ON THE APPLICATION OF HOUSEHOLD PRODUCTION THEORY TO HEALTH AND NUTRITION

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Abstract

This paper reviews the application of household production theory to health and nutrition and their determinants in the economics literature. We examine 17 recent studies applying this approach and analyse how they model utility functions, elementary goods, and production processes. Notwithstanding the valuable insights provided by these economic analyses into the phenomenon of obesity and health behaviour, the framework's basic idea, the separation of utility generation and production technology, is not pursued consistently. The majority of the studies reviewed focus solely on health production, thereby neglecting important production processes for other elementary commodities and their related inputs and technologies. We advocate a broader application of the household production principle and discuss how such a view can guide theoretical and empirical analysis and may provide inspiration for data collection and policy design.

Keywords

Household production theory; health; nutrition; obesity; economic analysis.

1 Introduction

"Economics is a science which studies human behaviour as a relationship between ends and scarce means which have alternative uses" (ROBBINS, 1932). This definition of the subject of economic research does not only include the case of firms which deliberate on what to produce to maximise profits or consumers who consider what to buy with their limited budget. It also applies to any human action, even in non-market settings. Every day we have to make trade-offs regarding what to eat (hamburger and french fries vs. chicken salad) or what to do in our leisure time (watching TV or playing football outside), because we have a fixed time budget of 24 hours, as well as limited mental and physical capacity to satisfy every wish that we can think of.

It was BECKER (1965) who translated this perception into a concrete model. The well-known household production function approach refined economic consumer theory in two ways. First, the notion that it is not the purchased market goods which provide utility but more elementary entities (which BECKER called commodities) demanded a more precise formulation of the "ends" that people strive for. Second, the idea that it is the households themselves that produce these commodities allowed assessment of the "means" that households have at their disposal in a more explicit and rigorous way. Among those means are the time available, the wage rate by which time can be converted to income, and abilities, knowledge, assets and environmental conditions (i.e. their "technology") that determine the production of the elementary commodities.

The literature contains much work that applies the household production approach to study the impact of economic variables and human capital (e.g. education) on non-market behaviour like diet and physical activity and resulting health outcomes. A first wave can be identified in the development literature of the 1980s and 1990s. At that time, researchers were predominantly concerned with the determinants of nutrient intake and health status in developing countries (see e.g. ROSENZWEIG and SCHULTZ, 1983; PITT and ROSENZWEIG, 1985; BEHRMAN and

DEOLALIKAR, 1988; STRAUSS and THOMAS, 1998). From 2000 on, a second wave has met the challenge of analysing the problem of rising obesity rates and overnutrition in industrialised countries. Household production concepts have been utilised as frameworks not only to illustrate the economic view of obesity in general (e.g. CHOU et al., 2004; CAWLEY, 2004; MAZZOCCHI et al., 2009) but also to focus on special factors and determinants. Among those are knowledge of health (NAYGA, 2000), healthy diet (RÖDER, 1998), healthy food variety (DRESCHER et al., 2009), time for and cost of food preparation (HAMERMESH, 2007; DAVIS and YOU, 2010; RASCHKE, 2011), effects of maternal employment on obesity (FERTIG et al., 2009) and physical activity (MULLAHY and ROBERTS, 2010), price effects on obesity (POWELL, 2009; STAUDIGEL, 2011) and blood pressure (CHEN et al., 2002).

These and other economic studies emphasize that it is important to consider multiple goals and the restrictions on achieving them in the study of health and nutrition. PHILIPSON and POSNER (2008) point out the important contribution of economics: "Naturally, when obesity is regarded as a public health issue, government intervention to control it is recommended as soon as a substantial percentage of the population weighs more than is optimal for maximizing health. From an economic standpoint, the proper maximand is of course not health but utility, in which good health is only one argument" (p.977). This raises the question what other arguments apart from health should be considered and how these multiple goals are related to each other. PHILIPSON and POSNER note that "rational persons constantly trade off health for competing goods, such as pleasure, income, time, and alternative consumption possibilities" (pp.978). However, it is not fully clear why trade-offs are necessarily at work here. Better health could just as well enable us to derive more pleasure from certain activities (like sports, etc.) and consumption possibilities. Healthier people have better chances of finding jobs and generating higher incomes and have – in the long run – more time at their disposal. A second example of trade-offs, concerning policy decisions, is given by MAZZOCCHI et al. (2009), who state that "although people support the goal of better human health, people would not choose to impose strict regulations if doing so would divert resources from other goals such as climate protection, education, and a decent standard of living" (pp.158). Again, pursuing these goals may also offer synergies instead of competition between each other.

In the light of the ambiguity concerning the goals related to health and dietary behaviour and their interrelations, it seems worthwhile to investigate more closely their nature and the processes that might lead to either synergies or trade-offs. Guided by the original ideas of household production theory, we provide a review of economic studies on nutrition and health and assess the framework's potential for future research. We draw the conclusion that a more explicit inclusion of other goals in household production approaches yields new insights into determinants of human behaviour, and possible interdependencies therein, can guide theoretical and empirical analysis and may be a source of inspiration for data collection and policy design.

We proceed as follows. In Section 2, we review the basic household production literature and discuss the advantages and disadvantages of the different specifications of utility functions and the respective commodities used in them. We turn to studies that apply household production functions to nutrition and health in Section 3 and discuss the state of the art in practice. In Section 4, we stress the importance of considering joint production as well as input substitution in household production. Section 5 addresses consequences for modelling, data collection and policy making that arise from the aspects discussed in the earlier sections, and it also draws a conclusion.

2 Household production theory revisited

2.1 Taste versus technology

We start our analysis from the basic advantage that the household production literature claims to possess over traditional demand theory. BECKER (1965) and MICHAEL and BECKER (1973) emphasize that a large part of what is usually subsumed under the diffuse term "preferences" can be explicitly expressed as restrictions. Pollak and Wachter (1975) concur with this view: "Traditional demand theory treats V(x) (the derived utility function) as the household's utility function and is thus guilty of confounding tastes and technology, rather than maintaining a separation between them. A consequence of this, as the household production function literature points out, is that changes in demand which are attributable to changes in technology must formally be described as changes in tastes" (p.260). The importance of separating production functions (i.e. the consumption technology) from utility assessments is stressed by SEEL (2006), who identifies an advance in modern economic thinking in two ways. The first is a more detailed and differentiated analysis of the restrictions imposed on human behaviour. The second is, as a consequence of the first, enabling utility theory to be free to concentrate on its core competence: the "finally decisive motives and values of human beings" (SEEL, 2006, p.115).

To prevent utility functions from being what MICHAEL and BECKER (1973) call a "hodge-podge of some arguments which yield satisfaction, some quantities of time and goods which are directly distasteful[1], and several arguments – e.g. age, education – which may have little direct utility associated with them", household production functions are introduced which "effectively separate objects of choice from the means used to produce them" (p.393). Therefore, MICHAEL and BECKER advocate the use of utility functions that exclusively contain Z-goods[2]. Hence, if the household production approach is to fully develop its potential, those who apply it will have to think carefully about what the objects of choice are and what the means are. However, "applying production theory to the household, the household production function literature has not attempted to draw the line indicating where production processes stop and utility begins" (POLLAK and WACHTER, 1975, p.274). Even more than four decades after BECKER's seminal paper, there is no consistent perception (let alone a definition) of what constitutes a Z-good. However, this lack of clarity has severe impacts on theoretic formulation, collection of data and policy recommendations on the basis of household production theory. Therefore the next section tries to locate and sketch the hazy concept of a Z-good.

2.2 What exactly is a Z-good?

BECKER (1965) assumes households "combine time and market goods to produce *more basic commodities* that *directly enter their utility function*." He provides the examples of "seeing a play", which is produced with actors, script, theatre and the playgoer's time, and of "sleeping", which depends on the input of a bed, a house, pills, and time[3] (BECKER, 1965, p.495). In the course of time, the nature of the Z-goods mentioned in Becker's work became more fundamental, together with the claim to explain an ever wider spectrum of human behaviour (MICHAEL and BECKER, 1973; STIGLER and BECKER, 1977). MICHAEL and BECKER (1973) state that the household production approach "views as *the primary objects of*

[1] In the sense of "utility-neutral".

[2] Commodities are written as "Z_i" in the household production framework, and therefore "Z-goods" is synonymous with commodities.

[3] Other examples in this article include leisure, reading a book, having a haircut, commuting, eating dinner, frequenting a night-club, sending children to private summer camps, business lunch, good diet, relaxation, transportation, milk-consumption at home.

consumer choice various entities, called commodities, from which *utility is directly obtained"* (p.381). Note that the terms "entities" and "primary objects" refer more strongly to final goals compared with "more basic commodities" in BECKER (1965). The new formulation also invites us to think about what provides "direct utility" (1973) instead of what "enters the utility function (1965)." MICHAEL and BECKER focus much more on the identification of **means and ends**: "Many discussions of the notion that goods are desired not for their own sake but for some specific service which they perform can be found throughout the literature" (p.384).

MICHAEL and BECKER perceive Z-goods as very basic and finally argue "that they (the consumers) all derive that utility from the same "basic pleasures" or preference function, and differ only in their ability to produce these "pleasures""(MICHAEL and BECKER, 1973, p. 392). Hence Z-goods should be regarded as elementary to human existence, which is reflected in the examples given by MICHAEL and BECKER. These are more basic than those from 1965 and include "good health", "children", "marriage", "intercity visits" and concepts like "envy", "prestige", "physical and psychological health", as well as "circumspectness". In line with this argument, STIGLER and BECKER (1977) maintain that preferences can be considered as constant and identical across individuals and over time and any differences in behaviour can be explained by prices and other restrictions. Although authors like HIRSCHMAN (1984) and COWEN (1989) provided good reasons to question this last conclusion, we could indeed think of elementary ends which every human being strives for (although these ends may be given different priorities). Moreover, most people would agree that people differ in terms of their abilities and strategies to reach these goals.

A suggestion of what such elementary goods might look like can be found in the work of ROKEACH (1973). In US-wide large-scale surveys, he examined the ultimate values of the population. He concluded that such "terminal values" can be expressed by a relatively small number of concepts. These are shared by everyone, but they are weighted differently across socio-economic status, occupation, gender, race, etc. ROKEACH's terminal values consist of: *True Friendship, Mature Love, Self-Respect, Happiness, Inner Harmony, Equality, Freedom, Pleasure, Social Recognition, Wisdom, Salvation, Family Security, National Security, A Sense of Accomplishment, A World of Beauty, A World at Peace, A Comfortable Life, An Exciting Life*. In the following, we utilize this list as a basis for discussion. It is surely not intended to be an exclusive or complete list of Z-goods but serves the purpose of being a reference point for argument. A look at commercials and marketing strategies may support the notion that these items are quite close to elementary goods. Often, one certainly gets the impression that it is the concepts from the list that are sold rather than cars, beer or cigarettes. Also, studies that deal with food consumption have picked up the topic of more elementary, stable preferences or values. Recently, LUSK and BRIGGEMAN (2009) took up ROKEACH's idea of terminal values to identify "a set of food values or meta-attributes for which people may have more well-defined preferences" (p.194). In the social sciences, SCITOVSKY (1981) describes the case of excitement for which people have a basic need. Since technical progress and increasing wealth have relieved humans of the daily struggle for life, other activities now serve the production of excitement, e.g. crime, extreme sports or other risky behaviour.

POLLAK and WACHTER (1975) point to several problems that arise when Z-goods are regarded in a very abstract manner. When the household production approach "is applied to variables which may be interpreted as "utilities" (numbers representing preference orderings) rather than "commodities" (the outputs of production processes)…the production function approach loses its unique identity and cannot be distinguished from a variety of hypotheses about the structure of the household's preferences" (p.256). Of course, when we lack direct measures of the produced commodities, it is not easy to identify what is still technology and what is already taste. The alternative offered by POLLAK and WACHTER is to study the allocation of

time and goods among household activities. A precondition for such an analysis is the ability to divide the day into non-overlapping activities. Additionally, such a procedure no longer focuses on the production processes and would be closer to traditional demand theory (POLLAK and WACHTER, 1975, p.256).

3 Applications to health and nutrition in practice

3.1 Specification of Z-goods in studies on health and nutrition

So far, we have collected rather theoretical arguments both in favour of using commodities that mirror the essential goals in human life and against using those which are too abstract and immeasurable to allow the identification of actual production processes.

Examining recent applications from practice enables us to check the soundness of those arguments as well as the relative advantages of each view. Table 1 in the Appendix shows excerpts from 18 recent studies applying household production approaches to health and obesity and the utility functions that they take as a basis.

A first look at the studies shows that hardly any of them exclusively employ elementary commodities in the sense of MICHAEL and BECKER (1973). Naturally, most of them include *health*, but only three of them add arguments that seem close to those *elementary ends* discussed in Section 2.2. CHOU et al. (2004) include the "enjoyment of eating palatable food" and the "entertainment provided by dining with family and friends in restaurants and at home". RÖDER (1998) regards "basic needs", "pleasure from eating" and, optionally, "leisure" as utility-yielding commodities. MAZZOCCHI et al. (2009) argue that "appearance" is an entity that affects utility directly. Besides health, CAWLEY (2004) includes *weight* in his utility function.

A whole series of studies include variables of *food and drink consumption* as a direct source of utility (CAWLEY, 2004; DRESCHER et al., 2009; HAMERMESH, 2009; HUFFMAN et al., 2010; HUFFMAN, 2011; MAZZOCCHI et al., 2009; POWELL, 2009). Most of the studies specify the taste of the food as the major component generating utility. HUFFMAN (2011) additionally sees social interaction during meals as a source of utility. The studies of CAWLEY (2004) and MAZZOCCHI et al. (2009) explicitly equate food and drink with energy intake (and thereby reduce the source of utility to the calories consumed).

Many utility functions also feature several *time inputs.* The most prominent item here is leisure, which can be found in eight studies. HUFFMAN (2011) divides leisure into "physically active leisure time" and "other leisure time". He assumes sedentary leisure (TV viewing, surfing the web) to be utility-increasing, whereas "time allocated to vigorous physically active leisure may directly reduce utility, i.e. adults find this activity unpleasant or uncomfortable" (p.51). CAWLEY (2004), in order to obtain the acronym '*SLOTH'* for his model, adds sleep, occupation, transport, and home production to leisure. HAMERMESH (2007), without explicitly specifying a utility function, directs his analysis to the "utility-maximizing production of the commodity eating".

Several authors introduce a residual that is defined either as a *composite of purchased goods* which do not affect health (CHEN et al., 2002; MAZZOCCHI et al., 2009), other purchased consumer goods (HUFFMAN et al., 2010; HUFFMAN, 2011), all non-food/non-drink items (HAMERMESH, 2009; DRESCHER et al., 2009), or as a "vector of other commodity-producing variable inputs that may also confer direct utility" (MULLAHY and ROBERTS, 2010).

The last group of variables included in utility functions are *individual and environmental characteristics*. HUFFMAN et al. (2010) state, that "a household's utility is determined by a vector of fixed observables, e.g. education of the adults and number of children" (p.12). HUFFMAN (2011) appends "gender, and race/ethnicity of adults" to this list. MULLAHY and

ROBERTS (2010) introduce "a vector of exogenously given environmental (social, natural, etc.) measures that may influence the marginal utilities of the other utility determinants" (p.414). MAZZOCCHI et al. (2009) do not explicitly specify variables but note that the "exact relationship (between utility and its determining factors) would vary for every individual according to their preferences" (p.46).

Only a few studies provide a statement about the formal characteristics of their utility functions. CHEN et al. (2002) employ a "weakly separable, well-behaved" utility function, NAYGA (2000) states that the utility function is "subject to the usual properties", and RÖDER (1998) notes that her formulation of the utility function implies additive separability, because leisure represented a potential commodity but has not been included. HUFFMAN (2011) and HUFFMAN et al. (2010) explicitly state that they employ "strictly concave" utility functions. CAWLEY (2004) argues that "the function of utility overweight is nonlinear for most people. Living at starvation weight causes disutility, achieving one's ideal weight provides positive utility, and morbid obesity causes disutility" (p.118).

The above assessment shows that most applications of household production theory do not strictly adhere to utility functions that exclusively contain Z-goods as claimed by MICHAEL and BECKER (1973). Apart from health, most authors include items we would assign to the categories of time and market inputs in the sense of BECKER. These are considered as a direct source of utility, but how and under what conditions their benefits accrue is not discussed explicitly. As we will show below, taking into account other production processes that are likely to be linked to health and nutrition yields a series of interesting and relevant insights and raises a lot of new questions for future research.

3.2 Production functions

Production of health

Remarkably, the examination of "technology" in the studies presented above is strictly restricted to the production of health, with most authors having similar perceptions about the health production processes taking place in households. The primary inputs, food or diet, enter in various forms. Besides very general specifications using "food intake" (CAWLEY, 2004), "food inputs" (HUFFMAN et al., 2010) or the "appropriate diet" (CHOU et al., 2004), more specific variables are used. These are often single *nutrients* people obtain from different foods (RÖDER, 1998; VARIYAM et al., 1999; CHEN et al., 2002) or measures of *diet quality* (MAZZOCCHI et al., 2009). Some authors introduce intermediate inputs like *weight* (CAWLEY, 2004; MAZZOCCHI et al., 2009), *meals* (CHOU et al., 2004), and *healthy food diversity* (DRESCHER et al., 2009) that are also "produced" in special production functions.

Additional inputs are often grouped as *non-food inputs* or *purchased health inputs* like "medical services and drugs" (HUFFMAN et al., 2010), "medical treatment or sports" (RÖDER, 1998), "medical care" (VARIYAM et al., 1999), "level of medication" (CHEN et al., 2002), and "medical services and exercises" (DRESCHER et al., 2009). A third group of variables consists of *time inputs* for several activities (CAWLEY, 2004; MULLAHY and ROBERTS, 2010), physically active and sedentary leisure (HUFFMAN, 2011) or the time a mother spends at home with her child (FERTIG et al., 2009).

In addition to those variable inputs, nearly all authors share the view that the production functions depend on exogenous observable or unobservable factors. *Education* plays a prominent role in the first set. VARIYAM et al. (1999) identify education as a key component, because "more educated individuals are more efficient producers of health because they are more informed about the true effects of inputs on health; they have higher allocative efficiency, i.e., ability to select a better input mix" (p.218). Some authors point out that measuring the

influence of education (or of single educational aspects) on health unambiguously is very difficult. *Other characteristics* referred to in this context are variables of gender, race, attitude or knowledge (DRESCHER et al., 2009), society's organisation of the health care industry and public health practices, society's stock of medical and nutritional knowledge and technologies and urban congestion (HUFFMAN et al., 2010), human capital in general (RÖDER, 1998), dietary knowledge (NAYGA, 2000) and nutrition information (VARIYAM et al., 1999). Finally, the *unobservable characteristics* included are exogenous state of health, exogenous health endowments or genetic ability.

Other production processes

Only a few authors mention production processes for commodities other than health. CHOU et al. (2004) list entertainment and enjoyment but just as outcomes related to eating. MULLAHY and ROBERTS (2010) point out that "the other commodities, z, are produced using the same inputs as go into the production of health." According to them, health or wellbeing of other family members would be examples, but they do not specify further Z-goods. VARIYAM et al. (1999) just mention that "households combine various inputs to produce 'commodities'" but don't specify them further.

4 Health production in a more complex setting

The previous section has shown that most of the studies that apply the household production framework to health and nutrition strictly focus on health as an elementary commodity. Although some of them explicitly or implicitly acknowledge that there are other production processes associated with diet and the production of health, these pathways are not pursued further. This section explores what can be gained by allowing for a more complex set of elementary commodities and interdependent production processes. We take the terminal values (ROKEACH, 1973) from Section 2 as a basis, and consider the role of health as well as joint production and input substitution.

4.1 The role of health

In household production frameworks, health almost exclusively has the status of a Z-good. However, when the underlying Z-goods are items like "Self-Respect", "Happiness", "Inner Harmony", "Freedom", or "Pleasure", we might well regard health not as an end in itself but rather as a means to realise other goals (albeit as a very important, if not the most important one). As soon as we regard health as an input into other production processes, we may think of substitution effects that emerge from technological progress or the change in social norms. Pain, for example, may diminish the production of "pleasure", where pills are an additional market input to stop this pain. In the context of obesity, the production of "social recognition" or "love" may be affected negatively. Another example is the production of "happiness", "pleasure" or "excitement", where former physically active production processes (sports, playing outside) may have been substituted by physically inactive alternatives like TV viewing or computer games.

4.2 Joint production

Although POLLAK and WACHTER had already pointed out in 1975 that "jointness is pervasive because time spent in many production activities is a direct source of utility as well as an input into a commodity" (p.256), the household production literature has largely avoided modelling the joint production of two or more commodities. SEEL (1991) shows that BECKER's approach allows joint production to be modelled in principle, but she also admits that the variety of potential processes makes this "hardly operationalisable". Disregarding the difficulties of

implementing joint production in a rigorous manner, we want to emphasize the importance it has for the analysis of nutrition and health. In fact, many of the studies implicitly describe joint production but hide those processes in the utility function. Consequently, the "technology" is dropped and does not enter consideration of how to explain behaviour or how to create policies to reach certain goals.

Activities like eating or sports generally yield more outcomes than just health. This can be illustrated by countless examples. Some of the studies examined here explicitly refer to such joint production processes. RÖDER (1998) includes the production of a commodity called "pleasure" with food as an input. CHOU et al. (2004) mention the "enjoyment" (of eating palatable food) and "entertainment" (provided by dining with family and friends in restaurants and at home). We could further think of "excitement" produced by eating exotic foods (an alternative version related to excitement would be that some people might prevent boredom by simply eating, no matter what), "social recognition" by consuming foods (or drinks) that are considered to be trendy in certain peer groups, or the production of feelings of "fairness or equity" by eating organic or fair trade products. Other authors are well aware of the multiple purposes food and eating can serve, but they regard those as a source of direct utility instead of assuming specific production processes. This is shown by the following example: "However, food intake also frequently yields utility directly because food texture and taste give satisfaction and eating and drinking together are a major part of satisfaction-yielding social interaction" (HUFFMAN, 2011, p.51).

Modelling the benefits of eating via differentiated production processes may direct our attention to the human capital necessary to generate pleasure. We definitely oppose the view that the utility gained from eating certain foods is just a matter of immutable preferences or tastes, and that, as CAWLEY (2004) argues, the attempt to alter them would probably be "futile" (in the case of ice cream and broccoli). Rather, the ability to derive pleasure from food (including broccoli, salads, vegetables, etc.) is in fact the result of a good upbringing and opportunities to collect impressions and experiences from as many different foods and flavours as possible. We are convinced that here lies a starting point for education measures. Many people may not lack the knowledge of how to produce health by consuming an adequate combination of "healthy" and "unhealthy" food products (which is the predominant view in the health production and public health literature) but rather of how to also produce pleasure (and other commodities) from healthy foods.

A second relevant sector where the analysis of joint production is worthwhile is sports or physical activity. In the frameworks presented above, physical activity generates utility indirectly through its positive effects on weight and health. Additionally, it is mostly connected to higher discomfort and regarded as directly affecting utility negatively (see e.g. HUFFMAN, 2011, p. 51). In keeping with the view that we hold in this paper, the negative aspect of physical activity could be described as reducing the commodity "comfort". However, we could think of many commodities where physical activity is a quite positively operating input, and the millions of people doing sports in their leisure time (and having fun with it) provide overwhelming evidence for this point. Hence, jointly produced commodities range from "excitement" and "freedom" (generated by skiing, (kite) surfing, etc.), to "inner harmony" (running, yoga) or even "mature love" (tango!). Further, team sports produce "friendship", and good performance yields "social recognition". Again, human capital is an important factor determining such production processes.

4.3 Input substitution

The issue of joint production is closely related to the question of input substitution within the production of several commodities. So far, substitution effects have only been considered in the

production of health. Unhealthy food items (burgers, pizza, doughnuts and soft drinks) should be substituted by healthy products (fruit, vegetables, whole grain, and lean meat), and it is better to replace sedentary leisure (TV, video games, car driving) with physically more demanding activities (sports, cycling). The prevailing view of economists is that whether a substitution occurs depends on relative costs determined by prices of food, entertainment products, leisure activities and transportation, transport infrastructure and workplace, and education. Education is important, because in this view it represents the knowledge of how to produce health most efficiently. However, when the modelling neglects joint production processes as given in the examples of Section 4.2, a multiple of substitution possibilities is lost for analysis and policy design.

Considering joint production of health, pleasure and other commodities requires us to model restrictions more accurately. Once we accept that pleasure may be produced by eating but also by exercise, sex, music, art or literature, we should extend our analysis to the abilities and knowledge people possess, as well as to what inputs are available to them, to produce pleasure from higher quality food, from listening to music or exercise. An associated question is how strong those substitution effects are, whether we can expect them to occur marginally or whether a fundamental change in lifestyle is necessary. The separation of utility and production functions supports modelling and analysing such relationships, as it emphasizes that most of the "preferences" are not god-given and immutable factors but rather technologies and abilities that need to be cultivated. Some economists might argue at this point that "taste" for fast food, vegetables, alcohol or exercise is beyond the scope of economics. However, to understand the trade-offs that people make in their every-day decisions, what ends they strive for and what restrictions they face, economists should work closely together with other disciplines to throw light on the production processes that are at work.

5 Discussion and conclusion

In the previous section we advocated applying household production theory more broadly to health and nutrition in a very intuitive but less rigorous manner. However, this implicit model of behaviour related to health and nutrition may serve as a valuable basis for (a) explicit models, (b) data collection and (c) policy design.

Modelling

It is a challenging task to model such complex interdependent processes as described above. In the light of joint production and reciprocal influences, SEEL (1991) points out that classical marginal instruments may soon reach their limits. She suggests using linear-optimisation models to allow for the "complexity of interdependencies by widely differentiating activities and restrictions as well as objectives and conditions" (ibid., p.181). Such a model would yield discontinuous reactions to changing prices under certain circumstances, which could be used e.g. to assess the effects of fat taxes. We could expect people to stick to unhealthy food even when their prices are increased via taxes because their technology restricts their production of "pleasure" solely to those unhealthy products. The changes would not occur marginally but all at once, when the financial pressure gets overwhelming.

HAMMOND (2009) points out that obesity exhibits the characteristics of a complex adaptive system. First, it involves a "great breadth in levels of scale" that are the object of different fields of science "from genetics to neuroscience to economics and political science". Second, the relevant actors ranging from consumers and politicians to firms, etc., are very diverse. They have "different goals, motivations, constraints, sources of information, modes of decision making and types of connections to other actors." Third, multiple mechanisms are at work that are not fully understood and often examined in the isolated setting of the respective field. As a result, "linkages and feedback between these mechanisms are not well understood" and

"interventions may affect each differently". HAMMOND recommends agent-based computational modelling as a tool to explicitly model such complex phenomena. Modelling macro-patterns like changes in the BMI-distribution, eating patterns and health outcomes should take the complexity into account. Path dependence issues could be analysed and policies could be simulated in computational laboratories. The broader, more complex household production framework presented in this paper could serve as a theoretical basis for approaching this task.

Data Collection

Critics of a broader view of the household production framework as presented here may object that there are no adequate data to examine the complex relationships described above. Defining and measuring those abstract commodities and those seemingly inscrutable production processes where multiple inputs serve multiple outputs appears to be an insoluble task. However, some trends from fields like happiness and experimental economics or neuroeconomics are a reason to be optimistic regarding future research.

POLLAK and WACHTER (1975) warned about the use of non-measurable "utilities" that just represent preference orderings. More than three decades later, psychologists as well as (happiness) economists are not that shy about measuring utility. Work in the field of happiness economics has shown that utility/satisfaction can be reliably and reasonably measured (see e.g. KAHNEMAN, DIENER and SCHWARZ, 1999). Of special interest is the use of area-related satisfaction that measures the contentment with work or leisure activities. Variables that represent commodities or are related to commodities have not yet been part of large household surveys. However, questions about satisfaction with life or satisfaction with certain areas of life like the "food situation" (e.g. in the Russia Longitudinal Monitoring Survey, RLMS) or "job satisfaction" (e.g. in the German Socio-Economic Panel, SOEP) are pioneering items that have entered these large-scale studies and may function as door openers. Likewise, education and abilities should be measured in more detail to cover as many aspects of household technology as possible.

Besides enhanced household surveys, the field of experimental economics is a promising source of information on commodities and their inputs used by different individuals. In their work on food values, LUSK and BRIGGEMAN (2009) state that "small-scale laboratory research can be used to determine the link consumers make between specific food attributes, such as use of biotechnology, fat content, meat tenderness, etc., and food values" (p.195). In principle, the same procedure could be applied to inputs and commodities in a more general setting. Further papers by NAYGA (2008) and ROOSEN and MARETTE (2011) give rise to optimism that new methods and data from neuroeconomics and experimental economics are potentially at hand that allow the measuring of such ostensible entities as pleasure, happiness, self-respect, etc., (albeit with considerable effort).

Policy Design

Mazzocchi et al. (2009) group nutrition policy instruments into 1) information measures and 2) market intervention measures. Group 1) consists of information campaigns, advertising regulations, nutritional education programmes in schools, labelling rules, nutritional information on menus, regulating health and nutrition claims. In group 2), they list taxes on unhealthy nutrients, price subsidies for healthy nutrients, regulation of the liability of food companies, food standards, facilitating access to shopping areas for disadvantaged (consumer) categories, regulation of catering in schools, hospitals, etc., and funding epidemiological, behavioural and clinical research. The majority of those measures target the narrow area of health production, the knowledge of how to produce health and the restrictions that people face in producing health. A more comprehensive approach that includes other aspects of life as well could be helpful to identify other points of action. The theoretical considerations above have made it

clear that production processes related to eating and sports pursue a wider set of goals than health, for example pleasure, excitement or recognition. The benefit derived by those processes is not determined by diffuse preferences hidden in the remotest corners of a utility function but can be represented by a production process whose inputs and technology allow scientific analysis. We are convinced that the economic principle is a powerful instrument to guide the analysis of the complexity inherent in nutrition and health. It is the more surprising that the household production literature, which, as such, accepts the application of economics to many parts of life, has not yet dared to go further. The success and substantial contribution of economics to uncovering some important factors responsible for rising obesity rates should be greatly appreciated. However, the instruments that might lead the way out of the crisis are likely to be found somewhere completely different. May the following statement of HIRSCHMAN (1984) be encouraging for future research: "Something is sometimes to be gained by making things more complicated. I have increasingly come to feel this way" (p.89).

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Appendix: Table 1: Specification of utility functions in studies applying household production theory to health and nutrition

No.	Reference	Study Object	Utility Function	Notes of the author(s)
1	Cawley (2004)	physical activity and eating behaviour	U=u(S, L, O, T, HP, F, W(.), H(.), Y); S=sleep; L=leisure; O=occupation; T=transport; HP=home production; F=food (calories); W=weight; H=health; Y=composite of all goods other than food.	"...sometimes people are less willing to sacrifice health in exchange for other things they value."
2	Chen et al. (2002)	prices and health impacts	U=u(H, L, Z); "weakly separable, well-behaved"; H=health state; L=leisure; Z=composite of purchased goods which do not contribute to bodily health.	"The person values the purchased goods (e.g. food, exercise bicycles, medication) because they produce characteristics (e.g. nutrients) necessary for the production of health"
3	Chou et al. (2004)	economic factors and obesity	Since no one desires to be obese, it is useful to consider obesity as the byproduct of other goals in the context of Becker's household production function model. "Three such commodities are health [...], the enjoyment of eating palatable food, and the entertainment provided by dining with family and friends in restaurants and at home."	
4	Drescher et al. (2009)	healthy food diversity	"Households maximise a combined utility function to produce final goods such as own health…". "These final goods are called 'commodities' and these provide utility." U=u(Q, h, Z); Q=food consumption bundle; h= health status; Z=consumption of non-food items.	"…food consumption bundles enter directly into the utility function because they are valued in themselves, e.g. foods are consumed because of taste."; reference to Variyam et al. (1999)
5	Fertig et al. (2009)	maternal employment and childhood obesity	No remarks on utility, just focus on production function for health: "The overarching theoretical principle [...] is the concept of a health production function for children, where **child's health** is the output and mother's time at home with the child as the input."	
6	Hamermesh (2007)	time and goods inputs to "eating"	Production of the commodity "eating".	
7	Hamermesh (2009)	eating patterns, meals, grazing	Assume that the typical consumer seeks to maximize: U=u(Z, F) - WS(nP); Z= composite commodity consisting of all non-food/drink items; F=commodity food/drink; WS(nP) is an expression for set-up costs of meals.	
8	Huffman (2011)	health, obesity, with food as an input	U=u(H, X, C, LP, LO; He, Z); H=health; X=consumption of food and drink; C=other purchased goods; LP=physically active leisure; LO=other leisure time; He=early health status; Z=fixed observables (such as education, gender, race).	However, food intake also frequently yields utility directly because food texture and taste give satisfaction and eating and drinking together are a major part of satisfaction-yielding social interaction.

9	Huffman et al. (2010)	obesity, health, non-communic-able diseases	U=u(H, X, C, L, ;Z1); H=current health status; X=consumption of food and drink; C=other purchased goods; L=leisure time; Z1= vector of fixed observables, e.g. education, that determine utility.	
10	Mazzocchi et al. (2009)	obesity, health	U=u(K, S, L, H, A, Z); K=calorie intake (from food & drink); S=smoking; L=leisure; H=health; A=appearance; Z=consumption of goods which do not affect health.	
11	Mullahy and Roberts (2010)	physical activity	U=u(h, z, t, v; e); h=measure of health; z=vector of other commodities produced by combining goods and time; t is a vector of time use activities; v is a vector of other commodity producing variable inputs that may also confer direct utility; e is a vector of exogenously given environmental measures (which influence marginal utilities; e.g. ice cream and jogging are more enjoyable at 30°C than at 0°C.	
12	Nayga (2000)	schooling, health knowledge and obesity	U=u(Xi, H); U is "subject to the usual properties; H=health; X="X-goods" (in the sense of market goods).	
13	Powell (2009)	food prices and obesity	"economic framework where individuals engage in behaviors related to work, leisure, and home production; they produce and demand health and weight; they also consume food which directly and indirectly (through health and weight) impacts utility."	reference to Cawley (2004)
14	Raschke (2011)	time cost, food preparation	U=u(Y, L); Y=total consumption; L=leisure.	
15	Röder (1998)	determinants of food demand	U=u(basic needs; pleasure; health); other possible arguments like "leisure".	implies additive separability of preferences; activity: eating; input substitution: concert visit produces pleasure too!
16	Variyam et al. (1999)	Information, health knowledge, dietary behaviour	"In this framework, households combine various inputs to produce 'commodities', including the health of family members, so as to maximize a joint utility function."	derive reduced form nutrient demand functions
17	Davis and You (2010)	time cost of food at home	U(X, L); X=consumption goods (or services); L=leisure (or consumption time).	