STRATEGIES TO ANALYZE THE ECONOMICS OF CASSAVA IN JAMAICA

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Dr. Roberto R. Saez
CIAT - Cassava Economics

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Jamaica is an island economy with 2.2 million people and a GNP per capita of US$1,330 in 1982, which was unchanged in constant terms during the last 5-6 years. Although agriculture is a large employer of labor with a 35% share, it contributes with a mere 7% of the total GNP. For the past decade foreign exchange unbalances have created problems due to severe drops in bauxita earnings in addition to falling exports of banana, sugar, coconut, cocoa, pepper, etc. (overall, since 1972 the rate of export earnings decline was 3.3% annually). At the same time agricultural imports like rice, milk, beef, fish, soybeans, corn, etc., began to rise at a faster rate. For instance, cereal imports which were 340,000 metric tons in 1974 moved to 405,000 m.t. in 1982. The average index of domestic food production per capita being 100 for '69 - 71 decline to 90 in 1980 - 82. Land started to become an abundant resource because of being unutilized or subutilized, and consequently unemployment increased. Meanwhile current account showed a deficit of $403 million in '82, with international reserves dropping to US$109 million in that same year, equivalent to only 0.7 month of imports, while external public debt outstanding peaked US$1.5 billion, roughly 50% of total GNP. Fiscal deficit climbed to a 16.6% of GNP in 1981 and gross domestic investment decreased at a rate of 7.6% annually from 1970 - 82 (The World Bank, 1984).

Plenty of factors can explain this poor performance of the Jamaican economy, but at least two of them are: (a) an overvalued exchange rate prevailing during most of this period, which imposed an indirect tax over export agriculture (making it relatively less profitable), while domestic agriculture had to compete with basic food imports under unfavorable conditions, and (b) a world-wide recession specially in the industrial economies which reduced effective demand for these products, as well as their corresponding prices (75% of Jamaica merchandise exports went to industrial markets in '82, and the terms of trade which were 107 in '73 dropped to 85 in '82) (the World Bank, 1984).

It is in this context that the present administration is pushing harder for a more open economy that gives additional incentives to the private sector in order to reverse these undesirable trends. In particular, a more realistic exchange rate has been set starting at the fourth quarter of 1983 (it moved from J$1.78 to J$2.38/U.S. dollar, while currently is reaching the J$5.40 level), and Agro 21 was created as a government agency aimed to estimulate agricultural production on both small and commercial scales.

Cassava fits very well within this strategy, mainly among those commodities which were selected for partial or total self-sufficiency during the next few years (i.e., rice, milk, beef, fish, soybeans). Specially imported corn will be the target at which additional cassava production should aim to replace at a rate of 40% approximately, generating foreign exchange savings of US$10 millions. Priority consideration in the utilization of this root will be as an animal feed, and secundarily to reduce the needs for imported wheat flour. A goal of 5,000 has. (1,200 has. privately owned by small farmers, and 3,800 has. government land, but mostly under lease arrangements) have been selected in parishes of the country for the promotion of this crop (Agro-21, 1985).

Neoclassical economic theory and its applications allow researchers to utilize numerous procedures to generate appropriate answers to some of the difficult real-world problems, like the ones mentioned before. In particular, the author has recently joined CIAT cassava-economics program with the responsibility to give full support to national cassava programs in a region composed by Mexico, Central America, and the Caribbean (Jamaica is among a five priority country group selected to carry out in-depth studies in such a crop). Consequently, this paper attempts to outline objectives, methodologies, data requirements and summarize the importance of the results to be reached, with the intention to create early feedbacks for ways to improve the study. Again, most, if not all, of the objectives and procedures to be described here will be conducted in Jamaica.

Objectives

Consistent with the general background described the present research has as a broad purpose to carry out an appraisal of the importance that a controlled expansion of cassava production would imply for each individual countries, and for the region as a whole. It is hypothesized that if this strategy is properly implemented, farmers, rural employment, agribusiness, final consumers, government revenues, and foreign exchange will be all net gainers in the process. Specifically, the following operational objectives were identified:

(a) Describe the macroeconomic environment of the country in terms of historical trends on GNP, consumption, investments, exports, imports, inflation, employment, exchange rates, foreign debt, government earnings and expenditures, etc. Also, a closer look at the agricultural sector should be taken to characterize its evolution (i.e., quantities and prices), and its relationship with general agricultural policy measures implemented,

(b) Conduct as many representative farm and regional models as necessary to see how, in an optimal setting, cassava fits into a producer's willingness to plant this crop. As a first approach, market prices will be used for outputs and inputs. Technical coefficients based on current and potential efficiency levels will be selected, and market and yield risk weights will be taken into consideration as well,

(c) Based on the models developed in (b) obtain supply response functions for cassava. Depending on data availability, equivalent supply functions could also be obtained using time series information and econometric procedures for cassava and livestock products where cassava can be an important input,

(d) Using household expenditure surveys, estimate own and cross price elasticities, and income elasticity for cassava by income groups. This objective will be accomplished only if there is readily available information, that is, no attempts will be made to conduct our own surveys,

(e) Carry out studies on transportation and processing costs for fresh cassava and its alternative uses as chips (dried cassava), starch, flour, silage, casabe, bammy, etc., for domestic and/or export markets,

(f) Study the competitive performance of dried cassava as a source of energy in animal feed rations, particularly with respect to grain sorghum and maize, as well as in alternative uses for the starch and bread-flour industries,

(g) Combining the results obtained in (c), (d), (e), and (f), determine the actual and potential size of the different markets where cassava is a feasible competitor,

(h) Compute the nominal protection coefficient, effective protection coefficient, effective subsidy coefficient, producer and consumer subsidy equivalent, domestic resource cost coefficient, net economic benefit and several welfare effects (i.e., net economic loss in production and consumption) for cassava and related crops. All these indicators aim to give a strong insight over the comparative advantage in estimulating cassava production in the country (region).

Methodology

The first specific objective mentioned before (identified as (a) in the objectives section) does not need any peculiar methodology. A major requirement is however, the actual gathering of this secundary data. Once classified and put into tables, a careful examination of this information will allow drawing conclusions by studying past performance of one or several parameters of the economy. Understanding the causes of a particular phenomenon one can get some feeling into what must be done to modify unfavorable trend.

For the second objective it will be required some modeling. One of the several ways to simulate the economic environment that producers constantly face is the following modified version of one initially suggested by Hazell in 1971:

Objective Function: $$\text{Max}_X Z = \sum_{j=1}^{m} C_j' X_j \qquad (1)$$

Subject to,

a) $$\sum_{j=1}^{m} a_{ij} X_j \gtrless B_i, i = 1,\ldots,n$$

b) $$\sum_{j=1}^{m} (C_{kj} - G_j) X_j - Y_k^+ + Y_k^- = 0 \ , \ k = 1,\ldots,s$$

c) $$\frac{1}{s} \sum_{k=1}^{s} |Y_{kj}| < \lambda \ , \ \lambda = 0 \text{ to unbounded}$$

d) $$X_j > 0$$

where:

C : is a m x 1 vector of expected prices or net expected revenues,

X : is a m x 1 vector of activities (i.e., commodities to be produced),

Z : is expected total net income,

a : is a n x m matrix of technical coefficients, B : is a n x 1 vector of resources,

s : are observations in a random sample of gross margins,

G : is sample income mean,

λ : is a scalar,

Y^+,
Y^- : is positive or negative deviations computed as:

$$\left| \sum_{j=1}^{m} (C_{kj} - G_j)\ X_j \right|$$

An unbaised estimator of the population mean absolute income deviation is given by (A):

$$A = \frac{1}{s} \sum_{k=1}^{s} \left| \sum_{j=1}^{m} (C_{kj} - G_j)\ X_j \right| \qquad (2)$$

This model intially named as MOTAD makes it possible to satisfy a risk objective within a standard linear programming approach (LP), by linear approximation. Thus, using absolute income deviation (A) as a measure of risk, it can be assumed that a decision maker may consider both expected income (Z) and (A) as the crucial parameters in the selection of a farm plan. Efficient Z-A farm plans are those having minimum mean absolute income deviation for given expected income levels (Z). It is the above restriction (c) (mean abasolute deviation) that when parametrized from zero to unbounded, gives the estimated efficient Z-A frontier. It is generally assumed that the individual is risk averter and thus, he will prefer less risk to more risk given the same monetary outcome.

The third objective can be readily accomplished as an extension of the model just described. If we parametrize (that is, give multiple values to a parameter) the price for cassava a farmer receives, keeping all other prices constant, one obtains new multiple solutions (not necessarily one for each price modification since over some range of prices there may be no change in the optimal solutions). Thus, as the price of cassava goes up *ceteris paribus*, more cassava will be produced. In order to get a continuous and average function from the typical stepped solutions of a LP parametrized model, one can apply ordinary least square regression to those multiple outcomes, and later on compute a price elasticity measure. To get cross price effects on cassava one can parametrize the price of alternative crops and see how this affects cassava production.

The previous supply function responses obtained based on LP models follow a normative approach to the problem, in the sense that they are the best estimates if and only if all farmers behave rationally, having both profit maximizing and risk aversion objectives as specified in equation (1). Another alternative is to reach these estimates but based on historical evidences (i.e., positive approach) to real price variation. These two approaches may not necessarily coincide.

Dual models allow to get direct statistical estimation of cost or profit functions and/or a system of their corresponding first partial derivatives taken with respect to exogenous prices. Given competitive behavior and certain fairly weak regularity assumptions in the production function, a unique relationship exists between properties of the estimated cost or profit function and properties of the production funtion (Lau, Jorgenson and Lau, Nash, Lopez, Saez, etc.). In particular, when the profit maximization postulate can be taken as a reasonable approximation, estimating the profit function allows measurements of all interdependent relationships of product supplies and variable input demands. Thus, the first derivative of a second order expansion to the normalized profit, price variables, and fixed inputs (i.e., normalized quadratic function) with respect to normalized product and input prices, along with additive error terms, gives product supply and factor demand equations which are linear in normalized prices and in quantitives of fixed inputs:

$$\text{(2a)} \quad \frac{\partial \Pi^{*'}}{\partial P_i} = Y_i = b_i + \sum_{h=1}^{n-1} b_{ih} P_i' + \sum_{j=1}^{m} e_{ij} R_j' + \sum_{z=1}^{s} f_{iz} \Theta_z + \varepsilon_i$$

$$\text{(2b)} \quad \frac{\partial \Pi^{*'}}{\partial R_j} = - X_j = c_j + \sum_{k=1}^{m} c_{jk} R_j' + \sum_{i=1}^{n-1} e_{ij} P_j' + \sum_{z=1}^{s} g_{jz} \Theta_z + \varepsilon_j$$

where:

Y is a vector of commodities (Y_i), i= 1, ..., n-1,

X is a vector of variable inputs (X_j), j= 1, ..., m,

Θ is a vector of fixed inputs (Θ_z), z= 1, ..., s,

P_i' is a vector of normalized expected product price, P_i/P_n,

R_j' is a vector of the normalized expected variable input price, R_j/P_n,

$\Pi^{*'}$ is the normalized indirect profit function, $\Pi^{*'}/P_n$.

The system of equations in (2) can be estimated simultaneously using Zellner's seemingly unrelated regression, when we assume or transform all right hand side variables into exogenous ones (ex-ante), being edogenous only the Y's and X's (i.e., determined within the system). It can also be shown that the following restrictions can be applied to the system in (2) which are direct consequences of economic theory considerations:

$$b_{ih} = b_{hi} \ , \ \forall_{i,h} \ , \ i \neq h$$

$$c_{jk} = c_{kj} \ , \ \forall_{j,k} \ , \ j \neq k$$

$$e_{ij} = e_{ji} \ , \ \forall_{i,j} \ , \ i \neq j$$

From the system in (2) own and cross price elasticities can be readily available.

The fourth objective is equivalent to the third one except that we are now interested in looking at consumer's rather than producer's behavior. Instead of maximizing profits subject to a set of production restrictions, we are now maximizing consumer's utility subject to an expenditure (budget) constraint faced by the average income group under investigation. Without entering in much details the idea is to estimate either a unique equation for cassava demand or a whole system of equations, where cassava interacts with several other complementary or competing goods, as a way to compute their price responses. In addition, since in the specification of these demand equations an important variable is available real income by consumers, an estimate of income elasticity can also be obtained for each of the goods studied. Authors which have devoted entire books on the theory and applications in this subject are Phlips, and S. Johnson, et al. The interested reader can consult them.

The next objective is to compute the transportation-processing costs in moving and converting fresh cassava into various end-products where an actual or potential demand for them do exist. Here, fairly standard economic procedures will be utilized to compute fixed and variable costs to transport cassava from the farm gate to its next stage, namely, direct consumption in urban markets, or being processed into products like chips, silage, starch, bread-flour, casabe, bammy, etc. Whenever the industrial stage to transform cassava is required, another set of fixed and variable costs are implied for each type of end-product,and consequently their appropriate estimation will be carry out. For instance, in the Jamaican case, priority will be given to estimate the cassava flour processing costs at the Goshen factory in St. Elizabeth, as well as the corresponding costs to transform it into silage in the large livestock operations, and into dried (chip) cassava using solar energy on large concrete floors.

Objective (f) will be accomplished by applying straight forward LP models to multiple sources of protein, carbohidrate, fats, minerals, etc. As opposed to the profit maximizing farm model presented in (1), the objective here is to minimize total variable costs to get an animal feed ration characterized for supplying specific nutrient contents and thus, meet livestock, pork, or poultry requirements. The interest point is to evaluate the competitive economic performance of cassava chips relative to other alternatives of energy, like maize and grain sorghum that generally requires to be imported. As a first approximation to the problem, relevant market prices will be selected in this analysis. A second round of evaluation can take place if one uses undistorted (i.e., shadow) prices to the main ingredients of the desired ration type. A direct comparison of both solutions can give us an idea of the impact that government intervention is causing for an appropriate allocation of resources in a particular economy.

An equivalent analysis can be carry out whenever we study the competitive ability of cassava as a source for producing starch and bread-flour relative to maize and wheat, respectively.

After being assessed both producer and consumer response to relative prices of cassava and their corresponding income effects by households (objectives (c) and (d)), the final cost to the various cassava end-products (objective (e)) in addition to their ability to compete against other products (objective (f)), an evaluation of the potential market for cassava must become apparent (objective (g)). This potential can be compared against its current shares in those markets. Any gap that results form this analysis will provide us with targets at which national programs should aim to reach desired social objectives consistant with economic efficiency and income distribution criterion. From this, major obstacles that prevent this crop from having a larger rol in the agricultural economy should be transparent, as well as alternative ways to remove them.

Finally, the last objective implies the utilization of the "comparative advantage" methodology that has been developed and applied by many researchers and institutions around the world in recent years (see for example, Ahmed, Byerlee, Field and Appleyard, Pearson et al, Scandizzo and Bruce, Tower, etc.). This technique attempts to evaluate single domestic prices, domestic value added and the cost of non-tradeable domestic resources required for the production of a particular good, relative to their corresponding international prices, value added and tradeable resources value at border prices within a context of free movement of goods with no domestic policy interferences among traiding countries. It is largely assumed that a country which its domestic price system follows closely the broadest possible price market (i.e., the world market) will generally reach a better allocation of scarse resources from an efficient point of view, rather than trying to apply artificial incentives and disincentives for each individual activity. Of course it can be other reasons for a country to adopt a policy that implies deviations from world prices, mainly because of income distribution problems (i.e., big unemployment in certain areas), infant-industry type of arguments, and so on. In any case, it will be very useful for a country to analyze the real costs it takes to carry out such policies, in order to let high ranking decision makers judge whether they are worth the benefits they are suppose to accomplish.

A quick review of different measures to appraise comparative advantages objectives are as follows:

a) <u>Nominal Protection Coefficient</u> (NPC)

$$NPC_i = \frac{P_i^d}{P_i^b} \qquad (3)$$

where,

P_i^d : is domestic weighted average price valued at the processing stage we are interesting in (i.e., farm, wholesale, retail levels, etc.), i = 1, ... , n,

P_i^d : is the corresponding price (CIF or FOB for an import or export good, respectively) adjusted by the official exchange rate to convert its foreign currency value into local currency, i = 1, ..., n

To get a true value of the P_i^b to compare against its corresponding P_i^d, we have to include port handling plus transportation, processing, and marketing margin costs at the point and stage we are doing comparisons.

Thus, if NPC > 1 it indicates that a positive protection for the domestic producer (and injury to the domestic consumer) does exist in relation to a complete free trade case. A slight modification of equation (3) is when we adjust international prices by the <u>shadow exchange rate</u> instead of the official one to reach the appropriate P^b

value. This way a more truely measure of protection is obtained.

(b) Producer and Consumer Subsidy Equivalents

$$(4) \quad PSE_i = \frac{P_i^d + \text{Input Subsidy} - P_i^b}{P_i^b} = \text{Producer Subsidy Equivalent}$$

$$(5) \quad CSE_i = \frac{P_i^b - P_i^d}{P_i^b} = \text{Consumer Subsidy Equivalent}$$

These relationships can be either positive or negative depending whether there are protective measures applied on consumers and producers by the government, relative to a free trade situation.

(c) Effective Protection Coefficient (EPC)

$$(6) \qquad EPC_i = \frac{P_i^d - \sum_j a_{ij} P_j^d}{P_i^b - \sum_j a_{ij} P_j^b}$$

where,

a_{ij}: is all traded inputs required to produce the comodity i, as well as all traded components of non-traded inputs.

Thus, if EPC >1, the process of adding value in goods i is being protected, as the final commodity price is being raised by the protection. If EPC <1, the industry is receiving "negative" protection.

(d) Domestic Resource Cost (DRC)

The DRC coefficient is a measure concerned with the relative efficiency of producing any given commodity domestically in comparison with reliance on imports of the commodity. A country is view as having a comparative advantage in the production of a given goods whenever the expediture on domestic resources in terms of foreign exchange is less than the domestic cost per unit of foreign exchange required to import the good.

$$(7) \qquad DRC_i = \frac{P_i^d - \sum_{j=k+1}^{J} a_{ij}V_j}{P_i^b - \sum_{j=1}^{k} a_{ij}N_j^b}$$

where,

V_j : is domestic shadow price of non-traded domestic input j,

N_j^b : is international price of traded input j,

j : 1, ... k for traded inputs,

j : k + 1, ..., J for non-traded inputs.

Thus, if DRC is greater than shadow exchange rate (SER), then a product should be imported as the domestic resource cost is greater per unit compared to the real resource cost of importing the good at the SER. Conversely, if DRC_i < SER, the good should be produced domestically and exported.

To avoid a more lenghtly exposition at this time, other indicators of comparative advantage can be computed but it will not be presented here. We can mention that several welfare effect measures due to trade distortion are available like (i) the net economic loss in production, (ii) the net economic loss in consumption, (iii) changes in government revenues, (iv) changes in foreign exchange outlays, and (v) the net effect on the whole society. All of them can also contribute to get a more complete view of cassava issues and their close competitor as energy source in a particular country.

Data Requirements

Due to the very nature of this research an ample need of information will be necessary for the study to be carried out, but it is hoped that most of it is going to be available.

For the first objective, published secundary data on important macroeconomic and sectorial indicators can be obtained from the International Financial Statistics (IMF), World Development Report (The World Bank), FAO Production Yearbook, FAO Trade Year Book, FAO Food Balance Sheets, The

Economist, etc., as well as from publications issued by The Central Banks and Ministy of Agriculture and Planning offices for each individual country in the region.

The second objective will require more detailed information which can be obtained through either personal communications with knowledgeable professionals in the study area, or by means of statistical farm surveys. Obviously, the first option is quicker and cheaper, and if caution is taken could also be fairly representative of the characteristics under investigation. However, if no reliable data is available there will be no other option but to conduct random farm (regional) surveys.

Supply response functions derived form LP models do not require any specific data once the farm models are built. However, to compute these functions starting from historical data, published time-series and time-series-cross-sectional data on quantities and prices will be necessary to gather in order to apply econometric procedures. Although we are not confident in collecting enough cassava information through time as we may want, due to a general little attention given to this crop, we believe that livestock and grain figures should be available.

As mentioned before cassava demand estimations based on household expenditure surveys will be conducted only if we have access to that specific information. In this respect we have herd that this data could be available for a few countries in the region.

Transportation and processing costs data for cassava and related crops can be developed by interviewing the appropriate (representatives) economic agents involved in these processes, i.e., truck companies, and cooperatives or private agribusiness transforming cassava into marketable products.

For the minimum cost LP models where cassava competes against alternative sources of energy, the information required is given by the nutrient specification for each type of feed rations to be analyzed (i.e., pork, poultry, dairy cattle, etc.), as well as the nutrient supplied by the various ingredients to be mixed. CIAT cassava program has already developed these type of technical coefficients and feed specifications, thus, it will be no problems in having access to this data.

Data needed to evaluate the actual size of the different markets for cassava and related commoditiees have to come from national publications, while the potential size of these markets will imply an analysis and integration of the previous results obtained.

Finally, for the comparative advantage methodology, an ample product and input price information will be needed at domestic and foreign levels. Most of this data should be available from international sources (i.e., FAO), and agricultural national planning agencies. On the other hand, the set of technical coefficients for inputs required in the production of a particular commodity should be the same as the ones used before for the farm budgets developed to run the LP models. In addition, the tax and subsidy rate structure and exchange rates of the country must also be available.

Importance of the Study

It is believed that once this research is completed, policy makers will have at their disposition unbiased conclusions and recommendations for them to make rational decisions on this subject. Although it can hardly be expected the same results for each country in the region, there are good chances that in general, additional cassava production and industrialization of the fresh roots will contribute positively to the well-being of a wide range of economic agents, mainly, agricultural producers, rural laborers, small scale agribusiness, government revenues, foreign exchange savings, and final consumers. This is due to the fact that developing economics have been inclined to penalized the agricultural terms of trade relative to other sectors of the economy, as a result of a variety of government intervention policies. However, if these terms of trade are place in more equitable levels, the agricultural sector should responde accordingly.

In particular, cassava has numerous characteristics which makes it suitable for cultivation under intense labor practices in relatively poor climate and soil conditions. Being allowed to fair relative prices, cassava should be a strong competitor for underutilized national resources to contribute to the domestic supply of well-needed end-products, instead of choosing the "easy" solution of importing increasing amounts of cereals (i.e., wheat, maize, sorghum).

REFERENCES

Agro-21. Economic Feasibility on Cassava, March, 1985, Jamaica.

Ahmed, Sadiq. Shadow Prices for Economic Appraisal of projects: An application to Thailand. The World Bank, Staff Working Papers Number 609.

Byerlee, Derek. Comparative Advantages and Policy Incentives in Wheat Production in Rainfed and Irrigated Areas of Mexico. CIMMYT, Economics Program, June, 1983.

Byerlee, Derek. Comparative Advantage and Policy Incentives for Wheat Production in Ecuador. CIMMYT, Economics Program, Feb., 1985.

FAO. Production Yearbook, various issues.

FAO. Trade Yearbook, various issues.

Field, Alfred J., and D. R. Appleyard. Analizing The Impact of Market Intervention in Agriculture. The World Bank, Staff Working Paper, June 1983.

Hazell, P.B.R. "A Linear Alternative to Quadratic and Semivariance Programming for Farm Planning under Uncertainty". American Journal of Agricultural Economics, 53 (1971): 53-62.

International Monetary Fund. International Financial Statistics, various issues.

Johnson, Stanley, Z. Hassar, and R. Green. "Demand Systems Estimation: Methods and Applications". Iowa State University Press, 1985.

Jorgenson, D. W., and L. J. Lau. "Duality and Differentiability in Production". Journal of Economic Theory 9 (1974): 23 - 42.

Lau, L.J. Applications of Profit Functions, in M. Fuss and D. McFadden (eds), Production Economics: A Dual Approach to Theory and Applications, North Holland Publishing Company, Vol 1, pp. 133 - 216, 1978

Lopez, R. E. "Applications to Duality Theory to Agriculture" Invited Paper Presented at the 1982 AAEA - WAEA Annual Meeting, August, 1982, Logan, Utah.

Nash, E. K. Examining Properties of Multiple Product Production Technologies and Profit Functions. M. S. Thesis, Texas A&M University, 1981.

Pearson, S.R., N. Akrasanee, and G. C. Nelson. Comparative Advantage in Rice Production: A Methodological Introduction. Food Research Institute Studies, XV, 2, 1976.

Pearson, S. R. Net Social Profitability, Domestic Resource Costs, and Effective Rate of Protection. The Journal of Development Studies, Vol 12, July 1976.

Phlips, Louis. Applied Consumption Analysis. North Holland Publishing Company, 1974,

Saez, R.R. Optimization Model Under Risk for Beef Cattle Producers in East Texas, M.S. Thesis, Texas A&M University, May 1978.

Saez, R. R. Multiproduct Agricultural Supply Response and Factor Demand Estimation in the U.S.: The Profit Function Approach. Ph.D. Dissertation, Texas A&M University, Texas, May 1983.

Scandizzo, P. L., and C. Bruce. Methodologies for Measuring Agricultural Price Intervention Effects. The World Bank, Staff Working Paper Number 394, June 1980.

The Economist. The World in Figures. The Economist Newspaper Limited, England, 1981.

The World Bank. World Development Report 1984. The World Bank, July 1984.

Tower, Edward. Effective Protection, Domestic Resource Costs, and Shadow Prices: A General Equilibrium Perspective. The World Bank, Staff Working Paper Number 664, September 1984.

Zellner, A. "An efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias". Journal of the American Statistical Association 57(1962): 348 - 68.