EMPIRICAL ANALYSIS OF FOOD DEMAND IN PERU: RESULTS AND THE USE OF *SAS* SOFTWARE

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ABSTRACT

Despite considerable progress in the technology of food, millions of people around the world continue to be and undernourished. It has been proposed that food-feed competition can aggravate the food crises, and affect the welfare of the poor adversely. This paper analyzes food consumption patterns in Peru using seemingly unrelated regression models, as opposed to the stylized ordinary least square technique. The analysis suggests that food-feed competition is viable in less developed economies that face economic growth, and hence a larger middle class, and increasing urbanization.

INTRODUCTION

Although there is disagreement about the quantitative estimates, it is generally agreed that the extent of malnutrition in less developed countries (LDCs) is large and that malnutrition is a serious problem. Among the adverse consequences of malnutrition are inadequate performance in the labor market [5], deficiencies in the health and schooling of children, infertility, still births and birth defects, and vulnerability to diseases and epidemics [3].

Despite the fact that there is general agreement that malnutrition is a serious social problem in LDCs, there is considerable controversy what determines it. In as much as the degree of malnutrition generally increases considerably during periods of food shortage many argue that it is determined by food shortage. Indeed, food shortages reduce not only the ability of the poor to be gainfully employed [8] but also their possibilities for survival [13, 17]. Nevertheless, since bad weather and crop failure cannot explain how famines can persist in the presence of food storage, trade and other means of providing people with food during famines, others [12, 14] trace the cause to institutional and market failures which impede alleviating responses.

An interesting and thus far insufficiently analyzed explanation of famines is that they might well be a consequence of efficiently working markets. Since by the end of the seventies the *green revolution* had significantly increased productivity in several crops, the continued occurrence of famines and malnutrition in various LDCs seems clearly attributable to inequality in consumption, arising out of market activity, rather than to supply shortfalls [12, 14]. In today's world where central planning is being globally replaced by market economy, it would seem especially important that this alternative explanation be thoroughly examined to ensure that major social catastrophes cannot be brought on.

While the aforementioned studies may have succeeded in treating a wide variety of possible explanations of malnutrition, , they have not made explicit use of the allocation of food among competing alternatives. Indeed, this is an important shortcoming in the existing literature, especially in view of widespread that income elasticities of demand vary considerably across both commodities and income groups. Yotopoulos [18] argued that, as more and more people graduate into the middle class, the demand for meat (with its high income elasticity of

demand) rises and thus so does the demand for food grains as feed. This competition partially crowds out the direct supply of food grains to the food markets, food being the main item in the consumption basket of the poor. The process is aggravated by the fact that the process of conversion of food grains into meat of equal nutritional value is extremely inefficient [4].

Since the development process is usually marked by an increase in the number and proportion of middle income families, the existence of food-feed competition has important implications for development policy. In general, development theorists have viewed this process of growth in the middle income class very positively, i.e., as being not only natural but also highly desirable. However, given the nature of food-feed competition, it is conceivable that this phenomenon could seriously adversely affect the food supply of the poor. Considering also that the early stages of development are marked by increased inequality [9, 2, 11], this is a sobering possibility.

ENGEL CURVE SPECIFICATION

The theory of food-feed competition suggests that there exists a hierarchical pattern of food consumption by individuals and households. Corn is the basic commodity in so far as food consumption is concerned. Meat is a luxury food commodity. Households consume primarily corn until they reach a threshold, this threshold being defined by a certain level of total expenditure. Once they overcome the threshold, there is a rapid increase in their demand for meat, and a significant decrease in the rate of increase in the demand for corn. In other words, once a household overcomes the threshold, the share of expenditure on corn decreases and the share of expenditure on meat increases.

However, the problem of modelling this phenomenon is not trivial. As the total expenditure (a proxy for income) of a household changes and it either adds commodities to its consumption bundle or drops some commodities from it, the budget constraint of the household changes. Thomas et al [15] note that "an appropriate model in this case may be an endogenously switching regression with as many regimes as there are possible commodity combinations." However, unless the number of regimes is very small, estimation of such a model is computationally difficult [16, 10].

The alternative, therefore, is to estimate Engel curves which have as explanatory variables (logarithm of) total expenditure, prices, and the size of the household expressed in terms of equivalence scales. The specification also includes other indicators of household composition (age of the household head, gender of the household head etc.), indicators of wealth of the households, and finally the profession of the household members. Further, the wealth of the household has been measured in terms of its ownership status with respect to the building in which they live, as well as the quality of the family home. Note that the value of the durable goods owned by the households is not being used in the specification because it has very high collinearity with the levels of total expenditure of the households.

It is to be noted that some of the explanatory variables mentioned above might have interactions. For example, a household with a farmer might consume its own corn and vegetables, but the extent to which it does so will depend upon the market price of these commodities. In order to capture these dynamics between the explanatory variables, interaction terms have been used in the specification. Hence, appropriate interaction terms have been used in the specification.

DATA

The Peru Living Standards Survey (PLSS) was conducted in Peru between mid-July 1985 and mid-July 1986. It is nationwide random sample of about 5109 households. During the course of the survey, information was collected on food and non-food expenditure, income of the households from various sources, demographic composition of households, status of health and education of household members, employment and other productive activities,

ownership of liquid and other assets, housing and other aspects of living conditions in Peru.[1] On average, the time difference between the dates of the first and the second interview was about fourteen days.

While the aforementioned surveys provide quite detailed information about many economic variables, there is hardly any information about the prices of the different food products that are required to estimate Engel curves for food commodities. Indeed, the specification of the Engel curve demands that we have disaggregated prices for the food commodities, as well as some overall price index. This information was obtained from the Instituto Nacional de Estadistica, Lima. Further, information about exchange rates are required to convert the values of all expenditures into *intis*, since the prices are quoted in that currency. This information has been obtained from the International Financial Statistics database at the University of Southern California.

RESULTS AND IMPLICATIONS FOR FOOD-FEED COMPETITION

The phenomenon of food-feed competition is critically dependent on the consumption behavior of households with respect to corn and meat. The underlying assumption, stated earlier, is that as the income, and hence the total expenditure, level of a household increases and exceeds a certain threshold, there is a sudden increase in its meat consumption, and a corresponding stabilization of corn consumption. Hence, the analysis in this paper will focus on the corn and meat demand by households.

A feature of the stylized Engel curve estimation process is to estimate the equations for the different commodity bundles separately. However, a serious objection can be raised in this context. A household faces a budget constraint, and hence how much it spends on one commodity bundle affects its expenditure on any other consumption bundle. Therefore, even if the expenditure on all commodity bundles is not simultaneously determined, it is likely that the error terms of the individual regressions are correlated. In other words, the appropriate econometric model is that of seemingly unrelated regression.

The regression estimates indicate that the share of expenditure of corn in the total expenditure falls with increase in total expenditure, albeit at a decreasing rate. At the same time, the share of expenditure on meat increases at a decreasing rate. The approximate shapes of the resultant share curves are given by figure 1, and are consistent with Engel's law, and the underlying assumptions of food-feed competition. The wealth effects are also consistent with the stylized microeconomic theory of Engel's law. As a household accumulates more wealth, as indicated by improvements in the quality of their dwelling, it spends progressively smaller shares of its total expenditure on corn, and progressively larger shares on meat.

The implications of this proposition for food-feed competition are clearly discernible. The poor and the middle class have a very high relative preference for high cost food, namely, meat. They are constrained by the facts that their incomes are very low and that they need a certain minimum amount of food to survive. This causes them to consume primarily grains. However, as some of them move up into the middle class and have a higher level of income, (both now and in the future), their demand for meat will increase substantially. Indeed, the percentage increase in their consumption of meat may well be greater than the percentage increases in (a) their income and (b) their expenditure on other commodities. Since such an increase in meat demand will translate into a large increase in the demand for feed, the stage is clearly set for the emergence of food-feed competition.

It can also be seen that the relative price of meat, and that of vegetables and fruits, have no significant effects on the shares of corn and meat in the total expenditure.[2] However, the relative price of the*other* food commodities (oil, vinegar, salt, tobacco etc.) significantly affects the shares of both these food groups. This can be explained by the fact that the

[1] A detailed description of this survey can be found in Grootaert and Arriagada [7].

[2] The price of corn is the numeraire.

components of the *other* food group have inelastic demand, such that an increase in its price leads to a greater expenditure on it. Hence, given some fixed value of the total expenditure, the shares of the corn, meat, and vegetables and fruits food groups will decrease. In other words, the demand for the different staple food baskets - corn, meat, and vegetables and fruits - are determined essentially by the total expenditure, i.e., income, and the wealth of the households.

However, the relative prices have significant effects on the shares of corn and meat if the household concerned has someone involved in farming. This can interpreted to be a consequence of the facts that (i) a farming household produces many different crops, and lives in an environment, such that it is easier for that household to substitute one food group with another in the event of a change in relative prices, and (ii) when relative prices change, a farming household has to optimize both as a consumer and a producer, and is therefore more reactive to the price change than other households.

It can also be seen that urban households are likely to spend a larger share of their total expenditures on meat, and that rural households correspondingly spend larger shares of their total expenditures on corn. Economic growth and industrialization in less developed economies are usually accompanied by migration into urban areas as more and more people shift from occupations in the primary sector, and into those in the secondary and tertiary sectors [11, 6]. In other words, economic growth and urbanization will result in higher demand for meat and lower demand for meat. The implications for food-feed competition are obvious.

USE OF SAS(r) SOFTWARE FOR THE ESTIMATIONS

The entire empirical analysis outlined in this paper has been accomplished using the SAS software, and SAS/ETS. The regression analysis, which has been outlined in some detail, was, in fact, the easiest part of the analysis. For example, White's test was implemented simply by using the SPEC option in the MODEL statement of PROC REG. Similarly, the seemingly unrelated regression model was estimated by introducing the SUR option in the PROC SYSLIN statement. The symmetry restrictions were imposed on the model using the SRESTRICT statements, following the MODEL statements in PROC SYSLIN.

However, therein lies the advantage of using the SAS software. Indeed, attempts were made to estimate the model using other statistical software and problems were encountered because of the size of the data, as well as the fact that simple yet a large number of arithmetic operations had to be performed during each run of the code, in order to obtain the sample which was finally used to estimate of the model. The code, written using the SAS software syntax, that has been used for the analysis was able to assimilate a huge number of data sets and variables using simple tools like KEEP, DROP, MERGE, PROC SUMMARY, ARRAY, and DO loops.

There is a certain aspect of the SAS software that this research has not explored. The code for the analysis put forward in this paper, and other code using household or demographic data, are very long. It is possible for the programmer to lose sight of the logic on which the code is founded, especially if she has to re-use a code after a long interval. It would thus be of great help if the SAS software is as structured a language as FORTRAN or C, and individual subroutines can be used to analyze and assimilate small and related sections of the data These subroutines can then be *called* into the *main* body of the code, and linked to the final step where regression models are estimated. If this feature is absent in the SAS software, it is worth exploring.

CONCLUSION

The phenomenon of food-feed competition is critically dependent on the (food) consumption patterns of the households. It can be seen from the empirical analysis that economic growth, the resultant creation of a larger middle income class, and increasing urbanization,

is likely to intensify the competition between staple food and feed. It is thus imperative that food consumption patterns of growing economies, especially those with large populations and substantial income inequalities, be examined. It will provide governments with important insights into the possible effects of their agricultural tax - subsidy, food distribution, and income redistribution policies.

Such data analysis, especially for large and culturally diverse countries, would require immense computing power, and software that can integrate data mining with statistical estimations. Further, it is likely that such analysis will be undertaken by social scientists who are not fluent in the use of computers and computing environments. Hence, the software needs to be user friendly in so far as the use of syntax is concerned. The SAS software is very appropriate for such research endeavors.

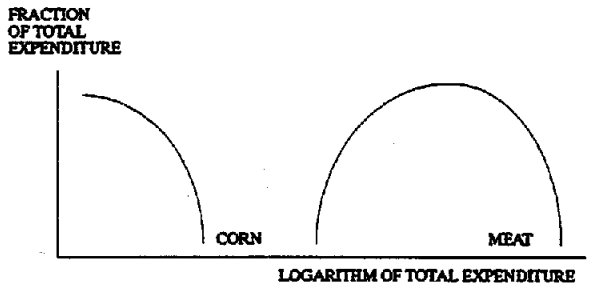

Figure 1: Effects of change in total expenditure on the shares of corn and meat.

References

[1] SAS(r), SAS/ETS(r) software. are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. (r) indicates USA registration.

[2] M. S. Ahluwalia (1976). Inequality, poverty and development. *Journal of Development Economics*, 3:307–342.

[3] J. R. Behrman and A. Deolalikar (1988). Health and nutrition. In H. Chenery and T. N. Srinivasan, editors, *The Handbook of Development Economics*. Amsterdam: North Holland.

[4] A. C. Bywater and R. L. Baldwin (1980). Alternative strategies in food - animal production. In R. L. Baldwin, editor, *Animals, Feed, Food and People: An Analysis of the Role of Animals in Food Production*. Colorado: Westview Press.

[5] P. Dasgupta and D. Ray (1986). Inequality as a determinant of malnutrition and unemployment: Theory. *Economic Journal*, 96:1011–1034.

[6] J. C. H. Fei and G. Ranis (1964). *Development of the Labour Surplus Economy*. Homewood, Illinois: Irwin.

[7] C. Grootaert and A. Arriagada (1986). The Peruvian living standards survey: An annotated questionnaire. Technical report, The World Bank.

[8] M. Kalecki (1976). *Essays on developing Economies*. Harvester Press Ltd. and Humanities Press Inc..

[9] S. Kuznets (1955). Economic growth and income inequality. *American Economic Journal*, 45:1–28.

[10] L. F. Lee and M. M. Pitt (1986). Microeconomic demand systems with binding nonnegativity constraints. *Econometrica*, 54:1237–1242.

[11] W. A. Lewis (1954). Economic development with unlimited supply of labour. *Manchester School*, 20:139–191.

[12] M. Ravallion (1987). *Markets and Famines*. Clarendon Press: Oxford.

[13] T. P. Schultz (1979). Interpretations of relations among mortality, economics of the household and the health environment. Technical report, International Labour Office, Geneva.

[14] A. K. Sen (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford University Press.

[15] D. Thomas et al (1989). Estimating the impact of income and price changes on consumption in brazil. Working paper, Economic Growth Center, Yale University.

[16] T. J. Wales and A. D. Woodland (1983). Estimation of consumer demand systems with binding non-negativity constraints. *Journal of Econometrics*, 21:263–285.

[17] J. G. Williamson (1984). British mortality and the value of life, 1781-1931. *Population Studies*, 38:157–172.

[18] P. A. Yotopoulos (1985). Middle income classes and food crises: The "new" food-feed competition. *Economic Development and Cultural Change*, 33:463–483.