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### **Abstract**

It is argued that urban economic resilience should be seen in terms of the capacity to maintain long-run economic growth pathways and the impacts of sudden and unforeseen shocks on those pathways. It is proposed that resilience is based on the long-run capacities of urban economies to re-invent themselves in the face of external shocks emanating from such phenomena as globalisation and technological change. This hypothesis is investigated by analysing employment change and the development of knowledge based private sector service industries and digital firms in English and Welsh cities from 1911. On the basis of this analysis, it is concluded that those cities with the highest levels of knowledge based employment in 1911 have emerged as the most resilient economies in terms of their long-term employment growth paths. Conversely, those urban economies with the highest levels of low knowledge intensity jobs in 1911 have tended to replicate those types of employment and consequently have suffered from low levels of resilience in the face of the local impacts of globalisation and technological shocks.

## Introduction

The recent recession and depression of 2008-09, when Gross Domestic Product (GDP) in the UK fell by -2.7% and -2.8% respectively, was the worst decline in economic growth since the “Great Depression” of 1929-33. The severity of this shock has stimulated current academic interest in the concept of resilience. Much of this has focused on the short-term impacts of individual recessions on regional economies and their different abilities to resist or recover from this type of external individual shock (e.g. special editions of CJRES on “The Resilient Region” 2010 and “Local growth evolutions: recession, resilience and recovery” 2015).

In contrast to concepts of resilience that focus on the short-term ability of a regional economy to bounce back to its previous growth path after a recessionary shock or to absorb the effects of such a shock and to maintain the status quo ante, arguments derived from the theory of complex adaptive systems suggest that economic resilience is based on the capacity to adapt and change over the long-term (Masten et al 1990, Kaplan 1999, Luther and Becker 2000, O’Dougherty-Wright et al 2013, Perrings 2006, Simmie and Martin 2010, Davoudi and Porter 2012). Moreover, there is considerable evidence to suggest that the capacities of urban and regional economies to maintain above average growth rates and demonstrate overall economic resilience differs significantly (Martin et al 2013, Gardiner et al 2013) and that such differences contribute cumulatively to uneven regional development (Bristow 2010, Hassink 2010) and the long-run divergence of the growth paths of more and less resilient economies (Martin and Sunley 1998, Michener and McLean 1999, Arbia and Paelink 2003, Rey and Janikas 2005, Neven and Gouyinte 2008, Simmie and Carpenter 2008).

In order to explain some of the causes of these observed differences it is argued in this chapter that one of the key causes underlying long-run urban and regional economic resilience is their capacity to adapt to and accommodate repeated technological shocks. These may be negative and destructive in the sense of old technologies and their respective industries becoming obsolete. They may also be positive and creative as new technologies and industries are created for the first time. Accordingly from this perspective a key element in regional economic resilience is defined as “*the capacity of a regional economy to maintain an above average long-term economic growth rate by adapting to the shocks arising from the endogenous or exogenous invention, innovation or diffusion of technological innovations*”.

Following this definition of economic resilience, the main question addressed in this chapter is therefore, can we illustrate some of the differences in the long-run growth pathways followed by different British city-regions in terms of their relative capacities to initiate or absorb technological shocks arising from the invention, innovation or diffusion of a radical new technology? The bundle of radical general purpose technologies selected for analysis in this chapter are digital information and communications technologies. Data on the current geographic distribution of the new digital economy in the UK is drawn from a dataset put together by Nathan, Rosso, Gatten, Majmudar and Mitchell (2013) as the basis for a study “Measuring the UK’s Digital Economy with Big Data”. Data on long-run economic change in English and Welsh cities is extracted from a dataset used to analyse “A century of cities: Urban economic change since 1911” constructed by Swinney and Thomas (2015).

Following this introduction, the chapter is divided into four subsequent parts. The first provides a brief critical review and development of evolutionary growth theory, its take on technological innovation and the possible explanations of regional and urban economic resilience that it may provide. Second, a methods section expands on the details and nature of the secondary data used in the empirical section. Third, the conclusions of the theoretical discussion are then used to inform an empirical analysis of some relationships between the growth pathways of British city-regions since the 1970s and the technological shock imparted by the invention, innovation and diffusion of digital ICT technologies. A final part draws together some conclusions from these analyses.

## **Evolutionary growth theory**

The continued success of capitalist economies depends on constant change and transformation. In contrast to Marx’s prediction of its inevitable collapse, so far at least, capitalism has been marked by the replacement of old and declining technologies, products and firms by waves of new ones. These continual processes of change are famously described by Schumpeter as “gales of creative destruction” instigated by technological and consequential structural change that drive the evolution of the economy “incessantly destroying the old one, incessantly creating a new one” (Schumpeter 1942, p. 83).

According to Schumpeter (1939) the evolution of capitalist economies is a long-run process marked by repeated cycles of prosperity, recession, depression and recovery. These cycles individually and repetitively drive aggregate long-run

economic change. Furthermore, Schumpeter (1939) identified innovation as the critical underlying driver of economic change in general and technological innovation as particularly significant in the creation of new products and processes by firms. But, in the context of these changes in the capitalist economy in general, Schumpeter is silent about the impacts of destruction and creation in local economic landscapes. He provides no a priori reason why the destruction of old technologies and industries in one locality is necessarily followed by the creation of new ones in those same localities.

In the evolutionary economics literature inspired by Schumpeter there is a long history of studying the shocks imparted by *major changes in technological regimes* that set off “gales of creative destruction” across the economic landscape in general and in different urban and regional locations in particular (e.g. Simmie 2014a). Such shocks can involve major shifts to alternative technological paradigms or General Purpose Technologies (GPTs). Examples include power looms and the puddling process for the production of iron (1787-1845), the Bessemer steel converter and steam powered ships (1846-1895), alternating current, electric light and the automobile (1896-1947), and, more recently, the transistor, computer, communication and information technologies (Hall and Preston 1988 p. 21). Old technologies and the industries based on them can become obsolescent in a relatively short space of time. Shocks of this magnitude can impact on the whole underlying knowledge base of all related industries in an urban or regional economy (Boschma 2014 p. 8).

The reorientation of the underlying knowledge bases of urban and regional economies is a very challenging task. This is not least because the historical trajectories of those knowledge bases are path dependent. That is to say, the histories of their past development “sets the scope for re-orienting skills, resources, technologies and institutions” (Boschma 2014 p. 5). Thus, it has to be recognised that the capacities of local economies that have been based on such activities as heavy industries or port activities in the past, to reorient the bases of their economies and create new pathways based on new technologies and forms of knowledge, are constrained by their previous historical pathway developments.

In the context of the shock and destruction wrought by the recent recession/depression the concept of resilience has risen up the academic agenda as a result of its potential for explaining the ability of urban and regional economies to resist or recover from such external shocks. In the Schumpeterian tradition this would be expected to involve a positive combination of the destruction of old technologies and industries, the creation of new ones as a

result of innovation and the reorientation of historical path dependent knowledge bases.

In the contemporary literature that develops the concept of regional and urban economic resilience the focus, so far, has been 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. Gardner 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.

With respect to economic approaches to understanding regional economic resilience three different models may be identified. These are the “plucking model”, “hysteresis” and “adaptive evolution”. Each defines regional economic resilience in a different way. These are summarised briefly below.

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 and Nelson, 1998, 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, p. 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 (1967), 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), for example, defines hysteresis as a situation “where one-time disturbances permanently affect the path of the economy” (p. 471). 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 some from internal emergent mechanisms or ‘self-organised criticality’ (Martin and 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, p. 10”. This is the definition of regional economic resilience adopted in this chapter.

Urban and regional economies are clearly complex systems and so this is the approach adopted in this chapter. From this perspective the relative adaptive capacities of local economies are critical in how they respond to external shocks. The adaptive capacities of local economies evolve over time and are 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 urban and regional economic resilience is a dynamic evolutionary and path dependent process.

In developing the concept of adaptive capacity in explaining economic resilience, evolutionary economic geographers have tended to fall back on the distinction between adaptation and adaptability (Grabher 1993, Grabher and Stark 1997). For the use of these concepts see, for example, Christopherson et al (2010), Pike et al (2010), and Bristow et al (2012). In this work “*adaptation* is defined as a movement towards a pre-conceived path in the short run, characterised by strong and tight couplings between agents in place. (In contrast) *adaptability* is defined as a dynamic capacity to effect and unfold multiple evolutionary trajectories, through loose and weak couplings between social agents in place, that enhance the overall responsiveness of the system to unforeseen changes” (see Pike et al 2010, p. 62).

It is argued in the resilience literature that there is a trade-off between the two (Hassink 2010, Pike et al 2010). This is said to be because regional economies that favour adaptation of their existing industries can be blind to possibilities for creating new industries based on innovations developed elsewhere (Malmberg and Maskell 1997, Boschma and Lambooy 1999). Adaptation on its own can lead to path dependent economic trajectories and ultimately to the lock-in of

historically outmoded technologies, industries, institutions and organisations. In these circumstances a locality's potential economic growth path may become weakened leading to long-run relative economic decline.

But the definitions of both adaptation and adaptability focus exclusively on the strength or weakness of the linkages within *local* economic networks. It is clear, however, that local economies are not isolated islands and “are always characterised by a high degree of openness to external events and forces” (Martin and Sunley 2014 p. 12). Globalisation is one of the most significant of these external forces. This has involved, since around the 1970s, the growing interconnectedness and networking of the world's national and local economies. In the UK, for example, globalisation has increased the competition for local mass production manufacturing and low cost services. It has led to structural changes in the UK economy with mining and manufacturing, for example, declining from 43% of all jobs in England and Wales in 1911 to less than 10% today (Swinney and Thomas 2015 p. 8). Therefore, a focus exclusively on the nature and characteristics of purely local economic networks can only offer a partial explanation of local economic growth pathways. For this reason the concept of “replication” is adopted in this chapter in preference to that of “adaptation”.

The concept of replication (Simmie 2014b) recognises the significance of the myopia of tightly coupled local economic networks in driving local industries along path dependent trajectories but, in addition, argues that these local networks are also forced to interact with other geographically defined networks both at home and abroad. This means that they are unable simply to continue indefinitely adapting their pre-existing industries. But, instead of responding to globalisation and technological change by starting “new economy” activities appropriate to the new international division of labour in advanced economies, such local economies have a tendency to replace or “replicate” their declining industries with similar modern equivalents. Thus, “they have replaced jobs in declining industries with lower-skilled, more routinized jobs, swapping cotton mills for call centres and dockyards for distribution sheds” (Swinney and Thomas 2015 p. 1).

The concept of “re-invention” (Simmie 2014b) is also preferred to that of adaptability in this chapter. This is again because an exclusive focus on loosely coupled local economic networks does not explain how radical new leading edge knowledge is generated or acquired and forms the bases for the creation of new economic pathways. Such knowledge is only generated in the first instance in a select minority of states (Audretsch and Feldman 1996) and regions

(Hilpert 1992). This suggests that a significant proportion of new leading edge technological knowledge needs to be acquired from sources external to any given local UK economy. Simmie (2003) and Bathelt et al (2004), for example, have argued that cities and regions are nodes in their respective national and the international economies and that a combination of both local “buzz” and multiple global networks or “pipelines” are required for the transfer and acquisition of both new leading edge tacit and codified knowledge.

Local new path creation and long-term economic growth is therefore argued to be based on the capacity of local economies to re-invent themselves in line with global and national “new economy” industrial and commercial change. In short “contemporary regional economic ... (growth) is driven by specialisation in those sectors that are undergoing a structural wave of expansion and growth” (Martin and Sunley 2014 p. 34, see also Lindqvist 2009). The challenge for local economies in the UK over the last 100 years has been to replace declining industries with new more knowledge based economic activities (Swinney and Thomas 2015 p. 9). This requires the continual re-invention of the local economy. The processes driving such re-invention form the bases of the long-run resilience of local economies in the face of global changes in knowledge, invention and technological innovation. Local economies with strong inherited entrepreneurial cultures, histories of innovation and new firm formation are better equipped to achieve such resilience than those without these characteristics. These arguments are summarised in Figure 1.

Figure 1 sets out a systematic approach for the analysis of the long-run emergence of possible combinations of the economic re-invention or replication of urban and regional economies. The approach consists of dividing the possible combinations of the re-invention or replication of local economies into a two-way matrix consisting of high and low levels of both phenomena. It is hypothesised that the combination of high replication with low re-invention is likely to lead in the long-run to path dependent development and lock-in of old industries. There will be an over reliance on existing local sources of knowledge. The result will be that when exposed to external shocks the resilience of such local economies will be very low. This combination of factors is likely to lead to long-term economic decline.

In contrast a combination of high re-invention and low replication is likely to be marked by new path creation stimulated by an entrepreneurial culture that seeks out new knowledge from external sources. In such circumstances resilience capacity is likely to be high. Such local economies are likely to be characterised by high aggregate long-term economic growth.

A combination of both high replication and high re-invention could lead to both the continued path dependent development of historical industrial and commercial sectors with the addition of the creation of some new pathways. The balance between the two will influence the resilience capacity of the local economy. If some of the traditional industries begin to decline while at the same time new economic pathways are being created then the aggregate outcome could be moderate long-term economic growth.

Finally, a fourth possibility is the combination of low re-invention and low replication. Such local economies are likely to be characterised by a long history of slow economic growth. Lacking in dynamic entrepreneurs the development of modern economic sectors will also be slow. These may be the type of local economy that time has forgotten. As a result external economic shocks that affect traditional industries or contemporary knowledge based industries may not have such a severe impact in such localities because they lack both types of industry. Nevertheless, their resilience capacity is likely to be relatively low in the case where external shocks impact the whole national economy or where they effect the particular industries in those areas.

**Figure 1: Re-invention, replication, resilience and long-run economic growth in local economies**

		<b>Low</b>	<b>Reinvention</b>	<b>High</b>
<b>High</b>	<b>Q1</b>	Path dependent development & lock-in of old industries. Reliance on existing local sources of knowledge. Resilience very low. Long-term economic decline.	<b>Q3</b>	Combination of continued path dependent development of historical industrial & commercial sectors with some new path creation. Resilience moderate. Moderate long-term economic growth.
<b>Replication</b>				
<b>Low</b>	<b>Q2</b>	Less history of old industrial sectors. But lacking in dynamic entrepreneurs. Slow development of modern economy sectors. Resilience low. Slow long-term economic growth.	<b>Q4</b>	New path creation. Entrepreneurial culture seeks out new knowledge from external sources. Resilience high. High aggregate long-term economic growth.

## Methods

In order to explore the relationships between replication, reinvention, resilience and long-run urban economic growth, two secondary datasets are used to analyse performance of the economies of English and Welsh cities. The first dataset used in this chapter has been constructed by Swinney and Thomas (2015) as the basis for their analysis of urban economic change in major English and Welsh cities since 1911.

This analysis uses a fixed geographical definition of cities based on their current boundaries using their Primary Urban Areas (PUAs). Where possible the PUA boundaries of today were matched to local authority boundaries for 1911 (Swinney and Thomas 2015, p. 3, see also [www.centreforcities.org/puas](http://www.centreforcities.org/puas)). This provides a sample frame of 57 cities across England and Wales. Among this list, Milton Keynes and Telford were excluded because they were not established until the 1960s. The total sample size of this dataset is therefore 55.

This dataset provides information on long-run employment and sectoral change within PUAs between 1911 and 2013. Growth or decline in total employment over this period of 102 years is used to indicate the relative resilience capacity of cities. Sectoral changes over the same period are used to indicate the degrees to which cities have reinvented or replicated the structure and knowledge intensities of their local economies. The dataset shows the share of jobs in extraction, manufacturing, docking and general working in the major English and Welsh cities in 1911. In this chapter changes in the sectoral structures of urban economies from these traditional industries to more knowledge intensive activities are used to illustrate the relative capacities of cities to reinvent their local economies over the last century.

Contemporary participation in the digital economy is used as a key example of a twenty first century knowledge intensive sector. In this instance a dataset provided by Nathan et al (2013) study entitled “Measuring the UK’s Digital Economy with Big Data” identifies the geographic distribution of the new digital economy in the UK. In this study the original dataset was provided by Growth Intelligence. This dataset comprises 3.07 million companies registered in the UK. From this dataset Nathan et al (2013) identify 269,695 companies constituting some 14.4% of total UK companies that made up the digital economy in 2012 (op cit p. 15). The resulting sectoral definition of the digital economy in the UK in 2012 is shown in Table 1.

**Table 1: Digital economy firms by sector, UK 2012**

<b>Sector</b>	<b>Per cent</b>
Information technology	39.38
Architecture	17.64
Telecommunications	10.79
Electrical/electronic/manufacturing	6.56
Printing	4.66
Entertainment/film/production	4.60
Marketing/advertising	4.41
Semiconductors	3.19
Photography	1.62
Publishing	1.16
Financial services	1.10
Other	4.89
<b>Total N</b>	<b>269,695</b>

Source: Nathan, M., Rosso, A., Gatten, T., Majmudar, P. and Mitchell, A. (2013) “Measuring the UK’s Digital Economy with Big Data”, London, Growth Intelligence and National Institute of Economic and Social Research, p. 14.

Note: Using Growth Intelligence sector-product classification

In this study a different geographical definition of cities is used in this dataset from that of Swinney and Thomas (2015). In this instance cities are defined according to their Travel to Work Areas (TTWAs). In this case TTWAs containing a core city of at least 125,000 were selected for study. So the two datasets are not directly comparable geographically. Nevertheless, the same cities can be identified according to both their PUAs and their TTWAs which overbound them. There are 53 cities, excluding Milton Keynes and Telford, where the PUAs from the first dataset form the core areas of the same TTWAs in the second dataset.

A comparison of the 1911 sectoral composition of the PUAs identified in the Swinney and Thomas (2015) dataset is made with the degree to which these had been changed by the introduction of digital firms in their TTWAs by 2012 in

order to illustrate the relative degree of the reinvention of their local economies by the latter date. It is argued that higher degrees of the introduction of digital firms indicates higher levels of the reinvention of local economies while lower degrees suggest, at best, higher levels of replication. In addition these results are compared with the long-run rates of employment growth or decline in the cities studied. It is argued that higher rates of employment growth indicate higher resilience capacity while lower rates and employment decline suggest a lack of economic resilience capacity over the long term.

## **Analysis**

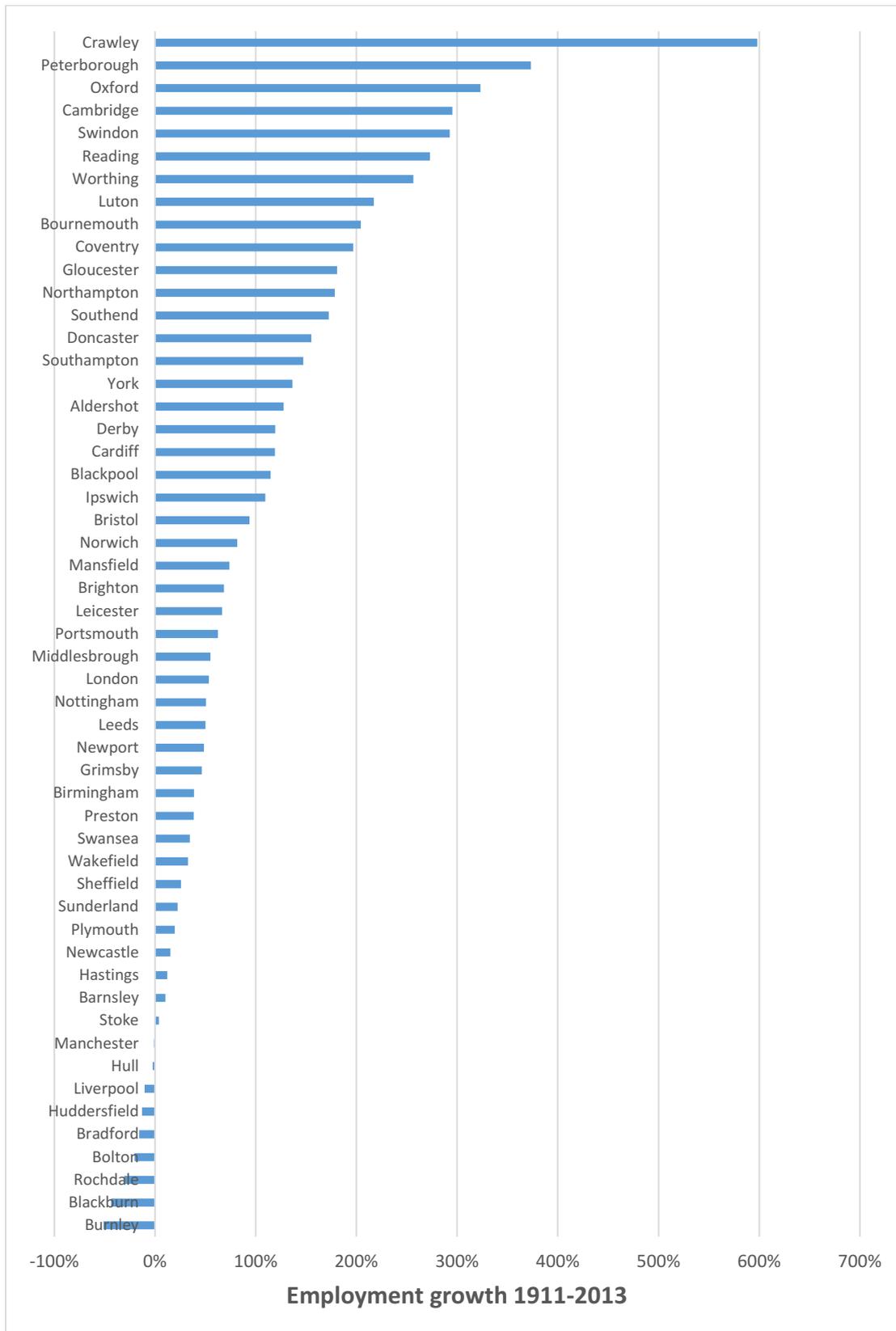
Following the argument that the economic resilience of urban and regional economies is indicated by their ability to maintain above average long-term economic growth rates (Martin et al 2013, Gardner et al 2013) in the face of continual shocks such as major recessions or the endogenous or exogenous invention, innovation and diffusion of technological innovations, the analysis turns first to an examination of long-run economic growth in English and Welsh cities. This is indicated by the rate of employment growth from 1911-2013 (Swinney and Thomas 2015).

Figure 2 shows that during the course of the century starting in 1911 the mean employment growth in 53 English and Welsh cities was 59%. This was comfortably exceeded by cities in the top quartile. In this group employment growth varied between 598% in Crawley to 173% in Southend. All of these cities are located in the south of England. They include four, Crawley, Peterborough, Swindon and Northampton that have been the subject of major public policy initiatives in the form of comprehensive town expansion schemes. With respect to the concepts of re-invention and resilience these cities have experienced a number of advantages. First they inherited a limited number of industries from the industrial revolution. Second, as their planned expansion took place, their developing industrial structure benefitted from the planned objective of introducing new and contemporary industries to their respective economies. As a result their local economies were being re-invented on a continual basis as each new phase of town development was introduced.

In contrast, at the other end of the scale in the bottom quartile, employment growth varied between -51% in Burnley to 15% in Newcastle. All of these cities are located in the north of England. They include some of the largest cities in the UK such as Liverpool, Manchester and Newcastle. While none of the cities in the top quartile participated to any significant degree in the industrial

revolution, most of those in the bottom quartile were involved in the manufacture of textiles or pottery or in port activities. These industries have left a path dependent legacy of declining industries in those cities.

**Figure 6.2: Employment growth English and Welsh cities 1911-2013**



Source: Swinney and Thomas (2015)

Overall it is argued that cities in the top quartile have demonstrated higher levels of resilience in the face of continual external shocks resulting from such phenomena as globalisation, national recession/depressions and technological change than those in the bottom quartile. In contrast, the level of path dependence and lock-in of the industrial structures and trajectories of those in the bottom quartile has been high.

This is illustrated in Figures 3 and 4. Figure 3 shows the correlation between those cities that started with the highest levels of employment in traditional extraction, manufacturing, docking and “general working” in 1911 and those that a hundred years later had innovated economic activities based on the new digital technologies. The figure is divided into four quarters corresponding to those shown in Figure 1 suggesting that cities in Q1 have been less resilient in dealing with technological shocks and their attendant industrial change than those in Q4.

Overall Figure 3 suggests that cities that started with the highest levels of traditional industries in 1911 have been subject to strong path dependence and lock-in as suggested by Boschma (2014). There is a weak correlation ( $R^2=0.1656$ ) between these cities and those that had created new technological pathways by starting up digital firms by 2012. Again, most of the cities that started with the highest levels of employment in “old economy” industries and have had the lowest rates of digital firm start-ups, are to be found in the north of England. Some 17 out of the 20 cities in Q1 Figure 3 are to be found in the north of England. Half of them are also to be found in the bottom quartile for employment growth as shown in Figure 2. Starting from above average levels of employment particularly in manufacturing and general working, these cities have been the least resilient in re-inventing their local economies in response to the shocks imparted by the digital revolution.

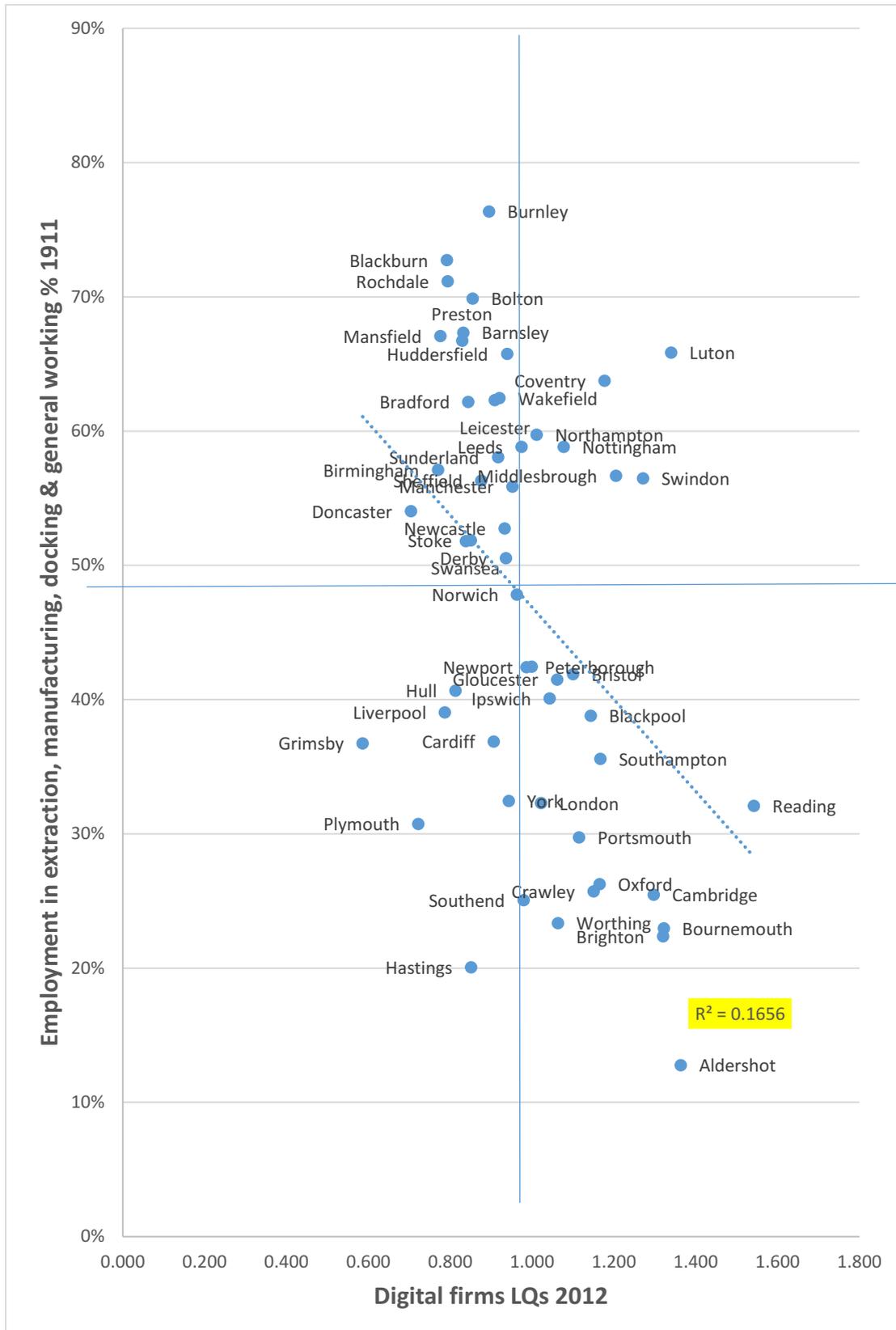
In contrast, among the cities located in Q4 of Figure 3, 15 out of 17 are located in the South of England. These are the cities that generally have the lowest historical legacies of old industrial activities combined with higher than average concentrations of digital firms. Nine of them are to be found in the top quartile of employment growth over the last century. This quadrant also includes the so called “golden triangle” of London, Cambridge and Oxford with its significant concentrations of R&D in general and the Thames Valley where the UK computer industry is particularly concentrated. This supports the views of Martin and Sunley (2014) and Lindqvist (2009) that regional (and urban) economic growth is driven by specialisation in those sectors that are undergoing

contemporary waves of international and national growth. The ability to do this underpins the resilience capacities of cities.

Q3 of figure 3 contains a select few cities that actually started with above average levels of “old economy” activities in 1911, but have also demonstrated a capacity to reinvent their local economies in respect of the introduction of new digital economy firms. The significance of public policy in the form of the town expansion schemes in Northampton and Swindon is shown in the possibilities afforded to innovative entrepreneurs to start up digital firms of the “new” economy as those cities were developed. In addition this quadrant contains five other cities, mainly from the midlands, with a history of light rather than heavy manufacturing industries. The only exception to this is provided by Middlesbrough.

Finally, Q2 contains a small group of mainly port and coastal cities. Although these cities started in 1911 with lower levels of “old economy” industrial employment, they have also made less than average progress in adopting the new digital technologies. In five out of eight cases they have also experienced lower than average or negative growth rates in total employment since 1911. Overall, therefore they may be considered to have demonstrated low levels of resilience to technological shocks over the last century.

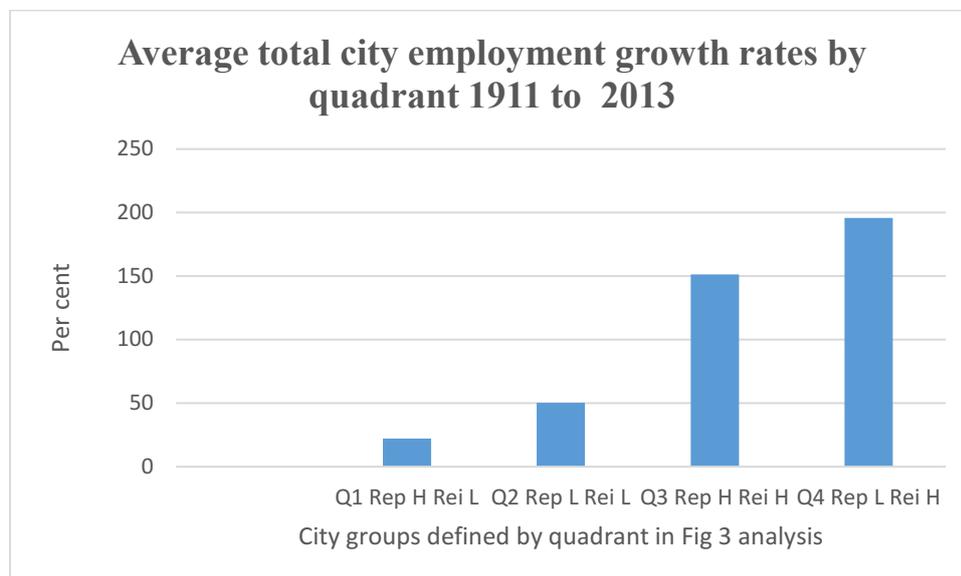
**Figure 6.3: “Old economy” employment 1911 versus the development of digital firms in English and Welsh cities by 2012**



Sources: Swinney and Thomas (2015), Nathan et al (2013)

It has been argued above that long-term resilience capacity is based, to a significant degree, on the ability of a local economic system to reinvent itself over time (Simmie 2014b, Swinney and Thomas 2015) and that new expanding specialised economic sectors drive economic growth in the localities where they develop (Martin and Sunley 2014, Lindqvist 2009). It is therefore to be expected that those English and Welsh cities where their local economies have been reinvented as a result of the development of new sectors such as digital firms will have had higher long-term economic and employment growth rates than those that have not. Figure 4 shows this to be the case across the groups of cities identified in the four quadrants of Figure 3. Thus, with respect to the average total city employment growth over the century from 1911 to 2013 there is a linear relationship between the group of cities with the highest rates of replication combined with the lowest rates of reinvention through the four quadrants to the cluster of cities with the lowest rates of replication and the highest rates of reinvention. The average total employment rate in the former Q1 was 22.5%. In contrast the average in Q4 was 195.88%.

**Figure 6.4: Replication, reinvention and long-run city employment growth rates**



Taken together these analyses suggest that if the ability of urban economies to maintain long-term growth rates, at least in employment, is an indicator of their economic resilience in the face of the local impacts of sudden and unforeseen external shocks imparted by such phenomena as recessions, globalisation and the digital revolution, then a key basis of their resilience capacity is the long-term and continual re-invention of their economies. From this perspective resilience capacity is developed over the long-term. It includes the ongoing development of local social capital in the form of an entrepreneurial culture, the development of loose knowledge networks particularly with localities where leading edge knowledge is being developed outside the local area and the absorptive capacity understand the significance of such knowledge and to deploy it in the creation of new technological pathways.

The long-term development of social capital for the re-invention of local economies has proved to be a difficult task in the face of the path dependent trajectories followed by those cities that started with the highest levels of employment in 1911 in extraction, manufacturing, docking and general working. With a few notable exceptions, these cities have tended to replicate the modern equivalents of those lower skilled jobs. In contrast to Schumpeter's (1942) argument many of their local economies have been characterised by more destruction than creation over the last century. Conversely, those that historically had a greater share of more knowledge based industries have generally found it easier to move in to the new knowledge based economy in the face of multiple external economic shocks occasioned by globalisation, technological revolutions and recession/depressions.

## **Summary and Conclusions**

In this chapter it has been argued that the concept of resilience should be focused on the long-term development of the capacity to develop and maintain long-run economic growth trajectories in the face of periodic and repeated unforeseen external shocks. In the context of recent history, most of the analytical focus has been on the kinds of shock imparted by national recession/depressions. But there are other types of shock with economic repercussions that impact on urban and regional economies, whose effects may also be magnified by recessions/depressions in "gales of creative destruction". These include the rapid development of globalisation and its consequential effects on the international spatial division of labour and radical technological change such as the digital revolution.

Explanations of the bases of resilience in the literature, up until now, have been based on disputed dualisms (Hassink 2010, Pike et al 2010). It has been argued that either Jacobs (1969) variety or MAR specialisation (Marshall 1930, Arrow 1962, Romer 1986, Lindqvist 2009), or Grabher adaptation or adaptability (Grabher 1993, Grabher and Stark 1997) provide the bases for the resilience capacities of local economies. More recently the supposed differences between these dualisms have become more ambiguous and it has been argued that combinations of these previously exclusive categories in the form of related and unrelated variety or diversified specialisation form the bases of urban and regional resilience.

In this chapter the two concepts of replication and reinvention (Simmie 2014b) have been adopted in order to understand some of the underlying differences between cities in terms of their resilience capacity. On the one hand the concept of replication recognises the significance of the myopia of tightly coupled local economic networks in driving local industries along path dependent trajectories. In such circumstances instead of branching into new related economic activities or creating new ones many cities have shown little resilience and “have replaced jobs in declining industries with lower-skilled, more routinized jobs, swapping cotton mills for call centres and dockyards for distribution sheds” (Swinney and Thomas 2015 p. 1). This has often been the pathway to long-term economic decline.

On the other hand, the concept of reinvention stresses the significance not just of loosely coupled local economic networks but on the need to acquire new leading edge technological knowledge from sources external to any given local UK economy (Simmie 2003, Bathelt et al 2004). This can form the basis of the development of entirely new technologies and industries to replace those nearing the end of their life-cycles.

With respect to the long-term development of economic resilience it has been argued in this chapter that local economies with a history of continual reinvention are best equipped to deal with the sudden and unforeseen shocks of globalisation, technological change and recessions. The acquisition of new knowledge from at home and abroad, and its absorption into local economies is a key requisite of this process. Local economies also have to respond to the general trajectory of change towards more knowledge based economic activities in the advanced national economies.

Cities that have characteristically replicated rather than reinvented their local economies have limited their resilience capacities in the face of globalisation

and technological change. Often the processes of replication are marked by inadequate movement into “new economy” knowledge intensive activities.

The empirical analysis suggests that there has been a high degree of path dependence in the trajectories followed by city economies in England and Wales since 1911. Most of the cities whose economies were based on low-knowledge work in 1911 also tend to have fewer digital companies today. In general, the capacity to effect significant change towards more knowledge based sectors has been lowest among city economies that started with the highest levels of employment in extraction, dock working, light and heavy manufacturing and general labourers in 1911.

There is also a distinctive geography to economic resilience expressed as the capacity to reinvent urban economies. With respect to the new digital economy, for example, out of the 20 cities with the highest levels of “old economy” employment in 1911 and the lowest relative concentrations of digital firms 18 were located in the north or Wales in 2012. In contrast of the 17 cities with the lowest levels of “old economy” jobs in 1911, and the highest location quotients for digital firms in 2012, 14 were located in the south of England.

These findings suggest a prima face case for investigating further the significance of the continual reinvention of urban economies in the direction of more knowledge intensive sectors as the basis of local economic resilience in the face of sudden and unforeseen external shocks. Such investigations would need to conduct intensive historical case studies of the ways in which specific urban economies have accessed and absorbed new types of leading edge knowledge. They would need to establish the degrees to which these processes have embedded cultures of continual reinvention in those local economies. Finally they would then need to investigate the impacts of different types of external shocks on those economies and how they had responded to them.

Such further research could provide evidence bases for the development of practical policies concerned to improve the long-term resilience capacities of urban economies. The evidence presented in this chapter has already suggested the success of historical planning policies in the form of large town expansion schemes in, perhaps unintentionally, contributing to the resilience capacities of their respective cities. This has been achieved on the back of long-run and coordinated physical development plans and public funding that have combined planned infrastructure, housing, services and economic development on the basis of attracting new forms of economic activity as the phases of development have been executed. Such schemes combined with an emphasis on new

scientific economic activities are quite common in Europe, particularly in France, but noticeable by their current absence in the UK.

A further policy lesson to be learned from such research is the significance of creating new technological and economic pathways based on leading edge knowledge, imported from wherever that is found, in order to reinvent local economies on a continual basis. Thus the evolutionary study of new path creation could form a productive basis for the development of practical policies to upgrade the knowledge bases of local economies and to serially reinvent them. This would also require the provision of long-run public funding to generate protected niches in which new technologies and industries could be developed before they become commercially viable in competitive world markets.

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