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Abstract

Evolution of consumers' preferences has been recognized by many scholars as being key to understanding technological change. However, mainstream economics cannot account for the seemingly irrational behavior of consumers based on changes in taste – consumer theory lacks exibility and accuracy to explain changes in consumer behavior. Adopting a behavioral psychology perspective, this paper argues that there is a rational pattern in the change of consumers' tastes. I argue that behavioral psychology offers us a unique perspective to solve some of the paradoxes of consumer behavior. This paper incorporates exibility into CES utility function to more adequately account for, and differentiate between, habit formation routines. A model is developed in which habit formation and consumption of new goods are interrelated.

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1 Introduction

In this article we want to study the effects of technical change from the final demand aspect. This means that we need the consumer to consider new products in her maximizing decisions and to understand the evolution of preferences. How preferences change to allow the consumer to choose new goods while retaining some old habits. That is the aim of this article - to explore ideas that allow consumer theory to explain the choice and consumption of new goods, and the cohabitation of such decisions with the formation of habits.

Even though we acknowledge the importance of new consumption, it is incorrect to base consumer theory purely on new products. If our goal is to explain real behaviour, we must take into account that consumer decisions are an interaction of new possibilities with previous purchasing habits. When we follow the patterns of an individual's consumption we see that some goods are consumed several times. We also see that sometimes new things are bought to try them out. After trial, some goods will become habitually bought and others never again.

Consumer theory, as it appears in text books, is not a useful theory when studying product innovation. It is a logical tool that only considers quantities and prices to explain a decision taken by an individual. Once the choice is made we can explain how the decision will change if prices change. The main problem arrives the second time the consumer must choose between the same goods. We have to assume that the person's preferences have not changed between these two occasions and so, if prices are also constant, the second decision must be exactly equal to the first one. This assumption is too strong and blocks the analysis of product innovation. Despite this fact, rather than negating the theory, we shall transform it to make it sufficiently flexible for our purposes.

Therefore we consider it worth dedicating this article to understanding and analysing preference evolution within the framework of technological change. Here, there will be not a final point on the state of consumer theory, but a first step toward some changes that need to be made to comprehend the importance of technology in the world economy.

Having said that, the main point of the article is the evolution of preferences - aiming to explain why old consumption patterns survive with new products. If this is our aim, there are some questions that need to be answered: Why and how do we develop consumption habits? Why do we consume new products? And how can these two actions be integrated into a single decision made by the consumer?

This article will not deal with the social dimension in consumer patterns although we acknowledge its importance. It will focus on the behaviour of an individual consumer. The work will be mainly looking at "inconspicuous" consumption patterns.

The article is organised as follows: in section 2 we review the literature concerning consumer behaviour, in section 3 the three main topics of habit formation, novelty and how to integrate both will be discussed, section 4 simplifies these ideas into a mathematical model and the last section, 5, provides a conclusion.

2 The dynamics of utility in the economic literature

The purpose of this review of the literature is to analyse attempts to make economic theory more responsive to consumer behaviour. We focus particularly on understanding product innovation from the consumers' perspective. With this in mind, we shall first look at the origin of two main assumptions which are incompatible with innovations: fixed preferences and intertemporal independence. The next step will be to analyse attempts to see how consumer behaviour is affected by either past or future consumption. Afterwards we discuss some criticisms made of consumer theory and try to locate our research in the literature.

The idea of fixed preferences follows from the theory of revealed preferences. It was proposed by Samuelson (1938) and it is one of the most restrictive ideas concerning consumer behaviour. He focused on the idea that when a consumer chooses a set of goods at a constant set of prices, she is revealing her preferences. Thus, assuming that her preferences are stable over time he argues that indifference curves are not very relevant, that a lot of information can be found from the consumer's elections independently of the existence of the utility curve. This information is more empirical and inductive than that derived from indifference curves. His main concern was the fact that utility can not be measured either in a cardinal or in an ordinal way; however, the consumer reveals her preferences every time she chooses something, and this is the information that economists should use. A deep view into the main issues he was dealing with will bring us to a discussion of whether utility can be measured. The impossibility of measurement is a central point of his discussion.

The issue of measuring utility brings us to the origin of the concept of utility, which goes back to Bentham and J.S. Mill. They introduced this concept, with the certainty that utility could be measured in a scientific way, as a result of processes of pleasures and pains. In their work they presented lists of sources of human pain and satisfaction. They argued that pleasure or pain could be measured depending on variables such as intensity, duration, certainty or uncertainty and propinquity or remoteness. After compiling an exhaustive list of human sources for pain and pleasure and the variables that control the level of satisfaction, they aimed to assess the state of any individ-

ual. Their ideas were further discussed and worked out by the marginalists (Jevons, Walras and Menger), crystallizing into one important concept: decreasing marginal utility. It means that when people enjoy things, the more they have the better it is, but each extra unit of the same good adds slightly less utility than the previous unit did. The concept was still based implicitly on measurability. Using this concept, Marshall (1890) deduced demand curves, making a strong logical link with indifference curves. However, the idea that utility could be measured was soon problematic. At the beginning of the following century an influential economist, Robbins (1935), came to the conclusion that utility could be only measured in an ordinal way. His idea was more that, even though it was possible to order the preferences of the consumer, it was not possible to assign a number to an experienced pleasure. In a way he tries to move consumer theory from a theory based on values to a general logical choice. Hicks and Allen (1934a,b), taking Robbins' arguments, make a whole review of critical concepts derived from consumer choice: marginal utility, elasticity of substitution, expenditure curves, demand curves, complementarity... basically they conclude that these concepts can be used even if we measure utility in an ordinal way. To end this issue we refer to the work of a prestigious economist - and note how economic theory evolves in a circular manner. Since, in more recent research, the Nobel laureate Kahneman and his colleagues (1999) propose going back to Bentham, arguing that science now allows us to measure utility with accurate methods. In his work he suggested two ways of measuring utility: based either on reports made by the consumer or in physiological measurements (heart pressure, brain waves...). He suggests that in such a way we could move toward a more experimental consumer theory.

Thus the notion that one can measure the hedonistic pleasure that any good gives to an individual leads to the idea that utility can also be measured, whether in a cardinal (Bentham and Mills) or ordinal manner Robbins (1935). Hicks and Allen (1934a,b) proved a demand curve can be derived from either case. However demand curves relate price and quantity for one single product. They are derived from indifference curves, which always relate a set of existing goods to levels of utility. The issue of the apparition of a new good, and how it affects indifference curves and demand, was never discussed by these economists.

A second point, which is related to the stability of preferences, is the inter-temporal independence assumption: preferences are affected by neither past nor future consumption. Under this assumption, what I consume today is not affected by what I consumed yesterday nor by something I will consume tomorrow. However this assumption is too unrealistic and too strong. The consumer is always the same person over time and a connection between decisions taken at different moments is to be expected. To illustrate the problems associated with the independence assumption, some

words from Samuelson, the economist who stated the theory of revealed preferences:

“ The amount of wine that I drank yesterday and will drink tomorrow can be expected to have effects upon my today’s indifference slope between wine and milk.” Samuelson (1952).

Some economists have tried to work on the relaxation of this idea. Two groups will be now discussed: scholars who try to see how past experiences affect present decisions and others who look to the relation between present choices and future elections. In other words the utility is affected either by past consumption or by future consumption. Starting with past consumption affecting present decisions, the first attempt to break the assumption of temporal consumption independence came from Duesenberry (1949). He was trying to find more coherent and realistic ways to explain consumer behaviour. In his book one idea is highlighted: consumption is used to create a self image. Consumption patterns are explained by belonging to a peer group; he was thus able to explain why consumption patterns were so stable in the presence of a change in income. One idea that follows from his work, and that is relevant for us, is that consumption is determined by habits. Hence present decisions are a consequence of past experiences. He proposed to look at past consumption and presented the idea of habit formation. Some years later Pollak (1970) presented a first formal study of habit formation in consumer theory. He focused on linear utility functions and the implications of introducing habit formation into the consumer maximizing behaviour. He concluded that consumer theory is more responsive if past consumption is allowed to interfere with present decisions. His contribution was further worked by Ryder and Heal (1973). They looked at how habit formation affects the optimal path of a neoclassical growth model. However, the literature concerning growth and habit formation will be presented in the next chapter. Therefore we return to contributions at the level of micro consumer theory.

The next point to consider is how future consumption affects present utility. The idea is not new, its roots going back to Jevons. The logic is the following: if somebody invites me to go to the cinema tomorrow, my utility is increased from the moment I am invited. However, future utility needs to be discounted to bring it to the present moment. In general this is done by using exponential functions. Ainslie (1975, 1991, 1992) has written strenuously against this method of discounting future utilities. Instead he gives founded reasons for using a hyperbolic discounted function. To understand the importance of the matter it is worth looking at the argument made by Thaler (1981): asked to choose, a person might prefer to have one apple today than two tomorrow while at the same time preferring to have two apples within 51 days than one in 50 days. Most consumers will chose

one apple today and two in fifty-one days. The hyperbolic function, being more concave than the exponential function, solves the problem. Despite the agreement on using a hyperbolic function when discounting, the value of the discount factor seems to depend very much on the empirical experiment. For a review of matters concerning discounting see Frederick et al. (2002).

As soon as future decisions become part of preference formation we have to take uncertainty into account. A general finding among economists and psychologists working with uncertainty decisions is the so-called loss-gain asymmetry. When the consumer is asked about the effect of a future gain she always overestimates its real utility, and when is questioned about a possible loss she underestimates it. For a group of researchers this is crucial, and it was first suggested by Markowitz (1952) that consumer theory should be based on gain and loss prospects instead of being based on choices of quantities depending on prices. Kahneman and Tversky (1979) incorporated this idea and they present a model of consumer decision-making under uncertainty. Their contribution solves Allais' paradox; decisions under uncertainty are not related to expected probability. They concluded that it is not the real probability that makes the consumer decide but the perceived uncertainty. When the consumer is discounting future outcomes the general conclusion is that losses are discounted at a lower rate than future gains. Tversky and Kahneman (1991) found that the ratio in which most consumers discount losses versus gains is almost constant, approximately one to two. They also point out that the key variable to look at is not general loss-gain but the relative gain. The consumer's initial situation determines her behaviour and the way she values things. Loewenstein and Prelec (1992) introduced a model that takes into account these irregularities. They work with a value based on deviation from an anticipated reference consumption. This function has different curvatures depending on whether the consumer is evaluating a positive or negative gain. With their work they are able to discuss the effect of the consumer's psychology on the economy. For example, they argue that the uncertainty the consumer faces about the future will reinforce business cycles. Another interesting conclusion is of the incapacity of the consumer to predict change in future utility. Loewenstein et al. (2000) find that even if the consumer is able to predict the direction in which her utility will change, she systematically miscalculates the impact of the change. They explain that the real utility lies between her prediction and her current situation.

Before continuing, we collect and summarize some of the issues that have been tackled so far. Our goal is to understand product innovation from the consumer's perspective. We agree that decisions concerning old habits and new consumptions intertwine in coherent consumer behaviour.

We consider the models of habit formation especially relevant and shall develop them further in the following sections, trying to look deeper into reasons relating past and present consumptions. Future consumption affects present decisions too, but the kind and level of uncertainty implied by the papers quoted so far, is not the central concern of our work.

Our ideas are closer to Witt (2001), he recognized as one of the main problems concerning the theory of technological change the fact that we know too little about demand, in particular about the evolution of preferences. In his article he asks about the satiation of needs, and how is it possible that in developed societies income per capita has been continuously growing but demand is never satiated. His main conclusion is that one possible explanation could be that the patterns of consumer demand are becoming increasingly specialised. In this chapter, we are mostly concentrated in how new goods enter the consumer's decision.

We consider it an important issue that economic theory gives very little explanation for the consumption of new goods; there is no formal explanation that helps us understand such consumption. The only relevant attempt was Lancaster (1966). He argued that goods are consumed because of their characteristics and that new goods are recombinations of old characteristics; the combination of characteristics that the new goods offer is closer to the consumer's preferences than those of the old goods, hence the new goods are bought. The main problem of this approach, as is mentioned by Swann (2002), is that the question of why we consume new goods is simply reworded as why we consume new characteristics of goods. Following Lancaster's ideas, Stigler and Becker (1977) suggest comparing the consumer to a firm. In this approach the consumer is treated as if he were producing utility in a firm whose inputs are characteristics. Thereby they succeed in presenting a more dynamic consumer. However, the question of why we consume new characteristics is left without answer. More successful although less formal is the explanation given by Scitosvky (1977); the consumer needs change in what she consumes simply because she needs novelty to reach well-being and comfort. Following his ideas, and merging them with the previous ones, we find useful the work done by Bianchi (1998, 2002). She argues that novelty is a relevant factor in the inputs that the consumer is using to maximize utility. Both Scitosky and Bianchi acknowledge in their work the research concerning novelty done by Berlyne (1974). He was working on novelty and the reaction of humans towards novelty. One of the most important conclusions from his research in behavioural psychology is the so-called Wund Curve. It is an inverted U-shaped curve that plots hedonistic reaction against novelty. Things too new or too old offer a low hedonistic satisfaction, the peak being somewhere between the two extremes.

We believe it necessary to develop further a sound theory that integrates some of the results produced by economists and psychologists working in

fields close to behavioural psychology. Some of these results are so crucial that we need to provide more detail, enabling the reader to get a clearer view why individuals consume new products. Hence the next section, in which we shall discuss in depth some of these results and link them to economic theory, in particular to consumer theory.

3 A new theory for consumer behaviour

Decisions concerning consumption cover a broad spectrum of goods and services: a car, a ticket for the cinema, a dinner in a restaurant, new shoes, a Picasso picture. . . . The reasons behind these decisions may well be quite different; the reason for going to the cinema is a probably very different from that which pushes you to buy a new car.

The first thing we need to understand is that there are two different activities that the consumer is continually repeating: buying and using. Buying means using money to get something. Using means getting utility out of direct contact with the object or service. One important issue in our argument is at what moment the consumer maximizes her utility; when buying or when using? In some cases these two actions are connected in time and they follow one from another; for example, drinking a cup of coffee in the cafeteria, where the actions of buying and using the good are linked in time. In this case, there is also a unique relation between the two actions: you buy one coffee and you can only use it once. In other cases, the two actions are neither so simultaneous nor are they in unique one-to-one relationships. Take a knife as an example; you buy it once and you may use it many times. The two actions are separated in time and are not bilateral.

We believe that the concept of “consumer utility space” can help us to understand consumer behaviour. We shall define this theoretical space as one that contains the object or service so that the consumer can extract some utility from it. It is not a physical space. Some examples may help to explain how we use this concept. Tomatoes in your refrigerator are inside the utility space, those in the supermarket are not. The films at the cinema are outside the utility space, the specific film for which you bought a ticket is inside it. Books in the library are outside, the book borrowed from the library is inside. Whatever we can use and get some utility from will be inside. Our consumer is able by direct contact to intellectually or physically enjoy things within the space.

First we should analyse how goods enter into this utility space. We suggest two possible ways:

- market provision, which basically means the consumers buy a good,

- non-market provision, for which we find various possibilities: home-made produce, loans, heritage, gifts. . .

Then we can describe three main reasons why the good leaves the space:

- The good disappears, such as food when eaten or the cinema film when it finishes. After using it once, it no longer exists
- The good breaks or gets too old to be used. An example would be an old computer
- We get jaded from using the good. This might happen in different ways, slowly (boredom) or quickly (dislike). Envisage the boredom of an outmoded t-shirt or the foodstuff whose taste we dislike from the very first trial.

These distinctions may appear redundant. However they are important variables which may explain product innovation and economic growth. Take a hypothetical case, that the average lifespan of electrical house appliances is under the control of the manufacturer. Think about an electrical appliance which most people already consume habitually, for example a refrigerator, and then imagine a cartel which decides to reduce the average life of refrigerators. If such a decision were taken and implemented it would have a positive impact on the growth of the country. However, this discussion is outside our scope and will be left for future research.

But to return to the previous point - once we have the good inside the consumer's utility space we can study the formation and evolution of preferences. This will be the main subject of subsection 3.1. However in the subsequent subsections, 3.2 and 3.3, we are more restrictive and focus on only one kind of good. Goods, and when we say goods we mean also services, of one single use. We define a single-use good as one, provided by the market, that the consumer buys (gets inside her consumer utility space) and uses (gets utility) before it leaves the space. For a single-use good the three parts of this process occur within each time period.

We discuss the evolution of a preference for a single good in the next subsection. The use of a good is compared to the exposure of an individual to a constant external stimulus. We argue that conclusions from behavioural psychology are valid when considering consumer behaviour. Novelty and its relevance for consumer choices will be the focus of the subsection that follows and in subsection 3.3 the two previous points will be integrated into a single process of decision as made by a consumer.

3.1 Evolution of preferences

We concentrate on the evolution of preferences for one good which is already inside the utility space. We will make a categorical definition of a good and

fix periods of time as follows: a short period in which the individual will consume the good, followed by a long period of time with no consumption. The break in consumption will be called the “time interval” between consumptions. Once the good and the period are defined we can study how this good affects the consumer, or in other words how preferences for this good evolve. Firstly we analyse the evolution of reactions of an individual who is repeatedly exposed to an external stimulus. Secondly we adjust the results from psychological behaviour to consumer utility, arguing that consumption of a good is an external stimulus. We then analyse some important differences for consumer behaviour.

To understand the evolution of reactions that an individual has towards a stimulus, we follow the research done by Solomon (1980). He was looking at the way individuals react to exposure for a few seconds to an external stimulus when followed by a long period without exposure. He focused on the evolution of reactions to the repetition of the experiment. Working with both positive and negative stimuli, Solomon measured reactions using physiological indicators: excitement, blood pressure, heart activity ¹... As an example of his animal experiments, he worked with young ducklings and studied their reactions (agitated movements and high peak sounds) to the presence of a moving mother duck (a positive stimuli). He studied how reactions evolved when the cycle of exposure followed by a long period without exposure was repeated. Other experiments involved dogs, monkeys, and humans.

As a result of his experiments the “Opponent process” theory was formulated. This theory states that if an individual is exposed over a period of time to a stimulus repeated at constant intervals, the effect of the stimulus will decrease over time. He argues that the impact of the stimulus on hedonistic perception depends on three variables: the length of the time intervals without exposure, the memory of the individual and the quality of the stimulus. The stimulating effect depends on these three variables as follows:

- Time interval between exposures: the longer the interval the greater the effect of the stimulus in the next repetition.
- The memory of the individual: the greater the capacity of the individual to remember past experiences the lower the effect of the stimulus in each repetition.
- The quality of the stimulus: an increase in the quality of the stimulus will cause an increase in the experienced hedonistic perception.

The consumption of a good can be considered a concrete example of the broad definition of an external stimulus. Thus the consumption of the

¹More recent research explains these reactions based on the endorphins. See for example Ito and Cacioppo (1999)

good generates in the brain a positive reaction which is perceived by the consumer as an increase in her hedonistic situation. To study the evolution of preferences we need to examine the relation between exposure of the individual to the same stimulus with the evolution in the perceived level of pleasure. Assuming our consumer is only affected by the consumption of a single good from within her consumer utility space, we shall consider how the three 'opponent process' variables alter this consumption. The utility that the consumer derives from something inside her space (i.e. the increase in her hedonistic level) will be called "experienced utility". How does experienced utility change as we modify the three variables, one variable at a time, while, as above, the individual consumes a good for a short period of time followed by a long break? Starting with the length of time interval between consumptions: if the time interval is sufficiently long for her memory to hardly evoke the last experience then the consumer will be able to enjoy the next consumption almost as she did the first time. As the time interval decreases the consumer will begin to develop an aversion to that specific good. If the intermissions are very short she may even develop an aversion strong enough to prevent the good's use for the rest of her life. If the aversion is not too strong, a long period of rest, a long break, might be enough to allow her to enjoy the good again.

Concerning the second variable, if our period of study is the consumer's whole lifespan then memory may play an important role. The better the consumer's memory the faster the level of experienced utility will decrease. For this case imagine two individuals, one adult (normal memory) and one old person (lower memory). Both being exposed to the same good for identical periods, the adult's level of experienced utility will decrease faster than that of the old person. Proving, as Scitovsky points out, that habit formation in elderly populations is stronger than that among younger adults. Scitovsky refers to experiments done concerning the diet of one group of old people versus another of adults. These two groups can be consuming the same thing, or doing the same thing, but reach boredom at different times, with adults becoming bored sooner than elderly people.

The third point is that an increase in the good's quality, *ceteris paribus*, will induce an increase of experienced utility.

At this stage, it is worth recalling classical consumer theory, and reflecting that the theory is only based on an increase in the quantity consumed. It states that greater quantity always causes a positive effect on the experienced utility but each extra unit consumed will have less effect (decreasing marginal utility). The classical theory presents an analysis of one single variable affecting the level of experienced utility: increases in quantity. But the analysis of the repetition of consumption of identical quantities at unchanging prices has always been ignored.

There is one important difference between a consumer theory and a be-

havioural psychology one. In the second case we are studying reactions to an external situation which is not determined by the individual. A consumer, however, has freedom to choose her own exposure to the good, thus setting up her own experimental environment. So we can postulate that the consumer subconsciously learns how to consume the good in the sense that, given a quality of the good and a stable memory, she learns to set the right time interval between consumptions in order to experience utility. In section 4, the model will assume fixed time intervals, constant memory and equal quality of a good while we give the consumer freedom to choose the good's quantity according to her experienced utility.

Concluding, three main factors explain the evolution of preference for a good: the time between each consumption, the memory of the consumer and the good's quality. Separate consumers may be exposed to the same consumption of a single good and may have very different levels of experienced utility; however the evolution itself of their preferences towards that good will follow similar patterns.

The next section concerns novelty, an important idea that explains how a good enters the consumer utility space.

3.2 The search for novelty

The focus of the previous section was the evolution of preferences and experienced utility, in particular the evolution of utility when neither quantity nor prices change. We were thinking about a situation in which the consumer has direct contact with goods and is learning from past experiences. While considering habit formation we were following the studies begun by Duesenberry, as noted in our review of the literature. We also know from the literature that several writers on economics try to explain present consumption as being influenced by future discounted utility (among many others: Jevons, Ainslie (1975), Thaler (1981), Tversky and Kahneman (1986), Loewenstein and Prelec (1991) and Ramsey (1928)). From their work we understand that consumers are able to improve their hedonistic situation by imagining that they are using goods and therefore deriving utility from future consumption. However here we shall be more precise in our interpretation. We are not looking at the impact that future consumption of old goods will have on the present consumer. Our main viewpoint is the present impact on utility that unused goods have on present decisions and that the idea of buying new goods raises the present level of utility. In the current section we argue that consumers search for a different form of utility, one derived from novelty. However our purpose is not to define novelty but rather to see how crucial it is to understanding consumer behaviour. Therefore we concentrate on a description of what we mean rather than on its definition.

To introduce this idea we quote Adam Smith:

“ The imagination and memory [...] fluctuated to no purpose from thought to thought, and we remain still uncertain and undetermined where to place it, or what to think of it. It is this fluctuation and vain recollection, together with the emotion [...] that they excite, which constitute the sentiment properly called Wonder, and which occasion that staring and sometimes that rolling of the eyes, that suspension of the breath, and that swelling of the heart, which we may all observe, both in ourselves and others, when wondering at some new object, and which are the natural symptoms of uncertain and undetermined thought”.²

Although Adam Smith was describing the reaction of the scientist when he finds something new, it is easy for the reader to imagine the same sensation of wonder applied to a consumer. And we, as consumers, have all observed these reactions both in ourselves and in others. The idea of possessing a new car, a new house, a digital camera, a new pair of shoes or even a new jacket. . . The list of objects is long that may produce similar feelings of wonder. Consumers may be excited by different objects or ideas but it would be difficult to find a consumer that has not ever experienced such sensations. Bianchi’s research (1998) presents these thoughts well. She argues that novelty is an important input determining the utility of a consumer.

This sensation of novelty is occasionally very strong and at others quite mild. We are happy to pay for a portion of this novelty, as in the case of a “news” paper where the utility does not come so much from reading the paper itself as from the feeling of getting some novelty. If we reconsider the previous discussion about the definition of goods, we could define the good as the “newspaper”, the consumer developing the habit of buying a newspaper every day. However if we define the good as “the new” then every day it is a different good. This point is important because it means that the consumer gets utility from what she does not know and is also willing to pay for it.

We now present two relevant results concerning novelty; as in the previous subsection they are part of psychological research. Presenting Berlyne’s work, we will discuss how people react toward different degrees of novelty, but beforehand we will also mention results by Hebb (1955). Hebb’s explanations of brain cell activity are very relevant for our own discussion. His main conclusion is that humans need a certain amount of novelty in their environmental stimuli to feel well. As an example, Hebb set up an experiment in which individuals were asked to fill in a questionnaire of basic questions about culture as well as performing basic mathematical exercises. Afterwards they were asked to spend several hours in an empty white room

²Essays on Philosophical Issues: History of Astronomy p. 39

before filling in an equivalent questionnaire. The majority of the individuals scored very poorly in the second test. He explains that to be able to perform intellectual activities the brain needs a certain amount of external stimulus. He was studying the relation between the activity of brain cells, neurons, and the feeling of well-being in humans. Arising from his studies he proposed a theory based on “arousal” due to environmental stimuli. He concluded that a person needs changing stimuli in order to feel well. His conclusion is interesting for us, because some changes in stimulus may come from goods that the consumer has in her consumer utility space, while others may be created by the market. The second case provides a reason why a consumer buys new things. So far economists have been interested in studying a single set of goods and the effect that these goods have on the consumer’s utility. Our argument is that the curiosity, and therefore the utility, of the consumer is raised by the idea of buying a novel good.

If consumers need novelty we should determine the degrees of novelty, and understand how changes in the degree of novelty affect consumers’ utility. The research presented by Berlyne (1974) brings some light to the issue of novelty and the level required by individuals. He studied the reaction of humans when exposed to novel objects. One example, among many experiments that he made, was to show drawings, for example of a tree, changing the degree of novelty in each drawing from a very basic tree shape to a futuristic image, passing by very detailed drawings. People were asked to choose which one they preferred; the majority chose one between the two extremes. Based on his experiments he concluded that positive perception of the novelty by the individual follows an inverted U-shaped curve, the so-called “Wund-curve”. The individual will dislike exposure to things either extremely original or too little so. He also reaches a similar conclusion to the one presented by Solomon: if a person is exposed for a long time to an extreme novelty, the initial dislike may with repetition turn to pleasure. Think for example how new fashions arise; at first very few people use the article but with time its consumption becomes massive.

Psychology, then, gives us two main ideas concerning novelty: we need a certain amount of it to feel good and the level of it that we choose is never extreme.

Still, as economists, novelty is important because it can explain why a consumer buys new goods. The utility she gets from a new item comes not from her personal experience but from imagining how well she could feel in the future. Lancaster (1966) argued that new goods are bought because they fit the intrinsic characteristics better. However, many economists, such as Swann (2002), recognise this replaces the question of why we consume new goods by why we consume new characteristics. We believe it is a matter of the good’s definition. Taking a mobile phone as an example, we could think of it as a telephone with a new characteristic. Lancaster’s argument is that the new good offers us the possibility to talk almost everywhere. Combining

the two characteristics allows one to talk to distant people while being free to move about. This optimal new combination makes one buy the good. Our line of argument is different. When confronted with a telephone characteristic such as “the capacity to talk without having a fixed connection” Lancaster’s theory cannot offer us an explanation because the characteristic is entirely new, not intrinsic. The question then becomes why we think we shall get some utility out of something we can never have experienced before. Our explanation is that the consumer buys the new good/characteristic because of the excitement produced in her imagination by the idea of using it. We believe that one buys new things because of their novelty value. This novelty produces in us so much pleasure that we pay for it.

In the next subsection we shall study how novelty and habit formation form a whole, how these two concepts are interrelated to maximise utility.

3.3 Deciding what to buy

We have talked about the consumer’s two principal activities: buying and using. Classical theory, in summary, states that the two are joined in time and that the consumer maximizes her utility between a fixed set of goods to result in an optimal combination of quantities according to prices and preferences. We propose the consumer’s choices are explained by a mixture of novelty and past experiences or habits and that what our consumer will be maximizing is a mixture of past and future expectation; we shall call it “decision utility”. This decision utility is not derived from direct contact with the goods but from an blending of what she learned from the past and what she is expecting in the future. Decision utility will determine what the consumer buys. Her purchase will enable her to use the goods and reach a level of perceived utility.

In a case where the consumer is subject to a budget constraint, let us analyse two situations: as election between habits, and as a situation where a new good appears and interferes with the old habits. In a case where the selection is based only on old goods, the consumer has information on each of them. She knows how much experienced utility each good gives her. In the hypothetical case in which all prices are equal, those goods with higher experienced utility will be bought in higher quantities. Experienced utility will affect decision utility. With differing prices, defining the marginal decision utility as the increase in the decision utility generated by the last unit of good, the selection of goods will be done in such a way that the ratio between the marginal decision utility and prices are equal for all selected goods.

In the second case, in which a new good appears, the novelty associated with the good will be compared to the experienced utility of old goods. The budget will be redistributed accordingly to reach an equilibrium at the point:

$$\frac{DU'_1(EU_1, 0)}{P_1} = \dots = \frac{DU'_n(EU_n, 0)}{P_n} = \frac{DU'_{n+1}(0, N_{n+1})}{P_{n+1}} \quad (1)$$

The formula attempts to explain that the consumer increases her hedonistic level not only from things that she knows about (experienced utility) but also from novelty. Both enter the decision of how much of each good to buy. In the formula experienced utility is given by commodities numbered 1 to n , while novelty in this formula is given by commodity $n + 1$. Our argument in this section is that the consumer forms her “decision utility” based on a mixture of “experienced utility” and “novelty”. She chooses quantities so that her optimal decision makes all these ratios equal. The terms experienced utility and decision utility are borrowed from Kahneman et al. (1997)³.

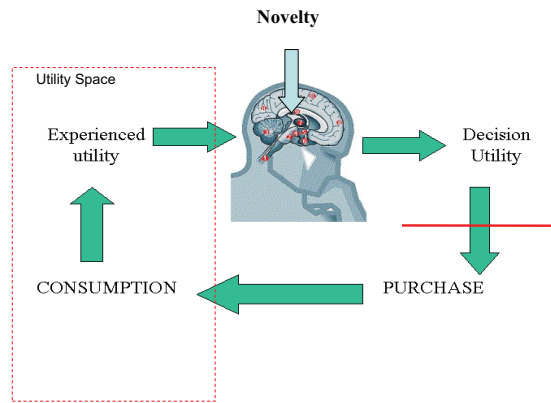


Figure 1: Formation of decision utility

Figure 1 attempts to clarify the whole process of deciding what to buy. Although we know there are other ways of getting goods into the utility space, I focus attention on market provision and, for simplicity, on goods with a single use. With a mixture of novelty and experienced utility the consumer will form her decision utility. Depending on prices and budget constraints she will get some quantity of each good, experience utility out of them and once again start the whole process.

³Kahneman is talking about instant utility and remembered utility. If the instant utility comes out of direct contact with the good, the remembered utility will be the retrospective reports that the brain of the individual is projecting. Here we will be considering only one past period which is affecting our present decision utility, so I use experienced utility as that based on some physical experienced contact with the good

It is worth highlighting one idea related to the new product. The first time the consumer buys the new good her hedonistic level is increased even though the rise does not come from direct contact with the good. As is the case for the old and known goods, the increase in this hedonic perception is a blending in the consumer's imagination. We have called this increase novelty.

We shall now classify goods according to how the consumer's decisions evolve. To do this we fix a long period and study the series of sequential decisions for a single good taken by the consumer during this time. The analysis shows four possible categories:

- Addictions: An addiction is the consumption of a good which in the long run will require all the consumer's income. Examples of such addictions are drugs, compulsive gambling... Socially accepted lesser addictions like drinking tea or coffee, smoking, and so forth are considered as habits.
- Eternal Habits: In this category we find goods which the consumer has learnt to consume and of which some quantity will always be chosen during the period studied even if new goods become available.
- Temporary Habits: The consumption of such a good will give the consumer utility for some time but it will be excluded from her preferences upon arrival of a new good. She will consume the good for a time but before our period finishes will banish it from her shopping basket.
- Novelty consumptions: The consumer buys such goods out of curiosity and will enjoy them until the novelty disappears. Once the novelty has worn off the consumer no longer uses the good.

We should like to reflect here on how new products are analysed in an environment of technical change. New products are in general better than earlier ones and the greater the number of new products the better it will be for the economy. The lack of a demand perspective hampers the distinction between innovations. We are not talking about a demand pull versus an innovative supply push. We are, however, interested in introducing into the discussion the real utility generated by an innovation and how effective this utility is in generating a habit in the consumer. We hope the reader sees clearly that a new product which becomes an eternal habit is not the same as a new product which becomes simply a temporal habit. The distinction can only be studied when demand plays a role. The value of an innovation, and its contribution to the wealth of the economy, depends on its capacity to be needed by the consumer. In other words, by the capacity of the good to develop a habit in the consumer. Habit in the long term is a major determinant. However a certain degree of novelty is crucial, otherwise the whole innovation could be wasted.

What is especially relevant for us is that consumer behaviour is explained by decision utility - the utility that she maximizes before making a purchase. This decision utility is a blend of novelty and experienced utility. Novelty is important in the first purchase; it helps us to understand the initial consumption of a new good. By studying the evolution of preferences over a fixed period we can classify them according to the trajectory they follow. This is further explained in the next section.

4 Formalization of the model

In this section we present a mathematical model rooted in classical consumer theory. The objective is to make the consumer more dynamic by introducing habit formation and novelty into the formation of preferences. Improving the dynamic behavior of our theoretical consumer gives us a routine in which new products are part of the maximising decision of the consumer, thus creating a theory that can be used to analyse technical change when we focus only on product innovation.

Although it is impossible to introduce all the complexity of the consumer into one formal model, the principal components discussed in the previous sections will be considered. As in any formal model, we deal with a stylization of the real consumer behaviour. Only goods of a single use will be considered. The model consumer, though affected by past consumptions, will maximise her utility in each period without considering the fact that her current consumption may affect her future decisions. She maximises over quantities, not over her habit formation. There are two principal reasons for doing this: one conceptual and the other technical. First we consider that such consumer behaviour is closer to reality, that any consumer maximising her situation uses past experiences when making decisions but does not consider the effects of present decisions on her future habits. In this way, preferences evolve subconsciously, not under consumer control. The technical reason is that the model has an analytical solution; omitting this assumption will force us to use simulation techniques. For the sake of simplicity in this article we will avoid the use of simulations. Therefore we model a myopic consumer in the sense that her past experiences affect present decisions, but the latter do not control the effect on her future choices.

The static maximization of the consumer will be the first part of the section. Afterward we will analyse the utility function that is used and its properties. The next step will be, linking the four categories of habit formations into the model, to study the dynamic subconscious process of the individual and to derive important conclusions for new products and habit formation. We finalise the section by suggesting possible extensions of the model.

The consumer chooses over a vector of goods $\vec{x} = (x_1, x_2, \dots, x_n)$. Prices

are given, so she will choose the quantities that maximize her decision utility function, defined as:

$$U(\vec{x}) = \left(\sum_{i=1}^n (x_i - z_i)^\alpha \right)^{1/\alpha} \quad (2)$$

with $0 < \alpha < 1$ and $(x_i - z_i) > 0$

The term x_i represents the quantity of the good, and z_i is the subsistence level of the good i . This level is formed by past experience and/or novelty. The terms x_i and z_i are always positive, x_i because it is a quantity and z_i because we only study goods, assuming any positive quantity of good will produce non-negative experienced utility. In a way, our function is the familiar CES modified by the z_i term. Or we could describe the function as a Stone-Geary function nested in a CES.⁴ We now explain the solution of the static problem.

4.1 Utility maximization in one period

Formally the consumer faces the following maximization problem:

$$\max \left(\sum_{i=1}^n (x_i - z_i)^\alpha \right)^{1/\alpha} \quad (3)$$

$$s.t. \quad \sum_{i=1}^n x_i p_i = E \quad (4)$$

The static solution for this problem is:

$$x_{it}^* = z_{it} - \frac{p_i^\xi}{\sum p_j^\xi} (\sum p_j z_{jt} - E) \quad (5)$$

with $\xi = \frac{1}{\alpha-1}$

The solution can be rewritten in the following way:

$$x_{it}^* = z_{it} + \psi \frac{(E - \sum p_j z_{jt})}{p_i} \quad (6)$$

⁴Another more classical form when dealing with similar problems in economics could be a CES with depreciating coefficients. This approach would explain the continuous decrease in utility given by the same good over time, but it would not permit the inclusion of information about novelty or past experience. This function offers us the flexibility necessary to further work on demand and technology.

In this way it can be understood, with ψ being a price index, that the level of consumption will be equal to the minimum “subsistence” consumption z_{it} plus a fraction ψ of the maximum amount of z_{it} that could be bought using the free disposable budget.

In the usual consumer problem, the marginal utility of each good tends toward infinity as the quantity consumed decreases toward zero. In such a setting all existing goods will be consumed even in infinitesimally small quantities. But we are interested in studying how new goods enter consumer preferences. To understand the introduction of a new good we shall specify that, on the first occasion, the consumer buys at least one full unit of it. If the maximization process give us a solution which is less than one, we shall assume that the consumer does not sufficiently appreciate the good so does not buy it. Such decisions lead to some goods not being consumed. To implement this consumer behaviour we follow an algorithm: if any of the resulting quantities fall below one, we shall eliminate that good and then repeat the process to maximize utility. Should the quantity chosen of two or more goods simultaneously be less than one, we eliminate first the good whose quantity is the smallest and repeat the process. If in doing so the other good now reaches a value greater than one, it will be retained, otherwise it, too, is omitted and we continue. We reason that the consumer weighs up all her possible options and if she cannot buy at least one first full unit she will buy none of this good at all and redistribute her income among other products.

By amending the classical theory, we derive that the following rule will be satisfied at equilibrium,

$$\frac{(x_1 - z_1)^{\alpha-1}}{p_1} = \frac{(x_2 - z_2)^{\alpha-1}}{p_2} = \dots = \frac{(x_n - z_n)^{\alpha-1}}{p_n}$$

In words, for each good the consumer is comparing marginal decision utilities divided by prices, such that in equilibrium the ratios are equal. The z_i terms act like a minimum desired level, holding information of how much pleasure she has previously received from consumption of each good. The maximum decision utility is achieved at the point where the last unit of income expended on each good, is such that distance from each good corrected by past experiences given by the good and divided by prices is equal.

4.1.1 Properties of the function

The first derivative of the decision utility with respect to the quantities is positive, and the second negative. As in the classical model, we have a marginal decision utility function which is positive but decreasing. Since z_i is awkward and rarely used in the literature, it is worth analysing its relation

to decision utility and to marginal decision utility. The effect of an increase in z_i in the decision utility function will be:

$$\frac{\partial U}{\partial z_i} = -(x_i - z_i)^{(\alpha-1)} U^{(1-\alpha)} \quad (7)$$

The sign of this derivative is negative, since by assumption $(x_i - z_i) > 0$. The idea behind the negative sign is that the higher our desire for a good, the worse off we shall be. If we increase this habit formation term, other things remaining equal, the current utility decreases.

The next equation presents the effect of this term in the marginal decision utility for that specific good:

$$\frac{\partial^2 U}{\partial x_i \partial z_i} = (1 - \alpha)(x_i - z_i)^{(\alpha-1)}(x_j - z_j)U^{(1-2\alpha)} \quad (8)$$

This term is always positive because the more accustomed you are to a good, the more value you give to each extra unit of it compared to other goods.

4.1.2 Elasticity of substitution

To conclude the analysis of this function, we calculate the elasticity of substitution between two goods:

$$\frac{d \ln (x_1/x_2)}{d \ln (U_{x1}/U_{x2})} = \frac{1}{\alpha - 1} \frac{\frac{1}{x_1} - \frac{1}{x_2}}{\left(\frac{1}{x_1 - z_1} - \frac{1}{x_2 - z_2}\right)} \quad (9)$$

This proves that unless the two values of z_i are equal to zero this function no longer presents constant elasticity of substitution. In other words, we will be working with non-homothetic preferences and that an increase in income will not be distributed proportionately among all goods.

4.2 Evolution of the dynamic subconscious process

Having studied the static maximization, we now analyse the dynamics of the evolution of subconscious preferences. The term z_i , as before, contains information on experienced utility and novelty. These concepts play a significant role in both short-term and long-term equilibrium. We explain experienced utility, then novelty and the way these two terms affect z_i . A set of dynamic equations will be set up to describe quantities bought over time depending on the evolution of preferences.

Working with non-homothetic preferences implies that increases in income will not be equally distributed among all goods. This point is a cornerstone of our research. Basically we are always working with goods which differ from each other in their capacity to produce experienced utility. If the same quantity of two goods is consumed, the experienced utility will

be different for each one, each unit of consumption of each good producing differing amounts of experienced utility. To derive the level of experienced utility produced by the total quantity consumed of one specific good, we multiply this total quantity by a goods-specific coefficient, whose range is from 0 to 1. This coefficient is an inner characteristic of the good and does not change over time. The consumer chooses the quantity but the characteristic is exogenous to the model. In our model experienced utility has the following analytical form:

$$EU_{it} = c_i x_{it-1} \quad (10)$$

with $0 \leq c_i \leq 1$.

The term c_i is the intrinsic capacity that the good has to produce experienced utility. This term is goods-specific, and it is constant over time. The actual level of experienced utility of the good i depends on c_i and on the past period quantity x_{it-1} .

Novelty will be modelled so that it decreases with time :

$$N_{it} = N_i \sigma^t \quad (11)$$

with $\sigma < 1$. This parameter controls the depreciation of novelty over time t , which is initially zero. The whole term measures how much the idea of consuming the good excites the consumer, and how this feeling loses its power over time. Later in the discussion we present an initial situation in which the consumer has already consumed something. Even though in the past these 'old goods' may have had some novelty, in the present the novelty is assumed to be zero.

In a general case the good has both novelty and experienced utility:

$$z_{it} = c_i x_{it-1} + N_i \sigma^{(t-1)} \quad (12)$$

For simplicity we will concentrate here on only two goods: x_1 , the old one (with no novelty) and x_2 , a new one (with no experienced utility for the first maximization period).

Introducing the definition of the z_i term presented by the previous equation in the static solution 5 will provides a system of differential equations. By studying the dynamics, the next subsection will extend the possible outcomes for any new good that appears in the consumer's life.

The dynamics of preference evolution are presented, concentrating on the simplest case. Considering only one old good (x_1) and one new one (x_2), their respective parameters z_i at each moment of time are $z_{1t} = c_1 x_{1t-1}$, $z_{2t} = c_2 x_{2t-1} + N \sigma^{t-1}$. Substituting these values in the solution 5 gives us the following system of simultaneous differential equations:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} c_1 \left(1 - \frac{p_1^{\xi+1}}{\theta}\right) & -c_2 \frac{p_2 p_1^\xi}{\theta} \\ -c_1 \frac{p_1 p_2^\xi}{\theta} & c_2 \left(1 - \frac{p_2^{\xi+1}}{\theta}\right) \end{bmatrix} \begin{bmatrix} x_{1t-1} \\ x_{2t-1} \end{bmatrix} + \begin{bmatrix} \frac{E p_1^\xi - N p_2 p_1^\xi \sigma^{t-1}}{\theta} \\ \frac{E p_2^\xi - N p_1 p_2^\xi \sigma^{t-1}}{\theta} \end{bmatrix}$$

with $\theta = p_1^{\xi+1} + p_2^{\xi+1}$. The system presents an analytical solution which for each good is equal to:

$$x_{1t} = A \lambda^t + B N \sigma^{t-1} + \frac{p_1^\xi}{\sum_{(c_1-1)}^{p_1^{\xi+1}}} E \quad (13)$$

$$x_{2t} = A' \lambda^t + B' N \sigma^{t-1} + \frac{p_2^\xi}{\sum_{(c_2-1)}^{p_2^{\xi+1}}} E \quad (14)$$

with $\lambda = \frac{c_1 p_2^{\xi+1} + c_2 p_1^{\xi+1}}{p_2^{\xi+1} + p_1^{\xi+1}} < 1$

The terms A, B, A' and B' are constants. Their values depend on the initial value we want to analyse. For a hypothetical case in which in the first period all income is used on the first good, and nothing on the new good, the values of these constants are as follows:

$$\begin{aligned} A &= \frac{E}{p_1 \lambda} - \frac{p_1^\xi (c_2 - 1)}{\lambda \vartheta} \\ B &= \frac{1}{N} \left[\frac{p_1 (\lambda - 1) (c_2 - 1)}{\vartheta} + \frac{E (c_1 - 1)}{p_1} - \frac{p_1^\xi (E (c_1 - 1) + N p_2)}{p_1^{\xi+1} + p_2^{\xi+1}} \right] \\ A' &= \frac{-p_2^\xi (c_1 - 1)}{\lambda \vartheta} \\ B' &= 1 + \frac{p_2^\xi (c_1 - 1) (\lambda - 1)}{N \vartheta} - \frac{p_2^\xi (E (c_1 - 1) + N p_2)}{N (p_1^{\xi+1} + p_2^{\xi+1})} \\ \vartheta &= p_1^{\xi+1} (c_2 - 1) + p_2^{\xi+1} (c_1 - 1) \end{aligned}$$

4.3 One new good, four possible outcomes

In this section we study how a new good enters into the utility space of the consumer and, if it does, how and why it remains there. As we said before, the maximization is done in repetitive steps with the condition that the solution for any good is greater than unity. Any good whose chosen quantity is less than one will be eliminated and the income redistributed among the other goods.

The entrance of a new good deserves special attention so an example with the easiest case will be analysed step by step. Initially the consumer only has one good and we wish to know whether or not she buys a new product. We also want to know if she will continue to buy this product in the future. The initial conditions for each good, and the value for their respective z terms, are the following:

- The consumer spends all her income on the old good so she consumes E/p_1 units of it. The experienced utility will be c_1E/p_1 . Because this good is an old one the novelty is zero. Therefore the habit formation is equal to $z_{11} = c_1E/p_1$.
- For the second good, since it is a new good its experienced utility will be zero and the only parameter will be the novelty. $z_{21} = N$.

Taking equation 5 and defining it for each good we have:

$$\begin{aligned} x_{11} &= z_{11} - \frac{p_1^\xi}{\theta}(p_1 z_{11} + p_2 z_{21} - E) \\ x_{21} &= z_{21} - \frac{p_2^\xi}{\theta}(p_1 z_{11} + p_2 z_{21} - E) \end{aligned} \quad (15)$$

with $\theta = p_1^{\xi+1} + p_2^{\xi+1}$

If we substitute the habit formation part for each good we have the first solution for the next period; for $t = 1$, we will have

$$\begin{aligned} x_{11}^* &= \frac{Ec_1}{p_1} - \frac{p_1^\xi}{\theta}(p_1 Ec_1 + p_2 N - E) \\ x_{21}^* &= N - \frac{p_2^\xi}{\theta}(p_1 Ec_1 + p_2 N - E) \end{aligned} \quad (16)$$

If $x_{21}^* < 1$ then the consumer will buy no first unit of the new good and she will still expend all her income on the old good. Given the rest of parameters, it is the level of initial novelty that determines the consumption of the first unit of good. The minimal level of novelty needed for the consumer to get a first full unit is:

$$N^* \geq 1 + \frac{p_2^\xi}{\theta}(E(c_1 - 1) + p_2) \quad (17)$$

Any value of novelty below this means the consumer is perhaps interested in the good but not enough to buy the first whole unit. As initial consumption does not depend on experienced utility, novelty is the only variable that controls it, other things being equal.

The next important question is, if the consumer buys a first unit, whether she will continue to buy it. In other words, whether or not she redistributes her income between two goods. By studying the solution presented by equations 13 and 14 we can answer this question. With $\lambda = \frac{c_1 p_2^{\xi+1} + c_2 p_1^{\xi+1}}{p_2^{\xi+1} + p_1^{\xi+1}} < 1$ and $\sigma < 1$, when t goes to infinity the system has the following long-term solution :

$$\bar{x}_1^* = \frac{p_1^\xi}{\sum \frac{p_i^{\xi+1}}{(c_i-1)}} E \quad (18)$$

$$\bar{x}_2^* = \frac{\frac{p2^\xi}{(c_2-1)}}{\sum \frac{pi^{\xi+1}}{(c_i-1)}} E \quad (19)$$

The long-term solution does not depend on novelty, but on the capacity the good has to provide experienced utility. It depends on the parameter c_2 . If we are interested in knowing whether the second good will become a new habit then we should find the conditions for which the solution is $\bar{x}_2^* \geq 1$.

A relevant result of this study is that although a good may have a long-term solution (in our example \bar{x}_2^*) greater than unity it might not have enough novelty value to be tried a first time. According to the values of novelty and experienced utility three interesting cases are possible:

- $N \geq N^*$ and $\bar{x}_2^* \geq 1$. This is the case of a successful innovation which will give utility to the consumer in the long run.
- $N \leq N^*$ and $\bar{x}_2^* \geq 1$. In this case, the innovation was potentially successful but the consumer never took an interest in it, possibly due to a failure in the marketing of the innovation.
- $N \geq N^*$ and $\bar{x}_2^* \leq 1$. This is a tested innovation that is found to give so little experienced utility that in the long run the consumer will go back to her old consumptions.

To conclude this section and to link its ideas, we reflect that up to now we have concentrated on the perspective of the consumer. So far, when we referred to novelty we assumed it to be an inner curiosity of the consumer. However, looking at things from the firm's viewpoint might bring different insights into the discussion. Should a firm wish to introduce a new good in a market, it is vital to raise the perceived level of novelty of its product. In solution 17 we can see good reason for a firm to do marketing and publicity; it is one of the best ways to raise perceived novelty. Otherwise, even if the good is technologically superior or useful to the consumer, it may never be sold. We consider it crucial that studies of technological change should include the marketing perspective and we return to the subject in the conclusion of this chapter.

4.4 Graphical analysis of the model

Figure 2, presenting four graphs, attempts to illustrate the concepts being discussed. The first three panels plot the quantity of each good over time in three different situations. In the first case we plot a successful innovation, case 2 is for a good which will not be chosen on a long-term basis and case 3 is that of an addiction. In panel 4 of the figure we plot, using indifference curves, the different situations in time at which the consumer might be.

In our graphs consumer income is equal to 1000; there are two goods, one old (x_1) and one new (x_2). The old good's price is $p_1 = 10$, the price for the new one is $p_2 = 5$. Varying the values of c_i s, the proportion of experience utility achieved by the consumer for each unit of good, and novelty; changes both the dynamics and the steady state.

The first panel of figure 2 is the case of a successful innovation. Initially the consumer buys a lot of this good, generating a peak in consumption at C. As the novelty value drops towards zero the consumer still finds this good useful but at a lower level of consumption, point B, where the long-term stable consumption level is reached.

Panel 2 is an example of a temporary consumption. The novelty for this product is high and therefore the person consumes it for a period, but as time passes she goes back to the original situation.

The next case is an addiction, in which the new good gives so much experienced utility that the consumer decides to use all her income on the new good. This is presented in the third panel.

The last item of the figure, the fourth panel, is an attempt to reconcile this theory with the classical consumer theories. This presents indifference curves that show the marginal decision utility that each combination of goods has at each moment of time. The curves represent different combinations of quantities from both goods, for which the consumer will be equally happy when making the decision. In our case the curves change over time as does the quantity chosen for each good. The lines A, B, C, D in the three previous panels represent situations in which the indifference curves are A, B, C or D. Still, as in the classical case, the solution for each moment of time is given by the point where the indifference curves are tangential to the budget constraint. In our case the curves move over time, though always tangential to the budget line, until the consumer reaches a long-term solution.

To clarify panel 4 let us compare it to the different situations described by panel 1. At the beginning only the old good is bought, which in panel 1 is marked by line A. In the fourth panel this is represented by indifference curve A, in which only the old good is consumed. The next line rightwards in panel 1 is line C, a situation that in the indifference map is represented by C. Line B and indifference curve B are similar. Panel 1 represents total quantities and changes in time. The dynamics in the indifference curves are expressed by movements of this curve over time as habits form. In the case of the panel 1, the evolution of the indifference curves over time is represented in panel 4, starting in indifference curve A, moving towards C and reaching equilibrium in B.

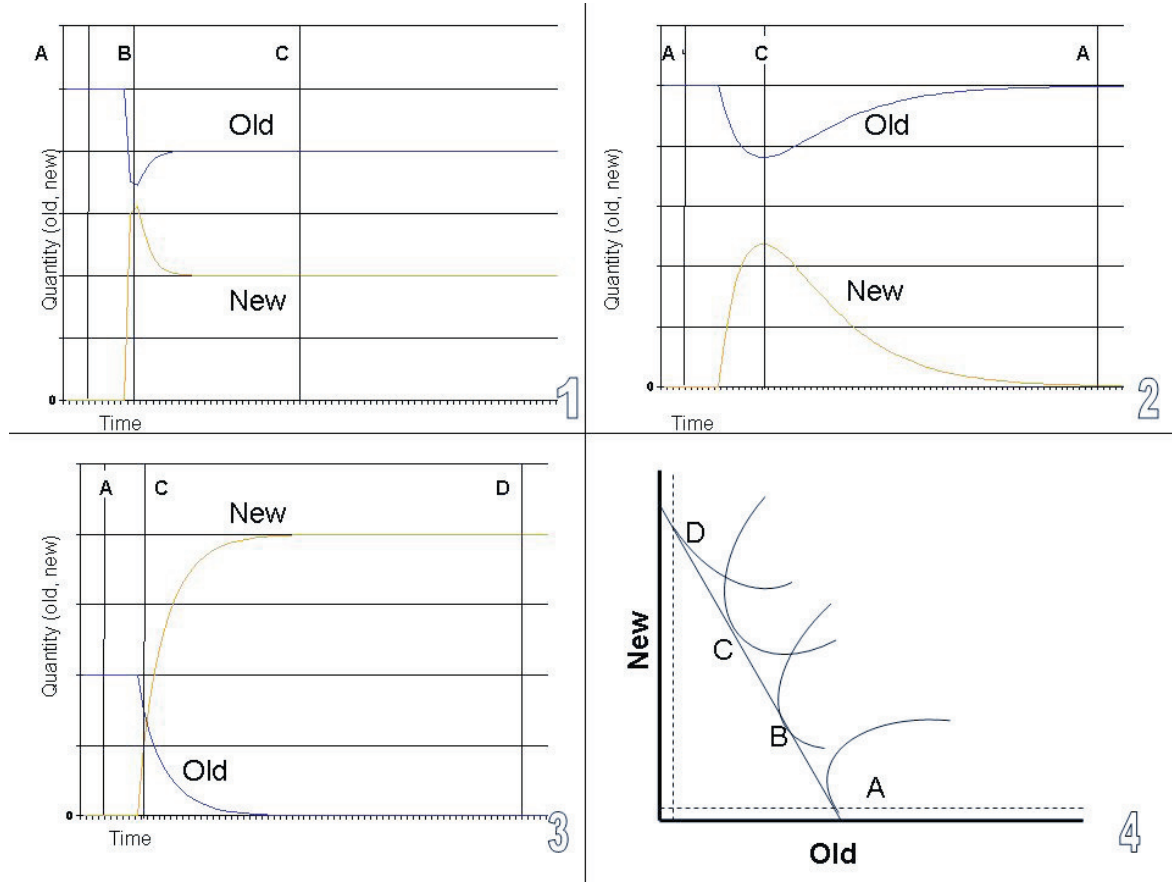


Figure 2: Time and preferences evolution

4.5 Extending the model

Although we concentrate mainly on inconspicuous consumption, in this section we allow the consumer to be partially influenced by societal choices, presenting a discussion based on long-term solutions. We assume here that consumers are not all equal and that our consumer is different from the rest of the society. We will be treating the society as one single big consumer. Acknowledging the importance of an initial level of novelty, and assuming that this level is reached, we look at the relationship between the solution for the society and that of the individual. Formally we remodel z_i to be:

$$z_{it} = \phi(c_i x_{it-1}) + (1 - \phi)(\eta_i X_{it-1}) \quad (20)$$

The c_i parameter captures the inner capacity of the good to produce experienced utility in the consumer. x_{it-1} is the amount of good previously consumed. The value of the ϕ parameter controls the extent to which the consumer is influenced by society. A value of $\phi = 0$ represents an outward-looking consumer, whose preferences are completely determined by society - a case of pure conspicuous consumption. At the other extreme, a value of $\phi = 1$ brings us back to the consumer presented in earlier sections, whose preferences are determined only by her experienced utility - an inward-looking consumer. The whole society is treated as a one big single consumer whose decisions are not controlled by our consumer. The η_i parameter, in a way parallel to c_i , accounts for the level of experienced utility felt by society as a whole for the consumption of each unit of goods. In principle, it is only interesting to study the case in which η_i is different from c_i , and is less than 1⁵. A capital X is used to denote the quantity consumed by society, X_{it-1} is the past consumption of the society for good i . We assume that the individual consumer does not have the power to change social decisions although these decisions affect her.

When $\phi \neq 1$, the question that we have studied before, the buying of the first unit of good and the habit formation of the consumer is affected by societal decision. Using the habit formation of equation 20, we work as in the previous sections by constructing the system of dynamic equations in x_1, x_2, X_1, X_2 (The system of equations is presented in appendix A)

When it comes to novelty, we assume that the level is high enough to allow our individual consumer to buy one first unit. We could also present a discussion on how novelty in this partially conspicuous model is affected. However, we shall leave that for future research as there are many assumptions which could be considered (for example: whether the good is new only for the consumer, new for all of the society; each possible combination will give a different solution). What becomes more interesting, and easier to

⁵If it is equal to one, the society will be in a situation of being in a total addiction, which does not make much economics sense, though it is possible to study mathematically.

track, is the effect of society on long-term solutions. For the whole society the long run solution will be:

$$\bar{X}_2^* = \frac{\frac{p_2^\xi}{(\eta_2-1)}}{\sum \frac{p_i^{\xi+1}}{(\eta_i-1)}} ESoc \quad (21)$$

The long-term solution for the consumer in this new case will be:

$$\frac{\frac{p_2^\xi}{(c_2-1)}}{\phi \sum \frac{p_i^{\xi+1}}{(c_i-1)}} E + (1 - \phi) \frac{\frac{p_2^\xi}{(c_2-1)}}{\phi \sum \frac{p_i^{\xi+1}}{(c_i-1)}} ESoc$$

or, simplifying,

$$\frac{\frac{p_2^\xi}{(c_2-1)}}{\phi \sum \frac{p_i^{\xi+1}}{(c_i-1)}} (E + (1 - \phi) ESoc)$$

One immediately notes that the long-term solution for the single consumer is not affected by the η_i parameter. It is only the long-term amount of the good bought by society (\bar{X}_2^* see equation 21) that really affects the decision of the individual consumer. The importance of this finding is that it opens up a way to connect the result of our consumer with the conspicuous consumption literature. It would be interesting to analyse the effect of an outward-looking consumer at the macro level, but this is outside the scope of our research.

5 Conclusions

The main motivation of the thesis is to analyse and study the effects of product innovation on the economy. By product innovation we mean neither improvements in quality nor the effect that new products have on production. We attempt to calculate the direct effect that an innovative product has on final demand. A major constraint was that classical utility maximization does not consider this factor; explanations such as that of Lancaster offer little flexibility when studying product innovation.

In the article we have attempted to incorporate ideas from behavioural psychology so that the consumption theory and its conclusions correspond more closely to real human behaviour. Therefore, together with this chapter's study of novelty, we use results from behavioural economics to build a theoretical framework flexible enough to explain habit formation and consumption of new goods and so to construct a more responsive consumer. By incorporating the two concepts with the idea that the consumer is maximizing decision utility we can understand why we consume new things and how

we form our preferences. When the maximization process is studied over time, continually repeated as by a real consumer, it clarifies the evolution of preferences. The article describes four possible outcomes: addiction, eternal habit, temporary habit and consumption of novelty.

Of special importance for technical change is that the value of innovation should be linked to the utility given to the consumer over a long period of time. Until now the value of an innovation has been approximated by the number of citations assigned to a patent or by analysing the percentage of sales due to innovative items at the company level. However, to our knowledge, no one has tried to calculate the value of an innovation based on the utility given to a consumer. Our concept allows one to relate closely the value of an innovation to the level of experienced utility.

Independently of an innovation's potential to generate new habits, the new good must present a minimum threshold of novelty. An innovation that remains unknown to consumers but has the potential to generate experienced utility may become a failure. Even very good innovations may require marketing effort to increase their novelty value so that they can in turn increase the well-being of society.

From the ideas put forward in this chapter, especially from the psychological introduction concerning the reasons why we form habits and seek novelty, we understand that humans are always searching for difference and novelty. It is in this eternal search that technology and inventions have a chance to become real innovations. The value of these inventions has to be related to changes in the standard of living. Also from this chapter we understand that there is a need for coordination between innovation and marketing strategies. For example, from a policy perspective, if the government targets funding to a group of firms the funding should also include some help towards marketing the new products. Otherwise very good inventions may fail simply because insufficient people hear of them thus wasting the costly innovation effort.

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A Dynamic conspicuous consumption: System of equations for the dynamic problem with conspicuous consumption

$$\begin{pmatrix} x_{1t} \\ x_{2t} \\ X_{1t} \\ X_{2t} \end{pmatrix} = \begin{pmatrix} \phi c_1(1 - \frac{p_1^{\xi+1}}{\theta}) & -\phi c_2(\frac{p_1^\xi p_2}{\theta}) & (1 - \phi)(1 - \frac{p_1^{\xi+1}}{\theta}) & (1 - \phi)c_2(\frac{p_1^\xi p_2}{\theta}) \\ -\phi c_1(\frac{p_2^\xi p_1}{\theta}) & \phi c_2(1 - \frac{p_2^{\xi+1}}{\theta}) & (1 - \phi)c_1(\frac{p_2^\xi p_1}{\theta}) & (1 - \phi)c_2(1 - \frac{p_2^{\xi+1}}{\theta}) \\ 0 & 0 & \eta_1(1 - \frac{p_1^{\xi+1}}{\theta}) & -\eta_2(\frac{p_1^\xi p_2}{\theta}) \\ 0 & 0 & -\eta_1(\frac{p_2^\xi p_1}{\theta}) & \eta_2(1 - \frac{p_2^{\xi+1}}{\theta}) \end{pmatrix} \begin{pmatrix} x_{1t-1} \\ x_{2t-1} \\ X_{1t-1} \\ X_{2t-1} \end{pmatrix} + \begin{pmatrix} \frac{E p_1^\xi}{\theta} \\ \frac{E p_2^\xi}{\theta} \\ \frac{E Soc p_1^\xi}{\theta} \\ \frac{E Soc p_2^\xi}{\theta} \end{pmatrix}$$

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