PN-AAY-457
ISN 52675

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Reprinted from the
Journal of Development Economics
Vol. 23, 1986

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1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 U.S.A.

Reprint No. 99

Journal of Development Economics 23 (1986) 19–39. North-Holland

DOMESTIC PRICE DISTORTIONS AND AGRICULTURAL INCOME IN DEVELOPING COUNTRIES

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Received December 1984, final version received June 1985

The static effects on agricultural crop production and income arising from the correction of three common policy biases in developing countries – the underpricing of food, agricultural export taxation, and currency overvaluation – are examined analytically and empirically (using Philippine data) based on a model of the agricultural sector with the food–export crop tradeoff in production as a key component. The findings argue for a careful examination of the relative efficiencies of different liberalization policy instruments in advancing specific development objectives in cases where, possibly for socio-political reasons, not all price distortions in interrelated markets can be corrected.

1. Introduction

The underpricing of food and overvaluation of the domestic currency – relative to what would prevail under a free trade regime – are two of the most widely observed features of the domestic policy environment in developing countries (LDCs), especially the less advanced LDCs. Additionally, agricultural products are often implicitly or explicitly subject to export tax, reducing their domestic price relative to the world price. In the past these policies gained support from arguments related to the need to promote industrialization. Low food prices keep real wages low which, in the classical growth model à la Lewis (1954), facilitates the transfer of workers from agriculture to the industrial sector. Agricultural export taxes encourage the domestic processing of primary commodities and export diversification into manufactured products. Finally, an undervalued foreign exchange makes imported material inputs and machinery cheap for domestic industries whose products can be protected from foreign competition through tariffs and other trade barriers.[1]

*Comments by Yair Mundlak, Jaime Quizon, Alberto Valdés and an anonymous referee on earlier drafts of this paper are gratefully acknowledged. Thanks are also due Ariane Alaman and Nhan Nguyen for assistance in data collection and computer work.

[1]Indeed, the heavy protection of domestic manufacturing has been a major contributing factor in the ability of many developing countries to maintain artificially low real exchange rates (in units of local currency per unit of foreign currency).

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More recently, neoclassical analysis has emphasized the potentially high social cost of domestic price distortions in terms of their resource allocation, national output and income distribution effects.[2] At a sectoral level, price intervention policies concerning food, agricultural exports and foreign exchange are likely to create biases in the structure of incentives within agriculture. The effects of such policies are presumably different for food exporting and non-food exporting LDCs. An agricultural sector dominated by export-oriented food producers is necessarily penalized, in terms of the impact on income, by the reinforcing effects of currency overvaluation, agricultural export taxation and low food price policy. Each of these policies creates a disincentive to agricultural production; in combination they lead to an even greater distortion of incentives biased against agriculture. In the case of a food-deficit LDC with comparative advantage in producing other farm crops (the 'export crops'), so that a tradeoff exists between food and export crop production, the effects of the three policies might be expected to be offsetting (at least partly), assuming that production decisions in agriculture are significantly determined by relative prices within that sector.

There has been growing recognition among LDC governments, in recent years, of the need to undertake 'liberalization policies' aimed at reducing domestic market distortions and raising allocative efficiency in resource use. Policy reforms involving foreign trade, exchange rate and agricultural price policies (among others) are increasingly being considered and implemented, sometimes with active support from some international organizations, calling for a relaxation of price and administrative controls in the domestic market. In many cases, restructuring of the industrial and energy sectors has been the primary objective of LDC liberalization policies, with scant attention given to the repercussions in the agricultural sector. Because trade and exchange rate policies can have a significant influence on relative prices and agricultural production incentives, there is a need to provide a systematic analysis of the effects of such policy adjustments on the agricultural sector. This would seem particularly true in many LDCs that effectively insulate the agricultural food sector from the world market but are significant exporters of some other agricultural products.

This paper examines how agricultural production and income would be affected by alternative liberalization policies involving the correction of the three sources of domestic price distortions mentioned above. A two-crop, general equilibrium model of the agricultural sector is developed, assuming that a tradeoff exists between food and export crop production. The model is used to investigate analytically the impact of exogenous changes in the food price, export tax and exchange rate variables on the production-mix and total crop income; in particular, the conditions under which a liberalization

[2]See, among others, Little et al. (1970), Bhagwati (1978) and Timmer (1980).

of food pricing, export tax and exchange rate policies will lead to higher agricultural income are derived, given alternative assumptions concerning the elasticity of foreign demand for export crops. An application to Philippine agriculture is also provided, analyzing quantitatively the income effects of some policy reforms toward a free trade regime, viz., removing – singly or jointly – domestic price distortions in the markets for food crops, agricultural export commodities and foreign exchange.

2. Model specification

Producer behavior is represented in the model by the following supply equations indicating a tradeoff between food and export crop production:

$$Q_f = Q_f(P_f, P_x; W, P_i; Z), \tag{1}$$

$$Q_x = Q_x(P_f, P_x; W, P_i; Z), \tag{2}$$

where Q_f and Q_x are quantities of food and export crop outputs, respectively; P_f and P_x are the domestic prices of food and export crops, respectively; W is the agricultural wage rate; P_i is the price of intermediate inputs; and Z is a vector of quantities of fixed inputs and other supply shifters such as technology and weather variables.[3] Labor is one of the variable inputs and its price is assumed exogenous together with the Z variables. Exogeneity of the agricultural wage rate is suggested by institutional and policy considerations in many LDCs where there is an excess of supply of labor within agriculture.[4]

Eqs. (1) and (2) may be considered part of a system of output supply and input demand equations which, under conditions of regular technology, competitive behavior and short-run equilibrium, can be derived from the variable profit function via Shepard's lemma; that is, $Q^* = \partial \Pi^* / \partial P = Q^*(P, Z)$, where Π^* is maximized variable profits, Q^* is the vector of optimal output supplies and variable input demands (in negative units), and P is the vector of output and variable input prices.[5]

It is assumed that the government, through appropriate food imports and/or food stocking arrangements, effectively controls the domestic food

[3]Except for the foreign prices (P_x^* and P_i^*, to be introduced below), all price variables in the real (non-monetary) system represented in the present model should be interpreted as relative prices vis-à-vis a numeraire (e.g., non-tradable goods).

[4]It is sometimes desirable to endogenize the wage variable, in which case the supply side of the agricultural labor market also needs to be modeled, including the processes of rural–urban migration and rural population growth. However, in a simplified static model such as the one developed in this paper, it is appropriate to treat the wage rate as a given. Bardhan and Srinivasan (1971), among other related studies, also assume exogeneity of the wage variable since 'it depends on a whole host of factors outside the agricultural sector' (p. 48).

[5]See Shepard (1970).

price (P_f), which therefore can be considered an exogenous policy variable.[6] This would seem a realistic assumption for most developing countries. Although the motivation may differ among LDC governments, the domestic price of food is generally considered too important, in an economic–political sense, to be determined by free market forces; in the less advanced developing countries, it is commonly the case that a low food price policy is adopted.[7]

The domestic price of export crops (P_x) is determined by the foreign price (P_x^*), the real exchange rate (R) and the agricultural export tax rate (t_x),

$$P_x = P_x^* R(1 - t_x). \tag{3}$$

Where state marketing boards have effective control over agricultural export trade (also not uncommon in developing countries), t_x would represent an implicit export tax underlying the disparity between the foreign price RP_x^* (in local currency terms) and the government-determined domestic price. Unless otherwise indicated, the analysis below will assume that the export tax is the policy instrument being used, rather than the direct price intervention policy of state marketing boards. While no analytical difficulty is presented by the latter assumption, it is clear that it makes a difference on the effects of an exchange rate change if the marketing board does not respond to a change in the foreign exchange rate by adjusting equiproportionately the domestic price of export crops. It is also assumed that the real exchange rate is a policy variable, determined not only by the country's monetary policy but also by its commercial policy, i.e., the structure of tariffs and subsidies on all tradable goods [cf. Cavallo and Mundlak (1982)].

The foreign price of export crops and amount exported can be treated in either one of two ways: (1) under the small country assumption (i.e., perfectly elastic foreign export demand), P_x^* is an exogenous variable and export supply is determined residually by subtracting domestic demand from total production of export crops, or (2) if the country's market share is not small, foreign demand for exports (E_x) is inversely related to the foreign currency price, and P_x^* becomes an endogenous variable – necessitating the introduction of a domestic market clearing equation,

$$Q_x(P_f, P_x, \ldots) = D_x + E_x(P_x^*, \ldots), \tag{4}$$

[6]In a more elaborate model, P_f can be endogenized through a domestic food market clearing mechanism in which a major exogenous influence would be the amount of government food imports or the supply of foreign exchange [cf. Bautista (1978) and Scobie (1981)].

[7]There is some evidence [cf. Anderson (1982)] that, with improving comparative advantage in industrial goods, developing countries over time tend to protect the domestic food sector and increase producer prices of food crops relative to world prices.

where D_x is the amount of export crops used domestically (as inputs to non-agricultural production). The other arguments in the foreign export demand function (apart from P_x^*) represents exogenous influences such as the supply prices of other exporting countries and activity variables for the importing countries. On the assumption of fixed agricultural input coefficients in domestic processing industries, D_x will not be affected by changes in P_x, and hence, is treated as an exogenous variable in the present model.

Intermediate inputs in crop production consist mainly of fertilizers, pesticides and other farm chemicals. It is frequently the case that their prices are subject to domestic price regulations. Their use is given price subsidies in some developing countries, while in others the domestic prices of fertilizers and other industrial products are made artificially high by a protective policy toward local producers. Since they are tradable goods, the domestic price of agricultural intermediate inputs (P_i) can be simply represented by

$$P_i = P_i^* R(1 + t_{mi}), \tag{5}$$

where P_i^* is the foreign currency price, and t_{mi} is the implicit tariff rate. Again, government policy may either fix P_i or t_{mi}; for purposes of the present model, t_{mi} is assumed to be the relevant policy instrument.

Agricultural income (Y) can be expressed as the sum of value added in food and export crop production,

$$Y = (P_f - a_{fi}P_i)Q_f + (P_x - a_{xi}P_x)Q_x, \tag{6}$$

where a_{fi} and a_{xi} are the intermediate input coefficients in the production of food and export crops, respectively.

The complete model under Case (1), which is based on the small country assumption, consists of eqs. (1), (2), (3), (5) and (6), involving Q_f, Q_x, P_x, P_i and Y as endogenous variables, and P_f, W, Z, R, t_{mi}, t_x, P_i^* and P_x^* as exogenous variables. Under Case (2), the model also includes eq. (4), P_x^* becomes an endogenous variable, and D_x is an additional exogenous variable.

3. Comparative statics

Consider first the effects of an upward adjustment in the domestic price of food crops. These would differ in the two cases distinguished above concerning the treatment of P_x^*. With given foreign price of export crops (under the small country assumption), to be labelled Case (1), the domestic price P_x is invariant with respect to a change in P_f. Other exogenous variables remaining the same, food and export crop production will be affected as follows:

$$\hat{Q}_f = \alpha_{ff}\hat{P}_f \quad \text{and} \quad \hat{Q}_x = \alpha_{xf}\hat{P}_f, \tag{7}$$

where α_{ff} (>0) and α_{xf} (<0) are the supply elasticities of food and export crop outputs, respectively, with respect to P_f, and the hat ($\hat{}$) over the variables denotes proportionate changes. Given the a priori signs of the elasticity parameters, a policy shift toward a higher P_f will improve relative incentives for food crops vis-à-vis export crops, and can be expected to raise food crop output and reduce production of export crops.

Agricultural income will therefore be subject to two opposing effects – a rise in income due to the higher price and output of food crops and a fall in income due to the lower export crop output. The net change in total crop income is given by[8]

$$\hat{Y}=\{(1+c_f\alpha_{ff})v_f/c_f+\alpha_{xf}v_x\}\hat{P}_f, \tag{8}$$

where c_f is the ratio of value added to the value of output in food crops production and v_f and v_x are the value added shares in food and export crop production. The necessary and sufficient condition for an increase in P_f to result in a higher Y is that the bracketed term in eq. (8) be greater than zero, or equivalently (substituting $v_x=1-v_f$),

$$v_f>\frac{-\alpha_{xf}}{1/c_f+\alpha_{ff}-\alpha_{xf}}. \tag{9}$$

It is intuitively clear that the positive effect of a change in food crop price on agricultural income will be larger the greater is the relative importance of food crops in agricultural income, the less substitutable are food and export crops in production, the larger is the own-price supply elasticity for food crops, and the smaller is the value added coefficient in food crop production.

Turning now to Case (2) in which the foreign price of export crops is influenced by the amount exported, both P_x and P_x^* will be affected by a change in P_f. From eq. (4) we have

$$\alpha_{xf}\hat{P}_f+\alpha_{xx}\hat{P}_x=n_xs_x\hat{P}_x^*, \tag{10}$$

where α_{xx} (>0) is the own-price supply elasticity for export crops, n_x (<0) is the price elasticity of foreign demand for export crops, and s_x ($=E_x/Q_x$) is the share of exports in export crop output. Since $\hat{P}_x=\hat{P}_x^*$ from (3), eq. (10) leads to

$$\hat{P}_x=\hat{P}_x^*=\frac{\alpha_{xf}\hat{P}_f}{n_xs_x-\alpha_{xx}}\equiv A\hat{P}_f, \tag{11}$$

[8]See appendix A below for a derivation of eqs. (8), (14), (17), (22), (24) and (29).

where $A>0$. Thus, the domestic and foreign prices of export crops will rise (by the same proportion) as the food price is increased. Notice from the equation (11) that small increases in P_x and P_x^* are associated with larger (absolute) values of n_x, and that an infinitely elastic foreign demand for export crops [implying $A=0$ in eq. (11)] leads, as in Case (1), to $\hat{P}_x=\hat{P}_x^*=0$. It is also to be noted that the positive effect of $\hat{P}_f$ on P_x depends crucially on the cross-price elasticity in export crop supply being non-zero.

The induced change in P_x gives rise to an offsetting effect on both food and export crop outputs. Thus,

$$\hat{Q}_f=\alpha_{ff}\hat{P}_f+\alpha_{fx}\hat{P}_x=(\alpha_{ff}+\alpha_{fx}A)\hat{P}_f, \tag{12}$$

where α_{fx} (<0) is the supply elasticity with respect to P_x for food crops. Since $A>0$ under Case (2), an increase in P_f will result in a higher Q_f only if $\alpha_{ff}>|\alpha_{fx}A|$. On the other hand, the effect on export crop output is given by

$$\hat{Q}_x=\alpha_{xf}\hat{P}_f+\alpha_{xx}\hat{P}_x=(\alpha_{xf}+\alpha_{xx}A)\hat{P}_f=\frac{\alpha_{xf}P_f}{1-\alpha_{xx}/n_xs_x}. \tag{13}$$

Thus, despite the positive effect on export crop output due to the induced rise in P_x, the net impact of a change in P_f on Q_x remains unambiguously negative as long as it is assumed that α_{xf} is negative. It is also worth noting that setting $A=0$ in eqs. (12) and (13), respectively, yields the same expressions for $\hat{Q}_f$ and $\hat{Q}_x$ as in Case (1), as can be seen in (7).

Agricultural income will be affected by a change in the domestic food price in Case (2) as follows:

$$\hat{Y}=\{(1/c_f+\alpha_{ff}+\alpha_{fx}A)v_f+(A/c_x+\alpha_{xx}A+\alpha_{xf})v_x\}\hat{P}_f, \tag{14}$$

where c_x is the ratio of value added to the value of output in export crop production. This represents a positive or negative effect depending on whether the bracketed expression is greater or less than zero. Equivalently, since $v_f+v_x=1$, an increase in P_f will lead to a higher Y if and only if

$$v_f>\frac{-(\alpha_{xf}+A/c_x+\alpha_{xx}A)}{(1/c_f+\alpha_{ff}+\alpha_{fx}A)-(\alpha_{xf}+A/c_x+\alpha_{xx}A)}. \tag{15}$$

With $A=0$, implying infinitely elastic foreign demand for export crops, the inequality (15) simply reduces to the condition obtained earlier in Case (1) given in eq. (9).

Examining next the effects of a reduction in the export tax rate, it is convenient to define $T_x=1-t_x$, the so-called power of the export tax. Under Case (1), the domestic price of export crops will change by $\hat{P}_x=\hat{T}_x$, from eq.

(3). Using the two supply functions (1) and (2), we have

$$\hat{Q}_f = \alpha_{fx}\hat{T}_x \quad \text{and} \quad \hat{Q}_x = \alpha_{xx}\hat{T}_x, \tag{16}$$

where α_{xx} (>0) is the own-price supply elasticity of export crops, and α_{fx} (<0) is the supply elasticity of food crops with respect to the domestic price of export crops. Assuming that $t_x < 1$, a decline in t_x means an increase in T_x, which from eq. (16) implies a shift in production away from food toward export crops.

The net effect on agricultural income is given by

$$\hat{Y} = \{\alpha_{fx}v_f + (\alpha_{xx} + 1/c_x)v_x\}\left(\frac{-t_x}{1-t_x}\right)\hat{t}_x. \tag{17}$$

Therefore, for any initial $t_x < 1$, agricultural income will increse or decrease due to a reduction in the export tax rate according as the bracketed expression is greater or less than zero. Since $v_f = 1 - v_x$, the necessary and sufficient condition for Y to increase is that

$$v_x > \frac{1}{1-(\alpha_{xx} + 1/c_x)/\alpha_{fx}}. \tag{18}$$

A fall in the export tax rate raises the domestic price of export crops, which leads to a production shift away from food crops and to a higher export crop output from both non-price and cross-substitution effects. It is then reasonable to expect that agricultural income will increase the higher is the initial share of export crops in agricultural income, the more responsive is expert crop supply to own-price changes, the lower is the ratio of value added to the value of output in export crop production, and the smaller is the supply elasticity of food crops with respect to the price of export crops.

Under Case (2), a decrease in t_x will not only raise P_x but also lower P_x^* since, from eqs. (3) and (4),

$$\hat{P}_x = \hat{P}_x^* + \hat{T}_x \quad \text{and} \quad \alpha_{xx}\hat{P}_x = \eta_x s_x \hat{P}_x^*, \tag{19}$$

from which

$$\hat{P}_x^* = \frac{\alpha_{xx}\hat{T}_x}{\eta_x s_x - \alpha_{xx}} \quad \text{and} \quad \hat{P}_x = \frac{\eta_x s_x \hat{T}_x}{\eta_x s_x - \alpha_{xx}} \equiv B\hat{T}_x, \tag{20}$$

where $0 < B < 1$ with a finite elasticity of foreign demand for export crops. As might be expected, the decline in the foreign price will be larger the less elastic is the foreign demand and the higher is the non-price elasticity of

export crop supply, while the same conditions are associated with smaller increases in the domestic price of export crops. With infinitely elastic foreign demand ($B=1$), $\hat{P}_x^*=0$ and $\hat{P}_x=\hat{T}_x$ as in the Case (1) result.

Food and export crop outputs will be affected as follows:

$$\hat{Q}_f=\alpha_{fx}B\hat{T}_x \quad \text{and} \quad \hat{Q}_x=\alpha_{xx}B\hat{T}_x. \tag{21}$$

In comparison with Case (1), the effects on Q_f and Q_x induced by a decline in the export tax rate are lower in absolute value, considering the range of B.

The effect on agricultural income can be expressed as

$$\hat{Y}=\{\alpha_{fx}v_x+(\alpha_{xx}+1/c_x)v_x\}\left(\frac{-t_x}{1-t_x}\right)B\hat{t}_x. \tag{22}$$

Eq. (22) is identical to (17) except for B. Since $0<B<1$ under Case (2), the effect of a reduction in t_x on agricultural income is smaller in absolute value compared to the Case (1) result. Also, the same condition given in eq. (18) will ensure a positive effect on Y for Case (2).

Considering lastly the effects of an exogenous change in the exchange rate, we are particularly interested in how agricultural income will be affected by an exchange rate liberalization, i.e., an increase in R. Devaluation of the domestic currency will have a direct positive effect on the domestic prices of export crops and intermediate inputs. Under Case (1) P_x^* is exogenous so that $\hat{P}_x=\hat{P}_i=\hat{R}$, from eqs. (3) and (5). Using two two supply functions (1) and (2), we have

$$\hat{Q}_f=(\alpha_{fx}+\alpha_{fi})\hat{R} \quad \text{and} \quad \hat{Q}_x=(\alpha_{xx}+\alpha_{xi})\hat{R}, \tag{23}$$

where α_{fi} (<0) and α_{xi} (<0) are the corresponding elasticities with respect to the domestic price of intermediate inputs in crop production. Export crop production is likely to expand (assuming that $\alpha_{xx}>|\alpha_{xi}|$) at the expense of food crops. The influences on agricultural income arising from an exchange rate liberalization consist, on the one hand, of the induced increases in P_x and Q_x which have a positive effect on Y, and, on the other, the induced decline in Q_f and rise in P_i which have a negative effect. The net effect on total crop income is given by

$$\hat{Y}=\{(\alpha_{fx}+\alpha_{fi}-r_f)v_f+(1+\alpha_{xx}+\alpha_{xi})v_x\}\hat{R}, \tag{24}$$

where r_f is the ratio of the cost of intermediate inputs to value added in food crop production. This may be positive or negative depending on whether the bracketed expression is greater or less than zero; a necessary and sufficient

condition for Y to increase due to a rise in R is that (using $v_f = 1 - v_x$)

$$v_x > \frac{1}{1 + (1 + \alpha_{xx} + \alpha_{xi})/(r_f - \alpha_{fx} - \alpha_{fi})}. \tag{25}$$

Therefore, agricultural income is more likely to increase with exchange rate liberalization the larger is the value added share of export crops, the higher is the own-price elasticity of export crop supply, the less substitutable are food and export crops, the lower are the supply elasticities with respect to the price of intermediate inputs, and the less important is the cost of intermediate inputs in food production.

Under Case (2), in which the foreign demand for export crops is not perfectly elastic, an increase in the exchange rate leads to a change in both the domestic and foreign prices of export crops. From eqs. (3) and (4),

$$\hat{P}_x = \hat{P}_x^* + \hat{R} \quad \text{and} \quad \alpha_{xx}\hat{P}_x = n_x s_x \hat{P}_x^*, \tag{26}$$

from which, similar to the effects of a change in T_x given in (20),

$$\hat{P}_x^* = \frac{\alpha_{xx}\hat{R}}{n_x s_x - \alpha_{xx}} \quad \text{and} \quad \hat{P}_x = \frac{n_x s_x \hat{R}}{n_x s_x - \alpha_{xx}} \equiv B\hat{R}, \tag{27}$$

where $B > 0$. Thus, P_x^* decreases and P_x increases with a rise in R.

The effects on food and export crop outputs are given by

$$\hat{Q}_f = (\alpha_{fx}B + \alpha_{fi})\hat{R} \quad \text{and} \quad \hat{Q}_x = (\alpha_{xx}B + \alpha_{xi})\hat{R}, \tag{28}$$

so that the net change in agricultural income can be expressed as follows:

$$\hat{Y} = \left\{(\alpha_{fx}B + \alpha_{fi} - r_f)v_f + \left(\alpha_{xx}B + \alpha_{xi} + \frac{B}{c_x} - r_x\right)v_x\right\}\hat{R}, \tag{29}$$

where r_x (analogous to r_f defined earlier) is the ratio of the cost of intermediate inputs to value added in export crop production. Setting $v_f = 1 - v_x$ in the bracketed term, total crop income will increase with currency devaluation if and only if

$$v_x > \frac{1}{1 + (\alpha_{xx}B + \alpha_{xi} + B/c_x - r_x)/(r_f - \alpha_{fx}B - \alpha_{fi})}, \tag{30}$$

which condition reduces to (25) under Case (1) upon setting $B = 1$ and recalling that $1/c_x - r_x = 1$.

Finally, it may be noted that the difficulty of establishing *a priori* the direction of change in agricultural income would be compounded in the case where any combination of food price, export tax and exchange rate adjustments is undertaken. The above analysis brings out the need to supplement the examination of the comparative static properties of the model with empirically-based values of the parameters in order to resolve the ambiguity in the results concerning the effects of these three common sources of domestic price distortions in developing countries.

4. Application to Philippine agriculture

The case of the Philippines provides an excellent empirical illustration of the model presented above. The dichotomous classification of agricultural crops adopted in the model conforms very much to the distinction used in Philippine agricultural data sources,[9] reflecting the wide recognition of substantial differences in the market characteristics of food and export crops. There has also been ample documentation, at the farm level, of significant output supply shifts due to changing relative profitabilities of specific food and export crops [e.g., Treadgold and Hooley (1967) and Bouis (1982)], although it remains to be seen whether aggregate relationships are sufficiently stable over time.

Policy instruments driving a wedge between domestic and foreign prices of agricultural products in the Philippines are consistent with the assumptions of the model. Government monopoly in the international trade of the staple foodgrains, rice and corn, has been the primary means to regulate their domestic price levels, supplemented by direct price controls. Based on direct price comparison – specifically, Manila wholesale against Thailand f.o.b. plus 10% – for rice of comparable quality made by Unnevehr and Balisacan (1983), domestic underpricing of rice is calculated to be 12.0% during 1973–80. On the other hand, the farm price of white corn has been estimated to be lower by 4% relative to the border price in the 1970s, while for other food crops no price disparity has been observed [David (1982)]. Thus the weighted average difference between domestic and world price levels for food crops is 6.1%.

Export trade in coconut products and sugar, the country's major export crops, has also been subject to government regulation, especially since the early 1970s. An export quota for sugar has been in effect since 1962 and, beginning 1970, sugar trading in both domestic and foreign markets has been done by state corporations. Copra and centrifugal sugar have been subject to a 6% export tax since 1970, other agricultural exports being taxed at rates

[9]See appendix B below for a description of the nature and sources of data used in the present study.

ranging from 4 to 8%. Based on the nominal protection rates estimated by David (1982) for individual export crops (−15% for sugarcane, −21% for coconut and −4% for other export crops), the overall implicit export tax (t_x) is calculated at 15.9%.

Intermediate inputs used in crop production consist mainly of fertilizers and other agricultural chemicals. Despite price controls and direct subsidies to local fertilizer producers, farmers have paid fertilizer prices above world levels, and 'the average implicit tariff between 1973 and 1981 when the fertilizer industry was almost completely regulated was still 10 per cent' [David (1982, p. 29)]. Even higher was the implicit tariff rate on other agricultural chemicals, estimated at 28% for the 1970s.

Currency overvaluation has plagued the Philippine economy throughout most of the postwar period [Baldwin (1975)]. While substantial changes in the official exchange rate had taken place – from 2 pesos per U.S. dollar to 3.9 in the early 1960s, to 6.4 in the early 1970s and to 11 by mid-1983 – the structure of tariffs, import licensing, export taxes and other trade barriers continued to effectively undervalue the cost of foreign exchange. For the mid-1970s it has been estimated by Medalla (1979) that the shadow price of foreign exchange was 32% higher than the official exchange rate, based on free trade assumptions [Bacha and Taylor (1971)].

While the estimation of output supply functions for Philippine agriculture has been the subject of a few previous studies, they pertain either to the entire agricultural sector [Quizon (1981)] or to individual crops [e.g., Mangahas et al. (1970) and Bouis (1982)] so that the available elasticity estimates are not usable for the purposes of the present study. Here we utilize a priori theoretical information inherent in the tool of the profit function, specifically of the 'normalized quadratic' functional form, to estimate jointly the interrelated supply functions for food and export crops and the demand function for labor.[10] Apart from labor, the other variable input considered is fertilizer and other chemicals (representing intermediate inputs in the model specification) whose price is used as a deflator to 'normalize' the profit and price variables. Linear homogeneity is thus built into the normalized quadratic profit function, the first derivatives of which yield output supply and input demand equations that are linear in normalized prices of outputs and variable inputs and quantities of fixed inputs. Using earlier notation, the set of output supply and labor demand equations to be estimated can be written

[10]See Lau (1976) for an analytical discussion of the normalized quadratic profit function, and Lau and Yotopoulos (1971) and Shumway (1983) for applications. Any 'flexible' functional form (i.e., giving a second-order Taylor series approximation to an arbitrary functional form) is sufficient to obtain a consistent set of output supply and input demand equations. In addition to the normalized quadratic, other flexible functional forms have been used for agricultural pr duction analysis, including the translog and generalized Leontief.

$$Q_f = a_f + b_{f1}(P_f/P_l) + b_{f2}(P_x/P_l) + b_{f3}(W/P_l) + \sum_j b_{f4j}Z_j + u_f, \tag{31}$$

$$Q_x = a_x + b_{x1}(P_f/P_l) + b_{x2}(P_x/P_l) + b_{x3}(W/P_l) + \sum_j b_{x4j}Z_j + u_x, \tag{32}$$

$$-N = a_n + b_{n1}(P_f/P_l) + b_{n2}(P_x/P_l) + b_{n3}(W/P_l) + \sum_j b_{n4j}Z_j + u_n, \tag{33}$$

where $-N$ denotes labor input quantity in negative units, the Z_j's are fixed input quantities and shift variables, and the u's are error terms. The demand equation for fertilizer and other agricultural chemicals will not be estimated; however, since it is a part of the system, its price parameters can be derived from the estimated equations, if one wants to. Our main interest is, of course, in the estimates of the price coefficients of the two output supply equations.

Assuming that the profit function is twice-continuously differentiable, its second partial derivatives are symmetric. Since output supply and input demand functions are the first derivatives of the profit equation, their coefficients (or slopes) are the second derivatives. Cross-equation restrictions are therefore necessary to be able to impose this symmetry property.[11] In addition, to take into account the possibility that the errors are correlated (since production decisions on outputs and inputs are interrelated), estimation is done below using Zellner's (1962) generalized least squares for seemingly unrelated equations – which provides an asymptotically efficient method of estimation.

The sources of data used to estimate jointly the two output supply equations and the labor demand equation are described in appendix B below, which also discusses the procedure adopted for aggregating data into the price and quantity indices for each of the food and export crop categories. All variables are expressed in current year values, except output prices; in contrast with the prices of inputs which are known at the time of purchase, crop producers have only expectations of prices at which they could sell their products. Based on the results of our exploratory regressions using alternative specifications of the Almon lag structure, P_f and P_x seem best represented by the weighted averages of the preceding two years' values (i.e., $0.667P_{-1} + 0.333P_{-2}$).

The following Z_j variables were initially considered to be included in the output supply and labor demand regressions: machinery and equipment for crop production (in constant price values) and total crop land area as the fixed inputs; and proportion of crop land area under irrigation, cumulative research and extension expenditures (in constant prices), and level of rainfall as the technology and weather shifters. However, as most of these variables

[11] This requires setting $b_{f2} = b_{x1}$, $b_{f3} = b_{n1}$ and $b_{x3} = b_{n2}$ in eqs. (31)–(33).

exhibit a strong time trend over the observation period, there emerged a serious multi-collinearity problem, the regression results revealing the characteristic symptoms of imprecise estimation of the model parameters and rather unreasonable coefficient estimates. To mitigate the effects of multicollinearity, the principal components technique was used: the complete set of Z_i variables was converted into three orthogonal components (PC_1, PC_2 and PC_3) and the regression of each of the dependent variables performed on PC_1, PC_2 and PC_3 instead of the Z_i's.

Table 1 reports the coefficient estimates for the two output supply equations and the labor demand equation. Although a few of the estimates are only marginally significant, the signs of all the price coefficients are consistent with a priori expectations.[12] The price elasticities implied by the

Table 1

Estimated output supply and labor demand equations (normalized quadratic functional form)[a]

	Output supply equations		Labor demand equation (N_1)
	Food crops (Q_1)	Export crops (Q_2)	
Intercept	1.574 (0.451)	2.132 (0.807)	0.301 (0.222)
Normalized prices			
P_f/P_1	0.383 (0.245)	0.491 (0.228)	0.339 (0.296)
P_x/P_1	−0.491 (0.228)	0.867 (0.401)	0.553 (0.195)
P_w/P_1	−0.339 (0.296)	0.553 (0.195)	1.152 (0.431)
Principal components			
PC_1	0.824 (0.143)	0.675 (0.205)	−1.293 (0.466)
PC_2	−0.472 (0.254)	0.619 (0.417)	0.322 (0.128)
PC_3	−0.253 (0.281)	0.224 (0.199)	0.482 (0.317)

[a]Standard errors in parentheses. Weighted R^2 for system = 0.92. Estimation by Zellner's seemingly unrelated regression technique with restrictions using the SAS program.

[12]It is worth noting that corresponding elasticity estimates for the entire agricultural sector derived in Quizon (1981) based on the generalized Leontief profit function are generally lower (in absolute value): the own-price supply elasticity is estimated at 0.104, the supply elasticities with respect to labor and fertilizer prices are −0.088 and −0.011, respectively, and the labor demand elasticities are 0.157 with respect to output price, −0.174 with respect to the wage rate, and 0.010 with respect to fertilizer price. In contrast with Quizon's finding that labor and fertilizer are substitutes, the results of the present study indicate complementarity between these two variable inputs, which seems more credible.

coefficient estimates contained in table 1, computed for the last observation (1974), are (using earlier notation),

$$\alpha_{ff}=0.302,\quad x_{fx}=-0.198,\quad \alpha_{fn}=-0.098,\quad \alpha_{fi}=-0.006,$$
$$\alpha_{xf}=-0.121,\quad \alpha_{xx}=0.251,\quad \alpha_{xn}=-0.115,\quad \alpha_{xi}=-0.015,$$
$$\alpha_{nf}=0.153,\quad \alpha_{nx}=0.294,\quad \alpha_{nn}=-0.439,\quad \alpha_{ni}=-0.008,$$

where the subscript n refers to labor. They include the elasticities for intermediate inputs (fertilizer and other agricultural chemicals), obtained by invoking the homogeneity assumption on the output supply and labor demand functions.

Our empirical examination of the effects of food price and exchange rate changes will use only the estimated output supply elasticities for food and export crops, labor demand not being included in the model specification. Other parameters of the model and the numerical values assigned to them are as follows:

$$c_f=0.879,\quad v_f=0.485,\quad r_f=0.138,$$
$$c_x=0.828,\quad v_x=0.515,\quad r_x=0.208\quad \text{and}\quad s_x=0.165.$$

which have all been calculated from the 1978 input–output table; additionally, the value of -5.0 for n_x under Case (2) can be used, based on the estimate of the price elasticity of foreign demand for Philippine 'major' (primary product) exports given in Power (1979).

We may now apply these parameter values to determine the direction of effects on agricultural income due to exogenous changes in the food price, export tax and exchange rate variables:

(i) From eq. (9), a rise in the domestic price of food crops will increase agricultural income if $v_f>0.077$ under Case (1) and, using (15), if $v_f>-0.030$ under Case (2). Since the actual value of v_f is 0.485, the condition is easily met in either case.

(ii) From eq. (18), a reduction in the export tax rate will improve agricultural income provided $v_x>0.120$ under Case (1), which condition also applies under Case (2). Since the actual value of v_x is 0.515, the condition is satisfied.

(iii) From eq. (25), an upward adjustment of the exchange rate will raise agricultural income if $v_x>0.217$ under Case (1) and, using (30), if $v_x>0.248$ under Case (2). Since the actual value of v_x is 0.515, the condition is fulfilled in both cases.

Regardless of the assumption used concerning the foreign demand elasticity for export crops, the general inference can be made therefore that under the conditions prevailing in the seventies, agricultural crop income in the Philippines would have improved had the food price and the exchange rate been made higher and the agricultural export tax made lower; alternatively stated, there was a social loss, in terms of lower agricultural income, associated with the domestic underpricing of food and export crops and overvaluation of the Philippine peso in the 1970s.

We can go further and quantify the static effects of the low food price policy, agricultural export taxation and currency overvaluation by using the estimates given earlier of the implicit export tax on agricultural crops (15.9%) and the disparities between actual and free trade prices of food crops and foreign exchange (6.1% and 32.0%, respectively). The results of the calculations are shown in table 2, including not only the effects on Y, but also on P_x, Q_f, and Q_x. The assumption on the foreign demand elasticity for export crops does make a difference in the quantitative effects, especially those induced by export tax and exchange rate adjustments. Among the three liberalization policy instruments. the food price is seen to produce the least significant income effect – 3.9% for Case (1) and 4.3% for Case (2), despite the much higher estimated own-price elasticity of output supply for food crops relative to export crops; this result is mainly due to the relatively small adjustment needed to align the domestic price of food crops to the world

Table 2

Static effects of alternative liberalization policies (in percent).[a]

Policy measures	Effects on: P_x (1)	P_x (2)	Q_f (1)	Q_f (2)	Q_x (1)	Q_x (2)	Y (1)	Y (2)
1. $\hat{P}_f=0.061$	—	0.007	0.018	0.017	−0.007	−0.006	0.039	0.043
2. $\hat{T}_x=0.189$	0.189	0.145	−0.037	−0.028	0.047	0.036	0.124	0.095
3. $\hat{R}=0.320$	0.320	0.245	−0.065	−0.052	0.076	0.057	0.151	0.102
4. $\hat{P}_f=0.061$ and $\hat{T}_x=0.189$	0.189	0.152	−0.019	−0.011	0.040	0.030	0.163	0.138
5. $\hat{P}_f=0.061$ and $\hat{R}=0.320$	0.320	0.252	−0.047	−0.035	0.069	0.051	0.190	0.145
6. $\hat{T}_x=0.189$ and $\hat{R}=0.320$	0.509	0.390	−0.102	−0.080	0.123	0.093	0.275	0.197
7. $\hat{P}_f=0.061$, $\hat{T}_x=0.189$ and $\hat{R}=0.320$	0.509	0.397	−0.084	−0.063	0.116	0.087	0.314	0.240

[a]Case (1) assumes infinitely elastic foreign demand for export crops, Case (2) assumes an elasticity value of −5.0. Change in t_x from 15.8% to 0% implies $\hat{T}_x=0.189$.

price. Elimination of the export tax results in an improvement in agricultural income by 12.4% and 9.5%, while the adjustment of the exchange rate to the free trade value raises agricultural income by 15.1% and 10.2%.

Because the relationships among the variables of the model are linear in proportionate changes, the net income effect due to simultaneous changes in any combination of the three policy variables is the algebraic sum of their individual effects. Rows 4 to 6 in table 2 indicate that, among the three pairwise combinations, lifting of the export tax accompanied by exchange rate adjustment yields the largest increase in agricultural income. Finally, from row 7, removing all three sources of domestic price distortions leads to an overall income improvement of 31.4% for Case (1) and 24.0% for Case (2). These are rather impressive figures, considering that they represent only the income effects from the correction of policy biases and resource reallocation without adding to the fixed inputs to agricultural crop production.

5. Concluding remarks

The static effects on agricultural income arising from the elimination of three common LDC policy biases – the underpricing of food, agricultural export taxation and currency overvaluation – has been examined analytically and empirically using a supply-oriented model of the agricultural sector with the food–export crop tradeoff in production as a key component. Output supply depends, among other things, on relative incentives to food and export crop production, which in turn depends on a host of factors including the policy-determined domestic price of food crops, agricultural export tax and the foreign exchange rate.

The comparative static properties of the model relating to changes in the food price, export tax and exchange rate variables indicate ambiguous qualitative effects on agricultural income. Using parameter values derived from Philippine data, the income effects of upward adjustments in the domestic price of food crops and the exchange rate to their free trade values and the lifting of the agricultural export tax are shown to be positive, regardless of the assumption used concerning the price elasticity of foreign demand for export crops. Complete liberalization of food price, export tax and exchange rate policies would raise agricultural income significantly (by about 31%, assuming infinitely elastic foreign demand for export crops), despite the (partially) offsetting effects on the production of food and export crops. From another viewpoint such income foregone within agriculture represents a social cost arising from the underpricing of food and export crops and of foreign exchange – which need to be considered by Philippine policymakers, given the official concern frequently expressed about rural welfare.

Appendix A: Derivation of eqs. (8), (14), (17), (22), (24) and (29)

Taking total differentials in eq. (6), we obtain

$$\mathrm{d}Y = P_f^n\,\mathrm{d}Q_f + Q_f\,\mathrm{d}P_f - Q_f a_{fi}\,\mathrm{d}P_i + P_x^n\,\mathrm{d}Q_x + Q_x\,\mathrm{d}P_x - Q_x a_{xi}\,\mathrm{d}P_i, \tag{A.1}$$

where $P_f^n = P_f - a_{fi}P_i$ and $P_x^n = P_x - a_{fi}P_i$. Eq. (A.1) can be divided by Y to yield

$$\hat{Y} = v_f\hat{Q}_f + (v_f/c_f)\hat{P}_f + v_x\hat{Q}_x + (v_x/c_x)\hat{P}_x - r_f v_f\hat{P}_i - r_x v_x\hat{P}_i, \tag{A.2}$$

where

$$c_f = P_f^n/P_f,\ c_x = P_x^n/P_x,\ r_f = a_{fi}P_i/P_f^n,\ r_x = a_{xi}P_i/P_x^n,$$

$$v_f = (P_f - a_{fi}P_i)Q_f/Y \quad \text{and} \quad v_x = (P_x - a_{xi}P_i)Q_x/Y.$$

(1) Setting $\hat{P}_{xi}$, $\hat{P}_i = 0$ and substituting in (A.2) the expressions for $\hat{Q}_f$ and $\hat{Q}_x$ given in (7), we have

$$\hat{Y} = (\alpha_{ff}v_f + \alpha_{xf}v_x + v_f/c_f)\hat{P}_f, \tag{A.3}$$

which simplifies to eq. (8).

(2) Setting $\hat{P}_i = 0$ and substituting in (A.2) the expressions for $\hat{P}_x$ in (11), $\hat{Q}_f$ in (12) and $\hat{Q}_x$ in (13), we obtain

$$\hat{Y} = \{(\alpha_{ff} + \alpha_{fx}A)v_f + v_f/c_f + (\alpha_{xf} + \alpha_{xx}A + A/c_x)v_x\}\hat{P}_f, \tag{A.4}$$

which upon simplification yields eq. (14).

(3) Setting $\hat{P}_f$, $\hat{P}_i = 0$, $\hat{P}_x = \hat{T}_x$, and substituting in (A.2) the expressions for $\hat{Q}_f$ and $\hat{Q}_x$ given in (16), we have

$$\hat{Y} = (\alpha_{fx}v_f + \alpha_{xx}v_x + v_x/c_x)\hat{T}_x, \tag{A.5}$$

which, using $\hat{T}_x = (-t_x/(1-t_x))\hat{t}_x$, simplifies to eq. (17).

(4) Setting $\hat{P}_f$, $\hat{P}_i = 0$ and substituting in (A.2) the expressions for $\hat{P}_x$ in (20) and for $\hat{Q}_f$ and $\hat{Q}_x$ given in (21), we obtain

$$\hat{Y} = (\alpha_{fx}v_f + \alpha_{xx}v_x + v_x/c_x)B\hat{T}_x, \tag{A.6}$$

which, using $\hat{T}_x = (-t_x/(1-t_x))\hat{t}_x$, simplifies to eq. (22).

(5) Setting $\hat{P}_f = 0$, $\hat{P}_x = \hat{P}_i = \hat{R}$, and substituting in (A.2) the expressions for $\hat{Q}_f$ and $\hat{Q}_x$ given in (23), we get

$$\hat{Y} = \{(\alpha_{fx} + \alpha_{fi})v_f + (\alpha_{xx} + \alpha_{xi})v_x + v_x/c_f - r_f v_f - r_x v_x\}\hat{R}, \tag{A.7}$$

which simplifies to eq. (24), noting that $1/c_x - r_x = 1$.

(6) Setting $\hat{P}_f=0$, $\hat{P}_i=\hat{R}$, and substituting in (A.2) the expressions for $\hat{P}_x$ in (27) and for $\hat{Q}_f$ and $\hat{Q}_x$ given in (28), we have

$$\hat{Y}=\{(\alpha_{fx}B+\alpha_{fi})v_f+(\alpha_{xx}B+\alpha_{xi})v_x+(B/c_x)v_x-r_fv_f-r_xv_x)\}\hat{R}, \qquad \text{(A.8)}$$

which, upon simplification, yields eq. (29).

Appendix B: Sources of data

The *Crop, Livestock and Natural Resources Statistics*, published by the Bureau of Agricultural Economics (BAE), is the source of annual data on quantity and value of production at farm-gate prices for specific crops, including home-consumed and marketed output. It distinguishes between 'food' and 'commercial' crops. The latter category includes all non-food crops (e.g., tobacco, rubber, abaca and other plant fibers, etc.) as well as some food crops which are largely processed before final consumption (e.g., coconut, sugarcane, etc.); the common characteristic among these crops is that they are produced by market-oriented producers for both domestic and export markets. Under the 'food' category are all crops intended for food that do not undergo significant processing before final consumption, and they consist mainly of so-called 'subsistence' crops (rice, corn, etc.) effectively isolated from world market developments by domestic price and trade controls; however, some food items under this BAE category are being exported in significant amounts (principally, banana and mango) which, for the analytical purposes of the present study, are more appropriately treated as export rather than food crops.

The composition of the two crop categories adopted here is, therefore, as follows: food crops – rice, corn, root crops, vegetables, peanuts, other fruits and nuts, beans and peas, other food crops; export crops – coconut, sugarcane, banana, coffee, cocoa, mango, pineapple, citrus, abaca, native tobacco, Virginia tobacco, rubber, ramie, maguey, other commercial crops. (This list exhausts all crops included in the above-mentioned data source.) Rice, corn and root crops are the major food crops, accounting for 22.1%, 8.2% and 5.0%, respectively, of the total value of Philippine crop production in 1980; coconut and sugarcane dominate the export crop category, contributing 24.4% and 11.1%, respectively.

Individual crops are aggregated into the food and export crop categories using chained Fisher quantity and price indices. Each of these indices is assigned a value of 1.0 for the initial year (1950) of the observation period.

Indices for agricultural crop employment and wage rate, producer prices of fertilizers and other agricultural chemicals, and quantities of the various fixed inputs and shift variables enumerated in the text are based on the data set covering the period 1948–74 compiled and used by Quizon (1980, 1981); a

printout of the data file at the Yale Computer Center was kindly provided to the present author. A full description of the data set is given in Quizon (1980).

Supplementary data from the unpublished 1978 input–output table (as of January 1984) compiled by the Statistical Coordination Office of the National Economic and Development Authority are used to derive some parameter values as indicated in the text.

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