Interactive innovation in financial and business services: The vanguard of the service revolution

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The concept of the reverse product cycle, as a theoretical model of innovation in services, is developed further in this paper, using the vanguard sector of financial and business services as a case study example of how innovation operates as an interactive process. The parallels between the emerging Service Revolution and the nineteenth century Industrial Revolution are explored in order to identify the key characteristics of the vanguard sectors in each technological revolution. The particular nature of the new techno-economic paradigm based on information technology is then identified, leading to a discussion of the unique conjunction of factors favouring financial and business services as the vanguard sector of the Service Revolution. The central part of the paper then offers an elaboration of the reverse product cycle model, stressing the interactive nature of the innovation process as it reflects the prevailing technological opportunities, market conditions and industry structures within the adopting sector. The example of retail banking is used to illustrate how the innovation cycle proceeds, from increases in efficiency through improvements in service quality to the generation of new network service products. There is then a discussion of the question of the optimal industry structure for innovation, suggestion that in the reverse product cycle large corporations are likely to dominate the early stage of incremental process innovations, whereas later in the cycle there is an important role for small entrepreneurial firms to advance more radical process and product innovations. The concluding section summarises six major characteristics of the Service Revolution, and suggests how it may proceed from its first to its second phase as the focus of innovation shifts from the vanguard sector of financial and business services to a much broader range of "higher level" knowledge-based services, many of which are currently delivered by the public sector.

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1. From industrial to service revolution

1.1. Common features of technological revolutions

In an earlier paper, attention was drawn to the parallels between the first phases of the Industrial Revolution of the early nineteenth century, and the emerging Service Revolution of the late twentieth century [6]. The most important common factor is the development of a relatively cheap but universal "enabling technology" which can profitably be adopted as a means of production by most if not all branches of the economy. In the Industrial Revolution the enabling technology was, of course, the steam engine; in the subsequent, manufacturing-based technological revolutions of the earlier twentieth century it was the internal combustion engine and the electric motor. There is now almost universal agreement that the predominant enabling technology of the current technological revolution is the microprocessor.

Closer examination of the parallels between successive technological revolutions suggests that there are three other common factors which are decisive in their development. First, the nature of each technological revolution is determined not so much by the nature of the enabling technology itself, or by the supply industries producing it, but rather by the range and type of adopting industries in which it finds its most far-reaching applications. Second, in the initial phase of each revolution, the major applications of the new technology tend to be concentrated in a relatively small number of leading sectors, or indeed even in one particular "vanguard sector". Third, the diffusion of the technology amongst a much broader

span of industries only occurs in a second phase; this is typically triggered by investment in a universal infrastructure network which opens up new domestic and business markets for the application of the technology.

We can now return to the comparison between the first Industrial Revolution based on steam power, and the new Service Revolution based on information technology. What marked the decisive breakthrough in the first phase of the Industrial Revolution was not the establishment of a manufacturing industry producing steam engines – though this was a necessary precondition. Rather it was the application of this new technology in just one "vanguard sector", the cotton industry, which during the first decades of the nineteenth century underwent rapid mechanisation, organisational change and market expansion. It required the massive investment in railways in the 1830s and 1840s to ensure the spread of industrialisation to other manufacturing sectors, and the foundation of those branches of heavy engineering which were the most distinctive feature of the new manufacturing economy during the latter half of the century [34].

Through the application of information technology, a similar process of industrialisation is now beginning among the service industries, and it is the financial and business services industry which seems to be taking the vanguard role in this Service Revolution. While the extraordinary advances made in the computer manufacturing industry over the past twenty years are of great significance, it is the diffusion of this technology among all branches of industry, and service industries in particular, which will be the dominant force in the world economy over the next thirty years. In view of the argued importance of the technological revolution now beginning in service industries, the main aim of this paper is to examine and draw lessons from the processes of innovation which are occurring in the vanguard industries of financial and business services, as their adoption of information technology continues to gather pace.

1.2. The special nature of the service revolution

In studying the emerging Service Revolution, it is worth noting that we are possibly beginning to enter a qualitatively different era of economic development. Two main factors perhaps distinguish this new era from that which encompassed the technological revolutions of the nineteenth and earlier twentieth centuries. First, because of its universal applicability, information technology is impacting upon all branches of economic activity, whether located in what are traditionally identified as manufacturing or service industries. Consequently, some blurring of traditional sectoral boundaries is already apparent, reinforced by the growth of multi-industry conglomerates. This process seems likely to accelerate in the next decade, as manufacturing industries spin off new IT-based service functions, while service industries become increasingly concerned with the manufacture of software embodying their service "products". By this means, information technology is transforming that continuous process of interaction between goods and services, termed "splintering" by Bhagwati [15], whereby new goods are substituted for traditional services – as in the earlier development of the "self service" economy [31] – and new services evolve to support traditional production processes – as in the current financial and business services boom.

Second, the special significance of information technology is that it is revolutionising the processing and storage of information, whereas the basic technologies of the previous technological revolutions (steam, oil, electricity) have all provided the means of new motor power in manufacturing processes. Consequently, among the advanced industrialised nations, this new technological revolution will effect a transformation of their manufacturing economy into what is increasingly being called an "information economy" [51], in which the most important commodity to be produced and consumed is information rather than manufactured goods. Given that information represents a culturally more advanced commodity than goods, being essentially an intellectual rather than material artefact, the implications of this transformation will extend far beyond the technological and economic realm, to make irreversible changes in all spheres of human activity.

The theoretical model used to examine the innovation processes now revolutionising service activities is that of the "reverse product cycle", presented in a previous paper [8] and supported by earlier empirical case study work of innovation

in service industries [11,12,13,58]. This model proposes a dynamic process of innovation in sectors adopting a new technology which is the reverse of that commonly identified as prevailing in those sectors which produce the capital goods embodying the new technology. In other words, the product cycle can in a very simplified way be characterised as progression from product innovations through radical process innovations to more incremental process innovations, as the new producer goods industries move from take-off through growth to maturity. Conversely, it is argued that among the adopting industries such as services, the progression is in the opposite direction:

(i) Initial investment in the new technology by established firms produces incremental, process innovations which boost labour productivity in existing services through a combination of capital deepening and embodied technical change with a labour saving bias [7]. Such investment tends to be employment displacing particularly where it is designed to reduce the costs and improve the efficiency of delivery of mature services in saturated markets.

(ii) In the second stage, the thrust of investment moves towards more radical process innovations which aim to improve the effectiveness rather than the efficiency of delivery of services; these generate improvements in quality rather than reductions in cost, which tend to encourage some expansion of markets for the improved products. There is an accompanying shift towards a more neutral form of technical progress, with greater emphasis on capital widening rather than capital deepening, resulting in a broadly neutral impact on employment.

(iii) The third phase involves a further progression towards product innovations which, rather than improve existing products, generate wholly new service products; these in turn shift the competitive emphasis to product differentiation and performance, as firms in new and transformed industries strive to open up and capture new markets. The overall impact on output and employment is now expansionary, with further adoption of new technology becoming employment generating as a result of capital widening investment and growing capital saving tendencies in technical change.

(iv) Thereafter, as the new service products become established, their further development towards maturity reverts to a path similar to that of the normal product cycle indentified for producer goods.

This model of innovation in services is developed further in this paper, using the case of financial and business services as the example. It is argued that the strategies pursued by firms in the adopting industries can be described in terms of a process of "interactive innovation" under conditions of rapid change and uncertainty. New technical possibilities are matched to changing market conditions within an evolving institutional context, leading to progressively more radical innovations. The cumulative results of this continuous process of interactive innovation within the reverse product cycle are just as fundamental as the more discontinuous, technology-driven product innovations which launch each new technological revolution in the Schumpeterian model. However, the manner in which the innovation process evolves in the adopting industries, and its influence on the firms within these industries, is very different from that which determines the development of the technology supply industry. To examine this process in more detail, we must set the scene with some observations about the new "techno-economic paradigm" associated with the emergence of information technology as the dominant technology of the late twentieth century.

2. The new IT paradigm

2.1. The potential impact of IT

Recent interest in the Schumpeterian concept of technological revolutions has led to several attempts to describe how major new technologies become established, and how they transform the structure of the economy and society as a whole. The best developed of these descriptions derive from the work of Freeman, Perez and others [22,29,30,49,50]. They identify clusters of product and process innovations which are technically and economically interrelated and together form what is termed a new technology system. When the same basic technology spawns several new technology systems spanning the economy as a whole, they talk in terms of a change in the techno-economic paradigm – which is similar to the Nelson and Winter concept of a "technological regime"

[45]. For this change in paradigm to occur, it is necessary for the new technology to be characterised by sustained cost reductions, unlimited supply and virtually universal applicability. Such a change in paradigm is argued to give rise to a potential quantum leap in the productivity of both labour and capital in existing industries, the emergence of entirely new industries serving new product markets, and an associated transformation of the socio-institutional framework of the economy.

The economic transformation which is only just starting to be generated by information technology qualifies as a change in techno-economic paradigm *par excellence*. As already noted, the most important characteristic of the technology is its availability in a cheap and portable form – the microprocessor – which has almost universal applicability as a basic building block for more complex technological systems. The history of the computer supply industry since the 1950s has been one of spectacular technological progress, based upon a seemingly continuous stream of process and product innovations which are estimated on average to have reduced the unit cost of computing power by at least 20 percent per annum [12]. Despite this rate of progress, the first stage of computerisation in the 1960s and 1970s, based on mainframes and minis, was to some extent constrained by the still substantial costs of acquiring the technology. However, with the advent of the microprocessor, costs have now reduced to such a level that they no longer constitute a barrier for even the smallest firms. Thus the latest generation of microcomputers, based on the 32 bit chip and costing under £10,000 has the computing power of a minicomputer which only five years ago cost ten times that amount. Given this shift in the price-performance ratio it is hardly surprising that the installed number of business microcomputers has been growing at 100 per cent per annum since the late 1970s [58].

2.2. Barriers to adoption

With microprocessors now being produced so abundantly and cheaply, their availability and price are no longer a barrier to virtually universal adoption. Two other technical barriers do still remain, however. The first is the quality, price and speed of development of applications software. Despite some progress in the development of software engineering, this remains the component of the technology which is the most labour intensive and offers the least economies of scale. It has also become the component which is the most critical to the successful adoption of IT, since applications software and their associated databases represent the direct embodiment of each user application. Given their importance, and the skilled labour inputs required to produce them, it is in the development of software and databases that the main value added of IT applications resides. This is reflected in the explosive growth in software expenditure since the late 1970s, to reach a level as high as that of total electronics R&D by 1983 [30].

The second technical barrier to the universal diffusion of the technology is the lack, as yet, of a suitable infrastructure of Integrated Services Digital Networks (ISDN) providing the capacity to carry a large number of interactive services linking all homes and businesses. While recent technical advances have already greatly enhanced the capacity of existing telephone and telecommunications networks, it seems likely that only when a new high capacity infrastructure is installed will the full force of the new technological revolution be realised – just as the building of the railways opened the way to the second, and much broader, phase of the Industrial Revolution [6]. The main essentials of the telecommunications technology necessary to build this infrastructure are now available, given recent advances in fibre optics and satellite communications. Furthermore, many large firms have realised the communication and organisational benefits of investing in their own private local area networks in recent years, with the result that the installed base of LANs has been growing at over 200 percent per annum [58]. Indeed, in their most advanced form, in the financial services sector, these private networks have grown into worldwide communications systems costing hundreds of millions of dollars [16].

However, progress towards the installation of universal national and international ISDN networks requires far more than just technical feasibility – it is also a question of telecommunications organisation and regulation, capital funding, and political strategy [42]. Thus, in countries such as the U.K. the Federal Republic of Germany and the U.S.A., ISDN provision seems likely to materialise as a spin-off of existing market-led

efforts to establish digital communications networks which are aimed primarily at the leased line requirements of large business organisations; in France and Japan, on the other hand, there is a more strategic "top down" approach by government to distribute the benefits of the technology as rapidly and as widely as possible. In particular, the progress being made towards a national "information Network System" by the Japanese, involving a government investment of between $80 and $120 billion between 1985 and 2000, seems likely to reinforce their technological lead in the second phase of the Services Revolution – just as Britain's pioneering railway investment prolonged its leading role in the Industrial Revolution for two or three decades.

In addition to these two technical barriers to the rapid and universal adoption of IT, several other broader economic, institutional, social and political factors will inhibit that rate of diffusion of the technology. These include shortages of personnel with the necessary skills and training to handle the technology, the inertia of existing organisational structures in firms and markets undergoing radical change, consumer resistance to some of the radical new types of home-based network services which will become available, and political concerns about abuses of the exponentially growing numbers of databases containing sensitive personal and business information [9]. For these and related reasons, Freeman is certainly right to point out that with a change of the techno-economic paradigm as fundamental as that being effected by information technology "It takes decades for the productivity gains to be realised throughout the economy as a result of a process of learning, adaptation, incremental innovation and institutional change" [30].

2.3. *Three radical impacts*

However, the length of time necessary for the new technological regime to become fully established should not blind us to the profound nature of the economic changes which are already beginning to be manifest. Three interrelated changes in particular are likely to be central influences on the course of the Service Revolution – first, a radical shift in the organisation of business activity towards a greater span of corporate control but a more decentralised pattern of decision making; second, a fundamental change in the composition and nature of capital investment in services, creating a strong capital saving tendency; and, third, the transformation of information into the most important commodity being traded in the economy.

To start with the organisation of business activity, information technology will undoubtedly tend to make large firms more efficient, in the sense of expanding their span of ownership and control. As Coase pointed out in his seminal paper on the nature of the firm: "Changes like the telephone and the telegraph which tend to reduce the cost of organising spatially will tend to increase the size of the firm" [18]. In other words, any technical change which reduces the transaction costs of information flows within the firm, increases the efficiency of use of resources and improves the returns to the management function, will tend to encourage expansion of the firm – both through vertical and horizontal integration. The potential for such scale economies through the use of IT networking is enormous, dwarfing any effect produced by earlier technologies such as the telephone. Paradoxically, however, the new technology is also a powerful stimulus to more flexible and decentralized management and decision making structures, since it allows for highly efficient communication between functionally and locationally separate units of business activity. Consequently, there appears to be the prospect of a shift to a more dispersed pattern of smaller production units, linked within ever-more integrated corporate structures – particularly in those service industries in which information is not just a factor of production but also the main product. Over time, this shift could be profound enough to reverse substantially the concentration of economic activity in large scale factories and offices, which was one of the most pervasive institutional effects of the Industrial Revolution. This is an issue we shall return to in more detail in considering the organisational changes now underway in the financial and business services sector.

The second major change of fundamental importance concerns the structure of capital investment in services. On this issue it is worth noting that since service industries have until recently operated in a largely "pre-industrial" mode of production, as much as two thirds of their capital stock has been tied up in relatively unproductive

but expensive buildings such as banks, offices and shops, and only one third in more directly productive capital equipment [5]. In contrast, around two-thirds of the capital stock in manufacturing industry has been accounted for by capital equipment and only one-third by buildings. However, as the service industries invest heavily in IT equipment, the composition of their capital base is beginning to shift closer to that of manufacturing industry. Furthermore, the organisational changes in service delivery which are being brought about by the adoption of IT mean that high rates of investment in equipment are creating a potential compensating capital saving tendency in terms of reduced demand for building investment. In particular, the trend towards smaller and more decentralised production units in services, which was discussed above, will tend to reduce the demand for large and expensive town centre buildings. This tendency will be greatly enhanced when eventually there is installed some form of ISDN network capable of carrying interactive services such as home banking and shopping, which will reduce the need for buildings housing sales outlets such as banks and shops. This reduction in building capital requirements forms part of the wider capital saving tendency which is becoming apparent with the adoption of IT, offering a major boost to total factor productivity, and to the growth of output and employment in service industries [30].

The third and related economic change which will have a crucial influence on the Service Revolution is the potential of IT to vastly increase the tradeability of information itself. It has for some time been recognised in the economic literature that information is one of the essential factors of production alongside raw materials, labour and capital, with "advances in knowledge" often being treated as synonymous with technical progress [21]. Indeed, so important has information or knowledge come to be regarded as a factor of production that it now warrants serious study as a commodity in its own right [39]. However, the progression from manufacturing to information economy lifts information from merely being an essential factor of production in the economy into being its most important product. Here the essential contribution of information technology is both to cheapen substantially the costs of producing information as a universal commodity, and also to provide a means by which this previously largely intangible commodity can be processed, stored, transmitted and marketed in electronic form as a database or software program. This in turn offers the potential for developing wholly new domestic and overseas markets for information products, again substantially increasing the scope for information-based service industries to expand their output, employment and exports through capital widening investment. Such trends are already apparent in the vanguard sector of financial and business services.

3. Financial and business services: The vanguard sector

3.1. What distinguishes the vanguard sector?

It has already been argued that the adoption of a fundamental new technology such as information technology does not proceed uniformly across all branches of industry, but rather is initially concentrated in a small number of leading industries, or even in one "vanguard sector". The cotton industry centred on Manchester was identified as the vanguard industry of the first phase of the Industrial Revolution, while the automobile industry played a similar role earlier in this century; now it is the financial and business services sector, based in the City of London and other world financial centres, which is leading the new Service Revolution. These vanguard industries are not, or course, the only sectors adopting and using the new technology in the first phase of each technological revolution, but they are the ones in which conditions are right for the most rapid initial rate of take-up, leading to the most spectacular growth in output and the most far-reaching set of process and product innovations. Furthermore, much of the experience of using the technology which is learned in the vanguard sector will have valuable application in other sectors as they begin to catch up and overtake it, so that its importance in providing the initial momentum of the technological revolution is out of all proportion to its contribution to total output growth.

The literature on technical change is in broad agreement about the factors which tend to ensure rapid take-up and use of a new technology within a particular industry [22,28]. First, there must be

the technological opportunity, which means both that there are suitable technical possibilities available with the new technology, and that these possibilities can be found suitable application within the adopting industry. Second, market conditions must ensure a sufficient demand for the expanded output of existing products, or the provision of new types of products, at a price which is profitable in relation to the investment and running costs of the installed technology. Third, the structure of the industry must favour the adoption of the technology, in the sense that prevailing institutional structures encourage rather than inhibit innovation, and existing firms have access to the necessary resources of capital and labour to take advantage of the technical and market opportunities. If there is a conjunction of all three sets of favourable factors in a particular industry, then it is likely to take a leading or vanguard role in the adoption of the new technology.

Such a conjunction of factors has been identified by economic historians as the explanation for the leading role of the cotton textile industry, rather than the previously dominant woollen industry, in the first phase of the Industrial Revolution [4, 38]. The technological opportunity for the introduction of steam power to replace water and hand powered spinning and weaving had already been created by a series of relatively low cost and simple mechanical inventions in the late eighteenth century; these were ideally suited to handling cotton as a material, and relatively easily adapted to steam power. Woollen material, in contrast, was less susceptible to mechanisation. Market conditions were similarly favourable to cotton, since there was a vast potential demand for cheap cloth in both the domestic market and the overseas colonial market, whereas the demand for woollen cloth, being more established, was less elastic. At the same time the supply of raw cotton from overseas plantations was also very elastic, in contrast to the domestic supply of wool. Finally, the infant, domestic cotton industry was relatively unhindered by regulation, the patents taken out on the various inventions used in its mechanisation were not effective for very long, and the entry of new entrepreneurs to the industry was made easy because the initial capital costs of the new mechanical equipment were not very high. The necessary capital investment did of course increase substantially as the industry was subsequently transformed from a small-scale, rural cottage craft into the first large-scale, town based factory industry, and this change in the organisation of manufacturing was so fundamental it came to symbolise the most visible manifestation of the new "techno-economic paradigm".

3.2. What is favouring financial and business services?

A similarly unique conjunction of factors is currently favouring innovation in financial and business services. This contrasts with other service sectors, particularly in the public sector, which are still being inhibited by factors such as political restrictions on investment and institutional rigidities. To start with the technological opportunity, it became apparent early on in the development of computing that information technology was ideally suited to handling large volumes of financial transactions data very simply, quickly, reliably and cheaply. Consequently, the financial services sector, and particularly the large banks and insurance companies, were among the earliest industries to find widespread applications for mainframe computers, as vast data storage and processing machines, during the first stage of computerisation. With the more recent advent of networking, the financial sector has undertaken a second massive wave of investment in communication systems, both within and between organisations, nationally and internationally, to handle banking payments, foreign exchange transactions, and stock market dealing [16]. Having automated the storage and transmission of basic data about financial transactions, the financial and business services industry is now finding new technical opportunities for developing higher level systems suited to handling more sophistical on-line financial and commercial information on the back of their existing databases. As the industry exploits these technical possibilities, the emphasis of its operations is shifting from effecting straightforward monetary transactions, to meeting the growing demand for information, such as the financial histories of corporate and personal clients, and the performance of different industries or national economies. For as the Citibank motto says "Information about money is becoming almost as important as money itself".

In parallel with the expansion of technological

opportunities for the adoption of IT in financial and business services, there has been an equally strong expansion of demand for these services. A variety of factors have been contributing to this rapid growth in demand, from the personal, the corporate and the overseas sectors. From the personal sector, there has been the rapid growth in the use of retail banking services, the associated explosion of consumer credit, and the increasing volume of investment in pensions and life assurances policies. From the corporate sector, there has been the burgeoning demand for specialist financial and business services, fed by the continuous restructuring of all branches of industry which has been occurring, particularly since the onset of recession in the 1970s. This restructuring of business activity tends to feed back on itself, forming larger and more complex organisations which create the demand for more specialist support services providing higher level information to assist the decision-making process. Similarly, there has been a dramatic growth of demand for international financial services over the past two decades, driven by the liberalisation of trade, finance and investment. This demand is further being stimulated by the technological possibilities of IT for increasing the tradeability of financial and commercial information.

The growth in demand for financial and business services has been closely interrelated with a whole series of institutional changes which are affecting the structure of the industry, and creating a more competitive climate suited to technological innovation. Perhaps the most obvious has been the deregulation of financial services, which has led to far greater competition between different sectors, and the formation of financial conglomerates spanning many previously separate industries – as epitomised by the mergers associated with the "Big Bang" on the London Stock Exchange. The creation of these conglomerates is further expanding the pool of capital and skilled labour available to each firm to pursue new investment in IT, extending the substantial investment they were able to make in the first phase of computerisation because of their very large existing capital base. An equally important organisational change in the longer term is the liberalisation of institutions such as building societies, and professional services such as accountants, lawyers and chartered surveyors, allowing them to incorporate and compete more aggressively in their expanding markets. Finally, as already noted, the liberalisation of international business activity has led to the "globalisation" of financial services, based on the creation of new financial instruments such as Eurobonds and twenty-four hour trading across the stock exchanges of the world's main financial centres. The combination of these specific institutional changes, associated with the rapid growth in demand for financial and business services, is powerful indeed, and has contributed to the dominance of a financial ethos in society which is so pervasive as to be reflected in the current political debate and in cultural stereotypes such as the "yuppy" earning "serious money". In this way is the new techno-economic paradigm beginning to change the "socio-institutional climate" in which it is operating [49].

3.3. The growth of U.K. financial and business services

To illustrate how this favourable combination of technological, market and institutional conditions has fuelled the expansion of the U.K. financial and business service sector over the past decade, figs. 1a to 1e plot the growth of output, employment, labour productivity, and investment in the sector, in comparison to equivalent trends in manufacturing industry and in services as a whole. Taken together, the trends reflect a very strong rate of capital widening investment leading to substantial productivity growth, a high rate of employment growth and an even higher rate of output growth as the markets for financial and business services have expanded and new products have been introduced. Thus output and employment in this vanguard sector grew at 6.3 percent and 3.6 percent per annum respectively between 1975 and 1986, whereas in services as a whole there were much more sluggish rates of growth, while manufacturing has experienced both output and employment decline. However, despite high rates of employment growth, labour productivity in financial and business services grew at around 2.5 percent per annum over the period, which was closer to the exceptionally high rate of 3.3 percent per annum in manufacturing than to the traditionally much lower rate of just over 1 percent per annum in services as a whole. While estimates of productivity growth in services are notoriously

difficult to make [5], these trends clearly show that financial and business services are moving away from the "pre-industrial" model of low productivity, employment generating growth in services, towards a technologically more advanced mode of high productivity, but still employment generating growth. The source of this high productivity growth is clear from the investment trends, which show an extraordinary rate of expansion of investment in new capital equipment in financial and business

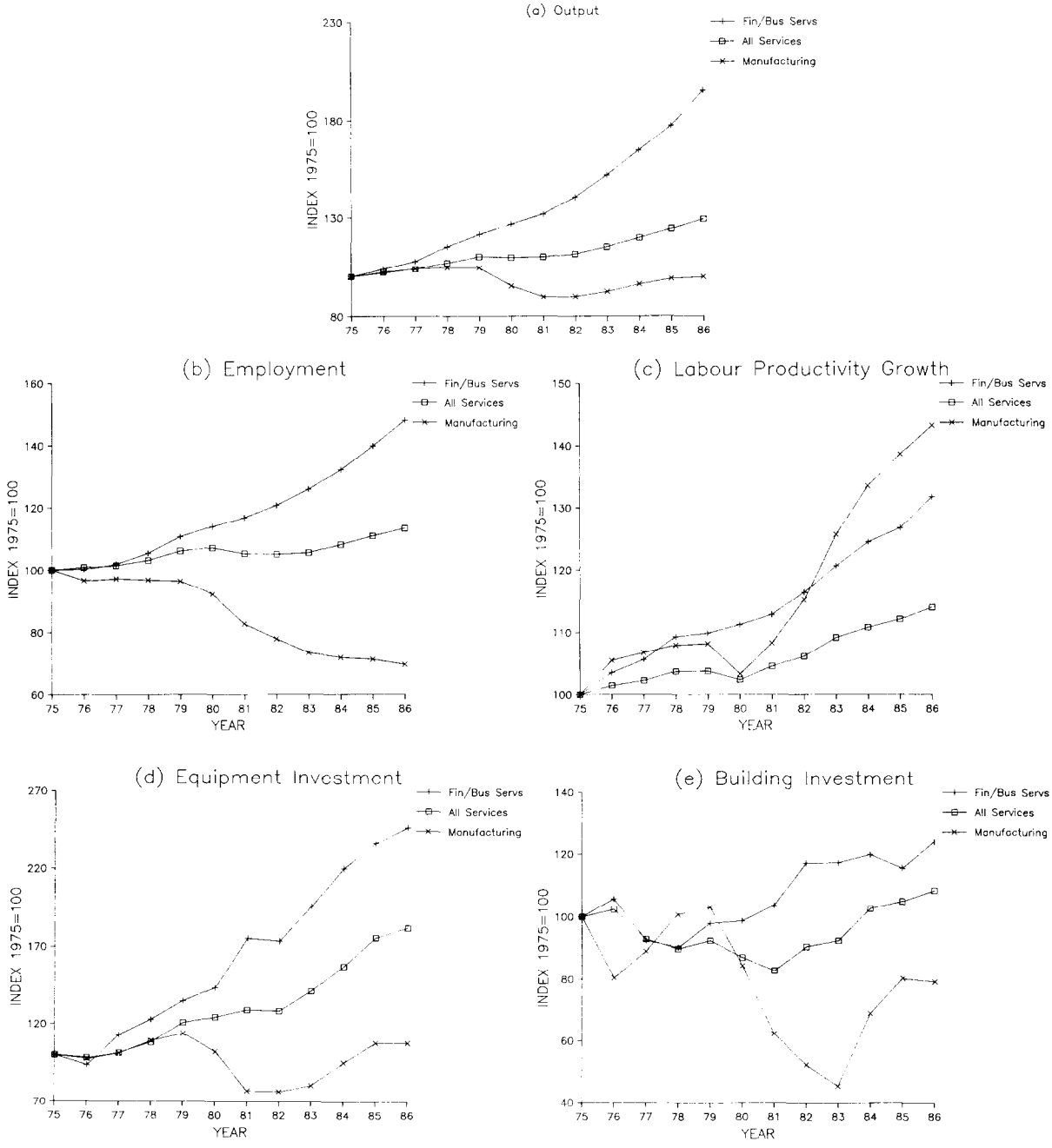

Fig. 1. U.K. financial and business services growth. (a) Output; (b) employment; (c) labour productivity growth; (d) equipment investment; (e) building investment. + = fin/bus servies, □ = all services, × = manufacturing. *Source*: U.K. National Accounts, CSO.

services (excluding equipment for leasing), increasing by two and a half times over the period. In contrast, there was a much more modest growth in building investment in the sector, closer to the average for services as a whole, illustrating the observations made in the previous section about the strong shift in the composition of services investment which is now taking place, and the capital saving tendency engendered by high rates of equipment investment which is reducing the growth of investment in buildings.

4. A model of interactive innovation in services

4.1. The reverse product cycle

From the above discussion, it is already clear that the technological, market and institutional conditions favouring innovation in a particular vanguard industry cannot be treated in isolation. Each interacts with the other, with results that feed back either to stimulate or inhibit innovation within the adopting industry. Thus the major financial institutions were only able to invest heavily in the technological opportunities presented by mainframe computers because their capital base gave them the capacity to do so; having built up their expertise with the first generation of the technology they were then able to remain in the vanguard by investing in the subsequent networking technology, which allowed them to improve their operating efficiency and serve the new international markets opened up by liberalisation and deregulation. However, it can equally be argued that the deregulation measures which have been undertaken were only made necessary, or indeed possible, by the technological capability which had built up in the industry, creating a potential for global financial trading for which there clearly was an enormous pent-up demand within the international financial system. It is to understand more fully how this innovation process operates in services that this section presents a conceptual model of interactive innovation along the reverse product cycle, which is illustrated in fig. 2 and further elaborated in the next section using the example of the retail banking sector.

The model incorporates the three sets of conditions which have already been identified as crucial influences on the innovation process in an adopting industry. These are the technological possibilities created by innovations in the technology supply industry, the demand conditions in the markets served by the adopting industry, and the organisational and institutional structure of the adopting industry itself. Not only is each set of conditions changing continuously, but the firms in the adopting sector will tend to have both imperfect information, and uncertain expectations about these changes – for example concerning the latest developments of the technology or the innovation strategies being pursued by their competitors. Firms within the adopting sector must therefore operate in an uncertain and changing environment, matching the known possibilities of the available technology with their perception of evolving needs and demands within their product markets, at the same time taking account of the actions and market position of competitors, and

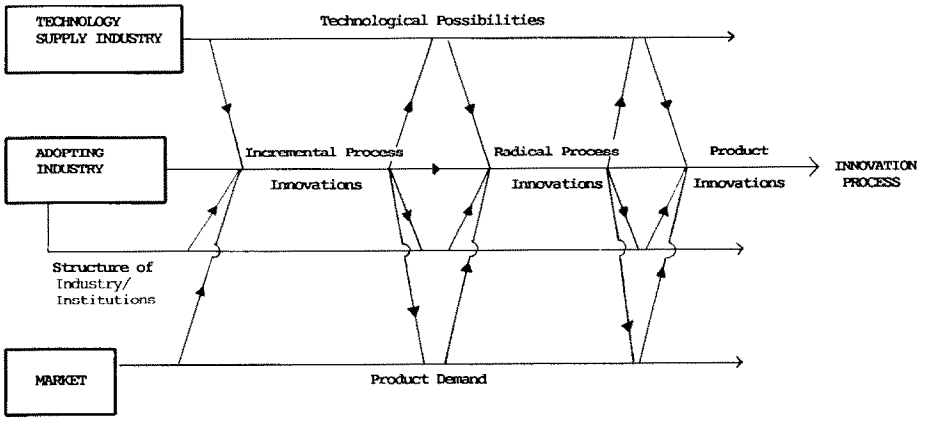

Fig. 2. Interactive innovation in the reverse product cycle.

the opportunities and constraints presented by the changing institutional context in which their industry is operating [37,46]. This continuous process of adaptation implies that both the "demand pull" factors stressed by Schmookler [54], and the "technology push" factors stressed by Schumpeter [55,56] are equally important influences on innovation, supporting the opinion that proponents of one model rather than the other in this long-running debate are inevitably taking only a partial view [28,53].

4.2. Stage 1: Improved efficiency

As firms move from initial adoption through successive applications of the new technology, they pursue what Nelson and Winter have aptly described as a "natural trajectory" of innovation [45]. This can be likened to a progression along a learning curve, in which the adopting firms are "learning by doing" [2], or as Rosenberg terms it, "learning by using" the technology [53]. Inevitably, therefore, the first steps along the trajectory will be the most tentative, applying the technology to obtain the simplest and most incremental process innovations which are aimed at improving the efficiency and reducing the costs of delivery of existing products. With the adoption of a technology as complex as IT in what were previously "pre-industrial" service firms, even the simplest initial applications will involve a major learning process for the workforce, and necessitate considerable organisational changes within each firm. At this first stage of the reverse product cycle, the adopting firms do not undertake any active R&D function, but rather their technological trajectory tends to be "supplier dominated" in the terms of the taxonomy developed by Pavitt [47].

Nevertheless, even at this initial stage, the process innovations introduced in the adopting industry feed back to influence its institutional structure, its product markets and the technology supply industry. By this means can the innovation process be characterised as truly interactive. Thus the cheaper, more efficient services which are produced will widen the market for the industry's products; the range of innovations in which the leading firms engage will alter the competitive environment for those which follow behind; and the experience of the first applications of the technology will induce secondary innovations within the supply industry, for example in the form of new or improved applications software. Innovations in the supply industry and the various adopting industries thus to some extent move in tandem, following what has been described as a "balanced diffusion path" [43].

4.3. Stage 2: Improved quality

Firms within the adopting industry, as they progress along the learning curve, acquire a fund of knowledge about the use of the technology which is embodied in the experience of the workforce, in its changed operating procedures and, in the case of IT, in its growing stock of applications software and databases. This accumulated fund of knowledge provides a springboard for launching into the more radical, "higher level" process innovations which mark the second stage of the reverse product cycle [8]. As far as innovations in services are concerned, these more radical process innovations are directed particularly at improving the quality of services delivered, since one of the distinguishing characteristics of services is their flexibility and almost infinite variability of quality, in contrast to the more standardised and discrete variations in quality which are typical of manufactured goods. Once again, however, it must be stressed that these quality innovations, though more radical than the efficiency innovations of the first stage of the cycle, can still only be undertaken effectively if firms continue to take into account the changes which are occurring in their technological possibilities, their market conditions and their institutional environment – changes which will partly have been induced by earlier innovations within the industry, and partly by external factors.

It is because of this continuously changing environment that individual firms do not tend to move at a uniform rate along the trajectory of innovation which is being mapped out within the industry. It is often assumed that some firms consistently take a leading role, persuing an "offensive" innovation strategy designed to secure technological and market leadership, while others follow behind them, engaging in "defensive" or "imitative" strategies designed to learn from the mistakes of the industry leaders and avoid the costs of pioneering development work [28]. However, case study work in mature service industries

such as insurance suggests that firms move at a differential rate along the trajectory; at one stage they adopt an offensive strategy, which involves a heavy investment in a new system to obtain temporary market edge, then at the next stage they fall back to a more defensive or imitative strategy while they absorb the costs of their previous innovative leap [11].

As the firms in the adopting industry pursue progressively more radical innovations, the accumulating experience of the use of the technology encourages selective standardisation, both in terms of the specification of technical systems and the design of operating procedures to make use of them. The adoption of information technology in banking provides two examples of such standardisation – in the operating procedures of the large number of banks connected to SWIFT, the international electronic messaging service, and in the sharing of automated teller machine networks among groups of clearing banks [23]. The result of such standardisation is the tendency for the technological trajectories of different firms within an industry to converge towards one or more "dominant designs" which dictate the subsequent form of the applications that are pursued [1]. While such standardisation may considerably speed up the diffusion of a particular innovation, the corollary is that the scale economies it generates can become irreversible, creating a tendency towards technological "lock-in" which may be difficult to escape [3]. The previously mentioned case study of the application of IT in the insurance industry illustrates how this "lock-in" phenomenon can slow down the rate of further innovation within an industry, once a particular "dominant design", in this case based on one supplier's equipment, has become entrenched [11].

4.4. Stage 3: New products

As the reverse product cycle progresses towards its next stage, firms in the adopting industry become more active in pursuing the R&D function so as to "expand technological possibilities" for themselves [20]. Typically in service industries this has initially involved a mixture of technology monitoring and market research, in order that firms can better appreciate their changing technological possibilities and market conditions. Increasingly, however, firms in vanguard sectors such as financial and business services have been investing substantial resources directly into development, particularly software development [44]. Such activities are either pursued by special departments within the major firms in the industry, or alternatively by subcontracting to small specialist consultancies which grow up to service these major firms. By this means the innovation process begins significantly to affect the organisational structure of the industry, in those areas of activity subject to the most rapid growth and change.

It is through the impetus generated by this development activity that the adopting industry is driven to the third stage of the reverse product cycle – the generation of new products. In service industries, there is some confusion as to what constitutes a new service, as distinct from an improved version of an existing service [8]. To a considerable degree this confusion can be attributed to the essential nature of services, whereby they are simultaneously consumed as they are produced [33]. This means that in many services, the product and its process of delivery are inextricably interlinked, which as Miles points out implies that "any process change is liable to involve product change" – at least in that part of the service activity which involves direct contact with the consumer [44]. Nevertheless, the more radical the service innovations become, the more reasonable it is to identify the resultant improvements in service delivery as "new services". These are typified by interactive network-based services, such as home banking and shopping, which are likely to become established once the current technological, economic and social barriers to their adoption are overcome [9].

By this stage, the technological trajectory in vanguard industries can be described as being "user dominated" rather than "supplier dominated". For the gathering momentum of innovation among leading firms will impose increasingly far-reaching demands upon the technology supply industry, as well as upon the institutional structures of the adopting industries, while at the same time opening up wholly new product markets for the new services. It is through these accelerating processes of technological, market and institutional change that the vanguard industries do so much to determine the character of the new techno-economic paradigm, creating opportunities for the much wider spread of product innovations

among other, lagging sectors of the economy. Such is the stage now being reached as the financial and business services sector sets the parameters of the emerging Service Revolution.

5. The example of innovation in retail banking

The developments which have been occurring in the U.K. retail banking industry provide a good illustration of how the interactive innovation process operates in a vanguard service industry, and how the progression through successive innovations tends to follow the model of the reverse product cycle which has been outlined. The corporate banking sector provides similar examples of how innovation in financial services involves the interaction of technological, institutional and market conditions [59], while examples from other financial and business service industries are provided by case studies of the U.K. insurance industry and accountancy profession which have been reported elsewhere [11,13].

5.1. Back-office computerisation

The reverse product cycle generated by the introduction of information technology in retail banking is illustrated in fig. 3. It started in the 1960s, during the period of most rapid growth in demand for retail banking services associated with the rising economic prosperity of the post-war boom. This both increased the volume of transactions going through each account, and also encouraged more of the population to open bank accounts, and more employers to pay wages through the banks rather than in cash [32]. This growth in demand, and thus in the volume of retail banking business, caused a corresponding growth in the size of the main clearing banks; by then these were already operating as a "cartelised oligopoly" which was being further reinforced by a wave of mergers [23]. The main requirement of these large and growing banking firms was to improve the efficiency of their operations, and hold down costs, in response to the rapid growth in demand and worsening shortages of the clerical labour needed to handle increased volumes of business. This requirement coincided with the first commercial availability of mainframe computers, and so the major banks were able to mobilise their very substantial capital base to become the largest private sector investors in the first wave of computerisation, from the mid 1960s through into the mid 1970s. By 1975, the clearing banks had an investment of £250 million in computer technology (in current prices), and the finance sector as a whole accounted for 50 percent of all U.K. computer mainframe installations [12].

The first large-scale mainframe systems in banking, operated by centralised data processing departments, were used to achieve a series of

Period	Technological Possibilities	Application	Type of Service Innovation	Industry Structure	Market Demand
Mid 1960s–mid 1970s	Mainframe computers	Automated transactions & financial records	Improved efficiency	Clearing bank cartel	Growth of personal accounts and transactions
Mid 1970s–mid 1980s	Corporate networking with dumb terminals	Automated cash dispensing (ATMs)	Improved quality	First wave of deregulation/ increased competition	Extended and easier access
Mid 1980s–1990s	Corporate networking with intelligent terminals	Financial/ customer information systems	Improved/new services	Second wave of deregulation/ integration of financial industries	Financial advice & broader range of services
1990s onwards (?)	ISDN networking	Cashless shopping (EFTPOS) Home banking	New services	Integration of banking and shopping (?)	Convenience and flexibility

Fig. 3. The reverse product cycle in retail banking.

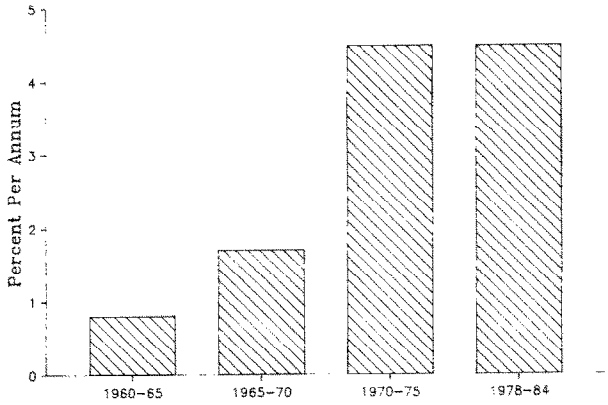

Fig. 4. Productivity growth in U.K. banking 1960–84. *Source*: Frazer [27]; Cooke [19].

incremental process innovations which automated the routine back-office tasks of dealing with customer accounts, such as cheque sorting, bookkeeping and producing customer statements. These technical innovations reduced the demand for the clerical labour which had previously undertaken these tasks, and so were clearly employment displacing in effect. Though routine in nature, the cumulative impact of this wave of innovations, in combination with associated changes in organisation and working procedures, was to transform the efficiency of the basic retail banking function, allowing the industry to expand its capacity in line with the strong growth in demand. Thus while the volume of banking transactions was growing at nearly 8 percent per annum, the productivity of the money transmission process was being transformed – from a growth rate of under 1 percent per annum in the early 1960s to 4.5 percent per annum by the early 1970s (fig. 4) [19,27]. Despite the tendency for this technical progress to displace clerical labour, employment was continuing to grow at around 3 percent per annum, to cope with the growth in the volume of business.

From the mid 1970s onwards, the rate of productivity growth in retail banking has levelled out (fig. 4), indicating that the first stage of the reverse product cycle had drawn to a close. By the mid 1970s the mainframe technology required to sustain steady productivity gains in the basic banking process was in place, and its use integrated into the organisation of banking firms and the working procedures of the labour force. However, the fund of knowledge and experience built up through "learning by using" their first generation of computer technology, and the corporate reorganisation associated with it, provided the banks with an ideal springboard for a second and more ambitious stage of innovation.

5.2. *Improved customer service with ATMs*

With the onset of recession in the mid 1970s the growth in demand for retail banking services began to slow down, from around 8 percent to 6.5 percent per annum, partly as a result of the lower growth in economic prosperity, and partly because the growth in the numbers of bank accounts inevitably began to lessen as an increasing proportion of the population became customers [19]. With continuing productivity gains, the growth in banking employment also slowed down, from around 3 percent per annum in the early 1970s to 2 percent per annum in the late 1970s and early 1980s. However, there was no equivalent slow down in the rate of investment in computer technology by the clearing banks. Between 1975 and 1981, their investment increased from £250 million to £750 million in current prices, equivalent to a growth rate of nearly 20 percent per annum [12]. Furthermore, given the rapid rate of cheapening of the technology due to continuous innovation in the supply industry, this growth rate is estimated to be equivalent to an astonishing 40 percent per annum in terms of computer equipment of equivalent performance.

In the face of changing market conditions, the cartel of clearing banks shifted the focus of their IT investment from process innovations designed to hold down the price of their services to more radical innovations aimed at improving their quality. This enabled the banks to engage in more aggressive marketing, in response to the slackening growth in the volume of their business and a climate of political opinion which had moved in favour of greater competition in banking – as manifested in a first phase of deregulation at the beginning of the 1970s [23]. One particular area in which customers were seeking an improved quality of service was in the period of time they could get access to the banks for cash withdrawals and account enquiries, and in the speed with which they could make their withdrawals. The cost implication of increasing the staffing necessary to provide a quicker service and to extend bank opening hours were enormous, but new develop-

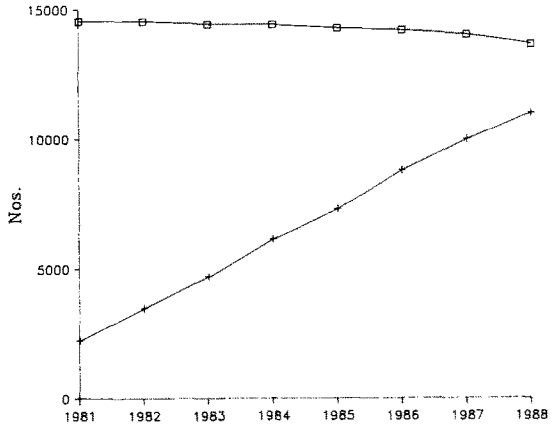

Fig. 5. ATMs in U.K. bank branches. + = ATMs, □ = branches. *Source*: Banking World.

ments in computer technology offered an alternative based on a simple form of electronic funds transfer (EFT).

In response to this technological opportunity, the banks engaged in a massive new wave of investment in corporate networks linking dumb terminals in the form of Automated Teller Machines (ATMs) to their central computers holding customers records [40]. The installation of these networks marks the second stage of the reverse product cycle in banking. While the first, very simple, cash dispenser machines were installed as early as the 1960s, investment in much more sophisticated ATMs did not take off until the late 1970s, when the number installed by the U.K. banks started to grow by up to 50 percent per annum (fig. 5). By 1981, the number installed in bank branches had reached just over 2,000, and this had grown to 11,000 by 1988. Most of these ATM networks have been used for the functions of cash withdrawals, balance enquiries and cheque book ordering, though there is now the technical capability to extend the available services to include cash and cheque deposits, dispensing of travellers cheques, transfer of funds between accounts, payment of bills and applications for financial advice [32]. This enhanced capability is beginning to be introduced via the "smart card" which can call up a wide variety of banking and other service functions across national and eventually international ATM networks [26].

By the mid 1980s, the rate of introduction of ATM installations in U.K. bank branches was beginning to slow down, having followed a typical logistic diffusion path [57] (fig. 5). With the market approaching saturation point for such installations [24], the second stage of the reverse product cycle in banking is in turn drawing to a close. By automating a part of the direct service delivery function, rather than just a "back-office" administrative function, the impact of this more radical process innovation has been felt primarily in terms of improved service quality instead of cost reduction. Consequently, its employment displacing effects have been less pronounced; a case study of eight branches of one clearing bank having found no evidence of reductions in staff numbers following the introduction of ATMs [61]. What has emerged as the main limitation of this ATM technology, however, is that "remote terminals keep a customer out of the branch" [36], so that though the service to the customer is improved, the direct link between service producer and consumer is weakened. In compensation, this second wave of IT investment has freed bank staff to begin to develop the broader range of high level financial services and direct "face to face" advice which their customers are now demanding – and which are now becoming the dominant feature of the emerging third wave of innovation in banking. This development in turn implies an expansion in the function of the clearing banks, from primarily handling money to also handling information about money, which is part of the wider transformation of the financial services industry which has already been discussed.

5.3. New network services

Following the first wave of deregulation at the beginning of the 1970s, the second and more drastic wave of deregulation and concentration of financial services in the 1980s has now created a very different and much more competitive institutional regime. Retail banking can no longer offer one separate service to be delivered in isolation, but rather it is being seen as one of a package of personal financial services which also includes mortgage lending, insurance, taxation and investment advice. Demand for these services is now increasing strongly, in response to the growth in personal wealth and house and share ownership among the majority of the population. In combination with deregulation, the inevitable result is the formation of integrated financial con-

glomerates or "financial supermarkets" attempting to offer the fullest possible range of services and competing fiercely to capture both existing and new business in market sectors in which they have not previously been active [25]. Consequently, just as the clearly banks have made inroads into the building societies' traditional market for mortgage lending and borrowing, so the building societies are now retaliating, by developing their own retail banking and associated cash dispensing facilities. Similarly, just as some banks have bought chains of estate agents to extend the span of their business, so competing alliances are now being formed between building societies and insurance companies, and while the banks continue to promote their credit cards, so the large retailing chains have responded by offering their own.

In this very competitive market for both new and improved financial services, the clearing banks are now moving into a further stage of innovation, based on the accumulated experience of over twenty years of computerisation. They are undertaking a more radical transformation of their whole branch network so that some are upgraded to offer the full range of financial services and others downgraded to more restricted sales outlets offering only basic services such as cash withdrawals and insurance quotations [58]. One example of such reorganisation is the establishment by Barclays of a network of 300 "Business Centres" to provide businessmen with specialist services which were previously only available through selected branches [25].

The enabling technology for this transformation is the upgrading of the banks' corporate computer networks as integrated systems based on real time, on-line transaction processing (OLTP). Such systems provide the main service outlets of the banks with intelligent mini or microcomputer terminals which can both access the main databanks of the organisation, now based on the concept of customer information files (CIFs), and provide autonomous support for the financial information and marketing functions being developed in the branches [24,36]. Despite continuing rapid improvements in the performance of the technology, the costs of setting up these network systems is massive, with the result that the rate of investment in IT by bank is is accelerating. It is estimated that the four main U.K. clearing banks will together have spent £1.5 billion on IT hardware, software and staff in 1988, 70 percent of this total being allocated to the automation of retail banking [41]. Furthermore, one projection for annual world wide sales of computer equipment to banks shows an increase from $5.5 billion in 1984, to $8.4 billion in 1988, and to $14 billion by 1994; as a result technology related costs are projected to increase from a current 10–15 percent of total operating costs to 15–20 percent by the early 1990s [26].

Not only do the latest banking innovations require a vastly enhanced level of technical support, but they are also creating demands for new types of staff, epitomised by the new role of "personal banker" with the inter-personal skills necessary to deliver the advice and sell the new services directly to the customer. Investment in these systems is therefore tending to be employment-generating, which is in line with forecasts projecting continued, if slower, employment growth in banking over the next few years [19,52]. Furthermore, the profile of employment is shifting towards more senior and skilled staff, for while employment in junior banking grades is tending to remain static or show a slow decline, growth is concentrated among the management and professional grades – with a 10 percent per annum growth in the top stream being reported in the case of one U.K. bank [58].

As the banks develop their branches, and their supporting computer networks, to offer a complete package of services covering personal investment, insurance, house purchase, travel, taxation and cash management, we are starting to enter the third stage of the reverse product cycle in banking. For so radical is the potential change in the nature and quality of services they will be able to offer, that it is not unreasonable to identify them, in combination, as a "new service". Of course, many of the innovations which are occurring are still process innovations, concerned primarily to improve the manner in which the service is delivered – for example providing on-line access to customer information within the branches. Nevertheless, the supporting technology will now allow for such a degree of integration of financial instruments, and such a wealth of information to support purchasing decisions, that in essence the banks will be offering their customers an entirely new service compared with the straightforward

cash withdrawal and deposit service on offer twenty years ago.

5.4. The integration of banking and shopping

It must be stressed, however, that the full realisation of the third stage of the reverse product cycle in retail banking still lies some time into the future. The current transitional phase is likely to gather pace during the early 1990s, as U.K. clearing banks respond to the new competitive pressures and opportunities opened up by the completion of the integrated European market in 1992 [25]. Thereafter, as and when universal ISDN networks become established, carrying interactive services between every home and business, it is likely that one of the applications destined to achieve early widespread adoption will be home banking. This will allow customers to use their home terminals to access financial information and directly to purchase the financial services available from banks – though given the importance of face-to-face customer-adviser discussions about such issues, it is unlikely that home banking will ever supplant the role of the service branch.

In parallel with the potential for home banking, there will probably be a similar growth in home shopping, once suitable interactive services networks are available. This could hasten the further integration of banking and shopping activity which has already been initiated by attempts to establish "cashless shopping" (EFTPOS) systems based on the convergence of the electronic funds transfer (EFT) systems used in the banks and the electronic point of sale (EPOS) systems being developed by the major retail chains [40]. The leading banks and building societies are now cooperating to promote EFTPOS in the U.K., with the aim of establishing the necessary technical infrastructure and formulating the regulatory regime within which the different service providers can compete. Throughout Europe as a whole, it is forecast that over 100,000 establishments with over 250,000 EFTPOS terminals could be in operation by 1990 [26].

Once interactive networking is established between households, shops and banks, the further service product innovations which will be generated will undoubtedly feed back to influence both market behaviour and the structure of the banking and retailing industries – just as previous stages of the interactive innovation process in banking have fed back to affect the demand for and organisation of personal financial services. However, so radical are such future innovations likely to be that they will require major social and institutional changes to accommodate them before they become an integral part of the paradigm of the information economy. Once more we are talking of decades rather than years before the full potential of current technological possibilities can be realised.

6. Industrial organisation and innovation

6.1. Two models of an innovative industry structure

One of the recurrent debates in the literature of technical change concerns the question of what type of industry structure, and which type of firms, tends to be the most innovative. The debate often polarises into two alternative idealised models of the optimal industry structure for driving the engine of growth in the economy; these can be termed the "entrepreneurial" and the "corporate" models. Schumpeter embraced both models at different periods, favouring the entrepreneurial model in his early work [55] and the corporate model, based on an oligopolistic market structure, in his later work [56]. Consequently, the two models are often termed Schumpeter Mark I and Mark II [20,29]. Observation of the innovation process as it is currently operating in the vanguard financial and business services sector suggests both types of innovation are co-existing side by side, though fulfilling rather different functions. Indeed, there appears to be a symbiotic relationship between the two, which as it evolves through the reverse product cycle may point to the type of industrial organisation likely to emerge as dominant in the Service Revolution.

The characteristics of the two models of innovation can be summarised as follows. The Schumpeter Mark I, entrepreneurial model focuses on the importance of individuals who match exogenously produced inventions or untried ideas with what they know about market demand, plus their assumptions about unmet needs, and risk investing in the development of radical innovations which incorporate these ideas. The successful innovations are then able to enjoy temporary mo-

nopoly profits until imitators "swarm" in to the market to erode the innovators' monopoly position. This model, in which successful entrepreneurs provide the main dynamic thrust of economic development, has many similarities with the subsequent work of Klein, who sees the best condition for innovation as being one of competition between a variety of small, risk-taking, "entrepreneurial" firms, each seeking to achieve "dynamic efficiency" within an uncertain and changing environment [37]. With this type of flexible industry structure, entry costs are low and experimentation is encouraged; in contrast as firms mature and grow larger, and the industry structure tends towards oligopoly or monopoly, it is argued that rigidities increase, firms become risk averse and innovation slows down.

However, the Schumpeter Mark II corporate model takes the opposite view and proposes a form of innovation which ultimately supersedes the entrepreneurial model. The corporate model stresses the scale economies to be derived from technological progress, and the advantage accruing to large firms with the resources to at least partly internalise the R&D process which generates new ideas. Once the investment is made to translate these ideas into commercial innovations, the scale economies deriving from the application of the new technology lead to increased levels of production which in turn generate further resources to invest in R&D. This virtuous circle will tend to continue until diseconomies of scale set in, deriving for example from bureaucratic inertia within management structures, and diminishing opportunities for further applications. It is an oligopolistic market structure which tends best to suit this model of dynamic efficiency, since the firms in the industry are large enough to generate the necessary internal resources for R&D investment, yet are still subject to competitive pressures – which are manifest more in terms of the quality and nature of the product than its price.

Again, this model is echoed in subsequent work, particularly the growing body of literature on the theory of the large modern corporation. This stresses how large corporations have been tending to shift from what has been termed the "U form", based on a vertically integrated structure of functions, to the "M form", based on a more decentralised, horizontally integrated structure of product divisions, in order to spread risk, reduce uncertainty and improve their span of control [17,60]. The advantage of the large multi-product firm is that it is thereby able to expand its technical and managerial knowledge base and its pool of specialist resources such as computer systems, thus providing a spur to further diversification and innovation as market opportunities arise [48]. Beyond the internal scale economies generated within the individual firm, there are the additional external economies derived from the progressive division and specialisation of firms within an industry as a whole, which is both a response to and a catalyst for the continuing expansion of its markets [62].

6.2. Large corporations in the reverse product cycle

While much empirical research has been devoted to trying to prove that the entrepreneurial or the corporate structure is the more successful source of innovation, the results have generally been inconclusive [28]. One of the problems with such studies is that they tend to emphasise too strongly a unidirectional causal relationship between industry structure and innovation, whereas it seems reasonable to suppose that the reverse causality is also operating [20]. In this regard, the effect of IT on firm size and organisation has already been noted. However, on the basis of the large amount of available evidence, Freeman considers

> it may be reasonable to postulate that small firms may have some comparative advantage in the earlier stages of inventive work and the less expensive, but more radical innovations, while larger firms have an advantage in the later stages and in improvement and scaling up of early breakthroughs [28].

Now this observation applies in particular to the product cycle operating in the producer goods industries in which a major new technology is developed. If the idea is applied to the reverse product cycle in adopting industries such as services, it suggests that large corporations are likely to dominate the first stage of incremental process innovations designed to improve the efficiency of delivery of existing services, whereas later in the cycle there is an increasingly important role for small entrepreneurial firms to advance more radical process and product innovations.

We have indeed already seen how the large financial institutions have played a dominant role in the early stages of the Service Revolution, following the Schumpeter Mark II model. They have mobilised their large capital base to invest heavily in mainframe computer technology, firstly to achieve efficiency gains in the existing services delivered to their captive markets, and then, when they had built up their knowledge base, to invest further in networking technology to achieve more radical improvements in service quality. In doing this, they have exploited the oligopolistic, cartelised structure of their industries to secure and expand their market shares through product rather than price competition. Furthermore, as the competitive regime within their industries has been sharpened through deregulation, the response has been a new wave of takeovers and mergers which have created large, multi-product financial conglomerates with the potential for realising further scale economies. By this means they have created massive pooled resources of computer systems, technical knowledge, managerial experience and specialist skills which give them a strong advantage in the next, even more radical phase of product innovation – particularly given the previously discussed tendency for IT to improve the operating efficiency of large, horizontally integrated firms.

However, some diseconomies of scale are also becoming apparent amongst the large financial corporations. For the corollary of the massive investments they have already made in information technology is the increasing risk of technological lock-in, particularly given the extraordinary rate of technological obsolescence still occurring in IT systems. Landes has neatly summed up this problem for the early nineteenth century entrepreneur by saying that he was in danger of becoming "a prisoner of his investment" [38], and for the modern corporation the danger exists on a much greater scale – especially with regard to the enormous investments being made in private telecommunications networks. Of course, the sheer weight of their investment may allow these corporations to continue to dominate their markets for some considerable time, but eventually their growing technological obsolescence is likely to catch up with them. Alongside this problem is the ever-increasing problem of organisational inertia and rigidity as the major corporations continue to expand, though as also previously noted, information technology does offer the prospect of establishing more flexible and decentralised management and decision-making structures to counteract this tendency.

6.3. The emergence of small entrepreneurial firms

Partly because of these diseconomies in the large corporations, and partly because more radical innovations are now required as the reverse product cycle in services progresses, the last few years have seen the establishment of a growing number of small entrepreneurial firms in the financial and business services sector – marking a new stage in the "division of labour" within these industries [62]. The new specialist firms tend to be market driven, in the sense that they identify and serve new niche market opportunities created by previous stages of innovation, and in many cases their main clients are the large corporations themselves, with whom they develop a symbiotic relationship as specialist sources of innovation similar to that which has been described in manufacturing industry [30,47]. The opportunities for these new firms are growing because, although the level of investment in IT systems by the major corporations is huge, the entry costs have now dropped very low for small firms concentrating on advanced and specialised software and database design. This allows such firms to concentrate the bulk of their investment in building up teams of skilled professionals who can operate in the classic entrepreneurial manner of the Schumpeter Mark I model, responding quickly to the rapid changes occurring in technological possibilities and market demand, and producing radical innovations which can at least for a while command monopoly profits in their specialised niche market.

These new firms are most active in the specialised consultancy and servicing markets of the financial and business services sector and in the rapidly growing sector of creative and media services. Examples include software houses, electronic publishing and design studios, advertising and public relations firms, and strategic business consultancies. In addition to the standard benefits of the entrepreneurial model, these firms may also enjoy one advantage specific to the service industries, which goes back to the essential nature of services as a product which is simultaneously pro-

duced and consumed [33]. In many financial and business services this means that the direct personal relationship between the service producer and client is of crucial importance. Such producer–consumer relationships are not being replaced by IT, but rather they are being enhanced by it, reinforcing the point that this type of service innovation tends to be employment generating, not employment displacing. It is thus the quality of the service professional, just as much as the scope of the IT systems supporting them, which determines the quality of the service product being delivered and thus the value added which is created. Consequently, the small entrepreneurial firm may enjoy a significant comparative advantage if it can retain its high quality staff and have access to similar supporting information systems as the large firms.

The new specialist entrepreneurial firms in the financial and business services sector are currently emerging in the transition phase between two techno-economic paradigms – one reflecting the previous "pre-industrial" mode in which the major corporations in the sector evolved, and the other incorporating what will be the dominant future mode of service production, based on the network delivery of tradeable electronic information services. How then are the new firms going to develop in relation to the established, but rapidly changing financial and business services corporations? Some, of course, will remain as small independent producers serving their niche markets, some will also retain their independence but broaden their markets and build up a sufficient capital base and management structure to grow into major corporations in their own right. Some are likely to be taken over and absorbed into one or other of the existing corporations, providing a distinctive, albeit probably only temporary, innovative impetus to the parent organisation. Perhaps most important are the groups which could join into looser alliances with one of the financial conglomerates which are currently being formed in response to the combination of technological opportunity and institutional deregulation in this vanguard sector. Given what already has been said about the likely impact of IT on organisational structures, these conglomerates seem likely to evolve into a more flexible and decentralised structure of semi-autonomous production units, which might fairly readily embrace the new specialist firms. By capturing both internal and external scale economies, such an organisational structure could at least to some extent combine the benefits of the entrepreneurial and the corporate model of innovation; it is consistent with the idea of "flexible specialisation" which is also gaining ground in manufacturing industry [44], and it could become the dominant mode of industrial organisation to be developed in the Service Revolution.

7. Prospects for the service revolution

7.1. Six major themes

To provide some concluding pointers as to how the Service Revolution may develop over the next twenty to thirty years, six major themes have been extracted from the preceding discussion.

(i) The starting point is that this Service Revolution, based on information technology, is the driving force leading to the transformation from a manufacturing to an "information economy", in which the most important commodity to be produced and consumed is no longer manufactured goods, but rather information defined in its broadest sense. As information becomes more tradeable in its electronic form, those activities which produce it will become the leading sectors in the economy, just as the consumer goods industries have been in the past.

(ii) The full transformation to an information economy, accompanying the transition from the first to the second phase of the Service Revolution, will only be achieved when a universal high capacity IT communications infrastructure capable of carrying interactive services is available. By linking all homes and businesses, this infrastructure can open up major new markets for corporate and personal information-based services, and allow the producers and consumers of services to communicate directly with each other.

(iii) As service industries move along the reverse product cycle of innovation, from incremental cost saving innovations through more radical quality improvements, to new service product innovations, the balance of techno-

logical progress will become increasingly employment generating. This is particularly true in service industries because of the unique nature of many higher level services, in which direct, personal contact between producers and consumers will remain essential to maintaining and improving the quality of the product; for such services capital investment in IT support systems will complement not substitute for labour.

(iv) The widespread adoption of IT in all branches of industry will lead to a radical restructuring of the organisation of business activity, allowing a wider span of corporate control across multi-product conglomerates, but at the same time encouraging a much looser, more decentralised structure of smaller production units. This could allow for the benefits of both the entrepreneurial and corporate models of innovation to be combined, with the new specialist service producers becoming fairly autonomous units within a wider corporate grouping.

(v) The development of a more decentralised pattern of smaller business units will reverse the concentration of economic activity into large-scale factories and offices which was the hallmark of urbanisation in the Industrial Revolution. The Service Revolution therefore seems likely to accelerate the processes of "de-urbanisation" which are already underway, with the trend towards a more dispersed pattern of residential, industrial and commercial development which was initiated by the construction of motorway networks being substantially reinforced by the construction of ISDN networks [10].

(vi) Just as important as the technological and economic transformations being wrought by the Service Revolution are the changes in social and institutional structures which are accompanying them. Given the all-embracing nature of information technology, there are great social benefits to be realised, for example through the shift in emphasis in productive activity from material to intellectual artifacts, but also great social and political dangers to be avoided – in particular from the banality of many new information products such as telephone "chatline services" and the potential scope for the political and commercial abuse of the power which comes from privileged access to information. In essence, political and social institutions must be created to control the new information services, before they are used to control us.

7.2. Beyond the vanguard sector

These trends will become more pervasive as the Service Revolution moves from its first to its second phase, and the transformation of services spreads from the vanguard sector of financial and business services to a much broader span of industries. The sectors likely to undergo the most radical transformation are those with a strong knowledge base to their product – such as education and training, health and welfare, public administration, entertainment and leisure. Their defining characteristics are that they tend to be personal rather than business services, and that many of them are delivered by the public sector, rather than the private sector.

The rate at which these service industries catch up with the vanguard sector will depend upon the rate at which they move towards the same positive conjunction of conditions which currently favours financial and business services. In many respects, the technological possibilities already exist, though delivery to domestic consumers will be made far easier when the right infrastructure network is available. However, given that these are, in the main, much higher level services, requiring much more sophisticated information handling than financial services, a great deal of software development is still required – for example using expert systems – before new services such as computer-aided learning and medical diagnosis systems can be considered satisfactory. As far as market conditions are concerned, there is again a great deal of public education needed, both of consumers and of service professionals, before there is acceptance, let alone willingness to pay, for radical innovations in these very traditionally organised services. As such innovations spread through a much wider span of services, they will create huge resource demands, both for skilled personnel and for capital finance, in industries currently far less well equipped than financial services to train staff and invest in major IT systems. Finally, profound institutional and organisational changes will be needed to allow the

new services to emerge, particularly in politically sensitive public service sectors such as education, health, welfare and public administration. Not only are these the activities in which problems of confidentiality and legal rights are most acute, they are also the activities requiring the most radical institutional changes if greater innovation is to be encouraged. Just as the deregulation of financial services has been on the political agenda during the past few years, the reform and restructuring of public services has already emerged as one of the dominant political issues of the next decade.

Despite these powerful barriers to the rapid spread of the Service Revolution, some clear signs of the potential are beginning to emerge [9]. The success of the French Telctel service is one pointer, but far more significant in the longer term is the commitment of the Japanese to establish a true ISDN network by the year 2000, a development which will almost certainly secure their leading role in the global information economy. Furthermore, the technological revolution currently underway in the financial and business services sector will have important multiplier effects in other services industries. The innovations which are already being made provide a demonstration effect for other sectors to follow, while many of the software and communications developments which have been initiated will find other, wider application. More generally, as the new financial and business services industries expand, their demands are also helping to expand the capacity of the IT supply industry to serve a wider market, while their profitability is leading to a major new wave of capital accumulation which could provide much of the funding for the second phase of the Service Revolution, and particularly the necessary investment in ISDN networks. By this means the vanguard sector is laying the foundations for new industries to expand and overtake it – just as the capital accumulation resulting from the first phase of the Industrial Revolution provided the resources for the vast programme of railway investment which created the springboard for the second phase of industrialisation [34]. However, the second phase of the Service Revolution is still some time distant. Meanwhile, we are living through the epoch of the vanguard revolution in financial and business services, and we must learn the many lessons it is offering in order successfully to industrialise those branches of knowledge which are socially more useful and culturally more advanced than that concerned purely with the making and spending of money.

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