ASSESSING STRUCTURAL CHANGE IN THE DEMAND FOR FOOD COMMODITIES

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"It should no doubt be a maxim for all writers in applied economics that the extent to which they push their discussion along various theoretical lines should be proportioned to the importance of this discussion in their practical work. . . . " J.R.N. Stone (p. 286)

Perhaps out of a concern for efficiency, or for other reasons, we develop or adopt rules—the simpler are called "rules of thumb"—to direct and govern much of our behavior. The bases for these rules are many and varied, assumption, conventional wisdom, experience, theory, to mention a few. When the circumstances or the environment change, many of these rules no longer work. This often leads to a phase characterized by a degree of confusion and anxiety that later gives way to one characterized by a reexamination of those rules and the bases for them. The numerous changes, some of large magnitude, that have occurred in our economic environment appear to have resulted in a similar situation regarding the economic "rules" governing demand and consumption behavior for food, thereby providing the motivation for the topic of this session. Since it is somewhat difficult and perhaps not very useful to determine exactly which phase exists at any given moment, I will concentrate on the last phase, specifically, the rules governing demand behavior for food—demand structure and assessment of possible changes in that structure.

To be sure, this raises important and difficult issues of research method and technique. But, lest we lapse into thinking that these issues are primarily academic, let me briefly indicate the fallacy in this by showing how the practical implications can be both important and diverse. For example, suppose that consumption of a product has been declining. An affirmative answer to the question of structural change implies possible changes in consumer tastes and preferences. This may lead to expensive surveys to determine how tastes have changed and subsequently to expensive advertising and promotional efforts to change the product image. In contrast, a negative answer to the question of structural change may imply that the product's competitive position via relative prices has declined. This may require basic product research, which can also be expensive. Traditionally, at least for many agricultural commodities, the implications of the affirmative answer have an impact on Madison Avenue, whereas those of the negative answer have an impact on experiment stations.

First, I will give a definition of demand structure and the basis for it and review some of the difficulties associated with implementing this conceptual framework. Then, I will briefly present and discuss some empirical examples of implementing this framework to estimate the demand structure for food and food commodities. Subsequently, I turn to the problem of trying to assess changes in this structure and the intractibility of obtaining *direct* evidence on structural change via conventional procedures. I propose and illustrate an alternative, *indirect* approach that provides useful information on structural change that may warrant further development. Finally, I offer some concluding remarks. As a prefatory note, in what follows my thinking has focused on analysis of time-series data. Therefore, while much of what is said may apply to the analysis of cross-section data, at least a degree of caution should be exercised.

DEMAND STRUCTURE

The static classical model of individual consumer demand provides at least the initial basis for the bulk of empirical work on estimation of demand structure and assessment of change. Therefore, I use this model as a basis for defining structure and structural change in order to illustrate its role and relevance to empirical assessment.[1] Since this model is more or less familiar (see Deaton and Muellbauer), I will only provide a very brief sketch of elements I want to use in this discussion. A central element of this model is the utility, or preference, function

(1) $U = F(q)$

where q is an n-component vector, representing the

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[1] This does not imply that this specific model *should* be the basis, or that modifications or other alternatives should be excluded or ignored. On the contrary, I think alternative theoretical formulations should be developed and explored. It is used here primarily to demonstrate the role and relevance of the assumed conceptual model of behavior in defining structure and assessing structural change.

complete set of goods that provide satisfaction for a given consumer and among which choices are made. This function is variously required to satisfy some or all of a set of six axioms, such as transitivity, continuity, convexity, that imbue this function with certain properties or characteristics (Deaton and Muellbauer, pp. 26–28). Given an n-component vector of prices (p) that correspond to the goods (q), the consumer is assumed to maximize (1) subject to the budget constraint.

$$(2) \qquad p'q = m$$

where m represents the consumer's total expenditure, and where m and the elements of p are exogenous. The solution from this optimization process is a complete set of unique demand functions, one for each of the n goods, in which the quantity of the good is a function of *each* element of p and m. This set can be written as:

$$(3) \qquad q_1 = f_1(p_1, \ldots, p_n, m)$$

$$\cdots\cdots\cdots\cdots$$

$$q_n = f_n(p_1, \ldots, p_n, m)$$

or, more compactly as

$$(4) \qquad q = f(p,m).$$

As a consequence of the specifications in the utility function (1), the budget constraint (2), and conditions inherent in the optimization process, the set of demand equations (3) possesses the well-known properties of negativity homogeneity, symmetry, and Engel aggregation. That is, the function f in (4) or the set of functions $f_1, \ldots, f_n$ in (3) must satisfy these conditions if they are to have resulted from this optimizing process. In effect, what this does is to restrict or prescribe the *admissible* set of functions that can be candidates for representing demand behavior. In this context, *demand structure* is defined to be the set of parameters and the form of the functions $f_1, \ldots f_n$ that are uniquely specified by the utility function (1).

The conceptual model above refers to individual consumer behavior. But, we are usually more concerned about analyzing market behavior, that is, the behavior of an aggregate of individuals. The problems and difficulties of developing rigorous formal correspondence between individual demand relation and counterparts at the aggregate level have been recognized, but a tractable solution is not available.[2] While explicitly recognizing the potential source of specification error, I adopt the often-used approach of assuming that aggregate per capita demand relations depict those for a "representative" consumer that corresponds to (3).[3] A number of knowledgable economists have referred to the wide gap between the conceptual model of demand and our ability to implement it empirically. Aside from the aggregation problem already mentioned, there are several others. Since they have particular relevance to the topic at hand, it will be useful to review some of them.

First, regarding the conceptual model, both the utility function and the corresponding demand functions are unknown, and the former is unobservable. The solution to the optimizing model provides a set of criteria that prescribes an *admissible* set of possible demand structures, among which a choice has to be made. This set contains a number of alternatives, and there is no uniquely prescribed set of objective criteria upon which to make this choice. Second, there exists an ill-defined correspondence between the elements of the conceptual model (p's, q's, m) and the real-world counterparts. Again there is no uniquely prescribed criteria to specify the ideal empirical observation. Further, if there were, more often than not, data to fit these criteria would probably be unavailable (see Morgenstein). Third, because of the above considerations and the fact that some resolutions must be reached before empirical implementation can begin, heavy reliance is placed on judgment and assumption. All of these factors then become more or less important potential sources of specification error. In another context, it is quite important not to lose sight of this; otherwise, interpretation of our empirical results may simply become a restatement of assumptions or judgments introduced at an earlier stage in the analysis.

In the following, reference will be made to *complete demand systems.* The set of demand equations (3) is the conceptual basis for this reference because it encompasses the spectrum of commodities in the consumer's budget and contains a demand function for *each* of those goods or commodities. For illustrative purposes, the complete set of price and income parameters corresponding to such a system is often expressed as a rectangular matrix. For example, given a total of three goods, say food, durables, nondurables, and services, whose respective prices are P_F, P_D, and P_N, and total expenditure is designated Y, the various elasticities can be represented as in Table 1.

TWO EXAMPLES OF DEMAND STRUCTURE ESTIMATES FOR FOOD

Having proposed a definition of demand structure and having reviewed some of the problems underlying

Table 1. Demand Elasticity Matrix for a Complete System of Three Goods.

Quantity	Prices			
	Food (P_F)	Durables (P_D)	Nondurables and services (P_N)	Expenditure (Y)
Food	E_{FF}	E_{FD}	E_{FN}	E_{FY}
Durables	E_{DF}	E_{DD}	E_{DN}	E_{DY}
Nondurables and services	E_{NF}	E_{ND}	E_{NN}	E_{NY}

[2] For an expository treatment of the theoretical properties that carry over to market demand, see Stone (Chapter 18).
[3] A summary treatment of a representative consumer concept is contained in Muellbauer.

the gap between the theoretical optimizing model and its empirical implementation, I want to consider two examples that obtain estimates of demand structure for food commodities in a complete demand system framework. These examples are drawn from a recent study on consumer demand for meat and related products (Haidacher et al.). The first example uses the linear expenditure system (LES) framework to examine the relationship between two food categories and between food and nonfood commodities. The data used are U.S. Department of Commerce annual data on personal consumption expenditure (PCE) for the years 1955–81. Following the format of Table 1, Table 2 presents the complete set of estimated elasticities for two food categories, Food-at-home (FAH) and Food-away-from-home (FAFH), and nine nonfood categories. The price elasticity estimates are uncompensated elasticities computed at the means.

First, I want to briefly summarize what I think are some of the more relevant empirical results. With the exception of two nonfood categories, alcohol and tobacco, and utilities, nonfood commodities are much more responsive to both income and prices than are food commodities. Income elasticity estimates for many nonfood categories are approximately one or above, while the food categories have elasticities less than one. The interdependence between food and nonfood commodities, represented by the relative magnitudes of the estimates, is measurable and not negligible. For example, a change in the price of transportation affects both FAH and FAFH, and has about twice the effect on FAFH. Within the food sector, FAFH is about twice as responsive to both income and other prices as is FAH.

Additional features of the results are that they satisfy the theoretical conditions of homogeneity, negativity, symmetry, and Engel aggregation. Negativity requires the income compensated, own price elasticities to be negative. From the viewpoint of consistency with the optimizing model, imposing these various restrictions is perhaps virtuous, since we have already assumed that they hold for the optimizing mode. But, it should be noted, these results are not determined by the data. They are imposed by the model and its estimation.

Other features appear in the results and need to be mentioned. All the uncompensated cross-price elasticity estimates are negative and the income elasticities are positive. The compensated cross-price elasticities (not shown) are all positive, indicating all goods are net substitutes. The various elasticities also vary with the magnitudes of prices, quantities, and income because the slope parameters of quantities with respect to prices and income are constant. In addition, the various rows and columns bear a rough proportionality to each other. All of these features are not a result of the sample data, nor are they conditions specified by the optimizing model. They are features inherent in the LES, and thus, they are the result of assuming this particular structural specification.

Given the empirical results and the host of judgments and assumptions, a few of which are specified

Table 2. Uncompensated Elasticity Estimates for a Linear Expenditure System.

Item	Food at home	Food away from home	Alcohol and tobacco	Clothing	Housing	Utilities	Transportation	Medical	Durable goods	Nondurable goods	Services	Expenditure
Food at home	-0.2073	-0.0119	-0.0113	-0.0169	-0.0261	-0.0125	-0.0226	-0.0165	-0.0217	-0.0116	-0.0257	0.3648
Food away from home	- .0882	- .3388	- .0235	- .0351	- .0544	- .0261	- .0471	- .0344	- .0452	- .0241	- .0535	.7598
Alcohol and tobacco	- .0649	- .0182	- .2191	- .0258	- .0400	- .0192	- .0347	- .0254	- .0332	- .0177	- .0394	.5592
Clothing	- .1124	- .0316	- .0300	- .4478	- .0693	- .0332	- .0601	- .0439	- .0576	- .0307	- .0682	.9686
Housing	- .1543	- .0433	- .0412	- .0615	- .6516	- .0456	- .0825	- .0603	- .0791	- .0421	- .0936	1.3297
Utilities	- .0853	- .0240	- .0228	- .0340	- .0526	- .3028	- .0456	- .0333	- .0437	- .0233	- .0518	.7354
Transportation	- .1215	- .0341	- .0324	- .0484	- .0749	- .0359	- .4717	- .0475	- .0622	- .0332	- .0737	1.0468
Medical	- .1553	- .0436	- .0415	- .0619	- .0958	- .0459	- .0831	- .6375	- .0796	- .0424	- .0943	1.3387
Durable goods	- .1624	- .0456	- .0433	- .0647	- .1001	- .0480	- .0868	- .0634	- .5413	- .0443	- .0985	1.3993
Nondurable goods	- .1063	- .0298	- .0284	- .0423	- .0655	- .0314	- .0568	- .0415	- .0544	- .3753	- .0645	.9158
Services	- .1136	- .0319	- .0303	- .0452	- .0700	- .0336	- .0607	- .0444	- .0582	- .0310	- .4753	.9788

Source: Haidacher, Richard C., John Craven, Kuo Huang, David Smallwood and James Blaylock. "Consumer Demand for Red Meats, Poultry, and Fish," United States Department of Agriculture, Economic Research Service, National Economics Division, Staff Report #AGES 820818, September 1982.

by the optimizing model and others are not, how does one attempt to determine the validity and usefulness of the results? There is no unique objective prescription, in my opinion, but I think there are approaches that have merit. Again, judgment has to play a large role. To begin with, we need to recognize that any estimated model is an approximation based on a relatively small data set. Second, I would suggest that the specific model and its inherent characteristics be examined in light of the data and the use to which it is to be put. A major question is whether the arbitrarily assumed characteristics are realistic with respect to the end use (e.g., linear quantity/expenditure relations) and whether they predetermine empirical results of particular interest or importance. Third, general assessment of the empirical results should be made where a primary question exists, whether or not the results make sense—in both the common meaning and in economic terms. Fourth, the various statistical measures obtainable from the estimation process should be analyzed to the extent feasible. In this respect, I would give strict hypothesis testing a relatively minor role in most time-series analyses, since the prerequisites for its validity are seldom met; that is, hypotheses are seldom *a priori*. Fifth, one can examine how well the estimated model describes and predicts the observed behavior of interest. A first step is to examine this in the sample used to estimate the model, and a second step is to examine it outside this sample. With the exception of the latter, as a matter of course, we generally perform most of these assessments to a greater or lesser extent.

For the estimated LES model represented in Table 2, the complete model was simulated over the sample period and the simulated and actual values for both FAH and FAFH were compared using the following criterion.[4]

$$\sqrt{\tfrac{1}{n} \Sigma (y_i - \hat{y}_i)^2} / (\tfrac{1}{n} \Sigma y_i) * 100.$$

The value for the estimated model of Table 2 was 2.6 percent for FAH and 3.4 percent for FAFH. Our conclusion is that the estimated model is a fairly good description of the food demand structure under study.

Now, I would like to turn to the second example, also taken from the study by Haidacher et al., which we will call the Composite Food Demand System (CFDS). Regarding commodity components, in contrast to the previous example, this system aggregates nonfood into one composite category and disaggregates food into 12 composite categories. For food commodities, the data used are annual indexes of USDA per capita consumption and corresponding BLS price indexes for the period 1950–77. For nonfood, the quantity index is based on per capita PCE for nonfood and the price index is the CPI for nonfood.

The form of this model and the underlying assumptions also differ from the previous LES model. Briefly, the model is obtained by taking the total differential of (4) and converting to elasticities to obtain

$$(5) \qquad \dot{q} = E\dot{p} + \eta\dot{m}$$

where $\dot{q}$ and $\dot{p}$ represent n-component column vectors of dq/q and dp/p, respectively, $\dot{m}$ = dm/m; E is an n × n matrix of price elasticities, and η is an n-component column vector of income elasticities. Expressed in this manner, the system could be termed a differential form of the demand system (4).

To empirically implement this conceptual model, the CFDS assumes the elements of E and η are constants and employs a constrained-maximum-likelihood-estimation procedure in which the classical demand properties of homogeneity, symmetry, and Engel aggregation are imposed as constraints. Partial results of the estimated structure that relate to meat commodities are presented in Table 3.

Table 3. Red Meat, Poultry and Fish: Uncompensated Elasticity Estimates from a Composite Demand System.[a]

Item	Red meat	Poultry	Fish	Other food items	Nonfood	Expend-iture
Red meat	- .6768 (.0300)	0.0984 (.0094)	0.0117 (.0052)	—	0.1033 (.0957)	0.6507 (.1012)
Poultry	.5649 (.0505)	- .8860 (.0406)	.0522 (.0184)	—	- .3560 (.1754)	.7470 (.1594)
Fish	.1590 (.0657)	.1199 (.0421)	- .0531 (.0426)	—	.0833 (.2544)	.5492 (.2289)
Other food items	— b/	—	—	—	—	—
Nonfood	- .0235 (.0027)	- .0088 (.0011)	- .0023 (.0007)	—	-1.0263 (.0120)	1.2064 (.0106)

[a] This table contains partial results of the estimated composite food demand system. The figures in parentheses are the estimated standard errors of the associated elasticity estimates.

[b] indicates that elasticities for these items were estimated as part of the system but are not included in the table.

Source: Haidacher, Richard C., John Craven, Kuo Huang, David Smallwood and James Blaylock. "Consumer Demand for Red Meats, Poultry, and Fish," United States Department of Agriculture, Economic Research Service, National Economics Division, Staff Report #AGES 820818, September 1982.

As before, the price-elasticity estimates are uncompensated. Again, we may ask what these estimates of the demand structure show. First, similar to earlier results, nonfood is much more responsive to own price and income than are meat commodities. Second, there is definite interdependence between the food and nonfood commodities and between meat and related commodities. The cross elasticities for this latter group indicate that they are gross substitutes and that the estimated uncompensated elasticities are not symmetric (e.g., note the elasticities for red meat and poultry). The income elasticities presented are all positive (some of those omitted were negative), and the direct price elasticities are all negative. It is worth noting that all these results are largely, if not totally, determined by the sample observations. That is, the constraints imposed directly are those of homogeneity, symmetry, and Engel aggregation specified by the optimizing model—

[4] This variant of the root mean square error was used in Haidacher et al. for making comparisons among different equations and models.

negativity was not imposed—plus the arbitrary imposition of constant elasticities and average budget shares. This complete system was also simulated over the sample period to assess how well it described the historic demand structure. The error statistics, in percentage terms, were 2.72, 3.97, 4.05 and 3.16, respectively for red meat, poultry, fish and nonfood. Our conclusion was that this estimated demand system provided a good description of the U.S. demand structure for meat and related products for the period.

ASSESSING STRUCTURAL CHANGE

Based on the previous discussion of demand structure and its definition, in brief summary fashion, let me sketch the problem of assessing structural change in demand as I see it. Since demand structure is uniquely determined by the utility function and the optimizing process, changes in structure must be a consequence of changes in the utility function, that is, a change in $U = F(q)$ that alters some or all of the parameters of the set of demand functions (3). But the preference function is not directly observable and, therefore, neither are changes in it. These changes are only reflected in the demand structure (which is unknown) and the observed behavior. Thus, we are confronted with a sample of observed behavior that embodies two potential effects, responses under a given structure and responses that result from changes in structure, and without knowing the structure we are to isolate and measure the two effects. And we must do this in full recognition of the problems causing the gap between theory and practice.

In conventional empirical investigations designed to obtain "direct" evidence of structural change, the above problem is usually cast in the familiar framework and terminology of hypothesis testing. We begin with a maintained hypothesis (MH) representing the assumed demand structure—that is, $q = f(p, m)$ is linear with constant parameters (of p, m) that are invariant with respect to time. In other words, even though this is a restrictive specification, it is *assumed* that all specification problems have been handled and we have the true structure, or an estimate of it. The stated alternative hypothesis (AH) may then be that the parameters vary over time and constitute structural change. The MH is confronted with a set of sample observations (on p's, q's, m), and a statistical test criterion is used to determine acceptance or rejection of MH. Rejection of MH leads to acceptance of AH and the conclusion that structural change has occurred.

There are several difficulties with this approach. The major ones can be brought into focus by recognizing the crucial role of the assumption that MH accurately represents the true structure. If this is not the case, there are numerous AH candidates rather than a single one. In other words, a number of major elements in AH are generated by the specification of the maintained hypothesis, due to the fact that the true demand structure is unknown and the fact that our empirical methods require greater specificity than those inherent in the optimizing model. As we have seen, even under the assumption of no change in $U = F(q)$, the general conceptual demand model cannot be implemented empirically without certain additional, *a priori* specifications that are not dictated by the optimizing model. Consequently, each of these additional specifications generate one or more elements in the AH set. For example, if the functional form assumed in MH is linear, then nonlinearity is added to AH. In addition, if all of the specifications of the optimizing model are not taken into account in the specification of MH, additional elements are generated in AH. For example, if the demand function for a given good does not include *all* prices and income, or if the demand equations for some goods are excluded, then, in principle, each exclusion adds at least one element to AH. Also, to the extent that there is not a precise correspondence between the variables (p's, q's, m) in the conceptual model and the empirical observations used to represent them, additional elements are implied for AH, (i.e. if the empirical observations do not constitute "scientific observations" a la Morgenstern, pp. 88–90, or are not good proxies).

The essence of this is that rejection of MH forces a decision among numerous alternatives without any objective criteria upon which a definitive selection can be made, and, consequently, the choice is arbitrary. Thus, obtaining direct evidence on structural change, given the current knowledge and the state of the art, is intractable and, therefore, we need to pursue more viable alternative approaches.

As an alternative, I would like to propose an *indirect approach* to assessing structural change. The essential features of this approach are fairly simple. They include using the conceptual framework of a complete demand system to estimate the demand structure, validation of the estimated structure, and an *indirect* assessment of possible structural change. Assuming we have adequately addressed the first two features in the earlier empirical estimates of demand structure, let me illustrate the third feature, starting with the LES estimate.

Hypothetically, suppose that the simulated values were identical with the realized values of the variables. Intuitively at least, it would appear reasonable to conclude that no structural change had occurred. If this is valid, then perhaps the estimated error between actual and simulated values can be used as a rough approximate bound on the magnitude of possible structural change, if it occurred. That is, if it occurred, the effect of structural change was approximately less than or equal to the computed error. Of course, this is a very rough approximation, and we need to recognize that such error measures include a number of possible sources, including specification error and unexplained random components. Nevertheless, if the estimated error is on the order of, say 5 percent or less, as in the present case, from a practical viewpoint we have obtained rather useful information regarding any structural change that may have occurred.

The estimated CDFS suggests some additional possibilities for assessing structural change. For example, in estimating CFDS a constant term can be introduced in each equation:

$$\dot{q}_{it} = \sum_{j=1}^{n} e_{ij} \dot{p}_{jt} + \eta_i \dot{m}_t + \widetilde{s_i} \tag{6}$$

The elements of the vectors $\dot{q}$ and $\dot{p}$, and $\dot{m}$ are approximated by the relative changes $\Delta q_{it}/q_{it}$, $\Delta p_{jt}/p_{jt}$, and $\Delta m_t/m_t$, respectively. For the results of Table 3, the estimated constant terms ($\tilde{s}_i$) for red meat, poultry, and fish were -1.6, 1.2 and -6.4, respectively, in percentage terms.

How might we interpret the estimates of $\tilde{s}_i$ regarding structural change? For illustrative purposes, suppose that over time we have no change in prices or income, that is, $\Delta p_{jt} = \Delta m_t = 0$. Then, Δq_{it} will change by s_i for each unit change in t.[5] This interpretation appears to be quite close to the definition of structural change set out previously—namely, a change in the utility function such that, for given p and m, the equilibrium value of q changes. In this context, given that the estimated structure provides a good description of observed behavior, perhaps the estimated $\tilde{s}_i$ term can be interpreted as a rough approximate bound to systematic structural change over time. Again, we should be cognizant that this measure may also include other effects. However, as remarked previously, it would appear that useful information for practical work has been obtained.

These examples are intended to provide a preview and perspective of the suggested approach, and from the standpoint of practical application, they constitute a first step, or better, a very rough cut. In addition to possible modifications or extensions of the underlying optimizing model, other refinements that may improve upon this first cut include the following: (1) extending the validation phase to sample observations outside the period used to estimate the structure, (2) incorporating dynamic aspects in the basic demand structure, for example, on durable goods, and (3) refine the statistical estimation procedure by incorporating contemporary developments on time-variant parameters, for example, perhaps along the lines of Chavas under the condition that a complete system is used. Possibly a preferable approach, if it can be implemented in a complete system framework, would be the one proposed by Swamy and Tinsley.

The rationale for the suggested approach is also quite simple. The use of a complete demand system more closely corresponds to the classical optimizing model than most, if not all, other specifications based on this model, since it encompasses the spectrum of goods in the budget. Furthermore, it provides the greatest potential for reducing the number of elements in the alternative hypothesis set due to specification error through omitted variables, the reduction being directly related to the degree of completeness attained in the empirically implemented specification. In addition, emphasis is placed on obtaining a good approximation to the underlying structure as a prerequisite for assessing structural change. Consequently, the structure per se provides the major explanatory basis for the observed behavior, while structural change plays a minor role. In the reverse situation, where structural change overwhelms structural behavior, the validity of the optimizing model itself is seriously in doubt, and hence any conclusion based on it is also doubtful.

However, the suggested approach is not a panacea—it obviously does not solve or circumvent all the difficulties inherent in the conventional approach. But it does have merit for practical work. There is a tradeoff: we give up superficially precise and definitive conclusions for some that are less neatly definitive, but which provide more relevant and substantive information for practical use.

CONCLUDING REMARKS

The assessment of structural change in the demand for food commodities is important for its many practical implications, and at the same time making such an assessment is a difficult task. From a very general viewpoint, conventional approaches that attempt to obtain direct evidence concerning structural change contain inherent deficiencies which potentially produce superficial and misleading, if not erroneous, information on the subject of demand structure. The conclusion is that, given the state of the art, obtaining direct information on structural change is a rather fruitless undertaking. An alternative approach to obtain indirect evidence is briefly described and illustrated via empirical example. This approach, while not a panacea, does appear to have greater potential for providing useful information for practical work concerning issues of structural change in demand.

[5] To make this more explicit, write the ith equation of (5) as

$$q_{it} = \propto_{oi} \left(\prod_{j=1}^{n} P_{jt}^{e_{ij}} \right) m_t^{\eta_i} e^{s_i t} \tag{5.1}$$

Transform to

$$\ln q_{it} = \ln \propto_{oi} + \sum_{j=1}^{n} e_{ij} \ln p_{jt} + \eta_i \ln m_t + s_i t \tag{5.2}$$

and differentiate w.r.t. t to obtain

$$\frac{dq_{it}/dt}{q_{it}} = \sum_{j=1}^{n} e_{ij} \frac{dp_{jt}/dt}{p_{jt}} + \eta_i \frac{dm_t/dt}{m_t} + s_i, \tag{5.3}$$

which is approximated by (6) with the variables defined as relative changes.

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