Product Characteristics, Innovations and the Evolution of Consumption. A Behavioral Approach

by Ulrich Witt [*)]

Max-Planck-Institute of Economics, Jena, Germany
Ulrich.Witt@econ.mpg.de

Paper prepared for the conference on "Technical Change: History, Economics and Policy" in honor of G.N. Tunzelmann, SPRU, March 2010

[*)] I should like to thank Tommaso Ciarli, André Lorentz, and Christian Schubert for helpful comments on an earlier draft.

I. Introduction

Industries differ with respect to the rate of innovations, technological progress, capital accumulation, and productivity growth. The resulting sectoral shifts in production costs and prices fuel the incessant restructuring of the industries. However, these developments are not the only cause of the ongoing transformations of the economy. The historically unprecedented growth in per capita income and consumption expenditures over the past century (by a factor three to six depending on the country, see Maddison 2001, Chap.1) also impacted the industries differently. As the rich empirical evidence accumulated in econometric studies of demand functions, Engel curves, and price and income elasticities of demand (see Deaton and Muellbauer 1980) shows, substitution within and between consumer expenditure categories changed the composition of consumption dramatically. While the understanding of the supply side causes of structural change have made great progress intensively been investigated (see von Tunzelmann 1995, Matsuyama 2007), the massive changes going on at the demand side of the markets – though considered important (Pasinetti 1993, Matsuyama 2002, Foellmi and Zweimüller 2006, Metcalfe, Foster and Ramlogan 2006) – are still largely unexplained.

A major obstacle to improving the understanding of what is going on at the demand side is the current state of microeconomic theorizing about consumer behavior. Over the past sixty years, theory development has effectively "purged out" what were considered "objectionable" conjectures (Samuelson 1947, pp. 90-1) about needs, wants, and the behavioral background more generally. As a consequence, despite its rigorous axiomatic formulation consumer choice theory has little to offer for explaining what it is that people consume and for what reasons – and why they change their spending behavior with rising income. In this paper an attempt will therefore be made to fill the gap by injecting hypotheses about consumer behavior and to derive the implications with respect to how the structure of demand is likely to change in growing economies. More specifically, we will draw here on experimentally well confirmed hypotheses generated in the behavioral sciences about drives and needs that motivate human behavior in general and consumption activities in particular. In principle, with some elaborations these hypotheses can also be cast in utilitarian terms (see Witt 2005). However, the need-theoretic representation allows to immediately grasp the crucial implication of the extension: the theoretical predictions about differences in satiability of needs that affect the demand for the industries' products and services serving those needs.

The paper proceeds as follows. Section II briefly summarizes the aspects of the underlying behavioral theory that are particularly relevant for explaining consumption behavior and the structural changes at the consumption side that are induced by rising income. Section III develops a simple model of how differences in satiability between needs translate into changes in the budget shares of products or whole expenditure categories that serve these needs with their characteristics. Unlike the usual estimation of income elasticities by which expenditure categories are classified as representing luxuries, necessities, or inferior goods, the model suggests a causal explanation for the elasticities. In Section IV the model is extended to account for the changes over time that are induced by rising income, both in terms of the composition of products and their characteristics and in terms

of the producers' variation of the characteristics in reaction to the differential satiation dynamics. Section V offers the conclusions.

II. A Behavioral Theory of Consumption Motivation

The motivational underpinnings of economic behavior in general and consumer behavior in particular are rarely explicitly addressed in economics. To deal with them would require to explain why some action is preferred over some other instead of simply postulating such a preference order, or to explain what the arguments in a utility function stand for and for what reasons. Obviously, these are questions different from those usually grabbing most of the attention, viz. how consumers, or decision makers more generally, actually make choices, whatever their motivation to act is: whether the choices are perfectly or imperfectly informed; whether they are made intuitively or contingent on subjective beliefs and expectations; whether they seek the best possible or only an action that satisfies some aspiration level, and so on. In contrast, the focus in the present paper is on explaining the motivations underlying consumer behavior – without denying, however, that in many circumstances cognitive reflections that enter the decision making process can affect and condition the relationship between motives and actual choices.

Regarding the explanation of motivation underlying economic behavior, different explanatory approaches can be taken. In the hedonistic approach (reaching back to Bentham's sensory utilitarianism recently revived by Kahneman, Wakker, and Sarin 1997), the explanation refers to the motives of seeking pleasure and avoiding pain. Non-hedonistic variants focus instead on the motivating power that (deprived) needs and wants have for consumption activities (as, among others, in Menger 1871, Duesenberry 1949, Georgescu-Roegen 1954, and Ironmonger 1972). Over the past decades both approaches to an empirical theory of consumer motivation fell out of fashion in economics. In the behavioral and human sciences, in contrast, research on motivational theories continued and was deepened further by extending the focus to the biological, evolutionary roots of behavior (Wilson 1975, Caplan 1978). With this extension attention is drawn to inter-personal commonalities in behavior that can be conjectured to be relevant also for consumer behavior. [1]

As explained elsewhere (Witt 2001), these developments in the behavioral and human sciences give rise to a new, behavioral, interpretation of need-based consumption motivation. It starts from the observation that a reduction or removal of deprivation or, conversely, an increase in the satiation level of certain needs caused by some action increases the rate with which that particular

---

[1] Much as the layout of the human body is genetically determined, so are basic human behavioral capacities and dispositions. They are shared by all humans with the usual genetic variance. Apparently, natural selection has not systematically modified them over the last millennia. They are therefore likely to be adapted to the living conditions in the early phases of human phylogeny in which selection pressure was still tight. These basic behavioral capacities and dispositions may best be understood in terms of the value which they seem to have had for reproduction and survival under such conditions (Barkow, Cosmides, and Tooby 1992).

action is chosen in the future. Hence, changes in the level of deprivation of certain needs connect with the (unconditioned) reinforcement of behavior effecting these changes. Restricting the notion of needs to those for which this connection holds ("basic needs"), need satisfaction can be identified with "primary reinforcement" in the theory of instrumental conditioning. [2] The explanatory power of this behavioral, need-based interpretation of action motivation becomes apparent when compared to the hedonistic theory of sensory utilitarianism.

Assume that satisfaction and deprivation of the mentioned basic needs (corresponding to primary reinforcers) is associated with pleasurable and painful experiences respectively. This straight forward assumption allows to construct a correspondence not only between need-theoretic and reinforcement-theoretic motivation hypotheses, but also between the former two and the hedonistic variant. To demonstrate this consider the choices by which a preference order is revealed. From a motivation-theoretic point of view, it has to be explained why an agent should be motivated to consider the (ordered) alternatives at all for being chosen and what determines the relative strength of motivation associated with the alternatives (which induces the order). One way in which the explanation can be cast is in terms of a predicted balance of pleasures and pains which the decision maker associates with the alternatives to choose from. Simplifying somewhat, pleasures and pains are assumed to be homogenized into a single hedonic currency – the utility index – taken to express the relative strength of the action motivation. [3] Another way of providing the explanation is in terms of the relative degree of deprivation of the needs served by the choice of the alternative actions. The more deprived a need is, the larger is the reward felt by serving it. Accordingly, the more likely an agent prefers the choice of an action that she expects, or has previously experienced, to reduce the level of deprivation (increase the level of satiation) of that need. [4]

A major difference between the two explanations is that, in the framework of sensory utilitarianism, a higher value of the hedonic currency suffices as a proximate cause for the motivation underlying an observed choice of an action. What determines the pleasure and pain feelings from which utility is derived does not have to be, and usually is not, specified. In contrast, the need-

---

[2] See Herrnstein (1990). Only a limited number of needs qualify for this category. In a rough approximation they can be identified with such activities as drinking, sleeping, eating, keeping body temperature, physical activity, sex, and seeking pain relief, shelter, affection, social recognition, sensory arousal, cognitive consistency, and achievement (see Millenson 1967, 386). Given their obvious reproductive value in times of fierce selection pressure, such basic needs can be argued to be innate and, indeed, they are commonly shared by humans (and not only humans) with the usual genetic variance.

[3] For a discussion of the actually more complex motivational explanation see Shizgal (1999).

[4] With reference to Maslow's (1954) need pyramid it is sometimes argued that the satisfaction of needs proceeds in a hierarchical order (amounting to the assumption of lexicographic preferences). However, there is little empirical evidence for such a hypothesis (Maslow 1971, Chap. 3; Wabha and Bridgewell 1976).

theoretic interpretation provides an ultimate cause for the motivation underlying the choice of an action. It does so by identifying how an action is capable of reducing deprivation with respect to one or several of the basic need(s) – related above to primary reinforcers – and, thus, triggers a pleasurable experience (i.e. generates utility).

In addition, the behavioral underpinnings of the suggested interpretation imply hypotheses on how consumer motivation can change over time by two very different kinds of adaptation dynamics: that of reinforcement learning (instrumental conditioning) on the one hand and that of conditioned reinforcement or conditioning learning on the other (see,.e.g., Leslie 1996). Under reinforcement learning the frequency distribution over actions converges to a state satisfying the so-called "matching law" (Herrnstein 1997). This is an empirical regularity considered one of the most robust experimental findings of behavioral sciences at the level of behavior with little or no cognitive intervention (Davison and McCarthy 1988). In contrast, conditioning learning – not to be discussed further here – results in the emergence of what can be called new, acquired wants ("secondary reinforcers") that modify and extend the individual preference order. [5]

The logic of the matching law is the following. Let there be several feasible actions h = 1,..., m that can serve to reduce deprivation in some basic need. By reinforcement learning an organism adjusts the relative frequency F_h of the alternative actions to the average rate of reinforcement. The latter can be captured by the *relative* size of the average reward R_h obtained by the actions. [6] In the simplest form the relation thus is

$$(1) \qquad F_h = \frac{R_h}{\sum_h R_h} ,$$

where R_h is gives the average reduction of the deprivation level (or the average increase of the satiation level) of need i per unit of time. However, there are differences between the standard laboratory experiments in which this relationship has been tested and consumer choices in real life, and these differences are crucial for the point to be made in the following.

---

[5] See Witt 2001 for a more extensive discussion. Both conditioning learning and cognitive learning are highly dependent on the idiosyncratic, though usually culturally contingent, learning history of the individual consumers and, thus, contrast with the commonly shared basic needs. While the latter can be assumed to be part of the human genetic endowment that should exert a systematic influence in the grand total of the population averages considered in the following, the idiosyncratic influences of both conditioning learning and cognitive learning will be treated here as random deviations contributing to the population variance.

[6] Adaptations under reinforcement learning or instrumental conditioning are also influenced by the immediacy and contingency of the reward, two variables not to be discussed here, see Leslie (1996, Chap. 2).

A first difference is that in an experiment both the rate of reinforcement R_h and the overall level of deprivation reflected by $\sum_h R_h$ are experimental control parameters. In economic reality, in contrast, both quantities are variables that are positively correlated with the size of disposable income. A second difference is that experiments are usually conducted with one reinforcer only (usually some form of food). In contrast, behavior outside the laboratory is subject to all, more or less, deprived basic needs at the same time. As a consequence, at any point in time the relative strength of the motivation to act to reduce deprivation of any particular basic need also depends on its level of deprivation relative to that of all other basic needs. Accordingly, by reinforcement learning the agents adjust over time to the size distribution of rewards across actions serving the single needs *and* across the different needs. Since a reinforcement history is subject to considerable inter-individual variance, consumers are likely to develop individual specialization patterns with respect to where they seek more or less intensely the rewarding experience of need satisfaction and how. Some become gluttons, some opera lovers, some computer freaks, some sex obsessed, and so on, and many a little bit of everything. (Such specialization patterns may be strongly supported by cognitively controlled self-efficacy.)

Nonetheless, humans share the basic needs. Despite the usual genetic variance and the variance due to individual cognitive and conditioning learning processes it can therefore be conjectured that some systematic effects of these commonalities are visible at the population level, i.e. at the level of the aggregate consumer expenditures time series. More specifically, these effects can be expected to result from differences in the deprivation-satiation characteristics of the basic needs as follows

Hypothesis 1 With a rising capacity for serving basic needs (i.e. with a rising income), these needs show characteristic, inter-personally similar differences in their deprivation-satiation patterns such that some are on average more easily satiable than others.

There are basic needs where deprivation can be reduced relatively easily up to the (temporary) satiation point once rising income allows to sufficiently increase the corresponding consumption expenditures per period of time. The motivation to consume is then (temporarily) reduced or eliminated. Examples are the homoeostatic needs underlying eating and drinking. But there are also basic needs where, for different reasons, homoeostatic features are absent, and where it is therefore difficult, if not impossible, to reduce average deprivation to zero. Typically, these are needs whose satiation level is defined in relative terms like the need for arousal or for social recognition.

III. Differential Satiation and Its Impact on Expenditure Elasticities

On the basis of Hypothesis 1, the behavioral approach to consumption outlined in the previous section suggests to focus on differences in the satiation patterns between innate needs as the shaping agent in the evolution of consumption when income rises. In order to make the expected differences in satiation patterns between basic needs operational for predictions about changing consumption expenditures it is necessary, however, to determine what products or expenditures categories serve

what needs. Products usually have several characteristics, and the different characteristics can appeal to different needs at the same time. Accordingly, the consumption of specific products can be motivated in multiple ways, and this can have important implications. [7] Nevertheless, for expository convenience we will abstract here from consumption activities with multiple motivation and assume that the consumption of a product or an entire expenditure category i = 1 ,..., n is motivated by one and only one need i.

An example for which this assumption can, in a first approximation, be justified are food products. The relevant characteristics are defined by the homoeostatic nature of the human metabolism as, for instance, the amount of a satiating components in a consumed quantity, measured, e.g., by the calory content, the alcohol content, the caffeine content, and so on. This means that the price (reflecting the fact that opportunity costs exist due to a binding budget constraint) is not the only variable that conditions demand. There is also a quality variable or, as it was put in the elder literature, a use value aspect. It reflects the particular features of the need that the consumed product is supposed to serve and can be quantified in terms of the intake of calories, alcohol, caffeine, etc. connected with a certain quantity of the item consumed.

As far as this insight can be generalized for consumption categories other than food, a simple relationship can be established between rising income and consumption expenditures on the one hand and the differential satiation dynamics of the served needs on the other hand. Let the quantities of products such as cheese, beer, or instant coffee or entire expenditure categories such as food, clothing etc. be measured not in terms of undated servicing units, but rather in average quantities $q_i(t)$ *per unit of time* t. [8] To avoid misunderstandings call this the rate of consumption per unit of time, where the unit can be a day, say, a month, or a year. Assuming for analytical convenience that the unit of time is chosen such that the prices p_i (t) = const, the expenditure $x_i(t) = p_i(t)q_i(t)$ is proportional to $q_i(t)$. The rate of consumption can then also be expressed in terms of expenditures per unit of time. Further, let total consumption expenditures $x(t) = \sum_i x_i(t)$ be a constant share of the consumers' income. Instead of a rising per capita income, increases in x(t) may then be taken to represent the conjectured driving force behind the restructuring of consumption.

Consider now the satiation dynamics described by the changes of the average level of satiation $\hat{s}_i(x_i(t))$ of need i over time. By definition, $\hat{s}_i = 1 - \bar{d}_i$ with $\bar{d}_i$ denoting the average level of deprivation. $\hat{s}_i$ is assumed to be a monotonously increasing function of $x_i(t)$, i.e. of the rate of

---

[7] See Witt (2001). For case studies focusing on single products or product categories serving multiple needs and controlling for the different satiation patterns of the involved needs see Ruprecht (2005), Frenzel Baudisch (2007), and Chai (2007), who investigate the changing consumption of sweeteners, footwear, and touristic services respectively.

[8] This means to acknowledge that there is not only a time constraint on consumption activities as often emphasized (see Becker 1965, Linder 1970, Steedman 2000, Metcalfe 2001), but also a systematic interactions between consumption activities satisfying a need and the recurrence of deprivation over time, e.g., as a result of physiological processes like the human metabolism.

consumption of items serving need i. Let S_i be the upper bound of $\hat{s}_i$ at which a state of satiety is reached for need i. Lacking evidence to the contrary it will be assumed that there is a finite upper bound $S_i < \infty$ for all i. (This does not exclude that some S_i can be so large that, in practice, it is next to impossible to reach that level even with very large amounts of spending). A normalized variable $s_i(t) = \hat{s}_i(t)/S_i$ can then be defined that gives the average degree of satiation of need i, $0 \leq s_i \leq 1$.

$s_i(t)$ is also a monotonously increasing function of $x_i(t)$

(2) $$s_i(t) = f_i(x_i(t)).$$

where the particular functional form depends on both the physiological or psychological satiation features of need i and the "technological" effectiveness with which the corresponding consumption items serve need i. It is reasonable to assume that the graph of the function passes through the origin and that $f_i' \geq 0$ and $f_i'' < 0$. Figure 1 shows the graphs of two possible functions satisfying these assumptions. Let the one represent a need i and a the other a need j. Need i is relatively more easily satiable than need j.

Figure 1 about here

Following to the behavioral theory discussed in the previous section, consumer behavior can be assumed to be subject to reinforcement learning except in situation in which consumers make decisions, particularly investment decisions, that involve intensive cognitive reflections. Under reinforcement learning the distribution of actions or, for that matter, of expenditures eventually converges to matching behavior. [9] If, for simplicity, we assume that for each basic need i there is only one way of making expenditures or, in case that there are several, one way dominates all others, we can ignore the reinforcement learning dynamics at the level of actions serving that need and concentrate on reinforcement learning across the different needs. Analogously to eq. (1), matching behavior then implies an allocation of the consumers budget x(t) over the need-specific expenditures $x_i(t)$ which is proportional to the rewards collected in terms of need satisfaction $s_i(x_i)$ as given by eq. (2). Hence, in the simplest case, the relation [10]

(3) $$w_i = \frac{x_i}{\sum_i x_i} = \frac{s_i}{\sum_i s_i}.$$

---

[9] For a discussion of the implications of matching behavior in an economic context see Herrnstein and Prelec (1991) and Metcalfe (2001).

[10] In the remainder of this section the variable t will for notational convenience be suppressed.

holds, where w_i denotes the budget share of expenditure category i and the adding-up condition $\sum_i w_i = 1$ or $\sum_i x_i = x$ is assumed to be satisfied.

As long as the satiation level regarding a need has not been reached, an increase in the degree of satiation of a basic need i, denoted here by $\triangle s_i$, continues to be experienced as a rewarding event. Such an increase becomes possible by a further growth of income making a corresponding increase in spending on need i by an amount $\triangle x_i$ feasible. The relationship between the action (additional spending) and the resulting reward (further increase in the degree of satiation) can be assumed to also follow the logic of reinforcement learning and the matching law so that

$$(4) \qquad \frac{\triangle x_i}{\sum_i \triangle x_i} = \frac{\triangle s_i}{\sum_i \triangle s_i}$$

holds with $\sum_i \triangle x_i = \triangle x$.

Dividing eq. (4) by eq. (3) gives the expenditure elasticity e_i of the demand for consumption items serving need i as

$$(5) \qquad e_i = \frac{\triangle x_i / \triangle x}{x_i / x} = \frac{\triangle s_i / \triangle s}{s_i / s} = \frac{\triangle s_i / s_i}{\triangle s / s} = \frac{r_{si}}{r_s},$$

In eq. (5) r_{si} and r_s denote the rate of change of the degree of satiation of need i and the average degree of satiation respectively. Depending on the shape of the particular functions for the different needs in eq. (2) the ratio of the two rates of change and, consequently, the expenditure elasticity differs so that

$$(5) \qquad \frac{r_{si}}{r_s} = e_i \begin{cases} < 1 & \text{if } r_{si} - r_s < 0 \\ = 1 & \text{if } r_{si} - r_s = 0 \\ > 1 & \text{if } r_{si} - r_s > 0. \end{cases}$$

If the extra spending on consumption items that serve need i can raise the degree of satiation of that need relatively more so than total need satiation rises by the budget increase, proportionately more income will be spent on that need ($e_i > 1$). Conversely, if, by an extra spending, the degree of satiation of a need cannot be increased at least as much as total need satisfaction rises by the budget increase, proportionately less income will be used to serve that need ($e_i < 1$).

Thus, as a consequence of a decreasing marginal satiation effect, the expenditure elasticity of demand varies with x_i and x. For basic needs that are easily satiable, like the need for food, the degree of satiation is relatively rapidly increasing (the case of the s_i - curve in Figure 1). Such needs grab relatively higher expenditure shares at low income/expenditure levels. They fall behind and become a “necessity” beyond those low income/expenditure levels if there are less easily satiable

basic needs. The larger total expenditures become, the more the not easily satiable needs, like the need for social recognition and status, attract the additional expenditures – the reason why expenditures on these needs qualify as "luxuries" in affluent economies. [11] The result of this section can thus be summarized by

Hypothesis 2 With a consumption motivation reflecting differences in the satiability of basic needs and a consumer behavior characterized by reinforcement learning and the matching law, those basic needs that are easily satiable attract relatively larger expenditure shares at low expenditure levels. However, the larger total expenditures grow, the more the not easily satiable needs replace the easily satiable ones in gaining the relatively larger expenditure shares.

IV. Satiation Dynamics, Innovations, and Structural Change in Consumption

The impressive amount of empirical work that has been done on demand systems and consumer expenditures over the past decades (see Deaton and Muellbauer 1980) has not been targeting at, and has not been able to make much progress with, the theory of structural change in consumption. Similarly, because of data constraints, empirical studies on Engel curves have usually taken a cross sectional approach (Lewbel 2007). This means to focus on systematic differences in spending behavior between households with different levels of income at a given point in time. Such an approach does not capture the restructuring in the consumption of the same households when their income rises over time and new consumption opportunities occur. In a longitudinal perspective it is quite likely that, over the period in which income rises, there are innovative transformations in the consumer products that affect their satiation characteristics. In the perspective of the behavioral approach suggested here this can be expected to affect spending behavior in a way that weakens or even overcompensates the satiation effects that would otherwise occur with rising income. Accordingly, the effects of such consumer innovations will now be accounted for by a corresponding extension of the model developed in the previous section.

Again starting from the condition formulated in eq. (3) the elasticity of the expenditure shares w_i, i = 1, ..., n with respect to total expenditure can be calculated as

$$(\triangle s_i - \triangle s)$$

---

[11] Differences between goods and services concerning the dependence of the related expenditures on the size of income or total expenditures can also be represented by means of Engel curves, i.e. by the functional relationship between the expenditure x_i on a particular consumption item or expenditure category and total expenditure x (see Lewbel 2007). From the condition in eq. (3) it follows that the theoretical Engel curve implied by the present model depends on the ratio $s_i(x_i) / \sum_i s_i (x_i)$. This is the ratio between the current degree of individual need satiation and total satiation of all needs. In order to determine the functional form of the theoretical Engel curve, the value of that ratio would have to be known for all needs, i.e. the specification of eq. (2) for all i = 1, ... , n.

$$(6) \qquad e_{wi} = \frac{\Delta s_i - \Delta s}{s} \cdot x .$$

Instead of the difference $r_{si} - r_i$ of the growth rates of satiation that were found to be decisive for the expenditure elasticity of demand given in eq. (5) it is now the difference of the corresponding incremental changes in the degrees of satiation that determines the sign of e_{wi} . If spending on consumption items that serve need i increases the degree of satiation of that need incrementally in a proportion that is larger than the incremental increase of total need satiation as a result of spending the extra budget, $e_{wi} > 0$ and vice versa. For notational convenience denote the fraction $(\Delta s_i - \Delta s)/ s = \nu_i$.

An elasticity can be interpreted as the ratio between two growth rates, in the case of e_{wi} the ratio between the growth rate of the expenditure shares and the growth rate of total expenditure. Using a discrete time notation for the growth rates, eq. (6) can therefore be rewritten as

$$(7) \qquad \frac{w_i(t) - w_i(t-1)}{w_i(t-1)} = e_{wi}(t) \frac{x(t) - x(t-1)}{x(t-1)} .$$

Alternatively, with $W_i(t) = w_i(t) / w_i(t-1)$ denoting the budget share in t as a multiple of the budget share of item i in t-1 and $\Delta x(t) = x(t) - x(t-1)$ denoting the incremental change of total expenditures, eq. (6) can be transformed into

$$(8) \qquad W_i(t) = 1 + \Delta x(t)\, \nu_i(t) .$$

Eq. (8) carries slightly different information than eq. (6). For example, if consumption items serving need i are “luxuries”, $W_i(t)$ increases when total expenditures rise. If $\Delta x(t) < 0$, however, $W_i(t)$ can increase or decrease, depending on whether $\Delta x(t) \cdot \nu_i(t)$ is greater or smaller than 1. The converse holds for “necessities”.

Specific information about the satiation function of all needs in eq. (1) is not available so that the size of the fraction ν_i for given $x_i(t)$ and x (t) can presently not be determine. However, as was explained in the previous section, a certain ratio between $x_i(t)$ and x is tuned in the longer run by matching behavior so that, in a long term perspective, the crucial relationship is that between ν_i (t) and x(t) (reflecting the long term changes of income). With respect to this relationship, the satiation functions suggest that, for easily satiable needs, $\nu_i(t)$ decreases more rapidly with growing x(t), and becomes negative for smaller x, than this is the case for less easily satiable needs. In a very rough approximation, this relationship can be expressed by a monotonously decreasing function ν_i (t) = ν_i (x(t)) that either converges at a value $x^\circ(\nu_i (t) = 0)$ to zero or exceeds that point and becomes negative. (If exceeded, the corresponding need-specific expenditures turn at this total expenditure value from a “luxury” into a “necessity”). Since the point is of great significance for the satiability features of a need let us denote $x^\circ(\nu_i (t) = 0) = \sigma_i$. The useful feature of this approximation is that, for long term increases in total expenditures, the different σ_i associated with the needs i = 1, ..., n

induce a rank order over the needs: the greater the value of $x°(i)$, the less easily satiable a need i is. This order can more easily be reconstruct from the satiation features of the underlying needs than the specific values of the elasticity e_{wi} .

To empirically test the conjecture implied by the above approximation, the rank order on the σ_i can be connected with the change of the budget share $W_i(t)$ in eq. (8) in such a way that a higher σ_i is correlated with a higher value of e_{wi} and, hence, higher values of $W_i(t)$. In a simple linear regression equation this can be expressed as

$$(9) \qquad W_i = k_i + b(W_i, \sigma_i)\, \sigma_i + \varepsilon_i ,$$

where k_i is a constant and ε_i an error term with $E(\varepsilon_i) = 0$. The theoretical expectation is $b(\hat{w}_i, \sigma_i) > 0$. (If the null hypothesis $b(\hat{w}_i, \sigma_i) < 0$ cannot be rejected, the differential satiation dynamics hypothesis would not be supported by the empirical data.)

Equation (8) captures that part of change in consumption that is due to what could be called a satiation-induced substitution process in which consumers shift expenditures away with rising income from more easily satiable to less easily satiable needs. However, as will now have to be elaborated, this is only one source of structural change in consumption. There are other processes as well that leave their mark on consumption over time. Apart from unsystematic exogenous changes that are represented in the statistical analysis by the error term, there is an important source of change that is triggered by satiation-induced substitution itself, i.e. by market saturation, and therefore has to be considered as endogenous. This is the process of innovation in the consumer industries, more specifically, of innovations directed at offering goods and services in new quality motivating additional demand. These innovations can affect the satiation characteristics of the goods and services relating to the different needs as represented by the variable σ_i. In the food example used above, a corresponding innovation is the creation of products with a lower or no content of the satiating component – calories, alcohol, or caffeine – as it indeed happened in the cases of Diet Coke, alcohol free beer, and de-caffeinated instant coffee.

As far as the effects of such product oriented innovations are concerned, structural change in consumption can be expressed in terms of a changing composition of the satiation characteristics of the products consumed. In fact, both processes – that of substituting away in consumer expenditures from products serving easily satiable needs to products serving less easily satiable needs and that of the innovative response to this substitution on the part of the producers – can be captured in terms of the changing frequency distribution over the σ_k-values of the actually consumed items k = 1,..., m within one expenditure category serving a particular need i. Now consider the mean of the satiation characteristic $\sigma_i = \sum_k w_k \sigma_k$ within that expenditure category. [12] Using a discrete time notation its change is given by

---

[12] To outline the basic idea let us make the simplifying assumption that producers who innovate always replace a previously existing product by a new one (with different satiation characteristic) so that the overall number of products m can be treated as a constant.

$$(10) \quad \Delta\sigma_i(t) = \sigma_i(t) - \sigma_i(t\text{-}1) = \sum_k w_k(t)\sigma_k(t) - \sum_k w_k(t\text{-}1)\sigma_k(t\text{-}1)$$

which can be rearranged into

$$(11) \quad \Delta\sigma_i(t) = \sum_k \Delta w_k(t)\sigma_k(t) + \sum_k (w_k(t) + \Delta w_k(t))\Delta\sigma_k(t),$$

with $\Delta w_k = w_k(t) - w_k(t\text{-}1)$. In eq. (11), $\Delta\sigma_k$ denotes the changes due to innovations in the product characteristic of item k (if there are any).

Let us turn to the first term on the r.h.s. of eq. (11). Due to the fact that under the adding-up condition for the expenditure shares $\sigma_i(t) \sum_k \Delta w_k(t) = 0$, we can expand

$$\sum_k \Delta w_k(t)\sigma_k(t) = \sum_k (\Delta w_k(t))(\sigma_k(t) - \sigma_i(t)) = \\ = \sum_k w_k(t) (W_k(t) - 1)(\sigma_k(t) - \sigma_i(t)) = \text{Cov}\,(W_k(t), \sigma_k(t)) .$$

By the definition of linear regression, the covariance of the change in budget shares and the satiation characteristics equals $b(\hat{w}_k, \sigma_k) \cdot \text{Var}(\sigma_k)$ so that

$$\sum_k \Delta w_k(t)\sigma_k(t) = b(W_k(t), \sigma_k(t)) \cdot \text{Var}(\sigma_k(t)) .$$

Hence, the first term on the r.h.s. of eq. (10) can be interpreted to give that part of the change in the mean amount of the satiation characteristic in the expenditure category that is due to the decreasing budget share as a result of an increasingly satiated consumption of items with a constant σ_k analogously to the regression eq. (9). As income rises, the increasing satiation induces the consumers to gradually substitute away from highly satiating items.

The decreasing budget share of the products that satiate consumers more easily means that the industry producing those items is faced with a shrinking market share. Since the change is a linear function of the variance, the reduction in demand proceeds more rapidly, if the variance is large, and it hits those products high in satiating characteristics most heavily. Such a situation is very likely to create strong incentives to change the product characteristics in such a way that the detrimental development can be halted. The innovative activities that may be triggered show their effect through changes in the composition of products expressed by the second term on the r.h.s. of eq. (11),

$$\sum_k (w_k(t) - \Delta w_k(t)) \Delta\sigma_k(t) = \sum_k w_k(t)\Delta\sigma_k(t) = \sum_k w_k(t)\cdot W_k(t)\cdot\Delta\sigma_k(t) = E\,(W_k(t)\cdot\Delta\sigma_k(t)).$$

This is the expected value of the change in product characteristics weighted by the new expenditure share which item k is able to capture in the subsequent period. Since the innovations aim at reducing or taking out the satiating component in order to escape from the satiation process, $\Delta\sigma_k(t) < 0$ and consequently $E\,(W_k(t)\cdot\Delta\sigma_k(t)) < 0$.

Putting the two terms together we get

$$(12) \qquad \Delta\sigma_i(t) = \mathrm{Cov}(W_k(t), \sigma_k(t)) + E(W_k(t) \cdot \Delta\sigma_k(t))$$

for the change in the mean satiability in the expenditure category.

Since both summands are negative, $\Delta\sigma_i(t) < 0$. However, while the effect on the budget share is negative according to the first term, the effect is not necessarily negative for the second term. Hence we arrive at

Hypothesis 3 If an consumer innovation is successfully reducing a satiating component of a product serving some easily satiable basic need, spending on that product can increase as a consequence of a reduction in the amount of the satiating component. Depending on the size of the income increases, this effect can partly compensate, or even over-compensate, the decrease in the budget share resulting from the mere incremental satiation effect of additional spending.

Hypothesis 3 does not support the frequently made assumption of an S-shaped Engel curve according to which consumption expenditures converge in absolute terms to an upper bound with rising income (see, e.g., Pasinetti 1993, Chap.4). Indeed, the finding contributes an important explanatory hypothesis for the fact that even expenditures for products serving an actually easily satiable need ("necessities") often show a sustained growth in absolute terms in the long run. [13]

In laying out the argument, the example of food was used to motivate the assumptions made. The example is particularly instructive as the satiation characteristics correspond here to the physiological satiation mechanism that can easily be understood. Nonetheless, even for this example, some puzzles seem to remain. In the light of the behavioral approach, the lasting success of innovations in consumer goods in upholding the motivation to consume by reducing the satiating component seems to contradict the very logic of the deprivation-motivates-action mechanism: the very motive to consume is the precisely the intake of the satiating component to reduce or remove deprivation. Without being able to go in the details here, the solution to the apparent puzzle can be argued to reside in the role that the taste of food stuff plays in assessing items regarding their physiological properties (see Rozin 1999 for a discussion).

In many cases, taste functions as a stimulus that is classified as rewarding (or as aversive) and thus triggers an impulse to consume (or to reject) the food stuff. For example, sweetness (in contrast, e.g., to bitterness) triggers an impulse to consume in almost all higher organisms, because in nature sweet food is highly correlated with a rich calory content. The impulse fades when, as a result of the calory intake, satiation in calories occurs. If this does not occur, e.g. because saccharose, rich in calories, is replaced by artificial sweeteners with low calory content, the impulse remains upheld. The development of consumer expenditures on natural, calory rich sweeteners vs. artificial,

---

[13] For the United States, for example, the annual per capita spending on food in USD of 2002 steadily grows from 1472 USD in 1901 to 2143 USD in 2002, an increase by 146 %, see U.S. Bureau of Labor Statistics (2006). See also the detailed discussion in Lebergott (1993, Part II).

low calory sweeteners over the past century reflects the innovation efforts directed at creating food and drinks exploiting the sweetness trigger without the break effect of the calories (see Ruprecht 2005).

V. Conclusions

Unlike earlier theorizing in economics about the role of wants and needs, which was mainly informed by introspection and common sense arguments, a behaviorally founded need-theoretic approach to consumption has been suggested in this paper. The core of the approach is a motivational hypothesis: it is claimed that the attempt to relieve or remove deprivation of the limited number of basic (innate) needs, corresponding to the list of primary reinforcers, is a major motivation to consume. Since these basic needs are inter-individually shared with the usual genetic variance, it can be concluded that human preferences have certain 'objective' features that should be identifiable at the population level, i.e. in aggregate consumer expenditures. This implication is helpful in filling the lacuna that has resulted from modern utility theory and its radical preference subjectivism (leaving open what it is that consumers have a preference for, or derive utility from, and why).

Despite the subjective variety resulting in consumption from cognitive reflection and subjective knowledge and experience, some general hypotheses that have been derived, based on the conjecture that there are differences between the basic needs in their satiation patterns as income rises. These patterns affect the expenditure categories differently because needs that can easily be satiated, and those that cannot, differ in the extent to which they keep up consumption motivation. In the light of this conjecture, it is straight forward to connect the predictable differences in satiation patterns between needs with differences between income or expenditure elasticities of the demand for products that are typically consumed to serve those needs. Systematic changes in these elasticities reflect the influence of differential satiation effects as a main driver of structural changes in consumption. However, rising competitive pressure in saturated markets can trigger innovative activities by the producers which target at create products with characteristics that delay or eliminate the satiation effect. As a consequence, when income rises, structural change in consumption results not only from substitution in consumer expenditures away from products with the more satiating characteristics. It also follows from the producers innovations cutting down on the satiating characteristics of their products which may compensate or even over-compensate the differential satiation effects that would occur in the absence of such innovations.

References

Barkow, J.H., Cosmides, L. and Tooby, J., eds., (1992),
The Adapted Mind, Oxford: Oxford University Press.
Bentham, J. (1787),

An Introduction to the Principles of Morals and Legislation, reprinted, New York: Hafner, 1948.

Caplan, A.L., ed. (1978,
The Sociobiology Debate, New York: Harper & Row.

Chai, A. (2007)
Beyond the Shadows of Utility: Evolutionary Consumer Theory and the Rise of Modern Tourism, Ph.D. Thesis, University of Jena.

Davison, M. and McCarthy, D (1988),
The Matching Law: A Research Review, Hillsdale: Erlbaum.

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

Duesenberry, J.S. (1949)
Income, Saving, and the Theory of Consumer Behavior, Cambridge, Mass.: Harvard University Press.

Foellmi, R. and Zweimüller, J. (2006),
"Structural Change, Engel Consumption Cycles and Kaldor's Facts of Economic Growth", mimeo.

Frenzel Baudisch, A. (2007)
"Consumer Heterogeneity Evolving from Social Group Dynamics: Latent Class Analyses of German Footwear Consumption", *Journal of Business Research*, Vol. 60, 836-847.

Georgescu-Roegen, N. (1954),
"Choice, Expectations, and Measurability", *Quarterly Journal of Economics*, Vol. 68, 503-534.

Herrnstein, R.J. (1989)
"Darwinism and Behaviorism: Parallels and Interseections" in: A. Grafen (ed.), *Evolution and Its Influences: The Herbert Spencer Lectures*, Oxford: Clarendon Press.

Herrnstein, R.J. (1997)
The Matching Law, Cambridge, Mass.: Harvard University Press.

Herrnstein, R.J. and Prelec, D. (1991),
"Melioration: A Theory of Distributed Choice", *Journal of Economic Perspectives*, Vol. 5, 137-156.

Ironmonger, D.S. (1972),
New Commodities and Consumer Behavior, Cambridge: Cambridge University Press.

Kahneman, D., Wakker, P.P, and Sarin, R. (1997),
"Back to Bentham? Explorations of Experienced Utility", *Quarterly Journal of Economics*, Vol. 112, 375-405.

Lebergott, S. (1993),
Pursuing Happiness - American Consumers in the Twentieth Century, Princeton: Princeton University Press.

Leser, C.E.V. (1963),
"Forms of Engel Functions", *Econometrica*, Vol. 31, 694-703.

Lewbel, A. (2007)
"Engel Curves", *New Palgrave Dictionary of Economics*, New York: MacMillan.

Linder, B.S. (1970),
The Harried Leisure Class, New York: Columbia University Press.
Maddison, A. (2001)
The World Economy: A Millennium Perspective, Paris: OECD.
Maslow, A. (1954)
Motivation and Personality, New York: Harper & Row.
Maslow, A.(1971),
The Farther Reaches of Human Nature, New York: Pinguin.
Matsuyama, K. (2002)
"The Rise of Mass Consumption Societies", *Journal of Political Economy*, Vol. 110, 1035-1070.
Matsuyama, K. (2007)
"Structural Change", *New Palgrave Dictionary in Economics*, New York: MacMillan, forthcoming
Menger, C. (1950),
Principles of Economics, Glenco, Ill.: Free Press.
Metcalfe, J.S. (2001),
"Consumption, Preferences, and the Evolutionary Agenda", *Journal of Evolutionary Economics*, Vol. 11, 37-58.
Metcalfe, J.S., Foster, J. and Ramlogan, R. (2006),
"Adaptive Economic Growth", *Cambridge Journal of Economics*, Vol. 30, 7-32.
Millenson, J.R. (1967),
Principles of Behavioral Analysis, New York: Macmillan.
Pasinetti, L. (1981)
Structural Change and Economic Growth, Cambridge: Cambridge University Press.
Pasinetti, L. (1993)
Structural Economic Dynamics, Cambridge: Cambridge University Press.
Rozin, P. (1999),
"Preadaptation and the Puzzles and Properties of Pleasure", in: D. Kahneman, E. Diener, N. Schwarz (eds.), *Well-Being – The Foundations of Hedonic Psychology*, New York: Russell Sage Foundation, 109-133,
Ruprecht, W. (2005)
"The Historical Development of the Consumption of Sweeteners – A Learning Approach", *Journal of Evolutionary Economics*, Vol. 15, 247-272.
Samuelson, P.A. (1947),
Foundations of Economic Analysis, Cambridge, Mass.: Harvard University Press.
Steedman, I. (2000),
Consumption and Time, London: Routledge.
von Tunzelmann, G.N. (1995),
Technology and Industrial Progress, Aldershot: Edward Elgar.
U.S. Bureau of Labor Statistics (2006),
100 Years of U.S. Consumer Spending, Report 991, Washington
Vaughan, W. and Herrnstein, R.J. (1987)

"Stability, Melioration, and Natural Selection", *Advances in Behavioral Economics*, Vol. 1.

Wabha, A. and Bridgewell, L. (1976),
"Maslow Reconsidered: A Review of Research on the Need Hierarchy Theory", *Organizational Behavior and Human Performance*, Vol. 15, 212-240.

Wilson, E.O. (1975),
Sociobiology: The New Synthesis, Cambridge, Mass.: Harvard University Press.

Witt, U. (2001)
"Learning to Consume – A Theory of Wants and the Growth of Demand", *Journal of Evolutionary Economics*, Vol. 11, 23-36.

Witt, U. (2005)
"From Sensory to Positivist Utilitarianism and Back – The Rehabilitation of Naturalistic Conjectures in the Theory of Demand", *Papers on Economics and Evolution*, # 0507, Max Planck Institute of Economics, Jena.

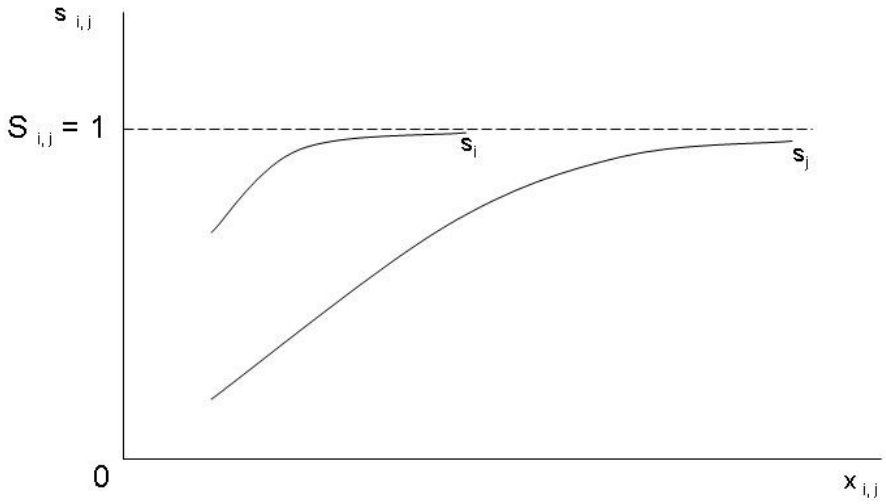

Figure 1 Possible Satiation Patterns for Two Needs *i* and *j*