5 Clusters and Knowledge Flows

Brychan Thomas, Christopher Miller and Lyndon Murphy

"All men are caught in an inescapable network of mutuality."
MARTIN LUTHER KING (1929–1968)

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Introduction

According to Oliver and Porta (2006) sticky knowledge (Lagendijk, 2000, p. 165) or knowledge accumulations (Florida, 2002; Storper and Venables, 2002) constitute the available intellectual capital (IC) sources of a cluster. Sticky knowledge is described as the knowledge embedded in the local industrial milieu which is difficult to copy or transfer to other areas (Oliver and Porta, 2006). Furthermore, sharing knowledge involves firms with a community of workers in a cluster (Harrison, 1991). IC arises from knowledge creation through linkages between firms (knowledge spillovers), firms and institutions, and informal relationships arising from an interaction process in a local skilled labour pool. Knowledge in the cluster is tacit, embedded and transferred within the cluster (Oliver and Porta, 2006).

Three mechanisms for the transfer of knowledge within a cluster identified by Keeble and Wilkinson (1999) include new firms, spin-offs from firms, universities and public sector research laboratories, interactions between the makers and users of capital equipment, interactions between customers and suppliers, and inter-firm mobility of the labour in the cluster. The relationships and mechanisms create flows within the cluster and the knowledge transfer processes result in cumulative know-how that is external to firms remaining internal to the cluster (Oliver and Porta, 2006). Empirical evidence has shown how knowledge sustainability (expenditure on education), regional economic outputs (earnings and labour productivity), knowledge capital (patents and R&D) and human capital (high tech employment) components have influenced regional competitiveness (Porter, 1990). Economic productive activities are enabled by tacit knowledge, the contribution of local businesses and infrastructures such as research institutes and universities, by employee exchange and the mobilisation of human capital resources (Oliver and Porta, 2006). According to the resource-based view of the firm (Penrose, 1959; Peteraf, 1993) the competitive advantage of companies arises from the core competences or knowledge of firms.

An important element of a cluster is the community of people (Harrison, 1991). Indeed, Porter's (1990) model included the skilled labour pool involving territorial human resources specialisation in clusters. Representing a cluster resource, the skilled labour pool is available to cluster firms (people educated on specific cluster university courses and trained through educational programmes in cluster requirements) (Oliver and Porta, 2006). In addition to training and education there are the social capital aspects associated with tacit knowledge and information flows attributable to directors, managers and workers in cluster companies (Uzzi, 1996). It has been reported by Dahl and Pedersen (2004) that in clusters knowledge flows take place through informal contacts. The local labour pool will contain the available pool of entrepreneurship, competences, education and traditional crafts (Oliver and Porta, 2006). But absorptive capacity is needed to capture, use and disseminate knowledge within the cluster (Zahra and George, 2002).

This chapter investigates the movement of labour in the Cambridge Inkjet Printing (IJP) cluster. Labour mobility and knowledge spillovers in clusters are interrelated phenomena with knowledge embodied in entrepreneurs and specialised workers spilling over from one enterprise to another through labour mobility and direct revelation (Guarino and Tedeschi, 2006). The case study of the movement of labour between the population of IJP companies in Cambridge is described. The mobility rate of labour in the IJP cluster is considered with reference to the growth of the cluster. Through the study of the mobility of labour the value of intellectual capital (IC) in the cluster can be considered (Oliver and Porta, 2006).

Clusters and Knowledge Flows

When investigating how embedded knowledge flows through labour mobility in regional clusters in Denmark Dahl (2002, p. 3) defined a cluster as "a geographically concentrated group of firms active in similar or closely connected technologies and industries with a degree of both horizontal and vertical linkages". He goes on to note that firms are inter-connected through the formation of a local labour market and that this is for a particular kind of labour. Furthermore, with regard to knowledge clusters and the specialisation of technological and economic activities resulting from agglomeration economies, the local labour force is specialised (Marshall, 1890; Piore and Sable, 1984; Krugman 1991(a); (b), Arthur, 1994, Saxenian, 1994; Porter 1998). In the area of the market suited to the companies in the cluster the growth of the cluster creates an increased demand for labour (Dahl, 2002). Feldman (2000) notes that job moves by workers between companies in an industry is influenced by ideas that are embedded in individuals' minds. Such moves allow the accumulated knowledge of the workers during their careers with companies to be taken advantage of by employers. As a result knowledge flows through the movement of workers between companies, and when start ups offer jobs (Dahl, 2002).

When start ups have accumulated experiences from parent companies, this allows knowledge diffusion which has been shown to be important in a number of industries (Franco and Filson, 2000; Klepper, 2002). Reasons why workers move within a cluster include existing social ties and risk aversion (Breschi and Lissoni, 2001). Similar companies in a cluster offer workers wider employment prospects and companies will pay higher salaries for needed knowledge from a previous employee of a similar company. The social and institutional context is important (Breshi and Lissoni, 2001). Employee mobility needs to be supported by the innovation culture involving not only the company but the community (Angel, 1991). Knowledge flows between companies will be greater where the culture and institutional setting of the cluster promote mobility (Dahl, 2002).

To climb the occupational ladder through job mobility requires a change of employer. Hall and Kasten (1976) show that for most job changes there is a move to a higher occupational category involving higher pay. The work of Saxenian (1990; 1994) includes many examples of mobility and inter-firm knowledge flows. But there is only indirect evidence on the link between employee mobility and knowledge flows from the literature (Rosenkopf and Almeida, 2001). One of the first empirical studies to delve further into knowledge spillovers was Zucker and Darby (1996) who found that workers had the skills and knowledge for technological development through the embodiment of ideas. In biotechnology case studies the star scientists (who had made major breakthroughs) drew on their intellectual capital in the innovation process. The knowledge on breakthrough techniques was held by these scientists.

Zucker, Darby and Brewer (1998) found clear linkages between the start-up of biotech firms and star scientists. Further investigation of these aspects was undertaken by Alemeida and Kogut (1997) who used patent data to track the inter-firm moves of the star engineering scientists to trace knowledge and idea diffusion in the semiconductor industry and showed that inter firm mobility enabled the transfer of ideas between companies with subsequent new patents through the star scientists. Franco and Filson (2000) focused on the mobility of employees creating spin offs which diffused knowledge. Patent citation analysis of the semiconductor industry was used by Rosenkopf and Almeida (2001) to study the way in which the search for new knowledge in companies through mobility and alliances was undertaken. They found clear evidence that companies used mobility to fill holes in knowledge (Rosenkopf and Almeida, 2001) which clearly supports inter firm mobility of workers facilitating inter company knowledge flow.

Dahl (2002) reported that in the latter period of cluster development there was entry by multinational firms. Lorenzen and Mahnke (2002) found acquisition of small firms by multinationals resulting in the local business environment changing. It was also found that social networking was discouraged by multinationals which focused on inter company networks (Lorenzen and Mahnke, 2002). This resulted in knowledge diffusion through networks and co-operation decreasing and knowledge diffusion through worker movement subsiding (Dahl, 2002).

It has been noted by Dahl (2002) that there can be mobile and non mobile engineers. It was found that mobile engineers were paid more for their acquisition of knowledge and in job learning than non mobile employees. New companies paid them more than they earned at previous companies because of the knowledge they brought. It has also been found that there is a positive impact of education since a longer education increases the ability to learn and absorb knowledge (Dahl, 2002). Furthermore, mobility appears to have a positive effect on earnings growth. Whether an employee has a degree, masters or PhD affects annual earnings (Dahl, 2002).

Mobility within clusters

In a cluster the mobility of highly qualified labour is an important vehicle for knowledge flow and indicators of the movement that takes place can help the investigation of important linkages. Mobility indicators can be used to determine the effects of the movement of labour on the development of the cluster. A parameter that can be used as an indicator of the potential in a knowledge based cluster is the stock of knowledge and the rate of mobility of labour can be used to indicate innovation potential. Information investigated includes gender, age, education and employment at a particular time and can be used to compare the stock of labour with different types of education across a cluster and describe the flow of labour between companies within the cluster. Higher education institutions (HEIs) and research institutes play an important role in the education and development of the workforce within a cluster. The mobility of highly educated labour is probably the most apparent mechanism of knowledge transfer. Mobility may take place without knowledge transfer and similarly knowledge transfer can take place without the mobility of labour. For example, information and communication technology (ICT) enables knowledge transfer without the physical movement of labour. In addition to the mobility of labour other knowledge transfer mechanisms include buyer-supplier relationships, co-operations, networks, R&D collaborations, staff placements and temporary staff exchange. Further indicators are the number of co-operations and external contacts, joint patents and citations and co-authorships. There is particular interest in the importance of senior labour as a vehicle for knowledge transfer. It has been found that PhD mobility appears to be a weak knowledge transfer mechanism (Stenberg et al, 1996).

A basic assumption is that the mobility of senior labour between companies indicates knowledge transfer. This depends on the ability and opportunity of the labour to learn from the company in which they are employed and on their education and time in employment which are variables that are available for analysis. Also, the occupation and position of senior labour within an organisation influences their learning. Mobility can be considered to be a change of workplace, organisation or company. Knowledge exists in a number of forms including codified knowledge, competencies, formal knowledge, skills and tacit knowledge. The indicator that has been taken to denote the level of knowledge has been formal education. Formal education has advantages over indicators of other forms of knowledge which have data that are difficult to collect and collate. Although the highest level of formal education achieved has limitations as a knowledge indicator it is the most appropriate available. Senior staff will tend to be highly educated (including those with research degrees) with a high degree of specialisation. Here indicators of formal knowledge should be an acceptable knowledge indicator.

The mobility of senior staff will involve both permanent employment and the temporary exchange of labour. There will also be higher and lower mobility exhibited by companies involving both 'movers' and 'stayers' (Graversen et al, 2002). Mobility will arise due to takeovers and acquisitions and it will also result from the entry and exit of companies into a cluster and where firms go out of business or are restructured they will change their identity. This impacts on the definition of mobility in terms of what is 'real' mobility and what is 'artificial' or 'false' mobility caused by change of company ownership in the cluster. As well as change in employment as a focus for knowledge transfer, involving labour transferring knowledge from their previous to their current workplace, there is also the turnover of labour in firms arising from employees leaving and retiring resulting in the employment of new staff from other companies, the unemployed or recent graduates. These employees will contribute to the renewal and flow of knowledge through new knowledge being brought into the company.

With formal education the senior labour's field will be of interest due to potential innovation power – this assumes that labour with high education have a higher level of innovative knowledge than those with intermediate or low education levels. The exchange of labour not only brings new knowledge into companies but also results in the loss of knowledge and the right balance is a major challenge for human resource departments in companies.

'Job to job' mobility involves 'in flows' and 'out flows' for companies. Those workers who have accumulated experience for one company may be viewed as valuable labour for another and will be considered to be experienced workers. If they change employers frequently they can be considered to be 'experienced nomads' (Graversen et al, 2002). On the other hand, inexperienced workers who have a tendency to move are 'inexperienced nomads' and will be recently educated seeking appropriate employment (Graversen et al, 2002). The loss of experienced workers will be considered to be more serious than the loss of those recently employed. Furthermore, senior labour that stays with the same employer will be considered to be stable workers. It has been found that the share of stable workers increases with age and the share of mobile workers decreases with age (Graversen et al, 2002).

Example of the Inkjet Printing Cluster in the Cambridge area

Ink jet printing in the Cambridge area has undergone a period of rapid change in recent years. A shift from a production to a knowledge based cluster has been influenced by acquisitions (Garnsey et al, 2009). In 2001 there were seven industrial inkjet printing companies operating in the Cambridge area: Domino, Inca, Linx, Videojet (who acquired Cambridge based IJP firm ElmJet in 1993), Willett (with headquarters in Corby but with a base in Cambridge), Xaar and Xennia (Garnsey et al, 2010). By mid June 2005 only three of these companies (Domino, Xaar and Xennia) had not been acquired. The Danaher Corporation had created their product identification division through the takeovers of Videojet (2002), Willett (2003) and Linx (2005), and Dainippon Screen Manufacturing Company bought out Inca in June 2005. In 2008 Xaar was taken over by Ten Cate from the Netherlands, leaving only two substantial independent players in the Cambridge ink jet industry: Domino and Xennia. Examples of small businesses operating in the IJP cluster included one of the early firms Biodot with four employees founded in 1994, Xennia with 30 employees founded in 1996, and a later company Inski founded in 2004 (Garnsey et al, 2010). Firm proximity is largely historical and grounded in the way they have spun out from one another. The transfer of tacit knowledge can be a major benefit of proximity and this is where the main benefits for the Cambridge inkjet firms are realised. The people, skills and knowledge base provided are a significant benefit of being located near to other inkjet printing firms in the Cambridge region. The Cambridge address and the prestige associated may be a significant factor. These are benefits from geographical proximity to other ink jet printing companies but also from being located in the Cambridge high-tech cluster.

The endowment represented by the University of Cambridge provided the critical conditions for the pre-history of the inkjet printing industry, via the creation of Cambridge Consultants Ltd (CCL) by two of its students. Both agglomeration economies and spin-offs have played important roles in the clustering as the firms in the IJP industry that spun-off from CCL moved beyond the orbit of the University. Through international demand for high tech products and services which the inkjet printing companies developed the competence to supply exogenous factors were at work (Stam et al, 2009). Clustering emerged as a self-reinforcing process stimulated by knowledge generation and transfer. It is with labour market advantages and the emergence of specialist suppliers that agglomeration economies are primarily associated. The amplification effects of the spin-off process in the Cambridge IJP industry are apparent in its multi-generational dimension. Here spin-off firms become the source of further spin-offs and attraction of entrepreneurs and firms from outside the region.

Takeover activity in the continuous ink jet printing dominated firms led to the departure of entire organisational operations from the Cambridge area. Departure impacts are still being experienced and there could be further problems for the cluster through negative impacts on the supplier network, reduced personnel movements, the area's reputation and attraction of business and personnel. On the other hand, as a result of redundancies the availability of highly skilled labour could lead to new spinout activity.

There is uncertainty regarding the future of the Cambridge inkjet printing cluster since the industry has undergone significant change resulting from acquisitions, the resultant rationalisation and restructuring, and increased competition from laser and drop on demand. Although many manufacturing operations have moved from the area it is likely that Cambridge will continue as a centre for R&D due to the skills base and the Inkjet Research Centre located at the University of Cambridge Institute for Manufacturing (IfM).

In association with, and supported by, the consortium, the IfM research centre intends to develop understanding of the fundamental behaviour of liquids in environments presented in inkjet printing. The aim of the project is to reduce duplicated research in local companies and to spread the financial burden. This represents the reconnection of the IJP cluster to the Engineering department at the University of Cambridge from which it originated several decades earlier. This should help the cluster to be sustained into the future and to add cohesion and build a reputation.

Conclusions

The example of the IJP case study shows that a local production network exists around companies. An extensive knowledge network has been built around the firms facilitated by senior staff movement between them. Competition within the group is intense and formal collaboration rare, and international concerns and relationships are of importance resulting in well developed global production facilities, suppliers, customers, partners and competitors, and contradictions exist between perceptions of members and the reality of linkages within the cluster. The cluster is local to the region but part of a wider international industry cluster with simultaneous importance of local cluster effects and extensive international links. In the early days of the industrial inkjet printing industry, most firms were associated with a particular technology, but as the industry has matured all of the major players have employed a range of technologies in their products. As a consequence of maturity the focus has shifted from technical development to marketing and distribution of the product.

Further Reading

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