Small Firm Innovation in Non-Clustered Regions:
Comparing High and Low Agglomeration Regions

Yazid A. Abubakar
And
Jay Mitra
Essex Business School
University of Essex

Abstract

We explore ways in which high technology firms develop new products in 'high' and 'low' agglomeration regions. The literature on the geography of innovation suggests that is the search for external factors that explain innovation in regions with high concentration of firms, often referred to as '*high agglomeration* regions. External factors influencing innovation in '*low agglomeration'* regions are rarely studied. Yet not all firms are located in high agglomeration regions and there is evidence to suggest that these firms can flourish in areas which do not attract concentrations of similar or related firms. Traditional research has generally viewed innovation as a one-dimensional construct, and expects the same set of factors to explain all kinds of innovation. The geography of new product development (NPD) as a specific type of innovation has not received much attention in the research community, despite its apparent importance in policy circles concerned with economic development.

We build a framework which helps to examine how small firms develop new products in two distinct environments: regions with local concentration of firms in high-tech industries (or 'high agglomeration'), and regions lacking concentration of firms in high-tech industries (or 'low agglomeration'). Levels of concentration of high-tech industries are measured in terms of below or above average densities of both firms and their respective workforce in those regions (the eastern region of the UK). The framework allows for the categorisation of external influences on NPD as *knowledge spillovers (*referred to as non-market based external sources of knowledge), and as *pecuniary knowledge (i.e.* market based external sources of knowledge). The Silicon-Fen of Cambridge and Essex in United Kingdom (UK) are chosen as 'high agglomeration' and 'low agglomeration' regions, respectively. This selection is based on the measure of concentration of high-tech industries referred to above. Twelve pilot interviews were conducted to ascertain if potential differences exist between the two regions in small firms' perceptions of external knowledge. Thereafter, surveys of 52 SMEs in the Silicon-Fen and 48 in Essex electronic and software industries were carried out with a view to determining the nature of new product development in the two sub-sets.

We found that in developing new products small, innovative firms in low agglomeration regions can be characterised as 'imitator's when compared to those in high agglomeration. However, there are similarities in that small firms in both regions are more influenced by knowledge spillovers over pecuniary knowledge, and by international knowledge relative to local and national sources. The paper thus makes several contributions to the knowledge spillover theory of entrepreneurship, pecuniary externality theory and the literature on technological capabilities of innovative firms. The findings should also help regional policy makers located in both high and low agglomeration regions to understand the significance of 'spatial levels' – local, national or international – of analysis and decision making. From a business strategy perspective, a critical understanding of the sources of external knowledge – spillovers or

pecuniary - are likely to influence new product development by small firms in their regions. This is crucial in an era in which 'geography' (especially that of regions) is seen as an integral part of innovation policy, and where new product and new business model development are seen as critical for firms as they struggle to stay alive and emerge from the recession. Implications are also drawn for educators and trainers especially those focusing on explaining different aspects of entrepreneurship and innovation.

Keywords: Small and medium-sized enterprises (SMEs), agglomeration, new product development, geography.

Introduction

The regional or the spatial dimension of innovation has captured the imagination of economists, entrepreneurs and policy makers since Marshall's pioneering work (Schumpeter, 1934; Grossman and Helpman, 1994; Acs, 2002). Innovation is today seen as one of the fundamental drivers of regional economic development and, therefore, features on policy agendas of many governments and regional development agencies in different parts of the world (Audretsch, 1998; DTI, 1998; Acs, 2002; DIUS, 2008). Affirmative action has become the policy of choice to support innovation at the regional level (Cooke, 2004; Acs, 2002). It is estimated that in England alone, cumulative expenditure by regional development agencies (RDAs) on promoting innovation for the years 2005 to 2008 has exceeded £1billion (DIUS, 2008). These policies, however, are now subject to intense scrutiny as questions are asked about whether similar or different policies need to be designed for supporting innovation across all regions (Breschi and Lissioni, 2001a and b; Heraud, 2003).

In the East of England, the regional development agency, has been spending £millions, with a view to becoming by 2031, an area with a global reputation for innovation (EEDA, 2008). Yet, despite this huge effort innovation appears to be concentrated around a few districts or sub-regions, especially around the world renowned Cambridge Silicon-Fen area. Most of the other areas of the Eastern region have an apparent dearth of innovation (Arthur D. Little, 2003; Abubakar and Mitra, 2007). Regional disparities in innovation prevail within a region as much as they within a country.

The East of England's Cambridge Silicon-fen area is ranked as one of the most innovative regions in Europe (OST, 1998). The region is home to $1 billion worth of home-grown success stories such as ARM, which controls over 75% of processors in the world's mobile phones, in all iPods and GameBoys; but also Cambridge Silicon Radio (CSR), which provides over half of all Bluetooth chips worldwide (Craig, 2007). By 2004, Cambridge Silicon-fen had contributed more than £50 billion and over 150,000 jobs to the UK economy (Library House, 2006 Craig, 2007). Existing data shows that while Cambridgeshire has a proportion of firms reporting innovative products of 14%, the corresponding figure for other parts of East of England, such as Essex is 1% (Annual Business Inquiry, 2004). Thus, a large share of government funding for innovation in East of England goes mostly to firms in Cambridgeshire (see figure 1).

Figure SEQ Figure * ARABIC 1: Number of Firms Applying for Innovation Finance per 10,000 Firms in East of England Sub-regions - 2008

Adapted from: EEDA (2008b) and ONS (2005).

From an economic development perspective, this regional disparity raises a problem about how to boost new product development by firms in other areas that by all accounts are less innovative (Heraud, 2003). Addressing such a problem demands a clear understanding of factors influencing innovation in different regional contexts (Heraud, 2003), so that theoretically and empirically informed innovation policies can be designed that take into account the regional context of innovation (Heraud, 2003).

Since our proxy for innovation is new product development we begin by looking briefly at the literature on new product innovation in small firms. This review is then followed by examining the literature on regional agglomerations with specific reference to the roles of technological innovation and small firms. These reviews help us to identify the concept of innovation in varying regional contexts.

New Product Innovation and Small Firms

According to Schumpeter (1939), innovation involves the production of 1) new products; 2) the introduction of new process; 3) the opening up of a new market; 4) the identification of new sources of supply of raw materials and; 5) the creation of new types of industrial organisation). Most studies emphasise new product innovations (Tratjenberg, 1990; Audretsch, 1998; Acs, 2002).

The discussion on factors influencing innovation usually begins with the firm (Arrow, 1962; Mansfield, 1988; Audretsch, 1998). Firms are seen engage in the pursuit of knowledge as an input into the process of developing new products (Griliches, 1979; Audresch, 1998). In this context, one of the most important, but not the only source of new knowledge is taken to be research and development (R&D) conducted internally by firms (Cohen and Levinthal, 1989; Audretsch, 1998). Sony, Nokia and IBM are some of the world’s most innovative companies (Business Week, 2008), and this is partly because they tend to have some of the highest investments in R&D in the world (DIUS, 2007). Therefore, the relationship between R&D and innovation is very strong especially at the industry level (Audretsch, 1995).

Models emphasising firm internal R&D become relatively weak when small firms are included in the sample, thus suggesting that small firms conduct little or no R&D (Audretsch, 1998; Acs, 2002). However, research clearly shows that small firms account for a higher share of innovations despite their low R&D expenditures (Acs and Audretsch, 1990). Small firms tend to have innovative advantages especially in industries which are R&D intensive, such as electronics, and computer software and biotechnology known as high-technology industries (Acs and Audretsch, 1987; Audretsch, 1995; Audretsch, 1998). Yet small firms, despite having little or no R&D, demonstrate high levels of innovative activities in high-technology industries raising questions about where small firms get there innovation inputs (Audretsch, 1988; Acs, 2002; Stuart and Sorenson, 2003). In this context, one line of inquiry has emerged which suggests that small firms tend to have innovative advantages when they locate in regions with large concentration of firms known as ‘regional agglomerations’ (Audretsch, 1998; Acs, 2002).

Regional Agglomeration, Innovation and Small Firms

Acs (2002) empirically linked product innovations with economic growth in 43 regions of United States. Prominent economists have pointed-out that it is important to measure and understand better the inputs of new product development and why there are variations with which they are pursued in different regions (Trachtenberg, 1990; Feldman and Florida, 1994). The particularly significance of regional location and agglomeration for small firm innovation (Acs, 2002; Stuart and Sorenson, 2003), continues to attract the interest of both researchers and decision makers.

Various innovative regions with high concentration of firms and employment in high-tech sectors can be found in different parts of the world. Examples include Scotland's Silicon-Glen, California Silicon Valley in the US and the Bangalore cluster in India among others (Saxenian, 1994; Manimala, 2006). The success story of these regions is today is widely attributed to a particular feature of these regions, namely regional 'agglomeration' (Saxenian, 1994; Keeble *et al*,. 1999; Athreye, 2001). By regional agglomeration, reference is being made to a concentration of economic activities, such as firms and employees in related sectors in a geographical area (Audretsch, 1998; Mayhew, 2004). The origin of this idea that regional agglomeration facilitates innovation can be traced to the work of the renown British economist - Sir Alfred Marshall (1890), who developed a theory that individuals learn better from each other when they live and work in close proximity. Marshall's theory thus provided the background for understanding benefits of external knowledge for innovation. The theory was later extended into at least two major perspectives: pecuniary externalities (Krugman, 1991and b; Antonelli, 2007) and knowledge spillovers (Arrow, 1961; Romer, 1986, 1990; Acs, 2002).

The pecuniary knowledge perspective headed by the 2008 Nobel Prize Laureate – Paul Krugman (1991a and b) argues that firms locate in regional agglomerations because agglomerations offer pecuniary advantages to firms in terms of reduction in transportation costs, larger local markets and pecuniary knowledge advantages i.e. in sourcing knowledge that requires monetary transactions (Krugman, 1991a and b; Fujita, Krugman and Venables, 1999; Antonelli, 2007). Most of the literature is focussed on transaction costs and international trade (Krugman, 1991a and b; Fujita, Krugman and Venables, 1999) or on productivity growth (Antonelli, 2007). It could be argued that they do not spell out the importance of innovation or the specifics of new product development let alone the role of small firms in the agglomeration-oriented space for new product innovations.

Knowledge spillover theorists bank on innovation. They argue that the concentration of firms in the same industry in a region helps knowledge to flow among firms thereby facilitating innovation as a result of spillovers of such knowledge (Jaffe, 1989; Audretsch, 1998; Acs, 2002). Knowledge spillovers refer to the use of knowledge by a firm, which is produced by other firms or institutions, without compensating the original source of knowledge (Grossman and Helpman, 1994; Harris, 2001). In this regard, regions with high agglomerations of firms are seen as facilitating knowledge spillovers because high concentration of people and firms in a region creates an environment in which ideas move quickly from person to person and from firm to firm (Carlino, 2001; Acs, 2002). Employees of different firms in an industry can exchange ideas about new products, and the greater the concentration of employees in a common industry in a given location, the greater the opportunity to exchange ideas that lead to new product innovations (Audretsch, 1998; Carlino, 2001; Acs, 2002).

Regional agglomerations like Cambridge Silicon-fen and California Silicon Valley in the United States have become models for fostering innovation and local economic growth (Saxenian, 1994; Brown and Duguid, 2000). However, policy makers are confronted with a major problem in that only a few regions in world are regional agglomerations (Brown and Duguid, 2000; Wired, 2000; see Figure 1 below), and the peculiarities of these regions are inimitable not only because of economic factors but also due to a wide range of social and institutional arrangements specific to those regions. Attempts at imitating the success of high regional agglomerations (HARs) in regions lacking agglomeration has often proved difficult (Brown and Duguid, 2002), causing a growing concern about the effective development of innovation policies across different regions (Brown and Duguid, 2000; Heraud, 2003). Can imitation work at the regional level? Do policy makers need to develop new approaches to innovation policy in regions which do not have high levels of concentration of similar or related firms? What separate factors need to be taken into consideration in 'low agglomeration' regions (LARs) which could support the growth of innovative firms? These are some of the questions that have begun to preoccupy the minds of decision makers as they try to grapple with the significance of regional differences and their impact on the innovation process.

Given that not all regions can boast of concentrations of high-technology firms and the fact that only a ‘few’ regions in the world are regional agglomerations, three questions emerge:

Can and should LARS be ignored for the purpose of promoting innovation policy in any country and should governments focus only on HARs?
If innovative firms can be found in LARS what do we need to know about their approach to new product innovation which is different from those of firms in HARs? and
How can policy be differentiated to ensure that firms in both HARS and LARS can benefit from informed and differentiated policy environments? more precisely - low agglomeration regions (Suarez and Walrod, 1997).

Figure SEQ Figure * ARABIC 2: “Few” regions in the world are high-tech Agglomerations

Source: Wired (2000).

The evidence that many new products are developed by firms in LARs is found in the work of Suarez and Walrod (1997) who show that firms in regions lacking agglomeration also introduce new products. But the key issue is that the sources of knowledge used for new product developments in these regions still remain largely obscure, as existing studies on regional agglomerations hardly address sources of knowledge for new product development in these areas.

According to Breschi and Lissoni (2001b), contributions to geographic theories on innovation can be classified into two main categories: 1) studies from mainstream economic approach and (2) studies employing non-mainstream economic approach. Researchers from mainstream economics have examined why innovative activity is located in a minority of regions, largely emphasising the role of localised knowledge spillovers in influencing the regional distribution of innovative activity (Jaffe, 1989; Feldman and Florida, 1994; Audretsch, 1998, Acs, 2002). Scholars of this perspective place a great emphasis on ‘local’ knowledge spillovers as primary source of innovation. In this context, the first researcher to examine the geographic extent of knowledge spillovers was Adam Jaffe (1989), who found a positive effect of university research on innovative activity at the U.S. state level. In 1994, Maryann Feldman extended Jaffe's (1989) study by incorporating regional knowledge infrastructure at the U.S state level, and found results that strengthened Jaffe's conclusions. Since then several other researchers have employed the econometric perspective to contribute to our understanding of the role of knowledge spillovers in fostering innovative activities (Varga, 2000; Acs, 2002; Stuart and Sorenson, 2003). These studies in general, examine associations between measures of the local R&D spillovers and local innovation outputs such as patents and innovation counts across space (Jaffe, 1989; Feldman and Florida, 1994; Acs, 2002; Stuart and Sorenson, 2003; Knudsen, Florida, Gates, and Stolarick, 2007).

Studies employing non-mainstream economic perspective (studies not using econometrics but relying on surveys, case studies etc.) have focussed for the most part on identifying mechanisms of local knowledge spillovers in large regional agglomerations of firms in high-technology industries. The findings emerging from this sphere brings to light the importance of informal personal networks, local labour pooling, imitation of rival firms especially in the local area, as the critical mechanisms that transfer knowledge among local firms in the U.S. high-technology agglomerations such as the Silicon Valley and their European counterparts (Saxenian, 1994; Keeble and Wilkinson, 1999; Simmie, 2002, 2003).

A third and relevant literature on use of external knowledge for innovation is that of technological capabilities, which argues that firm level technical change is a result of a learning process through activities such as R&D, that allow firms to absorb external knowledge and create new products (Mansfied, 1988; Cohen and Levinthal, 1989; 1990; Bierly and Chakrabarti, 1996; Kessler, Bierly and Gopalakrishnan, 2000). These studies argue that most external learning for new product development by firms requires investments in internal resources (Cohen and Levinthal, 1989; 1990; Kessler, Bierly and Gopalakrishnan, 2000; see Chapter 2 for more details).

Although the above studies take us a long way towards understanding the role of knowledge externalities in new product development, there are at least four key reasons why our understanding of the differences in the use of external knowledge for new product development by small firms in various types of regional agglomerations remains unsatisfactory.

First, there is an overwhelming tendency to concentrate on regional agglomerations by studies on knowledge externalities and innovation (Jaffe, 1989; Saxenian, 1994; Keeble, 1999; Acs, 2002). This approach calls into question or ignores the role of externalities in regions with a dearth of agglomeration.

Second, studies on knowledge externalities and innovation have historically (Jaffe (1989) to Krudsen, Florida, Gates, and Stolarick (2007)), focussed mainly on knowledge spillovers or knowledge acquired from non-market based sources (Grossman and Helpman, 1994; Breschi and Lissoni, 2001a). These studies overlook the role of knowledge acquired through market related mechanisms (Breschi and Lissoni, 2001a and b). The fact that knowledge spills over is hardly questionable, but at issue is the extent of and the use or exchange value of these spillovers and just how persuasive are the arguments for non-market related mechanisms facilitating innovation (Harris, 2001; Breschi and Lissoni, 2001a and b).

Third, it is extremely difficult using econometric approaches, to examine the relative importance of local, national and international sources of knowledge to small firms developing new products (Breschi and Lissoni, 2001b). While Krugman (1991a and b) acknowledge the importance of spillovers, both Krugman (1991b) and Simmie (2002) indicate that only sociological surveys could measure the extent of knowledge spillovers. Therefore, the emphasis on the importance of localised knowledge spillovers lacks conceptual clarity when it comes to disentangling the different ways in which knowledge flows are utilised by economic agents, both local and non-local (Brechi and Lissoni, 2001a). Attempts at examining non-local knowledge flows have largely been descriptive (Simmie, 2002, 2003). This has obscured our understanding of differences and/or similarities in the relative association of local, national and international knowledge flows (acquired through market and non-market related externalities) and new product development by small firms in different types of regional agglomerations.

Finally, in studies that emphasise localised knowledge spillovers, internal technological learning by the firms are not empirically investigated. The literature that looks at technological learning at the firm level does not systematically take into account the impact of spatial factors on such learning and in influencing innovation (Caniels and Romijn, 2003; p.1253). There is lttle integration between the two approaches (Caniels and Romijn, 2003; p.1253), even though the very use of external knowledge by firms requires that they invest in R&D so as to be able to understand and assimilate external knowledge (Cohen and Levinthal, 1989; 1990). We, therefore, argue that the integration of the two approaches will contribute immensely to our understanding of differences and similarities in the use of external knowledge by small firms in different regions.

The four reasons help explain why our understanding of differences and similarities in the use of external knowledge for new product development by small firms in high and low agglomeration remains unclear. Consequently, although the importance of externalities for generating innovative new products in HARs is widely acknowledged (Saxenian, 1994; Audretsch, 1998; Acs, 2002) differences and similarities with low agglomerations remain unexplored. There is therefore a need for theoretical and empirical investigations into the determinants of innovation that take into account the differences in regional contexts (Heraud, 2003). Since the global demand for developing new innovative products by small firms is growing rapidly, (Audretsch, 1998; Acs, 2002) it is imperative that researchers study sources of knowledge for new product development by small firms in low agglomeration as there is currently a dearth of such studies. Such studies are likely to be of benefit to policy makers by helping them to understand the important sources of knowledge that influence firms in their regions, so that effective policies for promoting innovation can be developed.

Knowledge Spillovers and Pecuniary Knowledge Externalities

We distinguish clearly between knowledge spillovers and pecuniary knowledge externalities. Although the two externalities are not entirely independent, they should not be equated, as equating them can be grossly misleading (Breschi and Lissoni, 2001a and b; Antonelli, 2007). There is presently a huge debate as to whether the forces which bring about new product development, are predominantly knowledge spillovers mechanisms acquired through non-traded sources (Jaffe, 1989; Audretsch, 1998) or pecuniary mechanisms sourced through trade related sources (Breschi and Lissoni, 2001a and b; Antonelli, 2007). According to Antonelli (2007), pecuniary or market related externalities are transferred through inter-firm supply and demand linkages, and therefore arise through trade related sources that have impacts on creation of new knowledge and goods. Knowledge spillovers on the other hand are transmitted outside the market system and arise when new ideas and knowledge, crucial for enhancing a firm's innovation potential, flows between firms through personal exchanges in the labour market (Grossman and Helpman, 1990; Saxenian, 1994). Knowledge spillovers occur as result of the use of non-trade related mechanisms outside the market, and pecuniary knowledge externalities more appropriately through trade and market related mechanisms (see table 1).

Table SEQ Table * ARABIC 1: Theoretical distinctions: External sources of knowledge

Knowledge spillovers (Jaffe, 1989; Audresch, 1998; Grossman & Helpman, 1991)	Firms (or entrepreneurs) acquire information created by others outside market transaction. No compensation given to the original source.	Personal networks, labour mobility, reverse engineering, conferences etc.
Pecuniary knowledge externalities (Johansson, 2004; Caniels & Romijn, 2005; Antonelli, 2007)	Firms (or entrepreneurs) acquire information created by others through market or trade related mechanisms	Technology licensing, formal collaboration, subcontractors, suppliers, consultants etc.

*****Definitions – The definition of knowledge spillovers is based on Grossman and Helpman (1991), while that of pecuniary knowledge externalities is based on Breschi and Lissoni (2001a and b) and Antonelli (2007)
******This distinction is based on Johansson (2004), Breschi and Lissoni (2001a and b)
*******Knowledge spillover mechanisms are based on Saxenian (1994), Stuart and Sorenson (2003) and Audretsch (2003), while that of pecuniary knowledge externalities are based on Breschi and Lissoni (2001a and b) and Antonelli (2007)

Research Questions

Based on the above discussion and to help address the problem we articulate above, we ask:

"What differences and similarities are there in the use of external knowledge for new product development by high-tech small firms in LARs, in comparison those in HARs?"

This umbrella question accommodates four research questions for our study:

RQ1: *Are the key spillover mechanisms used by small firms developing innovative new products in LARs different from those used by firms in HARS?*

RQ2: *Are the key pecuniary knowledge mechanisms used by small firms developing innovative new products in LARS different from those used by firms in HARs?*

RQ3: *What is the relative influence of knowledge spillovers vs. pecuniary knowledge on new product development by small firms in high and low agglomeration?*

RQ4: *What is the relative influence of local, national and international sources of knowledge on new product development by small firms in high and low agglomeration?*

The study compares small firms in two types of agglomerations with respect to the use of knowledge for new product development. In contrast to previous studies on innovation in regional agglomerations which mostly focus on only knowledge spillovers, we broaden the analysis to examine the use of both pecuniary knowledge (knowledge acquired through market related sources) and knowledge spillovers (knowledge acquired through non-market sources) in these regions.

Conceptual Framework

Using the insights provided by the literature and in order to attempt to answer the research questions above, we develop a conceptual framework (Figure 3.3. below) which suggests that firms may use a variety of external sources of knowledge to develop new products. These sources can be located within the firm's locality, at the national or international levels.

When a firm acquires knowledge locally outside of market relations, it makes use of *local knowledge spillovers*. But a firm may also acquire local knowledge through formal market relations, thus making use of *local pecuniary knowledge*. Knowledge needed for new product development may also be transferred through informal non-market relations at the national level thus making use of *national knowledge* *spillovers*. At the same time and at the national level, a firm may acquire knowledge through formal market relations, thus drawing from *national pecuniary knowledge*. Knowledge may also be transferred at the international level in an informal way, which may induce *international knowledge spillovers*. And finally, *international pecuniary knowledge* externalities can occur when firms acquire knowledge in a formal way through international actors. The framework in figure 3 summarises the knowledge flows.

Figure SEQ Figure * ARABIC 3: Framework of External Knowledge Influencing New Product Development by SMEs in High and Low Agglomeration

This framework is developed by integrating different theories, including:

Knowledge spillovers (Jaffe, 1989; Audretsch, 1998; Acs, 2002; Simmie, 2002, 2003);
Pecuniary externalities (Breschi and Lissoni, 2001a and b; Antonelli, 2003);
Innovation: New Product development (Mansfield, 1988; Kessler *et. al*, 2000); and
Technological capabilities: Absorptive capacity (Cohen and Levinthal, 1989, 1990)

We develop various hypotheses related to our research problem (see below). We however begin by acknowledging that high agglomeration regions have more R&D activities than their low agglomeration counterparts (Stuart and Sorenson, 2003). This is due to having a greater presence of finance institutions (Florida and Kenney, 1988) which can better facilitate their ability to utilise external knowledge that is related to R&D (Cohen and Levinthal, 1989, 1990). This means that there is a high possibility that small firms in LARs will have a disadvantage in accessing external knowledge that is R&D intensive. Some firms in those regions may be inclined towards using different forms of external knowledge in comparison to those in HARs for their new product development activities because of their relative dearth of R&D. This is likely to lead to variations in the use of key sources of knowledge influencing new product development between small firms in high and low agglomeration. We therefore hypothesise that:

> H1: There are like to be variations in key knowledge spillover mechanisms influencing new product development between small firms in high and low agglomeration.

> H2: There are like to be variations in key pecuniary knowledge mechanisms influencing new product development between small firms in high and low agglomeration**.**

Furthermore, advocates of knowledge spillovers have argued that spillovers are the key drivers of innovation in high agglomerations and they occur in high agglomerations (Audretsch, 1998; Acs, 2002). However, many spillover mechanisms such as patent disclosures are not constrained by distance (Breschi and Lissoni, 2001b) which implies that small firms in LARs are also likely to benefit from many knowledge spillover mechanisms beyond their localities. As spillovers are regarded as untraded sources of knowledge compared to pecuniary sources (Breschi and Lissoni, 2001a and b), it seems logical that they are easier to acquire since they often require no monetary payments (Von Hippel, 1989). Considering that small firms in LARs have less access to finance (Florida and Kenney, 1988) it seems plausible that they are more likely to draw from free sources of external knowledge than pecuniary sources. However, this is not in anyway to undermine the importance of pecuniary knowledge. Rather, pecuniary knowledge sources are also likely to significantly influence NPD in both regions, as firms may also acquire knowledge inputs through market related mechanisms. We, therefore, contend that:

> H3: Knowledge spillovers sources are likely to have greater influence than pecuniary knowledge sources on small firm NPD 'not' just in high agglomeration but also low agglomeration.

The advocates of localised knowledge spillovers try to over emphasise on the importance of 'local' knowledge for innovation, even arguing that firms in LARs could hardly acquire external knowledge resources due to the lack of proximity to knowledge sources (Audretsch, 1998; Stuart and Sorenson, 2003). However, our exploratory work reveals some *inconsistencies* with the literature. Interviews carried out by us suggest that although local knowledge is important for firms in HARs, sources beyond the local region might be relatively more important for new product development than local knowledge. This is because even in high agglomeration, intense competition in acquiring local resources such as labour, often means that innovative firms have to look beyond their local regions for resources. For example, Mike Beadman of Cambridge Design Partners explains the difficulty of acquiring local labour in Cambridge, saying:

> "*Funny enough, if I had to say that, I'd say there is a huge shortage and the reason is that they are already doing it, that's the only downside and in the last five years for recruiting we had to go outside Cambridge, or we are effectively poaching staff from other consultancies. It's either a long way ahead or people are already working in similar businesses. So it is a problem, recruiting is probably our biggest single limiting factor at the moment to growth. It's always been a problem. There is not a huge unemployed population of high quality engineers to think about".*

Similarly, Ray Anderson of Cambridge based Bango Ltd remarks on the labour situation in Cambridge, saying:

> *"(It is) better than average although we still gonna have to bring a range of people from outside to fulfil a range of roles".*

Paul Johnson of Cyan Technology in Cambridge also revealed that the people he worked with were not Cambridge based, although it's in Cambridge that product development comes together, saying:

> "*The initial people, one was in Hertford, one was in North London and one was in Suffolk. But Cambridge is the area where it all jells together, yeah. It all sorts of come together and anybody working in sort of like Hertfordshire, Cambridgeshire, Suffolk, Essex, they're going to be naturally attracted to Cambridge; not that far away is the technological centre".*

Most innovative firms have a high tendency to source knowledge beyond their localities. As noted by an authoritative report (PACEC (2003: p.43):

> *The most successful companies that developed from the science base in Cambridge include ARM, Autonomy and Cambridge Silicon Radio (CSR). These companies tend to develop and sell global but niche technologies — integrated circuits, software, design tools and development systems — which are integrated into OEM (Original Equipment Manufacturer's) equipment that is developed and manufactured elsewhere.*

In 2005, CSR won UK's biggest innovation prize, that is the Royal Academy of *Engineering MacRobert Award,* and much of this success is attributed to the companies' international operations. "Since 1999 they (CSR) have designed over 30 different BlueCore™ chips, which are manufactured in Taiwan, and the company is now ranked number one in every Bluetooth market segment (in the world). CSR has shipped more than 100 million chips since its foundation, covering 60 per cent of all qualified Bluetooth enabled products, to customers which include global industry leaders such as Nokia, Dell, Panasonic, Sharp, Motorola, IBM, Apple, NEC, Toshiba, RIM and Sony using BlueCore™ chips in their range of Bluetooth products". Thus, CSR's internationalisation has played a crucial role in its being a leader in innovation. This is especially because customer needs vary by regions, thus globalisation plays a vital role for identifying the potential for new products as needs of customers in diverse nations have to be met (Booze Allen Hamilton and INSEAD, 2006).

We argue that international sources of knowledge are more likely to influence new product development than local and national sources. This is especially in the case of regions with low agglomeration, since they have a dearth of local knowledge. As Brian Back of Radio-tech Ltd, winner of 2006 prestigious best small scale innovation explains about labour acquisition in Essex:

> "*People we employed from all over the world. We had to employ people from Poland; we had to employ people from all over the world".*

So, innovative small firms in low agglomeration are even more likely to benefit from international sources. Our contention as expressed in the form our next hypothesis is as follows:

> H4: International knowledge sources are relatively more likely to be associated with small firm new product development than local and national knowledge sources in both high and low agglomeration. This is likely to hold true for both spillovers and pecuniary knowledge.

The Research Contexts: Cambridgeshire 'Silicon Fen' and Essex

Cambridge Silicon-Fen and Essex are two centres of electronic and software entrepreneurship and innovation located on the opposite side of each other in the Eastern region of England. One of the most noted contrasts between the regions is the fact that the Cambridgeshire industrial agglomeration of high-tech firms is visibly concentrated around the City of Cambridge, while the Essex high-tech software and electronic industries go almost unnoticed as they are dispersed across the vast county (Abubakar, 2009).

The celebrated phenomenon known as the 'Silicon Fen' is a geographic area of intense high-technology agglomeration encompassing the City of Cambridge at its heart and the sub-regional Greater Cambridge hinterland of about 20 mile radius. It is located in wider region of the East of England, about 50 miles north of London, and is one of the fastest growing regions in the UK and Europe (Barrell, 2004). In 1999, the Cambridge area of Cambridgeshire accounted for 60% of all hi-tech establishments and over 70% of all hi-tech employment in the County (Athreye, 2001). Research and development employment in the region has a location quotient of 7.1 (i.e. a share of R&D employment seven times the national average (Barry, n.d.). The Cambridge Silicon Fen is now recognised globally as a remarkable example of a dynamic knowledge-based economy, based on the spontaneous development of a myriad of small innovative technology intensive firms, embedded in a rich and diverse science base and providing some 50,000 jobs (PACEC, 2003).

Table SEQ Table * ARABIC 1: Key Regional Economic, Knowledge and Clustering Indicators

GVA per resident	£17,631□	£13,631□
GVA per local job□	£32,404□	£29,786□
Population qualified to NVQ 4+	27%□	17.4%
Specialised sectors that are 'knowledge intensive' (prop. All)	16%	10%
Employees in specialised and 'Knowledge intensive sectors'	11%□	1%
Proportion of local employees in highly clustered sectors	6%	1%
ICT start-ups per 10,000 population	4.15	1.82

Sources: Annual Business Inquiry (2004), Arthur D. Little (2003), FRESA (2002), Abubakar and Mitra (2007)

While Cambridgeshire and Essex advance similar technologies, the contrast in clustering and knowledge intensive activities between Cambridgeshire and Essex is revealing. Today, Cambridgeshire has a massive proportion of employees in specialised and 'Knowledge intensive sectors' of 11% while Essex has a corresponding figure of 1% (Annual Business Inquiry, 2004 cited in Essex County Council, 2006; see figure 2 below). Data on the proportion of employees in highly clustered sectors further highlight the divergence in local agglomeration between Cambridgeshire and Essex; with the regions recording 6% and 1% respectively (see figure 3 below).

Source: Annual Business Inquiry 2004 cited in Essex County Council (2006)

If small firms in both regions develop new products, but differ in availability of local agglomeration - in terms of proximity to related firms and workforce - then a crucial question for those interested in fostering innovations in low agglomeration environments is – through what sources do firms in regions with low agglomeration source external knowledge for new product development? Put differently - what differences or similarities exist between small firms in high and low agglomeration exist in key external sources of knowledge used for new product development? These are crucial questions if we are ever going to design effective policies for boosting innovation performance of firms located in regions with low agglomeration, but also high agglomeration.

Research Methodology

The empirical data for this paper focuses on differences and similarities in external sources of knowledge used for new product development by small firms in high and low agglomeration. A common questionnaire was developed to collect cross-sectional data for the years 2004-2007 in order to facilitate comparison between small firms in the two regions. The firms were sampled based on the criteria of being: 1) SMEs i.e. having less than 250 employees; 2) belonging to high technology sectors - software development and electronic engineering (CCC, 2004); 3) being located in the high agglomeration of Cambridgeshire Silicon Fen and low agglomeration of Essex (see below).

To further ensure that small firms were selected from areas with high and low agglomeration, the relative agglomeration of electronic and software firms was calculated for each Local Authority of East of England in order to identify areas with above average densities of electronic and software workforce and workplaces. Workforce density was calculated as – number of employees per km^2, and firm density was calculated as number of workplaces per km^2. The areas with above average employment and workforce density were considered high agglomerations, while those with below average scores were considered having relatively low agglomeration. The correlation between workforce and workplace density as the two measures of agglomeration was 0.86 (R Square) thus indicating that the two measures are highly related. The Silicon Fen cluster around Cambridge City (Keeble *et. al*, 1999; Myint *et. al.*, 2005) had a density of 69.3 employees per km^2 and 8.3 workplaces per km^2 in comparison to the East of England average of 12.1 employees per km^2 and 1.7 workplaces per km^2. Essex had below East of England average for both workforce and workplace density. Firms in Essex areas were, therefore, considered to be located in low agglomeration regions.

Two sampling frames were obtained of SMEs in the local agglomeration of Cambridgeshire Silicon Fen and of Essex from the following sources: Yell.com; Cambridge Networks; Apple Gate Directory and Essex ICT Directory. The data was collected using the research questionnaire administered through internet and postal surveys (Bryman and Bell, 2003). A total of 52 SMEs were surveyed in Cambridge Silicon-Fen and 48 in Essex, yielding a response rate of over 20% in each region. The data collected was analysed with SPSS using factor analyses, cluster analysis and multiple regression as commonly used in comparative studies in entrepreneurship (Manimala, 1999; Lublinski, 2003; Bryman and Bell, 2003). The two samples from which data was collected were randomly selected helping to improve external validity (Bryman and Bell, 2003). The construct validity was improved by developing measures based on well acknowledged innovation studies, namely constructs such as new product development and externalities (CIS3, 2004). All factors derived from factor analysis were tested for reliability using Cronbach's alpha. The knowledge spillover factors had an average score of 0.79 while the pecuniary knowledge factors had an average score of 0.73, demonstrating appropriate levels of reliability (Manimala, 1999; Schutte et al., 2000; Bryman and Bell, 2003).

We used factor and cluster analysis to identify sub-types and groupings of firms and the different types of pecuniary and spillover knowledge used by respondent firms. We developed a Product Novelty Index to assess the innovativeness of products. Mutliple regression analysis was carried out to test the relative impact of independent variables on the dependent one, using the factors identified by the factor and cluster analysis above (to help avoid collinearity).

Empirical Results

H1: Variations in key knowledge spillover mechanisms between small firms in high and low agglomeration.

The first objective is to explore and identify differences in key knowledge spillover mechanisms influencing the development of innovative products in HARs and LARs. We focused on identifying and rating innovativeness of sub-groups firms based on the spillover mechanisms they use for developing new products. To help identify the subtypes, hierarchical factor analysis of 27 knowledge spillover variables collected from the questionnaire was conducted. The rationale for using factor analysis was to simplify the knowledge spillover variables from the questionnaire into fewer meaningful factors. The 6 factors that emerged on knowledge spillovers are significant and meaningful explaining 72.2% of the total sample variance and can be readily interpreted in economic terms. The 6 factors can be interpreted as: labour mobility, research institutes spillovers, spillovers from conferences, spillovers from informal contacts, imitation of existing products (reverse engineering) and international spillovers.

In order to identify the subgroups of firms we used cluster analysis, which aims at constructing homogeneous groups of firms in terms of the variables considered (Rabellotti and Schmitz, 1999). In both Cambridge Silicon Fen and Essex 4 subtypes each were found.

In order to assess the innovativeness of products developed by firms belonging to each sub-group, we construct a measure known as 'Product Novelty Index (PNI)'. The PNI is a combined measure for assessing the novelty of the new products developed by firms, based on common four different types of innovation indicators commonly used in major innovation studies (OECD/EC/Eurostat, 1997; European Commission, 2002; CIS, 2004).Thus, each small firm was assigned a PNI score based on the presence or absence of four types of innovation related activities (see table 3). The score for each firm ranged from a minimum of 0 to a maximum of 4.

Table SEQ Table * ARABIC 3: The Product Novelty Index (PNI)

Components	Score
The development of product "new to firm"?	1
The development of product "new to market"?	1
Changing product in a substantial manner for individual customers? Patent application?	1 1
Maximum (total) score	**4**

The subtypes found in general are:

a) *Imitators*– that is a sub-group characterised by firms which take other firm's product and reverse engineer it by finding new applications for it;

b) *Research institute spillover oriented firms* – which are small firms that focus on utilising mostly 'free' knowledge from universities and research organisations, which could be in the form of free conversations with academics and researchers in universities and colleges, public research that is made available without restriction to users etc;

c) *Loners*– firms are which negative scores for virtually all the knowledge spillover factors identified in the study, thus indicating that these firms remain somewhat isolated from knowledge spillovers;

d) *Labour oriented firms*- subgroup characterised by small firms with recruiting of new labour as their core external spillover focus; and

e) *International spillover oriented firms*- which are firms that focus their attention, as it relates to spillovers, primarily on sourcing knowledge from international sources.

Table SEQ Table * ARABIC 3: Subtypes of Firms based on Knowledge Spillover Sources and their PN Index Scores

a) Cambridge Silicon Fen

	Knowledge Spillover Factors							
	Research institutes	*Professional associations*	*Informal contacts*	*Labour mobility*	*Reverse engineering*	*International spillovers*	***Size (%)***	***Product Novelty Index(PN Index)***
INTERNATIONAL SPILLOVER ORIENTED FIRMS	-0.45	-0.07	1.29	0.49	-0.64	1.39	***18%***	***2.44***
LABOUR ORIENTED FIRMS	0.00	0.23	-0.27	0.89	0.41	0.08	***44%***	***2.68***
LONERS	-0.01	-0.08	-0.16	-0.77	-0.20	-0.29	***36%***	***2.06***
RESEARCH INSTITUTE SPILLOVER ORIENTED FIRMS	3.17	-2.82	3.20	0.77	2.16	-0.04	***2%***	***3***

N = 50

Note: These subtypes are based on spillover sources from 'local', 'national' and 'international' sources taken all together.

b) Essex

	Knowledge Spillover Factors							
	Research institutes	*Professional associations*	*Informal contacts*	*Labour mobility*	*Reverse engineering*	*International spillovers*	***Size (%)***	***Product Novelty Index(PN Index)***
Imitators	-1.29	-0.09	0.37	-1.16	3.10	-0.19	***9%***	***2***
Research Institute Spillover Oriented Firms	1.55	1.02	-0.08	1.11	0.22	0.70	***11%***	***2***
Loners	0.37	-0.09	-0.23	-0.86	-0.29	-0.05	***47%***	***1.86***
Labour Oriented Firms	-0.60	-0.20	-0.15	0.43	-0.61	-0.73	***33%***	***1.6***

N = 45

Note: These subtypes are based on spillover sources from 'local', 'national' and 'international' sources taken all together.

Our main finding as regards unique sources through which innovative firms in LARs acquire external knowledge is that the subgroup of firms known as 'imitators' appear to have greater presence in Essex than in Cambridge Silicon-Fen. Imitators are firms which rely on reverse engineering other firms' products. This is likely because firms in Essex have significantly lower internal R&D ($p<0.05$) and imitation requires less R&D (Kim, 1997). Reverse engineering in software industry can be described as "the analysis of a competitor's program by examining its coding and structure in order to develop programs which either compete with the program which has been analysed or interface with that program" (Gerald, 1990). It, therefore, has to do with the disassembling of the object code into a readable source code right up to the development of a new product based on the ideas revealed by disassembling (Mishra, 1997).

Interestingly, the subgroup of firms in Essex with imitative technological learning through reverse engineering appears to have a high PNI score (2.0), which is above the local average of 1.87. This suggests that imitation may be an important source of learning for firms in LARs especially because of internal R&D constraints. Similarly, reverse engineering has had a significant role in the early technological progress of developing countries such as Korea especially with the country's initial state of low R&D activities (Mishra, 1997; Kim, 1997; Wong, 1999; World Bank, 2000). Our results suggest that gaining new product development capability for firms in LARs may also be influenced by imitation through reverse engineering. In contrast, imitators are hardly found in the HARs of Silicon Fen, perhaps because of their high levels of internal R&D.

In Cambridge Silicon-Fen subgroups of small firms with above average PNI scores appear to be those that rely on labour mobility (PNI score = 2.68) and research institute spillovers (PNI score = 3.0). Labour mobility however does not appear to be have a high effect for firms in Essex (PNI score = 1.6). This is likely because taking advantage of labour mobility seems to be highly associated with firm R&D, which is another issue that has been overlooked by knowledge spillover theorists (Audretsch, 1998; Stuart and Sorenson, 2003: see figure 6).

Figure SEQ Figure * ARABIC 6: Correlation of Firm Internal R&D and Labour Mobility

($p<0{\cdot}01$; Pearson's r=0.33; N = 87)

H2: Variations in key <u>Pecuniary Knowledge</u> Mechanisms between Small Firms in High and Low agglomeration

The second objective of the study is to explore and identify variations in key pecuniary knowledge mechanisms influencing new product development between small firms in high and low agglomeration. Again, the proposition that we try to explore is whether the learning behaviour of the most innovative firms in LARs is uniquely different to the most innovative firms in HARs. We conducted a hierarchical factor analysis of the 27 pecuniary knowledge variables collected from the questionnaire, so as to simplify the variables into fewer more meaningful factors. The analysis yielded 7 pecuniary knowledge factors (the factors can be interpreted as collaboration with research institutes, licensing competitor's technology, subcontractors, knowledge from national market, knowledge from local market, and knowledge from international market.

We carried-out cluster analysis of the 7 pecuniary factors to identify different external learning behaviours of small firms in Silicon-Fen and Essex. The cluster analysis revealed 5 subtypes of firms in HARs and 4 in LARs that have previously not been discussed in the literature. Table 4 depicts the subtypes of small firms in HARSs based on pecuniary knowledge orientation.

The subtypes are:

a) *Market knowledge oriented firms* - a group of small firms whose knowledge (and learning) for new product development is based primarily on market relations they engage in;
b) *Consultancy oriented firms* - these firms develop their new products based on advice and other consultancy services received from consultants;
c) *Technology license oriented firms* - this subgroup of small firms is characterised by firms that develop new products with their external orientation based fundamentally on licensing the technology of competitors;
d) *Collaborators with research institutes* - These are small firms that collaborate or use paid services of universities and research institutes which are traditionally known as providers of basic research;
e) *Loners* - this represent a sub-group of autonomous small firms that are not oriented towards pecuniary knowledge sources.

Table SEQ Table * ARABIC 4: Subtypes of Small Firms based on Pecuniary Knowledge Sources and PN Index

a) Cambridge Silicon-Fen

Pecuniary Knowledge Factors

□*Contracts with public organisations*□*Technology licensing & R&D employees*□*Sub-contractors*□*National customers & suppliers*□*Local customers & suppliers*□*International customers & suppliers*□*Consultants*□***Size (%)***□***Product Novelty Index(PN Index)***□ **Market knowledge oriented firms**□-0.02□0.05□-0.43□0.37□-0.12□0.34□-0.45□43% 2.41 **Consultant oriented firms**□0.34□-0.15□-0.06□-0.76□-0.18□-0.52□0.83□25% 2.23 **Technology license oriented firms**□0.05□1.04*□0.64□-0.91□-0.25□0.92□-0.45□18% 2.67 **Subcontractor oriented firms**□-0.58□0.43□1.65*□0.93□0.59□-1.32□0.14□12% 2.33 **Collaborators with research institutes**□5.03*□-3.7□0.45□1.07□1.16□-0.33□0.93□2% 3 N=51

Note: These subtypes are based on pecuniary knowledge sources from 'local', 'national' and 'international' sources taken all together

b) Essex

Pecuniary Knowledge Factors

□*Contracts with public organisations*□*Technology licensing & R&D employees*□*Sub-contractors*□*National customers & suppliers*□*Local customers & suppliers*□*International customers & suppliers*□*Consultants*□***Size (%)***□***Product Novelty Index(PN Index)***□ **Market knowledge oriented firms**□-0.84□-0.2□-0.48□1.63□-0.7□0.23□1.18□16% **1.43** **Collaborators with research institutes**□3.07□2.27□0.36□1.13□1.21□0.24□1.18□5% **0.50** **Loners**□-0.03□-0.14□-0.46□-0.4□-0.11□-0.37□-0.24 □61% **1.63** **Subcontractor oriented firms**□-0.67□-0.85□1.14□0.04□0.97□0.88□-0.33□18% **2.75** N=44

Note: These subtypes are based on pecuniary knowledge sources from 'local', 'national' and 'international' sources taken all together

Our results suggest that the firms developing the most innovative products in Essex tend to base their use of external knowledge on sub-contractual relations, which contrasts with those in Cambridge Silicon-fen where firms collaborating with research institutions (e.g. universities) have the highest PNI score (3.0). Considering that collaboration with research institutes is carried out by firms with high investments in R&D (see figure 7), our results suggest that formal collaboration with research institutes has only relatively small impact on firms in low agglomeration. For firms in Essex, subcontracting to other firms appears to play the most significant role in helping firms develop innovative products.

Figure SEQ Figure * ARABIC 7: Correlation of Firm Internal R&D and Collaboration with Research Institutes

(P< 0.01; Pearson's r=0.29; N =87)

Since the findings in P1 and P2 above all suggest that small firms in both Cambridge Silicon-fen and Essex use knowledge spillovers and pecuniary knowledge sources, the next logical step is to compare the relative importance of knowledge spillovers and pecuniary knowledge for new product development by firms in both regions. This will allow us to identify which external sources of knowledge are more crucial for new product development especially in low agglomeration (Essex), thereby providing possible direction for policy

H3: Knowledge Spillovers vs. Pecuniary Knowledge on NPD

In this part of the analysis, we examine the relative importance of knowledge spillovers or pecuniary knowledge in accounting for new product development by small firms in LARS and HARs.

To test those external sources which are most favourable for new product development, we opt for multiple regressions. The importance of multiple-regression is that it allows the examination of the impact of independent variables on the dependent variable (Bryman and Cramer, 2001). For the purpose of the regression analysis, knowledge spillover and pecuniary knowledge factors identified through factor analysis above were employed. This is because the original spillover and pecuniary knowledge variables collected from the questionnaire are not appropriate for multiple regression analysis as there are high inter-correlations among some of the variables, thus risking multi-collinearity (Bryman and Cramer, 2001). The knowledge spillover orientations and pecuniary knowledge orientations identified account for 72.2% and 71% of the total sample variance respectively. It is, therefore, easonable to compare their relative impact on new product development. In this context, we consider knowledge spillovers to be more important than pecuniary knowledge externalities in high agglomeration if it provides the maximum explanation for new product development by small firms.

The PNI developed above does not relate to number of products developed but mainly the novelty of the products. Since the study is limited to technology product development, we employ ‘number of patents’ applied for by small firms as the main proxy for new product development. Patents are commonly used in a number of major innovation studies (Jaffe 1989; Jaffe, Trajtenberg and Henderson, 1993; Breschi and Lissoni, 2006; Krudsen *et al*., 2007). These studies show that there is a strong relationship between patenting and research and development (Scherer, 1983; Jaffe, 1989; and Griliches, 1990), which suggests that patents are a good measure of inventive activity. This is also indicated by our results, as we found a strong relationship between patents and internal R&D activity ($p<0.01$). We also note a significant relationship between patents and the PNI scores in both Cambridge Silicon-Fen and Essex ($p<0.05$). Therefore, the number of patents held or applied for by small firms was considered a useful measure of new product development in technology based industries. The validity of the regression findings based on patents was further strengthened as similar results were obtained when internal R&D was employed as the ‘dependent variable’, thus making the results more robust.

It should be noted however that although the knowledge spillover and pecuniary knowledge factors are regressed with the number of patents, causality cannot be directly inferred, since the variables were not measured with a time gap between them. In this context, our effort serves probably as the first attempt to measure the relative influence of knowledge spillovers versus pecuniary knowledge externalities on new product development in high and low agglomeration regions.

a*) Cambridge Silicon-Fen: Knowledge Spillovers vs. Pecuniary Knowledge*

We begin the analysis with the Cambridge Silicon-Fen sample. Table 5 below displays the results of the multiple regression analysis. Our results suggest that both spillovers and pecuniary knowledge are significant in explaining new product development in Cambridge Silicon-Fen. However, while Knowledge spillover sources are significant at $p<0{\cdot}001$ explaining 45% of the variance, pecuniary knowledge orientations are less significant than knowledge spillovers at $p<0{\cdot}05$ with less explanatory power at 32%. Thus, the findings suggest that in HARs knowledge spillovers have greater explanatory power than pecuniary knowledge externalities on new product development.

Table SEQ Table * ARABIC 5: Cambs: Influence of Spillovers vs. Pecuniary Knowledge on New Product Development

	□Unstandardised Coefficients	□Standardised Coefficients	□Sig.	□% Variance Explained (R Square)	□Sig.□□
MODEL 1: KNOWLEDGE SPILLOVERS					
International spillovers	2.54	0.58	0.000	**□45%□**	**0.000**
Spillovers from research institutes and patent disclosures	1.45	0.28	0.027		
Spillovers from Labour mobility	1.40	0.27	0.031		
Free' knowledge from informal contacts	-0.84	-0.19	0.117		
Reverse engineering□	-0.98	-0.17	0.186		
Spillovers from Conferences and Associations	-0.54	-0.11	0.383		
Constant□	1.247□				
N = 49					
MODEL 2: PECUNIARY KNOWLEDGE					
Technology licensing	1.75	0.38	0.015	**32%**	**0.017**
International market knowledge orientation	1.52	0.34	0.022		
Collaboration with research institutes	1.50	0.33	0.026		
National market knowledge orientation	-1.16	-0.23	0.091		
Consultants□	0.94	0.18	0.171		
Sub-contractors	0.82	0.16	0.245		
Local market knowledge orientation	-0.28	-0.05	0.683		
N=50					

b) *Essex: Knowledge Spillovers vs. Pecuniary Knowledge*

We use the same indicators of new product development, knowledge spillover and pecuniary knowledge for the Essex sample. Table 6.13 below displays the results of our analysis.

Table 6: Essex: Spillovers vs. Pecuniary Knowledge and New Product Development (Number of Patents)

	Unstandardised Coefficients	Standardised Coefficients	Sig.	% Variance Explained (R Square)	Sig.
MODEL 1: KNOWLEDGE SPILLOVERS SOURCES					
International spillovers	0.10	0.06	0.700	**30%**	**0.027**
Spillovers from research institutes and patent disclosures	0.42	***0.28***¤	0.056		
Spillovers from Labour mobility	0.41	***0.27***¤	□0.063		
Free' knowledge from informal contacts	-0.56	-0.310	0.048		
Reverse engineering□(imitation)	0.35	0.27	0.069		
Spillovers from Conferences and Associations	0.09	0.06	0.677		
Constant□					
N=44					
□MODEL 2: PECUNIARY KNOWLEDGE SOURCES					
Technology licensing □	0.25	***0.13***¤	0.537	**21%**	**0.254**
International market knowledge orientation	0.78	***0.44***¤	0.015		
Collaboration with research institutes	0.03	***0.02***¤	0.931		
National market knowledge orientation	-0.22	-0.13	0.392		
Consultants	-0.19	-0.19	0.236		

Sub-contractors	-0.48	-0.28	0.103		
Local market knowledge orientation	-0.19	-0.12	0.423		
N=43					

Again similar to Cambridge Silicon-Fen, the results replicate themselves. Knowledge spillovers again appear to have greater influence on new product development than pecuniary knowledge spillovers. While knowledge spillovers appear to explain 30% of new product development ($p=0.027$), pecuniary knowledge could only account for 21% ($p=0.254$) of the variance. The regression of knowledge spillovers versus pecuniary knowledge on new product development shows that spillovers have greater influence in both regions.

Having found that knowledge spillovers are relatively more important in both high and low agglomeration regions, it is now important for us to understand more clearly where these spillovers come from, especially for firms in low agglomeration? Is it from the local, national and international sources? Such information is also likely to help provide direction on spatial focus of innovation policy. Thus in P4, we investigate the relative importance of local, national and international sources of knowledge on new product development by small firms in different regions.

H4: Relative Influence of Local vs. National and International Knowledge on NPD

Our interest here is in investigating the relative influence of local versus national and international knowledge sources for new product development by small firms in high and low agglomeration. Firms were asked in the survey to rate the importance for developing products of various sources of knowledge acquired at the local, national and international levels. We then constructed variables for local knowledge, national knowledge and international knowledge. For example, the local knowledge variable was constructed in the following way: for each firm, we added up the scores of importance assigned to the sources of knowledge acquired locally.

In operational terms, the focus of the analysis is the relationship between use of knowledge at a particular spatial level and new product development. Accordingly, we employ the spatial variables developed on local, national and international knowledge to examine their relationship with new product development. We again employ number of patents as the proxy for new product development.

Figure 8 below displays the results of the analysis. For the Cambridge Silicon-Fen sample, two spatial levels appear to be significantly associated with new product development. These are ‘local knowledge’ ($p<0.01$) and ‘international knowledge’ ($p<0.01$). In contrast, in Essex low agglomeration, ‘international knowledge’ ($p<0.05$) is the main spatial level that appears to be associated with new product development activities. The results also hold even if sources of knowledge are divided into knowledge spillovers and pecuniary knowledge (see figure 9).

Figure SEQ Figure * ARABIC 8: **Cambridge Silicon-Fen**: **Correlations between Geographic Knowledge Sources and New Product Development**

N= 51

N= 51

N= 51

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Significant on NPD at the 0.05 level (2-tailed)/highest influence

Not significant

Figure SEQ Figure * ARABIC 9: **Essex: Correlations between Geographic Knowledge Sources and New Product Development**

Essex = 47

Essex = 47

Essex = 47

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Significant on NPD at the 0.05 level (2-tailed)/highest influence

Not significant

Concluding Observations and Some Policy Considerations

In this paper, we have investigated sources of new product development by small firms in low agglomeration by comparing them with those in high agglomeration. We end with a simple premise**.** If we stop thinking of small firms in LARs as lacking proximity to sources of R&D and formal collaborations with research institutions and start recognising them as users of other sources of innovation, a whole new world of opportunities could open-up for promoting technological innovations**.** The result of over three year intensive research, our results suggest that the key to understanding sources of new product development in low agglomeration lies in what we call the '4 sources of NPD in low agglomeration'. Our analysis suggest that sourcing knowledge through *imitation*, *subcontracting*, k*nowledge spillovers* and *international knowledge sources* are strong differentiators for small innovative firms developing new products in LARs.

Imitation (relative to other spillover mechanisms):
We found 'imitators', namely firms relying on reverse engineering products of others are more likely to be found in low agglomeration regions. Imitators in LARs appear to have the highest PNI scores. The role of imitation in the geography of innovation research has long been neglected. In HARs we found firms with high PNI scores focussed on labour mobility and 'not' imitation. Studies of rapid technological developing countries such as Korea, Singapore and Taiwan have shown the importance of imitation for innovation (Kim, 1997; Wong, 1999; World Bank, 2000). For example, an authoritative study published by Harvard University Press argues that the evolution of imitation to innovation has played a crucial role in Korea's rapid technological development (Kim, 1997). Our findings suggest that even in advanced countries, imitation is crucial for innovation by small firms mainly in low agglomerations.

Subcontractors (relative to other pecuniary sources).
Small firms in LARs appear to have quite different pecuniary knowledge acquisition approaches to developing capability for technological product development. Firms engaging in sub-contractual relations appear to have the highest PNI score in these regions suggesting the particular importance of such relations. Interestingly, sub-contractual relations have been particularly important for developing countries that have achieved remarkably rapid technological catch-up (Wong, 1999). For example, many firms from Singapore initially started as subcontractors and contract manufacturers for world class electronics Multinational Corporations (MNCs) e.g. Natsteel Electronics (Wong, 1999). Indeed, Singapore has now emerged as a leading hub for contract manufacturing specialists in the world (Wong, 1999). Likewise, firms in LARs even in advanced countries like UK, appear to benefit particularly from sub-contractual relations, which is a phenomenon that has hardly received any attention from geography of innovation literature.

Knowledge Spillovers (relative to pecuniary knowledge)
Knowledge spillovers have traditionally been thought of as mainly relevant to areas of high agglomeration (Audretsch, 1998; Stuart and Sorenson, 2003). Our results suggest that knowledge spillovers are relevant and significant for firms in LARS too. Relative to pecuniary knowledge sources, we found knowledge spillover sources as the key external factors influencing new product development by small firms in both high and low agglomeration. Advocates of spillovers should, therefore, explore both LARs and HARs to understand the different types of knowledge spillovers and their impact on innovation in firms.

International Sources (relative to local and national)
Although in a high agglomeration region local knowledge is clearly significant as pointed out by champions of agglomeration (Saxenian, 1994; Audretsch, 1998; Acs, 2002), our findings suggest that international knowledge sources appear to be the most correlated with new product development in both high and low agglomeration regions (also see figure 10). This finding holds for both regions even after dividing knowledge sources into knowledge spillovers and pecuniary knowledge, thus making the results more robust. This is likely because as firms cross regions, national and international boundaries, they are likely to encounter varying customer needs, the fulfilment of which often requires developing new products (Booze Allen Hamilton and INSEAD, 2006). This is a very crucial finding that appears to

suggest that there might be a solution for technologically lagging regions where differentiated policy measures would be necessary particularly in an era where easy, universal solutions are sought for promoting difficult and complex activities such as innovation.

Figure SEQ Figure * ARABIC 10: Small firm Innovation Continuum in Low Agglomeration

Supporting firms in low agglomerations to develop new products may require changing the dominant logic of innovation policy. We, therefore, conclude by asking policy makers and small firm managers 'to tread the path of innovation and entrepreneurship with morality and honesty' (Prahalad, 2008) by developing new models that take into account regional contexts of innovation (Abubakar, 2009).

Table 7: Changing the dominant logic of innovation policy in Low Agglomeration

From 'local' innovation policies:	To developing the 'New' Models???
Low agglomerations lack R&D sources (Florida and Kenney, 1988; Stuart and Sorenson, 2003)	Focus on creative imitation (especially sources beyond local boundaries and within legal boundaries)???
Low agglomerations lack formal collaborations with research institutions	Focus on subcontracting/outsourcing (especially beyond local boundaries)???
Spillovers are localised in agglomerations (Jaffe, 1989; Audretsch, 1998)	Spillovers are also effective for firms in low agglomeration???
Low agglomerations lack 'local' resources (Stuart and Sorenson, 2003)	Access to 'global' resources???

References

Wireless wizards scoop UK's biggest innovation prize. Online: HYPERLINK "http://www.csr.com/pr/pr196.htm" http://www.csr.com/pr/pr196.htm (Accessed: 28th January, 2009).

The measures for R&D Index are from our questionnaire and they were taken directly from Albaladejo and Romijn (2000). The is made up of three questionnaire items that gauge on a scale of 1 to 5, the importance of: a) Formal in-house R&D; b) Other in-house technological activities; b) ideas generated from marketing etc. The reliability test for Cronbach's Alpha is 0.67, which is considered reliable in innovation studies (Manimala, 1999)

Abubakar, A.Y. (2009) Agglomeration High-tech Firms and New Product Development: A Study of Firms in High and Low Agglomeration, PhD Thesis, Essex Business School, University of Essex

Abubakar, Y. (2009) Agglomeration of high-tech firms and new product development, PhD thesis submitted to Essex Business School, University of Essex.

Abubakar, Y. and Mitra, J. (2007) ‘Developing a culture for entrepreneurship in the East of England: the value of social and human capital’ Industry and Higher Education Journal, 21(2): 129-143(15).

Abubakar, Y. and Mitra, J. (2007) ‘Developing a culture for entrepreneurship in the East of England: the value of social and human capital’ Industry and Higher Education Journal, 21(2): 129-143(15).

Acs, J.S. (2002) Innovation and the Growth of Cities, Cheltenham: Edward Elgar Publishing.

Acs, Z. and Audretsch, D. (1990) Innovation and Small Firms, Cambridge, MA, MIT Press

Acs, Z. and Audretsch, D.B. (1987) ‘Innovation, market structure and firm size’, The Review of Economics and Statistics, vol. 69(4): 567-574.

Antonelli, C. (2007), ‘Pecuniary Knowledge Externalities and the System Dynamics of Growth’, Working paper No. 07/2007, Dipartimento di Economia "S. Cognetti de Martiis" LEI and BRICK - Laboratorio di economia dell'innovazione "Franco Momigliano", Bureau of Research in Innovation, Complexity and Knowledge, Collegio Carlo.

Arrow, K.J. (1962) ‘The Economic Implications of Learning by Doing’, Review of Economic Studies, Vol. XXIX, No. 80.

Arthur D. Little (2003), ‘Innovation and Technology Audit for the East of England’, A report to the East of England Development Agency (EEDA), UK: EEDA. Online. Available at: HYPERLINK "http://www.eastofenglandobservatory.org.uk/WebDocuments/Public/approved/user_729/Innov&Tech_Audit_2003.pdf" http://www.eastofenglandobservatory.org.uk/WebDocuments/Public/approved/user_729/Innov&Tech_Audit_2003.pdf (accessed 8th June, 2005).

Audretsch, B. (1998) ‘Agglomeration and the location of innovative activity’, Oxford Review of Economic Policy, 14 (2): 18-29(12).

Audretsch, D. (1995) Innovation and Industry Evolution, Cambridge, MA, MIT Press

Barrell, A. (2004) 'Innovation Champions Network: The Cambridge Cluster Description', International Network for Small and Medium Sized Enterprises-INSME. Online. Available at: HYPERLINK "http://www.insme.org/documenti/cambridgeStruct.pdf" www.insme.org/documenti/cambridgeStruct.pdf (16th May, 2005).

Bierly, P. and Chakrabarti, A. (1996) 'Knowledge strategies in the U.S. Pharmaceutical Industry', Strategic Management Journal, 17, Special Issue: 123-125.

Booze Allen Hamilton and INSEAD (2006) 'Innovation: Is Global the Way Forward', A report prepared by Booze Allen Hamilton and INSEAD. Online. Available at: HYPERLINK "http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf" http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf (28th January, 2009).

Booze Allen Hamilton and INSEAD (2006) 'Innovation: Is Global the Way Forward', A report prepared by Booze Allen Hamilton and INSEAD. Online. Available at: HYPERLINK "http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf" http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf (28th January, 2009).

Breschi, S. and Lissoni, F. (2001a) 'Knowledge spillovers and local innovation systems: a critical survey', Industrial and Corporate Change, 10(4): 975-1005.

Breschi, S. and Lissoni, F. (2001b) Knowledge Spillovers and Local Innovation Systems: A Critical Survey, LIUC Papers in Economics 84, ersa00p362, European Regional Science Association

Breschi, Stefano and Lissoni, Francesco (2006) 'Mobility of inventors and the geography of knowledge spillovers: New evidence on US data', CESPRI Working Paper 184.

Brown, J. S. and Duguid, P. (2000) 'Mysteries of the region - knowledge dynamics an Silicon valley', in Chong-Moon Lee, William F. Miller, Marguerite Gong Hancock, and Henry S. Rowen, editors, The Silicon valley Edge, Stanford, CA: Standford University Press, 16 – 39.
Bryman, A and Bell, E (2003), Business Research Methods, Oxford: Oxford University Press.
Bryman, A. and Cramer, D. (2001) Quantitative Data Analysis with SPSS Release 10 for Windows, London: Routledge.

Business Week (2008) The World's Most Innovative Companies by Region. Online. Available at: HYPERLINK "http://www.businessweek.com/table/08/0415_in_geographic.htm" http://www.businessweek.com/table/08/0415_in_geographic.htm (Accessed: 10th December, 2008).

Caniëls M.C.J. and Romijn H.A. (2003), 'Firm-level knowledge accumulation and regional dynamics', Industrial and Corporate Change, 12(6): 1253-1278.

Caniels, J. and Romijn, A.H. (2005) 'What drives innovativeness in industrial clusters? Transcending the debate', Cambridge Journal of Economics, 29(4): 497–515.

Carlino, G., Chaterjee, S., and Hunt, R. (2001) 'Knowledge spillovers and the new economy of cities', Working Paper, No. 01-14, Federal Reserve Bank of Philadelphia.

CCC (2004) ‘Employment in the Hi-tech ‘Community’ in Cambridgeshire and Peterborough’, Cambridgeshire: Cambridgeshire County Council Research Group. Online. Available at: HYPERLINK "http://www.cambridgeshire.gov.uk/NR/rdonlyres/8A1FEFB4-873D-45A4-B4E8-0EF1D5430E1A/0/EmploymentintheHi1004v2.pdf" http://www.cambridgeshire.gov.uk/NR/rdonlyres/8A1FEFB4-873D-45A4-B4E8-0EF1D5430E1A/0/EmploymentintheHi1004v2.pdf (Accessed 26th August, 2008).

CIS3 (2004) ‘Innovation in Europe: Results for the EU, Iceland and Norway from the Third Community Innovation Survey’, Luxemburg: Office for Official Publication of the European Community.

CIS3 (2004) ‘International comparisons of the third community innovation survey’, Department of Trade and Industry (DTI). Online. Available at: *HYPERLINK "http://www.berr.gov.uk/files/file9657.pdf"* www.berr.gov.uk/files/file9657.pdf (Accessed: 30th September, 2007).

Cohen, W. M. and Levinthal, D. A. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation, Administrative Science Quarterly, 35: 128-152.

Cohen, W.M. and Levinthal, D.A. (1989), ‘Innovation and learning – the two faces of R&D’, The Economic Journal, 99(397): 569-96.

Cohen, W.M. and Levinthal, D.A. (1989), ‘Innovation and learning – the two faces of R&D’, The Economic Journal, 99(397): 569-96.

Cooke, P., Roper, S., Wylie, P. (2003) ‘The Golden Thread of Innovation’ and Northern Ireland’s Evolving Regional Innovation System’, Regional Studies, 37(4): 365–379.

Craig, Tom (2007) Scientific and Technological Enterprise in Cambridge, BlueSci, Issue 9. Online. Available at: HYPERLINK "http://66.102.9.132/search?q=cache:fF5yzxLWq6IJ:www.bluesci.org/index.php%3Foption%3Dcom_content%26task%3Dview%26id%3D746%26Itemid%3D504+Silicon-fen+billion+a+year&hl=en&ct=clnk&cd=21" http://66.102.9.132/search?q=cache:fF5yzxLWq6IJ:www.bluesci.org/index.php%3Foption%3Dcom_content%26task%3Dview%26id%3D746%26Itemid%3D504+Silicon-fen+billion+a+year&hl=en&ct=clnk&cd=21 (Accessed: 11th December, 2008).

DIUS (2007) ‘2007 R&D Score Board: The Top 850 UK and Top 1250 Global Companies by R&D Investment’. Online. Available at: HYPERLINK "http://www.innovation.gov.uk/downloads/2007_rd_scoreboard_analysis.pdf" http://www.innovation.gov.uk/downloads/2007_rd_scoreboard_analysis.pdf (Accessed: 10th December, 2008).

DIUS (2008) ‘Annual Innovation Report’, Department for Innovation, Universities and Skills. Online. Available at: HYPERLINK "http://www.dius.gov.uk/policy/documents/21390%20AIR%20Report%20CHP7.pdf" ttp://www.dius.gov.uk/policy/documents/21390%20AIR%20Report%20CHP7.pdf. (Accessed: 10th December, 2008).

DTI (1998) ‘Our Competitive Future – Building a Knowledge Based Economy’, London:
Edquist, C., ed. (1997) Systems of innovation: technologies, institutions, and organizations, London: Pinter.

EEDA (2008) ‘Region’s small businesses remain ambitious despite economic downturn’, East of England Development Agency. Online. Available at: HYPERLINK "http://www.eeda.org.uk/search.asp?search=suffolk&page=12" http://www.eeda.org.uk/search.asp?search=suffolk&page=12 (Accessed: 12th December, 2008).

European Commission (2002) ‘High-tech SMEs in Europe’, Observatory of European SMEs, No. 6, Enterprise Publishing. Online. Available at: HYPERLINK "http://europa.eu.int/comm/enterprise/enterprise_policy/analysis/observatory.htm" http://europa.eu.int/comm/enterprise/enterprise_policy/analysis/observatory.htm (Accessed 19th February, 2004).

Feldman, M.P. and Florida, R. (1994) ‘The geographic sources of innovation: technological infrastructure and product innovation in the United States’, Annals of the Association of American Geographers, 84: 210–229.

Florida R.L. and Kenney, M. (1998) ‘Venture capital, high technology and regional development’, Regional Studies, 22(33): 48.

Fujita, M., P. Krugman and A.J. Venables (1999) 'The Spatial Economy: Cities, Regions and International Trade', Cambridge, MA and London: MIT Press.

Gerald, Dworkin (1990) ‘The Concept of Reverse engineering in Intellectual Property Law and its Application to Computer Programs’, The Intellectual Property Law Journal, 1(3): 164-180.
Griliches, Z. (1979) "Issues in assessing the contribution of research and development to productivity growth" The Bell Journal of Economics, Vol. 10, No. 1, pp. 92-116.

Griliches, Z. (1990) ‘Patent Statistics as Economic Indicators: A Survey’. Journal of Economic Literature, 28:1661-1707.

Grossman, G. M. and Helpman, E. (1994) ‘Endogenous innovation in the theory of growth’, Journal of Economic Perspectives, 8(1): 23-44.

Grossman, G. M. and Helpman, E. (1994) ‘Endogenous innovation in the theory of growth’, Journal of Economic Perspectives, 8(1): 23-44.

Grossman, G. M. and Helpman, E. (1994) ‘Endogenous innovation in the theory of growth’, Journal of Economic Perspectives, 8(1): 23-44.

Grossman, G.M. and Helpman, E. (1991) Innovation and growth in the global economy, Cambridge, MA: MIT Press.

Growth’, Working paper No. 07/2007, Dipartimento di Economia "S. Cognetti de Martiis" LEI and BRICK - Laboratorio di economia dell'innovazione "Franco Momigliano", Bureau of Research in Innovation, Complexity and Knowledge, Collegio Carlo.

Harris, Richard G. (2001) ‘The knowledge-based economy: intellectual origins and new economic perspectives’, International Journal of Management Reviews, 3(1): 21-40(20).

Heraud, J. (2003) ‘Regional innovation systems and European research policy: convergence or misunderstanding?’ European Planning Studies, 11(1): 41-56.

Jaffe A.B. (1989) ‘Real effects of academic research’, American Economic Review, 79 (5): 957-970.

Jaffe A.B., Trajtenberg M., Henderson R. (1993) ‘Geographic localisation of knowledge spillovers as evidenced by patent citations’, Quarterly Journal of Economics 10, 577-598.

Johansson B (2004) Parsing the Menagerie of Agglomeration and Network Externalities, CESIS Electronics, Working Paper Series, Paper No. 2.

Keeble, D. and Lawson, C. (1998) 'Collective Learning Processes, Networking and 'Institutional Thickness' in the Cambridge Region', in D. Keeble and C. Lawson (eds) Collective Learning Processes and Knowledge Development in the Evolution of Regional Clusters of High-Technology SMEs in Europe, Goteborg European Network Meeting report, Centre for Business Research, University of Cambridge.

Keeble, D. and Wilkinson, F. (1999) 'Collective learning and knowledge development in the evolution of regional clusters of high-technology SMEs in Europe', Regional Studies 33: 295-303.

Kessler, E.H., Bierly, P. and Gopalakrishnan, S. (2000) ‘Internal vs. external learning in new product development: effects on speed, costs and competitive advantage’, R&D Management, 30(3): 213-224(12).

Kessler, E.H., Bierly, P. and Gopalakrishnan, S. (2000) ‘Internal vs. external learning in new product development: effects on speed, costs and competitive advantage’, R&D Management, 30(3): 213-224(12).

Kim(1997), Imitation to innovation, Harvard Business School Press.

Krugman, P. (1991a) ‘Increasing Returns and Economic Geography’, Journal of Political Economy, 99(3): 483-99.

Krugman, P. (1991a) ‘Increasing Returns and Economic Geography’, Journal of Political Economy, 99(3): 483-99.

Krugman, P. (1991b) The Geography of Trade, Cambridge, MA: MIT Press.

Library House (2006) The Impact of the University of Cambridge on the UK economy and society. Cambridge: Library House.

Lublinski, A.E. (2003) ‘Does Geographic Proximity Matter? Evidence from Clustered and Non-clustered Aeronautic Firms in Germany’, The Journal of the Regional Studies Association, 37(5):453-467(15).

Manimala, M. (1999), Entrepreneurial Policies and Strategies: The Innovators Choice, India: Sage Publications.

Manimala, Mathew J. (2006) Evolution of the Bangalore ICT cluster: A stage theory on crystal growth model, Paper for presentation at the International Entrepreneurship Forum 2006 (IEF) 6th International Conference on New Venture Creation and the Creative Trajectory: Entrepreneurship, Innovation and Creativity in Business, Riga, Latvia: 31 August to 2 September 2006.

Mansfield, E. (1988) ‘The speed and cost of industrial innovation in Japan and United States’, Management Science, 34 (10): 1157-1168.

Mansfield, E. (1988) ‘The speed and cost of industrial innovation in Japan and United States’, Management Science, 34 (10): 1157-1168.

Mayhew, Susan (2004) A Dictionary of Geography, Oxford: Oxford University Press.
MBAUniverse.com (2008) IIM-K holds Convocation; Dr CK Prahalad calls for innovation and entrepreneurship. Online. Available at: HYPERLINK "http://www.mbauniverse.com/convocation08.php?id=1067" http://www.mbauniverse.com/convocation08.php?id=1067 (29th April, 2009)

Mishra, Rohan (2007), Reverse Engineering in Japan and the Global Trend Towards Interoperability, *Murdoch University Electronic Journal of Law*, Volume 4, Number 2 (June 1997)

Myint, Y.M., Vyakarnam, S. and New, M.J. (2005) ‘The effect of social capital in new venture creation: the Cambridge high-technology cluster’, Strategic Change, 14(3): 165-177.

Novalis Research (2004) ‘East of England ICT Study’, a report prepared for East of England Development Agency (EEDA), UK: EEDA.

OECD/EC/Eurostat (1997) Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual, 2nd edition, Paris: OECD.

PACEC (2003). The Cambridge Phenomenon —. Fulfilling the Potential. Technical Report. Greater Cambridge Partnership: Cambridge.

Rabellotti R. and Schmitz H. (1999) ‘The internal heterogeneity of industrial districts in Italy, Brazil and Mexico’, Regional Studies, 33: 97-108.

Romer, P. M. (1990) ‘Endogenous technological change’, Journal of Political Economy, 98: S71-S101.

Romer, Paul M. (1986) ‘Increasing Returns and Long-run Growth’, Journal of Political Economy, 94(5): 1002-37.

Saxenian A. (1994) Regional Advantage: Culture and Competition in Silicon Valley and Route 128, Cambridge, MA: Harvard University Press.

Scherer, F.M. (1983) ‘The Propensity to Patent’, International Journal of Industrial Organization, 1:107-128.

Schumpeter, J. A. (1934) The Theory of Economic Development, Cambridge Massachusetts: The Harvard University Press.

Schumpeter, J.A. (1939) Business Cycles: A theoretical, historical and statistical analysis of the capitalist process. New York: McGraw-Hill.

Schutte, S.N., Toppinen, S., Kalimo, R., and Schaufeli, W. (2000) ‘The factorial validity of the Maslach Burnout Inventory-General Survey (MBI-GS), Across Occupational Groups and Nations’, Journal of Occupational and Organisational Psychology, 73 (1): 53-67.

Simmie, J. (2002) ‘Knowledge Spillovers and Reasons for the Concentration of Innovative SMEs’, Urban Studies, 39(5–6): 885–902.

Simmie, J. (2003) ‘Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge’, Regional Studies, 37(6-7): 607–620.

Stuart, Toby E., and Sorenson, O. (2003) ‘The geography of opportunity: Spatial heterogeneity in founding rates and the performance of biotechnology firms’, Research Policy, 32(2):229-253.

Suarez-Villa, L. and Walrod, W. (1997) ‘Operational Strategy, R&D, and Intra-metropolitan Clustering in a Polycentric Structure: The Advanced Electronics Industries of the Los Angeles Basin’ Urban Studies, 34(9): 1343-1380.

Suma Athreye (2000) "Agglomeration and Growth: A Study of the Cambridge Hi-Tech Cluster," Open Discussion Papers in Economics 29, The Open University, Faculty of Social Sciences, Department of Economics

Trajtenberg, M. (1990) Economic Analysis of Product Innovation: The Case of CT Scanners, Cambridge, MA: Harvard University Press.

Von Hippel, Eric (1988) The Sources of Innovation, New York: Oxford University Press.

Wong, Po Kam (1999) ‘National Innovation Systems for Rapid Technological Catch-up: An analytical framework and a comparative analysis of Korea, Taiwan and Singapore’, Paper to be presented at the DRUID Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, Denmark, June 9-12.

World Bank (2000) ‘Republic of Korea Transition to a Knowledge-Based Economy, East Asia and Pacific Region, World Bank. Online. Available at: HYPERLINK "http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/0,,contentMDK:21014147~menuPK:2500572~pagePK:64156158~piPK:64152884~theSitePK:461198,00.html" http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/0,,contentMDK:21014147~menuPK:2500572~pagePK:64156158~piPK:64152884~theSitePK:461198,00.html (Accessed: 10th May, 2008).

Note: Regions were selected based on their performance in the following domains: These regions have captured a significant share of companies developing the technologies of tomorrow. They are attractive to the local community as they create high value and thereby generate the basis for a high remuneration to the owners and to the staff (The American magazine Wired, 2000).

Author’s interview with Mr Mike Beadman, a co-founder of Cambridge Design Partners, Cambridge

Author’s interview with Mr Ray Anderson, a co-founder of Bango Ltd, Cambridge

Author’s interview with Dr. Paul Johnson, a co-founder of Cyan Technology Ltd, Cambridge

Wireless wizards scoop UK's biggest innovation prize. Online: HYPERLINK "http://www.csr.com/pr/pr196.htm"

http://www.csr.com/pr/pr196.htm (Accessed: 28th January, 2009).

HYPERLINK "http://halmapr.com/news/radiotech/2006/08/14/radio-tech-wins-innovation-award-for-rail-temperature-monitor/" \o "Permanent Link to Radio-Tech Wins Innovation Award for Rail Temperature Monitor" ~~Radio-Tech Wins Innovation Award for Rail Temperature Monitor~~. Online. Available at: HYPERLINK "http://halmapr.com/news/radiotech/2006/08/14/radio-tech-wins-innovation-award-for-rail-temperature-monitor/" http://halmapr.com/news/radiotech/2006/08/14/radio-tech-wins-innovation-award-for-rail-temperature-monitor/ (Accessed: 28th January, 2009).

Author's interview with Mr Brian Back, the founder and Chairman of Radio-Tech Ltd, Essex

CIS3 (2004) 'International comparisons of the third community innovation survey', Department of Trade and Industry (DTI). Online. Available at: *HYPERLINK "http://www.berr.gov.uk/files/file9657.pdf"* www.berr.gov.uk/files/file9657.pdf (Accessed: 30th September, 2007).

International knowledge confers innovation advantages of:

1) Greater knowledge diversity due to varying customer needs (Booze Allen Hamilton and INSEAD, 2006);

2) Access to qualified staff (Booze Allen Hamilton and INSEAD, 2006)

INTERNATIONAL FLOWS

International knowledge spillovers
International pecuniary knowledge

(*Simmie, 2002; Malerba, 2003; Breschi & Lissoni, 2001a b*)

NATIONAL FLOWS

National knowledge spillovers
National pecuniary knowledge

(*Simmie, 2002; 2003; Breschi & Lissoni, 2001 and b*)

Innovation:
New Product development

(Mansfield, 1988; Kessler et. al, 2000)

LOCAL FLOWS

Local knowledge spillovers
Local pecuniary knowledge

(Audretsch, 1998; Antonelli, 2007)

Local knowledge confers innovation advantage of proximity to tacit knowledge (Audretsch, 1998; Stuart & Sorenson, 2003)

ABSORPTIVE CAPACITY
(Cohen and Levinthal, 1989; 1990)

SMEs in High Agglomeration

SMEs in Low Agglomeration

San Francisco
Silicon Valley
Seattle
Los Angeles
Salt Lake City, Utah
Albuquerque, New Mexico
Santa Fe, New Mexico
Austin, Texas
Chicago
Raleigh-Durham-Chapel Hill, North Carolina
Virginia,
New York City
Boston
Montreal
Companies, Brazil

Sao Paulo, Brazil
Cambridge Silicon-fen, Great Britain
Thames Valley, Great Britain
Glasgow-Edinburgh
Dublin
London
Trandheim, Norway
Oulu, Finland
Stockholm
Helsinki
Malmo-Copenhagen
Sachsen, Belgium
Flandern, Belgium
Baden-Wurtemberg, Germany
Bayern, Germany
Paris

Sophia Antipolis, France
El Ghazala, Tunisia
Israel
Gauteng, South Africa
Bangalore
Inchen, South Korea
Tokyo
Kyoto
Tai-pei
Hong Kong
Hainshu, Taiwan
Kuala Lumpur

Singalore
Queensland, Australia
Melbourne

b) Spillovers Sources

c) Pecuniary Knowledge Sources

Figure SEQ Figure * ARABIC 4: Proportion of employees in highly clustered sectors - 2004

Figure SEQ Figure * ARABIC 5: Employees in specialised & knowledge-intensive sectors - 2004

Cambs

Essex

Cambridge Silicon-Fen

a) All knowledge Sources

a) All knowledge Sources

Essex

c) Pecuniary Knowledge Sources

b) Spillovers Sources

Influence on Innovation (NPD)

Pecuniary knowledge (Especially ‘subcontracting')

Knowledge Spillovers (Especially ‘imitation’)