Cash and the Counter: Capabilities and Preferences in the Demand for Banking Technologies

Davide Consoli

Centre for Research on Innovation and Competition (CRIC), Institute of Innovation Research, University of Manchester, Manchester (UK) and Department of Economics, School of Innovation Studies, University of Turin (Italy)

Abstract The main argument of this paper is that consumption and demand, like production, are discovery processes guided by trial-and-error and learning by consuming. The key question that is addressed is: how do consumers deal with innovation? By bringing together a number of threads within the innovation literature my claim is that consumers, akin to firms, follow routines that shape their consumption bundle, conceived here as an ensemble of activities rather than a bunch of goods. The analysis developed in the paper takes a very specific angle by elaborating on empirical evidence on the patterns of use of retail payment services in the United Kingdom to appreciate how consumption and demand can be shaped by the intertwined evolution of capabilities and preferences.

Correspondence Address:
Harold Hankins Building (9.15); Booth Street West,
M13 9QH – Manchester (UK)
Tel. +44 (0) 161 – 275 7372
E-mail address: davide.consoli@manchester.ac.uk

INTRODUCTION

It is often claimed that technical change opens up new opportunities for producers and consumers alike, but most of the attention in the literature is directed at how new products and processes affect the organization of production, while consumers are left with a marginal role in this play. The main argument of this paper is that carrying out the ensemble of activities that compose the consumption bundle is a far more demanding task than generally acknowledged in the economic literature. Consumers need to be able to evaluate their current consumption, compare it with viable alternatives and, eventually, develop specific capabilities to use new artefacts and, more generally, to accommodate new habits (Earl, 1986; Loasby, 1988; Swann, 1999; Redmond, 2003). Therefore consumption and demand, like production, involve a great deal of decision-making and although consumers do not innovate in the most common sense, their behaviour affects the translation of individual instances into the design of a new product or of a set of complementary ones. My claim is that consumers, akin to firms, follow routines that shape their consumption bundle, conceived here as an ensemble of activities rather than a bunch of goods. In turn, the way in which habits change and capabilities are learned depends largely on the combination of each individual's characteristics with the influence exerted by the social context. These are latent but arguably unresolved threads within innovation studies[1] which are brought together in this paper against the backdrop of a case study on consumers' adoption of electronic payment services in the United Kingdom.

The choice of this specific context seems appropriate for a number of reasons. The organization of retail payments is the circulatory system of every economy: a nexus of

[1] There are different strands of research on consumption and innovation. With no pretence of being exhaustive, leading works in this area are: von Hippel's (1988) seminal work on the user-producer interaction on product development; the 'active consumer' framework in the collective book edited by Marina Bianchi (1998), the theoretical work by Dosi et al (1999), the institutional analysis of Redmond (2003) and the recent consumption practice approach by Warde (2003).

channels on which small-value transactions flow every day to ensure the exchange of goods and services. These channels can be accessed ubiquitously, across time and space through a variety of complementary, partially overlapping, front end technologies. Anyone familiar with Credit Cards, Debit Cards, Automated Teller Machines, Financial Kiosks and Internet Banking will acknowledge that these are good examples of the 'routinized' form of demand which is central for the theoretical purpose of the paper. Moreover, the UK banking industry is a good case in point due to its long-standing tradition of ground-breaking technologies and its recent structural transformations (Llewellyn, 1999; Consoli, 2005b). The story, succinctly, goes like this. Stimulated by regulatory changes and growing domestic and international competition, after the 1960s British financial institutions embarked on the re-engineering of retail services system. Far from consolidating their oligopolistic clutch, however, this process paved the way to increased contestability, re-shaping the boundaries and the structure of the industry towards a more competitive setting.

In such a turbulent context it is not surprising that the relationship between financial institutions and their customers has moved away from the traditional price mechanism towards a more articulated process of mutual adaptation. In particular, it is argued here that the use of automated retail payments reflects to a large extent the way in which the patterns of supply and demand have been dynamically coordinated in presence of technological change. In so doing the paper assesses how the emergence of a whole new set of technologies has shaped the preferences and the capabilities underpinning the demand for payment services and, indirectly, for some specific technologies.

The paper is structured as follows. In the first section we recast the analysis of demand and consumption within the growing literature on innovation and technical change. This is done with the intent to find some elements of continuity with the growing body of the role of knowledge on the organization of economic activities. Section 2 will present the case study,

thus overviewing the main dynamics that have characterized the evolution of the UK banking industry in the last three decades and the emerging trends in the domain of electronic payments. This will provide a most appropriate background for the analysis developed in the third Section on the coevolution between consumption capabilities and preferences. The main theme of the paper here is approached in a formalized way to highlight how learning by doing can stimulate or constrain the access to a specific payment channel. In short, this is analyzed by looking at the costs associated with learning how to use new automated services in presence of bounded rationality. Conclusions will summarize the main results.

Rather than falling into a general theory, this paper takes on observed patterns within a specific industrial context to elaborate on the underpinning behavioural foundations of demand which, rather than strictly rational, emerges primarily as a discovery process. Therefore the paper claims novelty for at least two reasons: first, it looks at demand as an emerging property across a population of agents driven by learning by doing (or by consuming); second, in the framework developed here demand is ultimately shaped by the ability to build specific consumption competences. In so doing the analysis accounts explicitly for complementarity, indivisibility and irreversibility in consumption choices.

INNOVATION AND CONSUMPTION: THE EVOLUTIONARY CONNECTION

In the post-Schumpeterian tradition the search for innovation involves broadly the implementation of new activities as well as the modification, or the elimination, of those already in place. This framework stretches out not only to new products and/or new markets but, more pervasively, to the emergence of new forms of economic organization. The innovation process is generated and, in turn, brings about a number of correlated features: increasing specialization in the generation, accumulation and use of knowledge; the coupling of economic and technological opportunities with an organizational structure; the dialogue of

economic agents with the relevant institutional set-up (Antonelli, 2001; Dosi, 1997; Nelson and Winter, 1977, 1982, 2002; Pavitt, 2005; Perez, 1983). Pushed by increasing returns in the accumulation of technological knowledge and, at the same time, constrained by irreversibility in the choices of production (and as we shall see later, of consumption) new patterns of behaviour emerge in the form of specialized competences and preferences (David, 1975; Dosi and Metcalfe, 1991; Antonelli, 2001). Further down this path of knowledge accumulation agents who committed their resources in a specific direction fatally confront high switching costs if they decide to embark in alternative activities. In other words, the accumulation of knowledge requires elevated costs to be able to maintain a high degree of openness and complementarity for future, unforeseeable uses.

While these arguments usually find almost unanimous consideration in the analysis of production, very little effort has been made hitherto to investigate whether and how such insights could be transposed on the domain of demand and consumption. Contrary to the Schumpeterian tenet in which consumers are relegated to a rather marginal role, it is argued here that there is a great deal to learn from what we already know on production to understand the thrust of new behavioural patterns in demand and consumption. True, the economic literature on demand is abundant, but the conventional appreciation of consumer behaviour is being challenged on the familiar terrain of its underlying assumptions, which are as controversial as they are ultimately necessary to uphold the whole analytical structure.

Fairly recently a number of scholars have put forth the idea that consumption is not a passive activity that can be reduced to the act of purchase of goods and services (see e.g. the volume edited by Marina Bianchi, 1998; Loasby, 2000). Rather, consumption can be seen as a set of complementary activities that are set in place to yield personal satisfaction. In this perspective, the use of new technologies offers a precious opportunity to reconfigure the existing set of activities. In other words, the exploration of new alternatives can modify established patterns

of demand in front of either improved access conditions to the consumption of existing products or services, or to altogether new alternatives. To fully incorporate these insights in the analysis of demand we need to make a few significant steps. In particular, it is necessary to depart from the mechanistic view that relegates consumption to the mere purchase of goods and services. For, by taking the cognitive process that characterizes consumption as given, this view ends up with assigning consumers a rather marginal role.

In the evolutionary literature it is often maintained that economic activities consist of an array of distributed processes coordinated by a set of formal and informal arrangements whose composition is a crucial to the process of economic growth (Dosi and Metcalfe, 1991; Loasby, 1998; Metcalfe, 2001; Metcalfe et al, 2003). In this context the array of effects stimulated by technical change converge in a domain which is complementary to producers and consumers, as – albeit with different purposes – they both contribute to create, dismiss and recombine economic activities that naturally feed and, in turn, are shaped by this process. Figure one presents a sketch of this line of enquiry, and in particular of how economic activities are selected through a process of trial and error in relation to their relative importance across the whole range of activities in place (see e.g. Metcalfe, 1998; Metcalfe et al, 2003). In the Figure this is stylized by the evolution of consumption broken in a three-stage recursive process[2]: Variation (V_i), Selection (S_i) and Developmental Feedback.

FIGURE ONE ABOUT HERE

The interaction between the endowment and the needs of a class of agents defines the economic objectives that are subsequently weighted by the interplay between preferences and capabilities of consumption. The final selection determines the demand which will confront the opportunities available in the market. At this stage some consumption plans (ds_a) will be

[2] More detailed account of the rationale behind evolution as a three-stage process can be found in Metcalfe and Georghiou (1998), Metcalfe (2001b) and, in a case of innovation in retail banking, in Consoli (2005b).

satisfied while others will face a mismatch due to lack of supply (d_{na}) of products or services.[3] This process generates a developmental feedback which stimulates changes in future demand and production plans alike. In turn, the outcome of the mutual influence between demand and supply depends on the institutional framework, and the extent to which it creates appropriate conditions for the replenishment of novelty and variety in the system (Lundvall, 1988; Metcalfe, 2001a, 2001b).

An evolutionary theory of demand founded on the principles outlined above needs to account for the emergence of changes in demand from within. Yet, very few ventured in this territory. The treatment of demand by Schmookler (1966) and the more recent framework of demand pull and technology push in the innovation process by von Hippel (1998) do not mention anything about the formation of preferences. A useful insight in this direction is provided by Hildenbrand (1994) according to whom the law of demand reflects the heterogeneity of the population of consumers, together with the empirical property that the statistical spread of expenditures tends to increase with income level. Put this way, heterogeneity across individuals is a most crucial requirement for a dynamic theory of consumption in which preferences, and the mechanisms underpinning their evolution, are contingent to the localised nature of each consumer's knowledge.

The framework outlined so far fall squarely within the framework of capabilities in production (Foss and Eriksen, 1995; Coombs and Metcalfe, 1999; Langlois and Foss, 1999; Mathews, 2002; Andersen, P.H., 2003) particularly in relation to the emphasis on how change in the array of activities (including both production and of consumption) carried out by boundedly rational agents is the result of a search and selection process. The necessary step to apply this analysis to demand and consumption is to focus on the growth of knowledge as a driving force for economic change (Langlois, 2001; Metcalfe, 2002). In the process of

[3] Conversely, the mismatch due to lack of demand for products is denoted (s_{na}) in the figure.

consuming, the accumulation of experience is a crucial element which has been stressed by many but applied by few (Loasby, 1998, 2000; Metcalfe, 2001a; Redmond, 2003; Swann, 1999). The sources of such knowledge are twofold and complementary: a trial-and-error process guiding the learning mechanisms of each individual agent and the effects of the interaction with other consumers.[4] By taking this view, we can look beyond the consolidated perception of consumers as blind, passive utility maximizers and employ evolutionary reasoning to gauge how innovations are absorbed in the patterns of consumption *pace* the emergence of technical capabilities. In short, learning by consuming emerges as the coordinating mechanism between the development of capabilities and the evolution of preferences.

THE EVOLUTION OF RETAIL PAYMENTS IN UK BANKING

Empirical analysis

Let us now provide a link between the line of enquiry outlined above and the industrial context of retail financial services in the United Kingdom. The UK banking industry has been dominated for more than three decades by a cartel formed by the four biggest deposit institutions. In recent years the pervasive deregulation combined with the wide diffusion of new technologies has re-designed the competitive boundaries of this market (Frazer, 1985; OECD, 1989; Essinger, 1992; Evans and Schmalensee, 1999; Llevellyn, 1999; Radu, 2002; Consoli, 2005b). The consolidation of computerized information management systems has changed the landscape of the leading providers challenging the typical dominant position held by the former incumbents. The extent of the structural changes in this banking system has been mirrored by the rapid development of a large array of customer services in recent years. In sum, variety has emerged as key dimension in the product dimension as suppliers have developed new generations of automated machines making them increasingly rich in the array

[4] This way one can be sure that economic knowledge will not be exogenous to the economic system but that,

of services provided. The paradigm of retail banking services provides useful insights on the forces underpinning the consolidation of processes as well as the recurrent redesign of products. The relevance of this case study in the wider frame of our analysis is compelled by the high profile that retail banking transactions have in the daily flow of goods and services in any economy.

Let us begin with an overview of the major trends in retail payments in the UK. The main instruments that can be used can be broadly divided into Cash and Non-Cash, and within the latter we find a number of nested sub-categories, as showed in Figure 2.

FIGURE TWO ABOUT HERE

The degree of use of such payments tools has experienced a slow change in the UK during the period between 1990 and 2003. This is summarized in the snapshot provided by Table 1 (Source: APACS[5]).

TABLE ONE ABOUT HERE

Interestingly enough, despite the introduction of automated instruments the value of retail transactions in the UK is still largely dominated by cash. Figure 3 shows that this trend has been decreasing over the years, the most recent share of cash payments being 64% in 2003 (79% in 1990) against 36% of non-cash (21% in 1990).

FIGURE THREE ABOUT HERE

Within the non-cash payments we observe a narrowing difference in favour of Paper-based payments (74% of the overall payments in 1990, 45% in 2003) against Electronic payments (26% in 1990, 55% in 2003), until the inversion in 2000 (see Figure 4). As shown in Figure 5, surely the growth of the plastic cards combined with the falling share of use of the cheque contributed significantly to this.

---

rather, the two will co-evolve.

FIGURE FOUR ABOUT HERE

FIGURE FIVE ABOUT HERE

Given this backdrop, let us now narrow the focus on one specific set of services. The banking technology that goes commonly under the label of ATM (Automated Teller Machine) is the familiar cash-dispensing device that is most often found outside the premises of a bank's branch. Despite the core function of cash-dispensers has not changed from its inception (early 1970s in the UK, see Consoli 2005b), the underpinning technical system has evolved remarkably. In particular, two major dynamics have shaped this process:

- the internal reorganization of the system, which is now entirely managed by all major UK financial institutions through the shared company LINK;
- the external transformation of the delivery of the service, which has now been integrated with a number of complementary payment services accessible via the new machines.

I have argued elsewhere that the two processes are strongly correlated (see e.g. Consoli, 2005a, 2005b) but the purposes of this paper I will just concentrate on the latter, that is, on the co-evolution between the interface of the automated service and the changing degree of use by customers. In the UK we find that ATMs are in reality a family of three generations of machines, which will be indicated with the following notation:

1. ATM_1 (1975-circa 1985): Cash-only dispensers; each bank uses proprietary machines;
2. ATM_2 (1986-circa 1996): New machines providing complementary services; growth of machine sharing across financial institutions;
3. ATM_3 : (1997- to date): machines connected to Internet (financial kiosks); total machine sharing through the LINK circuit.

[5] Available at www.apacs.org.uk.

Turning to the patterns of adoption and use, Figure 6 shows the growing capacity of the ATM network in the UK contrasted with the shrinking extension of the circuit of traditional brick-and-mortar facilities (Source: APACS).[6] The pattern of diffusion of the ATM in the Figure resembles a threefold family of S-shaped curves linked in correspondence of where the older curve approaches saturation and a new type of ATM is introduced, as in 1985 and 1996. This is not a new feature to anyone familiar with the class of models described by Metcalfe (1981; with Cameron, 1987) in which the pattern of diffusion generated by the interaction between demand and supply is *de facto* a process of substitution between incremental technologies.

FIGURE SIX ABOUT HERE

A similar model characterizes the pattern of actual used capacity of the ATM network with a threefold S-shaped curve in Figure 7, where the curves meet in correspondence of the transition from ATM_1 to ATM_2 and then to ATM_3 (clearly, the use lags of a couple of years behind the introduction of the new machines).

FIGURE SEVEN ABOUT HERE

As interesting insight on the technological evolution of the ATM in the UK is given by Figure 8, which shows the pattern of emergence of additional services (as anticipated above for the case of the ATM_2) in the deployed machines (expressed here in terms of percentage of the overall population of machines). The trend of integration of such services in existing machines has been growing over the 1990s, with an impressive acceleration after the entry of the ATM_3 in 1997. Already at the beginning of the decade a large number of machines featured basic services such as Balance (85% of the existing machines in 1990) and Statement Provision (72%) as well as other add-ons. At the end of the 1990s we notice the growing expansion of extra-bank transactions such as Bill Payment (62% of the existing machines in

[6] In a recent manuscript (Consoli, 2005c) I portrayed the changing organization of the system of retail payments in the UK as essentially driven by three evolving forms of increasing returns, namely economies of scale, of

2000), Inter-account transfers (61%), arguably facilitated by the emergence of Internet-based machines.

FIGURE EIGHT ABOUT HERE

Discussion: melioration and feedback in consumption

The application of network technologies in UK retail banking has undoubtedly stimulated the emergence of new patterns of demand for automated services (Essinger, 1992; Evans and Schmalensee, 1999; Radu, 2002). As it emerges clearly from the data, however, the transition towards electronic banking is far from being complete in the UK, and the picture is certainly in open contrast with that foreseen by cashless-society enthusiasts. The role of demand plays an important role in this scenario. The era of electronic banking has been characterized by an incremental process of assimilation of new technologies through the creation of new practices within the existing realm (Consoli, 2005b). As has been observed in the previous section, new modes of service provision often grow out of existing ones and become subsequently established as complements, rather than substitutes, for them. This is likely to occur when the learning associated with one routine is exhausted by customers – also as a result of the interaction with other customers – and they are ready to deal with alternative ways of service provision.

It is difficult to interpret this empirical evidence with the standard tools of the optimization. The neoclassical construct on the analysis of demand (see e.g. Stigler and Becker, 1977) is founded upon the assumption that consumers are endowed with all the necessary knowledge to make their intertemporal choices. In other words there is very little room for learning and experimentation. Yet in the case in point, each individual's ability to deal with innovation plays a key role. Learned behaviours in the context of daily banking transactions, such as

scope, and of system. For an overview of the latter see Davies(1996).

payments, are likely to emerge out of social practices and the involvement in groups of customers who share common patterns of consumption[7]. In this perspective, past and shared experiences moulds the future patterns of demand as well as offering important feedback to providers who are engaged with the task of creating either new services or new ways of providing existing ones.

In addition to that, very often utility theory does not explain with great clarity what the object of choice in consumption is. Most of the times this is readily referred to "individual purchases of commodities" (see e.g. Deacon and Muellbauer, 1980). As such, the standard microeconomic textbook's account in terms of an optimization under a budget constraint imposes on the representative agent the rather demanding task of being able to select the intertemporal pattern of consumption that yields the maximum level of utility. This broad definition overlooks an important aspect of the story: as consumption often involves multiple activities, the problem each consumer faces is not to select one product over another but to carry out a set of interdependent choices spanning search, trial and purchase. All together these form the consumption bundle.

A promising alternative seems to elaborate the notion of consumption routines in the wider evolutionary picture outlined before to explain the emergence of organizational capabilities in daily decision-making. The proposition made here is that banks' customers (and indeed consumers in general) should be seen as repositories of routines which are subject to selective pressure *pace* learning by doing. The mechanism in place is thus one in which routines are partly replicated and partly dismissed as new and better ones emerge. The broader picture is one in which the evolution of economic systems is associated with biological models of ecological succession. Evolution deals with the transition which systems go through, from an

[7] Cowan et al (1997) distinguish the effects of consumption choices relative to the co-existence of reference groups: a peer group of similar consumers, a contrast group and an aspirational group.

immature stage to the stabilization of the prevailing configurations; from the growth of new behaviours to the emergence of alternative configurations of the system. Innovation usually emerges in one area of a business and tends to expand within a production or consumption system when shared resources can be exploited. The way in which population dynamics bring about interactions at different levels, often result in an array of possible outcomes, including intra-area competition, inter-area competition but also cooperation (Andersen, E.S., 2003).

Put in the context of this case study, heterogeneity among consumers stimulates the supply of idiosyncratic groups of products. Indeed, the various generation of ATMs outlined before are good examples of artifacts that offer cumulatively enhanced access to a range of partially overlapping services. The scope for substitution depends on the redistribution of preferences and of capabilities across consumers due to the emergence of complementary yet idiosyncratic products. The framework that is proposed here links the process of preference formation to the development of specific capabilities relative to artifacts embodying more sophisticated ways of accessing the payment services. This interpretation of the process of decision making is centred upon the melioration hypothesis, according to which individuals make choices following more prosaic rules of thumb (see e.g. Herrstein and Prelec, 1991; Herrnstein, 1997; Metcalfe 2001a). In particular:

1) they value the average satisfaction received per unit of investment in each alternative;

2) they shift behaviours as an alternative yields a higher return.

By following these simple rules we can accommodate two important stylized facts of consumption: (1) the indivisibility of choices, that is the impossibility to disentangle consumption activities that by their very nature are strongly interdependent with others[8]; (2) the cumulability of choices that over time bias each consumer's set of preferences and

[8] For example, using internet banking involves having a Personal Computer and knowing how to use it (see Consoli 2005b on Internet banking in the UK).

capabilities. As a matter of fact such rules do not ensure that the consumption pattern is optimal in the sense of being the best possible choice among all available. In this type of analysis intertemporal consumption choices are rather consistent with past experiences and with the bundles of complementary activities already in place.

It is not surprising that these are some of the defining features of the process of growth of technological knowledge as it has been described by various scholars of innovation. After all, knowledge is a primary input in the determination of choices by agents engaged with economic action, and there is no reason why this should not apply to producers and consumers alike. Given this background, the objective of the last section is to conceptualize how experience and learning drive intertemporal consumption in front of new, idiosyncratic, services. The wider scope is to lay down some foundations of a theory of demand that can best accommodate conceptually the behaviour observed empirically.

A FORMAL ANALYSIS FOR RETAIL BANKING SERVICES

Let us now turn to see how the outlined theoretical framework fits the empirical evidence presented above by means of a simple formal analysis. Consider the utility function (1) associated with a bundle of N banking commodities (e.g. products or services) whose level is determined by the scale of consumption activity relative to q_i weighted by the value function v_i that each individual will assign to each commodity.

$$U = \Sigma\, q_i\, v_i(q_i) \qquad , (i \in N) \tag{1}$$

$$q_i = f_i \ [\, c_{i1}, c_{i2}, \ldots, c_M\, , c_N \ (n_{i1}, n_{i2}, \ldots, n_M\, , n_N\, ;\, s_{i1}, s_{i2}, \ldots, s_M\, , s_N)] \tag{1'}$$

The value function v_i depends on the distribution of all the commodities in the bundle. In particular, it is assumed that the value of each commodity is determined by a combination of characteristics that are partially shared with other commodities (capital subscript in the formula) in the bundle, and partially unique to each specific product (small subscript). Under

the hypothesis of bounded rationality, the agent will not know simultaneously the marginal attributes of each commodity, but rather their average value v_i (see Metcalfe, 2001a).

The value of the *i-th* commodity is determined by costs *c* associated with the use of a specific mode of service provision, including the learning process relative to use a new artefact or the search for facilities deployed in unknown areas. These costs, in turn, will depend on two complementary features: the number of times *n* that a certain mode of service provision is used, which accounts for the personal experience of the consumer together with the shared inputs *s* of being part of a group of customers ranging from common knowledge – i.e. recognizing the numbers, understanding the language of the instructions – to extremely idiosyncratic knowledge such as the PIN number[9]. Let us suppose also that each generic agent *i* chooses to allocate a fixed total amount of time T to non-leisure activities – as it seems plausible to think of banking transactions – per month:

$$T \geq q_0 t_0 + q_1 (t_1 (c_1)) \qquad (2)$$

where T will be no smaller than the overall time opportunity cost associated with each mode of service provision, t_i is the opportunity cost relative to time consumption of activity *i*, q_i the units of commodity *i* purchased, i.e. the amount of transactions relative to provision mode *i*, and $c_{j \neq I}$ the additional cost of learning how to use a new artefact. The conjecture is that the consumer will allocate time – hence will purchase units of each good – between the two complementary modes of service provision. Spelt out in more detail, the constraint in equation (2) sets a functional relationship between the time associated with the use of the familiar banking service and the costs associated with the shift to a new one. Take cash withdrawal as an example in relation to Figure 9, where provision mode 0 is human teller (*ht*) and mode 1 is automated machines (*am*). The overall allocation of time between these two

[9] Brenner (1999) considers a similar interaction of heterogeneous effects in habit formation, namely reinforcement strengths.

will depend on the cost associated with using the technology. Assume that provision mode 0 (human teller) has a constant marginal cost and that 1 (automated machine) instead has a decreasing marginal cost to use relative to the number of times *n* the service is accessed. It seems plausible to assume that initially the allocation of time will be in favour of the traditional service *ht* until the marginal cost relative to the automated machines reaches a threshold of accesses *n** beyond which the preference will be given to *am*. Hence, as a general rule $t_i > t_j \Rightarrow q_i < q_j$ $(i, j = 0,1; i \neq j)$.

FIGURE NINE ABOUT HERE

In the Figure the vertical distance between the upper time constraint limit T and the lowest of the marginal "cost of use" curves determines the composition of the consumption bundle. Two observations are in order at this point. The critical value of *n* is a proxy for the cost of learning *c* as in equation (1'), hence it will also depend on the shared inputs of knowledge *s*: *n** will thus be different for each consumer since the composition of the consumption bundle will vary accordingly with the inputs *s*. Moreover, the vertical dotted line at the end of the time opportunity marginal cost indicates the case (plausible but not certain) in which the vast majority of consumers enjoy the automated service provision inducing bottlenecks at some level $n^{\wedge}$ in the access to such machines. Accordingly, the combination of these two effects determines a change in the rate of substitution of the two commodities due to the presence of a differential cost in the time opportunity which elicits non-linearities in the budget constraint. Figure 10 shows that the time budget line is kinked in correspondence of q^*_1 which corresponds to the critical number of accesses that would yield positive returns to the use of that specific mode of service provision. Would learning effects have not been observed and neither been relevant, the constraint would have been linear and the highest feasible indifference curves would have been lower (like u_0 in Figure 10).

FIGURE TEN ABOUT HERE

Summing up, when learning mechanisms are at work technological change can induce local efficiency gains in consumption. The cost of learning depends on the average values of two components such as the time dedicated to transactions (pertaining to the individual's sphere of action) and the inputs of shared knowledge (as a result of being part of a community).[10] Considering the overall effects of technological change, if the learning threshold is low enough in the long run automated services should prevail in the overall composition of the consumption bundle[11]. The effects of learning outlined above can, thus, determine either the coexistence of two complementary modes of service provision or a shift of preferences towards one of the two. Moreover, an alteration in the perceived characteristics of one commodity will determine a bias in the share of importance of one product with respect to others. This argument can also be developed by means of a simple formal treatment.

As outlined before, according to the melioration hypothesis consumers distribute their endowment between alternatives of consumption guided by bounded rationality and they will decide on the basis of the average reward of an activity, rather than of its marginal return. In this case, the coexistence of two goods in the bundle is possible so long as their average rewards $v_{i,j}(q_{i,j})_{i \neq j}$ equalize. Hence, in the case under observation, also considering the time constraint, it will be

$$v_0(q_0) = v_1(q_1) \tag{3}$$

$$\alpha_0 q_0 + \alpha_1 q_1 = 1 \tag{4}$$

where $\alpha_i = t_i / T$ is the proportion of time budget that is destined to commodity i. The adjustments generate irreversibility when a commodity experiences positive feedback of

[10] The figure also accounts for the aforementioned emergence of bottlenecks in the provision of the automated service when consumption is subject to positive feedback for a critical number of adopters $n^{\wedge}$.
[11] For the sake of simplicity, the qualitative effects due to the increase of the range of transactions available with new machines will be left aside.

consumption out of the demand-supply dynamics previously outlined. Accordingly the activities whose average reward is higher will increase their share in the bundle.

The dynamics of the time allocated to each activity $z_i = \alpha_i q_i$ can be expressed by the simple replicator dynamics

$$\frac{dz_i}{dt} = \gamma z_i \left\{ v_i\left(\frac{z_i}{\alpha_i}\right) - \bar{v}\left(\frac{z_i}{\alpha_i}\right) \right\} \qquad (5)$$

where $\bar{v}(z_i) = \Sigma z_i v_i(z_i)$ and γ is a rate coefficient. This expression is the engine of the theoretical construct as it embodies the trial-and-error mechanism that determines over time the relative share of one activity within the overall bundles of activities. In typically evolutionary fashion, their relative importance over time depends on the distance from the average level of valuation across all the other activities. Applied to the case under analysis, this rule embodies the stylized fact that the commodity whose marginal utility is higher will be preferred. But this switch is likely to be gradual as learning by doing and experience allow for higher returns from the new activity. In other words, when the average reward associated with an activity is systematically higher than the others the preference towards this specific activity grows in relative importance across the whole consumption bundle (Metcalfe, 2001a). Therefore in the context of retail payment services the ability (or the inability) to use automated machines determines endogenously the preference towards this type of demand. The latter can be sharpened formally. Suppose, as it happens in the case of cash withdrawals, that some consumers face decreasing marginal costs to the use of the automated mode of service provision. This will yield a lower proportion of time budget for activity 1, α_1 in equation (4). Accordingly, activity z_1 will experience positive feedback from consumption as its average reward is higher. Taking these adjustments in terms of equations (3) and (4), where the derivative of the value function is denoted as $\partial v_i / \partial x_i = v'_i$, we have:

$$\begin{pmatrix} v'_0 & -v'_1 \\ \alpha_0 & \alpha_1 \end{pmatrix} \begin{pmatrix} dq_0 \\ dq_1 \end{pmatrix} = \begin{pmatrix} 0 \\ -q_1\, d\alpha_1 \end{pmatrix} \tag{6}$$

The effects of a decrease in the marginal "costs of use" of automated services induces the reinforcement of activity z_1 , as can be seen from the signs of the derivatives expressing the change in activity levels relative to changes in α_1:

$$d\,q_0 / d\,\alpha_1 = -\,(q_1\, v'_1 / \Delta) < 0 \tag{7a}$$

$$d\,q_1 / d\,\alpha_1 = (q_1\, v'_0 / \Delta) > 0 \tag{7b}$$

where $\Delta = (\, v'_0\ \alpha_1 + v'_1 \alpha_0\,) > 0$ is the determinant of the system.

The bottom line is that reinforcement in the consumption of a particular product is determined by a combination of individual factors, such as learning effects, together with features that result out of the interaction (direct and indirect) with other customers. This observation seems pertinent with the fact that complementary goods or services entail a common knowledge base while retaining an idiosyncratic character with respect to some characteristic, or some combination of them. Arguably, the mechanism of preference formation in this specific case is partially endogenized by the development of capabilities through learning mechanisms related to the costs *c*. In other words, the fact that a customer will choose one product will depend also on the degree of skilfulness. A variation in the bundle of characteristics of the new product will determine a change in customers' capabilities embodied in the quality variation altering endogenously, thus, the balance between the economic purpose (e.g. money withdrawal) and the endowment (e.g. the capabilities) of each agent[12] (Sen, 1985; Langlois and Cosgel, 1998).

[12] Arguably, if increasing returns are at work, the plan of intertemporal choices made by agents will affect also habit formation and the way consumption capabilities are learned (Pollak, 1970; Becker, 1976). These

The importance of learning mechanisms in consumption choices can be related to the concept of "availability heuristic" according to which choices and, thus, the information that is necessary, are restricted to the availability in agent's recent experiences (Tversky and Kahneman, 1974; Kuran, 1991). More generally the outlined economic scope of an agent, consisting in the relation between individual endowment - encompassing time, wealth and information - and the objective that an economic activity is carried out for, accrues more meaning to the distinction between preferences and choices in consumption. These two are often considered the same as they fall into the wider argument of consistency whereas, Sen (1973) argues that one specific need determines the preference for a good instead of another within a fixed functional purpose[13]. However, from the foregoing discussion it emerges that preferences are not always revealed through choices. Other complementary issues need be considered in the mechanisms of choosing and consuming, not least the constraints and the externalities stemming from the evolution of the economic scope of each agent, both individually and as part of several - sometimes overlapping - communities of consumption. In this dynamic account of how consumption patterns are created, dismissed, substituted and complemented, the emergence of capabilities through learning is a fundamental bridge across the various stages of incremental changes in demand.

CONCLUDING REMARKS

This paper has sought to provide a heuristic approach towards some unresolved issues of the theory of demand. Consumers, it was argued here, carry out an activity which is as organized as at least that of producers. The paper has taken on the case of small payment technologies in the UK banking system to provide useful insights on the consumption choices by boundedly

considerations may be extended to consider the ramifications of these changes in consumption behaviour including the emergence or the modification of a lifestyle (Earl, 1986).

[13] According to Sen, preferring a good *x* to *y* is inconsistent with preferring *y* to *x* as long as the choice is referred to a specific need whereby when the need changes reversal of preferences need not be inconsistent.

rational agents who choose between complementary non-leisure products according to the dynamic interplay between technical capabilities and preferences guided by learning by doing.

Similar to what happens in the context of firms, central to this perspective is the accumulation and creation of new knowledge. In the analysis developed here the implementation of new consumption habits depends largely on the development of specific capabilities and the way in which consumption practices – and economic choices at large – are embedded within an institutional and social context (Granovetter, 1985; Warde, 2003; McMeekin and Southerton, 2003; Redmond, 2003). Each individual's consumption strategy can be fruitfully seen as the result of a mix of personal experience, willingness to experiment and the degree of social interaction. In this perspective, the analysis developed in the paper could be applied to different industries characterized by a growing variety of consumption choices, provided that empirical evidence on the patterns of consumption are available. In turn, the element that distinguishes the demand for banking services from, say, the demand for entertainment is the absence of leisure. Future research willing to incorporate this element would have to go further down the road of psychological and sociological based approaches to the theory of consumption.

How far, then, is it possible to stretch the indications emerged from this case study? The empirical and formal analysis demonstrate the presence of hierarchy in consumption, especially when preferences and capabilities, rather than being superimposed, co-evolve in the determination of demand. The adaptive nature of agents who learn by consuming entails an organization of consumption activities which is rather heuristic, based on the calibration of resources and objectives to the opportunities provided by the market. In turn, the mismatch between agents' plans and the actual outcome of the market interaction generates the developmental feedback that induces endogenously the emergence of new habits and rules of consumption from within.

Framed in a broader picture, the paper looks at how the impulse of innovation elicits the growth in variety and capacity of the output in proportion to the speed of adjustment of the current set of activities (Metcalfe et al, 2003). Such a process, far from being deterministic, depends upon the qualitative components of economic growth encompassing producers' and consumers' learning, just as outlined in the present work. This is not just the preserve of theoretically-concerned scholars, but is a matter of dispute which bears practical relevance for practitioners and policy-makers alike. A detailed account of how the impulse of innovation paves the way to new patterns of behaviour in repeated forms of consumption serves this purpose and, hopefully, opens the way for a new line of research.

ACKNOWLEDGEMENTS

An earlier version of this paper benefited from comments by the participants of the DRUID Academy Winter Conference in Aalborg (Denmark) in January 2004, and in particular by Edward Steinmueller and Giampaolo Garzarelli. I am also indebted to Cristiano Antonelli, Franco Malerba, Stan Metcalfe, Dale Southerton, two anonymous refeerees and the editor of this journal for constructive suggestions over various redraftings. The collaboration of APACS, the UK payments association, for having kindly provided supplementary statistics is gratefully acknowledged. The usual disclaimer applies.

REFERENCES

Andersen, E.S. 2003: Railroadization as Schumpeter's standard case: An evolutionary-ecological account, *Industry and Innovation*, 9: 41-89.

Andersen, P.H. 2003: The embeddedness of selfish routines: how routines are replicated in business networks, *Industry and Innovation*, 10: 159-177.

Antonelli, C. 2001: *The microeconomics of technological systems.* Oxford: Oxford University Press.

Association for Payments and Clearing Systems (APACS), Payments: Facts and Figures, available at www.apacs.org.

Becker, G. 1976: *The economic approach to human behaviour*. University of Chicago Press.

Brenner, T. 1999: Consumer Behavior, Reinforcement Learning and the Dynamics of Fashion, Papers on Economics and Evolution. Working Paper No. 9903, Max Planck Institute.

Bianchi, M. (ed.) 1998. *The Active Consumer*. London: Routledge.

Consoli, D. 2005a: Technological cooperation and product substitution in UK retail banking: the case of customer services, *Information Economics and Policy* 17(2), 199-216.

Consoli, D. 2005b: The dynamics of technological change in UK retail banking services: an evolutionary perspective, *Research Policy* 34 (4), 461-480.

Consoli, D. 2005c: Changing boundaries and structure of a technological system: lessons from UK retail banking, Paper prepared for the 2005 DRUID Summer Conference, Copenhagen.

Coombs, R. and Metcalfe, J.S. 1998: Distributed Capabilities and the Governance of the Firm, Discussion Paper No 16, Centre for Research on Innovation and Competition, University of Manchester and UMIST, http://les1.man.ac.uk/cric/dp16.htm.

Cowan, R., Cowan, W., Swan, P. 1997: A model of demand with interactions among consumers, *International Journal of Industrial Organisation*, 15: 711–732.

David, P.A. 1975: *Technical Choice, Innovation and Economic Growth: essays on American and British experience in the nineteenth century*. Cambridge: Cambridge University Press.

Davies, A. 1996: Innovation in large technical systems: the case of telecommunications, *Industrial and Corporate Change* 5 (4): 1143-1180.

Deaton, A. and Muellbauer, J. 1980: *Economics and Consumer Behavior*. Cambridge University Press.

Dosi, G. 1997: Opportunities, Incentives and the Collective Patterns of Technological Change, *Economic Journal* 107(444): 1530-1547.

Dosi, G. and Metcalfe, J.S. 1991: On some notions of irreversibility in economics in Saviotti, P.P. and Metcalfe, J.S. (eds.): *Evolutionary Theories of Economic and Technological Change*. Harwood Academic Publishers.

Dosi, G., Aversi, R., Fagiolo G., Meacci , M., and Olivetti, C. 1999: Demand dynamics with socially evolving preferences, *Industrial and Corporate Change*, 8: 353-408.

Earl, P.E. 1986: *Lifestyle Economics*. New York: St. Martin's Press.

Essinger, J. 1992: *Electronic Payment Systems: winning new customers*. Chapman and Hall.

Evans, D. and Schmalensee, R. 1999: *Paying with Plastic: The Digital Revolution in Buying and Borrowing*. The MIT Press.

Foss, N.J. and Eriksen, B. 1995: Competitive Advantage and Industry Capabilities in *Resource-based and Evolutionary Theories of the Firm: Towards a Synthesis*, Cynthia A. Montgomery, (ed.). Boston: Kluwer Academic Publishers.

Frazer, P. 1985: *Plastic and Electronic Money: new payment systems and their implications.* Woodhead-Faulkner, Cambridge.

Herrnstein, R.J. and Prelec, D. 1991: Melioration: a theory of distributed choice, *Journal of Economic Perspectives*, 5: 137-56.

Herrnstein, R.J. 1997: *The matching law*. Harvard University Press, Boston

Hildenbrand, W. 1994: *Market demand*. Princeton University Press, Princeton.

Granovetter, M.S. 1985: Economic Action and Social Structure: The Problem of Embeddedness, *American Journal of Sociology* 91:481-510.

Kuran, T. 1991: Cognitive limitations and preference evolution, *Journal of Institutional and Theoretical Economics*, 146: 241-273.

Langlois, R.N. 2001: Knowledge, consumption and endogenous growth, *Journal of Evolutionary Economics*, 11(1): 77-93.

Langlois, R.N. and Cosgel, M.M. 1998: The organization of consumption, in M. Bianchi (ed.) *The Active Consumer*. London: Routledge.

Langlois, R.N. and Nicolai J. Foss. 1999. Capabilities and Governance: the rebirth of production in the Theory of Economic Organization. Kyklos, 52(2): 201-218.

Llewellyn, D. 1999: *The New Economics of Banking*. SUERF, Amsterdam.

Loasby, B.J. 1998: Cognition and innovation, in M. Bianchi (ed.) *The Active Consumer*. London: Routledge.

Loasby, B.J. 2000: Market Institution and economic evolution, *Journal of Evolutionary Economics*, 10: 297-309.

Lundvall, B. 1988: Innovation as an interactive process: from user-producer interaction to the national system of innovation in Dosi G. et al. (eds.) *Technical change and economic theory*. Pinter: London.

Mathews, J.A. 2002: A resource-based view of Schumpeterian economic dynamics, *Journal of Evolutionary Economics*, 12: 29-54.

McMeekin, A. and Southerton, D. 2003: Innovation, demand and final consumption, Mimeo, Centre for Research on Innovation and Competition, University of Manchester and UMIST.

Metcalfe, J.S. 1998: *Evolutionary Economics and Creative Destruction*, The Graz Schumpeter lectures. Routledge: London and New York.

Metcalfe, J.S. 2001a: Consumption, preferences, and the evolutionary agenda, *Journal of Evolutionary Economics*, 11: 37-58.

Metcalfe, J.S. 2001b: Evolutionary approaches to population thinking and the problem of growth and development, in Dopfer, K., (ed.) *Evolutionary Economics: Program and Scope*. Boston: Kluwer.

Metcalfe, J.S. 2002: Knowledge of growth and the growth of knowledge, *Journal of Evolutionary Economics* 12 (1): 3-15.

Metcalfe, J.S. and Georghiou, L, 1998: Equilibrium and Evolutionary Foundations of Technology Policy, *Science Technology Industry Review*, 22: 75-100.

Metcalfe J.S, Foster, J. and Ramlogan, R. 2003: Adaptive Economic Growth, CRIC Discussion Paper No. 59, University of Manchester and UMIST, http://les1.man.ac.uk/cric/dp59.htm.

Nelson, R. and Winter, S. 1977: In Search of a Useful Theory of Innovation, *Research Policy* 6: 36-76.

Nelson, R. and Winter, S. 1982: An Evolutionary Theory of Economic Change. Cambridge: Harvard University Press.

Nelson, R. and Winter, S. 2002: Evolutionary Theorizing in Economics. *Journal of Economic Perspectives* 16, no. 2: 23-46.

OECD (Organisation for Economic Co-Operation and Development) 1989: *Electronic Funds Transfer: Plastic Cards and the Consumer: Plastic Cards and the Consumer*.

Pavitt, K. 2005: Innovation Processes. In Fagerberg, J., Mowery D.C. and Nelson, R. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Perez, C. 1983: Structural Change and Assimilation of New Technologies in the Economic and Social Systems. *Futures*: 357-375.

Pollack, R.A. 1970: Habit formation and dynamic demand functions, *Journal of Political Economy*, 78: 745-763.

Radu, C. 2002: *Implementing Electronic Card Payment Systems*. Artech House.

Redmond, W. 2003: Innovation, Diffusion, and Institutional Change. *Journal of Economic Issues* 37 (3): 667-679.

Schmookler J. 1966: *Invention and economic growth*. Harvard University Press: Boston.

Stigler,G.J. and Becker,G.S. 1977: De Gustibus Non Est Disputandum, *American Economic Review*, 67: 76-90.

Sen, A. 1973: Behaviour and the concept of preference, *Economica*, 40: 241-259.

Sen, A. 1985: *Commodities and capabilities*, Amsterdam: North-Holland.

Swann, P. 1999: Marshall's consumer as an innovator, in Dow, S., Earl, P. (eds.) *Essays in honour of Brian Loasby*.

Tversky, A. and Kahneman, D. 1974: Judgments under uncertainty: Heuristics and biases, *Science*, 195: 1124-1131.

von Hippel, E. 1988: *The source of Innovation*. MIT Press: Cambridge, MA.

Warde, A. 2003: Consumption and theories of practice, Mimeo, Centre for Research on Innovation and Competition, University of Manchester and UMIST.

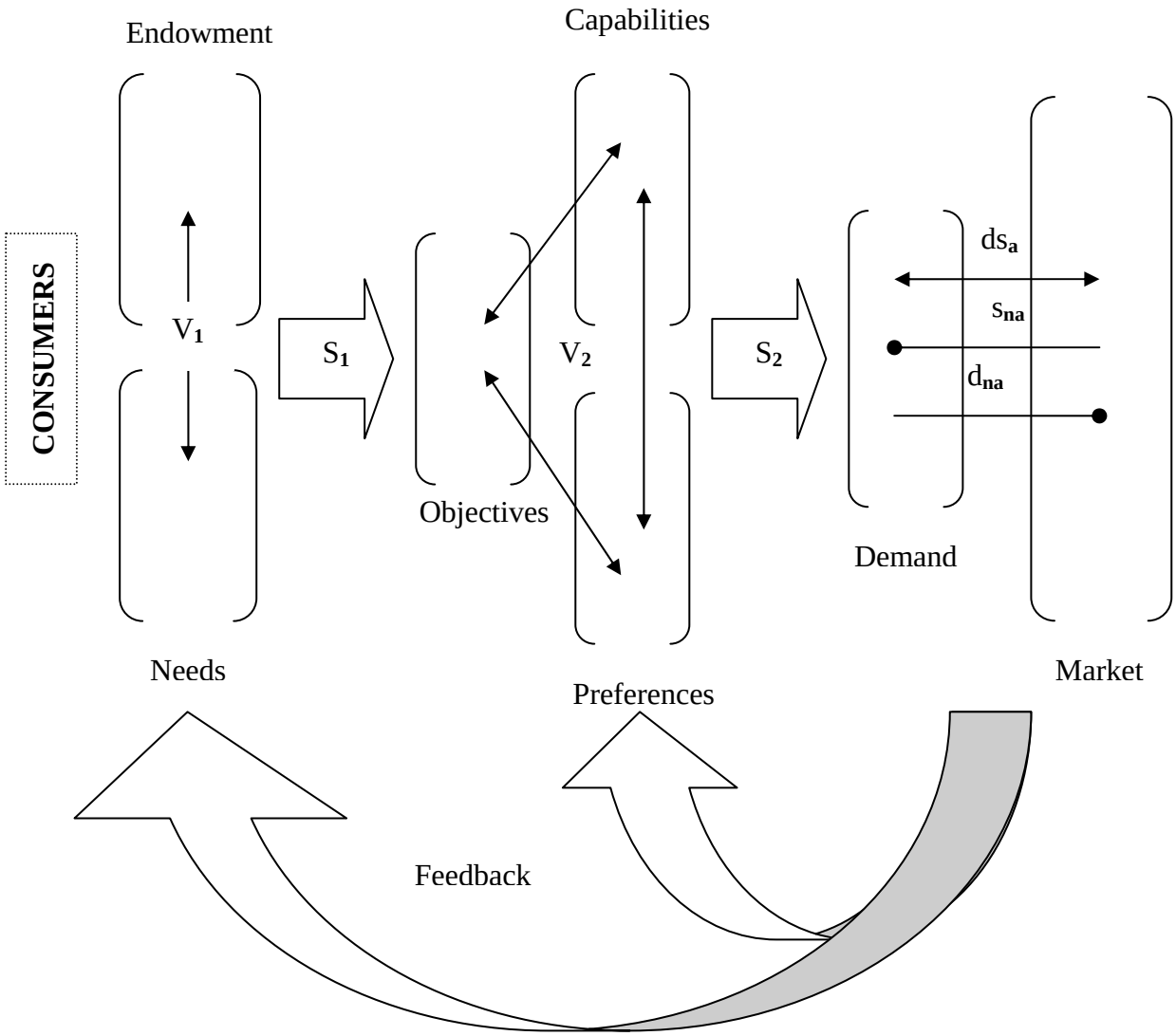


Figure 1 – Demand-side evolutionary dynamics

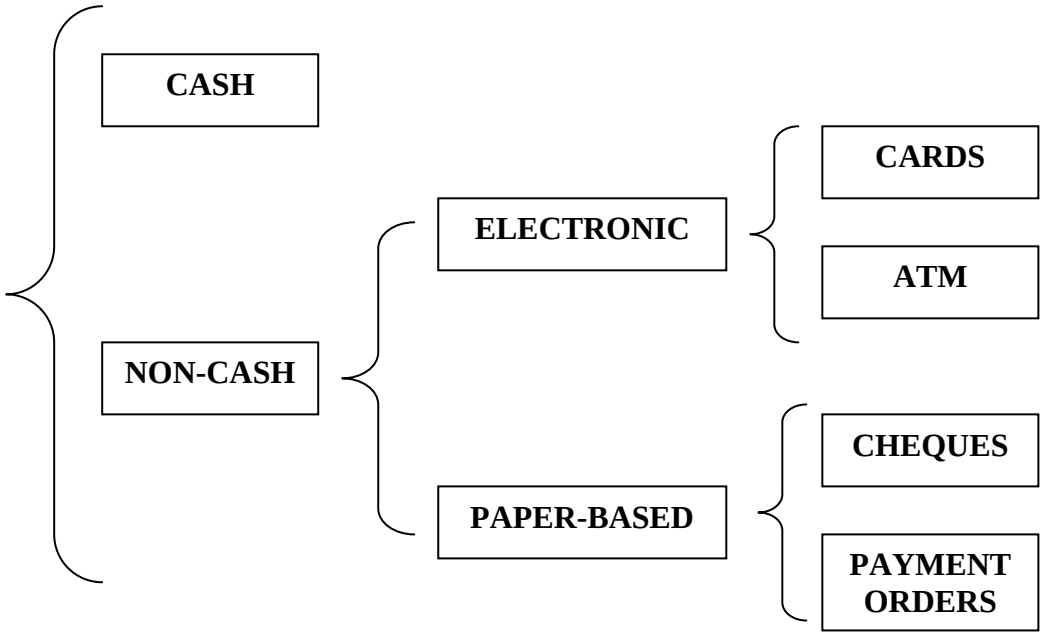
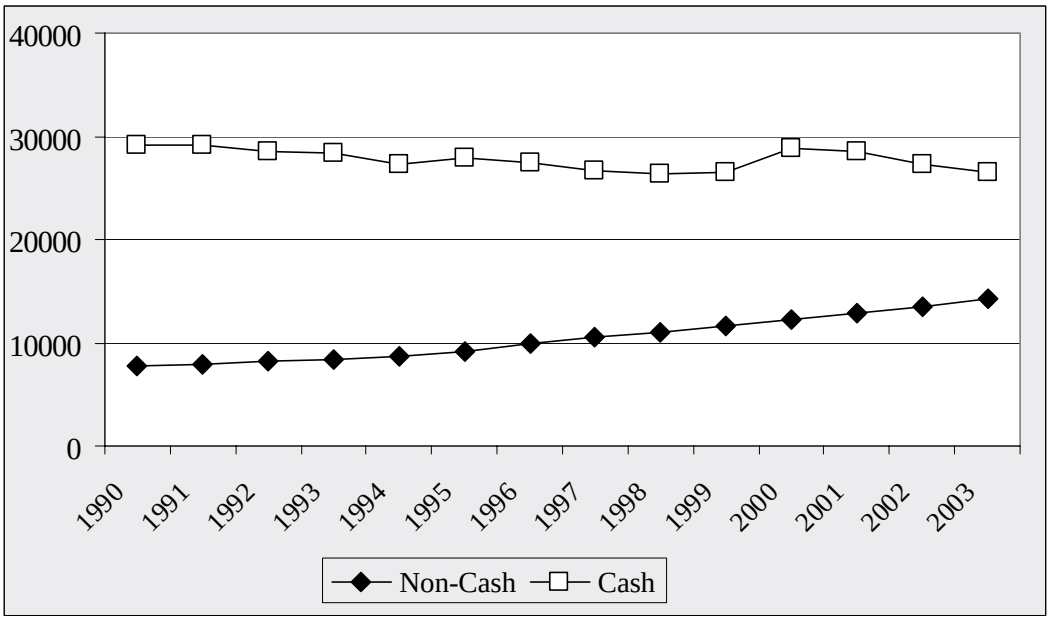


Figure 2 – The organization of Retail Payments in the UK

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Card Payments	934	1126	1320	1489	1723	2021	2413	2759	3094	3537	3914	4386	4814	5316
Card Withdrawals	1045	1112	1199	1277	1372	1512	1656	1809	1917	2025	2092	2250	2342	2457
Payment Orders	1741	1848	1962	2047	2196	2402	2613	2826	3056	3255	3470	3705	3930	4272
Cheques	3975	3882	3728	3559	3430	3283	3203	3083	2986	2854	2700	2565	2393	2251
Tot Non- Cash	**7695**	**7968**	**8209**	**8372**	**8721**	**9218**	**9885**	**10477**	**11053**	**11671**	**12176**	**12906**	**13479**	**14296**
Cash (Est)	29084	29078	28593	28417	27306	27883	27432	26606	26326	26558	28790	28475	27309	26549
TOT Payments	***36779***	***37046***	***36802***	***36789***	***36027***	***37101***	***37317***	***37083***	***37379***	***38229***	***40966***	***41381***	***40788***	***40845***

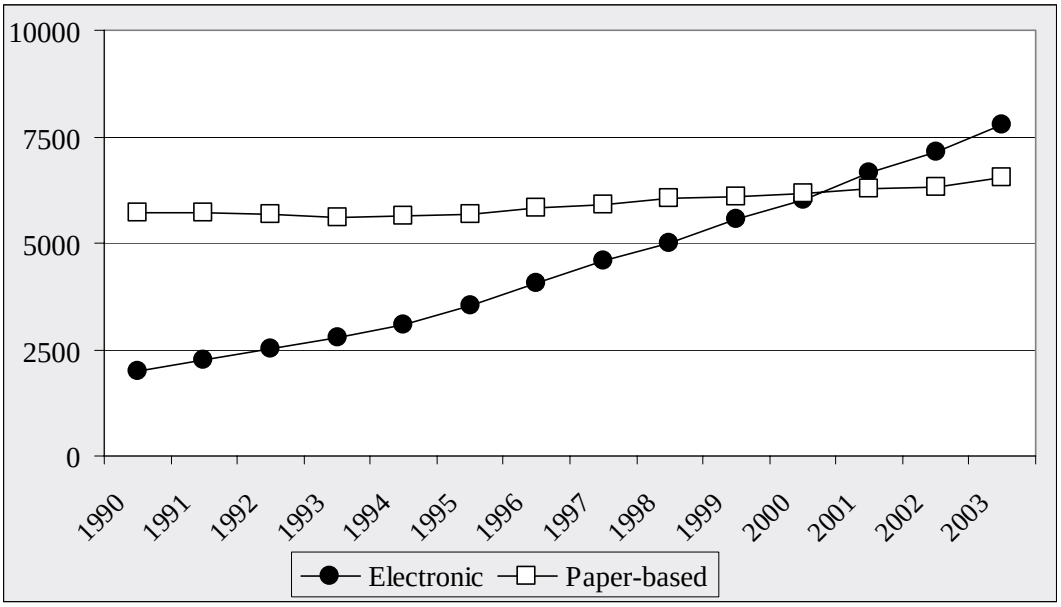
(Source: APACS)

Table 1 – Value of Retail Transactions: UK 1990-2003 (£ Millions)



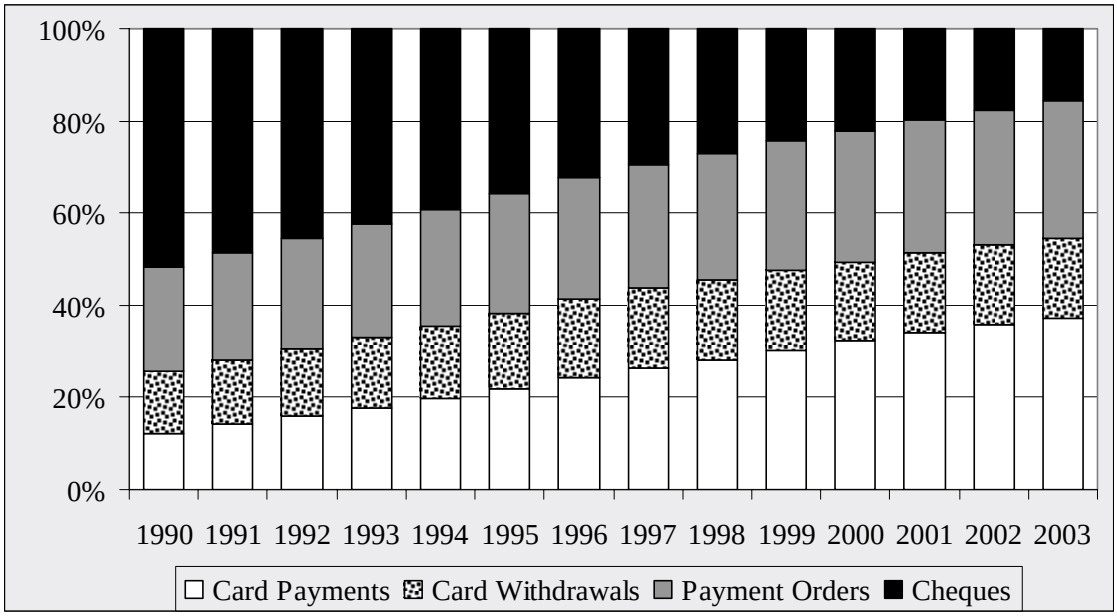
(Source: APACS)

Figure 3 – Retail Payments UK: Cash, Non-Cash 1990-2003 (£ Millions)



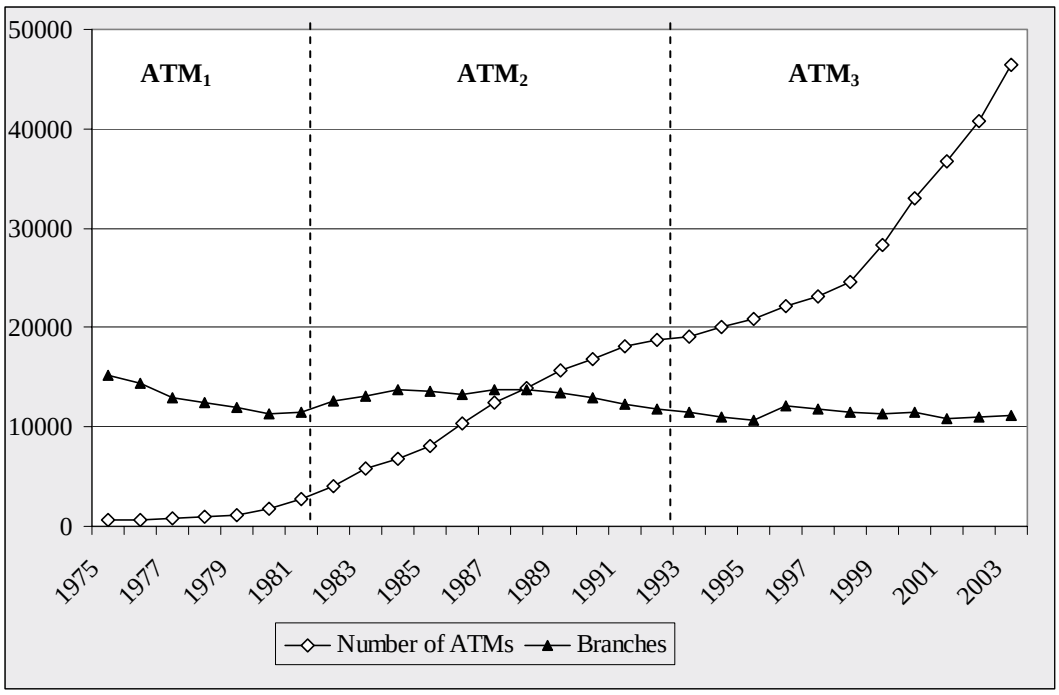
(Source: APACS)

Figure 4 – Non Cash UK Payments: Electronic, Paper-based 1990-2003 (£ Millions)



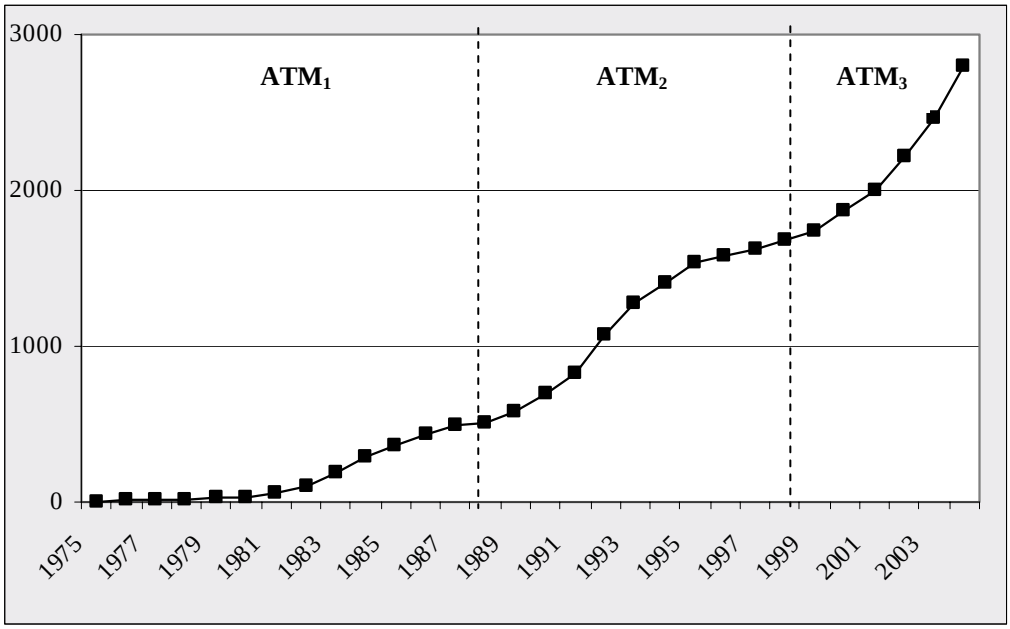
(Source: APACS)

Figure 5 – Non Cash UK Payments: Shares 1990-2003



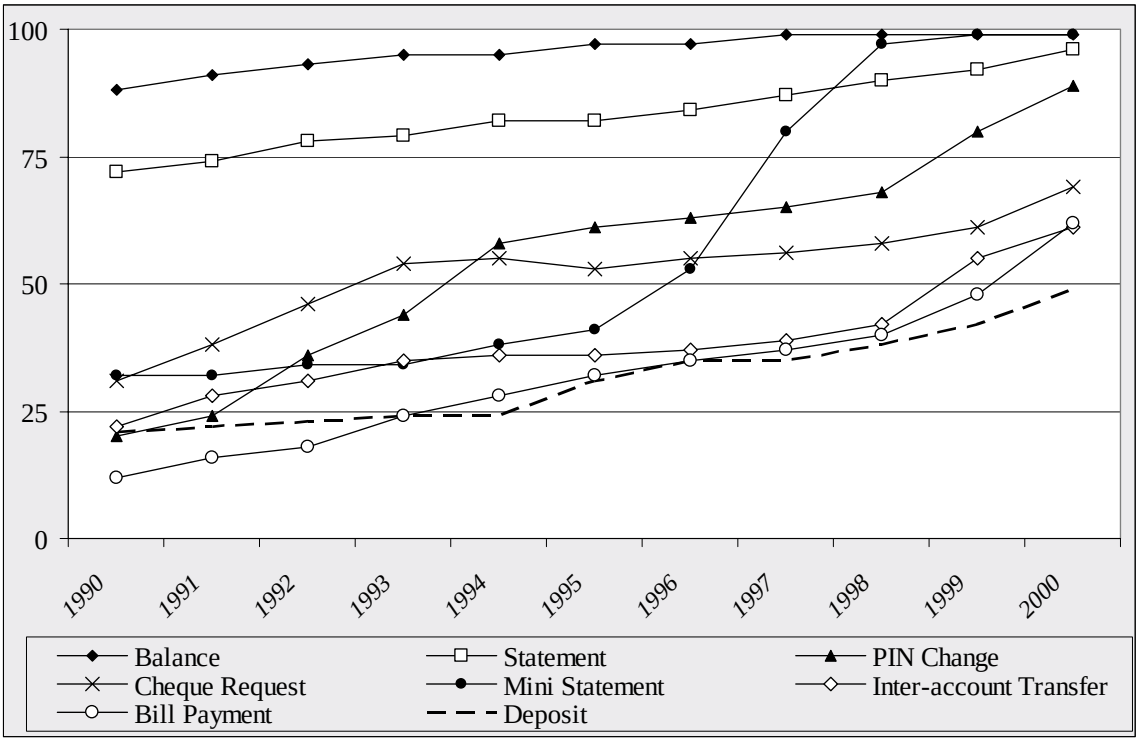
(Source: APACS, Supplementary Statistics)

Figure 6 – UK ATM network structure 1975-2003



(Source: APACS, Supplementary Statistics)

Figure 7 – UK ATM transactions 1975-2003 (Millions)



(Source: APACS)

Figure 8 – Additional Services on UK ATMs 1990-2000 (%)

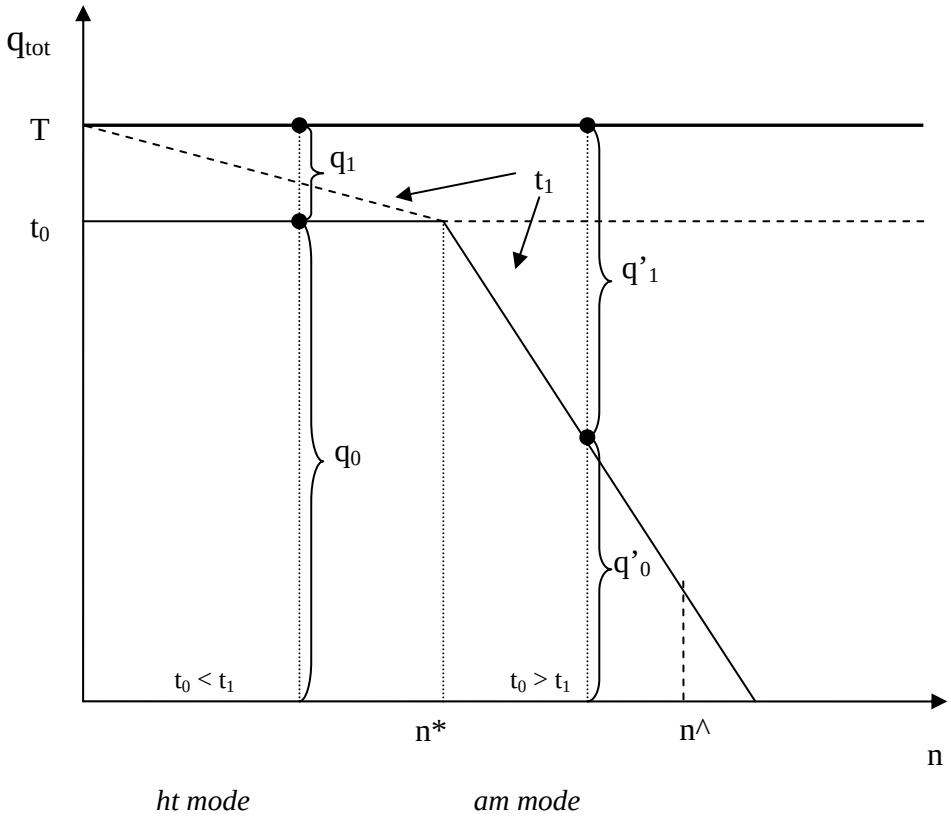


Figure 9 – Allocation of goods within the time budget constraint

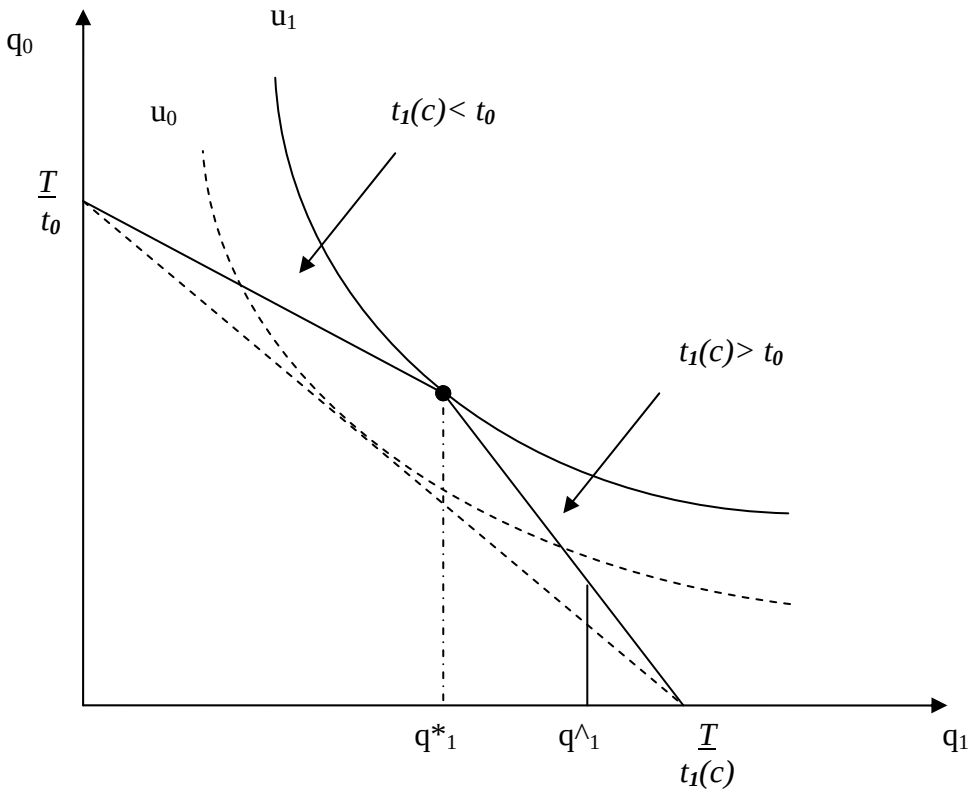


Figure 10 – Local efficiency gains out of learning