Cooke *Journal of Open Innovation: Technology, Market, and Complexity* (2016) 2:13
DOI 10.1186/s40852-016-0036-x

Journal of Open Innovation: Technology, Market, and Complexity

RESEARCH Open Access

The virtues of variety in regional innovation systems and entrepreneurial ecosystems

Philip Cooke

Correspondence: CookePN@cardiff.ac.uk
Center of Innovation Studies, Bergen University College, Bergen, Norway

Abstract

Today, interesting and important interconnections have been made that promise great leaps forward for innovation systems and entrepreneurial ecosystems - especially operating at the regional or sub-national level of the space economy. Of course, there are politics in such relationships. Most notable are those that are critical of anything that "interferes" with market hegemony (neoliberal bias) which has weakened commitments such as those pioneered in South Korea in the early years of the twenty-first century, later to be followed by numerous Scandinavian policy experiments (Denmark, Norway and Sweden) as well as austerity policy to enlarge regional governance spaces, as in Germany and France (not to mention the dismantling in 2010 of Anglo-regional governance in the UK). Meanwhile, however, it can be seen that good progress in regional innovation policy and entrepreneurial accomplishment at regional level proceeds apace. This is known as the "co-operative bias" in contemporary political economy. Entrepreneurial ecosystems and regional innovation systems are excellent examples of "generative growth" mechanisms (floated in Cooke, P, Generative Growth, Knowledge Economies and Sustainable Development: implications for Regional Foresight Policy, 2002) as a counter to Romer-style individualistic endogenous growth theory. The paper explores the virtues of variety against those of linearity in innovation and entrepreneurial ecosystems in exemplary empirical instances.

Introduction

This paper presentation looks back on an effort to counterbalance the growing emergence of neoliberal hegemony in regional political economy at the beginning of the present millennium. In a paper by Cooke (2002) which existed as a guide for EU policy makers to an alternative approach to "new growth theory" and especially that variant that stressed "endogenous growth theory" (Romer 1990) the idea of "generative growth" was formed. This derived from very different and equally deep theoretical roots to those of the neoclassical perspective. Basically, it was critical of the radical individualisn, determinism and linearity of the neoclassical perspective and preferred an evolutionary, socially interactive and non-linear approach to political economy. Of course, history reveals that zero attention was paid to my advice by the relevant EU policy maker team. They followed the various Goldman Sachs, not to say Lehman Brothers, herds like their US policy mentors had approved. This included bending over backwards to allow US corporate high-tech technology commercialisers to retain transfer-priced tax, health service and other public contracts, and free trade (TTIP)

benefits to accrue to their rivalrous competitors. Most shocking was the way corporates and the US government first warned then cowed the EU with legal threats against "competitive advantage" in their own backyards (Myant 2015). The proposed trade agreement would fuel concerns that, for example, sovereign UK National Health Service trusts could come under attack from private contractors using the ISDS (investor state dispute settlement) tribunal system. This simulates a kind of "Economic Caesarism" reminiscent of appropriation rule in Roman Britain for the contemporary era of global competitiveness by all possible means.

In reconsidering the massive growth of neoclassical ideology and the even greater growth in malfunctioning of social relations, catastrophic effects of war, refugees and migration that have beset the global economic space of regions, nations and broad territories, the first thing to record has been the decline of co-operative, socially interactive and collaborative action in economic affairs more generally from 2000–2016. This may be displaying growing signs of decay but the power of capital's vice-like grip on the leading institutions of the global, bloc and national economies has continued to strengthen. Where may signs of the emergence of more evolutionary, socially responsive and learning predispositions be found? Amongst a few may be counted the continued growth, albeit not overwhelming, of collective innovation and entrepreneurship activity. Both depend significantly on knowledge formation, exploration, examination and exploitation among "strange attractors" who are often capable of interacting across borders (industries, sectors, clusters) to create and innovate with different kinds of creative actors. Although they may compete, they are also capable of collaborating to create something of commercialisable social value. Furthermore, while narrowly-defined science, technology innovation STI patent data is carefully recorded, the much greater contribution to innovative value from DUI "doing, using interaction" activity is widely acknowledged to be under or even un-recorded in the same way. It is like "dark material" in the universe, all around us but difficult to see. Entrepreneurs and innovators are largely responsible for such "dark material".

What is generative growth?

Because of their scarcity, knowledge economies thrive under globalisation. This is the milieu within which localised knowledge clusters interact with global value chains managed by multinational corporations. It was, until recently, contested as to whether globalisation was a meaningful concept (Hirst and Thompson 1996; Ruigrok and Van Tulder 1995; Cooke et al. 2000; Dunning 2000). But there is now consensus that it exists and is marked by a heightened organisational strength, extensively over the globe and intensively through global value chains. Thus production of goods and services is more deeply integrated for different stages of the value chain in a wider array of global locations than ever before. Global value chains are increasingly embedded in local value chains or clusters. Competitive advantage increasingly lies in firms, regions and countries coming to terms with these new realities, intensifying their direct and indirect capabilities for knowledge-intensive production, enhanced productivity, innovation and new firm formation that accompany integration of local and global value chains. Generative growth feeds off these interactions rather than being unproductively transplanted, as often occurs with 'redistributive growth', the style of incentivised and regulated movement of jobs and capital from locations where they were abundant to those where they were not. Theoretically it is an evolutionary concept that moves beyond neoclassical constructs like 'endogenous

growth'. The latter, even with its more realistic acceptance of realities like 'increasing returns' and 'imperfect knowledge' remains wedded to a notion of the satisficing individual consumer and a reductionism in its analysis of spatial development processes that even one of its main progenitors admits is 'simplistic' (Krugman 2000).

As is by well-known after a quarter of a century of neoliberal market hegemony allied with neoclassicism, "endogenous growth theory" holds that economic growth is primarily the result of endogenous and not external forces. Quite how globalisation, let alone financial contagion got off scot-free in that assumption is, of course, mystifying. Endogenous growth theory held that investment in human capital, innovation, and knowledge are significant contributors to economic growth. Otherwise known as "new growth theory" this justified such often publicly-funded spatial inequities as "technology clusters". Furthermore the contemporary reification of science and technology innovation (STI) as the wellspring of economic novelty treated much more common but less elitist (Doing, Using and Interacting; DUI) "knowledge" as less pioneering, inferior and less growth-inducing. As has become clear, this "world-view" is widely presented as an apology for agglomeration, increasung returns to scale and massive social polarisation by austerity governance. Thus entrepreneurship, including Kirzner's "entrepreneurial discovery process" (EDP), is reified - though not as much as global corporatism - as the necessary means to kick-start capitalism after the financial meltdowns of 2007–8 and afterwards.

Generative growth balances up that minority of successful STI translations of laboratory bench research into commercialised products and services against the majority of incremental, recombinant and cross-cutting innovations at interfaces that typify the day-to-day practice of both innovation and entrepreneurship. Especially, the evolutionary nature of generative growth takes account of individual and collective learning by firms and among enterprise support agencies. It is interested in but critical of certain determinisms that neoclassicists find sympathetic, like narrow, linear and "locked-in" path dependence compared to a more Schumpeterian recombinant "path-interdependence" which captures the interactive, to some degree "unpredictable" even "lawless" creative process that often characterises innovation as a social process. In particular the "evolutionary perspective" is dissatisfied with non-explanations for economic phenomena like the effects of chance as deployed by leading figures in the linear path dependence school (Arthur 1994).

Generative growth evolves towards "disruptive change" or "punctuated evolution" as described by (Schumpeter 1975). A market forms and firms imitate or "swarm" around an innovation, usually in a knowledgeable or otherwise asset-privileged space, as a consequence of specialised knowledge application. There were two types of generative growth cluster in the earlier formulation of Cooke (2002): the pure 'Knowledge Economy' kind, and that better referred to as 'Knowledge Upgrading'. In Evolutionary Complexity (ECT) theory, these are known as the "Adjacent Possible" and the space of "Preadaptation" (Kauffman 2008). The former is exemplified in, say, a genomics cluster, the latter in a premium food or design-intensive textiles cluster.

Generative growth often occurs where local and global value chains move into alignment. The key policy demand is foresight and to be sufficiently knowledge-capable to anticipate such alignments. This is par excellence the province of the entrepreneur, especially that of

the entrepreneurial ecosystem, and a skill for the toolbox of the policy maker as collective entrepreneur. For as well as positive dynamic externalitities such as early access to innovations, special investment expertise and cultural assets like "swift trust" and "gift exchange" relationships, there are non-sustainable, negative spillovers like congestion, pollution, long working hours, tiny workspace "cubicles", uncertain compensation, high living costs and lengthy commuting that moderate the attractiveness of the model. However, these negatives also leave space for the judicious "collective entrepreneur" to operate.

But before exploring the downsides of extreme generative growth, we must extend this analysis to the question of sustainable regional development. The first critical perspective on this is the initial idea that sustainable development was complicit with entrepreneurship because it is fatally undermined by its dependence on the market mechanism above all. Therefore, even allowing for a regulatory constraint on overconsumption of natural and other exploitable resources, there remains an incentive to find entrepreneurial loopholes in the regulatory regime to earn profit. Moreover, exploitation of, for example, environmentally damaging resources was initially facilitated in "sustainable development" ideology as long as enough was left for future generations to exploit. This applied even if the future of the viability of the planet was threatened by not leaving-for example-polluting hydrocarbons in the ground. So the benign imagery of sustainable development became tarnished. The rhetoric of "communality" supervenes in preference to pure acumulation by "possessive individualism" over property rights. Comparably, Lukes (1974) critiques its "methodological individualism" which is given a radical reinterpretation by such communal entrepreneurial purpose as aspiring to more inclusive forms of power and profitability. It is in this "generative" dimension that the emergence of a more evolutionary approach to entrepreneurial ecosystems gains particular interest.

In this respect, three key lessons can be learned from the "innovation systems" literature, especially that associated with regional development, for reference to both the contrasting and competing interests of "entrepreneurial ecosystems". These are, in no particular order of preference, the following.

- First, innovation (after Schumpeter 1934) is inherently recombinant, drawing inspiration from several cognitive and material sources. These "new combinations" are inherently socially interactive in nature,
- Second, while commercial exploitation is the purpose of successful combinations, they may nevertheless be socially useful innovations for the innovator much more than the entrepreneur. There are many cases of altruistic innovation.
- Third, innovation is fundamentally a "learning" procedure involving networks of innovators in "gift exchange" or "studied trust" type interactions to achieve the "adjacent possible" or cross "structural holes" from the known to the unknown.

By contrast, entrepreneurship is less exploratory (despite Kirzner (1997) in its "entrepreneurial discovery process" or EDP) and relies more upon successfully repeated routines. This is because of its liberal individualistic tradition; with its more evolutionary learning mindset, entrepreneurial ecosystems thinking is likely to moderate such bias.

One important point which supports this last contention regarding interactive learning is found in the archetypal regional innovation system which also overlaps with

recombinant platforms of an entrepreneurial ecosystem is Silicon Valley. Just a single evolutionary concept that has occupied much thought among entrepreneurs calculating possible futures for this space is that concerning "basic income" (Green 1983; Green 1985). A basic income is an income unconditionally granted to all on an individual basis, without means test or work requirement. One key idea is that all citizens are guaranteed a wage, comparable to a retired person's state personal pension. The complementary idea is to promote a simpler, cheaper welfare system and to make it easier for unemployed people to get into the workforce. Despite its traditional provenance, recent advocacy for the reform has come from entrepreneurs and "small state" neoliberals but also other political camps than the right wing, such as the Greens and some socialists and feminists. Among various recent converts noted by (Fearn 2016) in a brief progress review are Canada's province of Ontario and other governments such as Switzerland (voting in June 2016), The Netherlands (Utrecht region) and Finland (launching a basic income in 2016). That it is adhered to by numerous Silicon Valley entrepreneurs is a sign both of that culture's abhorrence of regulatory control but also of a certain sympathy for communal action for socially useful purposes.

To conclude this sub-section, we have provided several discussion points about "generative growth". It can be seen to have evolutionary economic geographic origins and is set up in contrast to the unitary, atomistic and individualistic neoclassical "assumptive world" that fuels neoliberalist, market dogma. As such, it has recombinant and distributed knowledge sources that feed into innovations, commercialised for market and social purposes. A key element of its evolutionary economic geography resides in re-combinations of different kinds of nearby and more distant geographic proximity (Boschma and Martin 2010). These interactive characteristics express and realise advantages from social learning compared with the more "spontaneous" and opportunistic herd-instincts first characterised by Schumpeter (1934) as "swarming". Entrepreneurship involves much imitative "swarming" and it may be hypothesised entrepreneurial ecosystems retain that characteristic, albeit moderated to some extent by a less individualistic form of value capture. Innovation, notably at regional level, is frequently characterised by relatively low value capture and, in practice many innovators vacate the origin of their discovery in a start-up or spin-off firm accordingly. Here the skills of the other actors in the entrepreneurial "division of labour" are more highly valued for exploitation of a repetitive kind than the often unstable creative processes associated with exploration (March 1991).

Innovation and entrepreneurship: the regional milieu and the ecosystem

To elaborate somewhat on what was just referred to as the entrepreneurial "division of labour" it is worth reiterating that what were once summarised by Schumpeter as four functions have by now been elaborated to at least seven, as follows.. Thus modern entrepreneurship research recognises, apart from the innovator, more than Schumpeter's four roles in innovation, which were:

- the inventor, who invents a new idea;
- the entrepreneur who commercializes this new idea;
- the banker, who provides the financial resources to the entrepreneur (and bears the risk of the innovation project);
- the manager, who takes care of the routine day-to-day corporate management.

These roles are most often executed by different persons (Kenney 1986). Stam (2007) goes further in his review paper on distinctive roles found to be operating around innovation. He observed that nowadays these distinctions designate a complex-systemic (later "ecosystemic"; Stam 2015) - process whose key actors are as follows:

1. the person who bears uncertainty (Knight 1921);
2. an innovator (Schumpeter 1934);
3. a decision maker (Casson 2003);
4. an industrial leader (Schumpeter 1934);
5. an organizer and coordinator of economic resources (Marshall 1890);
6. an arbitrageur, alert to opportunities (Kirzner 1973, 1997);
7. an allocator of resources among alternative uses (Schultz 1982).

Accordingly, when one hears the somewhat simplistic injunctions that - to grow, regions should innovate – it is salutary to calculate the number and variety of skills and expertise required to actually move a "recombinant idea" into "practical commercialisation" status. This applies even more so to injunctions such as "entrepreneurial discovery." Moreover, as implied in evolutionary complexity theory (ECT), which ponders novelty and the nature of its embedding economic fabric (Kauffman 2008; Arthur 2009) innovation requires a clear purpose to initiate and energise such a complex project exercise. This is discussed in the fourth main section. Without a core idea on to which knowledge and artifacts may be brought to converge on some novel practical and/or commercial solution or offering to the market-say "manned flight" or "mobile communication"- there can be no innovation. The mistake is over-simplifying "entrepreneurial events" by conceiving them as individualistic practice rather than being embedded in "entrepreneurial ecosystems" of interacting and complementary capabilities and assets (Stam 2015).

As a result of thinking through the interactive logic of key distinctive functions in the EDP it is rapidly evident that entrepreneurship is both more complex than hitherto believed by those who conceive it as the expression of pure individualistic "outsiderdom" and yet simultaneously in a commonsense way "washing its face" in profitability. This introduces the (questionable) concept of the "entrepreneurial ecosystem". Questionable, because it proposes interactions among diverse skill-sets among enterprises, which are carriers of institutional value rather than atomised units of profit realisation. We shall return to this many times in what follows, tending to prefer the institutionally more accurate label (enterprise ecosystem) over the individualistic one. Thus it makes more sense to connect enterprise to the idea of an ecosystem, which (in economic terms) consists of interacting, value-creating entities embedded in a socio-technical system (STS) or context that sustains both.

It is meanwhile worth reflecting that entrepreneurial interactivity may display constraints of institutional "path dependence" that can habitually and easily cross the boundaries of legality. Enterprise ecosystems are less "privatistic" as Stam (2015) refers to them. Thus, as an illustration, the sale by a British entrepreneur of 1,500 fake bomb detectors at a cost to Iraq's interior ministry of £52 million occurred during 2008 and 2009. These were subsequently revealed to have been made from a metal aerial and an empty plastic box ("novelty golf ball finders") and the fraudsters jailed for 10 and 7

years. The devices cost as little as £2 to produce but were sold for as much as £15,000 each, resulting in a trade worth up to £3 m a year.

Responsible British government department administrators and their agents promoted international sale of the devices, which are on record as having cost lives, despite a UK government warning they were useless. Even in 2015 after the Sinai terrorist attacks, tourists trapped in Sharm el-Sheikh continued to be victims of the Egyptian security services using the same bomb detectors that had been exposed as fake over the previous 7 years. Naturally, this is an extreme case, but it is testimony to characteristics of entrepreneurship that are overwhelmingly rent-seeking and exploitative. Accordingly, they are shared to a far lesser degree than the explorative and often "disinterested" features of innovative activity. Yet, to reiterate Stam's (2015) observation above, the actors involved constituted an entrepreneurial ecosystem of military businesses supported by numerous government agencies, military engineering assessors "experts" and military marketing professionals from overseas trade shows to foreign sales networks.

So this is, in so many ways, from fraud and corruption to multi-client incompetence, a bad entrepreneurial ecosystem. To be as fair as possible in adjudging the potential for benign, collective exploitation of entrepreneurial ecosystemic behaviour, the following helps to balance up the picture. Here, a widely implemented business model involves social enterprise for employment and skills training. The entrepreneurial aspiration here involved building an online community of computer workers, hired from underemployed communities. The programme trained each of them to undertake, for example, a single language programming exercise or translating of code for a common application program interface (API). Recombining such skilled cohorts of practised entrepreneurs allows them to complete a service for a client that would normally only require 1 or 2 people. Accordingly, this exploits synergies among highly micro-specialized professionals. These reap both scope and scale advantages from divisions of labour which may form a "virtual assembly line" allowing faster task completion, lower service cost and higher quality standards. This scores particularly well over traditional outsourcing by general practice knowledge workers. Incomes and job satisfaction are higher from virtual assembly-line set-ups. This demonstrates that entrepreneurial ecosystems can be profitable, communal, based on learning and socially benign.

Two final points round off this preliminary analysis of the entrepreneurial ecosystem idea before a comparable exercise is conducted for the regional innovation system model. Two things remain to be tied up at this point. First, it is patently clear from the above discussion that entrepreneurship and innovation or their agents, entrepreneurs and innovators, are completely different in nature, skills and outlook. This will become even clearer in discussing the nature of innovation in the context of "novelty", creativity and the idea of "newness" per se. In brief, the entrepreneur is profit-driven to a far greater degree than the innovator. The latter may be interested in profit-taking but may equally be disinterested in or indifferent to profit and - for example - more actively interested in awards or social respect as expressed in social or academic prizes. Venture capitalists routinely replace, in particular, academics from management roles in scientific start-ups, as a case in point. Entrepreneurial ecosystems, too, are largely driven and governed by market relations and the profit motive. But, second, as demonstrated in the exemplar of the "virtual assembly line" among computer entrepreneurs, such ecosystems are capable of collective, communal or "generative growth" that is not

simply reducible to the bare "arm's-length exchange" of the individualistic pursuit of profit. Accordingly, there is potential for the accumulation of social value and associated economic efficiencies and effectiveness that are superior to the traditionally hegemonic model of individualistic "property rights" entrepreneurship.

Innovation and the regional milieu

In the following sub-section we devote attention to the more established evolutionary economic geography architecture of "regional innovation systems" (RIS) well-rooted in a twenty-five year pedigree of theory, empirical analysis and policy application. Currently such policy implementation became the European Union's required methodology (RIS3) for all regions in the EU to formulate their bids to the European Regional Development Fund for regional economic development assistance (€185 billion 2014–2020). For the first time since 1988 the EU programme budgetting methodology based on budgetary quantities, while retained as a financial management tool, shifted away from its purely procedural accounting approach to a more substantive, content-driven regional innovation policy (RIP) outlook. However, such are the "assumptive" ties that bind in Brussels that ideologically it remained wedded to a neoliberal economic EDP (entrepreneurial discovery process) model or "chaotic conception" requiring "smart specialisation" as its ideal regional scenario.

This overlooked at least 75 years of regional economic development research and policy analysis which demonstrated that economic variety is superior to specialisation. Forced to recognise this mistake by the EU's own economic geography advisors, a new RIS3 injunction that specialisation was to be treated as equivalent to diversification (or variety) thus resulted in the "chaotic conception" at the heart of the EU regional innovation strategy. Nevertheless, with its new emphasis on evolutionary economic development processes as the rationale for spatial strategy formulation the RIS approach marks a big step forward in the large-scale financing and policy implementation of the regional "milieu". Drawing attention to the importance of "regional milieu" emphasis is drawn to GREMI a Francophone RIP and economic geography community that first evolved the concept. It has three important elements, which build upon regional "varieties of capitalism". To summarise first, GREMI has to explain why the regional level of activity and identity is important. This is notably because some sub-national areas are very distinctive, culturally, democratically and even economically while others are less so, having weak cultural markers, centralised administration and disarticulated economic activities (neither specialised nor diversified).

One way of conceptualising this is by means of an approach to innovation governance, suitably adapted, that facilitates understanding (Dosi 1982; Freeman and Perez 1988). Overarching the two key sub-systems in this variant of milieu theory is the "socio-technical system" (STS). A good example of macro-theorising, this is in reference to the dominant socio-economic era which, from the Industrial Revolution to the present day, remains under the hegemony of hydrocarbons. All long waves (after Schumpeter 1934) have been fuelled by carbonised production processes. But within that STS, some regions innovated woollen and cotton textiles, or shipbuilding, or coal and steel, or food processing, furniture, carpets etc. in what Marshall famously called "industrial districts". These are the forerunners of "regional milieux". Each milieu has

an economic "paradigm" in which innovations (and subsequent "entrepreneurs") evolve, are fashioned or designed. They may often display diversity or what is nowadays called "related variety". Examples of this occurred in economic history after stagecoach building mutated towards bicycle manufacture, then motor-cycle manufacture and finally combustion engine vehicles. Often these mutations evolved in the same milieu, using similar raw materials such as steel, rubber and later, glass. Some later became aeronautics "milieux" and modern centres of expertise in systems and software. Together, although of different vintages, such milieux evolved over time by exploration in proximity of diversity. Such interactivity (which associates with "generative growth" most strongly) is based on synergies that derive from industrial relatedness. Together, these contribute in major "path dependent" ways to regional variety.

Complementing such a "regional paradigm" is what in the governance literature is known as a "regime" which in this context refers to the "regional regime". This is an organisational structure of governance bodies such as ministries and various regional agencies or bodies that receive funding in support of regional innovation policy. Networks of interaction among such RIP actors and "paradigm" actors facilitate "generative growth" but not neoliberal competition in the same way. Such regions nevertheless may display distinctiveness because of this. At a different strata of activity is the "institutional" level, which is more informal or less formal than the organisational structure of the region. Here "assumptive worlds" on reputational, expectation and rules of the game grounds mould the regional "regime" actors into something like a regional institutional culture. This also contributes to regional variety such that industrial character may be isomorphic with regime character in comparable regions, even in different countries. Finally, at a relatively diluted level we introduce the "conventional" level where everyday practice outside institutional and organisational life occurs. So uses of language, trust, exchanging favours, sharing seasonal tasks add to the "regional regime" in the form of specific bonding or bridging capital, which also has some economic value and further contributes to regional related variety.

It now remains to perform a comparable effort for RIS and its associated RIP to that done regarding "entrepreneurial ecosystems". It will be recalled that a binary good/bad ecosystem was hypothesised and supported with data. In this case, similar forms of disarticulated and articulated "paradigm" and "regime" relations will be explored. One of the most difficult RIS set-ups to deal with is one that has suffered a significant "resilience" shock. A paradigm case of this occurred in my own territory of Wales, the RIP experience of which was written up in Cooke et al. 2004). We can say that, if not a leading STI innovation arena, this complex nevertheless displayed clear DUI innovation features.

Following the deindustrialisation of Wales, which culminated in the Thatcher government's closure of most of the coal and steel industry, some effort was made at restructuring the economy. Before devolution in 1999, the UK government administration for Wales fashioned a strategy to intensify the level of investment, both domestic and overseas, in automotive and electronic engineering. By the 1990s the restructuring and downsizing of heavy industry had evolved. Accordingly, at that time, with 5 % of the UK's population and GDP, Wales attracted between 15 and 20 % of inward investment (FDI) in the UK (Cooke 1995).

This was not an "entrepreneurial ecosystem" but an "MNC-FDI ecosystem", for unlike earlier FDI it involved little elaboration of supply chains or "open innovation". But the influence of Asian and European FDI was different and anticipating supply chain

formation from domestic and foreign suppliers. Thus Sony arrived in 1974, followed by Hitachi, Panasonic (Matsushita), Aiwa, Brother, Sharp and Orion, all involved in consumer or office electronics. Later, LG from Korea, wafer fabrication firms International Rectifier (US) and Trikon (UK), and components firms from Hong Kong and Singapore joined the cluster. With the exception of Sony, which transformed itself from a TV and computer screen manufacturer into a leading microcomputer for code-training (Raspberry) in the 2010s. However, Sony employs about 100 compared to 1,400 twenty tears or more ago, while Panasonic, Hitachi, Aiwa and Brother have closed their operations in Wales and LG from South Korea lasted only a few years. Needless to say, "open innovation" and supply chain elaboration came to a grinding halt.

In automotive industries, Ford opened an engine plant in 1978, followed by acquisitions or new, greenfield investments by Calsonic, Valeo, Lucas-SEI, Robert Bosch, Trico, ITT-Alfred Teves, Ina Bearings, Sekisui, Yuasa, Gillet, Grundy and Hoesch-Camford. By 1992 production of 200,000 engines a year by Toyota began as supply to their European assembly plants. Valeo, Robert Bosch and Lucas-SEI have retreated but others have remained and now a thriving "open innovation" set-up has recently been announced as the new location for Aston Martin's luxury SUV (TVR sports cars also have Wales heading their location shortlist). Unlike electronics, automotives has proved more durable as a supply chain customer and RIP animateur. From 1999, the Ford Bridgend engine plant became the sole Zetec engine source, producing annually 700,000 of these and 55,000 Jaguar AJ26 V8 engines. New ranges of Jaguar and Land Rover engines were frequently announced in the 2000s, to be produced at a rate of 325,000 per year. Subsequently, when these customers were sold to Indian MNC Tata they continued to source relevant engine technologies. Simultaneously, Toyota engine production expanded to 500,000 engines by 2003. Formerly deindustrialising Wales had evolved into a key centre of high-quality, high-skill automotive engine production in Europe, with 2,400 employed at Bridgend and 600 at Deeside in north Wales.

Two shocks occurred amidst these developments. First, much of the demand for MNC-FDI in electronics disappeared with its importance to RIP and the RIS in engineering. Thus losing Hitachi and Aiwa with its local suppliers association shared partly with its parent Sony, meant its supplier links disappeared. Global-scale crisis in Asia at the turn of the millennium meant that the South Korean government enforced LG to sell Microchip assets to Hyundai. So LG could never implement its strategy to support university research. At that crisis time, purchase by Tata of Corus Steel meant closure of its 200-person new materials research laboratory. Embryonic 'Triple Helix' relations among universities, businesses and government agencies atrophied with the loss of regional personnel to act as intermediaries and commissioners of research. The second shock was that large numbers of jobs were lost even during this "second restructuring" undermining Wales' emerging reputation by some 44,000 jobs between 1998 and 2002. This meant that a further readjustment towards a "post-industrial" future and one based on less engineering had to be faced. One consequence of this was that the European Union recognised Wales as justifying the full measure of EU regional industrial and innovation assistance to the tune of some £3-4 billion from 2000 to 2020, a status that RIP has never managed to make significant inroads into in terms of "high-road", well-paid manufacturing employment. In contrast, Wales has evolved into a "low-road", "low-income" post-industrial retail and office-services economy. Needless to say, demand for RIP is scarcely buoyant under such circumstances.

RIS without RIP: innovation self-mutates

The most obvious RIS to transmute far more successfully, already by now a platform of intersecting clusters, is Silicon Valley. This is a type of RIS that displays strong, world-beating entrepreneurship rooted in its science and technology (STI) drivers that are primarily invoked by recombinant innovation (Saxenian 1994). It is widely referred to as an "entrepreneurial regional innovation system" (ERIS) because it doesn#t directly rely on the kind of public RIP strategising so common in Europe and many "developmental states" like Singapore and Taiwan, for example, in Asia (where the institutional regional innovation system (IRIS) is more pronounced). As is well-known, only a few of the original Silicon Valley semiconductor fabricators from the early days still have a presence in the core location, two of the best known being Intel and AMD. Alongside their suppliers and other design rather than fabrication plants we can say the original seed crystal survives. As for computer fabrication, clearly Apple, an original Cupertino locator from the early 1970s, and many of its suppliers (though many more are now in Asia) remain or join and - like Intel, a long-term Apple supplier - thrive and grow. Newer entrants, grown to giant scale, like Google and Facebook also thrive in this ICT ecosystem and to an extent diversify in terms of related variety, notably Apple towards electric vehicles (EV) and Google into electric automated vehicles (EAV).

This somewhat imitates the earlier move of former PayPal entrepreneur Elon Musk who established the successful Tesla premium EV brand in Palo Alto in 2003. But, of course, before these mutations from ICT into EV and other renewable energy applications, Silicon Valley had also become a favoured site in which biotechnology start-ups and spin-offs could thrive. Accordingly, early movers, like Cetus and Genentech located in south San Francisco, arguably close to but not right in Silicon Valley, started the earliest California biotech cluster. In such science-driven (STI) innovation, proximity to the "mother-ship" in this case the University of California Medical School, was essential. Nevertheless, venture capital from nearby Palo Alto was also available and, in any case, the biotech funding model is different, with a large patron like Swiss giant Hoffmann LaRoche (now Roche) being a normal funding and research partner and, since 2000, owner of Genentech, the early dedicated biotech firm (DBF) in question. Other incumbents in the Silicon Valley biotech ecosystem have included firms like Gilead, Amgen (HQ Los Angeles) and AbbVie (former Abbott Labs). Though these are biopharmaceuticals firms, 40 % are in biomedical diagnostics, directly utilising ICT advances from their advanced electronics neighbours in many cases.

Up to the present Silicon Valley ICT and - to a lesser extent - biotechnology firms have undergone a third mutation into renewable energies, notably alternative fuels based on algae and other types of agro-food derived combustibles. Also moves were made - as noted - into EVs and other applications. Major green industries with a significant presence in the state are: Solar, Wind, Biofuels, Smart Grid, Energy Storage, Fuel Cells, Hydro, Geothermal, Green Building, Energy Efficiency, Sustainability and Electric Cars. The top ten occupations for green jobs in California by the number of green jobs in each occupation are: Carpenters involved in green activities filled 46,150 jobs; followed by hazardous materials removal and remediation workers at 43,470 jobs; 43,110 people were employed in green, sustainable or organic agriculture; there were 40,350 assemblers working in green manufacturing; 36,060 recycling centre operators; 24,750 electricians worked in green sector jobs; there were 23,000 plumbers, pipefitters, and steamfitters working in green economy related jobs; 21,670 architects (excluding

landscape) worked in green economy related positions; 20,340 industrial production managers found employment in green sector areas; and 19,330 construction managers worked on green projects. Jobs also grew in the Silicon Valley (& San Francisco) smart grid sector from 1995 to 2011. Thus between 1995 and 2011, smart grid employment more than doubled to 17,800, up from 12,560 in 2009, and more than double the number of those jobs in 1995 (Cooke 2015).

It may briefly be concluded that Silicon Valley displays the two key modern-day forms that combine both innovation systems and entrepreneurial ecosystems. Historically, as Saxenian (1994) shows it displayed the kind of communality, shared communities of practice and, strikingly, a dynamic transformational "platform"- like interactivity based on recombinant innovation. In the absence of public economic governance more typical of RIS set-ups, community action was capable of being activated by the economic community who often co-inhabited the "silicon localities" in proximity with their workforces from whom they recruited. Nowadays, a new wave of less benign, excess-driven entrepreneurialism sees the San Francisco skyline changing wth luxury skyscrapers and infrastructure of a far more exclusive kind represented by "Google Buses". One of the key facilitators of this transition is the absolute social polarisation that has occurred by the awarding of huge shares of entrepreneurial wealth to an undeserving minorities of –"super-entrepreneurs". Thus we may conclude that there is some symmetry in the conceptual and empirical vignettes that have been mobilised in support of our thesis that innovation tends to be communal while entrepreneurship tends ultimately to be individualistic and exclusive. Accordingly, while both display system or ecosystem type qualities, those associated with innovation are less inegalitarian, less market-reifying and more attached to the disinterested pursuit of knowledge for its own sake. This inclines innovation towards the recombinant and interactive side of the equation while the entrepreneurial ecosystem is, in general, more imitative and profit-motivated with a relatively lower-profile moral business posture.

Reflections on current limitations of entrepreneurial ecosystems

We have now devoted a substantial amount of thought about conceptual and empirical matters on the subject of "entrepreneurial ecosystems". We now propose to elaborate on some of the key challenges faced by the emergent field, some of which show promise while others point to difficult or impossible impasses of a theoretical and, accordingly, scientific nature.

We can say, with Schumpeter (1934) that he set off a contest in which there was a clearer re-definition of novelty and "the new". But he also deduced there that as economics was an evolutionary science, the products of its recombinations were, in their practical and commercial use-value, strictly indeterminate or unpredictable. This, of course, is a major barrier to innovation. Finally, in an earlier article only published in English in the present century (Schumpeter 1932/2005) he concluded that it was the requirement of novelty that makes the process of innovation unpredictable, accordingly proposing that explaining how novelty is moved from indeterminacy to determinacy was the greatest unmet scientific challenge of his day.

It can be argued that the neo-Schumpeterian school that has made such major progress in the modern study of innovation as recombination of knowledge (including knowledge-embedded technologies) has answered important aspects of that puzzle.

Thus we can say with confidence that innovation has limits without being reductionist about its circumscription. Innovation is a creative, commercially (socially) relevant and novel recombination of old and new knowledge and technologies. "Relevance" here denotes novelty may have to await the removal of other innovatory bottlenecks Balconi et al. (2010). Accordingly time economies often interrupt innovation profitability: even novel methods of "knowledge insurance" such as milestone payments and special purpose vehicles (SPVs) are fashioned in recognition of the risk entailed in expectations of future rewards. Underlying that institutional willingness on the part of public and private innovation funding agents to execute such investment risks is what ECT theorists of economic evolution like Kauffman (2008) refer to the "purposiveness" of innovative action. As ECT suggests, surrounded by Lego bricks of all kinds, the innovative actor may veer from cognitive listlessness to paralysis in the search for inspiration by clear, purposive action. Only then are the appropriate recombinant, related varieties of knowledge and artifacts/technologies selected for assembly as purposive innovations. At high levels of complexity, self-organization of innovation processes are implied where the "global controller" used to manage the blueprint decision-making of earlier eras as described for assembly of the Large Hadron Collider (LHC) in Boisot et al. (2011). Among the associated advances, the analysis of the value curve also now shows the structuring of innovation value exchanged through "open innovation" in relation to the "power laws" of intellectual capital:labour and locational ratios (Cooke 2013).

By comparison, the state of development of entrepreneurship studies seems theoretically immature. These issues of complexity and interaction have for too long been overlooked in spatial entrepreneurship circles. The complexity dimension underestimates the difficulties involved in conducting entrepreneurship. The interaction dimension occurred traditionally by over-simplifying "entrepreneurial events" by conceiving them as individualistic practice. But new problems arise from the improved, evolutionary perspective we now find being embedded in "entrepreneurial ecosystems". Some problems resolved in neo-Schumpeterian evolutionary economic geography of innovation concerning interacting and complementary capabilities and assets remain open questions for entrepreneurship research (Stam 2015). Among that raised by Sternberg (2007), Malecki (2011) and Stam (2015) and others, in revaluing the ecosystem contribution to the analysis of "high-growth start-up entrepreneurship" is overestimating the role of STI practice in most innovation. A more nuanced recognition has emerged of high value innovation based on "doing and using innovation" (DUI) interactive learning in relation to cognitively but not spatially proximate regions (eg Wassermann et al. 2016).

Space constraints disallow further important conceptual distinctions that have evolved in the analysis of how "new combinations" occur. Foremost here is Andersen (2011) but it is also found in the entrepreneurship literature, which often closely relates to that focused on innovation, though, as we shall see, the two are widely different. A brief diversion on "entrepreneurship" is warranted by the heavy emphasis in EC (2012) on promotion of the "entrepreneurial discovery process" in RIS3 strategising. In Schumpeter (1932/2005) he "doubts the explanatory value of entrepreneurship", suggesting that theoretical advances were needed to fashion an improved theory of the social dynamics underpinning novelty in his terms. While Andersen (2011), in recuperating Schumpeter's framework for analysing regional innovation, draws attention to his functional differentiation of the roles of inventor, innovator, financier and entrepreneur,

showing already at that early stage practice was already much more complex than the proposed "entrepreneurial discovery process".

Much of this comes down to the, by now, questionable "assumptive worlds" that entrepreneurship advocates promote, Foremost among these is the still abiding adherence to the individualistic model of pure entrepreneurship that is promulgated in entrepreneurship studies. To its credit, albeit at an immature stage of theory and appropriate empirics, this is precisely what the "entrepreneurial ecosystem" idea rails against most. At least from this perspective the notion of "communities of practice" and functional divisions of labour among collectivities of enterprises is privileged. However, so far there is precious little conceptual evidence of two further elaborations needing to be adressed in the research designs of studies into what we will resist the temptation to term "enterprise ecosystems", First, there is little differentiation of entrepreneurship/enterprise in terms of sector, scale and structure in testing hypotheses about the importance of each to the specific population under inspection. Second, there is little evident appreciation of the issue of the extent of diversification or variety of interactions among ecosystem members as compared with the alternative of particularistic or specialist interactions and which are of value to enterprise performance under what circumstances, historically or spatially (including regionally and/or locally).

This atomized treatment of entrepreneurship as against the more non-individualised notion of "enterprise" betrays both its intrinsic "assmptive world" but it also acts as the source of the undifferentiated nature of the "classes" into which firms are selected – overwhelmingly, nowadays "fast, less-fast and slow growth entities". This finally devolves into measurement by profitability. And this in turn leads into measurement of entrepreneurs. In Stam's (2015) useful parody of the overarching rationale for entrepreneurial ecosystems, a weakness is that:

> "The (entrepreneurial ecosystem) phenomenon at first appears rather tautological: entrepreneurial ecosystems are systems that produce successful entrepreneurship and where there is a lot of successful entrepreneurship there is apparently a good entrepreneurial ecosystem." (p.1764)

As a rigorous agenda for a research programme, this clearly leaves a lot to be desired.

So unlike the "enterprise ecosystem" the "entrepreneurial ecosystem" is betrayed by its atomistic, undifferentiated (except in terms of "high-growth") profit-motive driven perspective into which it remains "locked-in".

The reverse side of this characterisation is that, what Stam (2015) terms the eternal "laundry lists" of attributes that successful entrepreneurship need to display to be deemed successful are largely meaningless because only the winners get bestowed with prestige. Presumably, research could show that the losers were even more assiduous in pursuing markets, workforce, finance, support, regulations, training and so on than the winners. This would then lead to attempts to discover the "magic elixir" that the winners absorbed but that the losers failed to appreciate; that way the road to alchemy beckons: "laundry-listism" has a notorious pedigree in business studies higher education, notably in "Change Management" MBA courses, where most recipes boil down to a kind of military "follow my leader" based on past history more than current or anticipated crises (Cooke 2012). More than anything such thinking is irremediably procedural and "process, process, process" ridden conservatism rather

than paying much needed attention to substantive, content issues of entrepreneurial "purposiveness" (Stacey 2002).

Finally, to return to Schumpeter's concerns about the static nature of entrepreneurship or, by now, preferably "enterprise ecosystems" we may contrast this with our earlier and indicative suggestion of static-dynamic relationships in innovation studies, but with a view to evoling a dynamic perspective there too. The ways in which static-dynamic interactions have improved RIS studies, leading to enhanced RIP formulations is exemplified in the following. Foremost is the emphasis on generative growth as discussed earlier. This is for three key reasons: first, unlike the atomistic, neoliberal perspective, which postulates little or no change in an equilibrium "assumptive world" with an atomised canvas of entrepreneurs, each competing for superior profit maximization, the entrepreneurial ecosystem appears to be the apotheosis of a static equilibrium outcome. Generative growth, as discussed is embodied in an evolutionary perspective, the enterprises for which are in dynamic relationships with each other as firms, intermediaries and – crucially – "purposive actants" searching for interactive learning opportunities by which they might communally move towards their optimal target of profit maximization. The associated search and select mechanisms, which engage opportunities for related variety across industry interfaces, comprise the innovative inputs for the enterprise outputs that rest, accordingly, on the specific skills of the entrepreneur, more than the innovator. Hence, a generative growth perspective entails a dynamic, disequilibrium character expressed as the cellular motion of the restless ecosystem as it mutates over time.

The correlate of the dynamic ecosystem in efficiency terms is the proximate nature of the cognitive and geographical knowledge relations by which the ecosystem mutates over time. It is not difficult to see how the structured, selected and sectoralised economic activities that spawned the "cluster platform" typical of Silicon Valley and other regionalised economic geographies thus emerges. In evolutionary "emergence" theory upward and downward motion circumscribe the limiting possibilities of currently available knowledge and technologies (Cooke 2013). Not only feasible "related variety" among clusters but unanticipated "revealed related variety" also captures the dynamism proferred by cognitive and geographical proximity. Hence semicomductors spawned microprocessors, interacting with personal and other computers along with related software and systems. Then, crossovers from ICT at industry interfaces with biotechnology began to structure not one but two sub-clusters, followed by a third in medical technology (further utilising ICT applications) followed by a fourth in "clean technology" ranging from "smart grids" to "driverless vehicles". One could probably map such "cluster platforms" in financial districts such as New York and London. The spatiality of such dynamic ecosystem interactions is fundamental to its cognitive and distributed innovativeness, creativity and opportunity for communal/collective enterprise.

Discussion and Conclusions

We have reached the three main discussion points of the foregoing analysis, as a prelude to the three concluding points to which they are related. The first of these opens up a more holistic, integrated and communal mode of institutional economic practice. This privileges – to an extent – the individualistic profit-seeking entrepreneur, though it prefers the more neutral and various characteristics of the enterprise as the vehicle

for value analysis and realisation. This correlates with the notion of "generative growth", a more evolutionary, communal and socially interactive learning process than the narrower theory of endogenous growth,. This is reductionist as well as individualistic and determined by its main focus on the profit motive par excellence. However "endogenous growth" is no greater insurance than "off the shelf" technology purchase, which is largely at the whim of the entrepreneur's risk judgement. By contrast, "generative growth" collectively exploits the strength in numbers that a more disinterested mode of business practice, gaining from "club goods" and "risk spreading" as described for classic Marshallian industrial districts. This resonates with the more communal, interactive learning disposition of regional innovation systems. These are even more disinterested in their innovations than entrepreneurs are in their profits. This is because they are driven by a problem-solving or discovery methodology that may not, even in the long-run, dependent upon context, reach profitability. To survive, they may have to construct new business models that have the character of "knowledge insurance" strategies (eg biotechnology start-ups; at a corporate scale, price-fixing by the state performs a comparable function towards nuclear energy generation). Just as entrepreneurial/enterprise ecosystems and regional innovation systems may have good and bad exemplars of acceptable practice. That associated with entrepreneurial ecosystems is much closer to the market in purpose, where for innovation systems sub-optimal performance is inclined to act "with good will" but be betrayed by "asymmetric information", adverse selection" or "market failure" issues that may blow policy off course (Stam 2015).

The second discussion point is the extent to which the enterprise ecosystem has yet developed, conceptually, let alone in terms of real practice, capabilities in relation to one of the key concepts in this paper, as expressed in its title, namely to develop a research methodology to handle diversity or, specifically, in the context of this paper "related variety" (including "revealed related variety"). This would entail multiple research designs, themselves diverse, to trace enterprise mutations or enterprise biographies that reveal themselves not as undifferentiated profit taking enterprises but purposive economic entities. These would construct their purposive actions in relation to other enterprises that facilitated the achievement of the higher purpose, such as the (LED) lightbulb, the smartphone or the prosthetic hip or knee joint. There is relatively little of this "ancestry analysis" by comparison with the volumes of studies of "the world's oldest firm" in entrepreneurship studies. There may be some risk attached to formulating "industry interface" or "cross-over" inter- sector or inter-cluster studies but from an innovation standpoint much innovation has this "related variety" character including "revealed" value occurring by accident as much as design. However it is the purposiveness that justifies the risk for search and selection potential.

And as a final discussion point, in regard to our discussion of statics and dynamics in relation to enterprise ecosystems. It seems likely that the more evolutionary ecosystem perspective may, if tackled and solved methodologically, assist the emergence of a more dynamic profiling of enterprise management if not entrepreneurship in itself. Static equilibrium and making safe bets by the inclination to imitate or "swarm" in Schumpeterian terms rather than engage in true risk-taking practice by backing purposive innovation for social value is holding back study in the field. Armed with the creativity implicit in cross-over and other kinds of entrepreneurial/

enterprise discovery (EDP) enterprise becomes more dynamic because embedded in emergent and evolving ecosystems. These are structured where feasible into cluster-platforms that celebrate their revealed related variety, for example engaging oil companies in conversations with food firms over biofuel energy, or watch-makers and combustion engine producers finding joint new markets and seat fabric users of nanotechnology to evolve new materials for antiseptic medical uniforms. The creative enterprise will be alive to such (unpredictable) revealed related variety outcomes because it celebrates dynamic change.

In terms of main conclusions, one of the strongest, theoretically and in analytical practice is that if entrepreneurship is difficult and enterprise management is circumscribed by the problem of "satisficing" and "bounded rationality," enterprise ecosystems are advantaged by their networking propensity, their regional "communities of practice" and the free goods of interactive learning from ecosystem peers whether firms ot intermediaries. Thus although it is an immature field, arising from "booster practice" rather than well-argued researcher discovery and real-world practical observation, it has worthwhile potential for becoming a dynamic contributor to theory and policy. Importantly, it is by now clear that entrepreneurship is different in nature and kind from innovative activity. But it is also clear that much effort conducted in enterprise ecosystems will be less than high growth firm performance based on hitting the STI jackpot. Rather it will be solid, necessary, problem-solving along the more normal DUI innovation routeways which account for the greater part of social value arising from the enerprise ecosystem setting.

Second, one of the insights of evolutionary complexity theory (ECT) that has performed a useful role in enterprise ecosystem theory has been that offered by Kauffman (2008) regarding the rate of evolution of novelty (innovation or creative artifact or service) is that as the economic fabric of the ecosystems within which they are embedded themselves evolve and become more complex in terms of their power laws of scale and scope, the greater is the opportunity for further, accelerating novelty, including that of enterprises. This connects back to our reference to what once seemed a utopian idea which - as a by-product - could cause a huge release of social energy into enterprise, namely the idea of a "basic income". Sufficient thought is now being given at national and regional governmental levels that it is beginning to be tentatively applied in practice for the first time since the Levellers and Diggers. Such is the vast burden of public expenditure occasioned by the huge weight of healthcare and welfare services and the armies of public servants that administer what can amount to 40 % + of national GDP that conditions are becoming appropriate to consider "basic income" for all citizens. Keep in mind the proposed Swiss monthly stipend is £1,700 ($2,400) paid to every citizen, a rate of £20,400 ($28,000). The Swiss health and welfare (including administration) budget Adult citizen population is 4.8 million. Swiss GDP in 2016 was $475 billion (PPP); Health and Welfare GDP is 36 %. Thus approximately $171 billion of GDP is spent on Health and Welfare. This compares with $140 billion in proposed Basic Income, a rough saving per annum of $31 billion to Swiss taxpayers. Some portion of this is private expenditure but even so, with two-thirds devoted to social security, public expenditure is substantial. The point here is that a surge of enterprise formation could be expected from these Health and Welfare ecosystems, which can

be expected to be dynamic, interactive, efficient and effective enterprises despite inevitable start-up and even maturer failures.

Finally, "variety" especially "related variety" (including "revealed related variety") in respect of "enterprise ecosystems" having been specified in terms of search, selection and structuring of enterprise potential in relation to ecosystem opportunities, offers a new and more "path-creating" trajectory of new and diversified business opportunity than more "path dependent" ways of thinking about entrepreneurship. In relation to the separate and distinctive but innovation-directed systems with which future, structured enterprise ecosystems (EE) may come to interact, the RIS and EE joint model offers a powerful conceptual and practical framework for purposive action. In "grand challenge" contexts like "ageing", "healthcare surges" and "ambient assisted living" each of which place enormous burdens on taxpayer resources and public investment, there could be no better global scale experiment upon which to begin evolving tools for complexity in both RIS and EE. Accordingly, with the latter even closer to the patient-provider interface than the RIS perspective, the interesting idea of "enterprise ecosystems" or, if preferred "entrepreneurial ecosystems" further underlines the potential of new opportunities for developing not only the "virtues" but the "value of variety".

Acknowledgement
This work was supported by the DGIST R&D Program of the Ministry of Science, ICT and Future Planning(16-IT).

Received: 18 May 2016 Accepted: 9 June 2016
Published online: 12 August 2016

References

Andersen, E. (2011). Schumpeter and regional innovation. In P. Cooke, B. Asheim, R. Boschma, R. Martin, D. Schwartz, & F. Tödtling (Eds.), *Handbook of regional innovation & growth*. Cheltenham: Edward Elgar.
Arthur, B. (1994) Increasing Returns and Path Dependence in the Economy, Ann Arbor, Michigan University Press.
Arthur, B. (2009). *The nature of technology*. London: Penguin.
Balconi, M., Brusoni, S., & Orsenigo, L. (2010). In defence of the linear model: an essay. *Research Policy, 39*, 1–13.
Boisot, M., Nordberg, M., Yami, S., & Nicquevert, B. (2011). *Collisions & collaboration: the organization of learning in the atlas experiment in the LHC*. Oxford: Oxford University Press.
Boschma, R., & Martin, R. (2010). *The handbook of evolutionary economic geography*. Cheltenham: Edward Elgar.
Casson, M. (2003). *The entrepreneur: an economic theory (2nd edition)*. Cheltenham: Edward Elgar.
Cooke, P. (Ed.). (1995). *The rise of the Rustbelt*. London: UCL Press.
Cooke, P. (2002). *Generative growth, knowledge economies and sustainable development: implications for regional foresight policy* (Paper prepared for 'mobilising the potential of regional foresight actors for an enlarged). Brussels: EU' STRATA-ETAN Expert Group Action and Conference.
Cooke, P. (2012). *Complex adaptive innovation systems*. London: Routledge.
Cooke, P. (2013). Qualitative analysis and comparison of firm and system incumbents in the New ICT global innovation network. *European Planning Studies, 21*, 1–18.
Cooke, P. (2015). *Boosting skills ecosystems for greener jobs*. Paris: OECD.
Cooke, P., Boekholt, P., & Tödtling, F. (2000). *The Governance of Innovation in Europe*. London: Pinter.
Cooke, P., Heidenreich, M., & Braczyk, H. (Eds.). (2004). *Regional innovation systems* (2nd ed.). London: Routledge.
Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technological change. *Research Policy, 11*, 147–162.
Dunning, J. (Ed.). (2000). *Regions, globalization, and the knowledge-based economy*. Oxford: Oxford University Press.
European Commission. (2012). *Guide to research and innovation strategies for smart specialisation*. Brussels: European Commission.
Fearn, H. (2016) Is the citizen's basic income an idea whose time has finally come? "The Independent", 9 March, p. 29.
Freeman, C., & Perez, C. (1988). Structural crisis of adjustment, business cycles and investment behaviour. In G. Dosi (Ed.), *Technical change & economic theory*. London: Pinter.
Green, P. (1983). Considerations on the democratic division of labour. *Politics & Society, 12*(4), 445–485.
Green, P. (1985). *Retrieving democracy: in search of civic equality*. Totoma: Rowman & Allenheld.
Hirst, P., & Thompson, P. (1996). *The globalization question*. Cambridge: Polity.
Kauffman, S. (2008). *Reinventing the sacred*. New York: Basic Books.
Kenney, M. (1986). Schumpeterian innovation and entrepreneurs in capitalism: A case study of the US biotechnology industry. *Research Policy, 15*, 21–31.
Kirzner, I. (1973). *Competition and entrepreneurship*. Chicago: University of Chicago Press.
Kirzner, I. (1997). *Entrepreneurial Discovery and the Competitive Market Process: An Austrian Approach Journal of Economic Literature, 35*(1), 60–85.
Knight, F. (1921). *Risk, uncertainty and profit*. Boston: Hart, Schaffner & Marx.

Krugman, P. (2000). Where in the world is the 'New economic Geography'? In G. Clark, M. Feldman, & M. Gertler (Eds.), *The Oxford handbook of economic geography*. Oxford: Oxford University Press.
Lukes, S. (1974). *Power: a Radical View*. London: Macmillan.
Malecki, E. (2011). Connecting local entrepreneurial ecosystems to global innovation networks. *International Journal of Entrepreneurship & Innovation Management, 14*, 36–59.
March, J. (1991). Exploration and exploitation in organisational learning. *Organisation Sciences, 2*, 71–87.
Marshall, A. (1890) Industry & Trade, London, Macmillan.
Myant, M. (2015). *TTIP: what it will mean for us and what is the alternative? Briefing Paper No. 11*. Brussels: Observatoire Social Europeén.
Romer, P. (1990). Endogenous technical change. *Journal of Political Economy, 98*(No. 5, Part 2), S71–S102.
Ruigrok, W., & Van Tulder, R. (1995). *The logic of international restructuring*. London: Routledge.
Saxenian, A. (1994). *Regional advantage*. Harvard: Harvard University Press.
Schultz, T. (1982). Investment in entrepreneurial ability. *Scandinavian Journal of Economics, 82*(4), 437–48.
Schumpeter, J. (1932/2005) Development, Journal of Economic Literature, XLIII, 104–116
Schumpeter, J. (1934). *The theory of economic development*. New Brunswick: Transaction Books.
Schumpeter, J. (1975) Capitalism, Socialism & Democracy, New York, Harper Torchbooks.
Stacey. (2002). *Strategic management & organisational dynamics: the challenge of complexity*. Harlow: Prentice Hall.
Stam, E. (2007). *Entrepreneurship and innovation policy*. Delft: European Association of Evolutionary Political Economy.
Stam, E. (2015). Entrepreneurial ecosystems and regional policy: a sympathetic critique. *European Planning Studies, 23*(9), 1759–1769.
Sternberg, R. (2007). Entrepreneurship, proximity and regional innovation systems. *Tijdschrift voor Economische en Sociale Geografie, 98*(5), 652–666.
Wassermann, P., Schiller, D., & Thomsen, S. (2016). Spatial co-operation patterns and their impact on innovation outcomes: lessons from firms in a low-technology region. *European Planning Studies, 24*(5), 1–3.