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Innovation, Value-Neutrality and the Question of Politics: Unmasking the Rhetorical and Ideological Abuse of Evolutionary Theory

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Abstract: Since the reconstruction of Joseph Schumpeter's view of innovation as a key factor of capitalist economic development and the neo-Schumpeterian formation of national innovation systems theory in the early 1990s, there has been an attempt to approach the emergence of new technological products and processes in evolutionary and institutional terms. However, much of this neo-evolutionism has positioned innovation as if it was a value-neutral process of supply and demand, taking place in a free market and having nothing to do with politics. I argue that such value neutrality is defended by some neo-Schumpeterian thinkers who take a socio-biological path to explaining innovation and technical change. In doing so, they abuse evolutionary theory to cloak the de facto strong role of political institutions and the state in innovation. Scholars of responsible research and innovation should unmask the public values involved in technological change and development.

Keywords: Innovation; Schumpeter; Value-neutrality; evolution; responsibility

Introduction

Innovation as such is about novelty. Whether doing something (product or process) new to the firm or new to the market or new to the world, or something old in new ways, the concept of

innovation describes the restless efforts of human beings to provide novel solutions to problems and transform their technical and socio-economic environment. For Joseph Schumpeter (1983), the founding father of contemporary innovation studies, these efforts lead to economic development. They cause creative destruction that is essential for the dynamism of the whole of capitalist system.

Since the reconstruction of Schumpeter's view of innovation as a key factor of capitalist economic development and the neo-Schumpeterian formation of national innovation systems (NIS) theory in the early 1990s (Lundvall 1992, Nelson 1990, 1992, 1993, Freeman 1995, Freeman and Soete 1997, Edquist and Johnson 1997, Edquist, 1997), there has been an attempt to approach the emergence of new technological products and processes in evolutionary and institutional terms. However, much of this neo-evolutionism has positioned innovation as if it was a value-neutral process of supply and demand, taking place in a free market and having nothing to do with political institutions and the state.

In this paper, I argue that such value neutrality is defended only by some neo-Schumpeterian thinkers who take a socio-biological path to explaining innovation and technical change. These thinkers are not necessarily consistent with Schumpeter's writings. In fact, their evolutionary rhetoric of free markets and non-interference of the state cloaks a de facto strong state intervention. Neo-evolutionism appears to be an ideological cloak that provides untoward government interventions in innovation with a false aura of biological (i.e. scientific) legitimacy¹. That is to say, some neo-Schumpeterian thinkers insist on the importance of necessity and inevitability of socio-biological process where there is in fact a value laden choice being made. This ideological and rhetorical abuse of evolutionary theory is an issue that needs to be addressed. Other neo-Schumpeterian thinkers do appear to acknowledge that capitalism itself is not a smooth and neutral process of socio-biological evolution but rather an uneven, value laden and dynamic process of technological change. These thinkers take a

historical path to explaining innovation and therefore are more consistent with Schumpeter's theory of economic development. This intellectual divide within the neo-Schumpeterian school of thought deserves further critical analysis. Can the theory of innovation be value neutral? Can the social and political context of innovation systems be ignored? What is the impact of value neutrality on effective integration of the systems concept with historical and political accounts of innovation? In answering these questions I highlight the increasing role of politics and the state in the innovation process as well as the emerging fact that innovation as such is pursued or induced by forces other than just the free market. This is the case especially in developing countries where emerging models of more responsible research and innovations are being heavily shaped by civil society values of solidarity and politics (Smith et al, 2017; Papaioannou, 2018; Cozens and Sutz, 2014). Responsible research and innovation (RRI) is a notion that seems to align knowledge generation and technological development with public value, integrating ethical, political and social considerations into scientific and technological processes (Lukovic et al, 2017). By analysing how neo-evolutionism make innovation to look as if it is value neutral, this paper offers insights into how scholars of RRI can critically engage with and unmask the values involved in technological change and development. In this sense, it contributes to both RRI and NIS literatures, going beyond issues of governance of science and technology (Stilgoe et al, 2013).

The remainder of this paper is structured as follows. Section 2 reveals the intellectual divide within the neo-Schumpeterian approach to innovation as regards value-neutrality. Section 3 addresses the question of politics, analysing innovation as a social process that is driven by both value and power conflicts. Section 4 redefines innovation in terms of history and context. In doing so, it exposes the myth of universal social and political values. Section 5 concludes the paper by summarising the argument of innovation as a social and political process.

The Divide within the Neo-Schumpeterian Approach to Innovation: Value Neutrality

Generally speaking, the neo-Schumpeterian approach to innovation is characterised by two elements. The first is the systemic element, namely that innovation is an interactive process, involving many different institutional actors. These actors tend to form a system of relations that can be *national* (Freeman 1982, 1987, 1988, Lundvall 1985, 1988), *regional* (Asheim, 1996, Asheim and Coenen 2005, Cooke 2006, 2007a, 2007b; Cooke et al. 1997; Braczyk et al. 1998), and/or *sectoral* (Malerba 2002, 2004), facilitating learning and production of new technology goods and services. The second element of the neo-Schumpeterian approach to innovation is the evolutionary element, namely that economic and technological change happen in an evolutionary way through a mechanism of variation, selection and retention. Nelson and Winter (1982) introduced these core principles to evolutionary economics of innovation and technical change in order to explain the dynamism of such processes within modern capitalism.

As has been argued elsewhere (Watkins et al. 2015) both the systemic or institutional and the evolutionary elements of neo-Schumpeterian approach constitute a response to the static neo-classical model of economic growth. Drawing on the work of Nelson and Winter (1982), evolutionary economists such as Freeman (1982, 1987), Freeman and Soete (1997), Lundvall (1985, 1988), Dosi (1982), Dosi and Nelson (1994) and many others persuasively argued that neo-classical growth models are inadequate as they tend to ignore the role of innovation in technological change and particularly in economies which are driven by strong science and technology to become competitive global forces. For these economists, technological change and innovation are central to economic growth. Thus, as Freeman and Soete (1997) have explained, since the industrial revolution of the 1780s, successive waves of technical change and institutional transformations have introduced innovations from textiles and railways to

microelectronics and information and communication technologies (ICTs) which have radically improved the lives of people across the world.

However, it might be suggested that neither for Schumpeter nor for Freeman let alone Lundvall the evolutionary process of innovation is consistently socio-biological. Schumpeter, following Marx, on the one hand argues that capitalism can never be stationary, and on the other insists that economic evolution is not merely a systemic adaptation to changes in external data but rather it occurs discontinuously and far from smoothly (Schumpeter 1983). In his *The Theory of Economic Development*, Schumpeter (ibid: 57-58) criticises the continuous enquiry for identifying the ‘meaning of history’ as metaphysical and argues against conceptions of uniform social development which draw on uncritical analogies with Darwin’s theory of evolution. As he says ‘Closely connected with metaphysical preconception – more precisely with the ideas which grow out of metaphysical roots and become preconceptions if, neglecting unbridgeable gulfs, we make them do the work of empirical science – even if not itself such a metaphysical preconception, is every search for meaning of history. The same is true of the postulate that a nation, civilisation, or even the whole of mankind, must show some kind of uniform unilineal development, as even such a matter-of-fact mind as Roscher assumed and as the innumerable philosophers and theorists of history in the long brilliant line from Vico to Lamprecht took and still take for granted. Here too, belong all kinds of evolutionary thought that centre in Darwin – at least if this means no more than reasoning by analogy – and also psychological prejudice ... But the evolutionary idea is now discredited in our field, especially with historians and ethnologists, for still another reason. To the reproach of unscientific and extra-scientific mysticism that now surrounds the “evolutionary” ideas, is added that of dilettantism. With all the hasty generalisations in which the word “evolution” plays a part, many of us lost patience.’

Schumpeter’s criticism clearly indicates that he is sceptical of the biological tradition as a force of explanation of evolutionary economic phenomena. For him the structure of the problems is

not the same in economics and in biology. In his *Business Cycles*, Schumpeter (1939: 102) argues that in fact ‘evolution is lopsided, discontinuous, disharmonious by nature ... studied with violent outbursts and catastrophes ... more like a series of explosions than a gentle, though incessant, transformation’. In this sense, biological metaphors are not applicable to explaining innovation and therefore remain irrelevant.

Like Schumpeter, Freeman and Lundvall appear to exclude the biological analogy from their evolutionary approach to innovation and technical change. Instead, they deliberately choose a historical method of approach that is designed to illustrate the broad, interactive, relational but also conflictual and discontinuous elements of the system of production, diffusion and use of knowledge and innovation. Geels and Schot (2016) and earlier than them Andersen (2009) and Hodgson (1993) accept that the Schumpeterians in the socio-biological tradition of evolution focus narrowly on firms, knowledge, innovation and market selection whereas Freeman keeps ‘the broad agenda alive’ (Geels and Schot 2016: 11) and insists on the need to reintegrate economic theory with other social sciences, including politics, and on the importance of institutional change in innovation. These elements indicate the importance of values (e.g. freedom, equality, justice, etc.), interests (e.g. material interests) and power relations (e.g. control over) within modern innovation systems. Freeman and Lundvall’s methodological framework is holistic and goes beyond the micro-evolutionary analysis of innovative firm behaviour. According to Freeman and Soete (1997: 17) ‘In order to make useful generalisations about R&D in relation to firm behaviour it is essential to place growth of this phenomenon firmly in a historical context and also in the context of specific industrial sectors’. The macro-evolutionary process of history as such is different from the micro-evolutionary process of biology. Whilst the latter involves a mechanism of natural selection of genotypic and phenotypic characters that takes place in the back of social agents’ decision-making, the former

involves a continuous conflict of values and material interests and power that takes place in the front of social agents' decision-making.

Certainly, those thinkers who have come at innovation from a historical and political perspective are more likely to highlight the processes of innovation as value laden than those thinkers who have come at innovation from a predominantly biological perspective. The latter are probably less aware of the importance of values in social agents' decision-making perhaps even out of convenience.

In any case, the cognitive aspects of social agents' decision making and the dynamic of their systemic interactions have been appreciated by both Freeman and Lundvall the same way as Schumpeter and Marx have appreciated the importance of (theoretical and practical) reason in human action. Indeed, as Hodgson (1993, 2002, 2003) has repeatedly argued, the principle precursors of socio-biological approach to economics are in fact Thorstein Veblen and Friedrich von Hayek who 'applied the Darwinian principles of variety, selection and retention to economic phenomena. Despite evolutionary credentials that are genuine in some broad sense, the same cannot be said for others, including Karl Marx and Joseph Schumpeter. They did not apply the key Darwinian principles to their economics'. Clearly, Hodgson's view of Schumpeter is not shared by economists such as Saviotti and Metcalfe (1991) who discussed the status and prospects of evolutionary theories of economic and technological change, insisting that Schumpeter's approach to innovation contains several elements embedded in modern socio-biological theories of evolution, including that of Nelson and Winter (1982). The same holds for a younger generation of evolutionary theorists such as Geels (2014) who seem to use biological metaphors to explain the domination of certain technologies and innovative designs in the market but also the domination of cognitive frames or paradigms of analysis. For them, the same way, more or less, as organisms develop variations in order to adapt to environmental conditions and get naturally selected for survival, firms seek to differentiate

themselves through product and process innovations which enable them to adapt to economic conditions and get selected within the market. According to Saviotti and Metcalfe (1991: 1) 'In biology organisms can reproduce (generally sexually) and pass on their genetic make up to their offspring. The meaning of reproduction is much looser in economics but relates to the maintenance of productive competence over time, and integral to this is the generation and storing of information. Organisations and technologies tend to show some continuity in the course of time, although the pace of change can be much faster and more discontinuous than in biological evolution.'

Although discontinuity is clearly recognised by these evolutionary economists as an important element of technological change, their main emphasis remains on the relatively smooth process of occurrence of various rule-guided behaviours which become routines within firms. As Nelson and Winter (1982: 97) stress, routines 'may refer to a repetitive pattern of activity in an entire organisation, to an individual skill, or, as an adjective, to the smooth uneventful effectiveness of such an organisation or individual performance.' More importantly, they claim, routines are analogous to genes. This implies that vital information for organisational survival are stored in routines. Evolution then depends on whether such information enables better adaptation to market conditions and competitive environments. Dosi (1982, 1988) and other followers of the socio-biological approach to innovation and technical change at the firm level have built on the notion of 'routines as genes' to introduce the concept of 'technological paradigm' that, in the words of Dosi and Nelson (1994: 161), 'attempts to capture both the nature of the technological change upon which innovative activities draw and the organisational procedures for the search and exploitation of the innovations.' This concept justifies modelling of technological change in terms of two determinants: first the 'firms' with their routines which embody knowledge and information for survival; second, the profitability of a new technology that determines its 'fitness'. Both determinants explain innovation

processes at micro level, failing to account for the complex and contradictory system of social and political relations at macro level.

In fact, it might be argued that these socio-biological metaphors impede the more effective integration of the systems concept with the historical and political account of innovation. The younger generation of evolutionary theorists are not oblivious to this fact. Especially Geels (2011, 2014) recognises that evolutionary economics has paid less attention to institutions of civil society and polity than to routines in firms and processes of adaptation in economic market environments. Thus, he suggests ‘a new conceptual framework ... which accommodates interactions between incumbent firms-industries and a broader set of environments (which also includes the economic environment)’ (Geels 2014: 262). Geels calls this framework an ‘interdisciplinary triple embeddedness framework’ (TEF). TEF conceptualises the interactions between firms-in-industries and their economic and socio-political environments. However, it appears to be an abstract and rather a-historical model that seems to ignore the concrete and complex ‘dialectics’ of innovation. Such ‘dialectics’ has been clearly captured through the notion of innovation systems introduced by more consistent neo-Schumpeterian thinkers such as Freeman and Soete (1997), Lundvall (1992) and Edquist (1997). These thinkers stressed that not only the market mechanism and firms (micro level) but also the state and politics (macro level) play key roles in innovation systems. As Freeman and Soete (1997: 14) put it ‘The market mechanism can be useful technique for allocating resources in certain rather specific circumstances, but it has its limitations, so that the definition and implementation of social priorities for science and technology cannot be left simply to the free play of market forces ...The political system is inevitably involved...’.

It might be argued that neither the political system nor the state can be seriously understood as important determinants of innovation by the socio-biological approach to evolution and

technological change. The reason is pretty simple: economists of innovation who draw on the socio-biological approach tend to think of evolution as a process of value-neutrality whereas more consistent neo-Schumpeterian thinkers understand evolution as a process that involves value judgements, including moral and political judgements about the normative direction of science and technology and innovation e.g. responsibility. In this sense, the latter thinkers are also in agreement with RRI scholars (Lukovics et al, 2017; Stilgoe et al, 2013) who build their conceptions of responsibility on the science and technology studies (STS) approach to technological change as not only technically but also politically constituted (Winner, 1977). The value-neutral position of socio-biological thinkers can be realised when one revisits the early writings of Nelson and Winter (1982), Savioti and Metcalfe (1991), Dosi (2013) and more recently Geels (2014) and others. These authors seem to rule out or at least underplay the vital importance of moral and political judgements in human action and social evolution. For them what matters seem to be the mechanisms of coordination and adaptation and selection as if the market as such was a socio-biological organism and not a historically developed institution founded upon the liberal state that protects exploitative relations of individual property rights and guarantees capitalist forms of economic exchange based on supply and demand.

Certainly, in later writings, authors such as Nelson (1990: 194) have come to accept that ‘the process through which technical advance proceeds in capitalist economies differs in various obvious respects from evolutionary processes of biology’. But Nelson (ibid) also insists that ‘On reflection, some of the apparent differences may be more apparent than real. Thus technology occasionally makes ‘big jumps’. This is inconsistent with traditional concepts of evolution in biology, but not with modern notions of punctuated equilibria. Also it is clear that innovation is far from a strictly random process; rather efforts to advance technology are carefully pointed in directions innovators believe to be feasible and potentially profitable. However, here again the difference with biological evolution may not be sharp if one

recognises the possibility (as do contemporary biologists) that selection has operated on genes to make viable mutations are more likely than would be the case were mutation strictly random'. For Nelson (2004) the fact that the market process of advancing technological innovation remains evolutionary does not deny the importance of institutions and politics. This argument also appears in his 1993 edited volume on *National Innovation Systems: A Comparative Analysis* and in his 1974 article 'Intellectualising about the Moon-Ghetto Metaphor: A Study of the Current Malaise of Rational Analysis of Social Problems'. In both works Nelson argues that market institutions have emerged through a complex process that involved both technological advance and the political state. His argument seems to endorse 'artificial selection'.

Long before Nelson, Commons (1924) and later Penrose (1952) have clearly pointed out that institutional evolution as such involves 'artificial selection'. This implies that human (individual and collective) action is guided not only by economic values and material interests but also by moral and political values. There is no such thing as pure calculative behaviour. Thus, it is clear that neither markets nor innovation systems evolve spontaneously as value-free or neutral mechanisms. Rather they are embedded in value-bound social, political and cultural relations. These relations are characterised by antinomies. This means that their evolution is driven by both value and power conflicts. Such conflicts are apparent in state planning where decisions about investment in new technologies take place. Against the myth of selection in markets and institutional environments, Block and Keller (2011) clearly show the expended role of government and the state planning in both funding of and engaging with big innovation projects.

The Question of Politics: Value and Power Conflicts in Innovation

If it is true that innovation is not a value-neutral process of socio-biological evolution, then it must be also true that it cannot be abstracted from politics. The latter is also a process of change that involves intentional human action and historical development of complex institutions such as the state. Social and political theorists from Hobbes (1651) and Weber (1904) to Poulantzas (1978) and Jessop (1990) have defined the modern state in different ways. However, all of them, tend to agree the state is a distinct set of institutions with dedicated administrative staff that has legitimate monopoly of authoritative and rule-making power within a bounded territory (Hay and Lister 2006).

Although the concept of politics as an activity whereby individuals and groups change or maintain ways of social reproduction (Papaioannou 2012) and the notion of state as an institutional ensemble that evolves over time (Hay and Lister, 2006) have been central in political studies for the understanding of social evolution, they have been side-lined or even abandoned in the mainstream innovation studies. As Steinmueller (2013: 161) recently confesses ‘Our field [innovation studies] has an uneasy relationship with ...politics. No doubt this is partially the consequence of the fact that so many of us are economists, a tribe that paradoxically dominates public administration while at the same time harbouring severe doubts about public purposes. This is reflected in our programmes of research and training – we rarely engage with scholars of law, public administration, social policy, or education, and even less with political theory, ethics or philosophy.’

The abandonment of politics in the neo-evolutionary (value-neutral) studies of technological innovation has provided false scientific legitimacy to the ideological rhetoric that ‘government is the problem, not the solution’ (Block 2011: 1) and that the markets are self-regulating mechanisms of socio-biological evolution that can solve problems of technological innovation without external (value-bound) political interventions. This rhetoric has been uncritically endorsed by current conservative and neo-liberal governments. For example, in his *Eight Great*

Technologies report, Rt Hon David Willets MP, former Minister for Universities and Science in the UK, argues that ‘After the failure of the economic interventionism of the 1970s and the triumph of the liberal revolution in economic policy of the 1980s, we are wary of government picking winners. In so far as government can raise growth, we tend to focus on measures that apply across the economy as a whole – such as deregulation or lower corporate taxes or ease of setting up a business’ (Willets 2013: 53). Willets’s argument clearly defends neutrality. Therefore it is in line with the neo-liberal approach to economics and politics (Hayek 1960; Nozick 1974; Friedman 1962) but not with the consistent neo-Schumpeterian theory of innovation and technical change (Freeman and Soete 1997, Perez 2002). The former cloaks the de facto involvement of politics and the state in innovation. By contrast, the latter maintains that politics and the state have not (and should not) been neutral to innovation. Rather they have been playing key roles in technological evolution, especially since the First World War. According to Freeman and Soete (1997: 375) ‘The First World War stimulated the growth of government support for scientific research and development in many countries, as for example, in the establishment of the Department for Scientific and Industrial Research (DSIR) in Britain in 1915 ...This continued as an agency in support of civil science down to 1960s, controlling a variety of government laboratories and funding university research. Similar developments occurred in many countries but it was the Second World War and the Cold War which led to the greatest surge of government funding of R&D. This took the form of massive support for huge projects, of which the most famous was the ‘Manhattan Project’ to design and develop nuclear weapons. It was followed by the establishment in many countries of large institutions for R&D in the military and civil applications of nuclear energy.’

Given the value-laden and political nature of all these historical developments, it is clear that technological innovation has been not just a scientific and/or technical process of introducing new products and processes but also a political process of value and power conflicts. Public

funding for basic research in areas such as nuclear power, genomics, biotechnology, information and communication technologies (ICTs), etc., has been highly contested in terms of political and moral justifications, including RRI. Thus, none of these technologies came about as an unintended outcome of human action. Take for example the biotechnology phenomenon. In countries such as the United States (US) ‘Where most previous accounts assume that the biotechnology revolution was spontaneously generated by the confluence of scientific discovery and profit-seeking incentives ...[in fact]...political structures and federal policy have played an equally critically but as yet insufficiently acknowledged role’ (Vallas et al. 2011: 57). This demonstrates that the socio-biological approach to innovation is not adequate empirically and that it cloaks the decisive role of state intervention, making deliberate political choices appear as evolutionary inevitability.

Most previous accounts, apparently influenced by liberal and neo-liberal thinkers, including Hayek and Friedman, have argued for a market fundamentalism in science and technology. Their arguments have been implicitly founded upon principles of negative freedom (i.e. freedom from) and equality before the law (Berlin 1969, Papaioannou 2012). For them, public funding for specific research and innovation projects ought to be withdrawn because the liberal state as such ought to remain neutral towards particular conceptions of the technological good, therefore also the economic and social goods. By contrast, consistent neo-Schumpeterian thinkers, including Freeman and Perez, have argued for state intervention explicitly founded upon principles of positive freedom (i.e. freedom to) and substantive equality. In their view, cessation of public support to scientific research and innovation would have disastrous long-term consequences for both economic growth and social welfare in most countries because it is highly unlikely that free markets would compensate for the collapse of the state funding.

It might be suggested, that only very recently innovation studies has begun a conceptual and empirical return journey to Freeman and Perez’s consistent neo-Schumpeterian writings,

gradually moving away from socio-biological notions of evolution and value neutrality, and to progressively concentrating on the importance of politics and the state for innovation. The main reasons for this return are the shocking polarisation and growing inequality for which socio-biological innovation studies are also to blame (in the sense of providing false scientific legitimacy to the ideological rhetoric against state planning and intervention in the supposedly smooth ecosystem of innovation) and the myth of ‘invisible hand’ in the market. Thus, scholars such as Block (2011: 3) reconstruct Freeman and Perez’s theories, arguing that ‘The historical experience with the innovation economy provides powerful arguments against the core assumption of market fundamentalism. For many technologies, it has not been Adam Smith’s invisible hand, but the hand of government that has proven decisive in their development.’

Indeed, Block and Keller (2011) refer to a number of examples which back this argument. These include: *Google* – the algorithm or the so called ‘secret sauce’ that made Google a successful search engine was initially funded by the United State (US) National Science Foundation (NSF); *Apple* – the dramatic growth of the computing industry in Silicon Valley is due to the US Defence Advanced Research Projects Agency (DARPA) critical role in setting the context for growth of personal computing; *Human Genome Project* – the technological goals and funding for this projects were set by government through the National Institute of Health (NIH) and the Department of Energy and the Strategic Computing Initiative by DARPA; Biotechnology industry – the emergence and growth of this industry is due to NIH and NSF support as well as government legislation that allowed the transfer of scientific discoveries made in publically funded universities and laboratories into private hands e.g. the Bayh-Dole Act (1980), the Stevenson-Wydler Act (1980) and the Orphan Drug Act (1983). Indeed, as Vallas et al. (2011: 66) point out ‘When taken as a whole, the pattern of state intervention ... suggests that the knowledge economy did not spontaneously emerge from the bottom up but was prompted by a top-down *stealth industrial policy*: government and industry

leaders simultaneously advocated government intervention to foster the development of biotechnology industry and argued hypocritically that government should ‘let the free market work’.

In her work *The Entrepreneurial State*, Mazzucato (2011, 2014) has built on these consistent neo-Schumpeterian arguments, especially on Perez (2002) and Block and Keller (2011), to challenge the value-neutral and rather minimalist view of the state and politics in technological innovation. According to the early version of her argument (published as a report for DEMOS, 2011: 16-17) ‘the role of the government, in the most successful economies, has gone way beyond creating the right infrastructure and setting the rules. It is a leading agent in achieving the type of innovative breakthroughs that allow companies and economies to grow, not just by creating the ‘conditions’ that enable innovation. Rather the state can proactively create strategy around a new high growth area before the potential is understood by the business community (from the internet to nanotechnology), funding the most uncertain phase of the research that the private sector is too risk-averse to engage with, seeking and commissioning further developments, and often even overseeing the commercialisation process. In this sense it has played an important entrepreneurial role.’

Certainly, Mazzucato’s argument is not founded upon a political theory of the state. In fact, it is not clear whether her understanding of the state is Weberian, liberal, pluralist, structuralist, etc. This lack of theoretical foundations is a particular weakness of Mazzucato’s argument for the entrepreneurial state. One can raise several questions here. Would a Weberian state (and indeed any other form of the state) be able to function as an entrepreneurial state? What are the theoretical presuppositions of such a state given that the Schumpeterian notion of entrepreneurship is strictly focused on individuals and not on political institutions? Clearly, modern social theorists such as Weber see the state as an organisation that deploys legitimate coercion and physical force to protect citizens’ private property and ensure they are free to

exchange goods in the market. As Weber points out ‘a compulsory political organisation with continuous operations will be called a “state” in so far administrative staff successfully upholds the claim to the monopoly of the legitimate use of force in the enforcement of its order (Weber 1978: 54). An entrepreneurial state in Weberian terms would be a state legitimate to impose its risk-taking vision on citizens for the sake of peace and security of civil society. This implies using legitimate coercion to push forward mission oriented investments for certain technological innovations which could maximise social redistributive benefits for citizens.

In the later version of her argument (published as a book) Mazzucato (2014: 3) explains that the reason why she talks of ‘entrepreneurial state’ is that ‘entrepreneurship – what every policymaker today seems to want to encourage – is not (just) about start-ups, venture capital and ‘garage thinkers’. It is about the willingness and ability of economic agents to take on risk and real *Knightian* uncertainty: what is genuinely unknown.’ However, there are two issues with her explanation that need to be addressed. First of all, Schumpeter would reject the idea that entrepreneurship is about taking on risk. In his *The Theory of Economic Development* (1983: 137) he clearly argues ‘The entrepreneur is never the risk bearer ... The one who gives credit comes to grief if the undertaking fails. For although any property possessed by the entrepreneur may be liable, yet such possession of wealth is not essential, even though advantageous. But even if the entrepreneur finances himself out of former profits, or if he contributes the means of production belonging to his ‘static’ business, the risk falls on him as capitalist or possessor of goods, not as entrepreneur.’ Clearly, if Schumpeter is right in what he argues then Mazzucato is wrong. That is to say, the state cannot play the role of entrepreneur in Schumpeterian terms but rather finance entrepreneurship through taxation.

This brings us to the second issue with the above argument which is that the state is not just an economic agent; it is a predominantly political agent and therefore, as Weber and other theorists would stress, any state function presupposes political legitimacy. Therefore, financing

entrepreneurship through taxation is not straightforward because it requires political legitimacy and justification, given that there are many other state priorities of redistribution (e.g. financing health through taxation, financing education through taxation, etc.). Mazzucato also seems to confuse the state with government and for this reason it is difficult for us to tell what kind of institution she has in mind for promoting innovation-led growth. From a Weberian point of view, such confusion also overlooks the historical fact that whilst governments change very often, the state, as a set of complex institutions, persist and evolves over time (Hay and Lister 2006).

However, despite conceptual issues and lack of theoretical foundations, Mazzucato's argument is powerful, constituting an implicit political critique of the abuse of evolutionary theory by some neo-Schumpeterians who endorse the value-neutral and socio-biological approach to innovation. As has been shown elsewhere (Papaioannou et al. 2009), this approach by using strong metaphors such as 'knowledge ecology' and 'innovation ecosystems' misses the concrete historical and political dimensions of knowledge and innovation environments. These dimensions are by no means value-neutral. Rather, they are reflexive of what Stirling (2014: 4) calls 'politics of choice in innovation' i.e. not just technically but also morally and politically chosen innovation pathways. Given that some of these pathways can quickly become irreversible, it is important to be politically and morally scrutinised at the earliest stages of innovation (ibid). Although, the debate of whether value pluralism is possible in developed and developing capitalist societies is still ongoing, one might agree with Stirling that the interests and motivations are not purely scientific but also moral and political. This also implies power conflicts mediated by the state that, in essence, provides normative direction to innovation in a number of contexts, including not only developed countries such as the US but also developing countries such as China. For example, China's hybrid approach (market socialism) to innovation, involves conflicting objectives and values of different government agencies,

market organisations and scientific and professional communities. These are blended for the sake of addressing the country's social, economic and national security challenges (Appelbaum et al. 2011). The state drives the direction of specific technologies e.g. nanotechnology but not in an exclusively top-down way. According to Appelbaum et al. (ibid: 225) 'the pressure for coordinating among different levels of government (central, provincial and local) and different government agencies ensures that promising technological directions are validated by multiple actors. These governmental actors have different agendas and incentive structures, and as a result nanotechnology projects are subject to conflicting and sometimes contradictory criteria'.

The Importance of History and Context

Rather than treating existing and emerging patterns of technological innovation as socio-biological and value-neutral, I propose to re-define them as both historical and contextual patterns. This does not only reveal the political nature of innovation for development but also debunks the myth of universal values and institutions. As has been argued by Srinivas (2012: 1), development as such 'is a menagerie that houses many institutional varieties – especially of states and markets'. More specifically, markets take different forms in different historical and political contexts. In some countries markets are absent and in some others they are underdeveloped.

In any case, markets are not spontaneously created institutions which fail or succeed to deliver innovation-led growth and economic prosperity. Rather they are historically created through a complex process that involves both technological advance and political institutions such as the state. Indeed, as has been pointed out elsewhere (ibid: 2) 'Even when dysfunctional or outright malevolent, and despite its limitations and contradictions, the state (and its governments) is inevitably the most important planning institution in these economies.'

The same also holds true for developed capitalist countries. An increasing number of economists and political scientists (Perez 2002, Block and Keller 2011, Vallas, et al. 2011, Lundvall 2013, Mazzucato, 2014) now agree that the political state has been the main driver of radical innovations with long-term effects for advanced economies and societies. Through the strategy of mission-oriented investments but also through the formalisation of normative directions for national, regional and sectoral innovation systems, the state has been actively promoting technological change. According to Mazzucato (2013: 196) ‘the mission-oriented investments ... make up about 75 per cent of public sector investments in innovation in many advanced economies ... Such missions, from putting ‘a man to the moon’ to developing the Internet (which was done through DARA ...) are driven not by the dynamics of the private/social ‘wedge’ but by direct objectives of government in question. Indeed, almost all general purpose technologies were fundamentally state funded.’

Government objectives are always justified in terms of certain moral and political doctrines which provide the overarching principles of political action and legitimacy. These doctrines include liberalism, neo-liberalism, socialism and social democracy. Clearly, since the 1980s, the justification of government objectives has been in terms of neo-liberal principles of individual freedom and equality before the law. The extension of these objectives to developing countries through the so called ‘Washington Consensus’ and ‘Structural Adjustment Programmes’ has failed to deliver across a range of regions, including Latin America, Sub-Saharan Africa and Eastern Europe (Papaioannou 2014). The neo-liberal doctrine behind the state of innovation in the last quarter of the 20th century has instead led to phenomenal inequality that now poses a fundamental challenge to sustainable prosperity in the 21st century (Ince 2014, Pikety 2013). This top-down science and technology (S&T) based innovation has claimed to be value-neutral but in practice has been a major contributing factor to the growing divide between rich and poor (Krugman 2002, Chataway et al. 2014). Evidence suggests that

how S&T based innovation is framed is a serious barrier to its usefulness in resolving major problems of global justice (Papaioannou 2013). Top-down innovation has been hierarchical and largely conducted separately from other non-government efforts to tackling major global challenges, notably in health, agriculture and energy. Therefore, it has excluded important segments of the population, failing to address inequality and the potential for long-term socio-economic prosperity.

In response to supposedly value-neutral, yet hierarchical and exclusive innovation that has been directed towards meeting the needs of rich winners in globalised markets, new models of innovative pro-poor products and services have emerged. These more responsible models of innovation have not been spontaneous by-products of globalised markets but deliberate and value laden efforts of civil societies and political states to innovate by taking on board societal, ethical and economic concerns in conditions of scarcity. According to Srinivas and Sutz (2008: 132-133) ‘scarcity-induced innovations (SII) [are] emerging from at least four important characteristics.

Cognitive: a) the canonical set of solutions can be relatively obscure and even absent from the mental landscape of the innovator, b) the innovator, even being aware of such set, is unable to use it and faces the need to address the problem differently.

Institutional or physical: lack of supporting organisations, laws, and technical instruments.

Socio-economic: a) when problems affecting developing societies have not been tackled at all b) existence of policy biases or c) solutions available are unaffordable, and new searching avenues need to be pursued ...

SII do not “scale up”. Individual capabilities do not translate into appreciable transmissible means of knowledge. SII are, more often than not “encapsulated” innovations. They can be “locally strong” yet remain isolated.’

These four characteristics of SII cannot be easily understood by those neo-Schumpeterian thinkers who conceive innovation in socio-biological and value-neutral terms. In developmental contexts, mechanisms of variation, selection and retention are vague whilst firms and routines barely exist in the way that such thinkers assume. Instead, there are innovation problems which need to be addressed responsibly with particular political and moral values in mind e.g. reduction of unjust poverty and inequality through responsible innovation.

Certainly the response of socio-biological thinkers to my criticism might be simply that ‘Darwinism provides an overarching framework of explanation, but without claiming to explain every aspect of detail ...Selection is the general principle, but it operates in different ways ...The sources of variation are very different in different contexts ...the transfer of Darwinian principles from biological to social evolution does not imply that the detailed mechanisms of variation, selection and inheritance are similar’ (Hodgson and Knudsen, 2004: 15). But if it is true that there is no implication of similar biological mechanisms working in social evolution then why some neo-Schumpeterians insist in the relevance of Darwinism for innovation studies in the first place? The answer might be found in their belief that the market is predominantly a value-neutral mechanism that leads to technical advances and for this reason it needs to be kept away from uncertain state planning (Nelson, 1990). Although uncertainty is a fact, it cannot reduce the importance of state planning and politics in the innovation process (Hurt 2011, Vallas et al. 2011, Keller 2011, Whitford and Schranh 2011). Contemporary neo-Schumpeterians such as Geels and Schot (2016: 26) are aware of the fact that critical sociologists and RRI and STS scholars are ‘allergic to evolutionary theories for three reasons. First, they associate evolution with developmentalism ... with a master process driving

societies through different stages towards a presumed end-state Second, they fear that biological analogies do not sufficiently acknowledge differences between humans and animals. Third, they assume that evolution proceeds through impersonal mechanisms with little room for agency e.g. blind mutations and market selection in evolutionary economics.’

Geels and Schot (ibid) make a genuine effort to alleviate the concerns of critical sociologists, RRI and STS scholars by emphasising the flexibility and broadness of socio-biological evolutionary concepts. However, what they seem to miss is the a-political nature of these concepts. This is in fact what critical sociologists, political theorists and STS scholars are allergic to: they find it difficult to explain technological evolution or sustainability transitions in abstraction from politics and the state. For them, who influences these institutions and shapes both funding and public opinion toward normative directions of innovation is important.

Conclusion

This paper has sought to unmask the rhetorical and ideological abuse of evolutionary theory by some neo-Schumpeterians’ value neutral and neo-evolutionist approaches to innovation, offering insights into how RRI scholars can demonstrate the value involvement in technological change. The aim has been to address three questions: can the theory of innovation be value neutral? Can the social and political context on innovation systems be ignored? What is the impact of value neutrality on effective integration of systemic, historical and political accounts of innovation? The answers to these questions are in the negative. Neither innovation can be value neutral nor can innovation systems be abstracted from their value laden contexts. However, not all neo-Schumpeterian thinkers share this conclusion with result the fragmentation of systemic, historical and political accounts of innovation. In fact, neo-Schumpeterian thinkers are far from constituting a unified school of thought in innovation. As

I have tried to show, there is a clear intellectual divide within this school of thought. Some neo-Schumpeterian thinkers tend to adopt value-neutral approaches and in this sense they are inconsistent with Schumpeter's theory of economic development. Most of these thinkers work within socio-biological frameworks of technological change and evolution, and tend to abstract from historical processes of value formation which influence the normative and political direction of innovation systems in developed and developing contexts. In this sense, they abuse evolutionary theory to cloak the de facto strong role of the state and politics in innovation. By contrast, some other thinkers appear to be more consistent neo-Schumpeterians, taking history and values seriously in their analysis of technological innovation. In doing so they understand politics and the state to be factors of generation of novel products and processes. For consistent neo-Schumpeterian thinkers the direction of innovation systems is predominantly normative and political. By contrast, socio-biologists are non-directional since for them the evolution of new technologies is a blind and non-teleological process of development. In conclusion, it might be said that independently of approach, neo-Schumpeterians need to explain better new emerging models of responsible innovation and technical change, especially in developing countries. These models are political and go beyond the classical notion of innovation based on individual entrepreneurship. A systems explanation of emerging models of innovation can still be possible provided it combines political and evolutionary factors from a historical perspective and not a socio-biological one.

References

Andersen, E. S. (2009), *Schumpeter's Evolutionary Economics: A Theoretical, Historical and Statistical Analysis of the Engine of Capitalism*, (London: Anthem Press).

Appelbaum, R. R., Parker, R., Cao, C., and Gereffi, G. (2011), 'China's (Not so Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the Twenty-First Century' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers), pp.217-235.

Asheim, B. (1996) 'Industrial Districts as 'Learning Regions': a Condition of Prosperity' *European Planning Studies*, 4, pp.379-400.

Asheim, B. T. and Coenen, L. (2005) 'Knowledge Bases and Regional Innovation Systems: Comparing Nordic Clusters', *Research Policy*, 34, pp.1173-1190.

Berlin, I. (1969), 'The Two Concepts of Liberty' in I. Berlin (ed) *Four Essays on Liberty*, (Oxford: Oxford University Press).

Block, F. (2011), 'Innovation and the Invisible Hand of Government' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers), pp.1-26.

Block, F. and Keller, M. R. (eds) (2011), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers).

Braczyk, H., Cooke, P. and Heidenreich, M. (eds) (1998), *Regional Innovation Systems*, (London: UCL Press).

Chataway, J. Hanlin, R. and Kaplinsky, R. (2014), 'Inclusive Innovation: an Architecture for Policy Development'. *Innovation and Development*, (4) 1, pp. 33–54.

Commons, J. R. (1924), *Legal Foundations of Capitalism*, (New York: Macmillan).

Cooke P. (2006), 'Devolution and innovation: the financing of economic change in the devolved administrations', www.devolution.ac.uk/pdfdata/Cooke_rsa_03.pdf

Cooke, P. (2007a), 'European Asymmetries: A Comparative Analysis of German and UK Biotechnology Clusters', *Science and Public Policy*, (34) 7, pp.454-474.

Cooke, P. (2007b), *Growth Cultures*, (London and New York: Routledge).

Cooke, P., Uranga, M. G. and Etxebarria, G. (1997), 'Regional innovation Systems: Institutional and Organisational Dimensions', *Research Policy*, (26), pp.475-491.

Cozzens, S. and Sutz, J. (2014) 'Innovation in Informal Settings' *Innovation and Development*, Vol.4, pp.5-31.

Dosi, G. (1982) 'Technological Paradigms and Technological Trajectories' *Research Policy*, (11), pp.147-162.

Dosi, G. (1988) 'Sources, Procedures and Microeconomic Effects on Innovation' *Journal of Economic Literature*, (26), pp.126-171.

Dosi, G. (2013), 'Innovation, Evolution, and Economics: Where We Are and Where We Should Go' in J. Fagerberg, B. R. Martin and E. S. Andersen (eds), *Innovation Studies: Evolution and Future Challenges*, (Oxford: Oxford University Press).

Dosi, G. and Nelson, R. R. (1994), 'An Introduction to Evolutionary Theories of Economics' *Journal of Evolutionary Economics*, (4), pp.153-172.

Edquist, C. (1997), *Systems of Innovation: Technologies, Institutions and Organisations*, (London: Pinter).

Edquist, C., & Johnson, B. (1997), 'Institutions and Organizations in Systems of Innovation', in Edquist (Ed.), *Systems of innovation: Technologies, Institutions and organisations* (London: Pinter Publishing), pp. 41-63.

Freeman, C. (1982), 'Technological Infrastructure and International Competitiveness', Draft Paper Submitted to the OECD Ad hoc Group on Science, Technology and Competitiveness, August.

Freeman, C. (1987), *Technology Policy and Economic Performance: Lessons from Japan*. (London: Pinter).

Freeman, C. (1988) 'Japan: a new national innovation systems?' in G. Dosi, C. Freeman, R. Nelson, G. Silverberg, and L. Soete, (Eds.), *Technical Change and Economic Theory*. London: Pinter.

Freeman, C. (1995). 'The National Innovation Systems in Historical Perspective'. *Cambridge Journal of Economics*, (19) 1.

Freeman, C., & Soete, L. (1997), *The Economics of Industrial Innovation*, (London: Pinter).

Friedman, M. (1962), *Capitalism and Freedom*, (Chicago: University of Chicago Press).

Geels, F. W. and Schot, J. (2016) 'Towards a New Innovation Theory for Grand Societal Challenges' *Paper for SPRU Anniversary Conference, 7-9 September*, pp.1-37.

Geels, F.W. (2014) 'Reconceptualising the co-evolution of firms-in-industries and their environments: Developing an inter-disciplinary Triple Embeddedness Framework' *Research Policy*, (43), pp.261-277.

Hay, C. and Lister, M. (2006) 'Introduction: Theories of the State' in C. Hay, M. Lister and D. Marsh (eds) *The State: Theories and Issues*, (Basingstoke: Palgrave Macmillan).

Hayek, F. A. (1960), *The Constitution of Liberty*, (London: Routledge and Kegan Paul).

Hobbes, T. (1968), *Leviathan*, (Harmondsworth: Penguin).

Hodgson, G. M. (1993) *Economics and Evolution: Bringing Life Back into Economics*, (Cambridge: Polity Press).

Hodgson, G. M. (2002), 'Darwinism in Economics: From Analogy to Ontology' *Journal of Evolutionary Economics*, (12), pp.259-281.

Hodgson, G. M. (2003), 'The Mystery of the Routine: The Darwinian Destiny of an Evolutionary Theory of Economic Change' *Revue Economique*, (54) 2, pp.355-384.

Hurt, S. L. (2011), 'The Military Hidden Hand: Examining the Dual-Use Origins of Biotechnology in the American Context, 1969-1972' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers), pp.31-56.

Ince, M. (2014), *Sustainable Prosperity: New Directions for Social Science Research: A Workshop Summary*, London: British Academy and ESRC. <http://www.esrc.ac.uk/files/news-events-and-publications/news/2014/sustainable-prosperity-new-directions-for-social-science-research/>

Jessop, B. (1990), *State Theory: Putting Capitalist States in their Place*, (Cambridge: Polity Press).

Keller, M. (2011) 'The CIA's Pioneering Role in Public Venture Capital Initiatives' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers), pp.109-132.

Krugman, P. (2002), 'For richer', in H.S. Shapiro and D.E. Purpel (eds), *American Education: Democracy and Meaning in a Globalizing World*, (New Jersey: Lawrence Erlbaum Associates).

Lukovics, M., Flipse, S. M., Udvari, B., and Fisher, E. (2017) ‘Responsible Research and Innovation in Contrasting Innovation Environments: Scio-technical Integration Research in Hungary and the Netherlands’ *Technology in Society*, Vol.51, 172-182.

Lundvall, B.A. (1985). *Product Innovation and User-Producer Interaction* (Aalborg: Aalborg University Press).

Lundvall, B.A. (1992), ‘Introduction’, in B.Å Lundvall (ed.): *National Systems of Innovation toward a Theory of Innovation and Interactive Learning*, (London: Pinter Publishers), pp. 1-19.

Lundvall, B.A., (1988), ‘Innovation as an interactive process: from user producer interaction to the national system of innovation’ in G. Dosi (ed.), *Technical Change and Economic Theory*. Pinter Publishers, (London: Pinter Publishers), pp. 349–369.

Lundvall, B-A. (2013), ‘Innovation Studies: A Personal Interpretation of ‘The State of the Art’ in J. Fagerberg, B. R. Martin and E. S. Andersen (eds), *Innovation Studies: Evolution and Future Challenges*, (Oxford: Oxford University Press).

Malerba, F. (2002) ‘Sectoral Systems of Innovation and Production’, *Research Policy*, (31), pp.247-264.

Mazzucato, M. (2011), *The Entrepreneurial State*, (London: DEMOS).

Mazzucato, M. (2013), 'Smart and Inclusive Growth: Rethinking the State's Role and the Risk-Reward Relationship' in J. Fagerberg, B. R. Martin and E. S. Andersen (eds), *Innovation Studies: Evolution and Future Challenges*, (Oxford: Oxford University Press).

Mazzucato, M. (2014), *The Entrepreneurial State: Debunking Public Vs. Private Sector Myths*, (London: Anthem Press).

Nelson, R. R. (1974), 'Intellectualising about the Moon-Ghetto Metaphor: A Study of the Current Malaise of Rational Analysis of Social Problems' *Policy Sciences*, 5, pp.375-414.

Nelson, R. R. (1990), 'Capitalism as an Engine of Progress', *Research Policy*, (19) 3, pp.193-214.

Nelson, R. R. (1993), 'National Innovation Systems: a Comparative Analysis'. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.

Nelson, R. R. (2004), 'The Market Economy, and the Scientific Commons' *Research Policy*, (33), pp.455-471.

Nelson, R. R. and Winter, S. G. (1982), *An Evolutionary Theory of Economic Change*, (Cambridge Massachusetts: Harvard University Press).

Nelson, R.R., (1992). 'National Innovation Systems: a Retrospective on a Study' *Industrial and Corporate Change* (1) 2, pp.347–374.

Nozick, R. (1974), *Anarchy, State, and Utopia*, (Oxford: Blackwell).

Papaioannou, T. (2012), *Reading Hayek in the 21st Century: A Critical Inquiry into his Political Theory*, (Basingstoke: Palgrave Macmillan).

Papaioannou, T. (2014), 'Innovation and Development in Search of a Political Theory of Justice' *International Journal of Technology and Globalisation*, (7) 3, pp.179-202.

Papaioannou, T. (2018) *Inclusive Innovation for Development: Meeting the Demands of Justice through Public Action*, London: Routledge.

Papaioannou, T., Wield, D. and Chataway, J. (2009) 'Knowledge Ecologies and Ecosystems? An Empirically Grounded Reflection on Recent Developments in Innovation Systems Theory', *Environment and Planning C: Government and Policy*, (27) 2, pp.319-339.

Penrose, E. T. (1952), 'Biological Analogies in the Theory of the Firm', *American Economic Review*, (42) 4, pp.804-819.

Perez, C. (2002) *Technological Revolutions and Financial Capital: The Dynamic Bubbles and Golden Ages*, Cheltenham and Northampton: Edward Elgar.

Piketty, T. (2013), *Capital in the Twenty-First Century*, (Cambridge Massachusetts: Harvard University Press).

Poulantzas, N. (1978), *State, Power, Socialism*, (London: New Left Books).

Saviotti, P. P. and Metcalfe, S. J. (eds) (1991), *Evolutionary Theories of Economic and Technological Change*, (Chur, Reading, Paris, Philadelphia, Tokyo and Melbourne: Harwood Academic Publishers).

Schumpeter, J. A. (1939), *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, (New York: McGraw-Hill).

Schumpeter, J. A. (1983), *The Theory of Economic Development*, New Brunswick and (London: Transaction Publishers).

Smith, A. Fressoli, M., Abrol, D. Around, E., and Ely, A. (2017) *Grassroots Innovation Movements*, London & New York: Routledge.

Srinivas, S. (2012), *Market Menagerie: Health and Development in Late Industrial States*, (Stanford: Stanford University Press).

Srinivas, S. and Sutz, J. (2008) 'Developing Countries and Innovation: Searching for New Analytical Approach' *Technology and Society*, (30), pp.129-140.

Steinmueller, W. E. (2013), 'Challenges for Innovation Studies in the Years Ahead' in J. Fagerberg, B. R. Martin and E. S. Andersen (eds), *Innovation Studies: Evolution and Future Challenges*, (Oxford: Oxford University Press).

Sterling, A. (2014) 'Democratising Innovation' University of Sussex, SPRU,
<https://www.sussex.ac.uk/webteam/gateway/file.php?name=innovation-paper---stirling--final.pdf&site=25>

Stilgoe, J., Owen, R. and Machaghten, P. (2013) 'Developing a Framework for Responsible Innovation' *Research Policy*, Vol.42, pp.1568-1580.

Vallas, S. P., Kleinman, D. L. and Biscotti, D. 'Political Structures and the Making of U. S. Biotechnology' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers).

Vallas, S. P., Kleinman, D. L., and Biscotti, D. (2011) 'Political Structures and the Making of U. S. Biotechnology' in F. Block and R. M. Keller (eds), *State of Innovation: The US Government's Role in Technology Development*, (Boulder and London: Paradigm Publishers).

Watkins, A., Papaioannou, T., Kale, D. and Mugwagwa, J. (2015) 'National Innovation Systems and the Intermediary Role of Industry Associations in Building Institutional Capacities for Innovation in Developing Countries: A Critical Review of Literature' *Research Policy*. (44), pp.1407-1418.

Weber, M. (1978), *Economy and Society: An Outline of Interpretative Sociology*, (Berkley, CA: University of California Press).

Whitford, J. and Schrank, A. (2011) 'The Paradox of the Weak State Revisited: Industrial Policy, Network Governance, and Political Decentralisation' in F. Block and R. M. Keller (eds)

State of Innovation: The US Government's Role in Technology Development, (Boulder and London: Paradigm Publishers), pp.261-281.

Willets, D. (2013), *Eight Great Technologies*, (London: Policy Exchange).

Winner, L. (1977) *Autonomous Technology: Technics out of Control as a Theme in Political Thought*, Cambridge MA: MIT Press.

Notes

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