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Demographic Aspects of a Model of the Philippine Agricultural Sector

by

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Introduction

It is obvious that population growth is the main determinant of increases in the demand for agricultural products. On the supply side, population is obviously the base of the labor force, and, although some economists doubt that labor's marginal contribution to agricultural output is large, labor as an aggregate is undeniably a necessary input in agricultural production. The aim of this paper is to add some meat to these well-known bones, by presenting recent econometric results on the agricultural sector, within the context of a short-term aggregate planning model.[1] The demographic implications present in the model are noted, and some which are absent are also noted. One advantage of the quantitative approach is the tendency for simplifications and omissions made in the course of study to get rather obvious, and to point to further work which needs to be done.

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The model is quite aggregative. By "agriculture" is meant the whole of agriculture, fishing and forestry, the first among the sectors for which value-added data are prepared in the national income accounts. There is no distinction between traditional and modern, or between subsistence and commercial. There is also no provision for imported agricultural items. As will be evident, a hypothesis underlying the choice of variables going into the behavioral relations is that the decision makers in the agricultural sector are economic men who react as welfare maximizers to changes in incomes, wages and prices.

Estimating the Model.

The production (value-added) and price data used are from the old national accounts series, viz., the recently revised figures for 1968 and 1969, which derive from different sources and methods than earlier figures, are not used for the sake of maintaining comparability within the estimation series. Employment and wage data are from the Labor Force Surveys of the Bureau of the Census and Statistics, and land data are from the Crop and Livestock Surveys of the Bureau of Agricultural Economics. Population figures for 1960-1970 are from the Bureau of the Census, derived by means of an annual intercensual growth rate of 3.01%; figures for 1950-1959 are from Lorimer (1966). The population series used is given in Table 1.

Table 1. Mid-year Philippine Population, in thousands.

Mid-year	Population
1950	20,231
51	20,830
52	21,453
53	22,101
54	22,773
55	23,472
56	24,198
57	24,198
58	25,739
59	26,556
1960	27,387
61	28,212
62	29,062
63	29,937
64	30,837
65	31,768
66	32,725
67	33,711
68	34,726
69	35,772
1970	36,849

Source of data:

1950-1959 Lorimer, Frank W. "Analysis and and Projections of the Population of the Philippines". First Conference on Population, 1965. Population Institute, University of the Philippines, 1966, p.230.

1960-1970 Bureau of the Census and Statistics.

The estimation method was ordinary least
Final specifications were chosen in accordance with both economic and statistical criteria; with respect to the latter, t-values were given more importance than the coefficients of determination. Durbin-Watson statistics are reported h re for information's sake, although they were treated as being of only minor significance.

There are three structural relationships in the model, a product demand function, a production function and a labor demand function. Together they determine three key variables: agricultural value-added, the general level of agricultural prices, and the level of agricultural employment. The structural equations shall be considered in turn.

Product demand. The a priori candidates as explanatory variables for the amount demanded of agricultural output (output measured by value-added) were population, real disposable income, the agricultural price level and the general price level for all commodities. "Good"[2] results were only obtained, however, when the wage rate of unskilled labor was added as an explanatory variable. A rationale for this variable is given later.

Population and real disposable income are extremely highly correlated (r = .997), and efforts to include them separately in a linear demand function resulted in very poor showing of the population variable. With linear specifications it would be sufficient to include either population or real disposable income. Results of both cases are found in the first two regression equations of Table 2. In the first specification, the income elasticity[3] of demand is 0.82, and the price elasticity of demand is -0.39. Since the disposable income variable is partially a proxy for population, the computed income elasticity would reflect this variable as well, thus becoming an overestimate. In the second specification, the price elasticity is -0.22, and the population elasticity is 1.11, implying that the demand for agricultural output grows more than proportionately to population. In this case, the population elasticity is an overestimate since the population variable is partially a proxy for real disposable income.

An appealing specification, on grounds of economic theory, is the third. Here per capita consumption[4] is made a function of per capita real disposable income, of the price of agricultural products relative to all prices in general, and of the wage rate of unskilled workers.

Table 2

Estimates of Structural Equations for the Agricultural Sector

Regression Equations	Time series. Regression Code $s/\bar{R}^2$/D.W.
Product Demand	
(1) $Y_a = 103.0 + \underset{(17.5)}{0.2532}\,(Y - T) - \underset{(-3.946)}{10.26}\,P_a + \underset{(4.749)}{1.235}\,W$	1952/68.SEP115.36 48.4/.995/1.66
(2) $Y_a = -\,1666.7 + \underset{(12.8)}{0.1321}\,H - \underset{(-2.972)}{5.568}\,P_a + \underset{(5.701)}{1.402}\,W$	1950/69.JAN16.9 81.5/.991/1.84
(3) $\frac{1000Y_a}{H} = 91.35 + \underset{(3.781)}{0.1149}\,\frac{1000\,(Y - T)}{H} - \underset{(2.394)}{0.4661}\,\frac{100P_a}{P} + \underset{(2.703)}{0.02140}\,W$	1950/69.JAN18.3 3.00/.919/1.29
(4) $Y_a = -1889.2 + \underset{(4.683)}{5.697}\,\frac{1000\,(Y - T)}{H} + \underset{(3.810)}{0.06085}\,H + \underset{(6.261)}{0.9363}\,W$	1950/69.FEB32.7 65.9/.994/1.62
Production Function	
(5) $Y_a = -2505.8 + \underset{(1.868)}{0.2740}\,L + \underset{(4.661)}{0.6705}\,N_a$	1957/67.SEP5J.96 112.2/.942/1.82
(6) $Y_a = -1325.9 + \underset{(2.617)}{0.2555}\,L + \underset{(1.581)}{0.2408}\,N_a + \underset{(3.600)}{2.117}\,K_a$	1956/67.SEP52.1 76.4/.976/2.98

Table 2 (continued)

Estimates of Structural Equations for the Agricultural Sector

Regression Equations	Time series. Regression Code $s/\bar{R}^2$/D.W.
Labor Absorption	
(7) $N_a = 15.80 + 0.8819\ U - 1.132\ W_a + 5.408\ P_a$	1956/68.MAY23.1
$\qquad\qquad\quad (4.797) \quad (-1.800) \quad (1.212)$	137.1/.941/1.33
(8) $N_a = 1096.5 + 0.8458\ U - 1.727\ \frac{100\ W_a}{P_a}$	1956/68.MAY23.2
$\qquad\qquad\quad (13.12) \quad (-2.316)$	123.5/.952/1.35

Note. Numbers in parentheses below coefficients are t-values.

s = standard error of estimate.

$\bar{R}^2$ = coefficient of determination corrected for degrees of freedom.

D.W. = Durbin-Watson statistic.

Table 2 (continued)

List of variables

Y_a = net value-added in the agriculture, fishing and forestry sector in million pesos at 1955 prices.

Y = Gross National Product in million pesos at 1955 prices.

T = direct and indirect taxes, deflated by the implict GNP price index, in million pesos.

P_a = implicit price index of the agriculture, fishing and forestry sector (1955=100).

W = annual money wage rate, computed as equal to the daily peso rate of unskilled industrial workers in Manila multiplied by 250.

H = mid-year national population, in thousands.

P = implicit price index of GNP (1955=100).

L = harvested area, in thousand of hectares.

N_a = persons employed in the agriculture, fishing and forestry sector in thousands; average of May and October surveys.

K_a = capital stock in agricultural machinery and equipment plus value of work animals, beginning of the year, in million pesos at 1955 prices.

U = total labor force less persons employed in all other sectors save agriculture, fishing and forestry, in thousands; average of May and October surveys.

W_a = undeflated annual peso earnings of wage earners in the agriculture fishing and forestry sector, computed as equal to the monthly peso earnings multiplied by 12.

In this form the population effect is strictly proportional. The income elasticity of demand is 0.37, much smaller than the previous estimate, and closer to cross sectional estimates pertaining to various foods.[5] The computed price elasticity of demand is -0.41.

Equation (4) includes both a per capita income effect and a population effect. In this specification, however, the price variable does not turn out significant any longer, and is dropped out. The per capita income elasticity is 0.66, and the population elasticity is only 0.51; the former would seem to be on the high side, while the latter definitely appears to be too low. On these grounds, and for lack of the price variable, this specification appears less useful than the earlier three.

The wage variable, which enters all four specifications, introduces what may be interpreted to be an income redistribution effect. Given the level of disposable income, an increase in the wages of unskilled workers implies an increase in the share of disposable income going to low-income consumers, who are known to have a higher income elasticities of demand than high-income consumers. Hence the positive coefficient of the wage variable.[6]

Population growth has thus contributed a steady push to the demand for agricultural products. On this accounts, its contribution cannot readily be separated from that of income as a whole.[7] Demand can be relied upon to have a steady trend, with some deviations on account of changes in prices and in wages. From the short-run forecasting standpoint, knowledge of the population level is hardly more helpful than a simple extrapolation.

Demographic variables can be expected to assume more importance when a longer view is taken. It will likely be several years before birth control measures succeed in lowering the population growth rate by a significant magnitude. A second phenomenon is the gradual shift in the population's age composition; as the proportion of children rises, the demand for agricultural products will tend to rise in a proportion smaller than the growth rate of the total population. On the other hand, the spread of family planning will tend to dampen the age-composition trend. A third development which would bear study would be the affect on demand of differential rates of growth of both incomes and population (as augmented or depleted through migration), among various regions or across urban-rural boundaries. It would be of interest to establish, for example, the effect of the extreme concentration of industry in the Manila area on the growth of agriculture in Central Luzon and the Southern Tagalog provinces. Finally, the industrial wage variable, which is not determined in the model, would not be insensitive to population growth in the long-run. Changes in present fertility rates will make their effects on the future supply of labor and thus on the level of wages.

The production function. The second set of equations in Table 2 gives two specifications for an agricultural production function, one with a capital stock variable and the other without it. They indicate: (i) a marginal product of land of the order of ₱255-275 per hectare; (ii) a marginal product of labor which is quite sensitive to the inclusion of the capital variable -- ₱670 per person (per annum) in one case, and only ₱240 in the other; (iii) a rather high estimate for the marginal product of capital, over ₱2 per annum per peso in the capital stock. The capital stock data are incomplete, however, including only machinery, equipment, and the value of work animals. With a more complete measure the estimated capital coefficient would be expected to fall, in which case the labor coefficient would be less sensitive to inclusion, or non-inclusion of the capital variable. In any case, the results are not striking enough for the question of whether or nor labor has a near-zero marginal product in agriculture to be resolved. Additional variables -- irrigation and availabilities of certain purchased inputs -- have also been tried, but with little success. Regardless of specification, an obvious problem of estimation with time series data is the inability to capture the structural change implied by the recent technological changes in rice. For forecasting purposes, more detailed analysis as to crop would be suggested.

That the marginal products are fixed in the linear form need not be cause for concern. The regression is presumed to be a linear approximation of that segment of the production surface which is relevant to the data period. In the long run, however, shifts in factor proportions and concomitant changes in marginal products can be substantial. The effect of population growth on the man-land ratio in particular takes on relevance here.

The human capital aspect is an area in which little research has been done. The productivity of labor undoubtedly increases with technical knowledge and skill, and the latter would be expected to be well correlated with the level of educational attainment.[8] Quantification of this relationship appears quite feasible; the forthcoming data from the 1971 Census of Agriculture would be of special interest.

This would make it possible to account for improvements in the quality of labor when making long run assessments of the growth of agricultural output.

The demand for labor. In the last two equations of Table 2, employment in the agricultural sector is expressed as a linear function of the labor force "available" to agricultur , the agricultural wage rate and the agricultural price level. The first explanatory variable is the total labor force less the number employed in all non-agricultural sectors. Agriculture is thus treated as a residual sector, which accomodates those not able to find work in other sectors, to an extent determined by agricultural wages and prices. This envisions an economy in which the direction of labor migration is from agriculture to industry. The coefficient of the residual labor force is between 0.8 and 0.9. This implies that, given the real agricultural wage, out of every 100 marginal entrants to the labor force who are unable to find employment elsewhere, from 80 to 90 can be absorbed in agricultural work. The form of the independent variable also implies that, for every additional 100 employment places found in non-agriculture, agricultural employment will decrease by 80-90 workers. Unemployment does exist in agriculture, but to a more limited extent than in industry (Table 3).

Table 4. Reduced forms of two models of the agricultural sector

Endogenous variables / Predetermined variables	Constant	GNP less agric. value-added, less taxes	Population	Land	Labor force available for agriculture	Agricultural wages	Industrial unskilled wages
			Income-Based Demand				
Agricultural value-added	-1945.4	0.0708		0.2168	0.4678	-0.6007	0.4871
Agricultural employment	835.8	0.1056		-0.8534	0.6977	-0.8959	0.7264
Agricultural price level	151.6	0.1952		-0.0158	-0.0340	0.0437	0.1343
			Population-Based Demand				
Agricultural value-added	-2168.4		0.0521	0.1659	0.3581	-0.4598	0.5529
Agricultural employment	503.1		0.0777	-0.1612	0.5341	-0.6858	0.8246
Agricultural price level	90.1		0.0144	-0.0298	-0.0643	0.0826	0.1525

NOTE: For units and other details, refer to Table 2. The first solution is that of equations (1), (5) and (7) in that table; the second is that of equations (2), (5) and (7).

Table 3. Experienced Labor Force and Employment in Agriculture Fishing and Forestry, Philippines, 1956 - 1968, May - October Averages

Year	Expe-ienced Labor Force (thousands)	Employment (thousands)	Unemployment Rate (per cent)
1956	4912	4796	2.4
1957	5140	4966	3.4
1958	5499	5300	3.6
1959	5562	5374	3.4
1960	5450	5286	3.0
1961	5724	5566	2.8
1962	6095	5904	3.1
1963	6072	5955	1.9
1964	6149	6015	2.2
1965	5986	5888	1.6
1966	6426	6282	2.2
1967	6850	6662	2.7
1968	6584	6416	2.8

Source:of basic data: Labor Force Surveys of the Bureau of the Census and Statistics.

Equations (7) and (8) differ in that the agricultural wage and price level are introduced separately in the former but as a ratio in the latter. Statistical significance is clearly superior in the latter form. The reduced-form estimates in the next section nevertheless make use of equation (7), purely for computational convenience.

There is no explicit link in the model between population and agricultural employment, in the sense that one supplies the labor force which delimits the other. This relationship probably has a lag of fifteen or more years, and would not be essential in a short-term planning model. There are present plans to extend the model's forecasting capacity over the longer run (20 years), in which the population-labor relationship cannot be ignored.[10] The link which does exist in the present short-term scheme between the two variables stems from the demand side: an increasing population requires more food and other agricultural products, and a demand is consequently derived for agricultural labor as a production input. This is treated in the next section.

Reduced forms.

One can examine the interaction between the three basic relationships by taking their joint solutions for agricultural production, employment, and the price level.

This is of course most convenient when the equations are all linear. As mentioned earlier, the close correlation between population and income growth make it difficult to establish the separate contribution of each variable. Thus the first two equations in Table 2 are taken here as alternatives, one setting demand for agricultural products as primarily income-based, the other setting it as primarily population-based.

In the case of the production function, the specification involving only land and labor is used here since the capital coefficient in the other specification appears unrealistic and, in any case, capital is a minor source of productivity growth in agriculture. It was mentioned that the estimated relationship describes the structure of production over the data period, thus neglecting the recent years of technological improvement. This implies that the coefficients here are underestimates. The two models considered are thus, in Table 2, (i) the set of equations (1), (5) and (7), and (ii) the set of equations (2), (5) and (7). The results are found in Table 4.

Over 1950-1969 (roughly, since the regression time spans are not all the same), one finds that a marginal change in GNP (net of agricultural value-added) of ₱1 million resulted in increases in agricultural output, by about ₱71,000; in agricultural employment, by about 106 workers; and in the agricultural price index, by about .20 of a point. These are from coefficients in the upper section of Table 4. Peso values are in 1955 prices. As earlier argued, however, part of these demand-induced changes should be attributed to population growth.

If one considered population in place of income as a demand determinant, the lower half of the table would be relevant. An increase in population by one million persons would then indicate a rise in agricultural output, by ₱52 million; in agricultural employment, by 78 thousand workers; and in the agricultural price index, by 14 points. These are, of course, <u>ceteris paribus</u> statements. Presumably land and labor force resources would be simultaneously growing, thus permitting production growth with less of an impact on agricultural prices; technological change, which is not well captured in the production function used, would make a further contribution.

The coefficients of the other predetermined variables under the alternative models are also given in the table. Although the signs do not vary between halves of the table, the sizes of the coefficients to some extent do. The coefficients are generally somewhat smaller in the population-based version.[11]

Feedback.

The discussion regarding limitations of the model has so far dwelt on demographic variables not considered in the model but which could conceivably affect some of the variables of the system. It was argued that the omissions would be more serious when a long-run perspective is required. A second type of omission concerns the effects of the economic variables on the demographic factors.

As production and incomes in the various sectors change, part of the response of families may be in the number of children they plan to have, and part in the "quality" -- schooling and training -- with which they will equip their children. (For instance, there are indications in Central Luzon that increased enrolment of school-age persons in non-free high schools can be attributed to the increase in family incomes made possible by the new varieties of rice.) When these young people enter the labor force, their numbers and their preparatory training will help determine their rate of employment and their wages, and then as well their demand for agricultural products. Increased technical knowledge among those in rural areas should then raise further the productivity of labor in that sector.

Footnotes

[1]Most of the esults presented here are drawn from Mangahas and Encarnacion (1971). The model described in the paper is a subset of a broader model which determines output (as measured by value-added), employment, and, to some extent, price levels in the seven major sectors of the economy. The sectoral model is an extension of a basic model (Encarnacion, Mariano and Bautista, 1971); the latter model has been used in preparing the most recent development plan (National Economic Council, 1971).

[2]In the sense of obtaining regression coefficients of expected sign and with significant t-statistics.

[3]Elasticities are computed at the means.

[4]Measured by production, for lack of stock change data.

[5]Cf. Darrah and Tiongson (1969), p. 53.

[6]The slope coefficients in the four specifications are all individually significant at the 1% level, except for the price and wage coefficients in the third equation, where the significance level is 5%. The coefficients of determination are high, as is quite common in time series analysis. The Durbin-Watson test at the 5% level shows no autocorrelation in the case of the second equation, and is inconclusive in the three cases.

[7]The "separation" of effects in third equation of Table 2 is artificial, since the population effect is a proportional one simply by assumption.

[8]When dealing with very low range of levels of schooling, 0-4 years, one might expect that direct measures of technical knowledge would have a much higher correlation with productivity than level of formal schooling. Cf. Mangahas (1970), pp. 52-53.

[9]Since industrial wages are correlated with agricultural wages, use of the industrial wage variable instead gives an equally good statistical fit. Its coefficient would measure the agricultural employment drawdown per unit increase in the industrial wage, as rural-to-urban migration takes place. Thus far a separation of the industrial wage effect and the agricultural wage effect has not been made.

[10]A by-product of the analysis would presumably be the determination of wage rates.

[11]From proxy-variable analysis, we know that the coefficient size-differences are a reflection both of the imperfection of the population variable, in explaining the contribution of the income factor and of the degree of multicollinearity between the population variable and the other included variables. The results however are not yet well explained in economic terms, and deserve further study.

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