From technology transfer to market transformation

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1. SYNOPSIS

Stresses importance of markets in mediating economic behaviour, attempts to identify some of the elements of a paradigm that could guide research on markets, and describes topics that might be included in a research program on markets.

2. ABSTRACT

A central theme of this paper is the need to give more attention to the study of markets. Much of what is being done to promote energy efficiency involves efforts to change markets. (These activities are often described as being directed towards "market transformation.") But, while these activities are trying to influence markets, surprisingly little is known about real markets. Some designers of policies and programs are too ready to think of "the market" as an abstraction, a place of exchange that, while it may suffer from some "imperfections," approximates the textbook model of fully informed actors making costless transactions that exchange abstract products. Real markets are more complicated than this. Real markets are not just the sum of transactions among individuals. Real markets have structure. This structure consists of rules governing the conduct of the market actors, relationships among the actors, and physical arrangements to facilitate exchange. In short, markets are not abstractions; they are social institutions. Our thesis is that policies designed to change markets will be more effective if these policies are grounded in an understanding of markets. Toward this end we suggest that comparatively recent advances in the social sciences provide insights about the dynamics of real markets. These advances also provide a context for identifying some of the elements of a paradigm that may be useful for guiding research and improving our understanding of consumption behaviour and innovation in specific markets.

3. INTRODUCTION

This paper is a continuation of a conversation between two of the authors[1] that began more than fifteen years ago. The beginnings of the conversation lay in our dissatisfaction with economic models of behaviour in which individuals with stable and coherent desires act rationally to maximise the attainment of those desires. In the usual application of such models the predominant desire is to be wealthy and individuals are presumed to be acting to maximise wealth. As shorthand we call these models "simple optimising behaviour" models. These models are part of a paradigm that has guided the research and practice of some (arguably, a large majority) of economists and policy makers[2]. Both of us thought that simple optimising behaviour models were poor guides for energy policy. Even when our conversation began, our scepticism about this type of economic model was widely shared. Now, even within the economics profession, these models are barely respectable (Rabin 1998, Elster 1998, Bowles 1998, Hodgson 1998, and Hubbard 1998).[3] But old paradigms die hard. As Kuhn observed (Kuhn 1996, 77), paradigms survive, even after they have been repeatedly shown to be deficient, if an alternative paradigm is not available as a replacement.

We are no longer interested in elaborating the critique of simple optimising behaviour models. That goose is already cooked. But the challenge remains to find better models that can be applied in practical situations. A basis for the construction of such models can be found in complementary work in institutional economics (e.g., Simon 1991, Hodgson 1997, Williamson 1985) and economic sociology (e.g., Smelser and Swedberg 1994, Powell and DiMaggio 1991). However this work has yet to be drawn together to form an alternative paradigm to guide the detailed research and theory development that is needed. Our goal here is to try to identify some of the elements that might be constituents of a such an alternative paradigm. .

Our starting point is market transformation. We have suggested elsewhere that there is a need for new theory and models to support this energy policy (Blumstein, Goldstone and Lutzenhiser 2000). Here we note that one of the elements of an alternative paradigm of economic behaviour is implicit in the idea of market transformation. That is, *economic behaviour is mediated by markets*. This means that it is usually not possible to understand economic behaviour without some understanding of the market that provides the context for the behaviour. The policy implication of this, and the rationale for market transformation, is that economic behaviour can be changed by making changes to markets.

Our thesis is that policies designed to change markets will be more effective if these policies are grounded in an understanding of markets. While this may seem obvious, surprisingly little material is actually available to provide the necessary understanding. A realistic understanding of any given market requires going far beyond an abstract model of markets. It requires a much more detailed model that incorporates knowledge of the particular characteristics of the products being exchanged and how these characteristics are shaped by the particular institutions in which that market is embedded. To obtain this detailed knowledge requires research on the specific dynamics of those markets that we wish to transform.

To elaborate this idea we will talk about the relation between markets and innovation and then sketch the rudiments of a theory about the relation between markets and consumption. The reason for this focus on innovation and consumption is that causing innovation is one way to change markets and the result of innovation can be a change in the pattern of consumption. Our rudimentary theory says that markets provide a "choice set." The choice set defines what is available for consumers. Innovation changes the content of the choice set.

While our theory is rudimentary, it can provide some useful guidance in policy deliberations. That said, we are well aware of the limitations of our rudimentary theory. More research on markets and on how markets mediate economic behaviour is clearly needed. In our conclusion we discuss how elements of an alternative paradigm might guide a research program that will both lead us in the right direction and foster development of the expertise needed to create better theory.

4. MARKETS

A central theme of this paper is the need to give more attention to the study of markets. Much of what is being done to promote energy efficiency involves efforts to change markets. But, while these activities are trying to influence markets, surprising little is known about markets. More precisely, surprisingly little is known about *real* markets. The designers of policies and programs are too ready to think of "the market" as an abstraction, a place of exchange that, while it may suffer from some "imperfections," approximates the textbook model of fully informed actors making costless transactions. This is a naïve view, to be sure. It overlooks a significant amount of work in transaction cost economics and allied fields. But it is still widely held in the energy policy world in the U.S., although perhaps less in Europe[4].

Real markets are more complicated than this. Real markets are not just the sum of transactions among individuals. Real markets have structure. This structure includes rules governing the conduct of the market actors, relationships among the actors, and physical arrangements to facilitate exchange. Real markets are heterogeneous. Their structure

varies greatly depending on the goods being exchanged. As we have been learning with a vengeance recently, markets for electricity are very different from markets for durable manufactured goods and markets for buildings.

The rules of conduct in a market may be explicit or implicit (typically markets have both explicit and implicit rules). An example of an explicit rule is the rule against insider trading in the stock exchange; an example of implicit rules are the norms governing tipping in restaurants. All markets involve more than just producers and consumers. Often a large number of intermediaries and other agents are involved. For example, in the buildings industry, in addition to the builders and the buyers, there are designers, bankers, appraisers, brokers, real estate agents, insurance agents, lawyers, and many more. Physical arrangements are equally diverse involving, for example, retail stores, wholesale distribution networks, commodities exchanges, and electronic communications networks.

In short, markets are not abstractions, they are social institutions.

In modern societies markets provide the context for most of the decisions about consumption. As we discuss below, part of a market's structure is a set of consumption choices. Market transformation can be thought of as a policy intended to alter this set of choices. That is, the policy seeks to include some new choices and exclude some old choices. Market transformation can also be seen as an endpoint in a process of innovation. That is, an innovation is complete when a market is transformed.

5. INNOVATION

The words "innovation" and "invention" are sometimes used interchangeably. Here we wish to make a clear distinction between them. We take innovation to include (1) the invention of new technology, new forms of organisation and new institutional arrangements that support market action, as well as (2) the general adoption of these. To put it another way, innovation involves invention but not all invention results in innovation.[5] An invention could be a new electronic system to control heating and cooling in a building. New methods to insure that the control system was operating properly before it was placed in service (commissioning) could also be an invention.

Causing energy-saving innovation has been a major focus of energy policy at least since the Arab oil embargo. In our definition of innovation, market transformation is synonymous with the process of adoption of new technology in a market. Arguably, market transformation has been a policy goal since the beginning. However, efforts to secure adoption of new technology have become increasingly sophisticated. The introduction of the phrase "market transformation" reflects awareness of the importance of markets as a context for decisions affecting energy consumption.

This was not always the case. In the early going at the US Department of Energy (DOE), the focus was on the invention part of innovation. One of us (Blumstein) began his career in energy in 1974 as a research scientist at the Lawrence Berkeley Laboratory (LBL)[6] in the midst of the first "energy crisis." At that time, when anything was done to cause the results of LBL research to be used, the effort was called "technology transfer."

During the 1970s at LBL, very few researchers were concerned about technology transfer. It was definitely a low status activity, assigned to a single individual who was rather far down in the Laboratory's hierarchy. The implicit model for technology transfer was what might be called the "better mousetrap model"[7] The idea is that, if you invent something useful and you make it known that you have done so, then the potential users will find you.

This model of innovation derives in part from the view, current after the Second World War, that innovation was a linear process, proceeding from research to development to demonstration to commercialisation. It is now widely recognised that this linear model of innovation does not describe a real world process. Real innovation processes typically involve complex interactions and lots of iterations among the steps (e.g., Thomas 1994, Utterback 1996). Attempts to commercialise new products reveal deficiencies that require additional development, which may reveal deficiencies that require additional research; and so on. The success of an attempt to innovate may depend on the

ability to communicate the information about deficiencies that is learned downstream (for example, by retailers, installers, end-users) back upstream (for example, to developers, designers, marketers).

6. THE PACE OF INNOVATION

The view that all that is required to move from invention to adoption is to make it known that the invention is available now seems rather quaint. Nonetheless, there is something in the better mousetrap model. We live in a culture that respects and values innovation. In some areas of technology such as microelectronics the pace of innovation is truly astonishing and it seems as if there is an amazing appetite for better mousetraps in these areas of technology. Unfortunately, energy use and particularly energy use in buildings is an area where the pace of innovation is slow and the mousetrap model does not apply.[8]

Obviously the pace of innovation is determined not just by the rate of invention but also by the rate of adoption. If adoption is slow, then innovation will be slow even if the rate of invention is rapid. But, it seems reasonable to suppose that the rate of invention and the rate of adoption are not independent of each other. A high rate of invention creates many opportunities for adoption. Conversely, when rates of adoption are rapid, the incentives for invention are greater. That is, if the rate of adoption is high, then the likelihood that invention will lead to a payoff in the marketplace is greater. Under the right circumstances the pace of innovation accelerates as rapid adoption stimulates further invention and further invention spurs more rapid adoption. This is particularly the case where "first movers" can capture market share for mass produced goods (the newest razor or wonder drug). This is hardly the case in commercial buildings markets, where there is little or no first mover advantage, since a well-received product cannot be quickly and exclusively produced to capitalise on market interest.

7. CHOICE SETS

Efforts to understand how and when adoption occurs have relied upon competing theories of consumption. In these theories, people are variously believed to make choices for reasons of economics (e.g., utilitarian value), psychology (e.g., personality, impulse), or the search for social status and cultural conformity (Wilk 1999). Often the competition among the disciplines that promote various theories is more distracting than illuminating. We agree with Wilk that none of these theories tells the whole story, although each has something to contribute. But we want to go beyond the pros and cons of competing theories to suggest that at least part of the reason that past work has failed to provide sufficient guidance is that it has too often focused on consumer behaviour and not on markets (Wilhite *et al*. 2000).

So, why is it that understanding consumer behaviour is not sufficient? The problem is that consumer behaviour is constrained. Consumers are not free to choose from among all of the technical possibilities. Rather, the market provides consumers with limited choices. We call the choices that are actually available to the consumer *the choice set*[9]. To make this more concrete, consider a consumer whose water heater has just failed. If she wants a quick repair, her choice set is typically limited to the one or two water heater models that the plumber has on hand. An appliance purchaser who has time to shop (and perhaps wait for delivery) has a choice set that consists of all of the models that manufactures supply to the market. An appliance purchaser whose time is constrained typically has a smaller choice set that is likely to consist of the more popular models.

How do we learn about what is in the choice set? How can we understand the factors that determine the choice set? This requires a shift in focus from consumers to producers and intermediaries who seek both to compete for customers and to routinise the choices presented in the market in order to simplify design and production, warehousing, merchandising, and supply chain management. In the case of commercial buildings, for example, the renter's choice

set is determined by the interactions of developers, architects, bankers, planning officials, and the manufacturers of component systems.

8. INNOVATION: CHANGING THE CHOICE SET

The idea of choice sets can be helpful in developing market transformation programs. In essence, market transformation *is* changing a choice set[10]. This can mean including something new in the choice set, eliminating something old from the choice set, or both. Successful market transformation usually involves permanent, or at least long lasting, changes. If something is added to the choice set that benefits the consumer, then the expectation is that consumer self interest will tend to maintain the change. If something in the choice set (say inefficient refrigerators) is proscribed by setting standards, then the expectation is that legal sanctions will maintain the change.

Innovation is one process that changes choice sets. Market transformation focuses on the latter stages of the innovation. The objective is to find efficient (that is, both low-cost and effective) methods for introducing new elements into the choice set. A well-known example of this approach was the Super Efficient Refrigerator Program (SERP). SERP, an effort of a consortium of electric utility companies, offered a large prize to the appliance manufacturer who was prepared to produce and market the best very efficient refrigerator. The idea was that offering an incentive to a manufacturer to produce an efficient model was cheaper than trying to elicit the production of efficient models with consumer incentives for the purchase efficient models.

While SERP succeeded in bringing an efficient model to market, the program has its critics. The SERP refrigerator was a high-end side-by-side model, although one that may not have competed very effectively even in that niche, and whose influence on other refrigerator models has been questioned. Still it serves well as an example of strategy for putting something new into the choice set.

Improvements in refrigerator technology made it possible to implement another strategy for changing a choice set—that is, using standards to eliminate elements from a choice set. In the case of refrigerators, efficiency standards have been wildly successful; over a period of twenty-five years the electricity consumption of a refrigerator has been reduced by around seventy-five percent.

Thus refrigerators provide a neat example of a market transformation strategy that relies on both consumer benefits and legal sanctions. Subsidies for innovation provide consumer benefits by encouraging the addition of more efficient products or practices to the choice set. The gains are consolidated by performance standards that remove inefficient products from the choice set. Innovation establishes the feasibility of new technology; standards make the new technology mandatory.

9. A RESEARCH PROGRAM

Very simply put, some of the elements of a new paradigm are (1) markets are heterogeneous, (2) markets mediate economic behaviour, and (3) one of the ways that markets mediate behaviour is to provide a choice set. As Kuhn observed, one of the things that paradigms do is help us to decide which research topics are worthy of attention. The elements of a new paradigm listed above suggest the need for a research program on markets. Below we describe some of the topics that might be included in such a research program.

Descriptive studies

Since markets are heterogeneous, an understanding of how markets mediate economic behaviour requires the study of many different markets. Much fieldwork needs to be done to develop descriptions of how markets actually work. A nice example is contained in (Lutzenhiser *et al.* 2000) where the market for new “class A” office buildings is de-

scribed. Studies like this can help to determine how choice sets are constructed and where there may be points of leverage for changing choice sets. Examples of markets that would be of interest are electricity, appliances, automobiles, existing housing, and building maintenance services.

Taxonomy

The language for describing markets needs to be refined so that descriptions of markets can become less amorphous. Analysis of descriptive studies of markets should lead to the construction of a taxonomy that can make description more systematic and comparison more precise. The economic discipline of industrial organisation (IO) is a possible starting point for taxonomy. IO is concerned especially with the degree of competition in markets. Some of the characteristics that IO has identified as important in the description of markets are

- *Entry* (how difficult is it for new firms to enter the market? what are the barriers to entry?)
- *Concentration* (how many sellers and buyers are there? what is their relative size?)
- *Transparency* (is it possible to know all prices and product variants? how much effort is required to know them?)
- *(Cross-)ownership* (are there particular formal (legally binding) ties among sellers or with other stakeholders?)
- *Government regulation* (also the sometimes double role of government as owner and regulator is relevant.)
- *Delineation and separability* (how well can the market be distinguished from markets for substitutes or complements; are there a lot of spill-over effects to or from other markets or non-markets including environmental effects?)[11]

To these characteristics we might add

- *Homogeneity of goods* (this can range from very homogeneous (for example, electricity) to highly differentiated (for example, buildings)).
- *Transaction repetition* (do buyers make often repeated transactions (for example, grocery purchases) or infrequent transactions (for example, automobile purchases)?)
- *Production modality of the market goods* (there is a continuum here from craft-based production (for example, buildings) to mass production (for example, refrigerators).
- *Social networks* (what is the nature of the informal relationships among market participants?)
- *Norms* (what are the agreed upon standards of conduct for market participants? what sanctions are applied to those who violate the norms?)

This list is meant to be illustrative, not exhaustive. The purpose of the list is to suggest the variety of descriptors that may be important. The research task is draw upon existing theory in economics, sociology, and other disciplines to create a framework that will aid in the interpretation of descriptive studies.

The Evolution of Markets

More research is needed on the ways in which consumer culture and choices in the marketplace interact with producer/retailer decisions and efforts to shape consumption. As Wilhite *et al.* (2000) point out, we know a good deal more than we did two decades ago about energy use behaviour, but we know relatively little about the co-determination of demand and how social "needs" are created. This knowledge is required in order for us to assess whether, when and how "social marketing" might appropriately (and effectively) be undertaken in this arena. It would also greatly benefit nascent efforts to "transform" those consumer-producer systems (Blumstein *et al.* 2000, Lutzenhiser et al. 1998, Lutzenhiser and Janda 1999).

Government policy and choice sets

The continuing expansion of societal energy consumption is evidence of growth in the development and diffusion of energy using devices and technologies. It is also evidence of the effects of state policies not directed toward energy and the environment—e.g., zoning and land use regulations, fuel subsidies, transportation planning, building codes, industry protection arrangements, and so on. The effects of these policy approaches in erecting and maintaining constraints on consumer choice and assuring an escalation of consumption should be examined. (Wilhite et al. 2001).

While many other research efforts can be imagined, those given above can make a significant contribution to the development of a theory of market transformation. It is worth observing that the development of such a theory would

ramify far beyond energy policy, providing a significantly greater understanding of economic behaviour in modern society.

10. REFERENCES

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11. END NOTES

[1] Blumstein and Lutzenhiser

[2] Following T.S. Kuhn, we use the word paradigm to mean a somewhat amorphous collection of rules and standards that guide a research tradition. "By choosing [the term paradigms], I mean to suggest that some accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—provide models from which spring particular coherent traditions of scientific research. These are the traditions which the historian describes under such rubrics as 'Ptolemaic' astronomy (or 'Copernican'), 'Aristotelian' dynamics (or 'Newtonian'), 'corpuscular optics' (or 'wave optics'), and so on. The study of paradigms, including many that are far more specialized than those named illustratively above, is what mainly prepares the student for membership in the particular scientific community with which he will later practice. Because he there joins men who learned the bases of their field from the same concrete models, his subsequent practice will seldom evoke overt disagreement over fundamentals. Men whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. That commitment and the apparent consensus it produces are prerequisites for normal science, i.e., for the genesis and continuation of a particular research tradition." (Kuhn 1996, 10)

[3] The papers that are cited here all appear in the March 1998 issue of the Journal of Economic Literature. These papers provide critiques of simple optimizing behavior models from a variety of perspectives.

[4] Ideas can linger in the policy world long after they have been abandoned by scholars, As J.M. Keynes wrote in his famous comment about the power of ideas, ". . . the ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back." (Keynes [1935] 1964, 383)

[5] The *OED*, quoting J.A. Allen, gives the following example of the use of the two words, "Innovation is the bringing of an invention into widespread, practical use. . . Invention may thus be construed as the first stage of the much more extensive and complex total process of innovation." (*OED* 1989, 7:998)

[6] LBL, now know as the Lawrence Berkeley National Laboratory (LBNL), is operated by the University of California for DOE.

[7] Apologies to our European colleagues who may not be familiar with this Americanism. It is attributed, perhaps erroneously, to Ralph Waldo Emerson. Emerson is reported to have said in a lecture, "If a man can write a better book, preach a better sermon, or make a better mousetrap than his neighbor, though he builds his house in the woods the world will make a beaten path to his door." (Webber and Feinsilber 1999, 86)

[8] One question about innovation that needs more research attention is, what are the reasons for the different paces of innovation in different areas of technology?

[9] We are not the first to observe that only a limited set of choices is available in the market. For example, Lancaster (1979) approached the topic from the perspective of neoclassical economics. Lancaster focussed on the role of economies of scale in limiting the variety of choices.

[10] More precisely we might say that market transformation is changing the probabilities of selection of elements from the choice set. [Something that is not in the choice set will be selected with probability zero.] Note that this changing of the probabilities might be accomplished by modest means (for example, the introduction of a new product into existing distribution channels) or by more far reaching measures (for example, a restructuring of a market).

[11] This list, slightly modified, was suggested by an anonymous reviewer.