Introduction

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Biographical notes: Cristina Martinez-Fernandez is Senior Research Fellow at the Australian Expert Group in Industry Studies (AEGIS), University of Western Sydney. Martinez-Fernandez's research concentrates on the dynamics of knowledge and innovation and the spatial analysis of innovation. She was the research co-coordinator of the international OECD project 'KISA' – Knowledge Intensive Service Activities.

This special issue represents the efforts of ten researcher members of the OECD 'KISA' project.[1] The project was conducted under the auspices of the OECD Technology and Innovation Policy (TIP) Working Group (OECD, 2002b), funded by country governments and some participant universities. The compilation of papers represent years of research, analysis and, most valuable, international collaboration in co-producing one of the first attempts to analyse innovation in the software industry with a global perspective. The special issue discusses the role of Knowledge Intensive Service Activities (KISA) in the innovation process of the software industry and identify areas of attention for the design of policies and programmes to actively stimulate innovation in the industry. Knowledge Intensive Service Activities (KISA) are defined as the activities originated by the production and integration of knowledge-intensive services crucial for the innovation process of the firm. They may be undertaken by firms in manufacturing or service sectors, and in combination with manufactured outputs or as stand-alone services (OECD, 2003,p.2). Typical examples of KISA include R&D services, management consulting, IT services, human resource management services, legal services (such as those on IP-related issues), accounting, financing, and marketing services. Activities oriented toward the use and integration of knowledge are instrumental for building and maintaining a firm's innovation capability. In practice, KISA in a firm are achieved by the use of in-house, or the combination of in-house and external, expertise. The capacity of the firm to perform these KISA more effectively may indeed be what differentiates a firm from its competitors. However, the interaction of these different KISA remains an *ad hoc* and largely informal process that firms are not totally aware of. Understanding how firms access and use the variety of innovation-related KISA available to them, in different industries and at different times, will help policy makers in the design of targeted policies and programmes to actively stimulate innovation across them. The study of KISA goes beyond previous studies of knowledge-intensive services in the literature (Miles, 2003), which has tended to focus on the supply side of such services as specialised activities. The present analysis, however, acknowledges the complex ways in

which users seek and acquire external services, and integrate them with other capabilities (including internal service provision) at the firm level. Thus we focus here on *activities* that firms *demand* and use themselves rather than those they *supply* to others.

Software firms are typically KIBS, classified among the group of IT services but here we are studying software firms as users of KISA in their own innovation processes, not simply as suppliers of services to clients. The studies here elucidate how KISA were sourced, used and integrated within software firms; and the challenges faced by software firms in this process. The rapid growth of the software sector in OECD countries is associated with increase in average company size. While the range of information technology and software functions representing the core operations of this sector have increased, firms may need to increase the number of other knowledge-intensive functions as well as to maximise their innovation capability and impact on the technological innovation of other industries. Though software firms have been hailed as vanguards of a new wave of firms in the 'knowledge economy' and pioneers of a new way of organising the production of knowledge through business strategies such as outsourcing and offshoring, the innovation paths observed in software firms do not appear to be particularly new. The industry is characterised by rapidly changing market structures as a result of technical innovation, entry of new firms, alliances, mergers and acquisitions, and fierce competition (OECD, 2003,p.32). The decreasing cost of technology as the tools of technology improve and the desire on the part of many industries to achieve more efficient information development and exchange processes, suggest that the software industry is likely to remain a source of major innovation for the foreseeable future (Howarth, 2003). Over recent years, the fast pace of technological development, the shortened life-cycles of products and heightened competition have encouraged businesses engaged in the Computer and Related Activities to invest more and more in R&D activities (OECD, 2002a). The substantial growth on R&D investment, the articulation of waves of hardware innovation and the challenges of instituting software engineering-type processes suggest that the industry may be adopting new technological advances in equipment and services and improving its capacity for knowledge-intensive activities for further development. All these elements are obviously very relevant to innovation not only in software firms but also in their clients.

The aim of the studies presented here is to understand whether KISA are crucial for the innovation development of the software sector, in order to give detailed information on how firms use services towards a more effective innovation-related policy approach. Specifically, the hypothesis investigated in these papers is that KISA play a critical role in the innovation process of the software firm, as these activities sustain the context where providers of knowledge and expertise interact. These knowledge-intensive service activities have not been discussed in the literature as part of R&D measures of firm innovation and so its analysis is a major contribution to the understanding of innovation in software firms. The research questions investigated are:

1   What is the role of KISA in the innovation process within the software firm?

- What does KISA mean?

- What KISA are used by software firms?

- What sources are more frequently used for KISA? How does KISA relate to firm capabilities?

- How are the different contributions to KISA mixed and matched by the firm?

- What are the main barriers to innovation in software firms?

2   What are policy areas for KISA in innovation of software firms?

The analysis draws on empirical results from Australia, Ireland, Korea and New Zealand, though the precise methodologies applied varied from country to country. Australian findings were based on an online survey of 54 firms, 41 semi-structured interviews and two in-depth case studies of software-specialised firms. The Irish study was based on both a survey that covered 274 firms (an estimated 30.4% of the entire national Irish software industry[2]) and interviews with 16 firms. The Korean findings were based on a survey of 58 firms and 17 semi-structured interviews. The New Zealand study drew on five previous studies of software and high-tech firms in New Zealand, together with survey and other statistical information from Statistics New Zealand. The results of the four country studies show the need in the software sector for highly specialised KISA. These come principally from software engineering areas but also from management, marketing, finance, legal and accounting, and other professional fields that specifically target the internationally traded service sector. Encouraging high standards of performance of internal KISA through adequate financial backing, specialised education and training courses is vital for the quality of KISA but also it is crucial in assisting the formation of more formal knowledge networks to facilitate the access to the most appropriate external suppliers of expert services from public, private and academic sectors. The studies suggest the critical importance of designing and evaluating knowledge intensive activities, especially for small and medium software firms with limited financial and human resources.

The papers argue that KISA play critical roles in the innovation process of the software firm, and specifically in the co-production of knowledge and innovation, as these activities sustain the context where providers of knowledge and expertise interact. Software firms, KIBS, RTOs and other organisations in the network space of the software firm form a knowledge network highly important for the innovation capability of the industry.

Policy makers interested in enhancing innovation in software firms with better KISA might like to explore timely and convenient ways to integrate new policies with the firms' innovation processes. Specifically, five policy areas emerged from the case studies:

1   design of tailored policies in conjunction with general policies

2   improve the time-scale and cost for funding applications

3   adapt software education related policies and programmes to the needs of the software industry

4   design instruments that encourage a more software industry oriented research within related university departments

5   design policies and programmes that promote and facilitate access to external KISA related services through the development of knowledge networks.

The country case studies

This special issue includes six papers. The first paper by M.C. Martinez-Fernandez of the University of Western Sydney and I. Miles of the University of Manchester discusses the concept of KISA in the process of co-production of knowledge and co-production of innovation of software firms. The four country-based papers present empirical work done by the authors as part of the OECD-based project investigating KISA in several product-service systems. The final paper by L. Martinez-Solano of the University of Warwick is an overarching concluding paper discussing findings by the country studies.

The Australian paper by M.C. Martinez-Fernandez and V.V. Krishna (University Western Sydney) presents findings based on an online survey of 54 software companies, 41 semi-structured interviews and two in-depth case studies with specialised software companies. The Australian firms performed the KISA most related to their core competencies internally. The survey of software firms shows that most knowledge service providers were mainly KIBS and that companies sought expertise more from local providers than from national or international sources. In doing this, software firms are both being exposed to and strengthened from the local innovation system where they are embedded. The case studies have shown that government programmes and policies for ICT were important in establishing an in-house R&D base and in developing important software products to sustain market expansion over time. Secondly, the interaction with and learning from public RTOs and government agencies and programmes played an important role in KISA because they were the main customers. The study also found a relationship between the size and sector of operation of the firms and the R&D intensity and ability to collaborate and benefit from such agencies and government programmes. The case studies confirmed the importance of tacit and informal component of KISA, that is, person and organisation embodied and played a crucial role both in the market expansion and product development activities. It was also seen to be important for absorbing and assimilating contributions for the generation of KISA.

The Irish paper by L.E. Martinez-Solano (University of Warwick), M. Giblin and E. Walshe (University of Galway) presents results of a postal survey of 808 software firms (with 40.1% response rate) and interviews with senior managers of 16 of these firms (73.7% of the respondents are fully Irish-owned while the remainder have some form of foreign investment). As in the Australian case the Irish firms focused on performing core KISA in-house, and outsource those at the periphery from specialised firms. Some access external services because of the lack of resources to develop them internally. These external 'KISA' enabled the company to create, complement, improve or support their own technology. Interestingly when the sample of firms was divided by nature of investment, it showed that Irish-owned firms accessed these services primarily from within their Irish base, while foreign-owned companies relied to a greater degree on their units abroad for these professional services. In fact the foreign-owned companies accessed marketing services (75%), engineering consultancy (63%) and management consultancy (63%) from the overseas units of their corporations. The Irish study found that providers of KISA were the carriers of knowledge that led to innovation within the software sector, as is evident from the breakdown of the product life-cycle which shows that the majority of KISA were performed in the innovative phase.

The Korean paper by K-R. Lee (STEPI), S-W. Shim (University of Changwon) and B-S. Jeong (OECD) presents findings from a survey of 58 firms. Further interviews were conducted with 17 firms. As in the Australian and Irish cases the survey shows that private contributions to KISA were much more used by Computer Software Service (CSS) firm than public contributions. Although the government regards its policies to be successful, the survey results showed that the firms in the CSS sector have not used public inputs to KISA to a large extent. In order to gain new knowledge, the majority of CSS suppliers preferred making strategic alliances with other firms for mutual benefits. The survey on how CSS are used by user firms in the manufacturing sector found that they functioned as a platform for diversification of manufacturing firms into knowledge-intensive service sectors. CSS firms became integrated or loosely coupled with manufacturing firms. In this report the Korean paper offers some insight into the use of software-related KISA used by manufacturing firms.

The New Zealand paper by J. Williams (Minister of Research, Sciences and Technology) draws on five previous studies of software and high-tech firms in New Zealand, together with a survey and other statistical information from Statistics New Zealand. One of the findings refers to New Zealand as a beacon for advanced wireless and mobile internet innovation. It is the world's ideal test bed for trial deployment of global fixed and mobile wireless technologies and applications. Mobile technology standards (TDMA, GSM, CDMA and GPRS) operate alongside numerous fixed wireless networks operating in both the licensed and unlicensed spectrum. Access to these standards provided by the large companies represents an important KISA for software innovation. The study found that small firms in particular could find it difficult to obtain the specialist advice they needed for growth in the sector. This includes intellectual property advice, lawyers, international marketing consultants (for both product promotion and market information), and small business advisors. The study identified the role of government as a facilitator in linking large multi-nationals with small-firm software developers. The government could support collaboration platforms for interaction between large firms, publicly funded researchers and small firm innovators.

The concluding paper by L.E. Martinez-Solano (University of Warwick) presents a comparative analysis of the role of KISA in software firms and identifies policy areas for KISA in innovation of the software industry. In general, the study found that KISA in software firms can be characterised as a function of knowledge engagement and interaction among professionals, from within the firms (*e.g.*, from different departments or expertise) or outside the firm (private, public and academic organisations and other organisations within the network space of the firm). The study found that when KISA are performed by the software firm, internal sources are critical for KISA. External sources can be differentiated among those provided by private, public or semi-public (hybrid) sources. The study also found that the mix and match of activities in the innovation process of software firms was dependent on the professionals in charge of the project and, as most firms were small, in most cases the owner of the firm played an important role for this particular activity. It was found that KISA play a critical role in the innovation process of the software firm as they sustain the context where knowledge providers interact. Parameters of proximity, the characteristics of the professionals involved in the interaction, and other environmental/contextual factors impact the quality of the interaction and complete the equation of the main elements involved in the innovation process of software firms: knowledge providers, the KISA *activity* and the

quality of the interaction among professionals. The findings suggest that KISA increase both codified and tacit knowledge critical for the development of core functions of the firms. The study emphasises the critical importance of assisting the development of knowledge-intensive activities, especially for small software firms with limited financial and human resources as can be seen in the rest of the paper.

While all papers present findings on the role of KISA in the innovation of software firms, different industry settings, cultures and different country frameworks present a diverse and challenging picture of the analysis of KISA as a global phenomenon. In this respect, the country papers present the information in a heterogeneous way reflecting the application of KISA methods and research questions to the particular country context. The independent studies in this collection constitute some of the earliest attempts to study the importance of KISA on innovation processes of software firms.

Acknowledgement

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Notes

1   www.oecd/org/sti/innovation (follow the link to Sectoral Case Studies on Innovation).

2   www.nsd.ie/htm/ssii/stat/htm