

Regional Economic Resilience: A Schumpeterian Perspective

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Received: 31 May 2013 / Accepted: 17 January 2014 / Published online: 5 April 2014
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Abstract This paper takes up the Schumpeterian argument that innovations drive economic recovery following cyclical phases of recession and depression. The performance of the regional innovation systems of two contrasting regions in England is examined in the light of this argument. It is shown that the long-term development of the regions' respective innovation systems contributed significantly to the long-run adaptation and consequential economic resilience of their economies in the face of periodic external economic shocks. It is also argued that regional innovation systems policies can contribute to the adaptation of regional economies and therefore their economic resilience.

Keywords Regional resilience · Schumpeterian business cycles · North East and South East England · Regional adaptation

Regionale ökonomische Resilienz: Eine schumpeterianische Perspektive

Zusammenfassung Dieser Beitrag basiert auf dem Schumpeterianischen Ansatz, dass Innovationen die wirtschaftliche Erholung im Anschluss an Konjunkturzyklen beeinflussen. Anhand der Ergebnisse in regionalen Innovationssystemen zweier gegensätzlicher Regionen in England wird dieses Argument geprüft. Es zeigt sich, dass die langfristige Entwicklung ihrer regionalen Innovationssysteme

maßgeblich zu ihren relativen ökonomischen Anpassungsfähigkeiten und zu ihrer Resilienz im Anschluss an exogene ökonomische Schocks beigetragen haben. Zudem wird begründet, dass regionale Wirtschaftspolitik die Entwicklung regionaler ökonomischer Resilienz beeinflussen kann.

Schlüsselwörter Regionale Resilienz · Schumpeterianische Konjunkturzyklen · Nordost- und Südost-England · Regionale Anpassung

It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.

Charles Darwin (1859) Origin of Species

1 Introduction

During the years 2008–2009 the UK economy experienced the deepest depression since the late 1920s. This has prompted both scholarly and policy debates on how and when it will be possible for the UK economy as a whole and its constituent regional economies to recover. The concept of 'resilience' has come to the fore as one possible way of conceptualising and analysing the impacts of recessionary shocks on national and regional economies. This is exemplified with respect to the latter by the special edition of the "Cambridge Journal of Regions, Economy and Society" on "The Resilient Region" (2010).

The current depression, however, is not a unique phenomenon in the historical evolution of the UK economy. Since the Second World War there have been four such periods when annual growth in GDP has been less than zero. These periods include 1974/1975, 1980/1981, 1991, and 2008/2009. Joseph Schumpeter, the father of evolutionary

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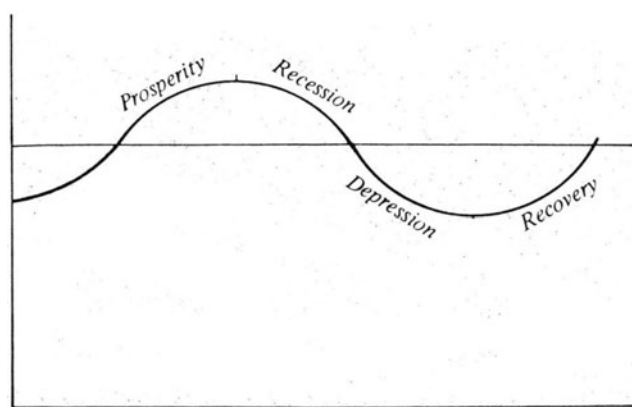


Fig. 1 Schumpeterian four phase cycle. (Source: Own illustration, based on Schumpeter (1939))

economics, was one of the first economists to recognise and analyse the repetitive nature of such events in his book “Business Cycles” (Schumpeter 1939). Using a combination of statistical and historical analyses he identified a recurring four-phase cycle of prosperity, recession, depression and recovery that characterised the development of capitalist economies. Unlike the contemporary technical definition of recession, which is simply two consecutive quarters of negative growth, in Schumpeter’s analysis recession consists of a period of economic decline following prosperity. Depression, on the other hand, is a period of below zero decline while recovery is the period of economic growth from below to above zero as shown in Fig. 1.

Schumpeter argued that the onset of recession and depression could have positive outcomes as what he called “gales of creative destruction” (Schumpeter 1942: 82) swept away old unproductive industries. At the same time he also argued that accelerations of technological innovation during periods of depression were the main drivers of recovery. Following this line of reasoning it is hypothesised in this paper that innovation is one of the key drivers of adaptation in economies and therefore of regional economic resilience.

‘Resilience’ is a classic example of what Ann Markusen (2003) described as a “fuzzy concept”. By that she meant a concept lacking in conceptual clarity and therefore difficult to operationalise resulting in a lack of acceptable supporting empirical evidence. The meaning of fuzzy concepts tends to vary according to their context or conditions. Their definitions are not fixed or generally agreed. As a result, a concept like resilience, as currently employed, has multiple meanings. One recent review of the literature, for example, identified no less than 16 ‘understandings’ of resilience in social, ecological and socio-ecological systems (Bahadur/Ibrahim/Tanner 2010).

Following this introduction, a second section of this paper will therefore explore some of the reasons why economic resilience is such a fuzzy concept. It will also attempt

to define, as precisely as possible, what is meant by regional economic resilience and how it may be analysed empirically. In this section the possibility that overall competitiveness rather than industrial structure is the key to the adaptation of and economic resilience in regional economies is examined.

This is followed by a third section developing the argument that, despite the overall convergence of regional industrial structures outside London, the productivity of different firms and industries in the same sectors is different in different regional settings. As a result, despite having apparently similar industrial structures, productivity and hence the adaptation and consequential resilience of regional economies can be significantly different. It is argued that differences in the characteristics and capacities of distinctive regional innovation systems (RIS) are the key drivers of regional sectoral productivity and hence the relative competitiveness of the regional economy as a whole. Invention and new knowledge production, and their commercialisation as new product and process innovations, are argued to underlie the long-term adaptation of and the development of economic resilience in regional economies.

In a fourth section these arguments are illustrated by some data bearing upon the innovation systems of two contrasting regions selected from the North and South of England. These two regions are the North East and the South East of England. Here the extent to which the evolution of their respective regional innovation systems during periods of prosperity develops the relative adaptive capacities of their respective economies and therefore their ability to recover and prosper after periods of recession and depression is examined.

A final section draws some conclusions from these analyses. Some regional economic policy prescriptions arising from these analyses are also explored.

2 Regional Economic Adaptation and Resilience

Contemporary literature that develops the concept of regional economic resilience has tended to focus not so much on the long-term, cyclical evolution of capitalist economies but more on their immediate reactions to recessionary shocks. This is partly a result of their ontological backgrounds. Gardiner/Martin/Sunley et al. (2012), for example, identified four different ontological sources of ideas for conceptualising regional resilience. These include ecology and socio-ecology, evolutionary developmental biology, economics and psychology.

Economic approaches to understanding regional economic resilience include the ‘plucking model’, ‘hysteresis’ and ‘adaptive evolution’. Each defines regional economic resilience in a different way. The first two are summarised

briefly below. The paper then focuses on the concept of adaptive evolution.

According to the ‘plucking model’ the development pathway of an economy can be likened to a tightened string attached to the underside of an upward-sloping board which is plucked downwards by recessionary shocks (Friedman 1993; Kim/Nelson 1999; Martin 2012). “The board represents a slowly-rising upper limit or ceiling on output set by an economy’s resources, the way they are organised, and their productivity. Though the extent of decline caused by a recessionary shock will vary from downturn to downturn, output is assumed to rebound in each case to the (upward-sloping) ceiling level. In other words, the plucking model predicts that recessionary shocks should be transitory, and should have no permanent effect on the economy’s long-run growth ceiling or growth trend” (Martin 2012: 5). In this case resilience is defined as the ‘bounce-back’ of an economy to its pre-shock growth path.

The concept of ‘hysteresis’ derives from studies of the magnetic and elastic properties of metals and materials. It was introduced into economics by Georgescu-Roegen (1966), Elster (1976), Cross and Allen (1988), Cross (1993), Göcke (2002), and Setterfield (2010). In mainstream economics the idea is used to describe situations in which an economy is shifted from one equilibrium position or stability domain to another as a result of a major external shock. The concept of equilibrium, however, is not essential to the idea. Romer (2001: 471), for example, defines hysteresis as a situation “where one-time disturbances permanently affect the path of the economy”. This involves structural change in the economy (Setterfield 2010). In this instance resilience is defined as the reaction of an economy to a specific external shock and the nature of the new trajectory of path dependent development that it moves to after the immediate impact of the shock.

The concept of ‘adaptive resilience’ is derived from the theory of complex adaptive systems. It is argued that what distinguishes complex adaptive systems is the way they exhibit self-organising behaviour, driven by co-evolutionary interactions among their constituent components and elements, and an adaptive capacity that enables them to rearrange their internal structure spontaneously, whether in response to some external shock, or in reaction to internal emergent mechanisms or self-organised criticality (Martin/Sunley 2007). From this perspective regional economic resilience may be defined as “the capacity of a regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies and institutions) so as to maintain an acceptable growth path in output, employment and wealth over time” (Martin 2012: 10). This is the definition of regional economic resilience adopted in this paper.

The adaptive capacity of a regional economy evolves over time and is dependent on such phenomena as the rate

of entrepreneurship and new firm formation, on the innovativeness of existing firms, on access to venture capital, on the diversity of a region’s economic structure, and on the availability of appropriately skilled labour (Martin 2012). In this sense regional economic resilience is a dynamic evolutionary and path dependent process. It resonates closely with the Schumpeterian idea of “gales of creative destruction” (Schumpeter 1942: 82). Recessionary shocks may destroy unproductive activities and open up opportunities for the creation of new technological pathways and industries. A key question for individual regional economies is whether the eventual creative elements of a recessionary shock outweigh the destruction that it wreaks.

Adaptive capacity is particularly critical for regional economies which are very open to outside forces and therefore vulnerable to the impacts of external shocks such as recessions and depressions. From a Schumpeterian perspective the ways in which technologies and institutions co-evolve in the face of external shocks is a particularly significant determinant of the relative economic resilience of different regional economies. For this reason the empirical analysis of this paper proceeds by selecting two representative and contrasting regions from the North and South of England and examining changes through time of their respective regional innovation systems through repetitions of the Schumpeterian four phase cycle of prosperity, recession, depression and recovery. So the first task is to identify the chronology of those phases in the UK economy as a whole over time and to indicate how they have impacted on the North and South of England.

3 Schumpeterian Cycles and Economic Growth

Figure 2 and Table 1 show the annual changes taking place in the GDP of the UK over the period from the early 1970s until 2010. During these decades there have been four Schumpeterian cycles of prosperity, recession, depression and recovery (Fig. 2)¹. During the depression phases UK GDP shrank in 1974/1975, 1980/1981, 1991, and, most severely, in 2008/2009.

Table 1 identifies the chronology of the Schumpeterian cycles and assigns them a number for brevity. Thus P1 is the first phase of prosperity, R1 recession, D1 depression, RE1 the first recovery phase and so on.

The impacts of these national cycles have been different in the different regional economies of the UK. Figure 3 shows the cumulative impacts in terms of the general divergence of the Gross Value Added (GVA) between regions in the North and those in the South of the UK. It may be seen

¹ <http://www.ons.gov.uk/ons/datasets-and-tables/index.html> (20.12.2007).

Fig. 2 Annual change in UK GDP 1971–2010 at constant 2003 prices. (Source: Office for National Statistics)

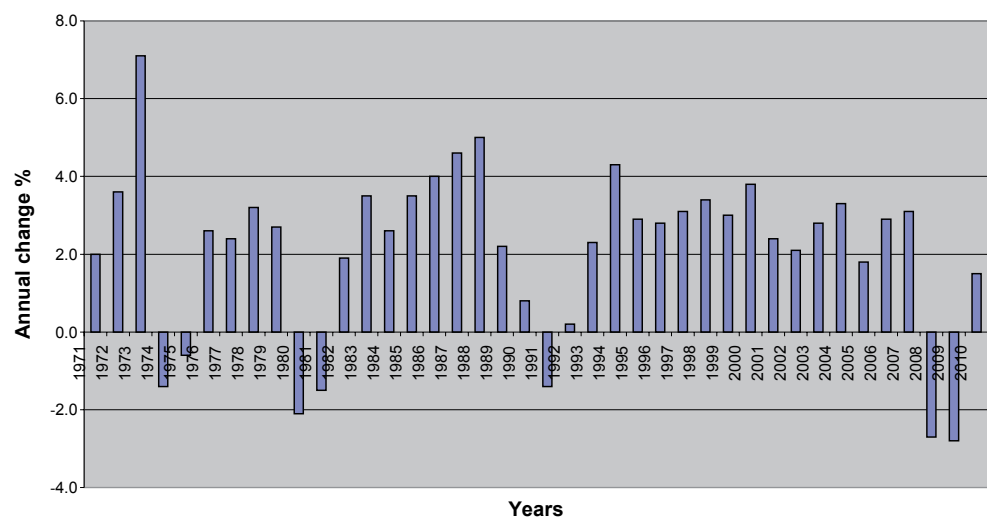
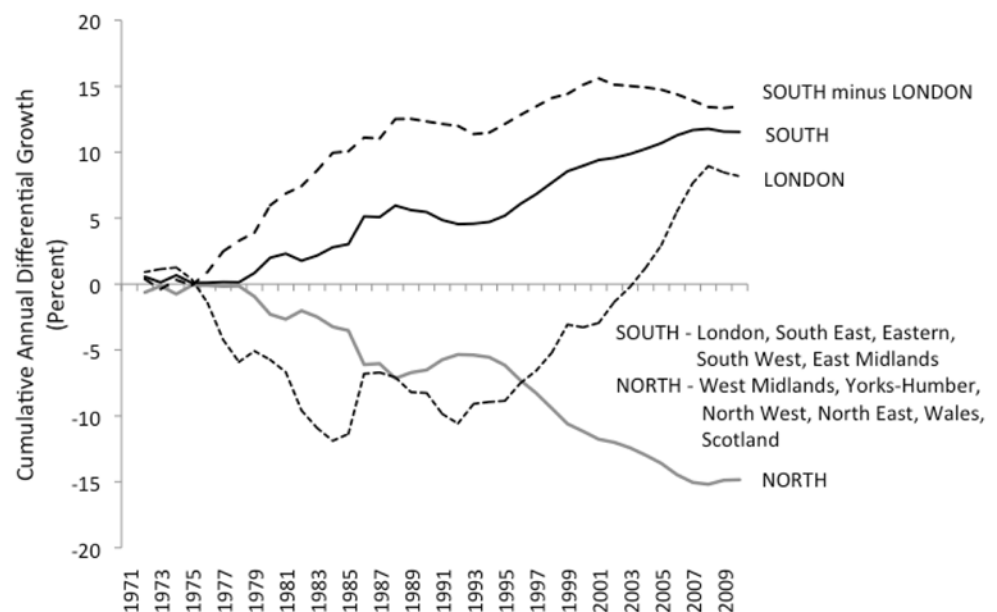


Table 1 Schumpeterian four phase cycle: UK 1971–2010

Prosperity	CP	Recession	CP	Depression	CP	Recovery	CP
1971–1973	P1	1973–1974	R1	1974–1975	D1	1975–1976	RE1
1976–1978	P2	1978–1980	R2	1980–1981	D2	1981–1982	RE2
1982–1988	P3	1988–1991	R3	1991	D3	1991–1992	RE3
1992–2007	P4	2007–2008	R4	2008–2009	D4	2009–2010	RE4

CP Cycle phase, P Prosperity, R Recession, D Depression, RE Recovery

Fig. 3 Cumulative north-south growth divergence (GVA, 2006 prices), 1971–2010. (Source: Gardiner/Martin/Sunley et al. (2013))



that with the impact of the 1978–1981 recession/depression GVA in the Northern regions went into decline. This decline continued until the 1988–1991 recession/depression when GVA recovered a little, but by the mid 1990s its long-term decline had been resumed.

In contrast with the North, Southern regions, minus London, recovered quickly from the recession/depression of 1973–1975. The recession/depression of 1978–1981 had little

impact on these regions and cumulative growth in GVA continued its upwards trajectory until the recession/depression of 1988–1991. By 1995 it had resumed its upwards course until the end of the 1990s when it began to decline slowly.

Figure 3 also shows the distinctive long-term decline and subsequent economic growth of the London economy. This is associated with the decline of manufacturing in the early period and the rapid growth in financial and business

services following the deregulation of financial markets in 1986 colloquially known as ‘big bang’.

Figure 3 also shows that the long-term trend line of the Schumpeterian four phase cycle is unlikely to be horizontal as shown diagrammatically in Fig. 1 above. In southern regions the long-term trend in economic growth has been upwards despite dips as a result of the shocks of periodic national recession/depression. In contrast, these national shocks have not generally been followed by recovery to previous rates of economic growth in the northern regions. London provides an atypical example where the impact of successive external shocks to its manufacturing industries drove its long-term growth rate downwards. But, following ‘big bang’ in 1986 and the recession/depression of 1988–1991, innovations in financial services drove its long-term growth rate upwards during the ensuing period of national recovery.

It is argued in this paper that innovation, or the lack thereof, is one of the key driving forces that underlie both these long-term trajectories in regional economic growth and the regions’ relative abilities to recover from external shocks such as national and international recessions/depressions. In order to illustrate these arguments empirically two contrasting case study regions are selected, the South East from among the southern regions and the North East from the North. The initial reason for the selection of these two particular regions is that, over the last four decades, the North East has had one of the lowest rates of cumulative economic growth among UK regional economies while the South East has had one of the highest. The locations of these two regions are shown in Fig. 4.

The cumulative effects of economic growth in the South East and economic decline in the North East over the last four decades are illustrated in Fig. 5². It can be seen that by 2011 GVA in the South East, at £192,208m, was 4.6 times that of the North East, at £41,423m. It is argued below that a significant part of the explanation for the long-term cumulative divergence of these two regional economies, resulting in such a large difference by 2011, lies in the relative performance of their respective regional innovation systems. These have contributed significantly to their capacities to adapt over time and to recover from the impacts of external shocks such as the onset of national recessions/depressions.

The method employed in this paper to analyse the adaptation and resilience of the South-East and North-East regional economies is to examine the long-term performance, or lack thereof, of their respective regional innovation systems in the face of successive major external shocks caused by successive national and international recessions. Their relative



Fig. 4 NUTS 1 regions of the UK

resilience is then assessed according to the degrees to which they were able to develop their respective adaptive capacities in the long term and to change and prosper in the face of such shocks.

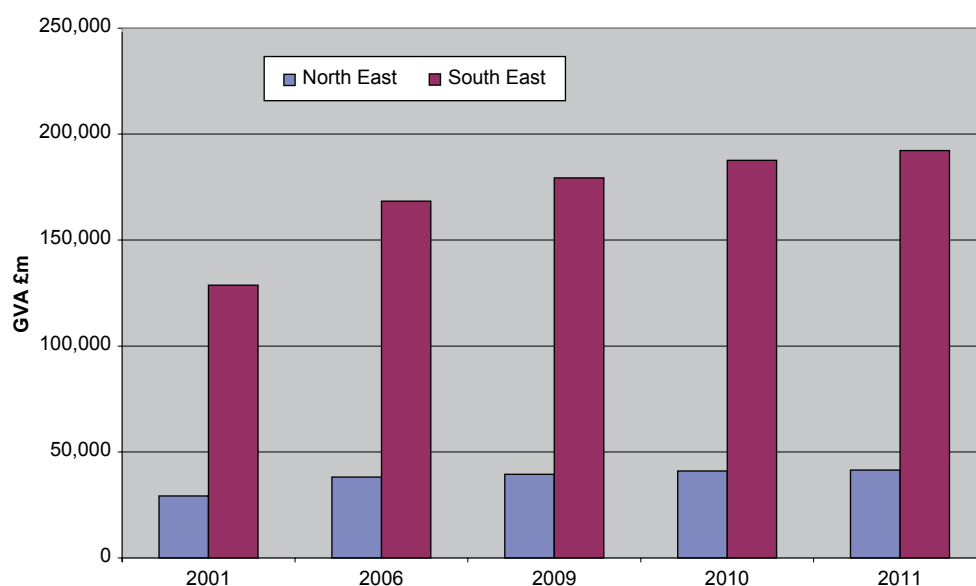
4 Resilience as Adaptation Driven by Innovation

Schumpeter argued that innovation is the key force that drives the recovery of economies following periods of recession and depression. In this paper it is argued that the emergent collective innovation and adaptation of firms within a regional economy determines, to a significant degree, the long-run adaptive capacity and the short-term resilience, in the face of recessionary shocks, of a regional economy. Innovation is not only of relevance in response to periodic shocks but also a key capacity in the ongoing need to compete especially in export markets. This evolutionary process involves both the innovative upgrading of existing firms and the birth and development of new ones. The latter is particularly significant in the creation of new industrial and technological pathways.

The significance of technological change as a driver of productivity and therefore economic growth was eventually also recognised by neo-classical economists. In the mid 1950s Solow (1956, 1957) and Swan (1956) independently

² <http://www.ons.gov.uk/ons/rel/regional-trends/region-and-country-profiles/region-and-country-profiles---key-statistics-and-profiles--october-2013/directory-of-tables.html#tab-Economy> (17.11.2013).

Fig. 5 GVA in the North East and South East regions 2001–2011.
(Source: Office for national statistics)



developed simple growth models that, for the first time, included a specific role for technology in economic growth. In Solow's model new capital is more valuable than vintage capital because since capital is produced on the basis of known technology, and technology improves with time, new capital will be more productive than old capital. In common with neo-classical models in general, however, this approach provides a post hoc analysis of the contribution of technological change to productivity and hence to economic growth but, unlike Schumpeter and subsequent evolutionary economists, provides no explanation of why and how new technologies are generated in the first instance.

The revival of interest in invention and innovation as key generators of technological change, mainly by evolutionary economists such as Nelson and Winter (1982), during the 1980s, established the idea that innovation relies on the activities not just of individual firms but also of other public and private actors and institutions. The contemporary view of innovation as a complex system is summed up succinctly by Nauwelaers. She says that "the innovation system approach pictures innovation as a complex and uncertain process, has enterprise dynamics at its core, places a premium on interactions and learning between actors, and emphasizes the importance of institutions, formal and informal, for the generation, diffusion and use of knowledge. It incorporates the idea that firms do not innovate in isolation, but rather through interactions with other firms, with users and with their environment" (Nauwelaers 2011: 468).

Key to the impact of innovation on productivity and hence economic growth is not simply the invention of new technologies in the first instance but also their diffusion and widespread use. The diffusion of innovations is the key process that spreads their use from original niche conditions to the point at which critical mass is achieved and a new eco-

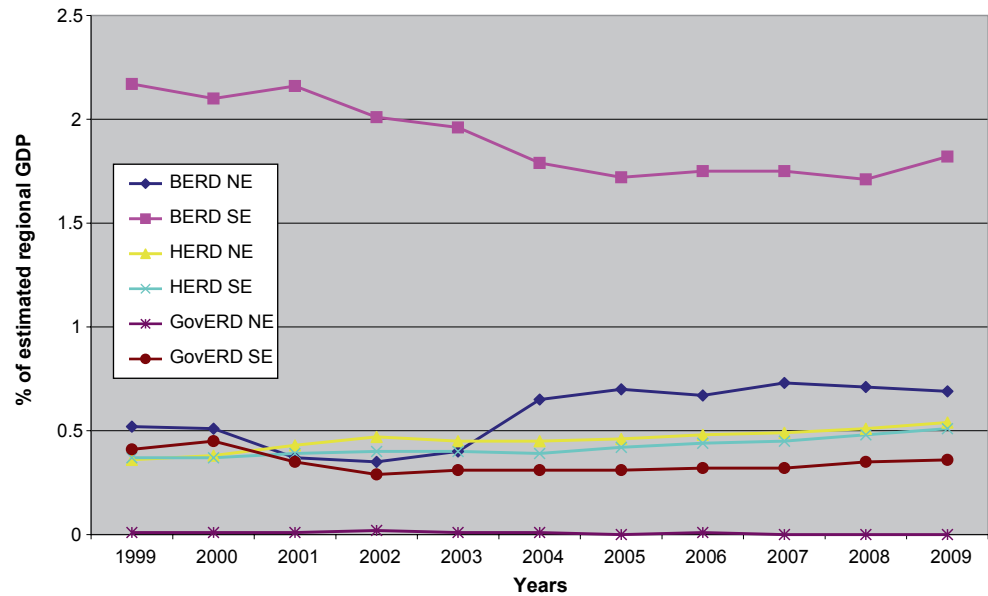
nomic pathway is created that represents a significant discontinuity with the existing paradigm or system (Witt 1997; Witt 2003). Pilat, Lee and van Ark (2002), for example, illustrate the significance to national economic productivity and growth of the diffusion and adoption of new information and communication technologies by companies such as Walmart in the USA.

In the innovation systems approach it is argued that what emerges at the macro economic level in terms of technological and other forms of innovation, is based on interactions at the micro level of an economy. These interactions take place between a wide range of economic and social actors in the context both of market forces and of a complex set of non-market institutions (Edquist 1997; Edquist 2005; Soete/Verspagen/ter Weel 2009). The key insight of innovation system theory is that although firms are the actors who combine new knowledge into novel combinations of new products and services, the development of knowledge and the skills required to create innovations requires a much wider and interlinked set of social institutions and organisations.

Four different approaches to the analysis of innovation systems have been developed. These are technological innovation systems (Hughes 1984; Carlsson/Stankiewicz 1991; Callon 1992), national innovation systems (Freeman 1987; Lundvall 1992), sectoral innovation systems (Breschi/Malerba 1997; Malerba 2002) and regional innovation systems (Cooke/Gomez Uranga/Etxebarria 1997; Cooke/Heidenreich/Braczyk 2004). Because of the regional focus of this paper the analysis that follows focuses on the significance of regional innovation systems for regional economic adaptation and resilience.

Differences between regions with respect to the complex of the organisations, institutions and the networks of inter-

Fig. 6 Research and development as a percentage of GDP (North East and South East 1999–2009). (*BERD* Business expenditure on research and development, *HERD* Higher education expenditure on research and development, *GovERD* Government expenditure on research and development. Source: Office for national statistics)



actions between them, account, in large part, for differences in their collective innovation performance and therefore differences in their adaptation over time and their resilience in the face of external and internal shocks. This is partly because, at the micro level, the adaptability of firms depends on their innovative capacity and this in turn is influenced by a region's distinctive assets, externalities and fundamentals which can shape the propensity for and the nature of innovation by local firms (Martin 2011: 241).

The key actors in a Regional Innovation System are not only private sector firms, innovation centres, financing organisations, and industry associations, but also public sector universities and other educational institutions, standard-setting bodies, and government agencies. Distinctive regional configurations of these private and public sector actors combine to produce regionally differentiated local economic environments, human and relational capital. Distinctive combinations of educational institutions and firms both generate a locally distinctive skills base and draw in relevant types of human capital from elsewhere.

With respect to relational capital Regional Innovation Systems are characterised by, among other phenomena, distinctive interactions between local businesses and between them and public sector institutions. Such networked interactions produce locally distinctive patterns of knowledge spillovers, knowledge exchange, spin-outs and spin-offs. These are embedded in local institutions as common habits, rules, norms and laws that regulate the interactions between local individuals, groups and organisations. These networked interactions both within and between regions are one of the key and regionally distinctive driving dynamics of the complex system as a whole and therefore of the emergence of the relative adaptability and resilience of regional economies.

Four key, interlinked elements of the North East and South East Regional Innovation Systems are analysed in this paper. They are:

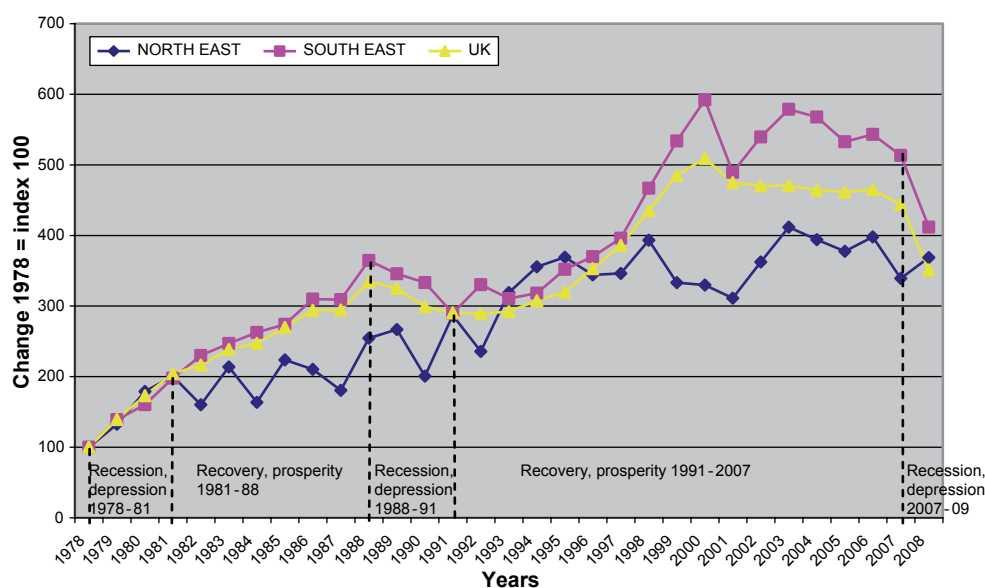
- New knowledge production from public (including universities, military, and health research and development) or private sources (private research and development).
- Learning through networked interaction linkages.
- The co-evolution and mediation of institutions including norms, rules and regulations.
- The commercialisation of new knowledge combined with venture or risk capital in the form of innovation (including new products, processes and services).

4.1 New Knowledge Production

Turning first to new knowledge production, Fig. 6³ shows that there have been some significant differences between the public production of new knowledge in the form of research and development in the North East and South East regions. Standardised as a percentage of regional GDP, the production of new knowledge in the two regions by universities has been at similar levels and, so far, has not been adversely affected by the onset of the current recession. There have been, however, significant differences between the relative expenditures by government research establishments in the two regions. In the North East there has been almost no government expenditure on pre-market research and development. In contrast government expenditure on research and development in the South East has been significantly higher.

³ <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcn%3A77-254270#tab-all-tables> (17.11.2013).

Fig. 7 Change in European patent office applications (North East and South East 1978–2008). (Source: OECD)



The largest differences, however, in the production of new knowledge are those developed in the private sector. Business research and development is relatively much higher in the South East than the North East. Given that private sector firms are the key actors in the commercialisation of new knowledge and its translation into marketable innovations this is a very significant difference between the innovation systems of the two regions.

New knowledge, particularly new technological knowledge, with potential commercial applications can be protected through the patent system. Patent applications are therefore one indicator of the production of new knowledge in a regional economy. Figure 7 shows the changes taking place in applications to the European Patent Office (EPO) for the North East, South East and UK over the 30 years from 1978 to 2008. With the notable exception of the short period between 1993 and 1995, patent applications have grown faster in the South East than in the North East.

Figure 7 also shows that patent applications grew more strongly in the recovery/prosperity phase 1981–1988 in the South East than in the North East. Their growth rate then declined in both the economies during the recession/depression of 1988–1991. During the recovery phase following this period, patent applications grew more strongly in the North East than in the South East. But, as prosperity developed patenting rates in the South East overtook those in the North East which fell back below the overall rate for the UK.

4.2 Learning Through Networked Interaction Linkages

In order to explore the key learning activities based on networked interaction linkages in the North East and South East some of the regional data provided by the Fourth UK

Innovation Survey⁴ (UKIS 4) covering the period from 2002 to 2004 is analysed. This time period is appropriate as it provides some indication of the nature and geography of the learning networks in the two regions prior to the external shock of the onset of the latest recession in 2007.

Figure 8 analyses the learning networks of the North East and South East together with their geography. It shows that only very small minorities of firms in both regions made use of co-operation networks in the development of their innovations. Within these minorities, firms in the South East were more extensively networked at all geographic levels than those in the North East. The only exception to this rule is the co-operation networks that firms in the North East had with their local universities. The universities there represent one of the few assets generating new, high level knowledge with which local firms can establish learning networks. This reflects a weakness in the Regional Innovation System in terms of a general lack of relevant actors with whom to collaborate and from whom to learn in the North East.

The comparative lack of local knowledge generating assets in the North East indicates a need for local firms to establish learning and knowledge networks further afield. But, Figure 8 shows that, in general, learning networks in the North East appear to be more parochial than those in the South East. Firms in the latter, for example, reported a greater use of international co-operation networks in all categories than those in the North East. The same also applies to national co-operation networks. Thus firms in the South East are more involved in learning networks both at the

⁴The UK Innovation Survey (UKIS) provides the main source of information on business innovation in the UK. It has been conducted on a regular basis since 1994. The UKIS also represents the UK's contribution to the Europe-wide Community Innovation Survey (CIS).

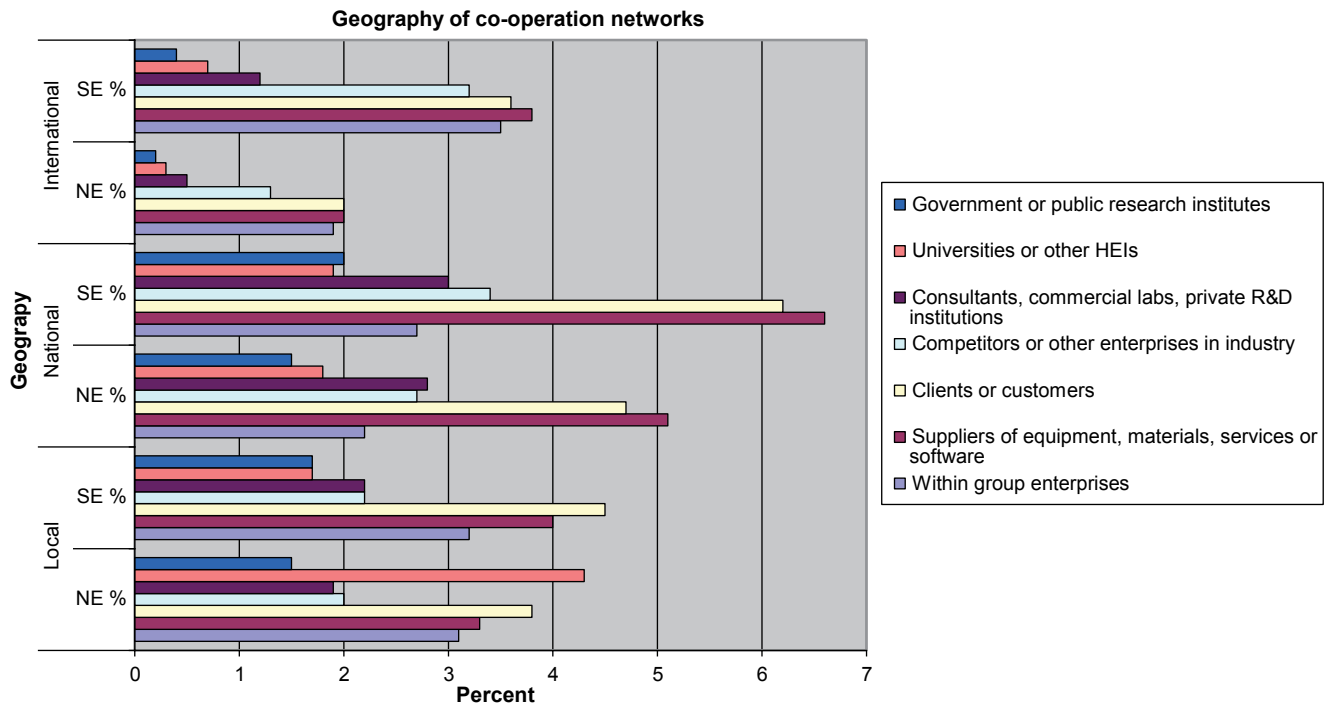


Fig. 8 Learning networks in the North East and South East 2002–2004. (Source: Office for national statistics)

local and at the national and international levels than those in the North East.

The participation of firms in local learning networks is itself a learning exercise. It provides them with the kinds of experiences needed to participate in networks located further afield. The North East Regional Innovation System therefore suffers from a number of disadvantages compared with that of the South East with respect to learning through networked interlinkages. Firstly, there are fewer relevant actors with whom to co-operate on innovation projects. Secondly, this limits the possibilities for acquiring the kinds of social capital needed for successful participation in learning networks in general. Thirdly, this also limits abilities to search for new knowledge and to participate in national and international learning networks. These barriers to the development of both intensive and extensive learning networks in the North East are a significant cause of the comparative weakness of its Regional Innovation System. The corollary of this weakness is a greater reliance on the non-networked reproduction of more traditional forms of economic activity for economic growth in the region.

4.3 Co-evolution of Institutions—Norms, Rules and Regulations

A key insight of the innovation systems literature is that innovation is not only an economic activity conducted by collaborative networks of firms and other actors but also requires the co-evolution of complementary institutions

(Freeman 1987; Lundvall 1992). These may be informal norms and accepted rules of behaviour. They may also be formal regulations and government policies. Regional innovation systems in the UK have been marked traditionally by the lack of the co-evolution of supporting institutions at this level. It is beyond the scope of this paper to analyse the evolution of informal institutions around the Regional Innovation Systems of the North East and South East. The task of analysing the co-evolution of formal institutions is much easier because the conditions pertaining to science and innovation by the late 2000s were described by one commentator as “a ‘minimalist’ system of multi-level governance in science policy in England, in which national actors continue to dominate, despite uneven yet parallel policy processes and considerable sub-national mobilization” (Perry 2007: 1052). Until 2000 science and innovation policies were decided almost entirely by central government. These decisions were technically ‘spatially blind’. But the results of this approach were to provide support to existing ‘centres of excellence’ which led to the cumulative concentration of resources in the Greater South East.

Issues around the spatial distribution of institutional support for science and innovation were brought to a head in 2000 when central government announced a decision to invest in a replacement for the “DIAMOND” synchrotron radiation source, located in the Daresbury Laboratory in the North West, at the Rutherford Appleton Laboratory located in Harwell in Oxfordshire. This galvanised regional consciousness around the importance of science and innova-

tion as key drivers of economic development not only in the North West but in other regions as well. The debates surrounding this issue developed the legitimacy of Regional Development Agency (RDA) involvement in policy and eventually “led to the creation of new institutions for science and innovation in all of the English regions” (Perry 2007: 1057).

The North East Regional Development Agency developed a ‘Strategy for Success’. It invested £200 million over five years in the Science and Industry Council formed in 2001, and a series of Centres of Excellence in life sciences, nano-technologies, new and renewable energy, digital media and process innovation. The South East Regional Development Agency established the South East Engineering and technology Advisory Council in 2003. By 2002/2003 the English Regional Development Agencies were collectively spending around 15% of their budgets on institutional support for science and innovation in their respective regions (Perry 2007: 1058).

At the sub-regional level the Chancellor of the Exchequer designated six ‘Science Cities’ in 2004. These were Bristol, Birmingham, Nottingham, Newcastle, York and Manchester. The rhetoric that accompanied these designations was that they would be in the vanguard of the sub-national campaign to make science, technology and innovation the engine of economic growth in the UK (Perry 2007: 1059). This was an ambitious objective given the relatively small scale of funding available from the Regional Development Agencies and the time limit of qualification for European regional development aid to accelerate innovation in those cities.

The traditionally centralised institutional support for science and innovation was re-asserted in 2012 when the Regional Development Agencies were prematurely abolished as a result of the government decision taken in 2010.

This has left lagging regions like the North East with a legacy of increased awareness of the importance of science and innovation in economic development combined with the re-assertion of centralised institutional control over policy and a lack of earmarked local funding. This may be summed up as a weakening of institutional support for the North East Regional Innovation System combined with the continuation of spatially blind support for the Greater South East.

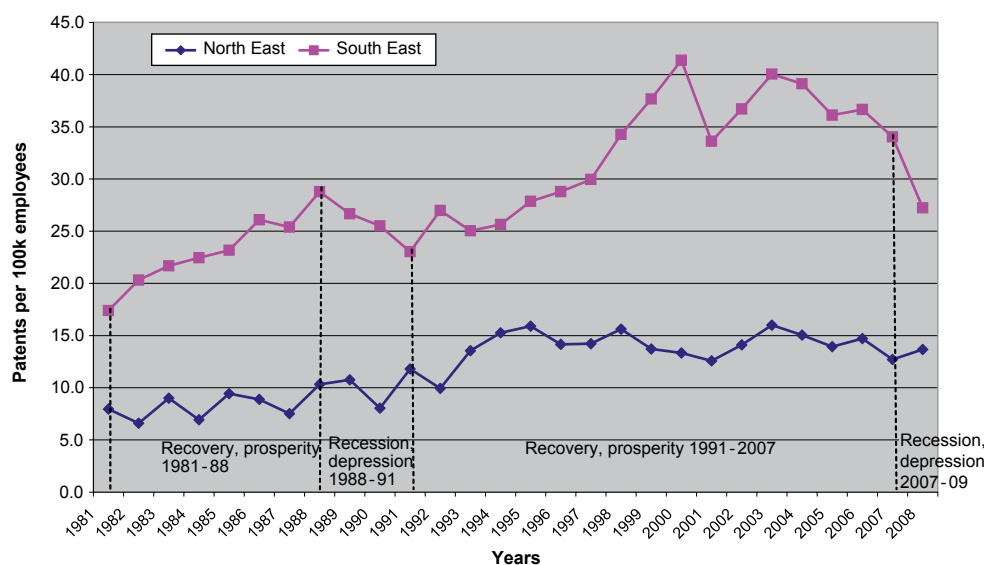
Thus, with respect to the co-evolution, at least of formal institutional support for the Regional Innovation Systems of the North East and South East, there has only been a brief period since 1971 when central and regional governments have sought to provide explicit encouragement for regional innovation. Outside that brief period the default institutional arrangements have contributed to the uneven distribution of innovation assets as illustrated with respect to government expenditures on research and development in Fig. 6. The combined effects of the technically spatially blind central government institutional support for innovation and differences in the informal institutions in northern regions as compared with those in the centralised metropolitan area has meant that, over many decades, Regional Innovation Systems in the Greater South East have experienced stronger institutional support than those in the North and other less favoured regions.

4.4 Innovation

Innovations are the critical outcome of successful interactions between new knowledge production, learning and the co-evolution of supportive institutions in a functioning Regional Innovation System.

Using patent applications, standardised per 100 thousand employees, to the European Patent Office as an indicator of potential innovation outputs over time, Fig. 9 shows that

Fig. 9 Patent applications per 100 thousand employees North East and South East 1981–2008. (Sources: OECD and office for national statistics)



there has been a consistent and cumulative higher level of patent applications in the South East than the North East over the more than two decades from 1981 to 2008. Figure 9 also shows that during the national prosperity phase of 1982–1988 patenting rose by more in the South East than in the North East. It is argued here that innovation during this period contributed to the development of the adaptive capacities of the two regional economies in such a way as to make the South East economy more resilient in the face of the national recession/depression of 1988–1991.

During the recovery phase of 1991–1992 the rate of patent applications accelerated in the South East but declined in the North East. In so far as these patents were subsequently translated into commercial innovations these data suggest that the economic recovery of the South East economy should have come sooner than that in the North East, as it indeed did (Fig. 3). This provides some support for Schumpeter's view that innovation drives economic recovery following cyclical phases of recession and depression.

One of the ways in which Schumpeterian gales of destruction can be creative is by the death of uncompetitive firms and the birth of new ones that introduce innovations. New firm formation is associated with the first introduction of product innovations. Thus the ratio of firm births to deaths in a regional economy provides an indication of growth and decline in the economy and of the degree to which 'old' firms are being reproduced or replaced by 'new', possibly innovative ones.

Coming in to recession/depression there is a risk that previously formed new small firms are potentially vulnerable to closure as a result of cash flow problems, lack of strategic planning or bank lending policies. Figure 10 shows the ratio of new firm births to deaths in the North East and South East from 1980 to 2010. It may be seen that, during the recession/

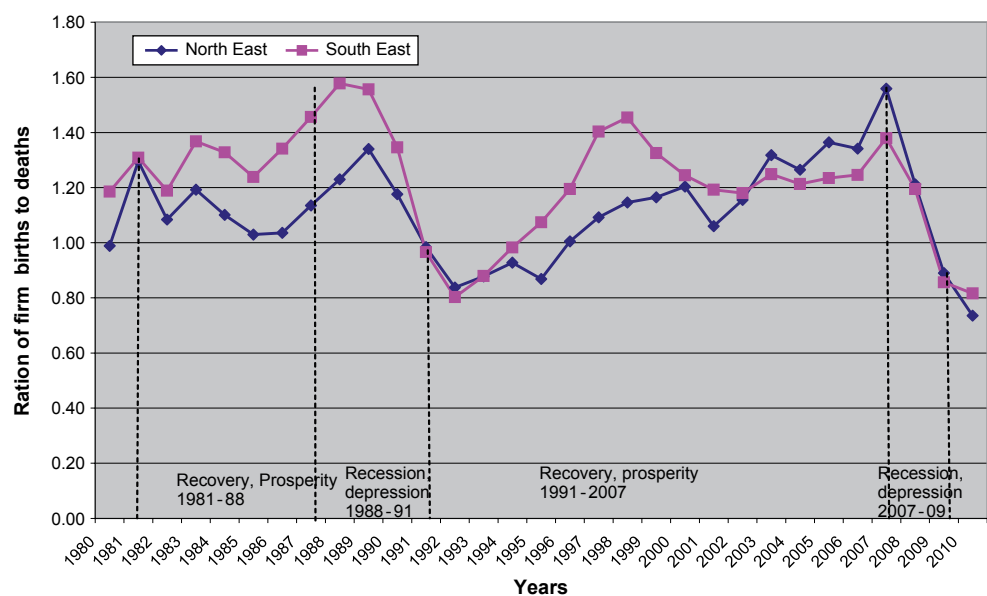
depression phases of the Schumpeterian cycles, firm deaths increased in both regions and the ratios of deaths to births were similar. In contrast during the recovery and prosperity phases firm births generally accelerated more rapidly in the South East than the North East. This is consistent with the higher rate of patenting in the South East than the North East during these phases.

During the phase of prosperity from 1982 to 1988 the rate of patenting and the ratio of new firm formation to firm deaths were consistently higher in the South East than in the North East. It is argued here that these phases of prosperity are the times when regional economies are most able to develop their adaptive capacities that form the bases of their resilience when subject to both external and internal shocks.

There is some support for this argument in the reaction of the two economies to the external shock of the national recession/depression of 1988–1991. By the end of these phases, firm deaths exceeded births in both regions. Although the effects of this recession/depression were felt most severely by service industries which formed a larger share of the South East than the North East economies, the excess of deaths over births was no greater in the South East than the North East. This indicates that the adaptive capacity of the South East, built up during previous years, assisted the regional economy to be comparatively resilient even in the face of the impacts of the shock of the recession/depression on its core industrial sectors.

As with the recovery phase of 1981–1982, the ratio of births to deaths continued to decline during the recovery phase of 1991–1992. New firm birth rates then recovered more quickly in the South East than in the North East. They reached parity with firm deaths in 1994 in the South East but not until 1996 in the North East.

Fig. 10 Ratio of firm births to deaths North East and South East 1980–2010. (Source: Office for national statistics)



After 2002, for the first time in two decades the ratio of firm births to deaths became higher in the North East than in the South East. This may reflect the outcomes of the North East 'Strategy for Success' outlined above. This came to focus very much on new firm formation in innovative new technologies. The results show that public policies that concentrate on innovation during phases of relative prosperity can have a significant impact on the adaptive capacity and subsequent resilience of regional economies.

5 Summary and Conclusions

It has been argued in this paper that regional economies are, in reality, complex adaptive systems that are subject to continual change and evolution. These are historical processes that take place over the long-term and therefore the adaptive capacity and economic resilience of regions are also developed over the longer rather than the shorter term. Over time such systems exhibit self-organising behaviour that includes adaptation of the configuration of their various structures, institutions and processes either in response to external shocks or as a result of internal emergent mechanisms. These evolutionary processes are not driven by a single 'guiding mind' in the form of the actions of major corporations, government institutions or governance in general. It would therefore be wrong to attribute a linear causal relation between any single elements of a regional economic configuration and its adaptation and resilience. It is the complex system as a whole that adapts and economic resilience is an emergent property of the self-organisation of the system.

Nevertheless, in order to unpack these arguments and concepts it is necessary to examine different elements that make up the specific configurations of particular regional economies. This paper focuses on the specific role that regional innovation systems play in contributing to their adaptation and resilience. It has been argued that the relative degrees of economic adaptation and resilience found in specific regional economies will depend significantly on the contributions of their respective regional innovation systems. In this formulation innovation itself is seen as a complex systemic process involving iterative interactions between the production of new knowledge, networked learning, and the co-evolution of institutions, in this instance, within the functional boundaries of a particular regional economy.

In this paper adaptation and resilience are regarded as possible general properties of regional economic configurations and their evolution over time. It is argued that these two general properties are the emergent effects of the evolution of other endogenous and exogenous economic, social and political phenomena rather than causes of their emergence.

This is not to argue that complex Regional Innovation Systems are the only phenomena that influence the adaptive

capacities of regional economies. In the short- to medium-term human capital in the form of labour force skills is a critical factor in the ability of a regional economy to adapt. Human capital and the knowledge that it embodies is required not only to contribute to the generation of innovations but also to put them into production.

The location of regions can also affect their relative adaptability. The South East, for example, has benefitted from the agglomeration effects of the post 'big bang' upturn in the economy of its neighbour London. Knowledge and highly qualified labour moves easily between the two regions. In contrast the North East is not located next to such a successful growth pole.

A fully functioning Regional Innovation System contributes significantly to the degree of adaption and resilience in a regional economy. This is particularly the case when the results are outputs of product innovations that can lead to a combination of economic growth and the creation of new economic pathways.

Over the long-term the North East Regional Innovation System has underperformed compared to that of the South East in terms of new knowledge production, the extensive use of networked learning, institutional support for innovation, and rates of product innovation and new firm formation. The net result is that the North East regional economy has demonstrated less adaptation and resilience than that of the South East.

In contrast the South East regional economy has been marked by the development of

- higher levels of new knowledge production particularly in government and university pre-market research and development,
- generally higher levels of networked learning with wider geographical scope particularly at the international level,
- less dependency on the relatively brief co-evolution of regional institutions of innovation that accompanied the formation of the Regional Development Authorities,
- higher rates of the commercialisation of new knowledge in the form of product and service innovation, and of new firm formation.

The impacts of these differences are cumulative. Each successive failure of a lagging economy, such as that of the North East, to recover as well and as rapidly as that of a leading economy, such as that of the South East, from the external shock of a recession/depression, contributes to the continuing divergence between groups of those two types of economy. The former tends to become increasingly characterised by path dependence and lock-in. The latter provides a more encouraging environment for innovation and the creation of new economic pathways that can maintain both economic and employment growth as traditional industries decline and eventually close.

In terms of policy there is no quick fix that will turn lagging regional economies into innovative, adaptive and resilient economies in the short-term. Just as the Regional Innovation Systems of leading regions have been developed over many years so the acceleration of innovation in lagging regions requires long-term, reliable and consistent policies. These have been noticeably absent in the English regions. So far, many science and innovation policies in the UK have been spatially blind, developed in the Metropolis, and have led to the very uneven spatial concentration of innovation resources within the Greater South East.

The establishment of the Regional Development Agencies in England had just begun to address this issue. ‘One North East’ was beginning to have some success by the early 2000s. This was achieved by focusing on measures to promote innovation and particularly new firm formation. These were backed by the allocation of significant funding. Had these policies and funding been allowed to continue for longer the results might have been more significant. But the Regional Development Agency was abolished long before the time horizon needed to produce major changes in regional innovation outcomes.

There are two general lessons for policy to be drawn from these results. The first is that regionally specific innovation policies are required in order to generate locally relevant configurations of actors, institutions, knowledge, skills, learning and networks that constitute a successfully functioning Regional Innovation System. Spatially blind national policies will not produce this result and may even contribute actively to the cumulative divergence of leading and lagging regions.

Second, it has to be recognised that the development of a Regional Innovation System is a long-term project. It has taken generations to develop the relatively successful Regional Innovation System of the South East. This development has also been aided by long-term investments that have emanated from central government spatially blind science and technology policies. Such differences are illustrated in Fig. 4. The policies that are required for the transformation of the Regional Innovation Systems in lagging regions therefore need to be both long-term and backed by significant government funding in their early stages.

At the time of writing central government science and innovation policy in the UK has returned to business as usual, so it is to be expected that innovation, adaptation and resilience in the North will continue to lag behind that of the Greater South East for some time to come. This is a major lacuna in the national government’s search for ways of stimulating new growth in the UK economy as a whole.

Part of the policy lacuna, especially in England, is that, outside Greater London, which is the only English region to retain a development agency, there are no region wide institutional set-ups that can promote and fund Regional

Innovation Systems in the English regions. The newly formed local economic partnerships (LEPS) are too small and underfunded to take on this role. This is not to argue that bringing back the abolished Regional Development Authorities would necessarily solve this problem. As regional governance institutions they had their limitations (Pearce/Ayres 2009). But, the devolved governments of Northern Ireland, Scotland and Wales, and, paradoxically, Greater London, are all possessed of powers and funding for economic development. In the context of this paper this raises the further research question of how far these institutional set-ups are able to promote and fund successful Regional Innovation Systems in their jurisdictions as compared with other regions in England that do not have such regional institutions.

Acknowledgements The author would like to thank participants at the conference on “Local Economic Growth: Recession, Resilience and Recovery”, St Catharine’s College, Cambridge, 2013, for their helpful comments and suggestions on an earlier draft of this paper, and the constructive suggestions from anonymous referees.

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