Demand for Meat; Seprability and Structural changes (A Nonparametric Analysis)

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DEMAND FOR MEAT; SEPARABILITY AND STRUCTURAL CHANGES (A NONPARAMETRIC ANALYSIS)

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This study provides information on the structure of the consumer demand for meat group (1950-51 to 2004-2005) in Pakistan. Nonparametric tests were used on the data set to check the consistency of the data with the theory of revealed preferences, e.g. the Afriat inequalities, GARP and the condition of weak separability. We started with 26 different consumer commodities and employed nonparametric tests to the different groups of commodities. But all other groups except meat group showed violations of generalized axiom of revealed preferences (GARP). So we limited our analysis only to meat group. It was found that there was no violation of GARP in our data set and hence consistent with Afriat inequalities. The data set also met the condition of weak separability. These test procedures imply that the data could have been generated by stable preferences. Furthermore, the existence and the nature of the structural change is checked by using GARP. Tests of structural change do support a shift in demand for fish in 1991-92.

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1. Introduction

Consumer demand analysis has become increasingly difficult, for applied economists, over the past 25 years or so. This is because twenty-five years ago a single-equation linear or double-log demand equation using OLS would have been regarded as generally acceptable, so long as the coefficients were plausible and there were no obvious statistical problems with the model. Nowadays, such models are mostly scorned in applied work. It is virtually obligatory to estimate demand parameters in the context of a system of demand equations based on some flexible functional form.

Even when flexible functional forms are used there are some imperative specification issues that remained to be dealt with. For instance, how do we know that the results would not be different with an alternative functional form? Is the price-dependent or quantity-dependent system more appropriate? Should the model be estimated with equation by equation or with a system of equations? Should the possibility of simultaneity bias be recognized? How should the structure of dynamics in the error term be specified? Should the model be first-difference? The implications are that the results are conditional on such specification choices and must be heavily qualified.

The nonparametric demand analysis holds the potential to allow conclusions to be drawn with fewer qualifications. This method uses only the conditions imposed on a data set by utility maximization. It avoids the problem of functional forms. It gives a test for stable preference for market goods that does not require that they be of a

particular form such as, the LA/AIDS, the Rotterdam Model and the Translog. Moreover, the nonparametric approach avoids the specification bias likely to arise due to arbitrarily selected functional forms or the pre-testing inherent in specification searches [Eales and Unnevehr (1988)]. The nonparametric approach to demand analysis uses the results of revealed-preference theory, first established by Houthakker (1960) and more recently advanced by Koo (1963, 1971), Afrait (1967) and Varian (1982, 1983). By putting in a nutshell we can say that the nonparametric techniques of revealed preference analysis can be used to test a finite amount of data for consistency with preference maximization model; construct a nicely behaved utility function capable of rationalizing a finite amount of demand data; compare previously unobserved consumption bundles and budget with respect to their ordinal ranking; compute cardinal bounds on the direct and indirect compensation functions and compute estimates of the direct and indirect demand correspondence consistent with previously observed demand data.

2. Objectives of the Study

The objective of this study is to estimate consumer preferences for food commodities using Pakistan's annual time series disappearance data from 1950-51 to 2004-2005. The study tests for the existence and the nature of the structural change in the commodities by exploring the levelness of the data with the utility maximization principles using nonparametric revealed preference axioms, more idiosyncratically, the generalized axiom of revealed preference.

We started with twenty six different food commodities and employed nonparametric tests to the different groups of commodities, but it was observed that all other groups

except meat group had shown violations of GARP. So keeping in mind these violations of different data sets we limited our analysis only to meat group. These tests revealed that our data set is consistent with the theory of consumer demand.

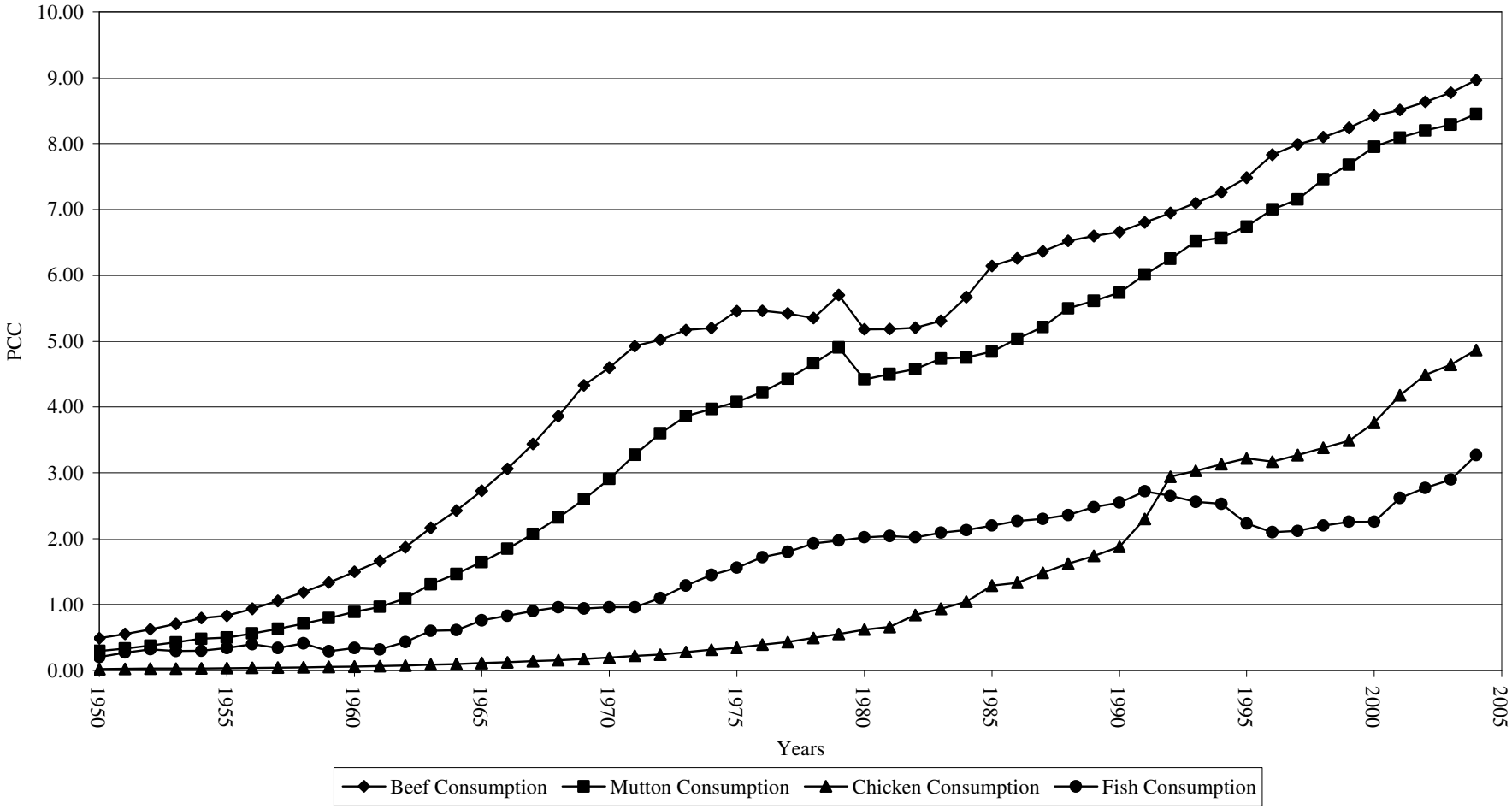
3. Consumption Patterns in Pakistan

Food consumption patterns have undergone massive changes during the past two decades. Particularly, the consumption of meats has registered an upward trend. Figure 2.1 illustrates consumption patterns of meats based on the annual per capita consumption data. Though consumption pattern of mutton and chicken has shown a perpetual trend of growth since early fifties, the meat consumption remained constant during this period. The beef consumption increased only in mid-eighties. Fish consumption, however, has remained constant during this entire period. Per capita consumption of chicken doubled in the first seven years and continued increasing rapidly in 1980's. The most interesting relationship, however, is the perfect substitution between beef and mutton all along the study period (figure 2.1).

It was further indicated that, within the meat group, beef has a lower preference, with regards to the consumer demand, as compared to mutton and chicken. This was further supported by the fact that during the study period, the price of mutton was more than double than the price of beef. The prices of mutton and chicken were similar during the 1970's, the price of chicken declined in 1980's. This is manifested by the increased production of chicken since 1980's due to government incentives. This has decreased the price of chicken relative to mutton and beef. Consumption of all meats has increased although the relative prices of beef, mutton and fish have increased more as compared to chicken. The observed changes in per capita

consumption of food can partly be explained by decreased prices of chicken owing to increased productivity, and partly by changes in the demand structure for food on account of changes in demographic factors, changes in economic well being, and most importantly a change in consumer preferences due to changes in consumer tastes. There remains, however, the possibility that some non price factors may also be instrumental in bringing about this change. For instance, a gradual change in consumer preferences could have taken place due to changes in tastes perhaps as a result of cultural onslaught through the remaining migrant labour force from the Middle East, or for unknown reasons. If this hypothesis is correct then these evolutionary changes may have produced new consumption patterns that may explain the observed growth in the demand for expensive food items.

Figure 2.1: Per Capita Consumption of Meat in Pakistan (1950-1951 to 2004-2005)



4. A Review of Nonparametric Approach

The nonparametric approach has been developed to test data for consistency with utility maximization, i.e., the test for consistency of the data with weak axiom of revealed preference (WARP) , strong axiom of revealed preference (SARP) and generalized axiom of revealed preference (GARP), and to recover the properties of the underlying preferences and to forecast demand behaviour [Varian, (1982, 1992)].[1]

According to WARP, 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 implies when a is preferred). WARP is violated if any such bundle b is also revealed preferred to bundle a (i.e., a lies inside the budget line that applies when b is purchased). Such a result implies that both aRb and bRa. This could occur only when the indifference curve shifts [Varian (1982, 1992); Eales and Unnevehr (1988)].

A finding that the data are consistent with WARP does not rule out the possibility of intransitivity. Therefore, it is necessary to check for consistency with SARP. This involves a search for intransitivity in the data, to see if bundle a, b, and c can be found that together imply 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 SARP only when no intransitivities are found.

[1]Empirical studies that have implemented nonparametric methods in consumer demand analysis include Diwert (1973), Diwert and Parkin (1978, 1985), Varian (1982, 1983), Chavas and Cox (1990), Chalfant and Alston (1988). Examples of parametric studies that also checked for consistency with GARP include Alston and Chalfant (1991, 1992 and 1993), Chalfant (1988) and Burki (1997).

The GARP is a generalized test for WARP and SARP in the family of revealed preference. WARP and SARP are standard tests, which require that for each budget there be a unique bundle demanded. In contrast, testing for GARP would allow multiple solutions to the consumer's optimization [Varian (1992)]. The consistency of data with GARP implies WARP, however, the reverse is not true. Even when we find no violations of WARP, it is necessary to check for GARP or SARP. Therefore, GARP is a necessary and sufficient condition for the consistency of data with utility maximization [Varian (1982)].

One drawback, to testing hypotheses with nonparametric approach, appears to be the unknown power of the tests. It seems reasonable to expect the power of nonparametric approach to be higher for disaggregated goods. Quantities consumed do not all raise uniformly with time and relative price variation is likely to be greater, relative to variation in real expenditure than for more aggregated bundle of goods [Eales and Unnevehr (1988)].

Even, when this power is low in nonparametric approach relative to some desired level, it does not mean that the parametric approach should be adopted. As Chalfant and Alston (1988) and more recently Alston and Chalfant (1991), suggested that when the data are such that the nonparametric tests are low-powered, parametric tests are also low powered. To this end, there has been some progress with methods for improving the power of the nonparametric tests. Progress in this direction seems to require imposing non-sample evidence on the data. For example, Chalfant and Alston

(1988) adjusted their data for expenditure growth in order to increase the number of comparable data points, but to do so it was necessary to assume values for income elasticities. They also pointed out that free testing of GARP on adjusted data is very sensitive to the chosen elasticities for adjustment.[2]

Although it would seem reasonable to expect researchers to apply at least the consistency test (at the minimum WARP), the studies that have applied these tests remain small. The low popularity of nonparametric approach is surprising given its potential to complement the parametric approach.

5. Specification of Nonparametric Approach

The procedure of testing the revealed preference theory as followed in the present study turns out to be not difficult. The revealed preference approach is more realistic, and not based on pre-determined functional form. This approach uses the data on observed prices and quantities and tests its consistency with utility maximization using the revealed preference axioms. These axioms are increasingly used in the consumer demand analysis as a complement to the parametric analysis, especially to pretest the consistency of data sets with the theory.[3] Revealed preference theory is formulated on the assumption that to each set of the given prices (P_o), there will correspond an optimal set of quantities (Q_o). In other words we are observing the behaviour and testing the consistency of the consumer on the basis of their total

[2]For a detailed discussion about the power of nonparametric approach, see, Eales and Unnevehr (1988, 1993).

[3]For recent applications, see, Chalfant and Alston (1988), Chavas and Cox (1990), Alston and Chalfant (1991) and Burki (1997).

expenditure on the goods. It is nonparametric: it provides a complete test of the hypothesis in the question alone, with no additional assumption about the functional form.

Alston and Chalfant (1992) describe the progress of the nonparametric analysis in consumer theory. It originated from Afriat. It is founded on Samuelson's revealed preference theory. It has been used by Diwert (1973), Diwert and Parkin (1978, 1985), Varian (1982, 1983), Alston and Chalfant (1991, 1992) and Burki (1997). Since its inception, nonparametric analysis has advanced from providing tests for consistency of the data Varian (1983) to the more complex tests. For example according to Alston and Chalfant (1991), data that generate low-powered nonparametric test also tend to yield low-powered parametric tests.

The advantages of this approach as pointed out by Varian (1982), "that the stability of the consumer preferences can be investigated without explicitly identifying and estimating the system of demand equations. Tests which rely on the specific demand are necessarily conditional on the validity of the restriction imposed by the parametric structure of the demand system. Nonparametric system avoids this drawback, and in addition, requires less computation". In short, the method for testing the revealed preference used here proved to be feasible.

To illustrate, suppose that in a price situation $P_o\left(P_{o1}, P_{o2}, P_{o3}, \ldots, P_{on}\right)$, the consumer buys a commodity bundle Q_o. This commodity bundle Q_o is said to be preferred to an alternative bundle Q_1 if $P_o Q_1 \geq P_o Q_o$. In the price situation P_1 in which Q_1 is bought the

Q_o basket must be at least as expensive. Therefore, $P_o Q_1 \leq P_1 Q_o$. This is known as weak axiom of revealed preference (WARP).

Both the homogeneity and the negativity can be tested with WARP alone. However, to prove symmetry of the substitution term $K_{ij} = K_{ji}$ WARP needs to be extended to what is known as the strong axiom of revealed preference (SARP) [Houtkhakker (1960)]. Infect WARP deals with only pairwise choices while SARP incorporates the consistency of the data set, i.e., if Q_o is preferred to Q_1 while Q_1 is preferred to Q_2 then Q_o is preferred to Q_2. This can be extended to any number of commodity bundles.

Consumers whose choices are governed by these axioms will always posses an indifference map. The consistency of data with WARP is established only when there is no violation of WARP. This is however, a necessary but not sufficient condition for utility maximization. SARP relates to the transitivity property of the utility function. Therefore, to search for in transitivity in the observed data the consistency of data with SARP is recommended.[4]

Generalized Axiom of revealed preference is a test, which generalizes other tests in the family of revealed preference. WARP and SARP are standard tests, which require

[4]Further, Houtkhakker (1960) has shown that if the preference ordering is reflexive, transitive, and the "no worse than" and "no better than" sets are closed, a continuous utility function exists. Infect, Houthakker has established the formal equivalence of the revealed preference and utility function approaches to the theory of consumer behaviour by showing that "a theory based on semi-transitive revealed preference enact the existence of ordinal utility, while the property of semi-transitivity itself was derived from utility consideration". Furthermore he analysed that the equivalence of these two approaches, and also that SARP can be replaced by WARP if the demand function satisfies the regularity conditions.

that for each budget there be a unique bundle demanded. In contrast, testing for GARP would allow multiple solutions to the consumer's optimization [Varian (1992)]. In other words, GARP also allows "flat spots" in the indifference curves. The consistency of data with GARP implies WARP; however, the reverse is not true. Likewise, even when we find no violation of WARP, it is necessary to check for SARP or GARP. Therefore, GARP is the necessary and sufficient condition for the consistency of data with utility maximization [Varian (1982)]. We pretest our data for GARP to see if the data is consistent with utility maximization.

Weak separability is another regulatory condition for utility maximization that we test by revealed preference axioms, this nonparametric method does not involve use of any assumed (parametric) functional form hence, it avoids the problems of functional form and does not involve regression analysis [Alston and Chalfant (1992)].

6. Data Description

This study has made use of time series data on prices and per capita consumption, which is to be analyzed using nonparametric demand analysis. Data on population and personal consumption expenditures was obtained from the *Economic Survey*. Per capita consumption was calculated by using the annual disappearance[5] data from *Statistical Yearbook of Pakistan*, Government of Pakistan. Prices data are averages of twelve centres and are obtained from Monthly *Statistical Bulletin* of the Federal Bureau of Statistics [Government of Pakistan (various issues)].

[5]Per capita consumption = [Total quantity produced in the economy (QP) in the specific year say 1972-73+ Imports of that year - Export of that year] / Total population.

7. Empirical Results of Nonparametric Tests

A common approach in consumer demand studies is to assure that different sets of consumer goods are weakly separable from other goods. This approach is questionable on theoretical grounds because the maintained hypothesis of weak separability between goods in different groups imposes a number of restrictions on the substitution possibilities [Moschini, Moro and Green (1994), Barnett, Fisher and Serletis (1992)]. Clearly, if these restrictions are not satisfied then the estimates of elasticities may be erroneous.

We use Varian's software NONPAR developed to conduct nonparametric demand analysis. We perform nonparametric test on our data set[6] to check the consistency of the data with the theory of revealed preference. We had performed various tests for it. For example we check Afriat inequalities, generalized axiom of revealed preferences and the condition of weak separability using NONPAR program developed by Hal Varian. We started with 26 food commodities and performed above mentioned tests to the entire data set. We found that all other groups except meat group showed violations of GARP.

If the entire data set satisfies Afriat inequalities then we can say that there exists a continuous, concave, monotonic non-satiated function that rationalizes the data. The consistency of the data with Afriat inequalities is sufficient condition to check the consistency of the data with GARP. According to Varian (1982) if some data set satisfies GARP then there is a nice utility function that will rationalize the observed

[6]Our data set contained 26 different food commodities

behaviour. If the data contains a violation of GARP then there does not exist a nonsatiated utility function that will rationalize the data. Hence we have a straight forward and efficient way to check a finite account of data for consistency with the theory of consumer behaviour. GARP is necessary condition to check the data for separability conditions.

Our data set have no violation of GARP and hence, is consistent with Afriat inequalities.[7] The condition of weak separability is also met. A check of consistency with axioms of revealed preference showed that the data could have been generated by stable preferences. Therefore, any conclusions from this data set that tastes have changed must come in the form of restrictions on the nature of these demand systems. The data alone does not indicate changes in preferences.[8]

8. Conclusions

This study estimates consumer demand and their responsiveness to prices and income for meat group using Pakistan's time series data from 1950-51 to 2004-05. We employ the nonparametric revealed preference approach to estimate consumer

[7]Afriat's theorem was first proved by Afriat (1967), Varian (1982) introduced GARP to replace a more unwieldy condition Afriat called "cyclical consistency". GARP is to be preferred to Afriat's cyclic consistency since it is much easier to test in practice. For detailed discussion see Varian (1982).

[8]This is not to say that the nonparametric tests are biased in favor of a finding of stable preferences, but it does reduce our confidence in concluding, based on nonparametric tests results alone, that their has been no structural change in Pakistan's meat demand. Nor does it mean that the nonparametric tests are low powered relative to parametric ones. We generally do not know the power of the structural tests using a particular data set, even under the assumption that the functional form is correct. An important point in this context is the idea that power relates very much to the nature of the data being studied, while we expect the nonparametric tests to have low power relative to the correct (but unknown able) parametric specification, at the same time we expect to find fewer false rejections as would result from imposition of the wrong functional form. For further discussion see Alston and Chalfant (1991).

preferences. The commodities included in the meat group are beef, mutton, chicken, fish and others.

Nonparametric tests were used on the data set to check the consistency of the data with the theory of revealed preferences, e.g. the Afriat inequalities, GARP and the condition of weak separability. It was found that there was no violation of GARP in our data set and hence consistent with Afriat inequalities. The data set also met the condition of weak separability. These test procedures imply that the data could have been generated by stable preferences. Tests of structural change do support a shift in demand for fish in 1991-92. More specifically, it was observed that the exogenous growth in the share of fish demand has declined after 1991-92. The observed decrease in the demand of fish can be explained by changes in tastes.

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