The evolution of retail banking services in United Kingdom: a retrospective analysis

Davide Consoli

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The University of Manchester
Harold Hankins Building
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Manchester, M13 9QH

Abstract. The purpose of this paper is to assess the sequence of technological changes occurred in the retail banking sector of the United Kingdom against the emergence of customer services by developing an evolutionary argument. The historical paradigm of Information Technology provides useful insights into the ‘learning opportunities’ that opened the way to endogenous changes in the banking activity such as the reconfiguration of its organizational structure and the diversification of the product line. The central idea of this paper is that innovation never occurs without simultaneous structural change. Thus, a defining property of the banking activity is the diachronic adaptation of formal and informal practices to an evolving technological dimension reflecting the extent to which the diffusion of innovation (re)generates variety of micro level processes and induces industry evolution.

1. Introduction

Banking represents one of the largest and most influential activities of any developed economy due to the strong linkages virtually existing with any part of the economic system. Recent developments in retail banking such as the enlargement of the plethora of services supplied have often been depicted as technologically driven phenomena. However, an in-depth analysis of these processes would reveal that several distinctive features accounted for the generation and replenishment of innovation in this sector. The aim of this paper is to assess the technological changes occurred in the banking system of the United Kingdom (UK) by contrasting the evolution of retail financial services against the implementation of Information Technology (IT). It seems that a proper historical assessment could be better developed on factual basis, by observing the succession of events leading to the definition of commercial banking as it is today. The large scale research presented here surveys the nature and the extent of retail banking innovation and seeks to reaffirm the significant effects observed in the increasing variety and pervasiveness of services as the engine of growth and of qualitative change of this sector.

After having observed their development over time, one may be tempted to conclude that the pervasive implementation of Information Technology in processes as well as in banking products represented the sole crucial factor of technological advancement. Nonetheless, other concurrent features such as organizational change and the growing role of users of services will be indicated as the co-determinants of an adaptive process. The unfolding of these phenomena is characterized by a succession of non-exclusively technical events resulting in a historical, hence, irreversible process. To be able to put this analysis in frame it is necessary to look at the banking sector as an evolving system whose components interact and mutually shape each other in order to exploit the existing set of technical features and to expand the frontier of latent technological opportunities. The analysis of technological change is developed by means of concepts such as trajectories or paradigm which, as it shall be argued, account for the direction of change but do not delve in the nature of the internal forces guiding such a process. Evolutionary analysis seems the most appropriate framework to describe the dynamics of these systems and the transient processes they follow (Kuznets 1930, Alchian 1950, Heiner 1983, Metcalfe 1998). In such a perspective the forces governing the cognitive ability of the agents are heuristic rather than fully rational and cognition itself is an adaptive, rather than deterministic, process of discovery through trial and error. Banking thus need be qualified as a knowledge intensive activity where functional learning processes are at work[1] so that it is possible to appreciate the cumulative and recombinatory characters of the growth of knowledge.

This study is a quest for the analysis of innovation systems aimed at pointing out the qualitative changes in the realm of forces yielding structural transformation along historical trajectories. In such a perspective, the changing structure of the banking industry emerges as a defining property of the processes of structural transformations involved. More importantly, this work seeks to add insights to the debate on the determinants of progress and its non-exclusively technological nature. The paper is organized as follows. The next section will briefly introduce the context of service development in retail banking in relation to IT implementation. Section 3 will present an historical background of technological events in this sector. Finally, a conceptual analysis based on the employment of a classic evolutionary model will be developed in order to assess the role of learning processes as engines of transformation and change. Conclusions will summarize the results.

2. Retail Banking and the provision of services

Within the financial services industry, banking is the largest sector including a wide range of activities. There are several types of banks, also called depository institutions, from commercial to investment banks, from savings and loan associations to credit unions. These exist in a wide range of sizes and differ in the number of services they provide. Commercial banks dominate this industry offering a full range of services for individuals and businesses from safeguarding money and valuables to the provision of loans, credit, and payment services. In their role as financial intermediaries, they use the funds they receive from depositors to make loans and provide mortgages to individuals and businesses. Commercial banks are, in other words, intermediaries operating between the agents who provide the capital, the investors, and those who use it, the

[1] A functional approach to innovation is based on the idea that technologies are mainly aimed to improve the product characteristics in relation to the production process (Sahal, 1981).

borrowers[2]. The nature of banking services is essentially related to the dynamic adaptation of organizational and technical instances around these main functions.

The devices that allowed banks to manage such a heterogeneous flow of information and transactions in a standardized way reflect to a wide extent the complexity and the interrelatedness of such activities. A range of official and unofficial practices characterize several internal as well as external functions of banks from bookkeeping to information storage, from enabling cash withdrawals to providing communications to customers. The increasing volume of transactions however called for greater rapidity as well as safety, issues that through the years have posed compelling challenges to the evolution of this sector. The intermediary function carried out by banks is essentially based on their ability to create added value by storing, manipulating and transferring purchasing power over time and space. The capacity and the quality of this transmission represent, thus, the core of most banking services. Information Technologies have undoubtedly played a major role through the years for they create a link between the economic incentives of banks in investing large portions of their capital to sustain the technological transformation of their activity, and the evolution of the sector through a wide range of dynamics involving organizational changes and demand growth.

Several contributions assessed the significance of changes occurred in retail banking in relation to the modified competitive dimension of this sector (Channon, 1986; Revell, 1985; Stevenson, 1986). The analysis of competition in retail banking has been grounded either on the evaluation of the net balance between interest rates and the amount of deposits/loans or on the expansion of the business at corporate level or at the extension of the geographical coverage (Child & Loveridge, 1990). These parameters, however, often neglect the large scale benefits entailed by new technology resulting, for example, in the creation of an integrated network. The implementation of Information Technologies in banking usually involve the creation of a transaction infrastructure that yields internal changes, together with the creation of new operative procedures, and external ones, such as the expansion of the product line. Moreover, in the attempt to confront the competitive pressures of an increasingly homogenous sector, by virtue of the emergence of a network structure, over the last decade many banks diversified and expanded into new business lines such as credit cards, stock brokerage, investment management services and insurance. This expansion of the retail activity reconfigured the array of existing strategies once aimed at enhancing information processing and later became progressively embedded in the development of a larger variety of processes and products (Frazer, 1985). Conversely, the implementation of technical changes in banking enhanced productivity in both old and new activities and, in particular, stimulated the shift of employed human and capital resources towards the provision of services.

Before turning to the dynamics of these processes, I will briefly outline some essential features related to services and their debated role within innovation studies, a discussion which will result central in the remainder of this work.

As it shall be pointed out, the overall processes encompassing services production and consumption display all the characteristics of the knowledge intensive activities. Indeed, if in manufacturing the variation of capital entails the introduction of technical innovation and the subsequent division of labour, in the service sector productivity gains can be accrued either through higher specialization and/or by acquiring new skills given their high labour embodiment and an intense knowledge-base. Hence, investment in knowledge represents a form of capital deepening for service-oriented activities for the adaptation of the existing stock as well as the creation of new one through the establishment of complementary activities[3].

To fully appreciate the complex nature of services and the interrelated issues, it is useful to refer thoroughly about the unfolding process that leads to their provision and consumption. Changes in the production of financial services, in particular, result from the combination of organizational and technical features becoming embodied in a process leading to the supply of a range of specific products. Due to their peculiar nature, their consumption does not involve a material acquisition but, rather, a process of transformation (Tether & Metcalfe, 2003). Innovation is the process determining structural change and the range of activities in which agents are involved is the unit of analysis. In the specific dimension of service analysis, such a process displays a discontinuous pattern characterized by the alternating occurrence – and

[2] Differently from investment banks, commercial banks loan assets by using the money of depositors and their profitability depends on their ability to increase the earnings of the lending activities against the costs of diversification aimed at attracting new depositors.

[3] Extensive coverage on recent literature on the nature of services can be found in Miles (2001) and Drejer (2002).

concurrence – of technical advances, historical events and social forces (Freeman et al, 1982; Perez, 1983, 1985; Freeman, 1991).

This paper is developed in a similar vein with respect to those works that acknowledge a global scope for innovation in services. As a matter of a fact, the development of services in the banking sector is characterized by the interrelation of several trajectories albeit not of exclusively technological nature (Uchupalanan, 2000). These considerations also urge a reconsideration of the deterministic approaches towards the study of technological implementation in economic activities. Although appealing, the claim that the changes displayed to a whole range of phenomena could be redeemed to a single determinant is not plausible. The process of innovation occurred in retail banking services can be placed in a wider perspective when the interactions between technology and organization are assumed to be playing a significant role. To account for such a variegated plethora of phenomena an historical and conceptual analysis will be now proposed, in the attempt to define a background against which the development of services will be adequately explained and elaborated.

3. Innovation in British Retail Banking

The succession of events that characterized the structural changes of the British society between the end of the 18th century and the beginning of the 20th is also the background story of its banking system.

Notably, the analysis of the banking sector reveals a resemblance with the development of other large socio-technical systems such as the railway or the electricity[4]. Along the argument of Gerwin (1981) and Miles (1993), the evaluation of a system design would make little use of the separation between technological and non-technological elements. Rather these systems, characterized as interrelated wholes (Dosi et al, 2000) or as an ensemble (Metcalfe et al, 2003), evolve through the interactions that connect their parts and structural change is brought about by the emergence of some initially isolated factor becoming amplified by positive feedback. The simultaneous levels of interaction that qualify this dynamic process are the existing system structure at a given time, including all the components that may undermine its stability, and, secondly, the interaction between the system and its environment providing opportunities that would favour change.

This argument is sustained in this work by looking at the banking system as a hierarchical set composed by interdependent parts which, unlike those of an aggregate, acquire their characteristics from the whole and through their interplay generate innovation. Technical improvements however necessitate of complementary adjustments in the related sub-systems be them reorganization of working schedules or creation of new professional, task-oriented figures. These changes brought about by the implementation of general purpose innovations as well as by the reconfiguration of localized activities around specific tasks[5], reflect the diachronic adjustments between external and internal functions of banking which is made viable through the establishment of formal rules and codes together with an array of informal arrangements. Learning hence plays a central role in shaping new opportunities as well as in constraining the development of the system by means of definition of interrelatedness and conformance with network standards (Antonelli, 1994; Metcalfe & Miles, 1994). The significance of a system perspective becomes clearer in such a context when one considers the impact of technical change in banking services' provision. Structural change is stimulated externally in this activity but is realized from within through the outlined array of adaptive transformations.

Drawing on this background and on recent insights on the history of retail banking (Swank, 1996; Radecki, 1998; Batiz-Lazo and Wood, 2000) this section will now propose a longitudinal analysis of the main events divided in five sections, starting from mid 1800s until recent times. It is possible to individuate four main phases in the process of development of retail banking services in relation to IT: Electric to Electronic Communication (1846-1945); Processors to Database (1945-1968); Automated Machines to Local Networks (1968-1980); Standardization vs Customization (1980-1998).

The recurrent features of these descriptive phases are the development of technical devices generating an initial impulse of innovation when implemented in the banking system and, subsequently, a potential for

[4] According to Hughes (1983) the development of systems is characterized by three main phases: the invention, the process of technical transfer and, finally, the overall growth of the system as final phase of integration and creation of sources for further development.

[5] Recent assessments of the historical patterns of important technological transformation in other sectors (van den Ende & Kemp, 1999; Geels, 2002), showed how innovation proceeds by means of the coevolution of its inner components within the direction established by the technological paradigm.

growth. The actual determination of the innovative process is then completed by diffusion, a contextual process with respect to the absorptive capacity of the system, allowing for the effective adjustment of production. Such a conceptual framework qualifies the endogeneity of the adoption dynamics with respect to the effects of innovation.

3.1.1 – Electric to Electronic Communication: precursors of change (1846-1945)

The first significant changes in retail banking occurred after the introduction of the telegraph in the early 1850s which made the process of communication and information exchange faster and reduced the price differentials between stock markets[6]. Moreover, a more intense level of communication induced frequent administrative transactions between the head offices and the branches. This later resulted in changes in the organizational structure so that peripheral offices became able of performing operations that were once exclusively delegated to the central offices. Nonetheless, banks' relationships with the customers remained virtually unchanged at that time since the supply of services did not change[7].

During the last quarter of the XIX century, banks were actively involved in the consolidation of branch networks so that they could operate in a more integrated manner at regional level, opening new offices and creating a structure of financial activities from lending to exerting the control of customers. Although banks accrued a large-scale dimension by means of extensive mergers and acquisitions, the non flexible structure of institutional practices and the insufficient information systems available induced commercial banks to adopt a defensive behaviour with respect to potential as well to existing customers, particularly towards industrial activities.

Table one provides an empirical survey of UK banking institutions over the period from 1850 to 1920. These figures show how the large number of banks existing in the XIX century contracted dramatically time. As suggested, a high number of mergers and acquisitions pushed such a dispersed whole to become a system and to accrue a more integrated dimension even under the point of view of the monetary policy, which displayed rather indirect characters out of the impossibility to design specific measures at the time.

TABLE ONE ABOUT HERE

The other observation arising from these figures is that the decline of British banks over time was accompanied by an increase in the number of banking offices. From the beginning of the period, private banks operated just under one-half of all bank offices but this figure faced a decreasing trend after the 1850s. These changes in the management of outlets were mainly due to a greater willingness of joint-stock banks to operate branch networks and a greater concentration of ownership through inter-bank mergers. The aggressive policy of branching continued after the 1900s when the number of offices resulted three times bigger. These considerations lead to the conclusion that whilst diminishing in number, banks accrued higher market concentration and, most importantly, more interoperability (Collins, 1988).

Financial services were then merely restricted to routine operations and the formal provision of short term loans (Capie & Collins, 1996). The necessity of an efficient and reliable information management became clear, for banks could not realize fruitful synergies with the set of industrial activities in the absence of adequate information flows. For these reasons, a core practice in banking has been ever since the creation of confidential records to be valid memoranda of the discontinuous relations with customers. More importantly, the activity of record keeping opened way to the definition of standardized practices aimed at connecting efficiently the local offices to the central management. The definition of unofficial standards in operative practices has been a long term phenomenon in banking and it is noteworthy to notice that the grounds of such an argument stand in the very nature of the banking, which is based on trust and confidence mutually established with customers and reinforced by information management. In this perspective, the emergence of clerks and typists seemed particularly important during this phase, due also to the commercial introduction of the typewriter in 1873[8], for these accrued a dynamic dimension to the process of division of labour. Banks and insurance companies hired senior workers who were differentiated from other clerks in terms of trust

[6] The introduction of the transatlantic cable, two decades later, further allowed concluding most of the transactions in one day.

[7] It is worthwhile to remind that the customer base was restricted to high income people and that banks did not really become depository institutions on a mass scale until the 1950s.

[8] Notably, in the late 1890s women increasingly became the majority of copyclerks, typists, calculators, stenographers, switchboard operators, bookkeepers, clerical workers, filing clerks, bank tellers, keypunchers, and data enterers.

their employers gave them and status, their responsibility being to supervise the work of the clerks as well as meeting clients[9].

These considerations point out the adaptive nature of banking practices in response to the dual nature of the effects brought about by the emergence of standards. On one hand, the core technical characteristics result modified constraining the development of the related activities; on the other hand the flexibility of dedicated internal practices, abiding to fundamental issues of security and confidentiality, allows faster adaptation to new instances. These two complementary features in banking activities resulted essential to foster technological change from within through the interface operated by standards in relating technical changes to the overall performance of services provision.

Notably, this period consisted in a long gestation of technical factors, precursor to the major changes that were to take place. Banking at the time had become a technically intensive activity, already mechanized through the development of punching machines and the tools that favoured bookkeeping and the advent of more powerful tools did impinge upon these fertile grounds. The inventions of the typewriting, the telegraph, the punching machine all provided a key impulse in establishing new operational practices in the management of transactions and information as well as their use and actual implementation further stimulated the refinement of such tools. The demand of these intermediary, dedicated inputs had a two-tailed effect on both the supply of new machines as well as in the final use of these functions.

As it will be seen in the next section, the effects of the experimentation conducted in the post-war period constituted a valid source of new technical opportunities that was about to expand a wide latent set of possibilities[10].

3.1.2 – Processors to Database (1945-1968)

The introduction of the computer represents a key moment of the post-war development. Although it was initially aimed at reducing the costs of routine operations by increasing the productivity of the existing administrative practices, it later opened the way to a number of other applications. During the mid 1950s, banks became effectively depository institutions on a mass-market scale, also reflecting a changed social structure. The enhancements in speed of processing created the conditions for more frequent dealings with customers, for new commercial agreements and generally for a wider and more variegated plethora of competitive opportunities.

During this phase the Database Management System (DBMS) was developed to allow the integration of that body of information that were to be processed so that data could become reliable and easily accessible. The main applications stemmed from the DBMS were the automation of the Clearing System (Morris, 1986) and of the retail money transfer (Thomson, 1967; Mandell, 1990). These two events will soon reveal to be key elements in the creation of a wider network since they stimulated the process of convergence towards a set of technical standards in banking. During this phase the first automated statements appeared, the first example of compound service product in that their production required the implementation of various forms of complementary knowledge, from accounting to processing[11].

Nonetheless, at this stage learning processes were still highly isolated and mostly aimed at cost saving. The existing state of the technology allowed banks to operate in a more efficient albeit isolated manner, hence, unable to realize a full exploitation of the potentials opened up by the employment of processors. This was also due to the high level of centralization and hierarchy displayed by banks in handling the processing tasks. Although most of the technical devices were successfully implemented, the majority of the procedures remained concentrated in the head offices, so that the positive effects of enhanced performance in routine operations remained rather circumscribed mainly because of high costs and limited communication channels in vertical coordination[12].

[9] Although these workers were regarded not as simple clerks, none of them could be considered managers for they could not make business decisions for the owners. They had duties and responsibilities but not authority.

[10] Progress often finds stimuli in the distortions of war time demand and supply generating techno-economic paradigms. In the case under analysis, the cold war revealed to be the crucial event that provided a driving force to the development of microprocessors.

[11] As it will be further showed, the services that will follow in future will tend to replicate this setting in that they will be the result of a cumulative process of combination of several, complementary knowledge assets into a unique functional application.

[12] As an example credit cards, already in use at that time, were usually offered to selected customers who, yet, could only use such a service only in a restricted number of shops due to the lack of a coordinated payment system structure.

3.1.3 Automatic Machines to Local Networks (1968-1980)

In 1965 IBM developed a magnetic strip on which data could be stored in binary form to be used through plastic cards for electronic reading; in 1966 Barclays launched the first Credit Card in U.K.; two years later, Barclays installed the first cash point in London, a machine that dispensed cash by means of a token. The latter was soon to be replaced by plastic cards with a magnetic stripe on them and the machines became Automated Teller Machines (ATM) using a technology developed in the meantime in the U.S.. The ATM is a form of unanticipated ("killer") application that had a strong impact in increasing customers' willingness to pay for this kind of services and in stimulating providers to invest accordingly on it.

The basic function of providing an automated teller rapidly opened up incentives to offer a wider number of interactive applications and expanded the provision of automated services causing a twofold reaction:

1. Increased consumers' awareness of how their preferences could be formed around their capabilities with respect to such machines;
2. Increased the search for profitability around the idea that the provision of services could become immediate and more integrated within a network of providers.

During this phase some degree of standardization took place with banks creating their own local networks by developing technical advancements accomplished in the fields of telecommunication and informatics. This strategy, however, was still adopted in a limited scale under the form of strategic alliances to overcome the limitations of a system of payments and transfers that could express only a fraction of its potential. The problem became more evident with the diffusion of ATMs for services offered by these machines were not complementary from one bank's facilities to another.

Because customers often needed to visit the branches, the existing organization of labour soon revealed to be insufficient and the number of branches expanded remarkably during this period making of these effective points of sale for services. The immediate consequences were the reorganization aimed at a higher level of decentralization and at the full automation of branches. As an example, the automation of the clearing fund system created benefits in that it ensured the settlement of money transfers without imposing on the customers the need to visit the bank-issuer of the cheque.

Despite the relevant changes observed in this phase, the banking system still remained loosely organized displaying ameliorative developments albeit in a dispersed manner so that the organizational advantages accrued by one bank often gave limited benefits that were rarely spread to the whole sector[13]. The spread of the automation systems throughout the single organizations succeeded in achieving the target of undercutting costs but created little value for customers who were increasingly involved in the management of their savings and required a more functional delivery of services. The number of increased users and applications stimulated the development of a network whose infrastructure was to be developed upon the improved possibilities of technological communication. At the time, banking activities needed exploiting enhanced connectivity and interactivity to accommodate the growing (qualitatively and quantitatively) demand for services.

3.1.4 Standardization vs. Customization within an Integrated Network (1980-1998)

During this phase, IT applications spread in all aspects of the banking activity and the shortcomings of the isolation in which banks operated were soon taken over. The process of standardization brought about an element of complexity in that the enlarged scale of operations soon pointed out the relevance of new issues like qualitative changes as well as security. Notably, the increasing dualism between the standardization and the customization of services became more evident. On one hand, since banks constituted a network, they could benefit from the adoption of standardized procedures which ensured homogeneity in the performance of transactions between banks (and not only within). On the other hand, the fact that most banks were offering the same services stimulated the search for product differentiation.

The early goal of IT was to enhance processing in form of text documents but the expansion of the banking activities and the enlargement of services offered to customers pointed out the necessity of developing communication systems that could manage multimedia applications. This, in turn, entailed issues in relation

[13] In the analysis of dynamic systems this phase is generally known as an immature stage in which highly decentralized agents operate in a highly competitive and un-coordinated manner displaying high and fast mutation rates (Fisher, 1930; Salthe, 1993; Johnson, 2000; Andersen, 2002).

to capacity, security and ability to transfer information in real time. The answer to some of these problems was the Information Switching technology (ITS), a UNIX based product which provides routing, packet-switching and device control between members of the network[14]. Growth was characterized by the consolidation of the network infrastructure together with expanded commercial use.

The increasing diffusion of *ad-hoc* databases and applications reinforced the process of redistribution of competences amongst personnel so that banks hired computer technicians and, subsequently, stimulated the internal development of specific skills changing, thus, their organization towards a more flexible and IT driven structure. As a result, together with the system designer, the professional figure of the developer became crucial in creating interfaces between banking routines and the software. Moreover, the creation of a standard operative platform ensured consistency to the network in that software packages could be created within and banking staff could operate in a familiar environment as they were assigned new mansions. The solution of relocating the existing personnel by letting them undergo progressive phases of differentiated training was adopted to contrast the salient generated from the increasing need of personnel which, it has to be pointed out, was in stark contrast with the objectives fixed at the beginning of the automation process.

The relationships with the enlarged and variegated customer base yielded further product diversification with the introduction of special products targeted to selected clients so that these could maintain differentiated privileges and status even within the provision of a class of standardized services. Banks also sought further differentiation by adding mortgages as well as pensions and insurance amongst their services. This was also due to the substantial process of de-regulation (or re-regulation, as suggested by many) that allowed the entry of new financial agents who operated in a diversified manner by offering services traditionally available exclusively by banks at lower prices. The existence of standardised methods of service provision lowered entry barriers and new entrants could provide the same services as banks but incurring in minor costs. Obviously, the spread use of IT caused the drastic reduction in imitation costs due to the wider accessibility and product availability in time and space.

Notably, the number of branches experienced a drastic contraction in that these were soon to be taken over by new points of sale. Automation created, in fact, another phase of expansion when it was further implemented to create new distribution channels, bringing about a remarkable process innovation. For example, the recent diffusion of microchips and digital technology allowed the creation of electronic points of sale, such as kiosks, which have enlarged the opportunities available to consumers.

TABLE TWO ABOUT HERE

Table two and Chart one summarize branches' contraction and ATM machines' expansion in the UK within a span of 25 years (Source: APACS, 2002). These figures show the significant changes in the banking structure of the UK: the number of branches contracted by 25% in a span of 25 years whereas ATMs increased by 65% between 1984 and 1999. Notably, in the period 1989-1994 the highest rate of branches closures corresponds to the highest increase in the number of ATM machines deployed in actual branches. The recent increase of branches needs be assessed bearing in mind that rather than being an enlargement, it reflects a process of rationalization of the existing personnel and the exploitation of potential advantages in expanding geographical coverage in targeted areas (Cruickshank, 2001).

CHART ONE ABOUT HERE

Another interesting figure is the one relative to the significant change ATMs are going through. Although their original core function was to distribute cash, the integrated banking structure allows the supply of a wider range of services. Chart 2 shows how ATM machines in the UK have become increasingly multifunctional in a span of 5 years by offering a wider range of services with the notable increase in the issuing of mini statements. It is worthwhile to notice that all these complementary services represent specific implementations built around the generic function provided by the general purpose technology by means of

[14] Packet switching is fundamentally different from circuit switching, the technology that connects ordinary telephone calls, already in use in banks during the 1960s. A switch is a network device that selects a path for carrying out digitally data transmission to a selected destination. On a packet-switched network information is broken up into a series of discrete "packets" that are sent individually, and reassembled into a complete message on the receiving end. This system allows the flow of a number of information across large bands making it accessible by means of an integrated control system. Digital packet switching offers performance and reliability advantages over analogical networks for data communications and was attractive to researchers hoping to construct a communications network less vulnerable to a targeted attack than the centrally-switched telephone network.

adaptive changes both in the internal and the external dimensions of the banking activity. This observation leads to strain once more the diachronic relation between the creation of a system design and its specific instantiations accrued by means of changes occurring at several levels, including in consumers' preferences and competences as well as in the organizational structure.

CHART TWO ABOUT HERE

Table three provides a synopsis of the relevant technological facts discussed in this section and of their effects in the UK retail banking system.

TABLE THREE ABOUT HERE

3.1.5 Recent trends in retail banking (1998-present): Successes and Failures

The emergence of various new technical devices has profoundly shaped the traits of the system and, particularly in the last part of the 1990s, this has often resulted in a process of redistribution of the resources in terms of skills as well as of habits of consumption. It is interesting to notice how the composition of the overall transactions changed within the last decade in the U.K. together with the joint process of dramatic changes some of the most common services are undergoing. ATM old machines are being gradually replaced by new multifunctional kiosks, which will make use of a new, fully integrated protocol of transmission, *EMMA*[15]. Customers can use a combination of ATMs and kiosks to access traditional account and card services, withdraw cash, make cash deposits in different currencies, and perform Internet-based transactions. Issues such as usability and availability justify the return of a method of carrying out transactions in the banks, due to the fact that still a few people have a PC at home.

Kiosks are intended to make customers more confident with internet based products. Moreover, kiosks ensure safety in checking accounts whilst the bank saves on costs allowing staff to concentrate on other activities such as offering loan advice and selling other financial products. Several major UK banks are already experimenting with kiosk programs. Another recent phenomenon is the wide spreading of cash machines in convenience stores resembling the old machines deployed in the late 1960s that simply allowed withdrawing money. Their number is growing consistently being these usually situated in targeted locations such as shops, stores and pubs so that at the end of 2001 they amounted to 18% of all the ATM machines in U.K. (*Ibid*). The coexistence between these two apparently competing facilities reflects a bifurcation in the provision of a service.

A further example is given by the dualism between online banking and phone banking. In order to realize the full advantages of internet, banks exploited the advances made in computer science in particular the development of communication protocols and devices that did not utilize the circuit-switched infrastructure operated for telecommunications[16]. The increasing use of Internet encouraged banks in the last years to pursue strategies based on the development of services available exclusively online. However, Internet banking services are experiencing a relatively slow start and it seems that telephone banking services are being preferred (table four). One possible explanation relies in the fact that although customers may have developed specific skills about the use of Internet, they may still encounter difficulties in exploiting the related benefits due to related issues such as security of the transactions or the relatively high costs of using such services from home.

TABLE FOUR ABOUT HERE

3.2 Patterns of development in retail banking

The growth of services was linked to the concurrence of related events in several areas of retail banking. Patterns of accumulated experience conditioned the development of new technologies in that they stimulated the formation of new knowledge in a twofold way: within banks, by developing new practices and enriching

[15] Kiosks have been in existence for 20 years already but only recently they have started to be deployed. There are around 500,000 kiosks in the world today, of these, around one fifth are financial kiosks, which can be defined as self-service devices that have financial functions but do not dispense cash (source: http://www.self-service-touchpoints.com/default.asp).

[16] Use of the Internet was primarily limited to researchers, computer scientists, and networking engineers through at least 1985. During the next 15 years, however, Internet displayed a dramatic expansion in the number of networks and users. In the case of ATM in banking, the development of Internet relied on a first "killer application" developed for ARPANET, the electronic mail (e-mail), in 1972. Within 1 year of its introduction, email generated 70% of the overall ARPANET traffic (Zakon, 2001; Mowery and Simcoe, 2002).

the specific purpose knowledge; at system level by enlarging the knowledge base of the sector. Banks became increasingly specialized in the management of the interface between external and internal knowledge operating as 'converters' of codified knowledge into localised competences, behaviours and routines resulting from a process of accumulation of special purpose knowledge. Services gradually emerged combining the advantages of technological proximity and socio-economic variety and the concurrent advances in the fields of information and communication technologies made possible the access to such a general-purpose knowledge base, giving these firms a global scope within a growing service dimension. The creation of a group of users (both at intermediate and at final levels) is the essential condition to define the market dimension of a product like a service. After having created an integrated retail banking system to exploit the potentials of its own structure by creating connections, the supply of services opened way to an adaptive evolution of the interfacing function, accordingly with modified technical capabilities and preferences of the customer base.

Standardized procedures such as information retrieval can be dead ends under an innovative perspective for they would not yield the recreation of new applications so long as there is no role played by (intermediate and final) demand through the change in habits, rules of behaviour and generation of new competences. The changing relation between major system frames and their specific applications defines in each case the diachronic interaction between the functional design of a product and its uses. It is in their uses that services find an identity displaying economic as well as social and cultural meanings. Innovativity in services can thus be assessed through the analysis of their diffusion pointing out the important interdependencies between existing activities are considered together with latent ones. Figure one represents a dynamic account for the sequence of events in order to highlight the functional interdependencies generated by the adoption of a technology and the trajectories derived by its applications[17].

FIGURE ONE ABOUT HERE

The innovative process that characterized the transformations occurred in the retail banking sector is here schematized by means of two dimensions: *cumulative* and *transformative*[18]. The former results from the interplay among the current set of competencies determining the gradual, incremental accumulation of competences. It can be argued that this process has a significant technical dimension in the framework considered. Transformative change yields that the process of implementation of the different phases of technical advance is not necessarily layered upon the previous ones but that it rather represents a redistribution of cognitive elements that generate new patterns of change. Accordingly, the evolution of this process is strictly related to the creative application of new routines as source of innovation. In such a framework complementarities are crucial in a twofold, yet non strictly technical, manner. They constrain the development of an articulated process of injection of new technology by connecting the performance of existing activities and the implementation of new ones. The combination of the existing competencies, in turn, needs to be complementary to reinforce the interplay between technology and services within a trajectory characterized by the formation of internal routines and the emergence of differential behaviours.

The figure also tracks the pattern of diffusion of IT in banking describing the effects that such a process generated as well as the related trajectories in the realm of current activities. In this perspective, cognitive capacity, technical abilities, sector specificity and consumers' manifested needs all represent localized features of the development of services and, more generally, of the development of the banking activity itself. Such an argument challenges the nature of diffusion studies based on deterministic models for these often focus on the pattern of technological paradigms without considering the interrelated effects of technical substitution in the existing environment and of, in turn, the effects that such changes have on the process of adoption (Metcalfe, 1981; Metcalfe & Cameron, 1987). The diagram provided here illustrates the evolution of a number of related activities in a sector after the implementation of a general purpose technology, the processor, and the subsequent array of side effects, from the demise of existing activities (eg branches

[17] Well known appreciative analyses have pointed out the concept of technological trajectories emerged around dominant designs (Nelson & Winter, 1977; Dosi, 1982; Freeman, 1987). In this case, it is preferred an analysis of the trajectories against the succession of the main technological events. This way, it is possible to relate the structure of events and the discontinuous character of these processes without imposing any parameter on the structure of development (see also Silverberg, 2002).

[18] Rosenberg (1982) referred to two characteristics of the learning process in relation to innovativeness. The first is "embodied" in that early experience with technology allows understanding of the relationship between design and performance resulting in a modification of the design. The second is "disembodied" in that new practices emerge and increase productivity. According to Rosenberg, learning by doing is naturally disembodied but becomes embodied once the feedback generated with the users' dimension produces new knowledge.

closure) to the generation of new ones in a recombinatory manner (eg financial kiosks or the new cash machines).

An analysis of the succession of these innovation waves points out the cyclical recurrence of the following stylized facts:

- ✓ Innovation is generated in localized activities and the division of labour contributes to spread and routinize it throughout the system. For example the development of specific database, whose origins are to be found in the massive implementation of processors in banking operations;
- ✓ Innovation is an incremental process, mostly due to the limits in the absorptive capacity of firms. These are often labelled in several ways: bottlenecks, reverse salients, structural tensions. On the other hand, the process of formation of capabilities is often an ongoing process like, for instance, the ability of consumers to fully exploit the potential of kiosks that partly relies on the fact that most people is likely to have confidence with personal computers;
- ✓ Innovation is followed by a phase of qualitative adjustments in which the adaptive capacity of the agents determines their *fitness* with respect to the competitive environment; as a consequence, organizational inertia due to inability to re-adapt the structure determines the demise of an activity or of a routine;
- ✓ Differential application of organizational and technical change is often the source of further innovation that feeds this cyclical succession of stylized facts.

The events analyzed in this section constitute the appropriate background to investigate the complex nature of the innovation process in that sector. It is now possible to propose a conceptual analysis of the properties that characterized the dynamics of this industrial development by means of an evolutionary approach in order to point out the articulated nature of these events and the patterns of change they generated within the dominant technological trajectories. In a context in which the strive of competition naturally generates idiosyncrasies and in them finds a unifying paradigm, the concept of evolution offers an integrated view of an overall competitive process in which the pattern of progress represents the synthesis of apparently counteracting forces. Contrarily to other deterministic approaches, the analysis proposed here is developed upon the strong contextual nature of the innovative forces of this process of industrial development.

4. Evolutionary analysis as a cognitive framework

The development of services in retail banking is an articulated process within which the technical and the organizational dimensions followed distinct, yet complementary, patterns of growth. The analysis of a multi-technological context in which several waves of innovation take place needs to carefully consider the properties of the product as well as of the environment in relation to its ability to implement the technological change. This is so since the structure of the receiving environment determines the success or the failure of a product. In the development of retail banking services this has resulted in the fact that the skills of suppliers and users were built upon cumulated levels of existing expertise leading to the emergence of new capabilities both in terms of professional figures and in an increasingly active consumers' role.

A considerable part of literature has related productivity growth in the banking system to capital deepening. In this class of works, namely investment-specific models, labour-augmenting technological change is incorporated to the production function yielding a linear relation between investment specific technology and increases in effective capital stock (Greenwood, Hercowitz and Krussel, 1997). These studies are carried out in the spirit of diffusion models (King & Rebelo, 1993; Jovanovic & Mac Donald, 1994 but also, more recently, Andolfatto & Mac Donald, 1998) in which it is possible to calculate the gap between productivity of the best technology available and the average productivity level observed. Capital deepening is the mechanism ensuring the adjustment of the existing productive structure and, subsequently, the convergence towards long run equilibrium.

In consideration of the pervasive process of innovation observed in banking, an analysis based on these arguments fails to account for the relevant role played by several other mechanisms at the core of productivity shifts such as organizational change and, most importantly in the case of services, the role of demand. Conversely, in the present paper this process will be characterized in terms of reciprocal growth stemming from the interaction between the implementation of IT and the adaptive development the banking system in providing services. As anticipated, this analysis will account for the role of consumers in

stimulating further development depending on their preferences as well as on the domain of capability to use services.

4.1 Evolution of retail banking

Along with recent contributions on the structure of classic models of evolutionary change (Saviotti, 1996; Metcalfe & Georghiou, 1998; Metcalfe, 2001) this section will be focussed on a conceptualization of innovation and evolution in the banking services sector as a tripartite process: variation, selection, feedback. Accordingly, these will correspond to specific events: the creation of new technology, its implementation in the existing productive processes and in the user/supplier interaction to generate the development of further variation. Contrarily to other approaches, this analysis is never aimed at reaching an equilibrium position, neither a stationary state but, rather, at describing the open ended process of the generation of innovation through transient phases[19].

This stylized description of the system is developed on the three relevant components that are pure technology, banking system and consumers represented here as sets. The elements within are their components expressed in form of matrixes whose rows and columns will correspond to dimensional characteristics. Figure 2 provides an illustration of the process.

FIGURE TWO ABOUT HERE

(1) Variation occurs when pure technology, matrix **T**, is implemented in the banking system. This process of implementation should not qualify technical change as exogenous, rather as "autonomous" (see Bronzen, 1953), since the technology we refer to is mainly referred to processors as well as to automated devices, all devices that are likely to be developed outside of the banking system. This assumption rests on the recognition that the development of a general purpose technology such as the microprocessor, together with the cascade of inventions that followed, may be exogenous with respect to the subsystem that is being considered – *eg* banking – but is endogenous in other subsystems – *eg* military research – (Lipsey et al, 1998).

Learning in this technological environment is purely aimed at the creation of new products or new processes and that innovation is not a random event but, rather, the result of specific cognitive process which will embed the receiving framework. Accordingly, these will provide a compelling stimulus to the organizational structure of the receiving environment. The specific application of technology in the structure of banking rarely did, in fact, stimulate incremental changes conducted through trial and error in implementing new and renewed routines and practices. The extent to which technical standards will determine these reconfigurations depends on the degree of specificity of the newly created applications. An obvious example is the adoption of microprocessors whose implementation in banking practices went well beyond its original purpose. Variation, it is argued here, accounts for the impulse provided by new technical tools.

(2) Selection occurs within the banking system through the interaction of bank organization (**BO**), banking technology (**BT**) and banking services (**BS**). During this phase banks coordinate the process of integration of new technology in the structure of their existing practices with the production of services as market products. The automation of office procedures highlights the significative role played by the implementation of IT with respect to the process of division of labour and can be constructively fetched up to the role played by intermediate demand of dedicated inputs in the definition of the array of activities generated within the development of banking services. Building technology is but the first step in the definition of a complex of activities that define the technological system in its mature stages.

The bulk of selection with respect to the impulse provided by innovation resides in the comprehension of how people work and in the determination of a network of interacting collaborative agents through the innovative use of goods and services. As mentioned before, the professional figures of designers fed the emergence of developers who operating in a specific organizational context allow the personalization of the input residing in the development of advanced technical systems. The development of software is a clear example of how the selection of major system designs becomes developed in a cascade of specific applications restricting and defining its functional relation with respect to the whole system. Learning

[19] Again, given the specific purpose of this paper, to assess the action of economic forces revolving around the technological development of banking services, I will not concentrate on the action of regulation. This is another important issue related to the activity of banking which deserves a separate, more dedicated digression.

reinforces the ability to select consisting in a wide range of processes, from the reorganization of back office operations to the development of specific software and databases. Banks' ability to adapt and change with respect to new, enhanced, technical possibilities is a crucial feature so that the investment in, together with the management of, productive capacity is determined through selection and, as time goes by and activities become more interrelated, through "learning to select".

The peculiar nature of services, however, entails that their characteristics, particularly the purely productive ones, depend also on the action of the users. The development of capabilities is an essential tool for the consumer to co-ordinate the transformation of his own preferences with the evolving structure of available products. The increasingly interactive nature of banking services, thus, points towards an active consumption practice in which what consumers want relies on what they can do.

(3) Feedback is the last stage of this evolutive process. Services are used by consumers by means of the interplay between their preferences (**CP**) and competences (**CC**), whose nature and structure change over time. Due to their highly technological dimension, the utilization of this particular class of products requires the formation of routines so that consumption itself becomes a learning routine. As suggested by Langlois and Cosgel (1998), consumption requires not just preferences but also capabilities in terms of knowledge, experience and skills.

Rosenberg (1982), Rogers (1983) and more recently Windrum (2002) pointed out the importance of consumers' willingness to use new products accordingly with the development of appropriate capabilities in order to observe the consolidation of a novel technology. The coordinated interaction between producers and users of services creates the developmental feedback which makes possible to trace the endogenous traits of innovation in that the market mechanism guides the user/supplier dimension and as well as creating reciprocally adaptive dynamics. Moreover, the presence of differential learning, a non-uniform cognitive ability, is a crucial feature in that it allows the generation of variety with respect to the implementation of technology by creating a differentiated ensemble of routines. Learning generates variation in this case through the coordinated interaction of the organizational and of the technical dimensions of the banking system.

This analysis reflects how the production of services in retail banking is embedded in the intimate nature of the processes that are realized within the activity at any level, from the phase of market research to the act of final consumption. As observed throughout, the boundaries of this system are renewed and changed over time by the interrelation of elements such as knowledge, competencies and organizations. Rather than in the ability to develop technical change *per se*, the source of economic change within a system of innovation resides in the distributed ability to create competences in relation to the adoption and utilization of a technology (Carlsson & Stankiewicz, 1991; Metcalfe, 1998). It is possible to qualify the development of this system as a coevolutionary process whose determinant forces are stimulated by a process of search via learning. Banks' internal dimension became dynamic through the interplay between the stimuli provided by enlarged technical possibilities and the subsequent adaptive process of organizational change. At system level, the interaction between firms and environment determines the formation of appropriate capabilities by consumers in order to become effective users of the more sophisticated services. This is particularly evident in the case of services since these are, by definition, products that embody characteristics of both producers and consumers activities.

In such a perspective, the diffusion of information technology in retail banking can be considered as path-interdependent. This argument has been developed thoroughly (Metcalfe, 1981; David, 1985; Arthur, 1989; Antonelli, 1997) to qualify the relation between the impulse and the diffusion of innovation on the basis of the diversity of rates at which technological displacement takes place. The more innovation becomes embodied in a well established production system, the more the interrelations between the existing parts of this structure will determine the degree of receptivity of the receiving environment. Whilst providing an impulse for the exploitation of wider possibilities, innovation limits structural change in an evolving system by selecting (and subsequently discarding all the alternatives) the patterns of growth on the basis of localized properties and of adjustment capacity[20]. The knowledge intensive character of the service sector compels an assessment of the mechanisms of knowledge exchange that are at work.

[20] This argument displays a parallelism with the issue brought forth by Schumpeter (1934) concerning the transient nature of profitability whose dual effects consist in accruing value to entrepreneurial activity as well as modifying the existing economic structure.

4.2 Innovation and learning in the development of retail banking services

The multifaceted nature of innovation in services is often determined to a varying degree by the producer-user interaction (Windrum & Birchenhall, 2002; Windrum, 2002). The development of services is deeply characterized by the unfolding of learning processes in both the activities of production and consumption. This is reflected in the technical and the competence dimensions observed in the continuous process of adaptation of the two classes of agents with the respective activities. Within the assessment of the learning processes occurred in this context, I want to point two factors such as the existence of functional channels of communication through the process of development of skills and the ambivalent relation between preferences and competences of consumers[21].

Let me first contextualize the relevance of learning processes in the framework developed in this work.

Rosenberg (1982) developed the concept of *learning by using* sustaining that products are improved and developed, both in embodied and disembodied ways, according to the experience of the product in use and by means of feedback from their diffusion and development. In his analysis the two processes of innovation and learning are clearly separated in that several types of learning exist and the stimulus to innovate is generated from different agents, particularly from users[22]. Recent studies highlighted the relevance of the cognitive structure with the crucial phase of decision-making in relation to the existence of innovation processes (Nelson and Winter, 1982; Coriat and Dosi, 1995; Metcalfe, 1998). These draw upon the idea that the organisational features of productive agents need to be assessed including in the analysis of contextual factors such as the institutional framework and the subjective cognitive ability. In particular, as far as the organisational aspects are concerned the relevance of internal changes in the structure of the firms (Teece, 1988). Moreover, as previously outlined, in the case of banking the emergence of a network compelled a coordinated effort in R&D for an integrated structure yields positive returns both for providers and consumers of banking services. The need for coordination at both internal and external level occurring in banks reflects the emergence of a new form of capital, a form of intangible assets based on dynamic and adaptive division of labour whose core resides in the generation and transmission of technological knowledge. As a result, organizational learning emerged as a new form of internal and external coordination mechanism, based on direct participation of employees as well as in the creation of dedicated working groups (Argyris & Schon, 1978).

The learning processes considered in the present work need not be strictly technical for scientific knowledge is embedded in hierarchically organised social structures in which creation and exchange of knowledge assume a key importance (Kuhn, 1962). Moreover, the neglected mechanisms of preference formation, expressed by means of behaviours that are typically embedded in social structures, contributes to define the relevance of learning processes. This argument brings to the fore wider cognitive and social aspects of knowledge creation. On one hand, the contingent, yet not always coinciding, evolution of preferences and activities of consumption. On the other hand, the analysis of organisational learning not simply as information processing but as a coordination mechanism that continuously recreates the conditions and the modes in which information is gathered and interpreted.

The argument relative to the existence of functional channels of communication – both within banks and between banks and its environment – stands in the idea of a structured level of knowledge in relation to a specific productive structure. Accordingly, selection consisting in the survival of certain routines as well as in the demise of others occurs by means of the modification and adaptation of such a "stock". Without these necessary processes, there would be no change in the existing technology and therefore no progress (Metcalfe, 2001, 2002; Antonelli, 2001)[23]. The transformation of the internal organization of banks was a phenomenon induced by technical progress and realized through a complex mixture of elements. For instance the development of *back-office* operations was formally rationalized through the mechanization of administrative tasks but, mostly, it became transformed by the existence of appropriate channels of

[21] Mechanisms of knowledge production and transmission within the firm are reviewed in Antonelli (2001) and in Patrucco (2002) where this concept is further developed in terms of "quasi-markets for knowledge".

[22] This approach has been enriched through the years in interactive learning environments. This is the case, for example, when the user dimension assumes a determinant role such as in the analysis of von Hippel (1988). In the learning economies approach proposed by Lundvall and Johnson (1994) in which the specification becomes even starker: information in this case corresponds to the set of elements of knowledge that can be exchanged.

[23] In this perspective, the distinction *a-la* Lundvall is appropriate in that the process of learning entails the transmission of the existing knowledge as well as the generation of new one.

communication (Antonelli & Quéré, 2002) within the organization. As a matter of a fact, the range of new competencies stemmed from such an adaptive behaviour allowed the realization of new services. Fleck (1996) stressed the importance of informal aspects of communication with specific reference to financial services. The increasing complexity of this class of products due to the expansion of the suppliers' space and to the strong knowledge-based nature of services, points the analysis towards a functional partition of knowledge into several levels of expertise: from the management of banking operations to the development of market strategies; from the organization of operational knowledge to the specialization of professional practices such as accounting and statistics.

What deserves equal attention is the fact that due to the peculiar nature of banking services, also consumers are engaged in a process of search and learning and that it is not possible to account for their development without having considered the role of consumers' learning. Indeed, at the same time another important branch of expertise was being developed by consumers through an ongoing process of interaction which generated several learning processes with respect, for example, to the payment network. Chart three shows how the volume of regular payments in the UK has changed composition in the period 1993-1998: consumers seem to rely more on electronic transfer methods at the expense of the use of cheques whose contraction amounts to 5% whilst cash still represents a steady means of payment (Source: Cruikshank, 2000).

CHART THREE

Together with the observation that services developed in ATMs have been expanded, this figure reinforces the effects of a mutual change in the supply as well as in the use of these services. The implementation of IT played a major role in the development of services for it stimulated the institution of the informal channels of communication that allowed the circulation of the effects of feedback back to the suppliers. More generally, since financial services embody a high technological dimension as well as an extended knowledge base, they sustain the dynamic interdependence between peripheral, yet opposite, levels of specificity by connecting generic knowledge towards specific applications and, vice versa, reproducing localized experience onto general cognitive frameworks (Antonelli& Quéré, 2002).

Banking services are often composite products as far as the knowledge embodiment is considered. The evolution of the relationship between banks and their customers is also based on a changing pattern of communication based on a reciprocal learning in that banks operate a choice regarding the format of communication for the sake of clarity and transparency, as much as customers often seem to determine the real competitive success of a product.

It is then possible to point out two categories of characteristics in retail banking services:

- The "visible" characteristics, notions that explicitly account for the delivery of services and for their efficient use. For example, the access to personal information by means of a website is often guided with specific instructions;
- The "invisible" characteristics, notions that are stratified/embodied on the product itself although their syntax is decodified purposefully for users. For example although accounting is a necessary expertise to manage the information about transactions, it is often the case that consumers do not learn it. Finite products like services are, then, complex in that their production and use are strictly related to the degree of coordination (although not necessarily contemporary) amongst specialist, suppliers and consumers.

The line between these two coexisting dimensions is the process of selection of information that makes it possible to interface functionally technical abilities with peculiar features typical of the banking activity. It seems the case to stress the relevance of the localized character of knowledge in relation to the local conditions which the correlational cognitive structure is built upon. The underlying learning process operates a selection of complementary notions to be codified and re-implemented so that, for example, complicated computer languages become simple instructions to access an account balance online without making use of http protocols and, generally, without accessing areas of specified knowledge.

Such an argument displays several resemblances with some works developed in the past. In particular, the contribution by Saviotti and Metcalfe (1984) in which a weight, based on the functional variation in the use of a product, was constructed in order to provide a qualitative measure of the impact of technical change on a product's set of characteristics. Similarities could be also traced with respect to the idea developed by Sahal

(1977) who proposed the construction of a similar weight, this time with respect to the technical "distance" between the initial and the final state of the process of innovation[24].

The analysis of banking technology seems to be a valid example for such theoretical insights also under the perspective of its evolution as a technological system. As already noted previously, the development of retail banking displays several similarities with the growth of technical systems. The dynamics observed in this system of innovation can be analyzed as distributed processes in which the continuous adaptation to the changing nature of the scope generates the incorporation of new agents and new knowledge sources, as well as the demise of unnecessary and exhausted resources (Coombs, 1999). The ability to translate latent opportunities into an integrated system of innovation requires that the activities are distributed and organized for a specific purpose, that is, to gain competitive advantage in the market process. Banks contributed to the development of an innovation system by realizing the articulation and the recombination of different innovative resources, amongst all of knowledge. The existence of multiple levels of knowledge defines the viability of the market and, thus, its extension.

5. Conclusions

Based primarily on the historical analysis of the facts, this paper reviewed the development of retail banking services in United Kingdom in a "history-friendly" fashion. The mechanisms of the banking sector evolution, and technical change within it, have been developed in an appreciative manner so that a qualitative judgement of the facts could be elaborated within a stylized framework of analysis. Arguments based on the parallelism between analytical frameworks and historical sequence of events have been recently proposed elsewhere with emphasis on different cases such as computerization (Malerba et al. 1999), the introduction of control systems towards information processing in investment banking (Nightingale and Poll, 2000) and the evolution of the railroad (Andersen, 2002).

The analysis of retail banking system developed in this paper points out that a consistent source of structural change is its own evolving structure. The notion of coevolving systems represents an appropriate framework for theoretical investigations of evolutionary change in the case of retail banking services since it is based on the effects of mutual changes originated by the interaction between adaptive agents and their changing environment. An overview of the forces that feed the process of transformation of the system pointed out the localized character of the action of banks as well as of consumers with respect to their ability to develop competencies and skills. Banks responded to the challenges of a changing environment by growing capabilities as well as by maintaining an active attitude to adjust. However, the development of the sector is not attributable exclusively to the activity of banks. The microfoundations of retail banking rather stand in the progressive interrelatedness of learning processes within the producer/user dimension of the service sector. Knowledge exchange provides a reliable measure of social responsiveness to the changing structure of the activity of production through the development of the competencies-structure dimension. Amongst these issues, demand is the component of this class of evolutionary systems that deserves more focussed and localized research.

These results confirm that the bulk of commercial banking innovation consists of interdependences created by the impulse of new technologies and propagated by means of adaptive changes in the organizational forms and in the absorptive capacity of demand accrued by means of capabilities and competences. Future research should be investigating the nature of such propagation mechanisms with special emphasis on the role of consumption as an active and organized economic practice resulting from the combination of personal (preference formation) and collective (technical capabilities) activities. The benchmark that evolutionary economics provides is based on the idea of a system of interacting agents carrying out a bundle of activities whose nature changes over time at different velocities. Mutual, interdependent adjustment allows the system to evolve for every part contributes to the definition of this ensemble. Innovation is the core of such a process and the array of activities that each agent undertakes represents the units of analysis of this changing set of interrelations.

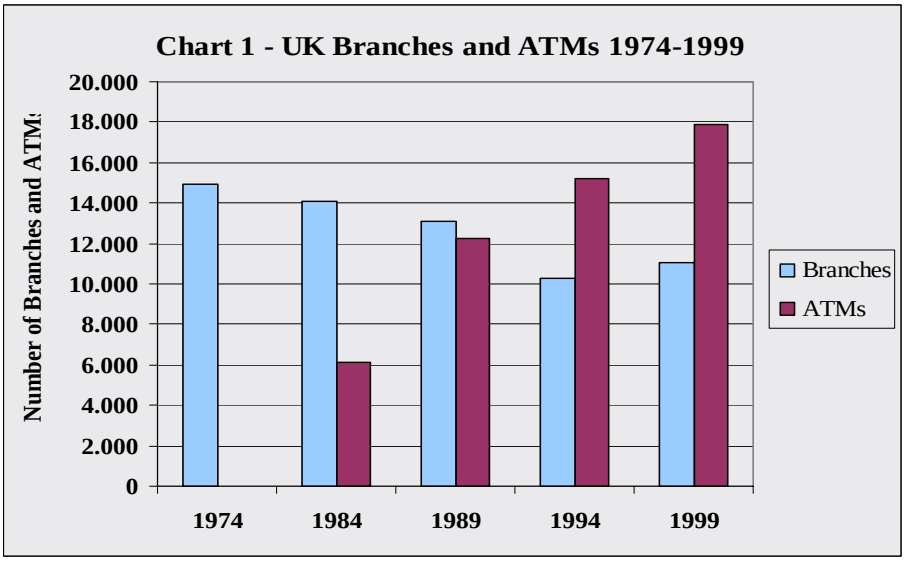
25 However, the former contribution explicitly accounts for the role of demand as well as of producers. This way it is possible to avoid the paradox of considering only quantitative changes so that a product in which the basic characteristics are redistributed but quantitatively maintained would result unchanged. On the contrary, and this is often the case with services, the qualitative effects of a redistribution of existing characteristics gives, in fact, a completely different product.

Table one – Number of Banks and Offices
UK 1850 - 1920

Year	*Banks*	*Offices*
1850	459	1685
1875	381	3320
1900	184	6269
1913	88	8610
1920	38	10726

Table two – Number of branches and ATMs
UK 1974-1999

Year	*Branches*	*ATMs*
1974	14.908	N/A
1984	14.058	6.106
1989	13.131	12.253
1994	10.274	15.180
1999	11.044	17.892



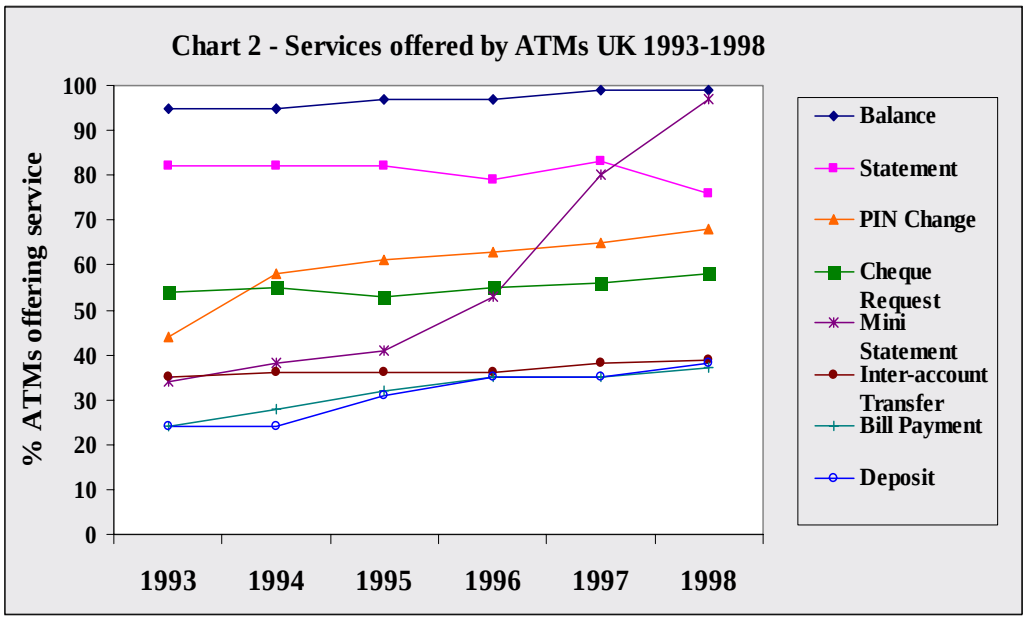


Chart 2 - Services offered by ATMs UK 1993-1998
% ATMs offering service
100
90
80
70
60
50
40
30
20
10
0
1993
1994
1995
1996
1997
1998
Balance
Statement
PIN Change
Cheque
Request Mini Statement
Inter-account Transfer
Bill Payment
Deposit

Technological events *Phases*	Service Provision *External Dimension*	Operational Function *Internal Dimension*
Electric to Electronic Communication (1846-1945) ♦ Telegraph (1846) ♦ Cheques become in use (1850s) ♦ Trans-Atlantic Cable(1866) ♦ Punched Cards (1890) ♦ Electric Typewriter (1901) ♦ Xerography (1944)	Trade execution is reduced from six weeks to one day: security price differentials are reduced; Banks emit bills of exchange and money transfers are settled through the Bankers' Clearing House ; Tabulating machines become in use;	Coordination between the head office and the branches increases although the management of service provision is clearly divided and most front-office procedures remain unchanged; Financial Intermediaries operate through nationwide retail branches to operate on behalf of their customers;
Processors to Database (1945-1968) ♦ Magnetic Stripe (1965) ♦ First Credit Card in U.K. (Barclays Bank) (1966) ♦ Database Management Systems (1967) ♦ First Computer Hardware is stored (1948) ♦ Facsimile machine (1966)	The Cheque Guarantee Card is introduced: the system of payment by cheques becomes more spread; The first Automated Bank Statements are printed; Central accounting units established; Money Transfer is automated: more transactions available in branches;	The cost of labour-intensive activities such as processing is reduced and the capacity to handle administrative tasks is enhanced; Computer applications are mostly concentrated in the back-office and operations remain centralized; Lack of specific software encourages the emergence of new professional skills;
Automated Machines to Local Networks (1968-1980) ♦ Operating System with multitasking (1969) ♦ Microprocessor (1971) ♦ Microchip is integrated in a plastic cards (1973) ♦ Personal Computer (1975) ♦ "Switching" technology in telecommunication (1979) ♦ *Ad-hoc* database become developed internally	The first Automatic Teller Machine is deployed in London; Branches become fully automated and services are now more easily accessible; Real time operation and control of branches are introduced; Customers can sort transactions in any branch of their own bank;	Several branches are opened as a complement to retail branch distribution; Financial resources are sought and new skills are developed to support the spread of ATM; Information systems provide monitoring for the bank's management;
Standardization vs Customization (1980-1998) ♦ Networking Software (1980) ♦ Microchip is used in a telephone card (1982) ♦ File Transfer Protocol (1985) ♦ ITS implemented as major technology for network connection (1988) ♦ Wide use of Internet for commercial purposes (1990s)	Gold Credit Cards are offered to selected customers; Bank of Scotland introduces a banking service available through the telephone; Debit Card is available to account holders; Non payment services are introduced (i.e. mortgages, pensions); Internet Banking is introduced: services can be bought from virtually anywhere;	Number of branches is reduced: the personnel is re-qualified and is given a more prominent role; Relationship Databases are developed to build customer profile; LINK Interchange Network Ltd (LINK) formed as a company jointly owned by banks to expand distribution channels; New issues such as security and reliability of information processing become essential features;

Table three: four phases of development of IT in banking

Table four - Use of Internet and Telephone Banking Services in the UK - Year 2000 (% adults)	
Adults having a current account (banks, building society, national savings)	82.3 %
Adults whose current account include telephone or internet banking services	46.5%
Adults using telephone banking services	19.5 %
Adults using internet banking services	3.2%

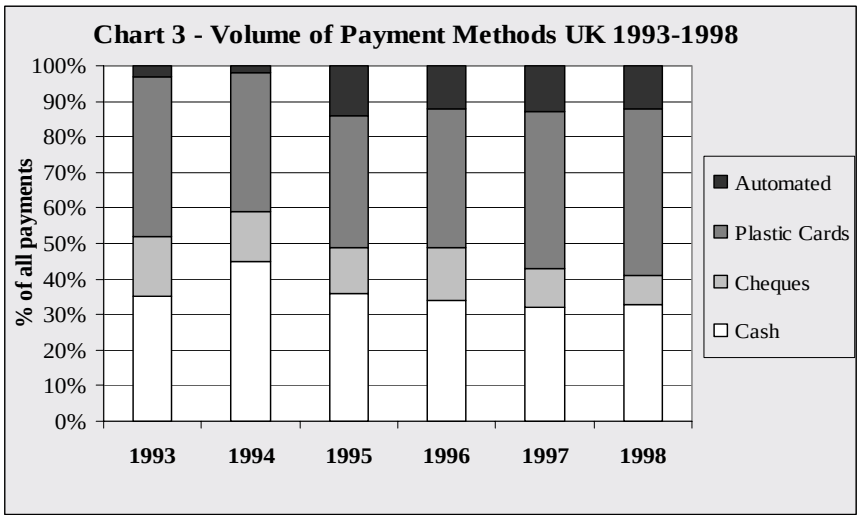


Chart 3 - Volume of Payment Methods UK 1993-1998
% of all payments
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1993
1994
1995
1996
1997
1998
Automated
Plastic Cards
Cheques
Cash

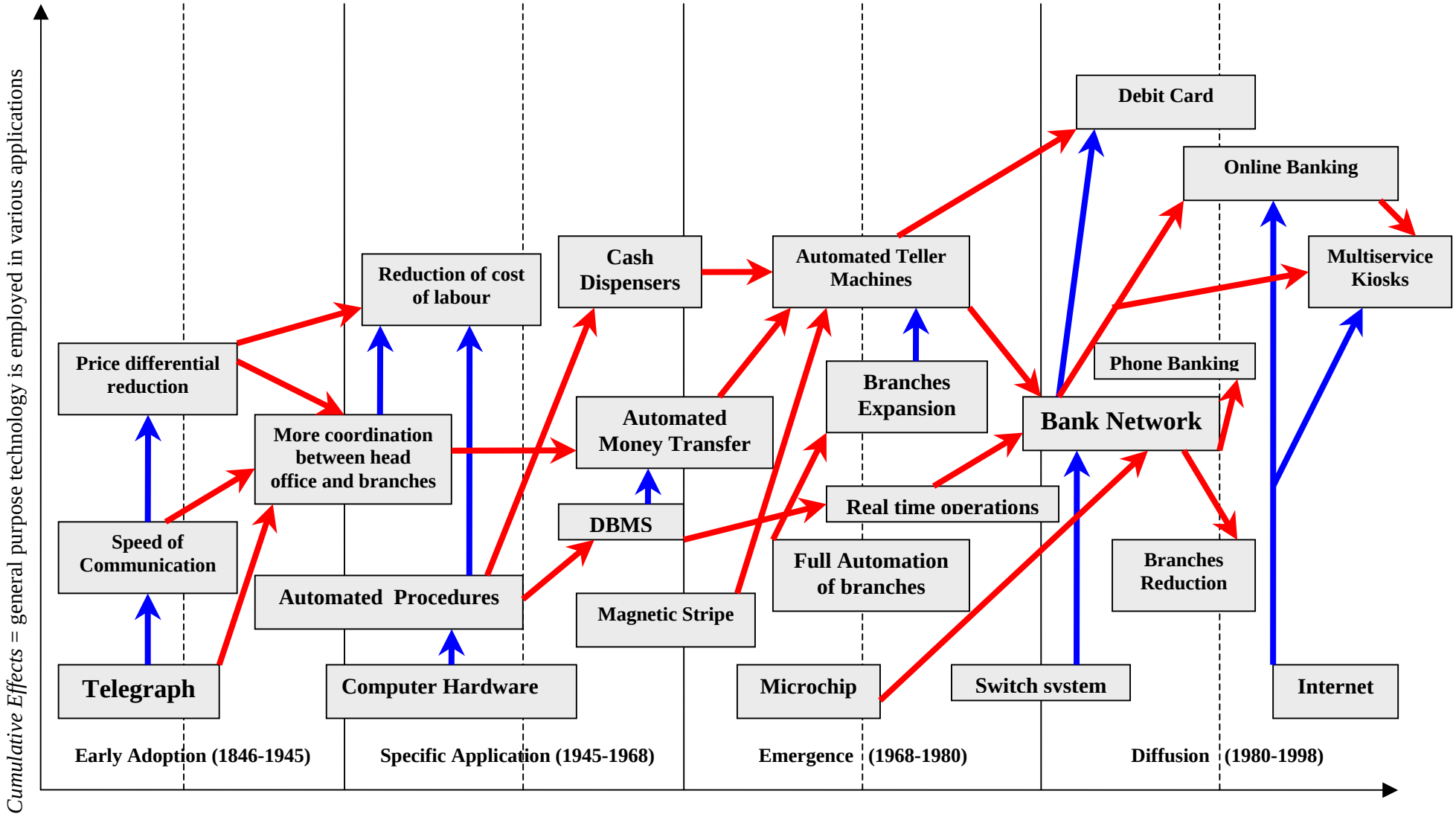


Figure 1: Two dimensional effects of IT application in retail banking

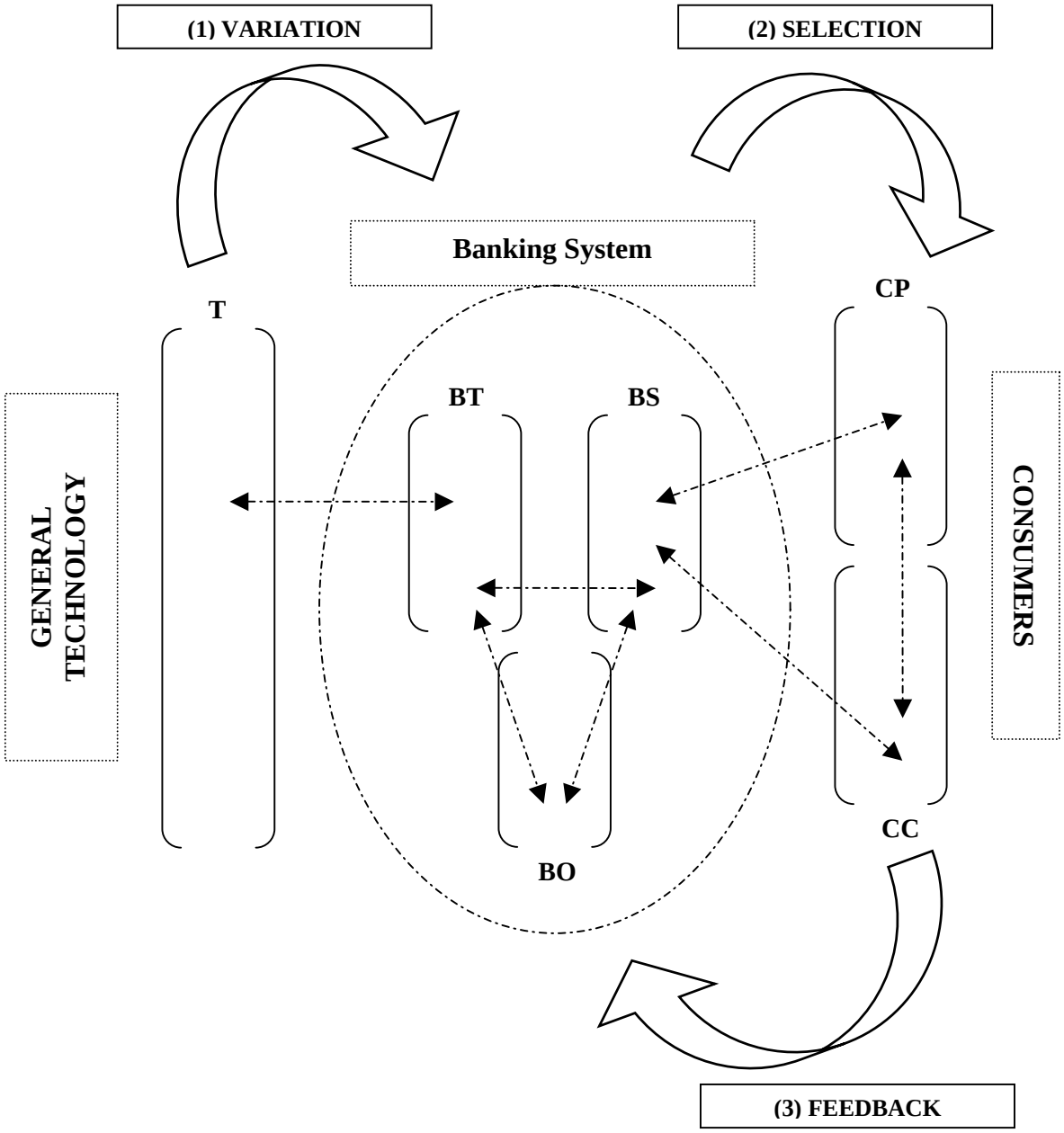


Figure 2 : Evolution in Retail Banking Services as a tripartite process

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