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Innovation paradoxes: a review and typology of explanations

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ABSTRACT

The concept of innovation paradoxes refers to a family of anomalous observations demonstrating that relatively high or outstanding innovation efforts lead to either insignificant or undesirable outcomes. While researchers have long been busy studying the nature and causes of innovation paradoxes, they have yet to assess the fruits of their research efforts. This paper addresses this neglect, in particular by identifying and reviewing the literature of two innovation paradoxes – the European innovation paradox and the Swedish innovation paradox. The findings show that research on both paradoxes has proceeded along similar lines, leading to the development of a working explanatory typology of innovation paradoxes. The paper ends with a discussion of key observations, findings and suggestions.

Introduction

Over the past four decades, a plethora of studies have confirmed the potency of one of Joseph Schumpeter's (1934) central theses (for a holistic overview of Schumpeter's diverse work, see Freeman, 1994a, pp.466–9 and Fagerberg, 2003, pp.128–35). This is that innovation – understood as new combinations of existing or the development of new resources which can take various forms such as new goods, processes, organisational models and institutions (Edquist, 2005, p.182) – is the main engine of economic progress in capitalist societies (Nelson and Winter, 1982; Porter, 1990; Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1994; Freeman, 1994a, 1994b; Acs and Varga, 2002; Fagerberg, 2003; Verspagen, 2005; Castellacci, 2007). More specifically, despite being risky, uncertain and failure-prone (Kline and Rosenberg, 1986; Van der Panne *et al.*, 2003), innovation enhances market leadership, competitiveness and survival of firms and sectors (Porter, 1990; Freeman, 1994b; Fagerberg, 2005; Tidd *et al.*, 2005). This, in turn, leads to significant improvements in living standards (e.g. increases in employment and income per capita) of territorial units (e.g. nations, regions and cities) where innovation takes place (Nelson and Winter, 1982; Porter, 1990; Romer, 1990; Grossman and Helpman, 1994; Freeman, 1994a; Acs and Varga, 2002; Fagerberg, 2003; Pianta, 2005; Verspagen, 2005; Castellacci, 2007). Thus, it is by no means surprising that a considerable portion of taxpayers' contributions worldwide is increasingly being allocated to the promotion and development of innovation

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and related activities (Marceau, 2000; Oughton *et al*., 2002; Nielsen, 2003; Archibugi and Coco, 2005; Kitagawa and Woolgar, 2008; Gackstatter *et al*., 2014; Edquist, 2014; Radicic and Pugh, 2017; Breznitz and Ornston, forthcoming).

This paper revisits the sound and insightful Schumpeterian thesis that innovation is the main engine of progress in capitalist societies. However, it does so in an unusual way: instead of groping around the relevant innovation literature for evidence favouring the thesis in question (the customary approach), the paper reviews the literature of a family of anomalous observations collectively known as 'innovation paradoxes'. In abstract terms, like any paradox (Etchemendy, 1999), the innovation paradox denotes the discrepancy between theory and observation (Halliwell and Smith, 2011; Fragkandreas, 2013; Liu and Laperche, 2015; Cirera and Maloney, 2017). There are various versions of innovation paradoxes in the literature. This paper deals with a particular variety of innovation paradox, the one noting that outstanding innovative efforts – regardless of how such activities are defined and measured – lead to either insignificant or undesirable economic outcomes (European Commission, 1995; Bitard *et al*., 2008; Audretsch, 2009a; Fragkandreas, 2013).

However, and while innovation researchers have long been busy recording and investigating innovation paradoxes (e.g. Solow, 1987; Edquist and McKelvey, 1998; Macdonald *et al*., 2000; Haour, 2004; Dosi *et al*., 2006; Bitard *et al*., 2008; Fragkandreas, 2013; Makkonen and Inkinen, 2013; Liu and Laperche, 2015; Cirera and Maloney, 2017), they have yet to reflect upon the fruits of their research efforts (*cf*. Brynjolfsson, 1993; Macdonald *et al*., 2000). In short, there is a generic lack of reviewing and reflection on innovation paradoxes. It is such a neglect that motivates this paper. In particular, the paper identifies and examines the literature of two of the most researched innovation paradoxes: the European paradox (EP) and Swedish paradox (SP). One of the main contributions of this paper lies in identifying 'trading zones' between the two kinds of literature under consideration, especially in terms of competing and complementary theoretical perspectives and empirically-verified or grounded explanations. This, in turn, allows the paper to develop in an 'inductive-integrative' manner (Cooper, 1988; Eisenhardt, 1989) a working explanatory typology of innovation paradoxes, enabling us to comprehend the fruits of innovation paradox research in a more holistic manner than hitherto. As will be shown later in this paper, typological thinking does not only structure our understanding of innovation paradox research, it also draws our attention to several important aspects of research, some of which carry valuable research and policy implications.

The rest of this paper provides an overview of the concept of innovation paradoxes, as well as discussing the key elements of the review design that have been followed in this review study. It then provides reviews of the relevant literature on both European and Swedish paradoxes, identifying a few empirically-verified and grounded explanations that are common to both innovation paradoxes under consideration. These explanations, in turn, constitute the raw materials for developing a working explanatory typology of innovation paradoxes. The paper ends with a discussion of concluding remarks and suggestions for further research.

Innovation paradoxes and research design

Innovation paradoxes: a discussion

To claim that innovation paradoxes are popular among innovation researchers may sound provocative. For instance, a search on the Scorpus scholarly database with the term 'innovation paradox' yields more than 930 results.[1] For others, however, this is not surprising at all, simply because social scientists have long been investigating innovation paradoxes (e.g. Solow, 1987; David, 1990; Edquist and McKelvey, 1998; Baker, 2003; Haour, 2004; Christopherson and Clark, 2007; Bitard *et al.*, 2008; Audretsch, 2009a; Ejermo *et al.*, 2011; Fragkandreas, 2013; Liu and Laperche, 2015). Popularity, however, does not necessarily entail homogeneity of opinion; in reality, just the opposite. The literature of innovation paradoxes is quite fragmented, consisting of more than one type of innovation paradox. For instance, Liu and Laperche (2015) use the term 'innovation paradox' to describe the observation that 'a quite important effort of SMEs in terms of R&D investments…' results in '…poor results in terms of innovation' (p.28). Others use the term 'innovation paradox' to describe the situation in which firms that were the very first to introduce a promising innovation in the market failed (although for various reasons) to capture significant economic benefits from it although followers and imitators were more successful in such a venture (Van der Panne *et al.*, 2003). Yet others use the term to illustrate that while the competitive advantage and survival of firms depends upon innovation, top business executives – the CEOs – do not place innovation at the top of their agenda (Haour, 2004).

While the above discussion has focused on the firm-level dimension of innovation paradoxes, sectoral researchers also use the term. Baker (2003), for instance, uses the term to demonstrate that while the emergence of survival of innovative sectors depends on the revenue and innovative capability of their constituent firms, the latter become less innovative as they grow. Furthermore, the term innovation paradox is used to denote two different observations: first, it is used to describe the apparent contradiction between the comparatively greater need to spend on innovation in lagging territories (e.g. cities, regions and nations) and the relatively lower capacity of such territories to invest and absorb funds earmarked for the promotion of innovation activities (Oughton *et al.*, 2002; Cirera and Maloney, 2017); secondly, the term also denotes innovation-economic performance or development anomalies such as when investments in innovation activities are not always that beneficial for the territorial unit in question, be it a city, region or a nation (e.g. Solow, 1987; European Commission, 1995; Christopherson and Clark, 2007, pp.107–22; Bitard *et al.*, 2008; Fragkandreas, 2013).

This paper deals with the last variety of innovation paradox, the 'innovation-economic performance' paradoxes. There are various reasons that make the paradoxes in question an interesting object of inquiry: first, innovation paradoxes have long been an object of empirical research; however, and secondly, research on innovation paradoxes has to date not been studied in a systematic manner by innovation researchers. Table 1 provides a selected list of innovation paradoxes. Of these, however, it is the relevant literature on both the EP and SP that qualifies as an appropriate object of review. This is for four reasons: first, the paradoxes in question are well-researched, implying that there exists an appropriate literature on the subject; secondly, both paradoxes fall within the cognitive boundaries of the field of innovation studies[2]; thirdly, these paradoxes are

operative in the sense that their underlying observation is still valid (Fragkandreas, 2013; Radicic and Pugh, 2017); and lastly, research on the European and Swedish paradoxes is of interest to both innovation researchers and policy-makers (European Commission, 1995, 2003, 2007; Dosi *et al.*, 2006; Jacobsson *et al.*, 2013), indicating their extra-academic relevance. In a nutshell, the literature of both paradoxes offers an ideal research setting for a review.

Review strategy, data collection, and analysis

According to Cooper's (1988) seminal taxonomy of literature reviews, central to any literature review are six key elements: focus, goals, perspective, coverage, organisation and audience. Table 2 provides an outline of Cooper's taxonomy. As is evident from Table 2, the primary focus of this review study is theoretical. Specifically, it identifies some of the most popular empirically-grounded theoretical accounts for the paradoxes under consideration. In doing so, it establishes links between different theoretical perspectives, assessing also the 'empirical application' of each perspective – this inevitably directs the analytical process to an assessment of research outcomes and methods. Furthermore, a theoretical focus is in line with the overall goal of this review study, which is to identify key concepts, themes, perspectives and research challenges. This could trigger potential cross-fertilisation of knowledge and research among different theoretical perspectives. In terms of perspective, this study takes a 'neutral' perspective. It is neutral, however, not in the positivist sense of the term, but in the sense that this review defends the appropriateness and superiority of none of the theories under consideration. The targeted audience of this review is specialised scholars, especially those who are interested in, or dealing with, the nature, causes and socio-economic implications of innovation paradoxes.

A database of journal papers, books, conference papers and reports was constructed at an early stage of the research process. The relevant contributions were identified through an iterative search on scholarly databases (Google Scholar, Scorpus and Social Science Citation Index-Clarivate Analytics). The following terms were used as inclusion criteria: 'European paradox', 'European innovation paradox', 'Swedish paradox' and 'Swedish innovation paradox'. The sampling strategy followed in this research was open-ended (Martin, 2012), combining an iterative search on scholarly database with a snowball citation search on the identified contributions, as well as with an extensive scanning of the references section of each contribution. The underlying aim was not only to maximise the sample, but also to achieve theoretical saturation (Glaser and Strauss, 1967) – the condition where further data collection makes no, or little, contribution to the analysis. In terms of the profile of the contributions under consideration, all are written in the English language and were published between 1990 and 2016. This time-frame was selected because research in both paradoxes under consideration began in the mid-late 1990s (European Commission, 1995; Edquist and McKelvey, 1998; Tijssen and Van Wijk, 1999).

Table 1. Select list of innovation paradoxes.

Name	Description	Source
Biotechnology growth-innovation paradox	The survival and strength of the biotechnology sector is based on the innovative capability of biotech companies, but these become less innovation-intensive as they grow.	Baker (2003)
Business strategy innovation paradox	While the competitive advantage and survival of firms lies on innovation, business executives pay little attention to innovation.	Haour (2004)
Developing nations innovation paradox	The paradox that while innovation is central to closing the gap between developed and developing countries, the latter do not invest enough on innovation	Cirera and Maloney (2017)
European paradox	The European paradox refers to the inability of the European Union to transform its scientific excellence into innovation, competitive advantage, wealth and employment.	European Commission (1995); Dosi *et al.* (2006)
European regional innovation paradox	The European regional paradox refers to the observation that some of the most innovation-intensive regions in Europe not only grow at a slower pace, but also have lower income per capita and lower employment than the national average under consideration.	Fragkandreas (2013)
Fogel's (1964) innovation paradox	This paradox refers to the observation that the benefits of investing heavily in a generic purpose technology, such as the railway, did not have a significant pay-off for the US.	Fogel (1964)
French innovation paradox	French SMEs dedicate a great deal of their resources to innovation (e.g., R&D investments), though this results in a weak performance in terms of innovation outputs.	Liu and Laperche (2015)
Norwegian innovation paradox	The Norwegian innovation system combines high economic performance and innovative capability with relatively low investments in innovation inputs.	Grønning *et al.* (2008)
Open innovation paradox	The open innovation paradox refers to the observation that firms seek simultaneously to share and protect knowledge when they form innovation collaborations and alliances with other firms and organisations.	Bogers (2011)
Periphery innovation paradox	This paradox refers to the observation that, despite the growing significance of innovation policy in both Latin American and the Central-Eastern European economies, the latter lack the relevant policy capacity and effectiveness to take advantage of innovation.	Kattel and Primi (2012)
Regional innovation systems paradox	This paradox refers to the observation that many regional innovation systems produce so little innovation and so few jobs.	Christopherson and Clark (2007, pp.107–23)
Scale effects paradox (also known as Jones critique)	The scale effects paradox refers to the observation that while the number of scientists engaged in R&D in advanced countries has grown dramatically over the last 40 years, the growth rates of advanced countries have either exhibited a constant mean or even declined on average.	Jones (1995)
SMEs innovation paradox	SMEs typically lack economies of scale and scope, financial assets, as well as having weaker competencies and absorptive capacity. Nevertheless, many SMEs invest heavily in high risk innovation-related activities, such as R&D.	Ortega-Argilés *et al.* (2009)
Solow paradox (also known as IT-paradox)	The Solow paradox is based on Robert Solow's observation that '[y]*ou can see the computer age everywhere but in the productivity statistics*' (p.36). In other words, investments in generalised purpose innovations (e.g., the computers) and related technologies do not pay-off.	David (1990); Macdonald *et al.* (2000); Solow (1987)
Swedish paradox	A generalised version of the Swedish paradox refers to the observation that outstanding investments in R&D and innovation-related activities generate little economic return in terms of competitiveness, growth and employment.	Edquist and McKelvey (1998); Ejermo *et al.* (2011)

Table 2. A taxonomy of literature reviews.

Characteristics	Categories
Focus	Research outcomes
	Research methods
	Theories
	Practices or applications
Goal	Integration: (a) generalisation; (b) conflict resolution; (c) linguistic bridge building
	Criticism
	Identification of central issues
Perspective	Neutral representation
	Espousal of position
Coverage	Exhaustive
	Exhaustive with selective citation
	Representative
	Central or pivotal
Organisation	Historical (chronological)
	Conceptual (thematic), including author or school-centric
	Methodological
Audience	Specialised scholars
	General scholars
	Practitioners or policy-makers
	General public

Note: Adapted from Cooper (1988)

European paradox research: a review

The emergence of new growth theory (e.g. Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1994) in the 1990s did, among other things, reinvigorate the linear theory on innovation (Kline and Rosenberg, 1986). According to the theory in question, research and development (R&D) is the more significant activity of knowledge creation and exploitation, and thus also of innovation and economic growth (Kline and Rosenberg, 1986; Romer, 1990; Grossman and Helpman, 1994; Edquist, 2014). In light of this, the 1995 *Green Paper on Innovation* (European Commission, 1995) stressed that the European Union (EU) suffers from a series of R&D weaknesses; among others, three stand out: 1) compared with the US and Japan, the EU member states invest less in R&D activities; 2) there is a significant lack of coordination in terms of R&D activities, programmes and strategies across Europe; and, lastly, 3) the EU suffers from an innovation paradox defined as the inability of the EU to transform 'the results of technological research and skills into innovations and competitive advantage' (European Commission, 1995, p.5). While each of the three observations has been the subject of considerable scholarly and policy attention (European Commission, 1995, 2003, 2007; Caracoustas and Soete, 1997; Archibugi and Coco, 2005), it is the last observation that has been the most popular and controversial of all (Dosi *et al.*, 2006, 2009; Jacobsson *et al.*, 2013).

Undoubtedly, what makes the EP a subject of popularity and controversy is, among other things, the policy implications that emanate from it, affecting the institutional set-up of European states, and thus also the lives of millions of citizens across Europe (Pavitt, 2000; Goldfarb and Henrekson, 2003; Geuna and Rossi, 2011; Jacobsson *et al.*, 2013; Breznitz and Ornston, forthcoming). For instance, informed by the broader neoliberal political discourse, several national governments (e.g. Austria, Denmark, Finland, Germany and Norway) have since the early 2000s either modified or replaced the traditional inventor ownership model of academic patent rights (i.e. the so-called

'professor's privilege'), by which the sole owners of publicly-funded research discoveries are the researchers) with an US-inspired institutional ownership model (i.e. the so-called 'Bayh–Dole Act' model), by which publicly-funded research results are owned by scientific institutions (Goldfarb and Henrekson, 2003; Geuna and Rossi, 2011). The underlying assumption is that transferring the ownership of intellectual property rights to scientific institutions will foster the commercialisation of promising scientific research.

The above discussion brings to the fore what Jacobsson *et al.* (2013) call the 'dominant beliefs' of the EP, one of which attributes the occurrence of the EP to inefficiencies and inabilities on the part of the European science system: '[c]ompared to North America, the average university in Europe generates far fewer inventions and patents…', and this '…is largely due to a less systematic and professional management of knowledge and intellectual property by European universities' (European Commission, 2007, p.7). However, several studies (Conti and Gaule, 2011; Jacobsson *et al.*, 2013; Lawton Smith *et al.*, 2013) indicate that European science may, actually, be more efficient than is depicted in the political discourses associated with the EP. In particular, Conti and Gaule (2011) investigate the extent to which US technology transfer offices are more productive, in terms of both licence agreements and revenue, than EU offices. The findings show that EU technology transfer offices are as productive (in terms of licence agreements) as their counterparts in the US. However, the EU offices seem to earn significantly less from licences than the US offices. Conti and Gaule (2011) put forward two hypotheses for this observation: hypothesis: 1 – US offices place greater emphasis on revenues than EU offices; and hypothesis 2 – US offices employ more experienced business employees than EU offices. Regarding the first hypothesis, Conti and Gaule find that the first hypothesis does not hold: EU offices place the same degree of attention as the US offices. However, they do find that their proxies on experienced staff have a positive and statistically significant impact on revenues, suggesting that the US offices hire more experienced employees in business than the EU offices.

Since the European science system has little to do with the EP, research has turned to the entrepreneurial and innovative capabilities of the European industrial system (Tijssen and Van Wijk, 1999; Dosi *et al.*, 2006, 2009; Dedrick and Kraemer, 2015). Hence, this leads to whether the European industry '…lack[s] the ability and/or absorptive capacity to use the knowledge produced in the science sector effectively?' (European Commission, 2003, p.413). Tijssen and Van Wijk (1999) were among the first to throw some light on the matter. Specifically, the authors examine in a comparative fashion (e.g. US and Japan) the scientific performance of the EU in terms of scientific publications and citations in three leading technological fields: computers, data processing, and telecommunications. The findings not only confirm the leading position of the EU in these fields, they also identify a serious weakness on the part of the European information, communication and technologies (ICT) industry, regarding its abilities to develop and commercialise the results of promising scientific research. More recently, Dedrick and Kraemer (2015) studied the invention, development and commercialisation of radical technology, the giant magneto-resistant (GMR) technology. They show that, while European (French and German) scientists were the original inventors of the GMR technology, the lion's share of the economic benefits from the

invention of GMR was captured by firms located in the US and Japan. Dedrick and Kraemer (2015) attribute this loss of value to the weak absorptive capacity of European high-tech firms.

In similar manner, several commentators and researchers have put forward the hypothesis that the EP can also be attributed to entrepreneurship in general, and to an entrepreneurial deficit in particular (Peterson and Valliere, 2008[3]; Audretsch and Keilbach, 2008; Audretsch, 2009a, 2009b). In a nutshell, these studies put forward the hypothesis that the EP is an outcome of a lack of entrepreneurialism on the part of the EU economic system (Peterson and Valliere, 2008). Audretsch and Keilbach (2008) argue that socio-cultural factors – the 'knowledge filter' as they call it – may hinder the commercialisation of new scientific knowledge in Europe. They also maintain that entrepreneurship overcomes the knowledge filter by transferring knowledge from the scientific domain to the economic domain. Entrepreneurship, therefore, 'is the missing link between investments in new knowledge and economic growth' (Audretsch, 2009a, p.92), and thus also to the EP. To substantiate their claims, Audretsch and Keilbach (2008) develop a production function model and assess its explanatory power in 440 German counties ('kreise' in German). The results suggest 'not only is entrepreneurial activity greater in regions with higher investments in new knowledge but that also those regions with more entrepreneurship exhibit higher growth' (p.1698).

While the aforementioned studies have sought to explain the underlying causes of the EP, other studies look at the observation that Europe is a world leader in science (Dosi *et al.*, 2006, 2009; Bonaccorsi, 2007; Herranz and Ruiz-Castillo, 2013; Rodríguez-Navarro and Narin, 2018). They examine the possibility that the EP may have nothing to do with the structure and functioning of European academic-scientific and economic systems, but may be the outcome of methodological issues. Dosi *et al.* (2006) argue that the EP is nothing more than the outcome of miscalculating (or misreporting) the relevant data. In particular, they show that, after adjusting the data for the population, 'Europe's claimed leadership in terms of number of publications disappears' (p.1454). They also find that, after controlling for both originality and impact of scientific publications (e.g. citations), the US is still well ahead in both indicators. As they put it,

> The general conclusion from the bibliometric data is therefore far from supporting any claim to European leadership in science. On the contrary, one observes a structural lag in top-level science vis-a-vis the US, together with 1) a few sectoral outliers in physical sciences and engineering, and 2) a few single institutional outliers (such as Cambridge in computer science and a number of other disciplines). (Dosi *et al.*, 2006, p.1455)

Dosi *et al.*'s (2006) findings are also consistent with subsequent studies (e.g. Bonaccorsi, 2007; Albarrán *et al.*, 2010; Herranz and Ruiz-Castillo, 2013). Herranz and Ruiz-Castillo (2013), for example, analysed 3.6 million articles published in the period between 1998 and 2002 in 219 fields; they show that while the European scientific system outperforms that of the US in terms of total publications, the European scientific system: 1) underperforms in both new and fast-growing scientific fields (e.g. ICT, biotechnology medical sciences); 2) has, in comparative terms, a poor citation performance in the majority of the fields under consideration; and that 3) it is highly specialised in slow-growing and mature scientific fields (e.g. physical sciences, engineering and mathematics).

Bonaccorsi (2007) extends our understanding of the pattern that the European scientific system excels mostly in mature scientific fields, whereas the US science system excels in newly emerging fields. In particular, Bonaccorsi (2007) argues that the European scientific system suffers from some 'serious deep-seated institutional features that make it difficult to adapt to new search regimes' (p.9). Such institutional rigidities seem to be rooted in the post-World War II period, in which Europe was well-prepared to face the infrastructural challenges posed by the then promising scientific fields (such as chemistry, physics, mathematics and engineering). Bonaccorsi (2007) maintains that the institutional infrastructure of the EU (especially of France, Germany and Italy) was unprepared to face the challenges posed by the advent of new technologically-oriented scientific fields (e.g. ICTs, medical and life sciences), fields characterised by continuous radical technological change rather than by incremental change. To substantiate the above claims, Bonaccorsi (2011) provides a comparative historical analysis (e.g. US, UK, Germany and France) of a science-based industry – IT. From an analysis of the *curricula vitae* of the top 1000 computer scientists in these countries, he finds that it was only in the US that the institutional setting was germane to the development of a competitive science-based IT industry.

Having discussed the relevant contributions, it seems that four main theoretical accounts are key to theory and research on the EP. These are as follows:

(1) The 'academic and scientific base' account: the European science system fails to take economic advantage of promising scientific research by exploiting it for wealth and employment-generating innovations.
(2) The 'industrial base' account: European industry lacks the necessary elements (e.g. absorptive capacity, relatively lagging in investments in R&D and in networks with science) that will enable it to commercialise promising scientific research.
(3) The 'entrepreneurial deficit' account: the EP is attributable to an entrepreneurial deficit on the part of the broader European economic system.
(4) The 'empirical validity' account: the EP is caused by methodological problems and measurement issues, especially with regard to measuring scientific performance.

Swedish paradox research: a review

The origins of the Swedish paradox (SP) lie in a debate that took place in the late 1980s (for an overview, see Jacobsson *et al.*, 2013; Lundberg, 1985). This debate was triggered by the empirical observation that the relation between R&D investments and aggregate economic output statistics was weak. Since then, different interpretations of the SP have been proposed (for an overview, see Ejermo and Kander, 2006). Nevertheless, as emphasised elsewhere (Jacobsson and Rickne, 2004; Ejermo and Kander, 2006, 2009; Bitard *et al.*, 2008; Ejermo *et al.*, 2011, 2011; Edquist and Zabala-Iturriagagoita, 2015), all versions of the SP lead – in one way or another – to the conclusion that outstanding investments in innovation activities generate few economic benefits in terms of high-tech products, exports, productivity, growth and employment. In other words, all versions of the SP indicate the

existence of 'a mismatch between very high values on indicators of inputs into innovation and low values on output indicators' (Bitard *et al.*, 2008, p.240).

Since the late 1990s, many studies have sought to explain the underlying observation of the SP. This has culminated in a noteworthy empirical literature, from which six theoretical accounts seem to have hijacked the interest of both innovation scholars and policy-makers[4]:

(1) The 'sectoral allocation of R&D activities' account: R&D activities are conducted by government-funded organisations and firms, the revenue of which grows fast, but not as fast as the rate of investments in R&D.
(2) The 'knowledge transfer problems and entrepreneurial inabilities' account: Knowledge generated through R&D activities, either/both in scientific organisations or/and corporate departments and organisations, stays within the borders of these organisations.
(3) The 'concentration and technological lock-in problems' account: The Swedish economy is heavily dependent on the innovation abilities of a few successful Sweden-based MNEs. These firms specialise in non-high-tech and slow-growing sectors of the contemporary economic landscape. Thus, their decisions to invest in high-tech innovation strongly affects the innovative capability and specialisation of Sweden.
(4) The 'globalisation of production' account: As stated above, the Swedish economy is heavily dependent on the activities of a few Sweden-based MNEs; these MNEs invest heavily in innovation within Sweden, but they produce the results of R&D activities in other countries. Thus, 'much of the return on Sweden's R&D investments is captured abroad, rather than domestically' (Bitard et al., 2008, p.265).
(5) The 'inefficient innovation system' account: The national innovation system of Sweden fails to transform resources devoted to innovation into wealth and employment-generating innovations.
(6) The 'theoretical validity' account: 'There is no paradox', it is all a matter of theoretical perspective. For instance, if a more nuanced theoretical perspective replaces the proportional logic of scale effects, then there is no reason to expect a strong link between innovation inputs and economic outputs.

Let us start with the first explanation, descriptive statistical evidence provides no support for the claim that R&D activities are mostly conducted by government-funded organisations: 74% of total R&D expenditure in Sweden is conducted by the business sector (Chaminade *et al.*, 2010). In addition, the business sector has increased its share of the total amount spent on R&D activities over the past four decades (Marklund *et al.*, 2004), of which 83% is carried out by large firms employing more than 500 employees (Bitard *et al.*, 2008). Ejermo and Kander (2006), showing that high concentration of R&D activities in a few large firms is one of the most persistent and distinctive features of the Swedish economy. This, as is argued elsewhere (e.g. Edquist and McKelvey, 1998; Henrekson and Jakobsson, 2001; Marklund *et al.*, 2004; Bitard *et al.*, 2008), can be attributed to both micro (e.g. firm-specific) and macro (e.g. historical, political and institutional) factors, both of which will be discussed.

While the above paragraph confirms that most R&D activities are conducted by the business sector, the explanation that government-funded R&D activities are not efficient enough has been quite popular in the political discourse on the SP (e.g. Henrekson and Rosenberg, 2001; Jacobsson and Rickne, 2004; Hellström and Jacob, 2005; Granberg and Jacobsson, 2006; Jacobsson *et al.*, 2013). Jacobsson *et al.* (2013) attribute this belief to the policy discourse on the EP. In particular, they argue that the underlying observation of the EP has given the impression that the European academic-scientific system, including that of Sweden, lacks the ability to commercialise government-funded R&D results (see also the discussion in Goldfarb and Henrekson, 2003). This, in conjunction with the Swedish economic crisis in the early 1990s, triggered discussions about the institutional and organisational changes required to increase the efficiency of government-funded R&D activities (Goldfarb and Henrekson, 2003; Geuna and Rossi, 2011). In this context, the presumed inabilities of the Swedish academic sector have been a recurrent theme in policy discussions, reports and empirical studies (Granberg and Jacobsson, 2006; Jacobsson *et al.*, 2013).

However, several studies have demonstrated that the belief in an inefficient academic sector may rest on questionable empirical grounds (Jacobsson and Rickne, 2004; Jacobsson *et al.*, 2013; Edquist and Zabala-Iturriagagoita, 2015). Jacobsson and Rickne (2004) demonstrate that the supposed inefficiency of the Swedish academic system is mostly an outcome of methodological problems. In particular, they show that the conventional way of measuring academic R&D expenditure skews the rankings in favour of a top position on the part of Sweden. It is argued that most ranking exercises neglect the significance of R&D efforts conducted by government and non-governmental research institutes, what Jacobsson and Rickne (2004, p.1361) call the 'extended academic sector'. Taking into account the contribution of the extended academic sector, Jacobsson and Rickne (2004) illustrate in a comparative fashion (e.g. EU and OECD countries) that the R&D expenditures of the Swedish academic system are average in terms of monetary input (e.g. measured as a percentage of GDP) and above average in terms of output (e.g. scientific publications related to gross domestic product) (for a similar assessment, see Edquist and Zabala-Iturriagagoita, 2015).

While the Jacobsson and Rickne (2004) study has shed light on the sectoral dimension of publicly-funded R&D activity in Sweden, Ejermo *et al.*'s (2011) study deals with business R&D activities. In particular, Ejermo *et al.* (2011) seek to investigate whether the underlying observation of the SP 'is a consistent feature across all sectors of the economy, or specific to either fast-growing or slow-growing sectors' (p.669). Ejermo *et al.* (2011) distinguish between growing and declining sectors, and analyse their long-term R&D patterns in relation to their added value over a 16-year period (1985–2001). The results show that 'the paradox occurs only in fast-growing manufacturing and service sectors' and not in the slow-growing sectors (*cf.* Edquist and McKelvey, 1998). However, Ejermo *et al.* (2011) seem to neglect the possibility that slow-growing sectors of the Swedish economy outsource an important part of their innovation and production activities to fast-growing sectors, as well as the fact that fast-growing sectors outsource an important part of their production activities abroad, e.g. through global production networks (Chaminade *et al.*, 2010). Nevertheless, Ejermo *et al.*'s study has made an interesting contribution to our understanding of the sectoral dimension of the SP.

The second explanation – technology transfer problems and inabilities – has also received considerable attention from both innovation scholars and policy-makers. Once

again, the Swedish academic system has been at the centre of both scholarly and policy attention. Henrekson and Rosenberg (2001) compare the incentive structure for commercialising academic research in Sweden with that of the US. The study indicates that the Swedish incentive structure provides far less encouragement than that of the US. Goldfarb and Henrekson (2003) attribute this observation to three factors: 1) the top-down nature of the Swedish academic system; 2) the lack of competition among universities in terms of funding and personnel; and 3) an academic environment that seems to discourage researchers from commercialising their ideas. This, as they argue, is in stark contrast to the institutional setting in the US, which is characterised by: 1) a 'bottom-up attitude' in the sense that universities are wholly responsible for designing their own strategies; 2) competition among universities for research funds and personnel; and 3) an attitude that encourages commercialisation and entrepreneurship.

However, there are differing views on the efficiency of Swedish academia and science sectors. Jacobsson *et al.* (2013), as well as Granberg and Jacobsson (2006), point out that the political discourse on both EP and SP have cultivated an image of European scientists as anti-social, self-sufficient hoarders of scientific knowledge, generally uninterested in sharing the benefits accruing from their research with the rest of society. In this regard, and since scientists are seen as recalcitrant, they are 'in a need of management' (Hellström and Jacob, 2005, p.444). Such a belief, however, finds very little support in the empirical research to date. Specifically, Granberg and Jacobsson (2006) refer to the results of several empirical studies showing that scientists in Sweden are quite active in disseminating scientific knowledge. Similarly, Bitard *et al.* (2008) refer to the findings of a few empirical studies confirming the existence of a close connection between science and industry in the field of biotechnology in Sweden. Furthermore, the results of recent empirical studies indicate that the Swedish academic system performs exceptionally well in terms of both international scientific collaboration and academic entrepreneurship, i.e. 'the variety of ways in which academics take direct part in the commercialization of research' (Henrekson and Rosenberg, 2001, p.207). In terms of international scientific collaboration, studies show that Swedish scientists seem to be quite active in writing publications with both national and international colleagues (European Commission, 2003; Bitard *et al.*, 2008). In terms of academic entrepreneurship, Lawton Smith *et al.* (2013) find in a comparative study that researchers at Chalmers University in Sweden are more active in creating spin-off firms than their counterparts at the prestigious Oxford University in the UK. In particular, they find that 75 spin-off firms were created at Oxford University and 271 firms at Chalmers University in the period under consideration (1997–2009). Similarly, in a study of the academic entrepreneurship of university spin-offs, Jacobsson *et al.* (2013) find that the birth rate of such firms was higher for the period between 2003 and 2010 in Sweden than of that in the US and in the UK (for more details, see Jacobsson *et al.*, 2013). In brief, there is evidence suggesting that the Swedish academic system performs exceptionally well in terms of both international collaboration and academic entrepreneurship.

Examination of the inabilities in the academic system adds very little that is new to our knowledge of the underlying causes of the SP. However, several studies have examined the possibility that the Swedish economic system may be the most significant factor in causal terms (Edquist and McKelvey, 1998; Ejermo and Kander, 2011, 2006;

Ejermo *et al.*, 2011). Ejermo and Kander (2006) note that, despite the low barriers to entrepreneurship, trade and competitiveness, as well as the high level of investments in innovation, Sweden seems to be unable to diversify its economic structure (Edquist and McKelvey, 1998; Marklund *et al.*, 2004; Bitard *et al.*, 2008). The dominance of large industrial groups has remained intact over the past four decades: only one out of the 50 largest firms in Sweden was created during this period (Ejermo and Kander, 2006). This, as argued elsewhere (Edquist and McKelvey, 1998; Ejermo and Kander, 2006), is in itself a strong sign of weak competitiveness and entrepreneurship. Bitard *et al.* (2008) argue that despite the high survival rate and the increasing birth rate of both high-tech and knowledge-intensive business services (KIBS) firms, Sweden still lags behind in the creation of new firms and in the contribution of these firms to the restructuring and renewal of the economy (see also the discussion in Marklund *et al.*, 2004). Moreover, the results of the Third Community Innovation Survey show that Swedish firms cooperate less often in the process of developing an innovation with other firms and organisations (e.g. universities, consultancies, etc.) than their counterparts across Europe; this is a pattern that seems to be consistent across all sectors of the Swedish economy, except for the KIBS sector (Bitard *et al.*, 2008). Furthermore, Swedish firms seem to be less active in terms of financing research activities at scientific institutions than their European counterparts (European Commission, 2003; Bitard *et al.*, 2008). For example, firms and non-profit organisations financed only 11% of the total budget of universities in 2010 (Chaminade *et al.*, 2010). Bitard *et al.* (2008) maintain that SP is an outcome of entrepreneurial, networking and knowledge transfer problems and inabilities on the part of Swedish firms and the Swedish economic base in general.

Two related explanations for the highly concentrated structure of the Swedish economic base have been proposed with regard to our understanding of the causes of the SP. The first explanation refers to lock-in problems and the second one to globalisation of production. Edquist and McKelvey (1998) show in their seminal publication that, despite investing heavily in R&D activities since the 1950s, the Swedish economy is mostly specialised in non-high-tech products, with telecommunications being an exception, and mostly in the hands of a few firms, such as the Ericsson Group (Chaminade *et al.*, 2010, p.4). Subsequent contributions (e.g. Marklund *et al.*, 2004; Bitard *et al.*, 2008) have not only confirmed this observation, but also extended it further. Marklund *et al.* (2004) show that a significant portion of business R&D activities in Sweden is conducted by MNEs in the telecommunications, automotive, pharmaceuticals, engineering and machinery industries, most of which have a foreign ownership structure: 'the dominance of MNEs has contributed to the Swedish paradox by diminishing commercialization of research results and maintaining a disproportionately high allocation of R&D resources to low- and medium-technology sectors with little potential for growth' (Bitard *et al.*, 2008, p.262). In addition, Marklund *et al.* (2004) cite empirical evidence showing that Swedish firms display 'a rather low rate of value-adding innovation [...] in terms of genuinely new products' (p.21), and that Swedish industry is considerably more competitive in adopting existing product innovations than in creating new ones. For Marklund *et al.* (2004), such patterns indicate a competitive economy in the sense of being capable of adapting to new technological changes through imitation and process innovation. For others (e.g. Edquist and McKelvey, 1998; Bitard *et al.*, 2008; Chaminade *et al.*, 2010), however, it is a symptom of lock-in problems, of heavy concentration on low and medium-tech sectors of the contemporary economic landscape.

Following Edquist and McKelvey (1998), the high specialisation of Sweden in low and medium-tech sectors can be seen as an outcome of micro (firm-specific) and macro (political and institutional) factors. Specifically, Edquist and McKelvey (1998) contend that, on the one hand, it is reasonable that Swedish MNEs invest heavily in low- and medium-tech products, since they possess the necessary capabilities to produce competitive products for their respective markets. On the other hand, it is worth asking why sizeable and resourceful profit-seeking firms do not consider investing in high-tech products as an opportunity to diversify their product range, thus also enhancing their competitiveness. Edquist and McKelvey (1998) argue that such behaviour is not only to do with firm-specific factors (e.g. strategies and decisions), but also with macro factors, such as economic policies. In particular, they point out that one of the most important policy tools for boosting the exports and competitiveness of the Swedish economy has long been devaluing the national currency, the Swedish krona. This, and in conjunction with several economic policies that have provided few incentives to firms in terms of developing and exploiting new product innovations, has made it – especially during the 1980s and 1990s – 'more profitable to export the same old products, produced in the same old way' (Edquist and McKelvey, 1998, p.142) than developing new products and production techniques. Consequently, macro-economic factors and policies in the 1980s and 1990s have reinforced further the significance of MNEs in the economy, and thus the occurrence of the SP (see also the discussion in Henrekson and Jakobsson, 2001; Marklund *et al.*, 2004). Since the innovation potential of Sweden is heavily dependent on the activities of a few Swedish MNEs, this opens up the possibility that the SP can also be caused by the production activities of such firms. Edquist and McKelvey (1998) were among the first to propose that the SP is partly caused by the globalisation of production. In particular, they argue that Swedish MNEs tend to conduct most of their R&D activities in Sweden, while the end-product of R&D efforts is produced elsewhere. In similar vein, Marklund *et al.* (2004) point out that Swedish MNEs 'find Sweden considerably more attractive for R&D activities than for production' (p.13). In other words, Swedish MNEs 'have made Sweden a knowledge producer without domestically translating that knowledge into economic value' (Edquist and McKelvey, 1998, p.140). Altogether, 'there is substantial support for the hypothesis that the Swedish paradox can be at least partly explained by globalisation, in the sense that R&D carried out in Sweden increasingly bears fruit in terms of innovations in other countries' (Bitard *et al.*, 2008, p.262).

Another popular explanation for the SP relates to the national innovation system, this being understood as a system consisting of 'economic, social, political, organisations, institutional and other factors that influence the development, diffusion and use of innovations' (Edquist, 2005, p.182). In particular, Edquist and McKelvey (1998) were also among the first to argue that the SP is an outcome of structural problems in the national innovation system of Sweden. More recently, Bitard *et al.* (2008) examined at length the extent to which the SP is an outcome of an inefficient national system of innovation. Following Edquist (2005), the analysis concentrates upon some of the key activities (or functions) of the system, especially the abilities of the innovation system to develop, use and diffuse innovation. Five main sets of activities were examined: knowledge inputs to innovation (e.g. R&D activities); competence building (e.g. training and education); demand-side factors (e.g. formation of new markets); provision of

constituents (e.g. entrepreneurship, networking, interactive learning and institutions); support services for innovation (e.g. incubating, financing and consulting activities); and innovation policies related to the above activities. The findings illustrate that the Swedish innovation system is strong with regard to R&D and competence building, but weak in many other activities, such as new firm formation, provision of venture capital, incubation support, the formation of new markets and labour market flexibilities. In other words, the Swedish innovation system is strong on some activities related to the development of innovation and weak on many other activities related to the development, use and diffusion of innovation (Bitard *et al.*, 2008; Edquist, 2010).

One of the least popular explanations for the SP is the theoretical perspective. Specifically, Ejermo and Kander (2006) maintain that the underlying observation of the SP rests on a proportional-mechanistic rationale informed by the scale effects assumptions propagated in the early endogenous growth theory models (e.g. Romer, 1990; Grossman and Helpman, 1994). They argue that once such assumptions are replaced by a more complex theoretical understanding that acknowledges some of the mechanisms (e.g. inventions, innovation and entrepreneurship) through which R&D is transformed into economic growth, there seems to be 'no sound reason to expect a strong proportional relationship between the level of R&D in a country and its growth performance' (Ejermo and Kander, 2006, p.32). In other words, '[w]ith lower and more realistic expectations, no paradox will exist' (Ejermo *et al.*, 2011, p.665). However, regardless of the theoretical perspective, the SP highlights that the Swedish innovation system needs to invest significant resources in R&D to achieve the same levels of competitiveness and welfare that other small national innovation systems in Europe (e.g. Denmark, The Netherlands and Norway) achieve with far fewer resources devoted to R&D (Bitard *et al.*, 2008; Castellacci, 2008). In this sense, the SP may constitute not only an unexploited opportunity for policy-makers (Edquist, 2010), but also an interesting contrastive regularity (Lawson, 1997, pp.206–8) for innovation researchers and social scientists in general.

An explanatory typology of innovation paradoxes

How have the innovation paradoxes under consideration been theorised and explained? Based on the above review, an answer to this question could be given in many ways. Fortunately, the various explanations identified in the previous two sections can be utilised as raw materials for constructing a working explanatory typology of innovation paradoxes. The proposed typology consists of four main explanatory categories, which can be distinguished along a continuum as complementary and competing (see Figure 1).[5]

(1) 'Academia-science base explanatory category'. This is one of the most popular explanatory categories in both literatures under consideration. The underlying argument is that an innovation paradox is mainly, or partly, caused by problems and inabilities (e.g. technology transfer problems, entrepreneurship problems, institutional rigidities) in the academic and scientific system. However, empirical research in both paradoxes under review has raised significant doubts about the extent to which explanations drawn from this category offer genuine knowledge

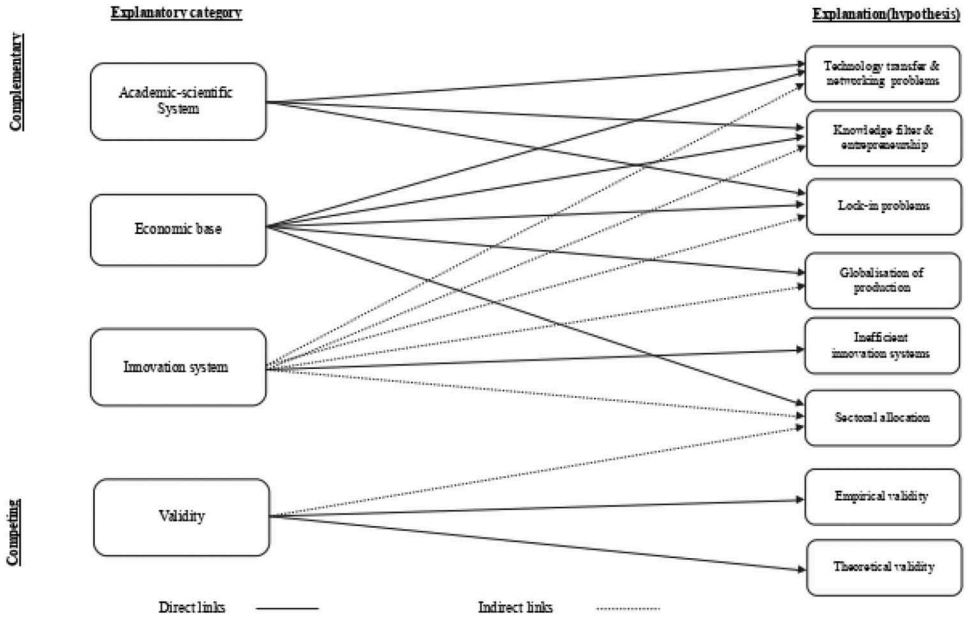

Figure 1. A typology of explanations.

on the underlying causes of an innovation paradox. Several empirical studies show that the presumed entrepreneurial inabilities of both European and Swedish science systems are largely fallacious. This, in turn, raises two important questions: first, why such explanations were proposed at the first place? Secondly, why have policy-makers taken the validity of some explanations for granted? It would be interesting to speculate at length on both these questions. For the purposes of this paper, however, it is reasonable to say that the early research on innovation paradoxes seems to have reinforced the belief that the European academic-scientific system is not very efficient in commercialising scientific research and knowledge. It must also be emphasised that the policy discourse on innovation paradoxes seems to have been somewhat slow in incorporating the results of research that disprove dominant beliefs.

(2) 'Economic base explanatory category'. Since research has shown that the academic-scientific system has nothing (or little) to do with the occurrence of an innovation paradox, empirical research has examined the possibility that it is the activities of firms and industries that induce the innovation paradoxes in question. While research on the EP has highlighted the weaknesses of the European industry in terms of developing and commercialising promising scientific discoveries, it is in the empirical literature of the SP that a few interesting explanations have been proposed and advanced over the past decade. Key explanations include the following: the increasing 'nationalisation' of R&D activities versus the increasing globalisation of production; the lack of certain innovation capabilities, especially in terms of investing in new high-tech products; the lack of network and technology transfer activities, especially with regard to innovation cooperation; and technological lock-in

problems on the part of both firms and industries. In other words, explanations falling into this explanatory category see an innovation paradox as the outcome of certain activities and inabilities of the industrial base. Although this line of argument may sound promising, there has so far been scant explicit empirical research on the EP that treats the EU economic base as the main causal factor.

(3) 'Innovation system explanatory category'. This is one of the most popular explanatory categories in the SP literature. The underlying proposition of this category is that the Swedish innovation system suffers from some structural problems and inabilities that have led over time to several inefficiencies in terms, for example, of providing incentives to firms and of transforming a large investment in R&D into wealth and employment-creating innovations. Compared with the other explanatory categories, the innovation systems category seems to be the only one which – at least *a priori* – is able to combine, in a flexible, holistic and interdisciplinary manner, several of the explanations identified in the other explanatory categories. In addition, the innovation systems explanatory category offers interesting arguments, relevant to both theory and policy. While the inefficient innovation system explanation has been proposed in the context of the SP since the late 1990s, no study has to date examined its explanatory power in the context of the EP. This, perhaps, could be attributed to the absence of a coherent (pan)-European innovation system (Caracoustas and Soete, 1997). Nevertheless, it would be interesting to examine, in a comprehensively comparative manner, the Swedish innovation system with another 'paradox-free' national innovation system in Europe (Denmark, Norway and The Netherlands are good candidates) (Castellacci, 2008; Edquist and Hommen, 2008).

(4) 'Validity explanatory category'. The previous three explanatory categories offered a set of complementary explanations for the occurrence of an innovation paradox. The validity explanatory category consists of a few competing explanations in the sense of providing explanations that doubt the actual existence of an innovation paradox. As shown throughout this review, these take the form of either/both empirical validity or/and theoretical validity explanations. The first set of explanations proposes that an innovation paradox is mostly attributable to methodological problems and related issues, both of which have to do with measuring innovation inputs and outputs properly. The second set of explanations argues that an innovation paradox is a matter of theoretical perspective, not an outcome of real economic structures and forces. One of the key merits of the validity category lies in its ability to draw, prior to the initiation of an empirical study, our attention to the possibility that an innovation paradox may be grounded on both/either shaky empirical and/or theoretical grounds. On the other hand, one of the key demerits of this explanation is that it provides no knowledge of the underlying causes of a genuine innovation paradox.

Concluding discussion, remarks and suggestions

This paper has provided one of the first reviews of research on innovation paradoxes. An important finding concerns the observation that research on the paradoxes under consideration falls, in one way or another, into a four-fold typology of (complementary and competing) explanations. This also points to the conclusion that innovation paradoxes are best conceptualised and analysed as multi-determined phenomena, as their occurrence can be determined (and thus also explained) by a wide array of forces and factors operating at various levels of socioeconomic organisation. However, much of the extant research seems to have underestimated this essential aspect of innovation paradoxes. This, in turn, leaves ample room for future research; for instance, future research can conceptualise and investigate innovation paradoxes by taking an integrative theoretical approach, capable of integrating explanations from more than one explanatory category. Here the innovation systems category would seem to have a natural advantage. As argued extensively elsewhere (Edquist, 2005), the innovation systems approach constitutes one of the most flexible, holistic and interdisciplinary theoretical perspectives within the field of innovation studies.

Furthermore, this review/study has underlined that the very essence of innovation paradoxes lies in the regularity between high inputs and low outputs. Related to this is the fact that much of the discourse on innovation paradoxes rests upon a latent proportional-linear rationale, the theoretical origins of which lie in the mainstream growth theory in general, and in the linear model of innovation in particular. This is surprising for a number of reasons; among them is that the linear model of innovation has, since the 1980s, been found wanting, especially when it comes to providing a sophisticated understanding of the non-R&D sources and dynamics of innovative activities, and thus of the causal mechanisms through which innovation contributes to economic progress (Kline and Rosenberg, 1986; Castellacci, 2007; Edquist, 2014). The assumption of linearity is inadequate.[6] However, innovation paradoxes research certainly has neglected the possibility that demand side factors (e.g. reduced real disposable income and buying power, lack of insightful public procurement policies, etc.) can exercise significant causality. This is of significance to innovation policy as innovation paradox policies betray the assumption that the best way to address an innovation paradox is to correct the supply (input) side. The assumption may be unfounded and inimical to taxpayers. After all, the commercial success of innovation is always dependent on an appropriate set of market conditions and needs (Schumpeter, 1934/2008; Van der Panne *et al.*, 2003).

Furthermore, the high-input and low-output pattern raises questions about the endurance of regularities in the socio-economic domain. As with every regularity of the human social world, innovation paradoxes are spatiotemporal phenomena. Though apparently straightforward to the point of banality, several key research implications follow from them: first, it appears that once the existence of an innovation paradox has been identified, research needs to proceed in a timely manner, especially if the research goal is to make a non-historical contribution to our knowledge about the most efficacious causal mechanisms. Secondly, it appears that innovation paradoxes research has to date remained oblivious of the geographical character of innovation activities (*cf.* Christopherson and Clark, 2007; Fragkandreas, 2013; Makkonen and Inkinen, 2013).

This is a crucial omission simply because – and as a great deal of research over the past four decades has shown (Feldman, 1999) – innovative activities are highly localised, being concentrated in a few cities and regions, and despite the twin forces of globalisation and digitalisation, which were meant to smooth the geographical distribution of innovative economic activity over time (Morgan, 2004; Asheim and Gertler, 2005). Against this backdrop, future research needs to address the sub-national nature and causes of innovation paradoxes.

The overall purpose of this review is theoretical. However, there are also methodological observations, reflections and implications that emanate from the study. Much of the extant research on innovation paradoxes is quantitative. Illustrative of this is the fact that none of the reviewed studies records the views of innovation actors (e.g. entrepreneurs, managers, business associations, policy-makers, technology transfer officers, labour union representatives, etc.) about the underlying causes of innovation paradoxes. The significance of this neglect lies not only in the inherently qualitative nature of innovation (Schumpeter, 1934/2008), but also in the inherently limited ability of quantitative methods to provide a deeper understanding of the contextually-rich nature of causality in the social word (Lawson, 1997). Methodologically speaking, a more pluralistic approach can produce a better understanding of innovation paradoxes.

Notes

1. Search date December 2017.
2. Innovation studies is half a century old, a cross-disciplinary field of the social sciences. Its primary aim is to study in a systematic manner the nature, determinants, social and economic benefits and consequences of innovation (Fagerberg *et al.*, 2013). While diverse, much innovation studies theory and research falls into three main strands: the economics of innovation strand, consisting of the mainstream economic school (e.g. Aghion and Howitt, 1992) and the evolutionary (neo-Schumpeterian) school (e.g. Fagerberg, 2003); the management and organisation of innovation strand (e.g. Tidd *et al.*, 2005); and the socio-economic strand, dealing mainly with the diffusion of innovation (e.g. Rogers, 2003) and innovation systems (e.g. Edquist, 2005). As a result of its multi-disciplinary nature, innovation studies research on innovation paradoxes provides a more holistic and nuanced understanding of the underlying causes of innovation paradoxes than discipline-based (e.g. economic) research on such paradoxes.
3. The author would like to thank an anonymous referee for bringing Peterson and Valliere (2008) paper to his attention.
4. Several more explanations can also be included here. However, like the previous section on the EP, this section deals with contributions that have explicitly addressed or referred to the SP either/both in theoretical or/and empirical terms.
5. As a reviewer has rightly pointed out, one can also develop various other typologies based on the findings of the previous two sections. For instance, one can distinguish among micro-level factors, meso-level, and macro-level (e.g. institutional and structural) factors. Despite its relevance, such a classification leaves no room for the validity explanatory category, discussed towards the end of this section.
6. This, however, does not necessarily mean that a 'linear-informed' innovation paradox is of little relevance to our knowledge, as some scholars may think or argue. After all, the inferiority or superiority of any theoretical perspective is best illustrated through concrete research in general, and causal explanatory research in particular.

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