

1. Introduction

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The branch of economics that is variously known as standard, conventional or neoclassical, places great importance on ‘markets’ and ‘market signals’ in explaining the allocation of resources and the making of decisions about technological change. This emphasis is reflected in politics and macro-level economics, especially in the Anglo-Saxon world but increasingly elsewhere, in an assumption that markets are the best or even the only possible way of efficiently governing an economic system. At the micro level, the firm in neoclassical theory is an actor which acts in order to maximize profits given the prices of inputs and outputs.

In contrast, evolutionary or neo-Schumpeterian economics emphasizes supply-side factors such as entrepreneurship and firm capabilities, and stresses the role of the firm as an actor which operates in conditions of uncertainty, which does not know the outcome of decisions which it might take, which must generate knowledge (at a cost), which takes risks, which goes through a learning process, and which develops strategies under the influence of its own culture, ethos and guiding philosophy and not only based on ‘objective’ knowledge.

However, evolutionary economists have somewhat neglected the demand side, possibly because it has been so strongly emphasized in neoclassical economics. Evolutionary economic theory has, on the demand side, developed the concept of the ‘selection environment’ in which products succeed or fail (Nelson and Winter, 1982), but it has been rather less well studied than supply-side factors within this tradition. However, at the macroeconomic and policy level, the variation and complexity of types of market and non-market governance considered in the many studies of ‘National Innovation Systems’ (for example, Lundvall, 1992; Nelson, 1993) and ‘Varieties of Capitalism’ (for example, Boyer, 1999) is an exception.

This book puts the focus on the demand side. In pursuit of the general theme of the series of conferences from which the papers are selected, ‘Advances in the sociological and economic analysis of technology’, the book explores the potential for *rapprochement* between economic, sociological

and other social science disciplines in considering 'the demand side'. Indeed, evolutionary economics' concept of selection environment includes markets, but also includes the strong influence of non-market factors such as government regulations, standards and public and professional pressure, which may all contribute to determining whether or not a market will exist. In this way, evolutionary economics may be said to have incorporated ideas from sociology and anthropology about behaviours and culture, and from psychology about motivation.

While refocusing on the demand side should not be seen as embracing neoclassical economic theory, neither should it be seen as denying the importance of the supply side. Versions of the 'nature–nurture' debate have been an enduring theme in the social sciences, reflected in the innovation field in the 1970s' debate about 'demand-pull' vs. 'discovery-push' as the prime movers in the stimulus of innovation. It has also been a feature of the history of science in the modification of 'internalist' accounts of the development of scientific theories by exploring the social, economic and political influences; and of the sociology of science, technology and innovation, where social shaping or social construction theories have challenged technological determinism. More recently various approaches have proposed 'hybrid' theories that allow demand-pull and discovery-push, or social, economic, political and technical forces to interact or, in the case of actor-network theory, have attempted to cut across the debate by following human and non-human actors and privileging neither (Green *et al.*, 1999).

If 'innovation' is used in the sense given to it by Schumpeter (1934) and Freeman (1982) to mean something which is both technologically novel¹ and has either been launched on the market and become the object of a commercial transaction, or in some other way has become incorporated into the social fabric, then (by definition) both supply- and demand-side factors are important. But it will not be *successful* (and innovations can be successes or failures) if there is no demand for it – if users do not want it. Understanding user needs was identified in early studies of innovation as an important success factor, and it is one of the justifications for market research: but knowing how important demand is, or understanding how important user needs are, in innovation does not tell us much about how they are actually detected or constructed by innovators, or how they are incorporated into the innovation. Some entrepreneurs find out what users want, or do not want, only when their innovation fails, or when customers complain or send it back. Some innovations are commercialized by entrepreneurs who say they 'just know' what the market wants; or who make assumptions about customers' needs (on the basis, for example, that the market is made up of people like themselves). In some cases an iterative process involving lead-users as 'trialists' takes place in which technology and markets are simultaneously constructed

in interaction with each other: the users modify the innovation to suit their needs better, while at the same time adapting their own work patterns and products to make best use of the innovation, and enlisting other potential users by recommendation and example (for example, Akrich, 1995).

Where a radical innovation is involved it may not be immediately obvious to potential customers that they have needs that might be met by the innovation. Equally, it may not be clear at first to the innovator which the most promising markets or market segments will turn out to be. Traditional market research is not very useful where a new product or process departs substantially from what is reasonably familiar to potential customers, and anthropologist Lucy Suchman (1987) has observed that, in these circumstances, innovators take 'situated actions', or actions which have to be adapted to the unforeseen contingencies of particular situations. The innovator may be unable to shape or adapt the product or process to the needs of target customers. A market in the accepted sense may not exist but may have to be created. Innovators might have to invent social and economic environments in which their innovations may be successful, and then seek to mould their environment accordingly, rather than just introduce new artefacts into a pre-existing environment in which they then have some impact.

Users, on the other hand, may be prime movers in the innovation process (Von Hippel, 1988), while user-supplier interaction may play a key role in its success (Lundvall, 1988). Provision of technical services and training to customers is a way of creating markets, customer loyalty and 'lock-in'. Intermediaries who recommend an innovation or raise areas of concern – such as doctors, nutritionists, consumer organizations, retailers or environmentalists, also contribute to market creation. The selection environment has many elements in addition to the market of consumers and potential consumers, plus a whole complex supply chain (perhaps it would be appropriate to call it a 'demand chain' in this context) including retailers and intermediaries, and (depending on the innovation) the regulatory system, intellectual property regime and various policy makers. Even the innovating firms (at the centre of the supply side of innovation) also contribute to the shaping of demand by their market creating behaviour and assorted lobbying activities.

In this book we have selected a range of papers from those presented at the 5th ASEAT conference in Manchester in 1999. The papers deal with an aspect of the demand side including users' needs and how they are identified or constructed, markets and market signals, or the construction of demand. In keeping with the aims of ASEAT, the papers use a variety of perspectives and draw on a number of disciplines. They also range over a number of industrial sectors and technologies, including chemistry, food, IT consumer durables, software and the Internet, new energy technologies and new services.

In Chapter 2, Arie Rip and Aard Groen provide a cogent overview of one of the most prominent features of the innovation literature in recent years. Using the metaphor of ‘many visible hands’ they drew attention to the fact that the overwhelming weight of much writing on innovation has been to emphasize not the anonymous, invisible hand of the market, but the visible hands which shape innovations around the spatial and temporal edges of the (narrowly defined) market. Surveying traditions such as evolutionary theory, actor-network theory, neo-institutionalism and others, they demonstrate that there is great force for the view that technologies and innovations are complex social ‘achievements’. Presenting them in this way can transcend, or at least side-step, any attempt to begin from a bi-polar model of ‘supply and demand’. Yet the force of these approaches lies in their ability to persuade us that enduring *patterns* in the behaviour of actors, their interests, and their technological products can be well explained. Of course, such explanations still have to draw upon some calculus of incentives, however tacit, and on statements about the differences between technologies and innovations which imply ‘better than’, or ‘cheaper than’ or ‘greener than’ and so on. Whilst these statements too are socially constructed, they are still ultimately constrained by the materiality of technology.

There has been relatively little work on the ways in which user needs are articulated during the innovation process in those medical products and procedures that do not involve large medical instruments or devices. Yet, with biotechnology promising a stream of new drugs and treatments over the next ten years, studies of the ways in which new scientific developments are taken up by new firms and shaped for novel medical interventions are much needed. Paul Martin provides such a study in Chapter 3 on the development of gene therapy techniques in the USA. Gene therapy is a much-trumpeted radical approach to the treatment of, amongst other diseases, cancer, HIV/AIDS and arthritis and has attracted the attention of at least 15 US companies over the last 15 years. Martin shows how the development of the therapies was socially shaped, but that there was not a simple one-way relationship between commercial developers and ‘users’ (who he sees as being US doctors and US drug companies, rather than patients). Initially, gene therapy was intended for use as an *ex vivo* technique. However, as drug companies began to get interested, the ‘dominant design’ changed towards conventional injectable drug techniques (‘genes in a bottle’). Martin gives an account of this change, showing how it needed the simultaneous development of the technology and of new categories of user.

Like Paul Martin, Dale Rose examines the development of a medical treatment in the USA (Chapter 4); in this case the development of a vaccine against Group B Streptococcus (GBS) which is a major cause of neo-natal death. Health authorities in the USA dispute the effectiveness of the vaccine.

Rose points out that the notion of who is the ‘user’ of this vaccine – as some sociologists of technology put it, who are the ‘relevant social groups’ – is problematic: is it the health care authorities, or the doctors, or the pregnant mother, or even the foetus? Rose uses this uncertainty to illuminate a more general analytical problem – of how we can identify who the ‘users’ of a new technology or product are, and how we can know in what ways their needs are being articulated by the developers of that technology or product. He does this by reviewing the literature on the sociology of technology and of science and technology studies. He concludes that all that we know is that the actors in any technological development are usually vague about who the users are and even more vague about how they know what users ‘need’. Yet, there are important issues at stake here, given that many actual users (in this case, poor African-American women, whose babies are most at risk) will have no means of directly articulating their needs.

Anna Johnson and Staffan Jacobson, in Chapter 5, are concerned with the renewable energy technologies that are now diffusing rapidly in the global market (if from a low base) in response to international concerns over climate change. The diffusion and development of these technologies is both aided and constrained by the ‘innovation system’ that surrounds them, generating the necessary technological variety and constituting the selection environment. They discuss the Swedish innovation system and how it has shaped the formation of industries that supply wind turbines, solar collectors, and biomass combustion and gasification equipment. Whilst Sweden’s technical competence in these industries is high, the market share of Swedish firms internationally is low. Johnson and Jacobson put this down to the strong mechanisms that block the growth of these firms, especially Sweden’s continued political stalemate over the use of nuclear power and the ‘lock-in’ by utilities into large-scale generating technologies. The development of wider Nordic and European energy markets makes it possible for the renewable energy technology industries in Sweden to escape their national ‘blocking mechanisms’. Johnson and Jacobson show, therefore, that the development of ‘users’ for a new technology can be a complex one, involving issues of politics and national economic development.

Chapter 6, by Andrew McMeekin, uses some detailed case material from the chemical industry – specifically that part of it which produces products containing chlorine – in order to extend the conceptual framework of evolutionary approaches to the study of innovation. His starting point is that the concept of a ‘selection environment’ (as derived from Nelson and Winter) is too static. In the received approach it is presumed to exist independently of the innovations that are placed into it by firms, and there is no explicit treatment of how it arises or changes. In the context of this volume this is a telling observation. It reflects very well our general concern to give the

'demand side' of the innovation story a properly theorized role. McMeekin's approach is to show that the selection environment is *actively created and shaped* by a variety of actors who include not just the obvious agents – the firms, the consumers, and the regulators – but also other actors outside this set. The empirical discussion describes the involvement of the environmental lobby group Greenpeace, and the counteracting activity of the industry lobby group Euro Chlor. Their arguments draw on a wide variety of economic and social resources, and influence the final markets for not one, but a whole family of chlorine-related products. One of the most interesting features of the analysis is that Greenpeace's role has shifted from one of simple opposition to that of a search for alternatives to replace chlorine-based products. In so doing, Greenpeace therefore has started actively and positively to shape the selection environment for quite different technologies, but not in a fully controlled or thought-out manner. This type of analysis alerts us to the interconnections in the selection environments for radically different technologies. This in turn reminds us that the consumption and demand spheres need an appropriate degree of analytical autonomy from technology in any discussion of innovation and technical change.

Adrian Smith and Alain Rajotte present in Chapter 7 a case study of what seems a clear example of 'market demand': the shift to chlorine-free bleaching technologies in the paper pulp industry from the late 1980s, following claims about the adverse environmental effects of chlorine pollution during production. While not denying that demand for chlorine-free paper from final consumers was influential in the *global scale* of the technological shift, there were other factors that were stronger in *initiating* the shift in Sweden, the first country to do so. Not least, there was Sweden's regulatory culture, which was moving more rapidly than other European countries to a precautionary approach. In any case, as McMeekin also points out (Chapter 6), chlorine became a highly politicized chemical element due to Greenpeace campaigns. These factors, together with the availability of alternative processing technologies, led Swedish firms to make the transition, even against the opposition of other firms and other countries. Smith and Rajotte's detailed account shows that trying to understand technological change as unequivocally due to market demand or to regulation policy is pointless; in achieving better environmental standards it is the *mixture* of the two which matters.

The Internet is frequently seen as a communication technology that, in some deterministic way, is bound radically to transform all existing business relationships: 'the social' and 'the economic' are reconstituted by cybernetworks based on computer and telecommunications hardware. Nikolaos Pisanias, in Chapter 8, strongly disputes this determinism in his analysis of the 'ship-broking' industry in Greece and the UK, which acts as an intermediary between import and export traders and shipowners with space to rent in

their vessels. Ship-broking, being an apparently information-intensive industry, would seem ripe for conversion to 'cyber' systems; but so far, the industry has confined itself to telephones (for speaking), telex, fax and e-mail. Broking is heavily based on informal channels and personal relationships based on trust, through which brokers can acquire private and confidential information that can give them a competitive edge. Such methods of networking are not (yet) possible, in a secure enough form, through Internet connections. However, as the brokers become more familiar with the Internet, they may begin to use it, if it can mimic some of these private and personal connections. As Pisanias sees it, new relationships structure new forms of technological development which are in turn brought into being by those changing relationships: demand, technology and users' understanding of demand and technology all dance together.

In Chapter 9, Maureen McKelvey is also concerned initially with the way that the Internet permits new models of business practice and innovation to be conducted. She provides a detailed case study of the emergence of Linux, the alternative operating system for PCs. The case shows that a community of users – software enthusiasts meeting through the Internet – have been able to take the initial piece of free software created by Linus Torvalds and develop it collectively to become more and more versatile and flexible, yet still free. So at first sight, the analysis seems to suggest that a new mode of innovation – with users re-positioned more centrally – is in fact possible through the Internet. However, in the second part of the chapter, McKelvey shows how the later stages of the Linux story involve a progressive commercialization and a partial re-absorption back into the 'mainstream' of large, firm-driven software development and distribution. Firms have become involved in packaging, promoting, and fine-tuning the software and this has increased diffusion rates and built the user-base. McKelvey concludes by suggesting that the case is perhaps not after all a contrast between Internet-based entrepreneurship versus conventional large firm innovation. Rather it is an example of the Internet being the new medium for the creation and diffusion of *public knowledge* relevant to innovation, but with conventional business models still driving the later stages of commercialization and market-building.

In Chapter 10, Les Haddon and Gerd Paul deal with the problem of involving the user in the design of products that use Information and Communication Technologies. Their starting point is that much of the current management literature stresses the need to involve users, but it mainly extols 'best practice', by segmenting your market and altering your market mix according to data obtained from customer complaints, the objective being to convert first-time contacts into regular customers. Thus, all the problems and their resolution are contained within firms' existing structures. This view, Haddon and Paul argue, is wrong. Instead, more visibility and credence ought

to be given to Human Factors studies and ergonomics. If, however, this strategy is to be pursued, then the identity of 'the average user' becomes problematic. Often the technological enthusiast is chosen, complemented by the technologically-aware designer. Products are then designed for a selected elite. To make the product users more inclusive, Haddon and Paul suggest moving to a 'Design for All' concept, a broad category of all users including the elderly and the disabled. This last group makes the strongest demands on product usability, but meeting them would benefit all categories of users as their needs would be included as well. Haddon and Paul outline the results of an empirical study into the use of the 'Design for All' concept in the European Information and Communication Technology market. The results were not very encouraging. Ex-public utilities that previously had some form of social responsibility in their charter only took account of the needs of otherwise excluded groups in the design of specially tailored products. Incorporating user needs in product designs, in general, were given little credence. All this highlights the gulf that exists between the lip-service that is paid to customer-involvement in product design and the reality.

Pursuing the same theme as Haddon and Paul, Remco Hoogma and Johan Schot's paper (Chapter 11) is an excellent example of the strong tradition in Northern Europe of practical attempts to increase the degree of direct user involvement in the development of innovations, especially where these are complex innovations with high public visibility, such as transport systems. They report three case studies of city-based experiments with electric vehicles and draw detailed balance sheets of the outcomes. The essence of their argument is that the attempt to involve users was too limited from the start. The approaches used tended to leave technologists alone to develop prototypes that were then placed in front of consumers in such a way that their role was constrained to one of 'improvement' rather than one of fundamental setting of design parameters. The authors argue that user involvement need not be limited in this way, and propose alternative approaches which counteract these limitations. The questions raised by this approach go to the heart of the debate. Here we are not only increasing the role of the demand side in the realm of academic analysis, but also in the real world. But, what are the criteria for setting the balance between this approach, which allocates a considerable amount of society's resources to 'active user involvement', and a more traditional approach which sees market experimentation and competition between alternative designs as the appropriate mechanism? Or is it possible to somehow combine, or at least reconcile, these mechanisms?

The involvement of users in new product development is routine in industries that change their products slowly and sell direct to individual consumers, such as the food and drink industry. 'Tasting sessions' are the most widely used mechanism for identifying whether consumers like a new product. Cécile

Méadel and Vololona Rabeharisoa (Chapter 12) report a study of tasting sessions carried out by an agri-food firm that specializes in fruit juices and drinks. This activity is not as straightforward as one might imagine. Tasting takes place in a number of different ways, usually using tasters who have to be trained to learn to taste in such a way that they can (claim to) represent others. The meaning of the tasters' reported opinions is never obvious, since tasters rely on bodily sensations (aroma, flavour, feel and so on) that have no objectively agreed standard. So, as the authors put it, 'tasting is a testing of the constantly changing relationship between product and consumer'. Studies of similar involvement of 'users' in other industries would make interesting comparisons.

Marcela Miozzo (Chapter 13) looks at the way in which technological change involving information-intensive services affects business organizations, the relationships between production and business services, and the institutional standardization barriers faced by Trans-National Companies (TNCs). Though information services are becoming technologically-intense, and therefore transformative, this does not lead to 'de-industrialization'. Instead, there is a 'splintering and disembodiment' process in which the creation of business services becomes part of the technical and social division of labour within production activity. Increasingly, knowledge-intensity services result in the externalization of these business services, allowing manufacturing firms to meet peak demands without increasing staff or capital investment. The strong production base needed to create a demand for these business services presents a problem for developing countries that may be struggling to create or sustain such a production base. Technological transformations wrought by these technology- and information-intensive services both blur the boundaries between industries and between public-private services sectors, and allow the internationalization of skills. A loss of competitive advantage in the production of goods affects the demand and type of business services available, yet a limited development of such services may weaken their ability to support the production of goods. Internationalization of these services provides a competitive advantage to TNCs because of the incremental cost in adding such services to the existing portfolio. However, it requires increasing deregulation of access to localized information from a central point. Diffusion of these technology- and information-intensive services, however, can result in polarization. Small firms can benefit from the externalization of these services, but TNCs require a universal right of access to information wherever it is located by databases that are centralized within the TNCs. This, for Miozzo, can lead to the ironic situation of a demand for the liberalization of international trade – especially in information – at the same time as an increasing global monopolization of information. Thus, policy discussions need to recognize

the close relationship between a strong production base and a well-developed technological- and information-intensive service sector.

In the final chapter, Andrew Tylecote and Claudia Galvao take an unusual approach to the role of user needs in the innovation process. Namely, the ‘inappropriateness’ of ‘Northern’ technology to meet the needs of users in ‘Southern’ or Less-Developed Countries, even though the adoption of ‘Northern’ technology persists. The inappropriateness of Northern technology lies in its high ratio of capital to labour, the high initial technological capability, and its large scale. The adoption of Northern technology will require high levels of scarce physical and technological capabilities as opposed to the Southern abundance of low-skilled labour. To avoid this dilemma, it is often claimed that the Southern countries should acquire ‘appropriate technology’ more fitted to their capital and labour supplies. They argue, however, that the Brazilian economy, for example, is highly resistant to such acquisition, in part due to the low levels of education for the mass of the population, and in part due to a policy of industrialization through import. Economic, social and cultural factors that produce severe inequality are major determinants in technology choice, combined with a lack of awareness of technologies more appropriate because of their labour-intensity, a distortion of factor prices and the spatial distance from appropriate technology. As a result, Brazilian user needs do not reach potential innovators. Thus, Tylecote and Galvao argue, the problem of appropriateness is two-fold: that of *creating* appropriate technology, and its *diffusion* – even to adjacent ‘Southern’ countries. They suggest the creation of an international aid fund that would identify appropriate innovations and technologies, monitor their use and pay a royalty to the innovator.

NOTE

1. This definition of innovation means ‘technological innovation’. There are also other kinds of innovation, such as organizational innovations, or innovations in design which are based on existing technology.

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