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Hierarchical Decomposition of U.S. Personal Consumption Expenditure: 1984-1991 and 2000-2006

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ABSTRACT

We conceptualize structure in personal consumption by more explicitly defining consumer objectives that underlie the use of goods and services and the organization of these objectives in their heuristics. This conceptualization suggests that goods used for these objectives are grouped together on bases often not predicted by their physical properties. We test our account of structure in personal consumption in estimation with recent and historical data from the U.S. Consumer Expenditure Survey (CEX). Results from estimation of an Almost Ideal (AI) Demand System in each of two study periods generally support the structural differentiation of consumption goods we introduce. An adaptation hypothesis receives qualified support.

Keywords: Personal Consumption, Consumer Heuristics, Econometrics.

INTRODUCTION

The economic and social importance of personal consumption is well documented. In the U.S. and OECD countries, personal consumption accounts for approximately two-thirds of GDP (e.g., U.S. Department of Commerce 2012). Consumption has been discussed as important to growth through its implications for the demand for labor (e.g., Shapiro 2006), productive use of capital (Devarafan, Swaroup and Zou 1996), and the savings rate (e.g., Bernheim and Shoven 1991).

While personal consumption continues to be investigated in a range of specifications, we believe that available studies predominantly address levels and remain too limited in the consideration of assortment. Understanding the basis for assortment can be important to a range of policy objectives (Silver and Verbrugge 2011). We will suggest a basis in consumer heuristics for the structure that consumers impose in their assortment of goods and service. By structure, we will mean the implicit categorization of goods that arise from constraints of their objectives in personal consumption and the organization of these objectives in consumer heuristics. We will suggest that the structure of demand that we cite is inherent in consumer applications of allocation heuristics and typically defines the resultant complimentarity and substitution between goods.

In the discourse to follow, we will outline fundamental objectives of consumers in personal consumption and the differentiation of goods and services that this implies. We will use this framework to propose categorizations of goods that this results in and differences in the price elasticities and cross-elasticities of goods that arise as a consequence of these categorizations. We will also propose transitions in the efficiency of goods for consumer objectives that occur as a consequence of adaptation. Our observations on categorization and price sensitivities will then be tested in panel data on consumer expenditure across a diverse set of goods and services.

Industrial Applications of Structure in Consumer Markets

Understanding structure in demand and the substitutability and complimentarity of goods it can denote has been shown to be important in industrial applications. For example, structure in demand has been shown to more definitively indicate competitors within a product class and has been invoked in applications such as damage estimates from patent infringement (Hausman, Leonard and Zona 1994) and inference on “taste” change (e.g., Verbeke and Ward 2001). However, the groupings in these studies have primarily been in terms of decompositions in which physical attributes predominate, e.g., “regular” vs. “light” or “premium” vs. “popular” price in beer or “regular” vs. “sugar-free” or “caffeine free” in soft drinks. As we will discuss, there are reasons to further introduce insights on internalized processing that is common to consumers as the basis for categorizations of goods and the structure of demand it generates.

We propose that a definition of consumer objectives in personal consumption can be offered from a rudimentary classification of the needs that consumers seek to satisfy and the constraints on the use of goods for objectives that properties of these needs introduce. Such a framework may better indicate price and income sensitivities and substitutability between goods than can be inferred from the physical dimensions generally used in industrial market decompositions. Following a structural decomposition from a rudimentary but defensible classification of fundamental consumer needs, empirical results on patterns of complimentarity and substitution of goods will be reported. We will also examine differences in adjustments across the categories of goods that we define over time and the insights that these differences can offer.

Consumer Objectives

In agreement with other investigators, we view consumer objectives in terms of the use of goods and services in activities to produce need-satisfying outcomes. From this perspective, it is the outcomes of using goods and services that are arguments of utility rather than the input goods and services themselves. Thus, if consumer objectives are outcomes that include sustenance and status because both are fundamental human needs, then goods and services for the respective objectives would be grouped together in their efficiency for these objectives rather than by their physical correspondence or undefined “taste” parameters. Especially in the case of social objectives such as status, seemingly heterogeneous goods and services can be grouped together in discrete categories. Defining need-based categorization of market goods that is typical of consumers can allow us to better specify structure in consumer demand and its market consequences.

Consumer Categorizations in the Structure of Demand

The categorization of personal consumption goods is exemplified in the historically important discrimination between durables and non-durables (Houthakker and Taylor 1970; Xie 1998). The property that distinguishes these categories is essentially in physical depreciation rates. The categorizations that we direct attention to are organized by consumer needs. As commonly defined in economic applications, needs define essentials for the well-being of agents. In psychology, a need can be defined as an innate drive that motivates an agent to action toward attaining a goal-defined purpose. Needs can be distinguished from wants because a deficiency in need satisfaction generally has a greater loss in welfare than a deficiency in satisfying wants. Needs can be physical, such as food or healthcare, or they can be subjective and psychological, such as the need for self-esteem. The needs that can be defined in even a rudimentary classification have properties that differentiate goods in their efficiencies for consumer objectives.

We distinguish a category of goods used to satisfy sustenance needs and two categories of goods used to satisfy social needs of status and identity. We further observe that although status and identity are both social needs, the conditions on efficiently satisfying them, and thereby the dependencies of demand for these goods, can be expected to differ. While we consider the goods that are used for sustenance to be defined by fundamental physical needs (and thereby as "essentials"), the goods that are used to satisfy social needs such as status are socially or culturally defined. These goods can be categorized as "non-essentials" that income and technology at any time make accessible for use to satisfy social objectives.

While in goods for sustenance needs, efficiency in satisfying objectives is likely to be closely related to physical properties of goods, goods for social needs are likely to evidence little or no correspondence between physical properties and efficiency in need-satisfying activities. Discrimination between categorizations of goods that we hypothesize consumers make can be empirically tested in own and cross price elasticities within and between a set of goods. Goods in the same category are expected to be complements while goods in different categories are expected to be substitutes.

Hierarchical Organization of Activity Classes

Since it has long been the assumption of theorists that needs are hierarchically organized (Clarke et. al. 2006), we expect budget allocation for inputs to activity classes to be correspondingly organized. In this section, we will give a form to a hierarchical organization of budget allocation to the activity classes we define in which budget levels drive movement across the hierarchy. The results of the sensitivities of these activity classes provide indication that a hierarchy in need-satisfying activities is an appropriate organizer of the dynamics of budget dependencies.

We assume that for each activity class, there are levels of activities that at least substantially diminish need intensity, *i.e.,* needs have what are at least partial satiation levels. These levels will be considered as thresholds. When activities attain this level, the marginal utility of outputs from activities for this need are correspondingly expected to substantially diminish.

In implementing this condition in a hierarchical system, we write additive utility as:

$$V = \left(V(\sum_{i=1}^{3} w_i A^{(i)}) \right) \tag{1}$$

where *w* is a weight for an activity class and write ordinal conditions on utility for the hierarchical organization of activity classes as:

If $A^{(1)} < A^{(1)}_{\max}$, then $V(A^{(1)}) > V(A^{(2)}) > V(A^{(3)})$

If $A^{(1)} \geq A^{(1)}_{\max}$ and $A^{(2)} < A^{(2)}_{\max}$, then $V(A^{(2)}) > V(A^{(3)} > V(A^{(1)})$

If $A^{(1)} \geq A^{(1)}_{\max}$ and $A^{(2)} \geq A^{(2)}_{\max}$, then

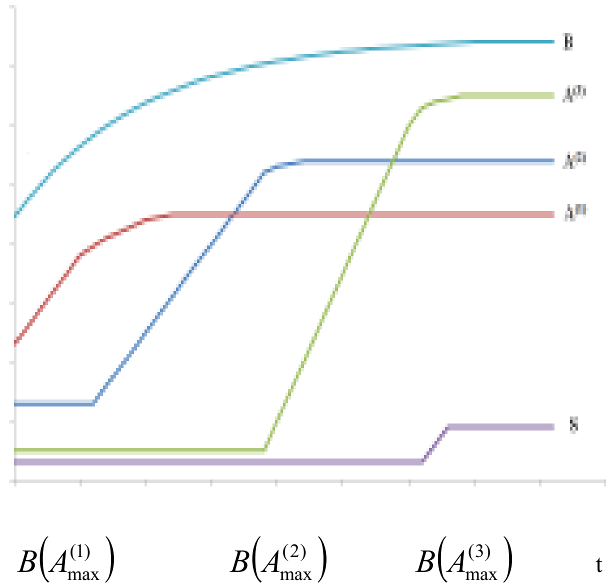
$V(A^{(3)}) > V(A^{(2)}) > V(A^{(1)})$

where $A^{(i)}_{\max}$ is assumed to be the threshold at which an activity class reaches a partial satiation level. It is assumed that a non zero level of $A^{(2)}$ and to $A^{(3)}$ are required at all budget levels.

The proposed organization of activity classes and the goods used in the respective classes can be shown to have implications for policy objectives. At least until recently, increasing the contribution of personal savings to capital formation has been a common policy objective in the U.S. and the OECD countries of Western Europe (Osberg and Sharpe 2002). In national accounting, savings has been defined as the residual after consumption is subtracted from disposable income.

The organization of consumption and savings that the ordinal conditions we postulate is shown in Figure1. Some level of each activity class is assumed to be produced at all budget levels. In the Figure, intercepts for $A^{(i)}$ are assumed to be minimum maintenance levels. In the Figure, $B(A^{(i)}_{\max})$ is the budget expenditure required for the level of $A^{(i)}$ to attain the threshold level for need satiation in the activity class. Before B> B($A^{(3)}$), saving is assumed to be precautionary and maintained at a fixed low level. When $A^{(3)} > A^{(3)}_{\max}$, expenditure or consumption is assumed to remain at or close to the level that maintains $A^{(i)}_{\max}$. After budget level is greater than $B\left(A^{(1)}_{\max}\right) + B\left(A^{(2)}_{\max}\right) + B\left(A^{(3)}_{\max}\right)$, increases in budget are saved.

Figure 1 Hierarchically Organized Consumption as a Function of Budget Level



where B is budget level

$A^{(i)}$ is the level of the ith activity

$B\left(A_{\max}^{(i)}\right)$ is expenditure level at the partial satiation level for the ith activity

S is the level of savings

Adaptation in the Categorization of Goods and Services for Social Objectives

Social needs introduce dependencies that imply the goods and services used in activities to satisfy them can be more time varying than those used to satisfy sustenance needs. For example, goods that were once status defining because they were owned by few can move out of that category and become normative because their usage has diffused in a population. It is easily recognized that ipods and iphones or their near equivalents have become at least semi-essentials ("got to have") for a certain demographic whatever their income level. We expect that once this occurs, these goods are increasingly less sensitive to price variation. Here, we hypothesize that the goods in a categorization of non-essentials are more likely to decrease in their price elasticities over time than goods in a categorization of essentials.

From the above, we expect that *ceteris paribus,* elasticities of goods in a non-essentials category at some time point will show decreases over time. In contrast, elasticities of goods classified as essentials are expected to show smaller magnitude and trendless variation over time.

EMPIRICAL ESTIMATION

We next provide an empirical test of these predictions on the categorization of goods in the structure of demand. We also examine the differential adaptation that the foregoing categorizations of consumer objectives imply. For this we will apply a multi-stage model of consumer expenditure to data on personal consumption from representative national samples. While we are unable to define and test hypotheses on thresholds in data that we can access, the multi-state model we implement has general properties that further our ability to test observations on the grouping of product or services in personal consumption. We will estimate the model in two time periods to test our observations on structure in consumer demand and the price and income sensitivities that result from transitions in the goods used in activities to satisfy objectives.

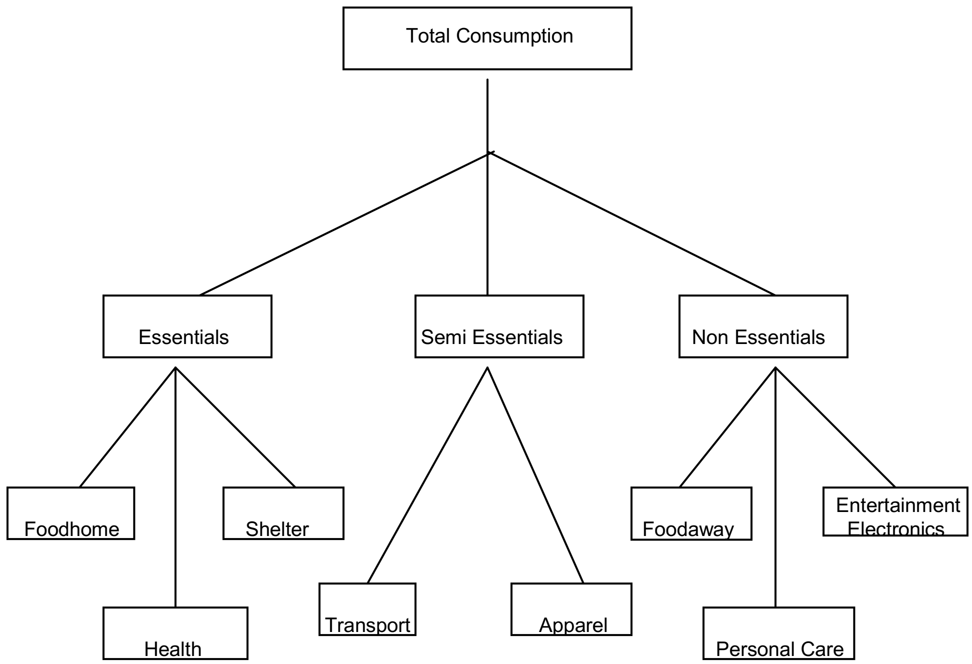
An Almost Ideal Demand System

We specify and estimate an Almost Ideal Demand System (AI: Deaton and Muelbauer 1980; also see Chang and Serletis (2013) and Markusen 2010) to test predictions from the categorization we hypothesize that consumers make in personal consumption. This system is a flexible functional form of a demand system (Pollak and Wales 1992) that has been shown to have considerable advantages over alternative demand systems in estimating price elasticities of demand. A flexible demand system allows for few restrictions on preferences while decreasing the number of unknown parameters through the use of symmetry and adding up restrictions from consumer theory. These conditions offer a convenient specification of non-homothetic behavior (Deaton and Muelbauer 1980; Hausman and Leonard 2005) and allow price elasticities to be unconstrained at the point of approximation.

From the preceding discussion of need-based consumer objectives, we classify goods in three categories. The requirement of complete price information by regions for the study years in available data necessitates some approximation and aggregation in category definitions. Based on this differentiation of goods, we show a hierarchical system to be specified in an AI model in Figure 2.

Figure 2

Hypothesized Consumer Decomposition of Demand



In the figure, activities for sustenance objectives are assumed to be produced from expenditure on food, shelter and health that are categorized as *Essentials*. Status-yielding activities are assumed to be produced from activities that input automobiles and clothing. Status properties of these goods are well documented (Gasana 2009). Inference on their use to convey status is complicated by their simultaneous use for functional purposes. However, increases in real gross expenditure that are controlled by number in the household members are considered to be a status indicator. Because of their simultaneous use for functional as well as social objectives we classify them as *semi-essentials*. Finally, we consider social objectives in identity to also be produced from expenditure on goods that are not essentials. Since food-away from home, entertainment and personal care do not predominantly have a functional property, we classify these goods as *non-essentials*.

The Flexible Demand System

We follow general procedure in estimating the model for the three-level system shown in Figure 2. We begin at the lowest level (*i.e.,* demand for each good within a category), and use price information from this level for consistent estimation at higher levels (*i.e.,* demand for a category of goods and total demand, respectively). For each good within a category (lowest level), the demand specification in Figure 2 is

$$S_{\text{int}} = \alpha_{in} + \beta_i \log\ (Y_{Gnt}/p_{nt}) + \sum_{j=l}^{J} \gamma_{ij} \log\ p_{jnt} + \varepsilon_{\text{int}} \tag{2}$$

Where, S_{int} is the share of total consumption expenditure of the ith good in the kth category,

Y_{Gnt} is overall expenditure in this category,
p_{jnt} is the price of the jth good in the nth geographical region,
J is the number of goods within the category.

We estimate (2) for each of the three categories we define. The estimated γ_{ij} permits a free pattern of cross-price elasticities. Given the estimates from eq (2), we calculate a price index for each category and proceed to estimate the next level of demand. To specify the middle level demand system we use the log – log demand system

$$\log\ q_{mnt} = \beta_m \log Y_{\beta nt} + \sum_{k=1}^{K} \alpha \log \prod_{knt} + \alpha_{mn} + \varepsilon_{mnt} \tag{3}$$

$m = 1, ..., M$; n = 1, ...N; t=1, ..., T

where, q_{mnt} is the log quantity of the mth segment in region nt and period t;
$Y_{\beta nt}$ is total consumption expenditure and
$\prod_{knt}$ are the segment price indices for city n.

The price indices $\prod_{knt}$ for the categories of products and services we study can be estimated either by using an exact price index corresponding to eq (2), that is constructed from the expenditure function for each segment holding utility constant, or by using a weighted price index of the Laspeyres type. The exact form of the price index has not been found to typically have much influence on the final model estimates (e.g., Hausman, Leonard and Zona 1994; Rickertsen 1998). We follow these authors and use a Stone index defined as

$$\log \mathrm{P} = \sum_{i=1}^{N} s_i \log\ p_i \tag{4}$$

where, s_i is the average of the revenue share in a category or segment over seven years in a period we have data for.

We use the mean revenue share in a category over the entire seven year period to avoid the possibility of endogeneity in the log price equation. Finally, we estimate the overall price elasticity of consumption expenditure as in the top level equation for Figure 1.

$$\log\ U_t = \beta_0 + \beta_1 \log\ Y_t + \beta_2 \log\ \prod_t + Z_t \alpha + \varepsilon_t \tag{5}$$

Where, U_t is overall consumption expenditure,
Y_t is deflated disposable income,
$\prod_t$ is the deflated price index for consumption and
Z_t is a vector of demographics.

We impose homogeneity of degree zero in prices and total expenditure, and Slutsky symmetry restrictions on parameter estimates as follows:

adding up: $\sum_i \alpha_i = 1, \sum \beta_i = 0, \sum_{ij} = 0 \forall j$

homogeneity: $\sum_j \gamma_{ij} = 0 \forall i$

and
symmetry: $\gamma_{ij} = \gamma_{ji} \forall i, j.$

Data Set

Data from the Consumer Expenditure Survey (CEX: U.S. Bureau of Labor Statistics 2008) was used to estimate the AI model. The years we use in the historical series are those in which there is complete price information on at least a region-of-the-country basis. Mean expenditure on a set of product and services in each of four U.S. regions is calculated from CEX data in the time periods of 1985-1991 and 2000-2006 with close to a ten year interval between periods.

We use quarterly data for each of the seven years and define a time period. This provides 112 observations for each of the two periods. A ten year interval between time periods is used to separate the time periods. Regional definitions and a quarterly price data for the time periods were obtained from the U.S. Bureau of Labor Statistics.

Instruments in Middle Level and Bottom Level Equations

We next consider the identification and consistent estimation of the middle level and bottom level equations. An often implemented strategy of estimating demand equations to avoid an endogeneity problem in prices is to use factor prices as instrumental variables (eg. Hamermesh and Grant 1979). This cannot readily be implemented in our application since producer prices are not adequately disaggregated at the region level. Hausman and Taylor (1981) used the alternative of using the panel structure of the data to solve this limitation. This procedure has been implemented here

For our application, the price for good *j* in region *n* in period *t* is modeled as

$$\log P_{jnt} = \alpha_j \log c_{jt} + \alpha_{jn} + w_{jnt} \tag{6}$$

Where, P_{jnt} is the price for brand; in region *n* in period *t,*

c_{jt} is the cost which is assumed to not have a region specific time shifting component

α_{jn} is a region specific good differential (as reflecting transportation costs or local wage differentials) and

w_{jnt} which is a mean zero stochastic disturbance.

The identifying assumption in (6) is that the w_{jnt} are independent across regions. The idea is that prices in one region (after elimination of region and good-specific effects) are driven by underlying costs. The latter provide instrumental variables that are correlated with prices but are expected to be uncorrelated with the stochastic disturbance. That is, w_{jnt} from eq (6) is uncorrelated with ε_{jlt} from eq (2) when regions are different.[1]

Elasticity Estimates

From the parameter estimates for eqs (2) to (4), we estimate own and cross price elasticities of demand for goods in each category. From the AI model and Stone price indexes, the equation for the elasticity of good i with respect to good j's price is

$$e_{ij} = \frac{1}{s_i}\left[\alpha_{ij} - \beta_i w_j\right] - 1\left[i = j\right] + \left(1 + \frac{\beta_i}{s_i}\right)\left(1 + \gamma\right) w_j \qquad (7)$$

Where, w_j is the average expenditure share of good j and the other variables and parameters are defined in eqs (2) to (4). In our application, the sign of the cross-price elasticities is an indicator of whether goods in a category are compliments or substitutes.[2]

ESTIMATION AND TESTING OF THE PARAMETRIC MODEL

Descriptives

Figure 3 and 4 show relative deflated expenditure for each of the products and services in our categorization as a percentage of income in each time period. Relative allocations are similar in both time periods. In the early time period, the goods and services under study constitute more than 90% of total personal consumption. In the later time period, goods constitute close to these 80% of total personal consumption with the remainder going to goods such as vacation travel for which prices are not available in both periods.

[1] Consider a case of two regions, indexed by j = 1,2 and the estimation of the share equation (eq (2)) for city 1. The reduced form eqs. for the prices of brand i in the two regions are

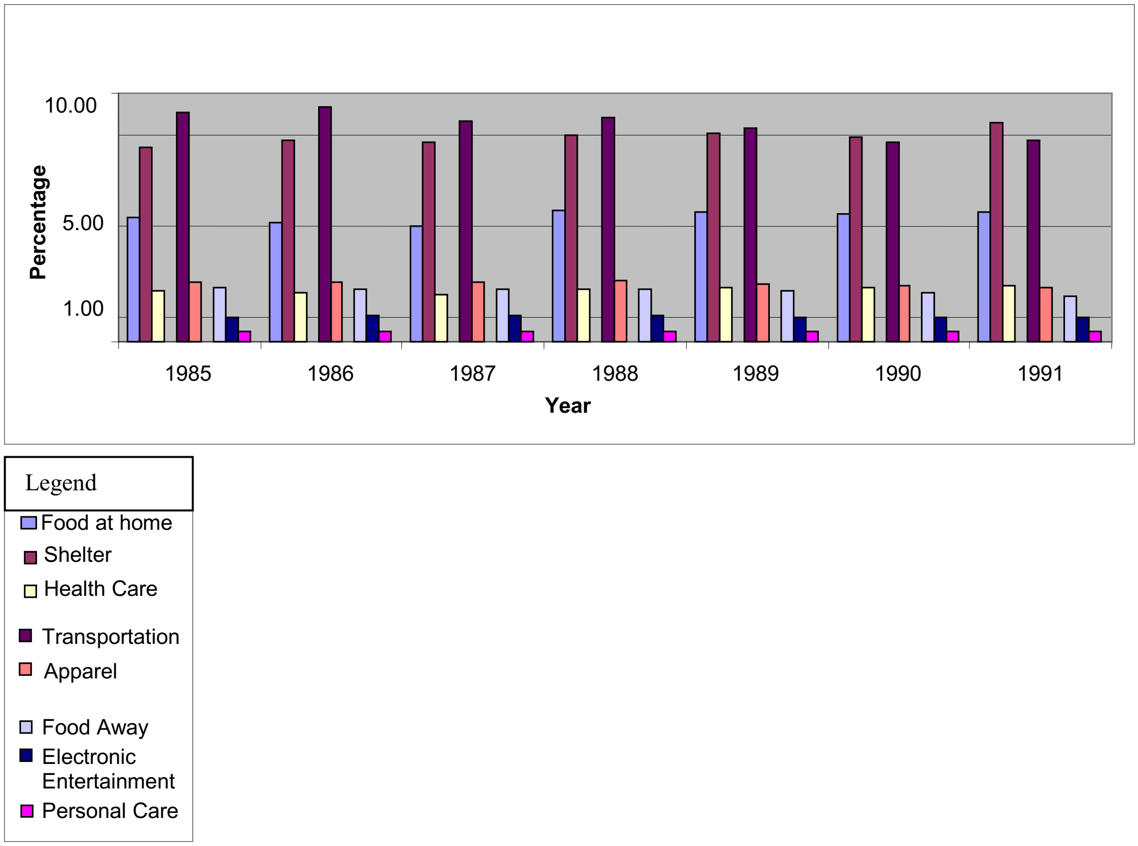
$$\log P_{i2t} = \prod_1 \log c_{it} + \mu_{i2} + Z_{2t} \prod_2 + V_{i2t}$$
$$\log P_{i1t} = \prod_1 \log c_{it} + \mu_{i1} + Z_{1t} \prod_2 + V_{i1t}$$

The result is to predict a given region's price from the prices of other regions and a set of demographic variables for the given region.

[2] A usual way to reduce the number of parameters in a flexible demand system is to impose more structure on preferences. Weak separability and multi (e.g., two) stage budgeting are frequently made assumptions. In two-stage budgeting, a first stage assumes that allocation of total expenditure can be divided into weakly separable groups of goods. In a second stage, expenditure on each group is allocated between the goods in each group. Given weak separability, the demand functions in a group are affected in the same way by a price change in any good, the two-stage approximation to results of single stage if it has extablished that weak separability.

Figure 3

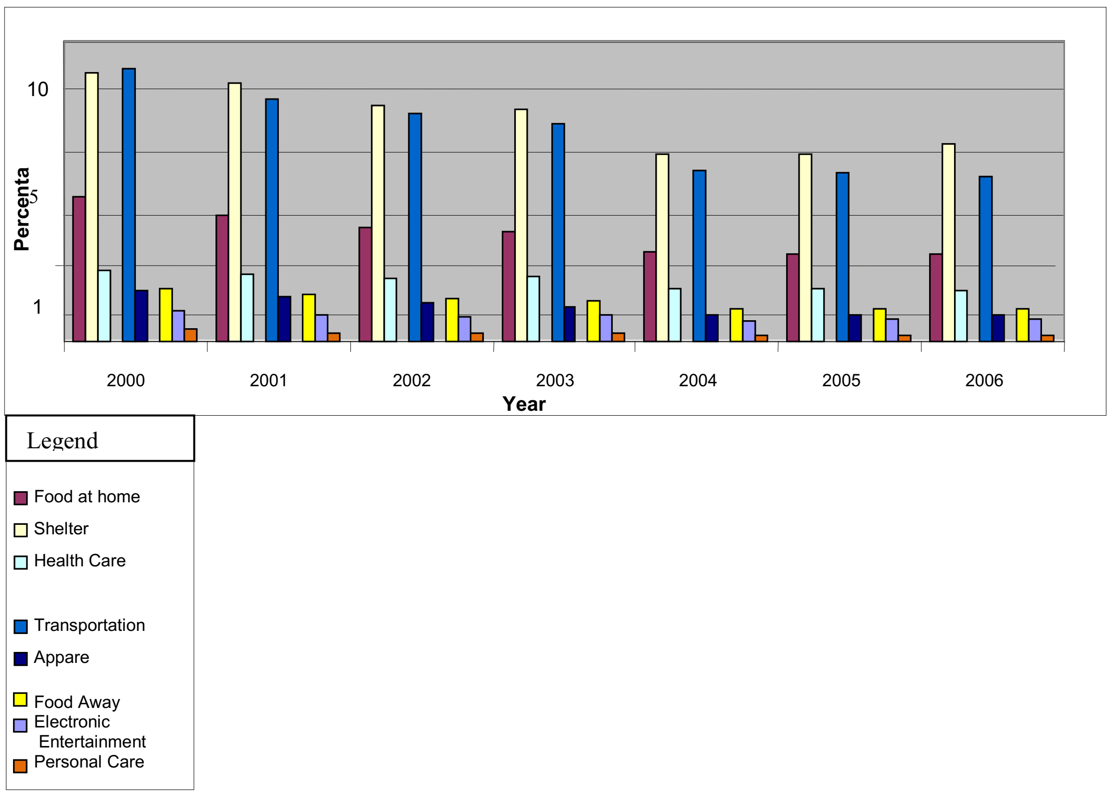
Deflated Expenditure as Percentage of Income in Three Product Categories, 1985- 1991[3]



[3] The three categories in their respective order for each year are: Essentials, Semi-Essentials and Non-Essentials

Figure 4

Deflated Expenditure as Percentage of Income in Three Product Categories, 2000-2006[4]



Separability Structure of the Model: GARP and Afriat Inequalities

Varian (e.g., 1983) has offered nonparametric methods to test for separability. In the first part of his tests, the data are checked for violations of the generalized axiom of revealed preferences (GARP: Cherchye, Demuynck, De Rock 2011). No GARP violations are a necessary condition for the validity of the proposed separability structure. In the second part of his tests, Afriat numbers (see Varian 1982) are constructed to see if the subutility functions fit within an overall utility function. This is said to be a sufficient but not necessary condition for separability. Barnett and Choi (1989) have shown that this sufficient condition is biased toward rejection of the proposed separability structure and thus a conservative estimate of separability. Varian's Nonpar program was used for the separability test.[5]

[4] The three categories in their respective order for each year are: Essentials, Semi-Essentials and Non-Essentials

[5] We thank Hal Varian for providing a copy of the most recent version of Nonpar.Following Chalfant and Zhang (1995) we rescale the data for Afriat indices used in nonparametric analysis.

In an initial application of Nonpar, no violations of GARP were detected at the second (*i.e.,* segment of class) or third (*i.e.,* share of product or service) stage. Although there were no violations at the third stage, we studied the robustness of the model by intentionally misclassifying goods in non-essentials category into the semi-essentials or essentials category. We found four violations from classifying essentials into semi-essentials and semi-essentials into essentials.[6] These violations disappeared when the initial classifications were restored. Results of GARP testing thus support our definition of structure in consumer expenditure.

Own and Cross-Price Elasticities

Following the nonparametric results, we estimated the parametric model. We estimate the bottom level with a seemingly unrelated regression (SUR) procedure. Tests of homogeneity and symmetry were performed with a likelihood ratio test. To control for income and price variation across time periods, we re-estimated elasticities for the 2000-2006 period with parameters from estimation of the AI model in the 1985-1991 period. Estimated demand elasticities by goods, categories of goods and time period are summarized in Tables 1 to 3.

Table 1

Estimated Demand Elasticities 1985-1991 and 2000-2006: Essentials

Elasticity of demand		With respect to the price of		
		Foodhome	Shelter	Health
Foodhome	1985 – 1991*	-.4206(.01385)	-.439(.00197)	-.3326(.00217)
	2000- 2006	-.3362(.00391)	-.6834(.00339)	1.1995(.00760)
Shelter	1985 – 1991*		-1.0977(.00036)	-.3258(.00195)
	2000- 2006		-.6766(.00282)	-.0572(.00023)
Health	1985 – 1991*			-.5194(.00574)
	2000- 2006			-.9256(.02494)

Note: Std. Errors are in parentheses next to coefficients
* 1985-1991 parameters with 2000-2006 income and prices.

[6] We also tested robustness of the parameter estimates to "small" amounts of measurement error. Here we constructed a set of errors that can be added or subtracted from some observations. As is common practice, we focus on measurement error in quantities not prices (Alston and Chalfant 1992). The resultant GARP violations were found to be small. Results show that estimates are robust for smaller measurement error.

Table 2

Estimated Demand Elasticities 1985-1991 and 2000-2006: Semi- Essentials

Elasticity of demand		With respect to the price of	
		Transport	Apparel
Transport	1985 – 1991*	-2.2140(.00561)	-.4099(.00220)
	2000- 2006	-1.8391(.00079)	-.9836(.01572)
Apparel	1985 – 1991*		-1.1349(.00251)
	2000- 2006		-1.6494(.01163)

Note: Std. Errors are in parentheses next to coefficients
* 1985-1991 parameters with 2000-2006 income.

Table 3

Estimated Demand Elasticities 1985-1991 and 2000-2006: Non- Essentials

Elasticity of demand		With respect to the price of		
		Foodaway	Electronic Entertainment	Personal Care
Foodaway	1985 – 1991*	-1.4628(.00261)	-.3622(.00211)	-.1210(.00069)
	2000- 2006	-1.3239(.00403)	-.3851(.00174)	-.5111(.00247)
Electronic Entertainment	1985 – 1991*		-1.2425(.01059)	-.5490(.00588)
	2000- 2006		-1.3491(.01992)	-1.2531(.01056)
Personal Care	1985 – 1991*			-1.7195(.00504)
	2000- 2006			-1.4352(.01407)

Note: Std. Errors are in parentheses next to coefficients
* 1985-1991 parameters with 2000-2006 income and prices.

The magnitude of cross-elasticities within and across categories further suggests that the constituent goods are placed in appropriate categories. The shelter-health cross-elasticity in 2000-2006 is an exception that is not consistent with this inference. We note that as now well recognized, the behavior of home prices in the 2000-2006 period was atypical. This may have resulted in a downward bias in the shelter price elastic and cross-elasticities.

Adaptation

Comparison of own price elasticities in the different study periods (1985-1991 and 2000-2006) provide only qualified support for an adaptation hypothesis. This hypothesis predicts that (1) when income and price variation is controlled, price elasticities of goods in a non-essentials category will tend to decrease over time and (2) goods in an essentials category will show significantly less variation in price elasticities across the estimation periods than goods in a non-essentials category.

In the non-essentials category, food away from home and personal care do show significant decreases in own elasticities over the study period with the latter being and variation that is of greater magnitude than own elasticities for goods in an essentials category. However, the price elasticity of electronic entertainment does not evidence a significant decrease in these data. In the essentials category, changes in food-at-home shows a change of relatively small magnitude across estimation periods. The decrease in the elasticity of shelter and increase in the magnitude of health care are moderate order and thereby greater than anticipated.

These results can be given contextual interpretation. For both shelter and health services, there may have been exogenous influences on price elasticities that are not controllable in the data or the method of estimation. It has been suggested that there was a structural shift in the valuing of home ownership during the latter period in response to which price elasticities may have decreased. Correspondingly, medical advances and increased specialization may have increased the number of requisite health services and decreased substitutability. It is recognized that even if accurate, these explanations are post hoc.

SUMMARY AND DISCUSSION

We have introduced a conceptualization of structure in personal consumption that follows from explicitly defining the basis of utility in need-based objectives that consumers use goods and services to attain. We give forms to production functions for activities for each need and examine their sensitivities analytically given the limitations of their complex forms. Following upon the conceptualization of these needs, consumer objectives in the proposed categorization are considered to be hierarchically ordered. We show the dynamics of this ordering as a function of budget level.

We then abstract from the conceptualization in an empirical application to structure in personal consumption address the categorizations of goods and services that follow from consumer need-based objectives. We differentiate sustenance needs from two categories of social needs and operationalize the differentiation in categories of goods in the CEX. To empirically test hypotheses that follow from this account, we review the background in industrial applications that decompose consumer markets. As in the industrial applications, complementarity and substitutability are expected to arise from consumer judgments of the definition of the sets of goods in market offerings.

In industrial applications, the categorizations typically follow physical properties of goods with lesser attention given to the processes that generate structure. In the conceptualization of structure that we offer, the categorizations we postulate are hypothesized to arise directly from consumer processing to satisfy common need-based objectives. These categorizations imply patterns of complimentarity and substitutability that many cases would not be predicted from physical properties of goods.

Operationally, it is difficult to define goods that are used for objectives in social needs and also have large enough expenditure in a representative sample of households and requisite price information. In the CEX data, food-at-home, shelter and health related services are defined as goods and services in an "essentials" category. Clothing and transportation are considered to be "semi-essentials" because they are in part functional. Since goods that include automobiles and clothing that we define as semi-essentials have functional uses as well as being status markers, we have used a method of adjusting expenditure for these goods by the number of household members and a BLS measure of regional minimal expenses for these goods (ref). After controlling for expenditure as "essentials", we define incremental expenditure as status-yielding. Goods and services in a "non-essentials" category are defined as: dining-out, entertainment electronics, and personal care.

We have also offered hypotheses on adaptation that occurs in consumer processing of goods and services for objectives and is typically observable in goods that we place in a non-essentials category. In the case of non-essentials, we conjecture that consumers adapt to the use of goods that income and technology make available. The resultant habituation and integration of such goods in lifestyles make the goods less sensitive to price variation. Authors in several disciplines have directly and indirectly observed this effect. (eg. Redmond 2001; Tatzel 2002).

For example, technology has made new forms of electronic entertainment widely available and this has resulted in their being integrated into consumer activities. Ownership and use of such goods is now *deriguer* for lifestyles of many consumer demographic segments. This can extend even to the brands of the goods as reputed to be the case for Apple products. Thus, while price sensitivities of goods that are used in activities for sustenance objectives are expected to typically change slowly over time, we expect the goods that we group in a non-essentials category to become integrated into routinized activities and typically decrease in their price elasticities. Similarly, role changes that have made career paths for working women more prevalent may have contributed to making dining out more a part of consumer lifestyles. These effects are independent of income.

Our conceptualization was tested in estimation with data in two comparison periods of the U.S. Consumer Expenditure Survey (CEX). We use the years 1984-1991 and 1999-2006 with quarterly observations over the seven years in each period with an eight year hiatus between periods to increase the distinction between periods. Data on geographical region of residence were used with available quarterly observations on each sample cases to define consumer panels. To control for direct effects of income and price change, we estimate parameters of the 1999-2006 period with income and prices from the 1984-1991 period.

The estimated model was an AI flexible demand system first put forth by Deaton and Mulbauer (1980; also Hausman, Leonard and Zona 1994 and Hausman and Leonard 2005). Parameters for the AI model were then used to estimate elasticities and cross-elasticities. We empirically tested the prediction from our conceptualization of structure that although the goods and services we define within the categories under study differ in their physical properties, the products and services within a category will exhibit cross-elasticities with goods in the same categories that are significantly different from zero in both time periods and are significantly greater than cross-elasticities with goods that are in different categories. Results for both periods generally support the structural differentiation of consumption that we make in the categorization. Cross-elasticities within a category are near uniformly negative and statistically significant. This supports the grouping of goods in each category as compliments.

There are exceptions to these results. Although complimentarity is generally indicated, results do indicate substitution between health services and shelter. Contextualizing this, we note that traditional relationships between health services and shelter may have changed in the second period under study. In health services, new technology and increases in cost for medical services personnel may have atypically increased prices in the second period of our data. In shelter, we note that there is indication of a structural shift in shelter that was taste-driven and supported by policy changes that favored ownership and thereby not controlled for in our use of constant income and prices across periods in parameter estimation. These observations are post ad hoc. For more definitive statement, the cross-elasticities of these goods clearly require testing in other data for the same and different time periods.

Results of GARP testing supported our definition of structure in personal consumption. Misclassifying the goods and services in categories introduced GARP violations that were corrected by restoring the initial structure. We also investigated results of misclassification by testing models in which goods or services that are hypothesized to be in one category are placed in another category. We find that the goodness-of-fit of the model in which there is misclassification of goods and services significantly decreases and the magnitudes of cross-elasticities between correctly classified and misclassified goods and services are in general significantly smaller than cross-elasticities between goods and services in the definition of categories that we initially proposed. These are consistent with results of the GARP application and support our definition of structure.

In testing adaptation, our results are less clear-cut. While food away from home and personal care do show significant decreases in price elasticities, entertainment electronics does not. Here, we note that technology changes not present in other products in the category may have affected the price profiles of electronic entertainment products. Additionally, shelter shows greater variability than was expected for goods in a sustenance category.

Several limitations are imposed by the use of available CEX data. Perhaps most importantly, the restriction of information on location of households to U.S. geographical regions rather than SMSAs or MSAs is likely to reduce detectable price variation between observations that is important to the definitiveness of results. This restriction of information on geographical location is imposed to maintain confidentiality.

Finally, we briefly consider policy implications of our conceptualization of structure in the categorizing of goods and services by consumers. In industrial applications, structure has been used to predict competitor effects and assess damages in loss of market share from patent infringement (e.g., Hausman and Leonard 2005). In a welfare-based application to personal consumption, it may be possible to identify goods in categories of semi-essentials or non-essentials that have greater negative externalities than alternative goods in the category. This has, for example, been suggested to be the case in goods that are used in status competition (Corneo and Jeanne 1997, Oxoby 2004). It also has been suggested that the use of informational goods in personal consumption that can be semi or non-essential have important positive externalities (e.g., Silver and Verbrugge 2010). These suggestions show the policy relevance of the assortment of goods and services in personal consumption.

Once goods with positive (or negative) externalities are identified, it may be possible to modify the weights consumers give to goods in the category through tax policy. Under a value-added tax (VAT) system, goods with positive or negative externalities could be differentially taxed with the expectation that there would be increased substitution between goods in the category for a given objective. Selectively removing state sales tax on printed matter and software to increase the use of these goods as non-essentials in leisure or recreation would be a modest example of such a policy undertaking. Consideration of the possible benefits of policy here is facilitated by methodology that can test structure in the goods and services in the classifications of categories of objectives that consumers make. Industrial applications we cite provide direction in accomplishing this.

As initially noted, consumption constitutes about 2/3 of GDP in developed countries. Although consumer heuristics have a fundamental dependency on income and price constraints, they also depend on microprocesses such as categorization that can have social as well as physical dependencies and are not always obvious. What appear to be subjective consumer judgments on categorizing goods and services can significantly structure demand. We have sought to indicate the importance that internalized categorizing by consumers for need-based objectives can have and to suggest bases to extend inquiries to more complex representation of such categorization.

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