factors may be provided by special physical or psychical treatment or the neurological activation of certain areas in the human brain. With regard to all discussed operations – and a potential instability of these – neuroeconomics may give important insights and suggestions for incorporation (cf. Glimcher and Fehr, 2014). To consider forces causing instability in an agent's set of operations seems counter intuitive because they restrict the autonomy of intelligent agents having 'control both over their own

internal state and over their behaviour' (cf. Wooldridge, 2013, p. 5). But trying to create a model representative of human decision makers whilst neglecting the vulnerability of an agent's autonomy – would by naive.

When discussing the potential distortion in the set of operations itself, one also has to discuss its evolution: issues like learning, memory and introspection play an important role. Internal operations responsible for *conservation* or *mutation* refer to the process of saving and adapting informational elements in the individual data store representing an agent's knowledge and maintaining its internal state (cf. Salamon, 2011, p. 77). Internal operations can also be responsible for influencing themselves, so the operating structure itself has to be seen as a partly endogenously evolving and changing system ⑨. There is the link to another part of cognition (discussed in more detail in section 3) – imagination, creativity and problem solving. When a human decision maker is hindered from executing an action, or the actual outcome of an action does not equal the expected outcome, there are more options than bullheadedly following fixed algorithms of behaviour. Instead, mutation allows the generation of new solutions. Potts (2001, pp. 117–124) talks about 'dynamic operators as genetic algorithms' and 'mechanisms governing the process of evolution' and discusses preferences, skills or competences adopted by an agent.

All together this suggests that perception serves as a recipient for inner impulses and data, as well as for stimuli from outside the agent's organism. Those stimuli, however, are causal and path dependent and effect the outcomes themselves. An operation external to the agent determines the effect an *action* has on the *situation* ④. Similarly, it is an operation external to the agent that determines which informational element describing the situation finds its way into the set of an agent's *perception* ⑥. So far the regular external feedback loop is described.

2.3 Perception and Action – Assignment and Subjectivity

At this point it is also important to once again emphasise the subjectivity of individual perception. An agent individually deciding in favour of an action does not automatically imply that the action takes place. While an agent perceives that the ability to act in a certain way may be warranted, that action may not actually be carried out. Overestimation of one's own capabilities, unknown circumstances or unforeseeable dynamics may let the agent fail to achieve the desired outcome (Wooldridge, 2013, pp. 5–6). In addition, when agents represent human decision makers, they have to be 'assumed to be autonomous entities, pursuing their own individual goals based on their own beliefs and capabilities' (Dignum and Padget, 2013, p. 60). Both may be restricted or even faulty. That means, even if an action can be performed in the aspired manner, the actoin and its consequences may be perceived differently by different agents (Wooldridge, 2013, p. 15). An agent's perception therefore is subjective – a subjective excerpt of the modelled environment, including all agents and the agent itself.

An agent is not only an operating system but simultaneously an entity of superior economic, social and ecological systems forming the environment – rightfully or wrongly perceived. Other entities may be other individual agents as well as multiagent systems and organisations on a collective or aggregate level – like firms, markets or even societies (Dignum and Padget, 2013, pp. 51–52). The term 'agent', therefore, is used synonymously with 'entity' and may refer to a single subject as well as groups – and thereby formed subsystems. With regard to common economic frameworks then, most informational elements perceived by an agent are somehow assignable to types of agents, too.

2.4 Situation – Objectivity and Consistency

The term 'situation' in the operating structure refers to the highest systemic level as well as the corresponding objective – the general and positive record of all occurrences in the model and all its entities. If a model allows for faulty perceptions, the idea is that for every informational element existing in at least one individual perception, there also exists a corresponding element in the set describing the situation. This element is not only allowed to differ in value, but its value only becomes relevant in cases where there is a difference – as it defines the true determination. The situation – as a set of elements – therefore can be interpreted as the flawless perception of the modeller.

3. Innovative Behaviour

The main objective of this paper is to look at how economic agents are modelled. The operating structure and the set of internal operations discussed previously, aim to remind modellers about the complexity of the subject they are trying to model as well as its facettes, which in favour of simplification tend to get neglected rather than incorporated. One of these facettes is the operations I referred to as mutation and conservation. These are worth focussing on as they determine the evolution of all the remaining set of operations. Mutation, in particular, addresses a characteristic of economic agencies and systems that most classical and neoclassical models hardly consider: ongoing change, challenging every stationary and even steady state – so dearly desired by some theorists.

One driver of mutation might be the direct learning from others. In this case the agent just has to preconceive the alternative, mutate in the originally-applied algorithms, and then conserve the new routine. This can also be called an 'imitation process' (cf. Shone, 2002, p. 415). With respect to the learning agent, this implies a change, and with regard to the aggregate this behaviour forms the foundation for adopting a more efficient routine. The origin of this routine – representing an innovation, though, has to be found elsewhere.

3.1 Origin – Compromise of Exogeneity

In economic terms an innovation generally refers to an invention that stands the profitability test at the market (Kurz and Salvadori, 1995, p. 400). An invention, therefore, is the first occurrence of an idea, while an innovation already refers to the practical and successful implementation of an invention (Enock, 2006). Looking for the origin of an innovation among agents, therefore, means looking for their inventiveness – and, therefore, for creativity. It is creativity that can be seen as the precondition for innovations and inventions in the first place (cf. Scott, 1995, pp. 64–65). Succinctly speaking, creativity allows for the imagination of alternatives so far unknown.

With regard to computational agents, creativity is what enables an operation to alter and especially extend the set of so far imaginable operations. With respect to the agent's design these operations can be understood as algorithms of behaviour. When behaviour is finally determined by decisions, creative mutation then extends the variety of possible choices. In other words: 'an innovation corresponds primarily to an evolution of decision spaces' (Blaseio, 2016, p. 2). Assuming creativity to be no more than a fixed algorithm, though, somehow presumes that upcoming inventions are predetermined by a given operating structure of the human mind and stepwise extended knowledge. Thinking of its

practical modelling, explicitly defining an algorithm altering and extending an actual set of solutions would thereby determine all the potential future sets from the starting point.

Arthur (2009, pp. 124–130) to some extent provides a perspective that supports such a simplified approach, when he says that something novel 'emerges always from a cumulation of previous components and functionalities already in place' and 'to invent something is to find it in what previously exists'. At the same time, though, he adds that the causal history of the new does not imply its appearance is predetermined. A more comprehensive interpretation of Schumpeter's (1939, p. 63) older and well-acknowledged concept of innovations as new combinations, states that not only does it open a dynamic view of technology and preference space of economic agents, but also 'allows for a reshuffling of the dimensions of the agents space itself' (Hanappi and Hanappi-Egger, 2004, p. 4). This reshuffling and, in terms used previously, mutation as a creative task, seems to go beyond computation. According to psychological theories such a task must, instead, be open-ended and must not be purely algorithmic (Amabile, 2012, p. 3). While this, in turn, suggests insurmountable limits for an algorithmic computational agent, to some extent there exist such creative activities where machines employed with genetic algorithms out-perform the capabilities of humans (cf. Füllsack, 2009, p. 109). However, in such cases machines have to be comprehensively fed with information translated into readable code first. In principal, computers would have to be told what to do and every performable action would have to be anticipated and planned by programmers (Wooldridge, 2013, p. 4). So computers may be helpful in looking for symmetries or qualities observable in the code, however, they cannot interpret and understand non-codified content (Blaseio, 2016, p. 7). As creativity goes beyond what can be captured so far by any computer and artficial intelligence, it is a truly open-ended task and cannot be implemented fully endogenously in a model of computational agents.

The origin of inventions in agent-based models of economies, therefore, has to be exogenous. Accepting this, using algorithms for modelling inventiveness is a pragmatic but also effective way of incorporating innovative behaviour (e.g. Dosi, Fagiolo, and Roventini, 2006 to Dosi et al., 2016). Such implementation of creativity does not imitate the true activity, but focusses on its main economic result: an invention that extends the decision space and, more generally with regard to the agent's design – mutates the set of operations.

3.2 Determinants – Potential for Endogeneity

Creativity and, therefore, inventiveness are not independent from other elements also addressed by the agent's design. Creativity and the success of creativity depend upon personal factors – like cognitive style, ability and expertise – as well as pressures, resources and other social contextual influences (cf. Csikszentmihalyi, 2002, pp. 313–314, Woodman, Sawyer, and Griffin, 1993, p. 301). There is a whole componential theory of creativity. Besides the already mentioned personal factors, it emphasises domain-relevant skills, task motivation and the social environment as main determinants (Amabile, 2012, pp. 3–4). Returning to the agent's design, the most fundamental determinants of human behaviour should also be discussed with respect to creativity: needs. In the course of his investigation of the nature of technology and innovation, Arthur (2009, p. 109) states that invention 'consists in linking a need with some effect to satisfactorily achieve that need'. In addition, creativity is not only driven by certain needs, but also depends on the satisfaction of other needs. All these psychological insights are known and applied by entities of the economic reality, consultants and advisers (cf. Your Coach, Value Based Management, Leadership-Central and others). Therefore, they may also be worth implementing in economic models.

By returning to the agent's design we are reminded of the potential implementian of several factors that can foster or hinder creativity at individual and organisational level – factors that are intensively discussed and reviewed in psychological and managerial literature (cf. Shalley and Gilson, 2004). Those using economic models of innovation are well advised to consider such factors when they want to claim explanatory power with regard to the emergence of innovations. If the model is about the effects of innovation only, however, the excursion into the field of creativity may be spared.

4. Conclusions

The most important potential of the agent's design, as suggested in the first section, is to force modellers to identify and reconsider several relevant parts of the subject of interest at several levels. It does not deny the potential that isolated and simplified examinations of economic issues may offer. If the scope for detailing the full story using the operating system has not been employed then, with regard to the economic agent and to computational simulations, any 'emergent pattern cannot be understood without a bottom-up dynamical model of the microfoundations on the relational level' (Macy and Willer, 2002, p. 143). The operating structure, therefore, helps and invites us to keep the big picture in mind and provides an initial indication of the degree of simplification.

Focussing on the implementation of innovative behaviour, an agent's design that tries to more adequately approach human decision makers does not directly suggest a new concept. The reason is that innovations are inventions in the first place, and inventiveness and creativity are more than algorithms processing a given code. While the challenge of a largely imponderable 'creative act' remains (cf. Arthur, 2009, p. 107) the operating structure can be used to reasonably implement determinants of successful creativity, if desired.

After all, the agent's design helps us to base any economic agency or economic story on more solid foundations. And operating structure does not rule out simplified concepts – as embodied by *homo economicus* – but somehow asks for a more reasonable description and argumentation of the applied entities. It, therefore, may help us to address an urgent requirement of the stories told by economists: that they consist of identifiable characters in meaningful adventures (cf. Potts, 2001, p. 2) – a *hetero economicus* as a model of human decision makers perceiving and interacting according to their motivation and within situational conditions.

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