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Toward an Evolutionary Theory of Innovation and Growth in the Service Economy

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Abstract *We propose a theory of innovation in services based upon the development of new markets that exploit the powers of ICT to coordinate service production and delivery. As digital communications and computational infrastructure have developed over the past few decades, the scale and scope of the service sector has also evolved such that it is now, we believe, in the midst of a productivity revolution driven by the ICT enabled decomposition of services to their elemental parts and the subsequent gains through specialization and reintegration of these elements. This works to advance existing services and create new services, and so to drive the growth of economic activity. In this paper, we propose a theory of this evolutionary process.*

Keywords: innovation; services; knowledge economy; ICT; industrial dynamics; complex systems

Introduction

In the old days, the production and consumption of a service were necessarily simultaneous. A haircut or concert performance was produced at the same time it was consumed, as were education, transport and health services. This severely constrained the development of improvements in efficiency and productivity, as compared to, for example, the manufacture of pins or engines, which could draw upon specialization and the re-coordination of the space–time structure of production and the supply chain. For most of the nineteenth and much of the twentieth century, the great drivers of growth and gains in productivity came from the classic industrial sectors that could exploit new technologies for transforming resources by reorganizing the production and distribution process in new ways, variously at new scales and with new divisions of labour.[1]

To this day, many serious economists and most economics textbooks regard the notion of productivity growth and innovation in services as an oxymoron.[2] Indeed, this was precisely what the Classical economists (especially Marx) taught, namely that services were unproductive of wealth. But prejudice was retained by the early

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Neoclassicals and remains mostly unchallenged to this day.[3] The implication was that because services were deemed constitutionally incapable of productivity growth and innovation, they were irrelevant to policy and unworthy of serious study.

But things are different now, because we have a 'new economy'. That's sometimes seen as a hackneyed or vacuous phrase, but we mean something very specific by it, namely that the vast global build-out of ICT infrastructure over the past few decades, and the vast rafts of enterprise and mechanisms that now populate this space, has changed the nature of the service economy in two fundamental ways. The first is in the ability of traditional services to become more like manufacturing as they adopt new information and communication technologies (ICT).[4] This creates new divisions of labour and knowledge in the organization and coordination of production (and delivery) to newly enabled patterns of consumption. Transport, financial, educational and health services are leading this charge. The second is in the ability of traditional manufacturing to transform into a provider of services—a process we call *servisization*—through the adoption of new ICT to create new patterns of consumption. This process occurs as new competences are enabled in the coordination of producer knowledge to meet real time consumer needs. The transformation of *General Electric* from a manufacturer of jet engines to a provider of the service of 'power by the hour' is a good example of this process.

The developments in ICT over the past century have accelerated spectacularly in the past few decades. This has opened a new way forward for innovation and productivity improvement in services via their impact on organization and coordination. This occurs as existing services increasingly harnessing the division of labour, and as existing manufacturing enterprise increasingly meeting customer needs with services. Both are economic evolution in consequence of technological, social and behavioural change in ICT that enables the separation of production and consumption in space and time.[5] Both are evidence of the evolution of services in consequence of increasing specialization limited only by the extent of the market and the technology to coordinate ideas. We argue that the ICT revolution comprising of semiconductors, software, satellites and the Internet, as well as broader notions of technology extending to new organizational forms associated with markets and firms and new behavioural regularities associated with processing and search, is currently powering the evolution of the service economy. We further suggest that the ICT powered evolution of services is the prime driver of modern economic growth.

That's a big claim, of course; but if true, it implies a perhaps radical reconsideration of the theory of economic growth and development and, therefore, of the proper goals and instruments of economic policy. New services drive growth,[6] and innovation in services has received a great boost recently from new ICT and accompanying market evolution. This is more than just an outward shift in the production function, but rather the evolution of economic coordination through increasing division of labour. This is not just making existing services more productive, but, more fundamentally, is opening a seemingly vast space of opportunities for new services.

The Digital Economy

Innovation in services is part of a new economic context, or phase of market-capitalism. Understanding this new context assists in the understanding of services

innovation. Different observers have coined different terms for this context. Greg Hearn *et al.*, drawing on long wave theory, called it the *new digital era.*[7] OECD (1996) called it the *knowledge-based economy* (KBE).[8] John Dunning referred to it as *alliance capitalism.*[9] Yet following the likes of Brynjolfsson and Kahlin,[10] we shall call it the *digital economy.* This involves more than just the development of the computer and the economic use of computation and communications technologies, but the linking of these into a networked space for coordinating and conducting economic activity.

The emergence of the digital economy is the direct consequence of a communications revolution based largely on consumer and business use of the Internet. The purely digital service economy (e.g. Web 2.0) originated in the mid-1990s, when business and private individuals across the OECD started to adopt the Internet as a commercial and recreational medium. This time frame represents an approximate starting point for the digital economy era in which the Internet has become the workhorse of modern economies in industrialized countries.[11] Below, we examine some of the central features of this new era in order to illustrate aspects of its fundamental and revolutionary change in the nature of business and economic activity.

Knowledge Intensive Services

First, there is a growing importance of intangible knowledge activities and assets in the digital economy. Knowledge, which includes intangible assets such as intellectual property, human and social capital, technology, brand names, customer databases, core competencies and business relationships, is becoming the key resource in the new economy, just as land, buildings and physical capital were the key resources in the old economy. A knowledge-based economy (KBE) is an economy in which knowledge is the most important *productive* factor.[12] Of course, knowledge does not render physical assets redundant; instead it builds on them. The KBE idea is part of the story of what is really new about the on-line digital economy. The digital economy is best considered a new *evolutionary* phase of the knowledge economy that was already beginning to emerge in advanced economies by the 1950s.[13] The catalyst for this new phase was the hardware and infrastructure build-out and widespread business and community take-up of the Internet that began in the 1990s.

In any system, the level of complexity increases as the number of elements and connectivity between them increases.[14] This is precisely what has happened with the digital economy, and why the current growth process is not just an outward shift in a production function, but an endogenous transformation of the computational capacities of the distributed system of economic activity due to increased connectivity and access.[15] This is economic evolution, and it *causes* economic growth, not *vice-versa.* By definition, this results in increased complexity (or division of labour, as Classical economists called it), and in the early phases of the *digital trajectory* the rapid economic evolution of economic activities will inevitably be turbulent.[16] Yet, this is a normal process of economic evolution through 'creative-destruction', and will in time stabilize (i.e. re-coordinate) into a new economic order.[17]

The growth of the service economy is now being driven by the new on-line digital economy made possible by the leap in ICT enabled knowledge capabilities that can now be deployed as marketable services. This value has been created by

significantly enhancing the effectiveness or competitiveness of existing services, or through the creation of new services not previously viable or even commercially imagined. So although the digital economy runs on physical infrastructure and hardware (e.g. satellites, digital processors, fibre-optics, etc.), and although these engineering feats are embodiments of surprisingly recent knowledge (e.g. quantum mechanics, information theory, etc.), they are no more or less the key resource in the digital economy than land was the key resource in the manufacturing economy. There will always be rental income to landlords and infrastructure providers, and these will sometimes be subject to speculative booms and frenzies of 'property development'.

Yet the key resource in the digital economy is the operational knowledge required to provide existing services better and the conceptual knowledge necessary to innovate new services. These services involve much more than just the engineering of physical things, for they build upon that, but extend to the enterprise 'engineering' of new economic relations between people and their technologies. The service economy is therefore central to modern economic growth through its role in the evolution of new coordination opportunities.

Digital Convergence in Services

The origins of the digital era of the service economy emerged, in significant part, from the convergence of computers and telecommunications. Business IT usage shifted from the disconnectedness or stand-alone functions of the earlier era to the connectedness of networked personal computers linked to the Internet.[18] And befitting the scale of this market opportunity, there is a veritable cornucopia of business, management and pop-culture media that have announced this revolution and sought to offer guidance on the nature of this convergence;[19] yet the economics of this process have only begun to be addressed.[20]

Convergence is a pervasive new behavioural, social and technical connectedness that is changing how companies deal with suppliers, customers and rival firms. It is changing how consumers buy things and revolutionizing firms' management and organizational structure. And it is creating a whole set of new or transformed firms and collaborative alliances between firms to capture Internet-based gains in efficiency through the creation of new Internet-based products and services. For example, convergence has enabled new opportunities for the digital-delivery of services such as: e-commerce generally, e-banking and share trading in the finance sector, e-shopping in the retail sector, telemedicine and e-health in the health sector, flexible delivery in the education sector, and the e-provision of government services.[21] This list could be vastly extended and continues to grow and evolve rapidly and with unparalleled scope. The e-delivery of services has become an important aspect of services sector innovation.[22]

Convergence, or the breaking down of boundaries between formerly separate activities, is also occurring more generally across the economic order. For example, it is occurring between industries with emerging technological overlap and new logistics; between work and leisure with 24/7 schedules; between industry and government with innovation policy; and between business and the community with notions of stakeholders once distinct now overlapping, such as the tension between the economic and social roles of shareholders and employees.

In an open evolving economy the boundaries between knowledge domains do not last long, and in an open system they are forever being torn down and rebuilt

anew. And the central force of creative destruction in the modern economy is, seemingly, the convergence of computation and telecommunications as the central enabling technology, production platform and market opportunity for the evolution and growth of the service economy. From the evolutionary perspective, then, the most interesting aspect of 'economic convergence' is not the *macroeconomic* catch-up of poor countries to rich countries, nor the *microeconomic* benefits of rational institutions, but the *meso-economic* convergence of social and physical technologies to create a new space of economic opportunities in the service economy.[23]

Service Sector Innovation Based on ICTs

A radical change in the KBE era has been the rise of service industries as the main source of innovation in the economy. As well as the topic of this paper, it is also a key feature of the new on-line economy. Following the work of recent scholars of innovation in services,[24] we shall argue that services innovation is not directly based on R&D, but on investments in and the adoption of new information and communication technology (ICT) platforms and the subsequent adaptation of these through entrepreneurship and enterprise in order to produce new products and services or improved business processes.

Prior to the consumer and business adoption of the Internet, there was limited capacity for productivity improvements in the services sector because, generally, a service was consumed as or immediately after it was produced. But the Internet has revolutionized the services sector by breaking this symmetry, and so has enabled it to become the major source of innovation in the economy by creating a space/time gap between the production and consumption of services. Previously, services had tended to be consumed at the same time and in the same place as they were produced. But, with the new opportunities and capabilities offered by ICT, that simultaneity (or generic coordination symmetry) can be broken and new structures and systems of production, and of course consumption, can occur.

The impact of ICT is not just in the increased efficiency of information that more readily enables trade in services via, for example, the e-delivery of services on domestic and international markets, but rather a structuring process that also provides the opportunity to innovate in the services that can be produced and the way they can be delivered. In consequence, much service sector innovation involves intimate collaboration between firms as well as competition, and intimate engagement between firms and consumers, as well as raw supply.

Of course there have been technological antecedents: e.g. the phonograph record was an ICT device that enabled a service to be stored and brought to a wider geographical and temporal zone. But what is novel about the Internet is its pervasive inclusiveness across the entire services sector combined with its real-time, interactivity aspects that make for new possibilities in coordination. This of course had its antecedents, but these were exclusively industry specific—e.g. computer networks in the travel and banking industries. But now it has escaped that Pandora's Box, and runs wild across the economic order but is concentrated about the digital economic aspects of the service sector.

The Rise of Organizational Networks of Collaboration

Business collaboration and networking has become a key segment of corporate strategy. Indeed, the on-line economy is presently evolving into a networked

economy and a networked society of ties and interdependencies between people, organizations and nations. The economic system is therefore a complex evolving network.[25] Yet we are not so much interested in physical structure of networks, but in the increasing prevalence of the network form of industrial and consumer organization. These can variously be inter-organizational networks, an organization adopting a network structure, or loose coalitions of individuals, or anything in between.

Yet the network form of organization may be contrasted to hierarchic forms of organization. Most organizations, be they firms, government agencies, unions, churches, or universities, are still primarily hierarchical in the form of the traditional command and control over a supersessional structure. Network organizational forms are not hierarchies. Instead, we think of networks as 'unstructured organizations comprising clusters of communicating agents sharing common interests, values or goals'.[26] Whereas hierarchies tend to work by coercion, networks primarily work by cohesion, and thus the importance of shared values, goals, visions and trust in networks of distributed agents seeking to coordinate their specific goals. Networks are more flexible than hierarchies, mainly for informational reasons, and thus may be more suited to the natural generic turbulence (or creative-destruction) of the on-line economy. Services are perhaps better understood as networks rather than as production systems and the evolution of services is correspondingly then perhaps better understood as the increasing complexity of an evolving network rather than as the shifting-out of a production function.

Organizational networks may also be contrasted to other forms of resource allocation, such as markets and hierarchies (i.e. firms), by drawing on the transactions cost framework. Richardson (1972) has made the triple distinction between firms, cooperation and market modes of resource coordination.[27] Contrasting features of these three modes of organization—hierarchies, networks and markets—have been summarized by Kaneko and Imai.[28] On a continuum, they hypothesize that networks fall somewhere between markets and hierarchies (Simon 1991) .[29] Thus in terms of degree of flexibility: markets are high; hierarchies are low; and networks are medium.[30] In terms of formal connections among participants: markets have none; hierarchies have strong connections; while networks have weak formal connections between members. In terms of communication media: markets rely on price signals; hierarchies have an implicit code system; while networks rely on context. For conflict resolution: markets rely on price mediation; hierarchies rely on authority or coercion; while networks utilize context or cohesion. This context and cohesion is being supplied by the new services operating over the Internet.

Organizational networks have become pervasive in the digital economy in a number of areas (Mandeville 2005) .[31] We focus below on those involving business. Consider, first, inter-organizational networks in business and collaboration between firms. Examples include strategic alliances, geographic clusters of firms, joint ventures and industry associations. These arrangements can also include interlocking directorships, partial shareholdings, and the process of trust building via regular trading relationships.[32] Detailed studies by von Hippel (1982), Macdonald (1986), Rogers (1982) and others[33] have long been pointing out that various inter-organizational network-like relationships between firms in highly innovative industries have been evolving since the 1960s. These include informal personal networks, supplier–user relations, user–user relations and supplier–supplier relations.

In the digital economy the services sector, especially innovative services based on ICT platforms, has become a key source of innovation.[34] Since the beginning of the 1990s, announcements of various strategic alliances or joint ventures in rapidly growing knowledge industries have become commonplace. A good example is business-to-business e-commerce procurement alliances, some of which include the world's biggest retailers, car manufacturers, miners, and food and drink groups. Thus novel collaborative business practices that were previously only found in places like Silicon Valley have become widespread. In the new network economy, business collaboration is becoming necessary for competitiveness in most industries.[35]

Second, the firm is a network. Kaneko and Imai[36] were among the first observers to point out that the modern business organization is becoming a combination of the interpenetration of the pure network form of organization with hierarchical elements. In other words, rather than a pure hierarchy or network, the firm is evolving into a hybrid, blending traditional hierarchical practices with network forms. Examples include quality circles; multi-skilled work teams;[37] virtual teams; intrapreneurship; the growing importance of shared visions, values and corporate culture; and the rise of stakeholder capitalism. More fundamentally, perhaps, is the relatively recent emergence of flatter, lattice-like, web-like, or matrix-like forms of horizontally connected organizational structure, with lots of cross links between the nodes, gradually replacing the triangle-shaped, vertically integrated, hierarchical chain of command. Overall, in terms of its internal organizational structure the twenty-first century firm is tending to look more like a network than a traditional hierarchy, but is still a hybrid, blending the two organizational forms.[38]

The third dimension of organizational networks is converging collaborations. Breaking down of boundaries between formerly separate activities is a pervasive form of new economy convergence.[39] This is reflected in growing numbers of collaborative arrangements across formerly separate segments of society or between formerly separate sovereign governments. Examples include business collaborations involving participants from different industries, collaborative arrangements between business and government such as public–private partnerships, community–business partnerships, and the various forms of intergovernmental cooperation. This connective process is integral to the evolution of the service economy and naturally results in the evolution of complexity in its structure.

The fourth dimension of network organization is that of the whole macroeconomy, a process otherwise known as globalization, or the reduced importance of geographic distance and national boundaries in economic activity, which has entered a new, revitalized phase in the digital economy era. Perhaps the best illustration of this new phase of globalization is with regard to the global outsourcing of high level, knowledge-based services jobs to developing countries. In the previous era, it was commonplace to outsource low level manufacturing jobs to developing countries. Indeed, this is still occurring with China becoming the world's factory. But what is completely new in the digital economy era is the increasingly routine outsourcing of ever higher level knowledge-based services jobs to India, for example.[40] In this way, the structure of comparative advantage is itself evolving as a consequence of uptake of ICT and the evolution of services.

Information and Complexity Perspectives on Innovation

Our story so far suggests the need for more relevant models of innovation in the digital economy. Such perspectives would transcend the conventional R&D

perspective to provide more realistic views on innovation in the services sector and more broadly in society as based on evolutionary complexity theory and the economics of information and knowledge.[41] While conventional neoclassical economics may have been appropriate for previous eras, these alternative approaches may be more relevant to this new one. We shall review the basic features of the conventional model of innovation and contrast this with the information/complexity model of innovation.

Conventional Model of Innovation

Knowledge is inherently intangible, yet our concepts of technology are very much concerned with the tangible. Richard Nelson points out that within economics, as well as more generally, technology carries an engineering connotation.[42] That is, knowledge is being characterized by machines, blueprints or recipes like in a cookbook. This leads to a highly codified or tangible view of technology. In this framework, technological change or innovation simply involves the introduction of new or improved blueprints. New blueprints come about via a set of routine activities directed to producing them, namely via R&D. Moreover, in the conventional model of innovation, R&D conducted within a firm is devoted to the production of new blueprints, or inventions (an idea for something potentially useful), which after more R&D become innovations (commercially successful inventions), which are then adopted by users, and thus diffuse out into the economy creating economic effects such as increased productivity or new industries.

Informational Model of Innovation

An informational approach to innovation moves beyond the confines of tangible and highly codified technology, discrete R&D cycles, and the individual firm to encompass a much more holistic view of the innovation process.[43] This enables us to focus on service sector innovation. We begin with Richard Nelson who argues that generally, whatever it is that permits a firm to operate a technology in a particular way with particular outcomes is only partly describable in a blueprint, teachable by example, or purchasable in the form of a machine. Thus, every organization must learn somewhat on its own, in a somewhat idiosyncratic and inimitable way. Thus technology is primarily uncodified or tacit information and must be learned.[44] With regard to R&D, Stuart Macdonald argues that if technology is the totality of information that allows things to be done, such total information is unlikely to arrive in a crystallized package from the conventional R&D process.[45] What emerges during R&D is information and knowledge, rather than full bodied inventions and innovations, and this information and knowledge must be supplemented by other information and knowledge for value to be created.[46]

The conventional view of innovation also regards the production of technology as something that happens mainly within the isolated firm. A more realistic view embraces the concept of innovation as a social process involving many participants.[47] The production of new technology often depends on the flow of technological information between firms. This is especially so in rapidly changing, highly innovative industries. It is a process whereby bits of information are gathered from a variety of sources, mostly outside the individual firm, to be assembled in new pattern within the firm or a group of firms. We have seen that collaboration is a

defining feature of the on-line economy and so, too, is the emphasis on networks of information, knowledge and people.

The complexity perspective emphasizes the new products, ideas or firms that arise endogenously and then exert an adaptive effect on other elements of the economic system. This transformative innovation occurs best when the system has an abundance of micro-diversity and variety. It also suggests and encourages experimental behaviour, diverse viewpoints and an understanding of the value of failure.[48]

We can provide a summary of these two models of innovation as follows:

Conventional model

- linear flow from invention to innovation;
- emphasis on R&D, the individual firm and manufacturing industry;
- emphasis on tangibles;
- well understood by policymakers.

Informational model

- non linear;
- information from many sources, collaboration, services;
- emphasis on intangibles, flows of knowledge;
- not well understood by policymakers.

Toward an Evolutionary Theory of Innovation in Services

Evolution is normally a gradual process of the adaptation of knowledge to a marginally changed environment, but in economic evolution, as in biological evolution, there sometimes occurs a revolutionary form or idea that transforms everything, both marginally and radically. The ICT revolution, or the digital era, has been building for the past three or so decades, but has only recently emerged as a new order of economic activity that is being colonized and developed by the service sector through the combination of new technologies leading to new economic activities and forms of organization, along with new specializations and divisions of labour and knowledge.

At present, and as a consequence of the ICT 'revolution', the greatest evolutionary activity in the economic system is occurring in the service sector. Innovation in services is different to innovation in manufacturing in that it draws more heavily on intangible resources and developments, making it difficult to quantify and study. Compared to innovation in manufacturing, half of which is due to formal R&D, innovations in services appear to be non-technical and to result from mostly small changes in processes and procedures, organizational arrangements and markets that ultimately do not require as much formal R&D or property rights protection.[49] Service sector innovation instead draws extensively on knowledge from outside sources, either by hiring skilled labour (including consultancy) and/or adopting new process technology (especially ICT). The development of skills within a service firm is more important to innovation than in manufacturing firms because of the more specialized contexts and problems that service firms face, as well as their higher reliance on generic knowledge rather than specialized capital.

Furthermore, the innovation cycle in services is the reverse of the manufacturing model: it begins with the adoption of a new technology to improve process

efficiency, and so the quality of the existing service, leading to the emergence of a new service. In manufacturing, it's the opposite; first a new good, then the efficiency improvement. Services also deliver a much higher proportion of 'non-generic' innovation, as solutions to context-specific situations as a consequence of interaction with a client. Indeed, the *ad hoc* delivery of micro-innovations is a significant business model in the service sector.[50] Services have long been perceived as being non-innovative or technologically backward. Until the 1990s, they were largely perceived as passive adopters of technologies developed by manufacturers.[51] In the twenty-first century, it is clear that this view is, at best, an oversimplification. Services are certainly major users of technologies, not least ICT, but they often use these in creative rather than standard ways. Furthermore, their needs for new technologies are a major stimulus to innovation by manufacturers and computer software creators. Even as users of technologies, services are often innovators. Traditionally, a service is produced and consumed at once. This limits advantages of scale of storage and process management, and means that it cannot experience the implications of new divisions of labour and organizations of knowledge and coordination of activities, which is a major source of productivity growth in manufacturing. However, ICT can change that. It can enable services to be broken into pieces, and this process may well be in the early stages of a great leap in the evolution of economic activity. New business models and organizational forms emerge about the uptake of new technologies in order to normalize solutions to problems. This will most often happen in the form of new services. The evolution of the service economy is, in this model, the major driver of economic growth and evolution as it adapts new technologies to new problems with new solutions. This new structure may provide a new environment in which new niches can emerge, including manufacturing industries to supply the material accompaniments and embodiments of the service. It is our hypothesis, then, that new technologies often get their start through the development of new services, and furthermore that through growing use and experience, these services may eventually embed themselves in mass produced goods. Economic systems grow through the evolution of services. The era we are living through now, we suggest, is well understood as a period of rapid economic evolution as re-coordinated by the service sector as a consequence of new ICT and the Internet.

Marx and Engels famously said of capitalism that 'all that is solid melts into air'. They meant that as a critique; but the evolution of market capitalism proceeds as all that is solid transforms into knowledge and information, and all that does not is selected against. That, we think, is our current phase of economic evolution due to a technical and social revolution in ICT and its effect on the possibilities and opportunities for the re-coordination of economic activities. The innovative nature of services and their role in economic evolution might therefore provide a constructive basis for re-examining the role of the service sector in relation to the theory of economic growth.

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31. Thomas Mandeville, 'Collaboration and the network form of organization in the new knowledge-based economy', in D. Rooney, G. Hearn and A. Ninan (eds), *Handbook on the Knowledge Economy*, Edward Elgar, Cheltenham, 2005, pp. 165–77.
32. Richardson, *op. cit.*
33. Eric von Hippel, 'Appropriability of innovation benefit as a predictor of the source of innovation', *Research Policy*, 11, 2, 1982, pp. 95–115; Stuart McDonald, 'Information networks and the exchange of information' in C. Antonelli (ed.), *The Economics of Information Networks*, North Holland, Amsterdam, 1992, pp. 51–69; Everett Rogers, 'Information exchange and technological innovation', in D. Sahal (ed.), *The Transfer and Utilization of Technological Knowledge*, Lexington Books, Lexington, MA, 1982, pp. 105–23.
34. OECD, *Innovation and Productivity in Services*, OECD, Paris, 2001.
35. Neil Kay (*Pattern in Corporate Evolution*, Oxford University Press, Oxford, 1997) points to a distinction between individual and multiple relationships between firms, the latter including strategic alliances and other network-like relationships involving multiple firms in multiple relationships. While there has been considerable interest in the economic literature in terms of modelling individual business level cooperative behaviour, such as between two firms, multiple relationships have been neglected. Kay notes that the latter is not something that the neoclassical perspective is well disposed to recognize, let alone analyse. Thus the need for new economic perspectives in the new on-line economy, such as those utilized here.
36. Kaneko and Imai, *op. cit.*
37. Human resource development is especially important to service firms, given their high reliance on highly skilled and highly educated workers, as well as indications that a lack of highly skilled personnel is a major impediment to service innovation in most OECD economies (see OECD, 2001, *op. cit.*).
38. Service-sector innovation derives less from investments in formal R&D and draws more extensively on acquisition of knowledge from outside sources acquired through purchases of equipment and intellectual property, as well as via collaboration (*Ibid.*).
39. The role of newly established firms in innovative activity is greater in services than in manufacturing, so that entrepreneurship is also a key driver of service innovation. Nonetheless, small firms tend to be less innovative than larger firms (*Ibid*; Tether, 2003, *op. cit.*).
40. A. Blinder, 'Offshoring: the next industrial revolution', *Foreign Affairs*, 85, 2, 2006, pp. 113–28.
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42. R. Nelson, 'Production sets, technological knowledge and R&D: fragile and overworked constructs for analysis of productivity growth', *American Economic Review*, 70, 1, 1980, pp. 62–7.
43. T. Mandeville, *Understanding Novelty*, Ablex, Norwood, 1996; T. Mandeville, 'An information economics perspective on innovation', *International Journal of Social Economics*, 25, 3, 1998, pp. 357–64.
44. Michael Polanyi, *The Tacit Dimension*, Doubleday, Garden City, 1967.
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46. Johann Peter Murmann, *Knowledge and Competitive Advantage: The Co-evolution of Firms, Technology and National Innovation Systems*, Cambridge University Press, Cambridge, 2004.
47. Nathan Rosenberg, *Perspectives on Technology*, Cambridge University Press, Cambridge, 1976.
48. John Stanley Metcalfe, *Evolutionary Economics and Creative Destruction*, Routedge, London, 1998.
49. Tether, 2005, *op. cit.*
50. Correspondingly, the service sector engages with the public sector (government and universities) for innovation much less so than the manufacturing sector. Participation of service firms in sector-neutral innovation programmes is systematically low irrespective of whether these are academically or policy led. The service sector has a low capture of public funding for innovation.
51. Services singularly fail to command even approximate policy weight in proportion to their economic significance (OECD, 2001, *op. cit.*): tax, trade, employment and regulatory policy is typically designed with manufacturing in mind, even though it accounts for less than a fifth of economic activity; university and other public research is heavily concentrated on primary and secondary sector research.