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ACCOUNTING FOR CHANGES IN TASTES

by

James A. Chalfant and Julian M. Alston

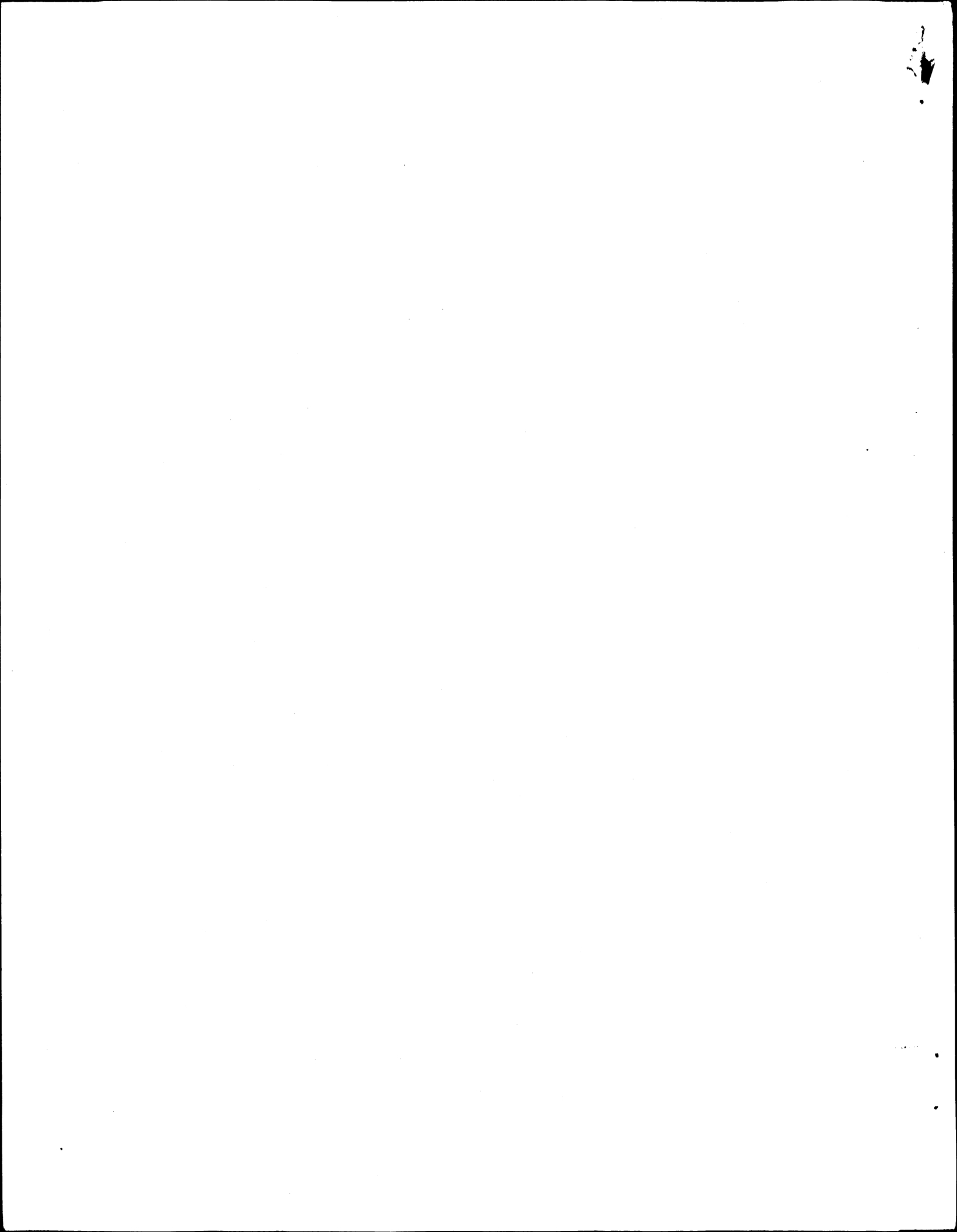
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## ACCOUNTING FOR CHANGES IN TASTES

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### Abstract

It is often asserted that there has been a shift of consumer preferences away from red meats in response to increased health consciousness. Econometric studies seem to have provided some empirical support for this notion, but there is no consensus.

Testing for changes in preferences is fraught with difficulties, especially when a single time series data set must be used both for estimating the parameters of demand equations and testing for structural changes in the system. There is a significant risk that specification errors will indicate taste changes where none have occurred.

This paper makes use of aggregate time series data from two countries, the United States and Australia, to test for structural change in consumption patterns. We do so using revealed preference axioms and the nonparametric approach to demand analysis. For these data sets, we find that changes in consumption can be accounted for using only relative prices and expenditures. Only when a particular functional form is imposed can the conclusion be reversed. This result suggests that errors in the specification of econometric studies of meats demand can account for findings of taste changes.

## ACCOUNTING FOR CHANGES IN TASTES

"It is a fallacy, of course, to say that there's no accounting for taste."

--Pierre Franey  
*The New York Times 60-Minute Gourmet*

### I. Introduction

A common procedure in empirical demand analysis is to estimate a system of demand equations defined only over market prices and quantities and then to examine the compatibility of the results with utility maximization. In many cases, prices and expenditure seem inadequate in explaining observed patterns of consumption. Quite often, the rejection of symmetry or homogeneity restrictions, the presence of apparent dynamic influences on consumption, or significant unexplained trends in the data lead to the conclusion that "tastes" have changed over time.

The arguments of Stigler and Becker (1977) suggest a different interpretation of results of this type, and a different response. They proposed that it is more useful, and valid, to treat individual preferences as constant and to seek an economic explanation for any observed changes in demands for market goods. At the level of the individual, such changes may arise from changes in the shadow prices of household resources or changes in the household technology used to transform market goods into fundamental goods. Alternatively, even when individual demands are constant, per capita demands at, say, a national level could change as a consequence of demographic changes or changes in the distribution of income.

With this interpretation of demand theory, a finding of structural change in a model of per capita demands for market goods should not be surprising. It could result, for instance, from inappropriate aggregation of individual data, the exclusion of relevant variables such as the opportunity cost of time, or

some other specification error.

As well as having implications for the validity of econometric work, shifts in market demands are of direct interest to industry and policymakers. The current concern over declining consumption of red meats provides an excellent example. There is at present a great emphasis on altering the nature of products and promotions to offset the effects of taste change in the meat industry. That it remains to be established whether the demand for red meat has, in fact, changed provided the initial stimulus for this study.

The focus of this paper is on a nonparametric method for testing whether market demands have shifted. The advantage of the approach is that it gives a test for stable preferences for market goods which does not require that they be of a particular form, such as the translog. We apply the technique to the demand for red meats using time series data from the United States and Australia, testing for whether market prices and expenditures provide a complete explanation of consumption patterns.

The paper proceeds as follows. The next section contrasts two approaches to testing for structural change in empirical demand studies. The third section discusses the case of the demand for red meats and a fourth section addresses some caveats related to necessary aggregation and separability assumptions. The nonparametric method is described in a fifth section, and the following two sections describe results and some of the issues surrounding tests for stable preferences. A summary of results concludes the paper.

## **II. Parametric and Nonparametric Approaches to Structural Change**

Searches for structural change in commodity demands can take two forms. Each one amounts to a check for the compatibility of data with some stable set of well-behaved preferences. The first approach is the more familiar one. A functional form is chosen for demand curves and the parameters are estimated.

Tests for the stability of parameter estimates, statistical significance of trends, autocorrelation of residuals, or other diagnostics are then used to detect structural changes in the estimated system.<sup>1</sup> All such tests are conditional on the functional form being correct; it is uncommon to see several alternatives examined, nor would it be desirable to attempt such a specification search without some systematic approach.

A definitive test would involve only the hypothesis that preferences are stable, not stable and of a particular form. Such a test would produce either a yes or no answer to the question, "Is it possible to explain this data set with some demand system?" A nonparametric alternative to the traditional approach makes this possible while avoiding the problem of having to estimate all possible demand systems. It uses the results of revealed preference analysis, established by Samuelson (1938) and Houthakker (1950), more recently advanced in papers by Afriat (1967) and Varian (1982, 1983).

As in the parametric approach, the null hypothesis is that there is a stable set of preferences so that variation in observed quantities consumed can be explained by changes in relative prices or total expenditures. When the strong axiom of revealed preference is satisfied by the data, there is a stable demand system that fully explains observed consumption patterns. This holds because the strong axiom is equivalent to the existence of a well-behaved utility function. The axiom need not hold in the data when structural changes occur, so a test for violations of the axiom is capable of identifying changes in preferences. In addition, the approach avoids the specification bias likely with arbitrarily selected functional forms or the pretesting inherent in specification searches.

Previous applications of the technique include studies by Landsburg (1981); Varian (1982, 1983, 1984, 1985); Hansen and Sienknecht (1985);

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<sup>1</sup> This explains the use of the term parametric for this approach. For an analogous approach to the measurement of technical change, see Berndt and Khaled (1979).



Thurman (1986); and Swofford and Whitney (1986).<sup>2</sup> Two of these applications have been concerned with testing for stability of preferences over time. In his analysis of the demand for meat in the U.S., Thurman (1986) found that 25 years of annual data were consistent with revealed preference. He noted that there has been steady growth in real expenditures and suggested that the method might have low power when used as a test for stable preferences. This observation was also made by Landsburg (1981) for several data sets from the United Kingdom and by Varian (1982). When budget lines shift steadily outwards over time so that they rarely cross, there will be little chance of finding observations inconsistent with the axioms. Each year's consumption bundle is revealed preferred to all previous ones. Thurman argued that the finding was therefore necessary, but not sufficient, to conclude that preferences had remained stable.

In the sections that follow, we test for the stability of per capita demands for meat in both the U.S. and Australia using the nonparametric approach and we examine the power of the test for stability under alternative assumptions. In the next section, we discuss the background for the study and review some of the necessary caveats when using aggregated data in demand analysis.

### III. The Context of the Study

Agricultural economists and other observers in both countries have paid increasing attention in recent years to the question of structural change in the

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<sup>2</sup> Varian (1982, 1983) discussed the application to consumer expenditure data, and later extended the method to tests for cost minimization by producers (Varian (1984)) and to formal statistical testing for violations of the axioms (Varian (1985)). Diewert and Parkan (1985) showed how tests for the separability of a subgroup of commodities could be performed using the nonparametric approach. Hansen and Sienknecht (1985) used the nonparametric approach as a preliminary test of expenditure data which they used to compare a variety of demand systems. Finding that the data were consistent with revealed preference ensured that it was possible to fit demand systems to the data, and that poor performance of a particular form would not be attributable to having used a data set inconsistent with demand theory. Finally, Swofford and Whitney (1986) checked for the consistency of observed quantities and user costs of several monetary assets to verify that a demand system with restrictions from utility theory could be used to model the demand for money and money substitutes.

demand for meat products, especially beef.<sup>3</sup> Per capita consumption of red meat has declined in recent years and it is widely suggested in industry circles that this reflects a shift of consumer preferences, due to dietary concerns. The notion that preferences have shifted dramatically has been used to justify attempts to shift them back through promotion, the development of new grading systems, and other product innovations.

Although these investments may well have a positive rate of return, independent of whether any taste change has occurred, finding stability of preferences would suggest, as Wohlgenant (1985) concluded, that production research might remain a better investment than attempting to shift consumer preferences that are in fact rather stable. In any event, a necessary first step in evaluating the rate of return to such activities is accounting for the various influences behind shifting consumption patterns. We use time series data sets of per capita consumption and prices to examine the stability of preferences among meats in the United States and Australia. Given the paucity of evidence of a longitudinal nature, this is the typical sort of data set used in testing for structural changes.

To study Australian meat demand, we use Martin and Porter's (1985) data set for five meats-- beef, chicken, lamb, mutton, and pork. These data include quarterly domestic disappearance for the five meats during the period 1962:1 to 1984:4. They were not seasonally adjusted. It seems to be a harmless assumption to ignore most other commodities in the analysis, but omitting fish consumption data may bias results if fish substitutes for the included goods. Unfortunately, for Australia we do not have a consistent series for fish consumption or a fish price which can be incorporated into the analysis. We also

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<sup>3</sup> Studies on several aspects of the demand for meats in Australia and the United States include Alston and Chalfant; Braschler; Chalfant; Chavas; Christensen and Manser; Fisher; Haidacher; Haidacher et. al.; Main et. al.; Martin and Porter; Menkhaus et. al.; Moschini and Meilke; Murray; Nyankori and Miller; Pope et. al.; Richardson; Thurman; and Wohlgenant.

used two data sets for the United States which have been studied previously. The annual data set (1947 to 1978) reported by Blanciforti (1982) was used to examine the demand for beef, chicken, pork, and fish, and a similar data set which extends to 1983 from Wohlgenant (1985) was also tried.

There are some interesting differences in consumption patterns and in the data between the two countries. Lamb and mutton are important in Australia but are relatively unimportant in U.S. consumption. In both countries, per capita chicken consumption has risen considerably over time, while consumption of red meats has declined. In Australia, consumption of beef, mutton and lamb has declined, while the same is true of beef in the United States.

These trends in per capita quantities consumed are not inconsistent with relative price patterns. Increased consumption of chicken and reduced consumption of beef in both Australia and the United States may be explained by the fact that in both countries, real chicken prices have fallen and real beef prices have risen. On the other hand, it is difficult to account for the broad changes in consumption patterns with increased health consciousness alone. Any widespread move by consumers away from red meats would be expected to have affected pork in the same way in both countries, yet we observe pork consumption rising in Australia while it is relatively constant in the United States. Pork prices have diverged somewhat in the two countries and that could account for the divergent movements of pork consumption.

On the whole, then, the behavior of meat consumption patterns is not grossly inconsistent with stable market demands, given the directions of movements of relative prices and incomes. Still, changes in preferences may have contributed to the observed changes in patterns of meat consumption, and many people have taken the trends in the data as evidence of structural change; primarily, a substitution of chicken for beef in both countries beyond

that which would have resulted from changes in prices and income alone.

#### IV. Theoretical Restrictions Applied to the Demand Models

Considerable attention has been paid in the literature to whether it is justified to expect theoretical propositions which relate to the individual to hold for an aggregate, or representative consumer, especially over a subset of goods. It is quite possible to reject the theoretical restrictions on the demand system solely due to biases induced by aggregation or by erroneous separability assumptions. That possibility would presumably carry over to tests of stable preferences. Even when individual preferences are stable, per capita demands could appear unstable due to aggregation bias or as a result of excluding a relevant good.

In practice, the analysis of aggregated data for consumption of a subset of goods can proceed in two ways. One approach is to abandon contact with the underlying theory, not invoking the restrictions of homogeneity, symmetry, and so on. A belief in aggregation or separability bias would justify this but would leave absolutely no guidance as to the nature of the demand curve which should be estimated.

The second approach, the preferred one, if its prevalence in the literature is any guide, is to model the data as having been generated by a representative consumer maximizing a stable utility function over the goods under study, subject to a constraint on expenditures. Separability assumptions are dictated by the difficulties in modeling a large number of goods, even if data limitations do not preclude a broader study.

In this study, we chose to require the existence of a representative consumer as part of our test for stability of preferences. In other words, we test the stability of demands which are consistent with a set of underlying preferences, as opposed to ad hoc demand equations which do not satisfy the restrictions

from consumer theory. Furthermore, we adopted the assumption that meats comprise a weakly separable group in each country. Rejection of the stable preferences hypothesis may be due to aggregation bias rather than shifts in individual consumption patterns or to omitted goods; however, if instability is not found, it seems safe to conclude that these are not significant problems.

An additional concern relates to the nature of the alternative hypothesis in structural change studies. Whether a parametric or nonparametric approach is used, there is generally no specific information about the nature of the structural change, and the alternative hypothesis is usually no more specific than that the null hypothesis is incorrect. It would be preferable to incorporate directly the determinants and the nature of any hypothesized structural change in a more specific alternative hypothesis. However, problems arise due to the number of possible influences, the lack of adequate data, and the uncertainty about the manner in which they might affect demands.

#### **V. Nonparametric Analysis of Structural Change in Red Meats Demand**

To test the stability of the demand for red meats, we ask whether relative prices and expenditures on meat can provide a complete explanation of meat consumption patterns. The null hypothesis in these tests is that observed data conform to the restrictions implied by a stable set of well-behaved preferences, under the necessary additional restrictions that meat comprises a weakly separable group and that it is appropriate to analyze per capita consumption data as having been generated by maximization of a utility function by a representative consumer. In other words, all that is necessary for the null hypothesis to be correct is that we could plot the data and superimpose on our plots a set of indifference surfaces and isocost planes consistent with the rational purchase of those quantities by a consumer facing observed relative prices.

A time series of prices and quantities can therefore be checked for consistency with this hypothesis using revealed preference axioms. We examine the data using both the weak axiom and the strong axiom. The weak axiom is a convenient means to illustrate the method, but the strong axiom is required to verify that the data are consistent with utility maximization.

According to the weak axiom of revealed preference, a bundle  $a$  is revealed preferred to any other bundle  $b$  (denoted  $aRb$ ) that could have been purchased instead (i.e.  $a$  is preferred to all points within the budget line that applies when  $a$  is purchased). The weak axiom is violated if any such bundle  $b$  is also revealed preferred to bundle  $a$  (that is,  $a$  lies inside the budget line that applies when  $b$  is purchased). Such a result implies both  $aRb$  and  $bRa$ , which could occur only if indifference curves had shifted, given our maintained hypotheses.

For each data point  $a$ , let  $P_a$  be the price vector and  $Q_a$  the quantity vector, each with length equal to  $N$ , the number of goods. The cost of purchasing bundle  $a$  is then  $P_a'Q_a$ . A time series including prices and quantities of  $N$  goods can be examined for consistency with the weak axiom by forming a matrix  $\Phi$  with typical element

$$\Phi_{ab} = P_a'Q_b$$

so that each element  $\Phi_{ab}$  gives the cost at time  $a$  prices of purchasing the bundle of goods consumed at time  $b$ , as would enter the calculation of a cost of living index. For instance, the elements in each column give the cost at various price vectors of obtaining the consumption bundle  $b$ , while the elements in any particular row allow comparisons of the cost of the various bundles at a fixed set of prices.

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<sup>3</sup> For convenience, we use a single letter of the alphabet where the meaning is clear to denote both a particular observation and the bundle of goods consumed at that point, so that  $aRb$  and  $Q_aRQ_b$  are equivalent.

If actual expenditures in time  $a$  exceed the cost of bundle  $b$  at time  $a$  prices, so that

$$\Phi_{aa} > \Phi_{ab},$$

then  $aRb$ . Violation of the weak axiom occurs if it is also true that bundle  $a$  was affordable at time  $b$ , so that

$$\Phi_{bb} > \Phi_{ba}$$

and  $bRa$ . Keeping well-behaved, weakly separable per capita demands as a maintained hypothesis, any such violation of the axioms of revealed preference must be interpreted as evidence of a change in preferences between time  $a$  and time  $b$ .

The absence of any violations is consistent with stable preferences. It is worth noting, as well, that this finding would confirm that it is permissible to impose symmetry and homogeneity on the demand system used to explain these data; that is, those restrictions are not inconsistent with the data.<sup>4</sup>

Finding that the data are consistent with the weak axiom does not rule out the problem of intransitivity. It is also necessary to check for consistency with the strong axiom. This involves a search for intransitivity in the data, to see if bundles  $a$ ,  $b$ , and  $c$  can be found which together imply that  $aRb$ ,  $bRc$ , and  $cRa$ . The number of bundles of goods that can come between  $a$  and  $c$  is limited only by the size of the data set. The data are consistent with the strong axiom if no intransitivities are found in the matrix  $\Phi$ .

When no violations are found, it is possible to "rationalize" the data, to use Varian's (1982) term. The data set can then be said to have been generated by

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<sup>4</sup> Whether that will be true with a particular parametric demand system is another question, of course. Two papers which examine the validity of those restrictions in a parametric framework are Christensen et. al. (1975) using the translog and Deaton and Muellbauer (1980a) using the almost ideal demand system. A series of papers beginning with Laitinen (1979) has explored the statistical reasons for the tendency to reject these properties in practice.

the maximization of a utility function by a representative consumer. In the event that some of the observations are inconsistent with the axioms, it is possible to test whether the deviations from utility maximization are significant ones. Diewert and Parkan (1985), Varian (1985), and Epstein and Yatchew (1985) each discussed ways to test for the statistical significance of such violations.

It is possible to think of each observed quantity consumed as being made up of two components, the true quantity and a measurement error. It is the true quantities that should be tested for consistency with utility maximization, not those measured with some error. The question then becomes whether there can be constructed a set of "small" measurement errors, to be subtracted from the observed quantities in such a way as to satisfy the strong axiom. Varian shows how comparison of the variance implied by the constructed measurement errors to a hypothesized value permits significance levels to be assigned to the deviations from the strong axiom.

## VI. Results Using U.S. and Australian Data

Using the Australian data set, we applied the weak criterion to the quarterly data used by Martin and Porter (1985) for the period 1967:1 to 1984:4.<sup>5</sup> We constructed the matrix  $\Phi$  described in the previous section, of dimension 72 by 72, so that the first row gives the cost of buying the 72 different bundles at 1967:1 prices, the second row the costs of the same bundles at 1967:2 prices, and so on.

It is easy to characterize  $\Phi$  under the null hypothesis--no violations of the strong axiom will be found. All observed choices are consistent with maximization of the same utility function.

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<sup>5</sup> For the first five years of Martin and Porter's data (1962:1 to 1966:4), quarterly values for chicken consumption were imputed from annual quantities, so we deleted those data points (see Fisher (1979)).



Suppose that the alternative hypothesis is true, and there has been a substitution of chicken for beef due to health concerns or other factors not related to prices and expenditures. The hypothesis of stable preferences could be rejected if consumption patterns evolved along the following lines. First, a bundle (or bundles) purchased early in the sample was affordable later in the sample but was rejected in favor of a bundle with more chicken and less beef. This implies a preference for the bundle with more chicken. If this latter bundle was affordable earlier but was not chosen, we would conclude that, over time, preferences had shifted to chicken and away from beef. That is the only way to reconcile these events with rational choice, and is also the only way to reject the stable preferences hypothesis using the nonparametric test--such a reversal of choices must be found.

We find no such switch of preferences. The data are almost entirely consistent with the hypothesis that relative prices and the level of expenditures completely explain shifts in consumption patterns. We found only two minor violations of the weak axiom of revealed preference, as shown in Table 1.

In practice, it is convenient to form ratios of elements in  $\Phi$ , which turn out to be quantity indexes. We compute these by dividing every element in  $\Phi$  by the diagonal element in the same row, forming the ratios  $(\Phi_{ij}/\Phi_{ii})$  for all  $i,j$  combinations. These indicate whether the bundle of time  $j$  quantities was affordable at time  $i$  prices. Thus, a ratio less than unity indicates that  $iRj$ . The size of the index can be used to judge the importance of any violation which occurs when  $jRi$  also occurs.

In Table 1, these ratios are shown for the two pairs of data points found in violation of the weak axiom. These violations occur with the pair formed by time  $i = 1971:3$  and time  $j = 1972:2$ , and with the one formed by time  $i = 1973:2$  and time  $j = 1982:4$ . At time 1971:3 prices and expenditures, the bundle con-

sumed in 1972:2 was affordable, though just barely. The ratio  $\Phi_{ij}/\Phi_{ii}$  of 0.99993 indicates that the latter period's bundle was just 0.007% cheaper than what was actually consumed (and revealed preferred). Similarly, when the ratio of the cost of the 1971:3 bundle is computed at 1972:2 prices and compared to that period's expenditures, the earlier bundle is revealed inferior, costing almost 0.08% less. This is shown by the ratio  $\Phi_{ji}/\Phi_{jj} = 0.99924$ . Similarly, the comparisons for time  $i=1973:2$  and time  $j=1982:4$  show that the cost of these bundles was virtually the same at the prices which were observed in either period. These comparisons show violations of the weak axiom, but negligible ones. Independent of the statistical significance of any of these violations, the deviations from one do not occur in significant digits, given the precision of measurement of quantities consumed.

Moreover, we found that with minor adjustments in the values for mutton consumption in two periods, 1971:3 and 1973:2, these violations of the weak axiom no longer are present. We selected mutton as the culprit for a number of reasons, in part because the observed value for 1971:3 was unusually high (near the maximum of the entire series) and that for 1973:2 was somewhat low, in comparison with adjacent sample values. Any of the other commodities could have been used. As shown in Table 1, when we reduced 1971:3 mutton consumption by 1%, from 5.37 kg. to 5.316 kg., and raised 1973:2 mutton consumption from 2.41 kg. to 2.55 kg., this was sufficient to remove the violation of the weak axiom. The extent of the adjustments necessary to restore the data set to consistency with utility maximization is certainly plausible as a correction for measurement error. In any case, the small corrections needed are not of the sort that would lead to the conclusion that preferences are shifting away from red meats. They involve only mutton.

Mutton consumption was a minor component of meat expenditures and

declined steadily throughout the sample, to the point where mutton's share is never above 5 percent of meat expenditures after 1975:1. Also, Beggs (1987) noted that in later quarters, mutton prices were inferred from the lamb price, providing an additional reason to suspect that the mutton data are less reliable than the data for other meats. Consequently, we omitted the mutton data and tested for stability of the demand for the four other meats, equivalent to assuming them to be separable from mutton. We also aggregated the values for mutton and lamb consumption and tested that data set. No violations were found in either case. As noted by Epstein and Yatchew (page 155), a statistical procedure is not needed with such an outcome.

With the original data set, we also applied the more general test for violations of the strong axiom but found no further cases beyond the two observations inconsistent with the weak axiom in the actual data.<sup>6</sup> Again, with mutton excluded or aggregated with lamb consumption there were no violations. These findings support the hypothesis that observed consumption patterns in the Australian data set are consistent with a stable set of demands. Even if the measurement error interpretation is unacceptable, and instead one questions the series for mutton consumption, there do not appear to have been shifts away from lamb and beef towards chicken.

Using the United States data for 1947 to 1978 from Blanciforti (1982), we observed the same outcome--no violations of revealed preference were discovered. An identical result was obtained with the data used by Wohlgenant (1985), which includes the years 1947 to 1983. This represents an additional five years of more recent data and takes the sample well beyond the dates when most observers consider structural changes to have occurred.

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<sup>6</sup> We thank Hal Varian for providing us with his programs for nonparametric demand analysis, which were used for checking consistency with the strong axiom.

The revealed preference results indicate that these data sets are consistent with maximization of a stable utility function. A complete explanation of changes in consumption patterns over time can be given using prices and expenditures. Whatever biases have been induced by the separability assumption or by imposing restrictions from the theory of the individual consumer with per capita data, they are not of a form which causes us to reject the stability of a well-behaved set of demands over only the included goods. Only if the hypothesis of stable preferences is replaced with one that requires stable preferences of a particular functional form can rejection occur.

### **VII. The Interpretation and Power of the Nonparametric Test**

One drawback to testing hypotheses with the nonparametric approach appears to be the unknown power of the test. Is the failure to reject the hypothesis of stable preferences a strong indication of the absence of structural change, or could the data be consistent with revealed preference even in the presence of substantial structural change?

The power issue relates to observations made by Landsburg (1981) and Varian (1982) that, when the nonparametric method is applied to aggregate consumption series, one is unlikely to find a violation of revealed preference axioms because the budget lines drawn for annual observations rarely cross. Aggregate consumption of every good is rising through time in such applications, so each bundle of goods is revealed preferred to all previous ones. Concerns over power therefore relate not so much to the method as to the data set under study. If growth in real expenditure dwarfs variation in relative prices, it is likely that less will be revealed about substitution relationships among goods than would be the case if real expenditure remained relatively constant. This will be true using either parametric or nonparametric methods.

We examined this problem using our data sets. It seems reasonable to expect the power of nonparametric tests to be higher for disaggregated goods such as these than for more aggregated goods. Quantities consumed do not all rise uniformly with time, and relative price variation is likely to be greater, relative to variation in real expenditure, than for more aggregated bundles of goods. However, this is much more true of the Australian data than the U.S. data, mainly because the U.S. data are annual and cover a longer time period. Between observations and across the sample, the growth in real expenditure is greater in the U.S. data.

The matrix  $\Phi$  used to perform the tests illustrates this notion of power. Recall that the data were arranged chronologically, so that the first row relates to period one prices, the second to period two prices, and so on, while the columns involve observed quantities in the same way. When real expenditures rise through time, it is likely that the cost in any time  $t$  of buying bundles purchased earlier in the sample will be less than observed expenditures at time  $t$ . Similarly, the cost of bundles purchased later in the sample, when measured at time  $t$  prices, is likely to exceed actual expenditures in time  $t$ . The extreme case is when all numbers below the diagonal in  $\Phi$ , call them  $\Phi_{ij}$ , ( $i < j$ ), are less than the diagonal elements  $\Phi_{jj}$  for any time period  $j$ , and at the same time, all elements above the diagonal,  $\Phi_{ij}$ , ( $i > j$ ), exceed  $\Phi_{jj}$ .

To indicate the importance of this type of problem, for each data set we checked the number of occurrences of  $\Phi_{ij} < \Phi_{ii}$  for entries above and below the diagonal. The results are given in Table 1.

In the Australian data, there are 1088 instances in which observed bundles were affordable at price and expenditure levels observed earlier in the data set. While this is less than the 1345 observed below the diagonal, it is not so small that concerns over power need be great. On the other hand, using Wohlgemant's

data set, there are 73 above the diagonal and 581 below. This reflects the greater growth in real meats expenditures over the longer time period covered by these data. Real expenditures were smallest in the sample in 1951, reaching their peak in 1976 at a level over 40 percent higher. They declined slightly and almost monotonically from there to 1983. A similar pattern exists in Blanciforti's data.

Even when the power is low in nonparametric tests, relative to some desired level, it does not follow that the parametric approach should be adopted. There are two reasons for this. First, the same concerns over the nature of the data set would affect tests that require the estimation of demand systems. In a parametric analysis it seems likely that when Engel curves explain more of the variation in quantities consumed, less is revealed about substitution between goods, just as with the nonparametric approach. Second, when a particular form for the demand system is estimated, the test for stable preferences is replaced by a test for stable preferences of the translog, almost ideal, or some other form. It is well known that an arbitrarily chosen demand system may perform very badly as an approximation of the mechanism by which the data were generated (e.g. Deaton (1986)). Rejection of hypotheses such as stability or homogeneity could then be due to use of the wrong functional form, rather than a rejection of the economic proposition.

This problem and the concern over growth in real expenditures in time series data sets led us to consider an alternative procedure. It is easy to see that the power of our test for stable preferences depends on the variation in relative prices being large relative to that of expenditures, though it is hard to quantify the power relationship. Monte Carlo simulations might be formulated to do so under a variety of conditions, but care must be taken in applying such results to data sets that might not follow the mechanisms used to generate the

simulations.

Another procedure which might be used to increase the power of non-parametric procedures involves using the data set under study, rather than simulated data. It suffers from the same criticism as the parametric approach; it is arbitrary and requires the use of a joint hypothesis, but we find it considerably more intuitive.

The problem with the parametric approach is that there would have to be a search over an infinite number of functional forms to "prove" that stable preferences do not exist; every structural change test with a particular functional form can only indicate instability of that form. Picking a functional form is a means of imposing prior beliefs on a demand system in an attempt to glean more information from the data set. However, we would expect that no one has any priors about functional forms, apart from a requirement that they be compatible with economic theory and a preference that they be somewhat parsimonious.

An alternative way of imposing prior information on the analysis is to perform the equivalent of "detrending" the data by making an adjustment for real expenditures. This involves imposing prior beliefs about income elasticities, which seems more natural than imposing priors about functional form. Income elasticities are easily linked to past experience with similar data sets and can be connected with the Bayesian approach to inference with much less difficulty than can the problem of selecting the functional form.<sup>7</sup>

To see if our conclusions concerning the stability of preferences were a consequence of real income growth alone, we imposed prior beliefs about income elasticities as follows. First, each data point was adjusted for changes

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<sup>7</sup> Though see Rossi (1985) for an example of selection of functional form using Bayesian techniques.

in the level of real expenditures (actual expenditures on meats divided by the Consumer Price Index), based on an assumed expenditure elasticity of one. We replaced the observed quantity of good  $i$  at time  $t$  with an adjusted value, calculated using

$$\hat{Q}_{it} = Q_{it} * (1 - DINC_t),$$

where  $DINC_t$  is the percentage by which real expenditures in time  $t$  exceed the minimum for the sample.

After this adjustment to reduce variations in the level of expenditures, the constructed quantities should mostly lie on budget lines which cross. The remaining variation in quantities consumed was then tested for consistency with revealed preference. To a certain extent, this violates the spirit and intent of the approach; additional assumptions are introduced and become joint hypotheses which are being tested. However, this might be preferable to the application of the test to unadjusted data, depending on one's view. It is certainly preferable to imposing an arbitrary functional form or searching over alternative specifications.

Our results are shown in Table 1. If alternative income elasticities are considered, it would be possible to report intervals for each elasticity within which there is no significant violation of revealed preference. The user of such information would be free to choose whether the constructed intervals are reasonable as a description of reality. The same exercise could be performed using price elasticities, if the constant elasticity assumption is acceptable.

The results continue to support the stable preferences hypothesis. Even after the quantities consumed were adjusted by the level of expenditures, they were consistent with the strong axiom of revealed preference. Variations in constructed quantities, after adjusting for changes in the level of real expenditures, are consistent with maximization of a stable utility function.



### VIII. Summary and Conclusions

This paper has used a nonparametric approach to test for structural change in the demand for meat, applied to the United States and Australia. A check for consistency with the axioms of revealed preference showed that the data from both countries could have been generated by stable preferences. Therefore, any conclusions that tastes have changed using these data sets must come in the form of restrictions on the nature of these demand systems (e.g., to be of the almost ideal form). The data alone do not indicate changes in preferences. Relative prices, instead, can account for the observed shifts in consumption patterns.

There is some uncertainty about the power of such a test. Power is likely to be low for most data sets consisting of aggregate consumption, since each year's consumption bundle will be revealed preferred to that of the previous year. For disaggregated goods such as meats in the data sets we examined -- where relative prices have varied considerably while real expenditure on the meats group varied less--the test seems likely to have sufficient power. Unfortunately, while this notion of power is analogous to the usual statistical definition, it is harder to quantify.

Our investigations of data constructed from the observed quantities using a procedure which adjusts for growth in real expenditures supported the findings with unadjusted data. We imposed restrictions on expenditure elasticities, corrected for expenditure effects, and found that variation in relative prices continued to explain the remaining shifts in consumption patterns.

It will be of interest to attempt to estimate a demand system and elasticities consistent with the stable preferences indicated by the revealed preference results. Experimentation with alternative functional forms would be required, and the drawbacks with that have been discussed. Several authors have ques-

tioned the approximation potential of models such as the translog or almost ideal. It may be that testing for structural change as did Wohlgenant (1985), using the variable number of parameters of the Fourier flexible form, will avoid misspecification implicit in more restrictive forms. That approach falls between the fixed-parameter forms such as the almost ideal and the completely non-parametric approach using revealed preference.

The assumptions concerning weak separability and aggregation over consumers can be challenged. However, our nonparametric results do support the stability of well-behaved separable per capita demands for beef, chicken, lamb, mutton, and pork in Australia and for beef, fish, pork, and poultry in the United States. On this basis, we interpret past work as rejecting the stability of particular functional forms for those demands, rather than as an indication of structural changes in demand.

We began the paper by distinguishing taste changes reflected in commodity demands from those discussed by Stigler and Becker defined over fundamental goods. To most people, there seem to be fairly compelling reasons to believe that consumer preferences for meat have changed. It may be the case that household production functions have shifted over time and that meat is being perceived and used differently by consumers. Yet, when conventional demand theory is applied to market demands, we find that we are unable to reject the stability of a set of preferences defined over market quantities of meat items.

Stigler and Becker appealed to economists to augment their models to account for changes in demand. Our results indicate that, in the case of meat, there are not any changes to be accounted for. Moreover, we find nearly identical results in two countries where the conventional wisdom is that preferences have changed in important ways in recent years. This duplication of results adds force to our conclusion that we can account for the conventional wisdom:

the models which indicated structural change did so because of the chosen functional form.

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TABLE 1. RESULTS OF NONPARAMETRIC TESTS FOR CONSISTENCY WITH UTILITY MAXIMIZATION

Time period	Goods	Consistent?	Observations violating the axioms		Comparable data points		
			Period	$\phi_{ij}/\phi_{ji}$	$\phi_{ji}/\phi_{ij}$	Above diagonal	Below diagonal
Martin and Porter	1967:1-1984:4 beef, chicken, lamb, mutton, and pork	No	i=1971:3, j=1972:2	0.99993	0.99924	1,088 of 2,556	1,345 of 2,556
Martin and Porter	1967:1-1984:4 Same, except 1971:3 mutton consumption reduced by 1% and 1973:2 mutton consump- tion increased by 6%	Yes	- - -	0.99938	0.99780	1,088 of 2,556	1,344 of 2,556
Martin and Porter	1967:1-1984:4 beef, chicken, lamb, and pork	Yes	- - -	- - -	- - -	847 of 2,556	1,630 of 2,556
Blanciforti	1947-1978 beef and veal, fish, pork, and poultry	Yes	- - -	- - -	- - -	33 of 496	456 of 496
Wohlgenant	1947-1983 beef and veal, fish, pork, and poultry	Yes	- - -	- - -	- - -	73 of 666	581 of 666
<u>Constructed Data Sets, Expenditure Elasticities Assumed Equal to One</u>							
Martin and Porter	1967:1-1984:4 beef, chicken, lamb, mutton, and pork	Yes	- - -	- - -	- - -	1,036 of 2,556	1,444 of 2,556
Wohlgenant	1947-1983 beef and veal, fish, pork, and poultry	Yes	- - -	- - -	- - -	250 of 666	380 of 666

