A user-based perspective on limits to the adoption of new technology

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Abstract: This theoretical paper investigates limits to adoption that new technologies are more likely to find from users of notionally out-of-date technologies. An interpretive framework is posited explaining that older technologies may continue to be used when: features of the old technology have superior complementarity or benefit from technological complexity; their community of users hold negative stereotypes of newer technology or the new technology has not created a strong enough contagion effect; expertise in the existing technology does not help use the new technology or use of the new technology requires high switching costs.

Keywords: knowledge; innovation; community of users; non-use; consumer expertise.

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1 Introduction

User adoption of new technology has been a serious field of study for management scientists, psychologists, social scientists and government agencies for more than 40 years. If it is accepted that private sector market research is intrinsically concerned with user adoption, then this genealogy can be set back at least 40 years more. In this time, the prime question has ever been: "What factors lead users to adopt a new technology?" Academic research into this question has yielded many important insights on the nature of ergonomics, quality, value, user learning and patterns of consumption. Leaders in this field argue that up to 70% (Venkatesh et al., 2003) of the variation in the adoption of new technology can be accounted for by models of *technological attributes*, *social conditions*, or *user learning*. Surprisingly, one of the least understood strands of new technology research is non-use of new products by consumers of categorically similar (price, function, availability) technology. To date, most empirical work has assumed that, for these consumers, eventually new technology will replace old. But what if for some, it does not?

This theoretical paper investigates limits to adoption that new technological innovations are more likely to find from users of notionally out-of-date technology. Selwyn (2003) argues that simply conceptualising such users as materially or cognitively deficient is far too crude an analysis. Moreau et al. (2001) also indicate that continued use of existing technology is not necessarily technophobia, as old technology users have often invested significant time in acquiring skills associated with a given category of technology. Thus, any future research into this group of users must be both underpinned by a sound understanding of the motivations behind technology use, but at the same time examine the more complex story behind non-use (Webster, 1995). Therefore, the objective of this study is to construct a theoretical understanding of the limits to the adoption of a new technology according to an older technology user perspective.

The work that follows constructs a frame of reference for the research question: what conditions limit the adoption of a technological innovation within a community of users? To do so, the paper first examines the classic literature explaining technological change and diffusion of innovation. Next, it examines user-specific explanations for technology adoption. These conditions are categorised as *technological*, *social* and *learning*. After the review of conditions more likely to lead to acceptance of new technology, an interpretive framework is proposed examining the extent to which the existing literature explains the continued use of older technologies, including well-known examples from a developed world consumer perspective. This examination provides logic to support six propositions that may explain variation in old technology use. These propositions form a rich picture on which future empirical research can be based. The paper concludes with managerial implications for producers of technological goods, both new and old.

2 Technological change and the adoption of innovations

The topic of innovation has, at one time or another, been explored through most of the major economic and management theory approaches (Table 1).

Table 1 Business economics and management and innovation

Approach	*Main authors*	*Central objective*	*Factors considered*	*Application to innovation*
Industrial organisation	Mason, Baine	Market structure	Competition, demand, market power	Influence of sectoral factors and public incentives
Transaction cost economics	Coase, Williamson	Existence and limits of the firm	Uncertainty, information asymmetries, bounded rationality, opportunism, specificity	Activity potentially generating transaction costs
Positive agency theory	Jensen and Meckling, Eisenhardt	Relations and conflicts between principals and agents	Information asymmetries, incentives	Source of information asymmetries
Resource-based view	Wernerfelt, Barney, Grant	Sources of competitive advantage	Resources, capabilities, core competencies	Importance of internal resources on technological capability
Evolutionary theory	Nelson and Winter	Evolution of the firm, analysis of technological change	Organisational routines, selection, diversity	Accumulation, path dependence, sources of knowledge, patters of innovation

Source: Adaptation of Galende (2006)

This being said, investigations of how innovations spread within a social system (such as an industry or a consumers market) are usually conducted according to two complementary points of views:

- the dynamics and processes by which a technological innovation enters into an industry
- the dynamics and processes by which an individual (or a community of individuals) adopts a technological innovation.

Both of these perspectives deserve attention given they frame assumptions that other authors work within when exploring technology use.

The diffusion of an innovation is the sum of more user adoptions within a market (Schumpter, 1934). Diffusion, thus, is considered the last step in many models of technology adoption (Rogers, 1995). Such models posit innovation as a social and economic process through which novel technologies rise and accrue within an industry, substituting former technologies. Technological change involves firms, adopters and others parties greatly affected by their cultural mindset and external contexts. It is possible to group the different approaches developed to explain the driving forces behind this phenomenon in three main ways.

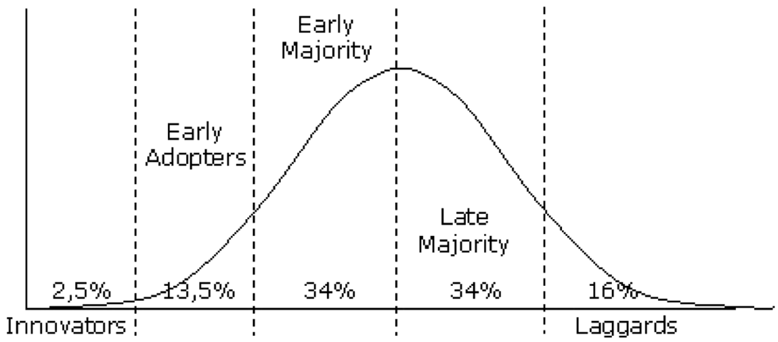
The first approach is called *technology-push*. Authors supporting this view argued that technological change mainly depends on firms (the supply of technological innovation) and their capability to promote innovation into the market. Schumpeter (1934) was one of the first to recognise how firms, through their *creative destruction*, contribute to transform an intention into an innovation and to support its diffusion within the market. This evolutionary process can lead to the development of an economic system.

An alternative view is the *demand-pulled approach*. In this view, the technological change and the diffusion of an innovation mainly depend on market needs and firms capabilities to satisfy them through technologically new products (Schmookler, 1962).

A third approach to technological change came from the *evolutionary economics* (Dosi, 1982; Nelson and Winter, 1982). This view has its theoretical roots in the Schumpeterian thinking. The scholars of this stream assert that the diffusion of an innovation is a *path-dependent* process (Rosenberg, 1969). It evolves over time within specific technological trajectories and depends on organisational routines (capabilities) of firms and on their continuous search of new technological solution to offer to the market.

Once firms embodied their knowledge and capabilities into an innovative product or technology, their main concerns are the speed and degree of its adoption within the market. The adoption dynamics of an innovation often follow an 'S-shaped' growth path (Figure 1). Scholars distinguish various ideal-types of adopters according to their rapidity in becoming users of the innovation compared with the rest of the market[1] (Rogers, 1995; Schilling, 2006): innovators, early adopters, early majority, late majority and, finally, 'laggards' (the latest individuals to adopt the innovation).

Figure 1 Adopter categorisation on the basis of innovativeness



Source: Adaptation of Rogers (1995, p.262)

The process of diffusion of innovation depends on the characteristics of innovation, innovators and the external environment (Wejnert, 2002). Rogers (1995) provides a widely accepted social explanation of the adoption process of an innovation. This is defined as "a process by which an innovation is transmitted over time between the members of a social system through specific communication channels". This conceptualisation is akin to the communication model of Shannon (1948). According to this theoretical viewpoint, adoption is part of a five-stage process:

1 awareness of the innovation

2 interest

3 evaluation

4 trial

5 user adoption.

Rogers also argues that the success of a diffusion process within a system can be hampered by both technological–industrial and socio-cultural conditions.

Network externalities are a typical technological condition that significantly affects the adoption and diffusion of an innovation, respectively, at both individual and industrial level. This construct refers to the utility an individual adopter of an innovation achieves by the increase in total number of adopters in the technological market (Shapiro and Varian, 1999). Classic examples of how network externalities facilitate the diffusion of a new technology include the Telephone, Fax or Internet. Similarly, technological conditions are critical in the so-called network industries[2] (e.g., broadcasting, video-games and air transports), in which the diffusion of an innovation is not possible if specific complementary technological infrastructures (e.g., televisions, personal computers, or airports) are available and work (Shy, 2001).

A second kind of limit stems from the social system in which the potential adopters are located. Several studies explore the importance of communities of practice[3] for learning and innovation adoption (Brown and Duguid, 1991; Wenger, 1998). Individuals who decide whether to adopt a given technology tend to act and exchange information within one or more social communities to which they belong. The adoption of a technological innovation, and technological change itself, is thus dependent on an individual sense-making process that a potential adopter undertakes every time he or she recognises that an innovation may satisfy their needs and be socially accepted and awarded by their community.

Given these two perspectives, it can be reasonably assumed that the technology adoption process must rest on the evaluation of both *hard* and *soft* features of both the substituted technology and the substituting technology. However, a third level of analysis, user knowledge, should be considered given its critical role in the determination of both these conditions. User knowledge has an important influence on the market technological change as it mediates individual choice for the adoption of an innovation. Shapiro and Varian (1999) in their work on information economy use the concept of switching costs[4] to stress how the extent of knowledge and capabilities of individuals using an existing technology can hamper their adoption of a new technology aimed at substituting the former one owing to a 'lock-in'[5] constraint. Conversely, Moreau et al. (2001) highlight that the product-class knowledge held by existing users can provide a distinct advantage in understanding the value of the innovativeness of a new product. Therefore, it is not surprising that recent investigations of high-technology product introduction suggest the need for producer-driven training to be provided (Hänninen and Sandberg, 2006).

These notions strengthen the idea that adoption of a technological innovation is an evolutionary socio-technical process in which the demand and supply of innovation co-exist and co-evolve in a complementary way. Further, it is widely accepted that knowledge exchanges are the main way through which this collaboration between demand and supply happens. For instance, firms may decide to involve lead users (Urban and Von Hippel, 1988)[6] in their new product development activities to both find innovative research and development directions for their products (through the lead users testing) and extend the adoption of their innovations into the market (through lead users adoption) (Von Hippel, 1988; Aggarwal et al., 1998). Furthermore, adopters can 're-invent'[7] firm products and give them additional functionalities and values. This reciprocal influence between firms and consumers and within communities of consumers promotes dynamics of individual and collective learning that increase the speed of the diffusion of an innovation.

Summarising, this section highlights that some studies explain the adoption of innovations as a variable of technological improvements and quality of products. Other studies explain the adoption of innovation as a variable of social dynamics and values related to innovation use within a specific community. Finally, research indicates that user's knowledge and switching costs can also affect the speed of the technological change at industrial and individual level.

3 Conditions enabling individual user adoption of new technology

Section 2 outlined three categories of conditions (technological, social and learning) explaining the adoption of new technology within a system or market. This section deepens this understanding by outlining features more likely to affect individuals, and shows how such features are often connected with each other, creating a complex picture of user adoption.

Technological conditions help explain technical and market features of the substituting technology and the substituted product. New technological products entering into a market are rarely completely new, more often their design arises from other substitutor and complementor technologies or market products (Brandenburger and Nalebuff, 1995).[8] The availability of *complementary technologies* positively affects the adoption of new substituting technology (Teece, 1986; Gandal et al., 2000). For instance, the rate of adoption of USB pen-drives (technological device substituting hard-diskettes) was strongly dependent on the prior diffusion of USB ports in the personal computer market. Similarly, the diffusion of operating systems has historically been correlated with the amount of software available for it to run.[9]

Given the complex nature of high-technology products, most of their developer markets consist of industrial networks. For users, this results in a need to access a greater number of technologies to utilise a single product. When this process brings about the presence of an industry standard, there is usually a reciprocal reduction in the adoption of radical technological innovations within that market. Indeed, a standard links together a *network* of more complementary technologies (e.g., CD players, compact discs and software). This makes it harder for users of an existing technology (and its technological network) to adopt a newer and completely different product satisfying the same needs, as the utilisation of the innovation requires complementary technologies not yet widespread in the market.

Furthermore, the *technological complexity* of an existing and widely adopted product reduces its *retire-ability* as well. If a complex product is an artefact bridging together more levels of technologies (each one with specific design settings) (Murmann and Frenken, 2006), then users may find it both risky and expensive to shift to a different technology made by technological subsystems utilising different components. For instance, car drivers often prefer to buy cars produced in their own country, as it is often cheaper and faster to buy their spares. This brings about certain user expectations of the success of an emerging technology; thus, its network of complementary products will affect its rate of adoption (Gandal, 2002).

Social conditions explain the cultural and relational specificities (e.g., norms, values, hierarchies) widely shared within the groups or communities to which users belong. For instance, the status that users acquire within their own social group by using a given technology influences their propensity to change it for newer products. From this perspective, if a member of a community of vintage cars installs a modern CD player, other members probably would 'disapprove' of this change and consider them (and their car too) less worthy to be a community member.

This risk probably might be lower if the adopter was a community opinion leader.[10] This kind of individual plays a critical role in the diffusion of innovations (Rogers, 1995). If the use of a technological innovation is negatively accepted or misunderstood within a community, the rate of its adoption is more likely to be slowed too. Firms usually ask for opinion leaders support to preventing this risk. A positive appreciation of opinion leaders (if they exist) is critical for expanding the social acceptance of technological innovation within their community (or market).

However, diffusion of innovation can also be considered a 'bandwagon' process developing within a social network and relying on reciprocal contagion between its 'peer' nodes (e.g., Abrahamson and Rosenkopf, 1997). *Social contagion* is the process by which a person catches an idea or behaviour from another person (Burt and Janicik, 1996). It is a specific feature of networks and is commonly operationalised through cohesion and structural equivalence, two typical network measures considered as the driving mechanisms of contagion. Medical innovation is a well-known example of how social contagion within a community of users can determinate the dynamics of adoption of a technological innovation (Coleman et al., 1966). Contagion and personal preferences of doctors are equally critical to orient adoption of innovations in medical communities (Burt, 1987).

Learning conditions are individual characteristics of a single user. These conditions are more likely to affect the acquisition of new competencies and capabilities necessary to use a new technology. But, learning is also a multi-step social process through which an individual (or an organisation) acquires codified information or tacit knowledge from its external environment, internalises this new bundle of knowing, and utilises it to innovate its actions. *Socialisation* is a critical phase of this process (March, 1991; Nonaka, 1994) and it depends on the extent of social contagion of the user's community. However, adopters must be able to absorb external knowledge and apply it to utilise new technology. Thus, the extent of the single users absorptive capacity (Cohen and Levinthal, 1990)[11] can positively affect their learning of how to use a new technology and make it less difficult to retire an existing one.

Furthermore, the extent of the *switching costs* that a potential adopter of a new technology has to afford to learn how to utilise the new one depends on how much time and effort this individual spent learning how to use the old technology and its features. For instance, a typical advantage of first movers in network industries is their capability to establish a dominant design (Abernathy and Utterback, 1978),[12] which can quickly enter a market, making it harder for competitors to gain market share with alternative products afterwards. The main implication of this is the first mover product becomes the standard its competitors are forced to follow. A similar situation characterises the software industry where Microsoft with its suite (Microsoft Office) was the first mover (1989) in the market segment of office suites, and today it is still the leading design standard between the various office suites.[13]

Table 2 summarises the conditions outlined for each category. Each affects the likelihood that users will (or not) adopt a new technology, as discussed earlier.

Table 2 Summary of conditions commonly associated with user adoption of new technology

Technological	Technological complementarity of products
	Technological complexity of products
Social	Opinion leaders orientations
	Extent of social contagion
Learning	Users absorptive capacity
	Users ‘switching costs’

In the interpretive framework that follows each of the six conditions from Table 2 is related to a historical case of technology non-acceptance using a simple content analysis method. In each case, it can be seen that the driver of technology acceptance (as highlighted in the literature review) may also explain non-acceptance where the inverse Technological, Social or Learning conditions are present.

4 Interpretive framework for continued use of older technology

Following the popular Apple vs. PC debate, many *expert* PC users often ignore data indicating that the *majority* of PC users access just a fraction of the functionality and flexibility that PCs provide. Scanning popular technology periodicals, Apple all-in-one systems are usually rated as meeting user needs in key areas more reliably and with technology ready to use ‘out of the box’. Thus, following a purely utility maximising model of technology adoption, Apple should by now be the dominant player in the home computing market. One factor explaining the 5% or so market share of Apple, and the 90% share held by Wintel (Windows operating system/Intel processing chip based) PCs is the disparity in availability of complementary technology, such as free software, inexpensive peripherals and local support available from trained technicians. Thus, for non-expert users, the utility of PC technology may be limited, but it is greatly extended by the complementarity of its related industrial network.

There are several obvious empirical indicators for this construct. First, it would be fairly simple to have users list the most important/useful features of a technological product, and examine the simple percentage of these features relent on network suppliers rather than on the prime technology producer. It is also possible to examine such user’s purchasing behaviour, so to explore the frequency or even necessity of complementary product purchases. Finally, the network of new technological products can be evaluated for indicators of the correlation between growth in network size/maturity and product market share.

Proposition 1: *Older technologies survive when: the technological complementarity of the older technology creates higher total utility for its users than would be gained by adopting the new technology.*

The technology behind electric car engines and batteries is often categorised as underdeveloped when compared with petrol engines. This being said, electric car technology is quite advanced and is also supported by developments in the car production network as a whole. Given its ‘green’ credentials, why have advancements in electric engine and battery design not resulted in the demise of petrol engine automobiles? It is neither for lack of 'new' technology (of which there is a plethora), nor for lack of complementarity (those who can afford a car invariable have a suitable power supply). The significant problem electric cars face is that users of automobiles construe performance based on the overall effectiveness of the product. From a user perspective, even very poor performing petrol engine cars cost less, drive further, and are cheaper to maintain than the best electric cars. So while it can be assumed that their will be a time when all of the various technologies needed to make electric cars cheap and far reaching will come (as is arguable the case for digital SLR cameras, which have only recently replaced film-based models), this is not dependent on developments in electric engine and battery technology alone.

Highlighting empirical indicators for technological complexity is not a difficult task. For example, the change in purchase cost, or better still, in perceived value when one or more new technological innovations has been added would allow for a realistic interpretation of the contribution that made to the product as a whole. It is also possible to analyse the rate of technological change within a product category. When 'overall' technology changes relatively slowly, it is possible to assume that, disregarding economics factors, users will rarely purchase technology based on incrementally different innovations or designs.

Proposition 2: *Older technologies survive when: the technological complexity of the product category tends to focus user evaluations on overall effectiveness rather than the utility of newer features.*

In the developed world, most people have an appreciation for recorded music. For the audiophile, one who has developed *enduring involvement* (Richins and Bloch, 1986), this appreciation also extends to the technology used to recreate the music, where quality is synonymous with a reproduction that is as close to the original performance as possible. The result within the related 'Hi-Fi' sector has been a drive to reduce distortion in recording and increase the ability to hear the full range of tones emitted. There are, of course, some limiting factors in this reproduction, of which one of the most important is the change in the characteristics of sound as it is amplified or captured. Many guitar enthusiast (or more generally those who enjoy classic rock, blues, or jazz music reliant on electric guitars) share a strong conviction that the amplification and capture process should utilise 'tube' technology, so named for vacuum tube circuit devices used in the amplification process. Early research suggested that the use of such technology is not limited to simple qualitative appreciation for 'warm' music from such systems, but that they also have specific and measurable effects on the characteristics of the recorded sounds (Bussey and Haigler, 1981). In the last 10–15 years, the capability of digital equipment to model and replicate 'tube sound' has dramatically increased, effectively wiping out the empirical difference between tube and transistor amplification or capture. Still, it is only necessary to have a cursory glance at any music enthusiast magazine or website to see one or another professional musician proclaiming their dedication to a favoured piece of tube technology. In fact, most audiophiles believe that there is such complexity to the sound of a vacuum tube system that empirical measurement of the differences has yet to uncover the 'X factor' in tube sound, which the experienced technician can always recognise. So while electrical engineers might reasonably accuse audiophiles of having generated some form of groupthink (Janis, 1972), it must also be acknowledged that users develop their own patterns for making sense of technology (Seligman, 2006) and that it is this process that forms the grounding for evaluations, not for bench science. Accordingly, users of tube technology continue to hold negative stereotypes about digital technologies, many of which stem from weaknesses highlighted during the technology's introduction over 30 years ago.

Empirical indicators for the notion of negative stereotypes stem from qualitative descriptors used by old technology users. It would also be possible to examine the variables used by older technology user communities to understand both the important factors in older technology appreciation, and in negative evaluations of newer technologies. Thus, it would be reasonable to characterise older technology users as having negative stereotypes where their evaluations of newer technologies include quantitatively detailed but qualitatively selective evaluation criteria for categorically similar technologies.

Proposition 3: *Older technologies survive when: their community of users hold negative stereotypes of newer technology.*

Information and Communication Technology (ICT) has supplanted so many existing technologies, both at home and in the workplace, which it is near impossible to fully codify the extent of its diffusion. In high-technology 'corridors' such as Silicone Valley (California, USA), ICT has become not only a useful tool, but also a necessary feature of day-to-day life. The digital divide, a disparity between those who have the full range of technologies allowing them to thrive in such regions, and those materially or cognitively deficient (thus not able to fully utilise ICT), has become part of the common vernacular in most English-speaking countries. However, despite the often lauded advantages of such technology, and ensuing attempts to 'bridge' the divide, many communities in other high-technology corridors, such as Bangalore in India, eschew ICT's other uses, such as dating, food delivery and social networking. The interesting factor is that the knowledge workers of Bangalore are deficient in neither cognitive nor material ability to access ICT.

Selwyn (2003) argues that most research explaining technology non-use does so through the use of at least one of four discourses (such as user deficiency), but that no matter the discourse, each assumes that new technology creates greater utility over time. Bruland (1995) argues that non-use should rather be seen as a positive part of the social selection process. So, in California, where non-use of ICT limits social contact, non-users may be categorised as 'technology-phobic'; but in the strong family and community-oriented nation of India, ICT non-use in one's social life would more likely have little to no effect on the quality or amount of social contact received.

To study the strength of the social contagiousness of a new technology, it would be necessary to understand the individual, local, cultural and linguistic characteristics of the intended user groups. Similarly, to understand non-use, it would be necessary to distinguish between the personal attributes of users and non-users, rather than of the characteristics of the new technology relative to the old. In communities significantly different in social attributes, research should also predict a similar or even stronger variance in technology diffusion.

Proposition 4: *Older technologies survive when: the new technology does not create a strong enough social contagion to displace the community of old technology users.*

Bower and Christensen (1995) argue that many successful innovating organisations fail to recognise the effect that really new technologies will have on existing markets. Furthermore, they state and that being close to your traditional customers may lead to missing the next technological 'wave'. Of course, introducing a radically new product is never easy, and can be made much more difficult if the product requires targeted marketing for consumers to understand that the new product is in the same product class as the old. One popular solution to the difficulty of introducing a new product is association with an existing product (Brucks, 1985). This being said, some innovations never fully disperse into their intended market and may never displace the established standard devices. Good examples of this phenomenon are digital input technologies such as voice or handwriting recognition. While there are many good technical rationales supporting the development of such technology (allowing support for disabled users, speed of use, simulation of natural handwriting, etc.), traditional typing surfaces or telephone keypads remain by far the most dispersed and adopted technologies in the ICT market.

While it is possible to argue the relative merits of voice or handwriting recognition from a technical perspective, one straightforward explanation for the relatively low uptake of this newer technology is that being able to use a keyboard or number pad does not in any way prepare users for 'talk-type' microphone systems or 'stylus'-based handwriting recognition devices. In fact, most such devices require the user to learn the correct input technique, even though this is supposed to be based on normal speaking and handwriting. Hänninen and Sandberg (2006) go so far as to suggest that high-technology manufacturers should set out a 'roadmap' to ensure that end-users learn enough to be able to use the technology in a really new product. Nonetheless, such an educational framework is of little interest to the passive technology user, and to some extent this explains the continued popularity of a number of notionally out-of-date technologies.

It is possible to identify or classify technologies that are unlikely to displace current technology in at least two ways. First, if the new technology requires an overly large quantitative difference (relative to the perceived gain in utility) in learning or experience for it to become unconsciously useable, then current users will more likely retain the older technology. Second, if the newer technology is qualitatively different in operation, appearance, interface, or packaging, then users may not understand that the new technology is in the same product class as the old. This would result in reluctance to even *try* the technology, regardless of its simplicity to learn.

Proposition 5: *Older technologies survive when: Experience or expertise in the older technology does not significantly assist in use of the new technology.*

As is well accounted for in the existing literature in the field (Venkatesh et al., 2003), perceived utility is usually considered the most important factor in the purchase of new technology. One example of a product providing significant utility is a bespoke corporate ICT system. Well-known corporate ICT systems, such as the SABRE ticket booking system developed for American Airlines by IBM in the 1950s, have created a distinct competitive advantage. In the SABRE case, the advantage generated by an innovative ICT system, and the relatively late uptake (16 years later) of such technology by others, is often attributed to the collapse of several competitors in the market (such as Braniff International Airways).

However, such systems represent probably the largest single investment that a business can make into ICT. These costs arise not only from the development of the software, but also from the installation of appropriate hardware, group-specific configurations, user training programmes and ongoing system maintenance. It is no surprise then that organisations invest substantial time and money choosing between system providers and available end products. Such an investment in learning, management time and capital expenditure is not given up lightly, and so it is quite common for such systems to remain in use when newer technology has long surpassed the older technology's capabilities. Therefore, one final explanation for this continued use of an older technology is the extent to which a new technology requires 'switching costs' higher than the perceived utility gained by its use.

Investigating newer technologies that require high switching costs would require a similar empirical pattern as followed in previous sections. In this case, identification of an older technology (unlikely to be replaced) requires both a qualitative understanding of the willingness to engage with a new technology and a quantitative understanding of the investment (in learning, time, and money) necessary to introduce it. Again, this value would need to be weighed against a user-centred measure of utility.

Proposition 6: *Older technologies survive when: the 'switching costs' from old to new technology are high.*

It is important to note here that while each of the six propositions has faced validity relating to the context in which the non-use took place, the use of a single case is for the purpose of illustration more than empirical analysis.

5 Conclusions and managerial implications

This paper proposes a multi-level theoretical framework to understand conditions motivating an individual to retain an older technology given the opportunity to adopt a new product satisfying the same need. In economic literature, it is traditionally assumed that a technology user is an efficiency-seeker. Their choice of adopting a new technology, retiring the old one, is affected by the amount of utility they gain by superior innovations. The framework proposed in this paper suggests that user's adoption of innovation is much more complex than this cost-benefit analysis. The process of adoption is, rather, based on the sum of personal, social and technological utilities. These values overlap and interact, influencing user choice and consequently, the diffusion of innovation.

The overarching conclusion of the paper is that user's prior experience and knowledge matter in determining individual adoption, and by proxy, industrial diffusion. An interpretive framework is posited explaining that older technologies may continue to be used when: features of the old technology have superior complementarity or benefit from technological complexity; their community of users hold negative stereotypes of newer technology or the new technology has not created a strong enough contagion effect; expertise in the existing technology does not help use the new technology or use of the new technology requires high 'switching' costs. Indeed, if the relative ease or difficulty of retiring an old technology depends on its social, technological and learning factors, then relevant opportunities for firms may come from a strategic consideration of these constraints.

A first important managerial implication of this study is that research and development managers may find guidelines for new product specification by looking ‘back’ the technological antecedents of an emerging technology. Following this view, it is possible to hypothesise that, when these conditions apply, firm may develop a new Schumpeterian[14] formula of innovation, mixing old and new technologies. The main prescriptions of a ‘vintage innovation’ model are:

1 the development of new technologies combining new technological features and specificities with some of the complementary products and devices associated with the old products that they are going to replace

2 the development of new technologies able to exploit the social contagion phenomenon within users communities via their similarity with older technologies

3 the development of new technologies re-utilising a large part of the knowledge and prior experience of users (developed through their use of the older technology) to minimise their switching costs.

This can be a fruitful model for a new product development strategy, since it may reduce the risk of low and slow user’s adoption of radical innovations owing to their technological, social and cognitive differences with former products. The main limit of this framework is that it cannot be successfully applied to the understanding of the adoption of ordinary products or simple and not-networked technologies. Of course, a vintage innovation approach to new product development for ‘resuscitating’ simple and easy-to-use technologies would be superfluous and, probably not valued in the marketplace.

A second managerial implication arises for strategy and marketing boards of high-tech firms. Technological, social and learning conditions, in fact, may affect greatly marketing actions and competitive strategies of this type of organisations. For instance, if some firms perceive users switching costs (or community resistance) for the adoption of a new technology are too high, they should not risk to engage a direct competition with innovation pioneers. Conversely, they could exploit these conditions and seek for new opportunities, for instance, by launching products aimed at revitalising the declining technology. Similarly, they could arrange some marketing actions (e.g., media campaigns) to reinforcing the social acceptance and utilisation of the old technology within its user’s community.

These conclusions and implications also provide the basis for further empirical research. The authors suggest that surveys could be conducted to investigate how much prior experience of users matters in retiring an old product. Furthermore, it may be of value to conduct case study research describing practically how a *vintage innovation* was developed by firms in the past so as to inform such development in the future.

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Notes

[1]Of course, innovation scholars know perfectly and consider that within a market there will be even some individuals not interested in becoming adopters of the innovation.

[2]A network industry is a market with the following characteristics: complementarity, compatibility and standards; consumption externalities; switching costs and lock-in; significant economies of scales in production (Shy, 2001).

[3]"A community of practice defines itself along three dimensions: 1) What it is about – its *joint enterprise* as understood and continually renegotiated by its members; 2) How it functions – the relationships of *mutual engagement* that bind members together into a social entity; 3) What capability it has produced – the *shared repertoire* of communal resources (routines, sensibilities, artefacts, vocabulary, styles, etc.) that members have developed over time" (Wenger, 1998).

[4]Switching costs are generally defined as the costs in which a costumer affords when he or she decides to switch to a competitor's product or service.

[5]"Lock-in arises whenever users invest in multiple complementary and durable assets specific to a particular information technology system" (Shapiro and Varian, 1999, p.12).

[6]"Lead users of a novel or enhanced product, process or service are defined as those who display two characteristics with respect to it: 1) Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them and 2) Lead users are positioned to benefit significantly by obtaining a solution to those needs" (Urban and Von Hippel, 1988, p.569).

[7]Re-invention refers to "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 1995, p.174).

[8]"Substitutors are alternative players from whom costumers may purchase products or to whom suppliers may sell their resources complementors are players from whom costumers complementary products or to whom suppliers sell complementary resources" (Brandenburger and Nalebuff, 1995, p.60).

[9]This explains why recent releases of various open sources operating systems (e.g., Ubuntu) comprise compatible free software packages as well.

[10]Opinion leaders are individuals who frequently influence others' attitudes and behaviours in adopting an innovation (Rogers, 1995).

[11]It is commonly defined as the ability to value, assimilate and apply new knowledge (Cohen and Levinthal, 1990).

[12]A dominant design is a product widely adopted within the corresponding industry and its emergence apparently changes the nature of the market competition (Abernathy and Utterback, 1978).

[13]Microsoft launched the programme Word 1.0 for Macintosh in 1984 (first year of commercialisation of this computer) before packing it with other applications (as Excel or Powerpoint) into the first Office suite five years later.

[14]Vintage Innovation is Schumpeterian in the meaning of creative destruction.