PN-ABL-239
ISN 77111

Domestic Terms of Trade and Agricultural Growth in Developing Countries

Romeo M. Bautista

Reprinted from *The Balance between Industry and Agriculture in Economic Development,* Proceedings of the Eighth World Congress of the International Economic Association, Delhi, India, Volume 5: FACTORS INFLUENCING CHANGE, edited by Nurul Islam, The Macmillan Press Ltd., 1989

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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

Reprint No. 207

1 Domestic Terms of Trade and Agricultural Growth in Developing Countries

Romeo M. Bautista
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE, WASHINGTON

1 INTRODUCTION

Writing twenty years ago, Raj Krishna (1967) made a distinction between *negative* agricultural price policy, in which 'the terms of trade of agriculture are deliberately depressed', and *positive* price policy 'which attempts to improve or at least maintain the terms of trade of agriculture'. He also observed that 'a negative agricultural price policy . . . has been a common feature of policy in the early phases of development in capitalist as well as socialist countries', but that there were emerging signs of 'a reluctant turn to a positive agricultural price policy' as developing country planners saw agricultural output failing to grow at a rate necessary to achieve the desired growth of the national economy.

In this paper we first present and analyse, in Section 2, the observed movements in the agricultural terms of trade, since the early 1960s, for 41 low- and middle-income developing countries. Indeed, a significantly increasing trend in domestic agricultural prices relative to non-agricultural prices is shown for a large number of developing countries, including several Sub-Saharan African economies. We then examine, in Section 3, the trends in agricultural production for the same sample of developing countries. A striking observation is the large number of countries, mostly Sub-Saharan African countries, with low or negative agricultural growth rates.

It is a standard formulation of the empirical relationship between agricultural output and relative prices in developing countries that agricultural supply is influenced by relative price changes, the latter being assumed to be independently determined. In Section 4 of this

paper, we argue that the assumed exogeneity of the domestic terms of trade is inappropriate, and that it is necessary to examine the simultaneous determination of domestic supply and the relative price of agricultural products, taking demand influences systematically into account. As a special case, we also explore the hypothesis that, for the countries in Sub-Saharan Africa, domestic agricultural supply is primarily determined by non-price factors (cf Delgado and Mellor, 1984), which implies a reverse direction of causality, that is, the exogenously determined agricultural output affecting the domestic terms of trade (rather than vice-versa).

These relationships are subjected to empirical investigation (in Section 5) based on the collective experience of the developing countries in our sample during 1960–84. The results bear out the inadequacy of single-equation price elasticity estimates of aggregate agricultural supply and the need to consider the agricultural terms of trade as being determined (jointly with domestic output) by supply–demand interactions. For the Sub-Saharan African countries it may well be appropriate to assume that non-price influences had been the dominant factors in the determination of agricultural supply which in turn significantly affected the domestic terms of trade.

Finally, in Section 6, some concluding comments are given concerning directions for further empirical work, Krishna's distinction between positive and negative agricultural price policy, and the intersectoral resource transfer implicit from temporal changes in the agricultural terms of trade.

2 TERMS OF TRADE MOVEMENTS

The domestic terms of trade are represented in the present study as the ratio of agricultural prices to non-agricultural prices (Pa/Pna), calculated from annual data since the early 1960s on agricultural value added (AVA) and gross domestic product (GDP) which are available at current and constant market prices from the World Bank Data Tape (Economic Data Sheet I).[1] Both trend and variability (instability) of the terms of trade are examined in this section. The trend measure used is the coefficient estimate in the logarithmic trend regression based on the annual values of Pa/Pna, the dispersion around the logarithmic trend representing the instability measure.[2]

The developing countries included in our sample consist of all 'low-

income and middle-income economies'[3] in which the contribution of agriculture to GDP was at least 20 per cent in the early 1970s *and* for which data are available to compute for Pa/Pna as described above for the time series beginning 1965 at the latest and ending 1981 at the earliest. It was possible to meet these requirements in 41 countries. The most complete time series (1960–84) was obtained only for 17 countries.

In view of the sharp changes in the international price structure since 1973, some interest attaches to comparing the trend and instability values between the two subperiods 1960–72 and 1972–84. It has been pointed out, for example, that the higher energy prices in the 1970s 'caused macroeconomic pressures on the balance of payments and foreign exchange rates', inducing a deterioration in the agricultural terms of trade for the oil-importing countries and an improvement for the oil-exporting countries (Timmer, 1984, p. 54). Also recent discussions of agricultural development and price policy have drawn attention to the special problems of Sub-Saharan Africa (see, for example, Delgado and Mellor, 1984). Moreover questions on the reliability of economic data for many of these countries are frequently raised.[4] Table 1.1 presents the calculated values of the trend and instability measures for Pa/Pna, distinguishing between the two subperiods and between countries in Sub-Saharan Africa (from here on, 'Africa,' for short) and other countries in the sample. Low-income (LI) and middle-income (MI) economies are also identified in the table.

Consistent with Krishna's observation, a relatively large number of developing countries – 17 out of the 41 countries in the sample – show a significantly positive trend in the domestic terms of trade since the early 1960s (c.f. column (1) of the table).[5] However, significant terms of trade deterioration can also be observed for 7 countries, and no significant trend is found for the remaining 17 countries. Somewhat surprisingly, only 4 of the 19 African countries have had a negative trend; a significant improvement in Pa/Pna is seen for 9 countries, the rest of the African countries showing non-negative but statistically insignificant trend values. Among the 22 non-African countries, 9 show a significantly positive trend, and 4 have had a significant terms-of-trade deterioration, these are exactly the same numbers for the two trend categories within the Africa group. Distinguishing by income category, a significantly positive trend is observed for 10 low-income and 8 middle-income countries, while 3 low-income and 5 middle-income countries have had a significantly negative trend.

Table 1.1 Trend and variability of the domestic terms of trade

Sub-Saharan Africa	*1960–84*		*1960–72*		*1972–84*	
	Trend (1)	*Var. (2)*	*Trend (3)*	*Var. (4)*	*Trend (5)*	*Var. (6)*
1 Chad (LI)	0.81*	8.11	0.28	9.78	0.24	5.31
2 Ethiopia (LI)	1.08*	5.19	1.21*	4.95	1.73*	5.61
3 Mali (LI)	0.02	7.69	−0.84	8.87	0.69	4.92
4 Tanzania (LI)	2.64*	21.27	−2.22*	5.73	8.05	7.84
5 Uganda (LI)	6.59*	18.03	3.34*	9.54	9.93	20.92
6 Togo (LI)	2.15	36.71	11.12*	34.66	−2.66	24.91
7 Cent. African Rep. (LI)	−1.88*	12.85	−4.47*	8.59	−2.35*	9.80
8 Somalia (LI)	−4.37*	15.95	−6.48*	15.70	−4.87*	11.12
9 Kenya (LI)	2.11*	11.87	1.99	12.57	0.22	8.91
10 Sierra Leone (LI)	1.39*	11.17	0.21	3.68	0.08	12.54
11 Ghana (LI)	3.47*	20.53	2.72*	14.72	1.79	24.00
12 Sudan (LI)	0.00	0.19	−0.03	0.28	0.00	0.11
13 Senegal (LI)	0.02	11.09	−0.54	10.76	−0.71	11.01
14 Mauritania (MI)	4.99*	16.92	5.83*	15.60	1.29	14.48
15 Liberia (MI)	0.56	9.65	−2.79*	4.61	1.64	9.57
16 Ivory Coast (MI)	0.21	5.57	−0.59	5.63	0.38	3.98
17 Nigeria (MI)	−1.60*	11.87	−2.00*	8.47	1.24	9.74
18 Cameroon (MI)	2.32*	8.50	−1.61*	3.50	3.04*	7.07
19 Congo (MI)	−0.40*	6.00	−0.09	2.41	−1.23	8.10

Other Countries							
20	Nepal (LI)	1.92*	10.65	1.11	5.03	1.22	8.46
21	Burma (LI)	2.42*	10.65	0.07	5.98	2.18*	9.59
22	India (LI)	−0.40	11.19	1.94*	7.62	−1.98*	8.79
23	Sri Lanka (LI)	1.27*	7.59	0.25	5.09	0.79	8.54
24	Pakistan (LI)	−0.98*	8.50	−0.95*	2.96	−2.26*	11.08
25	Bolivia (MI)	−0.53	11.06	−2.28	3.64	0.80	13.54
26	Indonesia (MI)	−2.11*	12.10	−0.88	12.75	−0.92	8.32
27	Philippines (MI)	1.04*	11.36	2.90*	3.98	−2.06*	6.66
28	Morocco (MI)	1.34*	9.62	−1.33*	5.64	2.55*	3.89
29	Honduras (MI)	−0.72*	8.59	−2.27*	2.20	−1.06	10.47
30	El Salvador (MI)	0.13	18.95	0.23	4.04	−1.84	24.27
31	Egypt (MI)	2.41*	6.41	2.93*	2.25	1.14	7.30
32	Thailand (MI)	0.55*	7.95	−0.07	6.86	−1.14*	4.17
33	Dominican Rep. (MI)	0.79*	10.15	0.65	7.73	−0.79	10.64
34	Ecuador (MI)	0.92*	8.32	−1.72*	4.02	−2.09*	8.97
35	Turkey (MI)	−0.37	12.48	−0.03	2.18	−3.63*	10.37
36	Costa Rica (MI)	0.68	11.78	−1.72*	4.41	0.65	9.11
37	Paraguay (MI)	1.08*	9.49	1.10*	5.47	−2.09*	5.61
38	Tunisia (MI)	−0.18	6.55	0.80	6.34	−1.31*	7.03
39	Colombia (MI)	−0.50	8.88	−0.01	3.10	−2.27*	10.15
40	Malaysia (MI)	−0.34	6.81	−1.81*	3.56	−0.54	6.71
41	Korea (MI)	0.57	11.70	0.52	13.82	−1.14	7.44

Notes: Trend values represent compound annual rates of change, in per cent. LI and MI denote low-income and middle-income economies, respectively.
*Significant at the 5 per cent level.

In terms of the instability measure, a wider range of values are seen among the African countries – from 0.19 for Sudan to 36.71 for Togo; the range for the group of other countries is from 6.41 for Egypt to 18.95 for El Salvador (c.f. column (2) of Table 1.1). The mean values are 12.7 for the low-income countries and 10.0 for the middle-income countries, the difference between which, using the t-test, is not significant. Therefore, it cannot be said that the middle-income countries have shown a greater capacity to deal with domestic terms of trade instability.

Distinguishing between the two subperiods, we note a reversal of trend in Pa/Pna from 1960–72 to 1972–84 for several countries (c.f. columns (3) and (5)). Thus, the significantly positive trend for India, the Philippines, and Paraguay during the first subperiod became significantly negative; these countries are all oil importers, so that the presumed favourable effect of higher oil prices on the agricultural terms of trade in the post–1972 period is not borne out. Of the three countries whose terms of trade moved from having significantly negative to positive trends from the first subperiod to the next, *viz.*, Tanzania, Morocco, and Cameroon, the last is an oil exporter – which again contradicts the expectation. Among the other middle-income oil-exporting countries, Nigeria and Malaysia also show an improvement in the trend of Pa/Pna; on the other hand, a post-1972 deterioration is seen for Indonesia, Egypt, Ecuador, and Tunisia. No blanket statement can be made, therefore, about the actual direction of terms of trade changes based solely on the distinction between oil-importing and oil-exporting countries.

Higher values of the variability measure are observed during the second subperiod for a relatively large number of countries in the sample (c.f. columns (4) and (5)), suggesting that the increased instability in the world economy was passed through to the agricultural terms of trade in those countries. Nonetheless, 6 countries each from the low- and middle-income categories show more unstable terms of trade movements during 1960–72.

3 AGRICULTURAL GROWTH RATES

Calculated values of the annual rates of change in agricultural value added at constant prices, based on logarithmic trend regression, are given in Table 1.2 for the 41 countries in our sample, distinguishing again the Sub-Saharan African countries, the two income (LI and MI) categories, and the two subperiods 1960–72 and 1972–84.

Table 1.2 Compound annual growth rates of agricultural value added (at constant prices), in per cent

Sub-Saharan Africa	*1960–84*	*1960–72*	*1972–84*
1 Chad (LI)	−0.69	0.91	−0.99
2 Ethiopia (LI)	1.49	2.22	1.01
3 Mali (LI)	2.92	1.72	4.43
4 Tanzania (LI)	2.84	3.16	2.53
5 Uganda (LI)	1.33	3.62	−0.52
6 Togo (LI)	1.58	2.68	1.16
7 Cent. African Rep. (LI)	1.86	1.14	2.36
8 Somalia (LI)	2.17	2.15	2.77
9 Kenya (LI)	4.20	5.41	3.07
10 Sierra Leone (LI)	1.97	1.54	2.24
11 Ghana (LI)	1.19	4.75	−0.23
12 Sudan (LI)	3.05	0.32	2.85
13 Senegal (LI)	1.36	2.25	−0.13
14 Mauritania (MI)	−0.38	−0.17	0.94
15 Liberia (MI)	4.47	6.27	2.48
16 Ivory Coast (MI)	3.76	3.92	3.38
17 Nigeria (MI)	0.60	0.64	−1.25
18 Cameroon (MI)	2.87	4.69	1.70
19 Congo (MI)	2.14	2.21	0.71
Other Countries			
20 Nepal (LI)	1.28	1.75	1.23
21 Burma (LI)	4.21	4.02	5.88
22 India (LI)	2.24	1.97	2.40
23 Sri Lanka (LI)	2.81	2.70	3.75
24 Pakistan (LI)	3.50	4.58	2.93
25 Bolivia (MI)	3.01	3.14	1.50
26 Indonesia (MI)	3.73	3.07	3.78
27 Philippines (MI)	4.21	4.11	4.02
28 Morocco (MI)	2.05	4.76	0.29
29 Honduras (MI)	2.89	4.89	2.84
30 El Salvador (MI)	2.72	3.10	1.26
31 Egypt (MI)	2.78	2.87	2.48
32 Thailand (MI)	4.69	5.18	3.95
33 Dominican Rep. (MI)	3.51	2.92	3.19
34 Ecuador (MI)	3.03	3.93	2.10
35 Turkey (MI)	2.87	2.83	3.11
36 Costa Rica (MI)	4.03	5.67	1.79
37 Paraguay (MI)	4.68	2.30	6.04
38 Tunisia (MI)	4.21	4.17	1.76
39 Colombia (MI)	3.76	3.60	3.47
40 Malaysia (MI)	4.68	4.40	4.36
41 Korea (MI)	3.23	3.94	2.03

Note: LI and MI denote low-income and middle-income economies, respectively.

Generally lower agricultural growth rates for the African economies compared to the other countries are revealed by even a cursory examination of the table. Mauritania, Sudan, and Chad during 1960–72, and Nigeria, Chad, Uganda, Ghana, and Senegal during 1972–84, are the extreme cases. For the entire period (c.f. column (1)), less than 2 per cent growth is seen for 10 of the 19 African countries, versus only one (Nepal) from the larger non-African group. Also, the latter category includes 7 countries exceeding 4 per cent growth, while the Africa group is represented by only two countries (Kenya and Liberia). Interestingly, agricultural production in either group of countries did not seem much affected by the unstable conditions in the post-1972 period: the difference between the mean growth rates observed during 1960–72 and 1972–84 is positive but not statistically significant.

Distinguishing by income category, MI countries are found to have posted significantly higher agricultural growth rates than LI countries for 1960–72 and 1960–84, but not for 1972–84. Also, the growth rates for the LI group during the two subperiods are not significantly different. In the case of the MI countries, the 1972–84 growth rates are found to be significantly lower; drastic declines in agricultural production are seen especially for Bolivia, Morocco, El Salvador, Costa Rica and Tunisia.

Comparison between Tables 1.1 and 1.2 indicates no close correspondence between the trend values for agricultural terms of trade and output. Among the African countries, three of the four best production performers during 1960–84 (Liberia, Kenya, Ivory Coast, and Sudan) did not benefit from a significant improvement in agricultural prices (Kenya being the exception). Where a positive trend in the domestic terms of trade had been strongest (Uganda, Mauritania, and Ghana), agricultural growth rates much less than the average (2.04 per cent) were achieved. Two (Tanzania and Cameroon) show both higher than average growth rates and a significantly positive trend in the terms of trade, while one (Nigeria) has had both low agricultural growth and significant terms of trade deterioration. The simple correlation coefficients between the trend values of Pa/Pna and agricultural value added among African countries are 0.182 for the entire period, 0.023 for 1960–72, and 0.208 for 1972–84.

In the case of the other countries, 4 of the 7 with the best agricultural growth record during 1960–84 show a significantly positive trend in the terms of trade (Paraguay, Thailand, Burma,

and the Philippines). However, the two lowest growth countries (Nepal and Morocco) also have had a significant improvement in Pa/Pna. Among the 4 countries with a significantly negative trend in the terms of trade (Indonesia, Pakistan, Ecuador, and Honduras), the agricultural growth rate is observed to be higher than the 3.37 per cent average for the group in two cases (Indonesia and Pakistan). The calculated values of the simple correlation coefficient are 0.238 for 1960–84, 0.505 for 1960–72, and 0.191 for 1972–84.

It is remarkable that the domestic terms of trade and agricultural growth are found to be negatively correlated for either group of countries in each of the three observation periods. This would seem to suggest, following what most empirical investigators of agricultural supply response have assumed, that non-price influences have dominated the presumably positive terms-of-trade effect on agricultural output.[6] Another possibility would be that it is domestic output which affects (negatively) the agricultural terms of trade, rather than the other way around.

The conclusion that emerges from the above findings is that the relationship between domestic terms of trade changes and agricultural growth is not a simple one. Other factors influencing either or both variables must have changed concurrently, confounding the *ex post* correlation between them. These analytical issues are examined more closely in the next section.

4 RELATIONSHIP BETWEEN TERMS OF TRADE CHANGES AND AGRICULTURAL GROWTH

The agricultural terms of trade, or more generally, agricultural pricing policy, are widely regarded as an important instrument at the disposal of developing country governments that can be used to pursue growth and equity objectives. Given international prices of tradable agricultural and non-agricultural goods, government restrictions on imports and exports through trade and exchange rate policies determine the equilibrium domestic terms of trade in a small, open economy. In turn movements in the terms of trade affect the relative profitability of producing agricultural goods, encouraging or discouraging domestic supply. The direction of causality in the relationship between the domestic terms of trade and agricultural output is, therefore, widely assumed to be from the former to the latter.

It is conceivable, however, that the main line of causation is in the opposite direction, the relative agricultural price being dependent (at least in part) on exogenously determined domestic output. This could be the case, for example, if the degree of government reliance on, or access to, foreign trade in agricultural products were itself dependent on the domestic terms of trade. In addition to domestic and foreign supplies, demand factors would also influence the behaviour of the agricultural terms of trade over time in such a case. More concretely, consider the following aggregate supply, demand, and import functions for agricultural products:

$$S = S(P, X) \tag{1}$$

$$D = D(P, Y) \tag{2}$$

$$M = M(P, Z) \tag{3}$$

where, S, D and M denote domestic production, consumption, and net imports, respectively; P ($\equiv$ Pa/Pn) is the agricultural terms of trade; X represents other supply influences (for example, public inputs); Y represents other demand influences (for example, national income); and Z represents other trade influences (for example, a capacity-to-import variable). The expected signs of the partial derivatives with respect to the terms of trade are given by: s_1 ($\equiv \partial S/\partial P$) > 0, d_1 ($\equiv \partial D/\partial P$) < 0, and m_1 ($\equiv \partial M/\partial P$) > 0.

Because the domestic price of agricultural products (in particular, food) represents a politically sensitive issue in most developing countries, government intervention in agricultural markets is prevalent. Thus it is frequently the case that the government has a monopoly of the international trade in major food and other agricultural products. It is assumed above that, as the domestic terms of trade rises (falls), the government increases (decreases) net imports of agricultural products. While imports (exports) serve as a safety valve to promote stability of domestic agricultural prices, the 'trade policy function' given in equation (3) also presupposes some constraints on the actual volume of trade (in the form of Z, as additional explanatory variables). Thus, if there is a shortage in foreign exchange due to external imbalance, a food-deficit country may not be able to import sufficiently to prevent an excessive food price inflation. In this formulation, the import function (3) replaces the horizontal import supply function normally implied by the small country assumption.[7]

Changes over time among the variables included in (1)–(3) would be related as follows:

$$\dot{S} = s_1 \dot{P} + s_2 \dot{X} \tag{4}$$

$$\dot{D} = d_1 \dot{P} + d_2 \dot{Y} \tag{5}$$

$$\dot{M} = m_1 \dot{P} + m_2 \dot{Z} \tag{6}$$

$$\dot{M} = \dot{D} - \dot{S} \tag{7}$$

where $s_2 \equiv \partial S/\partial X$, $d_2 \equiv \partial D/\partial Y$, $m_2 \equiv \partial M/\partial Z$, and a dot ($\cdot$) over a variable denotes its total derivative with respect to time (for example, $\dot{P} = dP/dt$).

The equation system (4)–(7) contains 4 endogenous variables (in time rates of change), namely, P, S, D and M, each of which can be expressed in terms of the exogenous variables X, Y and Z. The reduced form equation for the terms of trade variable is given by

$$\dot{P} = (1/s_1 - d_1 + m_1)(-s_2 \dot{X} + d_2 \dot{Y} - m_2 \dot{Z}) \tag{8}$$

which shows the effects on relative domestic prices of changes in the exogenous variables influencing agricultural production, consumption, and trade. The coefficient $(1/s_1 - d_1 + m_1)$ has a positive sign.

Referring back to the supply function (1), several empirical investigations have yielded (single-equation) estimates of the price elasticity of aggregate agricultural supply that are invariably near zero.[8] For this reason it is sometimes assumed that agricultural growth in developing countries is 'more a function of public policy towards research, education, and such matters than of price policy' (Mellor, 1969, p. 1414). Indeed, where agricultural technology is stagnant and rural infrastructure remains underdeveloped, it does not seem reasonable to expect that an improvement in agricultural price incentives will lead to higher output. On the other hand, technological change and infrastructure development can loosen supply constraints and result in higher agricultural production even if relative prices remain the same.

In the context of the above-specified model, the case of zero supply response to agricultural terms of trade changes would imply that $s_1 = 0$ and $\dot{S} = s_2 \dot{X}$. Equation (8) then becomes

$$\dot{P} = (1/d_1 - m_1)(\dot{S} - d_2 \dot{Y} + m_2 m_2 \dot{Z}) \tag{9}$$

and S can be treated as an exogenous variable. The expected sign of the coefficient $(1/d_1 - m_1)$ is negative.

Alternatively, equation (9) can be considered as part of a complete, two-equation system which, together with equation (1), jointly determines $\dot{S}$ and $\dot{P}$ given $\dot{X}$, $\dot{Y}$ and $\dot{Z}$.

The empirical analysis in the following section makes use of the analytical framework developed above. In particular, we are interested in estimating equations (1) and (9) based on the alternative interpretations (a) that they are independent, and (b) that agricultural supply and the domestic terms of trade are jointly dependent variables.

5 ESTIMATING AND INTERPRETING THE AGRICULTURAL SUPPLY AND TERMS OF TRADE EQUATIONS

In investigating empirically the relationship between agricultural growth and terms of trade changes, our interest is in the collective experience, rather than individual experiences, of the developing countries in our sample; additionally, we are also interested in examining the special case of Sub-Saharan Africa. Furthermore, it is the medium- to long-run, rather than short-run, relationships that we want to analyse; for this reason the critical variables are expressed in average annual (compound) rates of changes (that is, the trend values) over the observation period 1960–84. In contrast to time series analysis, using this type of cross-country data enables us to abstract from dynamic considerations (for example, adjustment lags) and short-term disturbances (for example, weather). Multi-country, long-period analysis is advantageous in that it reduces the probability of gross error arising from sources peculiar to individual countries and specific short periods.

Using the simultaneous equation model formulated in the preceding section, we need to specify the explanatory variables assumed to influence domestic agricultural production, consumption, and trade. Considering first the agricultural supply equation, the domestic terms of trade – in terms of both its trend (Pa) and, as a measure of price risk, its instability (Is), together with the trend in GDP per capita (Gc), rural population density (RPD), life expectancy (LE), and the proportion of agricultural land irrigated (ALI) are hypothesised to affect the agricultural growth rate (Sa). GDP per

capita can be considered, following Mundlak and Hellinghausen (1982), to represent a country's ability to finance agricultural investments, especially public expenditures on research, extension, transport, and other rural infrastructure facilities.

The three 'endowment' variables RPD, LE, and ALI have been found in recent empirical work using cross-country data (cf. Binswanger *et al.*, 1985) significantly to affect agricultural supply. Higher population density is believed to induce greater specialisation in rural production activities and to lower the per capita cost of providing rural infrastructure, conditions which favour more rapid agricultural growth (Boserup, 1965). On the other hand, a larger rural population on a given land area can also be associated with greater use of land for human settlement to the detriment of agricultural production. Life expectancy is used as a proxy measure for health, which is expected to have a positive influence on labour productivity; LE is admittedly a very imperfect measure since it pertains to the entire population rather than just the rural population (on which the required data are not available). We also considered an education variable, represented by adult literacy rate, which however turned out to be highly correlated with life expectancy.

The non-price demand factors (represented in the analytical discussion above by the vector Y) are assumed to consist only of GDP per capita and size of population (POP). While we acknowledge that demand for agricultural products is determined in part by the distribution of national income (due, for example, to the higher marginal budget share of food in lower income households), income distribution data are simply not available for the majority of developing countries in our sample. As for the trade policy function, the (non-price) capacity-to-trade variable (CT) is represented simply by the observed growth rate of each country's aggregate imports in US dollars during 1960–84. While CT is not a quantity measure, it is assumed that the same trend in the dollar price of agricultural products over the observation period applies to all developing countries in our sample; hence there is no need to introduce a world price variable in the trade policy equation. Tables 1.3a and 1.3b present the estimated equations for agricultural supply and terms of trade[9] using ordinary least squares (OLS) and two-stage least squares (TSLS) on 1960–84 data for the entire set of 41 developing countries and the subset of 19 Sub-Saharan African countries. Because the regressions are based on cross-country, rates-of-change data, we can be more liberal in the interpretation of the resulting test statistics.

Nonetheless, it is necessary to acknowledge that some relevant characteristics of LDC economies have not been taken into account (including non-quantifiable cultural and institutional factors) that must have had significant differential effects across countries on the domestic market for agricultural products.

What is most important about the regression results for present purposes is that they provide empirical support to the hypothesis raised earlier concerning the direction of causality in the relationship between agricultural growth and terms of trade changes. Single-equation (OLS) estimation of the agricultural supply function is seen from Table 1.3a to yield a negative coefficient for the terms-of-trade variable in both equations (1) and (4). Based on the two-equation model in which Sa and Pa/Pna are jointly dependent variables, estimating the supply equation by TSLS results in a positive terms-of-trade coefficient, as shown in equations (2) and (5), Table 1.3a. For the 'All countries' regression, the estimated terms-of-trade coefficient of 0.739 does not seem an unreasonable value of the aggregate supply elasticity averaged across the developing countries in our sample.

That the coefficient estimate (and its t-value) for the terms-of-trade variable in the Africa equation is lower than that for 'All countries' is not surprising, given the relatively undeveloped rural infrastructure and stagnant agricultural technology in Sub-Saharan Africa. Indeed, suppressing the Pa/Pna and Is variables tends to improve the overall fit of the Africa regression, as shown by the OLS-estimated equation (6). Consistent with the Delgado–Mellor hypothesis, non-price factors – represented particularly in growth of GDP per capita (public investments) and the health (LE) variable – appear to be the primary determinants of agricultural growth in Sub-Saharan Africa during 1960–84. A final observation on the regression results for agricultural supply is that they bear out the expected direction of the effects of Is, Gc, LE and ALI; contrary to the Boserup hypothesis, however, the coefficient of RPD turns out to be always negative.

Considering now the results of the regressions with the domestic terms of trade as dependent variable (Table 1.3b), it is striking that the signs of the coefficient estimates for the explanatory variables appearing in equations (1) – (4) are consistently correct, indicating negative effects of the supply variables Sa and CT and positive effects of the demand variables Gc and POP. The quantitative effect of domestic output on the terms of trade is seen to be larger than

that of the trade variable. It is also remarkable that population shows up consistently to have a much more potent influence on the domestic terms of trade than per capita income. This is particularly so in the regression results for Sub-Saharan Africa.

In the 'All countries' regressions, the TSLS estimated terms-of-trade equation appears more acceptable than the OLS result. The opposite seems to be the case for the Africa equations, in which the TSLS result (c.f. equation 4) shows a considerable reduction in Sa coefficient estimate and its t-value.

Therefore, to the extent that the underlying data for the Sub-Saharan Africa countries are reliable, it would seem that the simultaneous equation bias in the relationship between agricultural growth and terms-of-trade changes during 1960–84 can reasonably be ignored. The direction of causality is, however, different from what is invariably assumed in most existing studies of agricultural supply response. Instead of an exogenously determined domestic terms of trade variable affecting directly agricultural output, the above results indicate that it is the terms of trade that are directly influenced by agricultural supply, which in turn is primarily determined by non-price factors (such as public investments in technology development and rural infrastructure).

More generally, our findings from the 'All countries' regressions suggest that agricultural growth and the domestic terms of trade are jointly dependent variables and that single-equation estimates of the price elasticity of aggregate agricultural supply can be grossly misleading. The empirical results call attention to the need to take systematically into account the demand-raising effects of population growth and per capita income on the domestic market for agricultural products. Analysis of the relationship between agricultural growth and terms-of-trade changes is also likely to prove inadequate unless the role of trade policy in influencing total availability is appropriately specified.

6 SOME PERSPECTIVES AND CONCLUDING REMARKS

There are obviously many ways of extending the empirical work of this study. First of all, it would be useful to verify, using independent data sources at the individual country level, the behaviour of the domestic terms of trade observed above for the 41 developing countries. The World Bank data files offer the most comprehensive

Table 1.3a: Regression results: dependent variable, S_a

Equation No.	*Estimation technique*	*Constant*	*Coefficients of:* *Pa/Pna*	*I_s*	*G_s*	*RPD*	*LE*	*ALI*	*Coefficient of determination*
All Countries									
(1)	OLS	−0.660	−0.063	−0.031	0.212	−0.244	0.072	0.009	0.449
		(−0.59)	(−0.69)	(−1.08)	(2.19)	(−0.69)	(3.12)	(0.40)	
(2)	TSLS	0.078	0.739	−0.090	0.384	−1.072	0.060	0.046	0.473
		(0.04)	(1.02)	(−1.22)	(1.65)	(−1.10)	(1.38)	(0.87)	
(3)	OLS	−1.044	—	—	0.250	−0.388	0.071	0.018	0.447
		(−0.98)			(2.68)	(−1.16)	(3.09)	(0.81)	
Sub-Saharan Africa									
(4)	OLS	−9.461	−0.170	−0.028	0.274	−0.7[illegible]	0.281	0.368	0.355
		(−2.12)	(−1.39)	(−0.75)	(1.88)	(−0.57)	(2.57)	(0.56)	
(5)	TSLS	−6.546	0.139	−0.048	0.308	−0.798	0.209	0.669	0.360
		(−0.76)	(0.20)	(−0.75)	(1.57)	(−0.46)	(0.99)	(0.63)	
(6)	OLS	−8.477	—	—	0.321	−1.166	0.245	0.777	0.366
		(−1.91)			(2.17)	(−0.83)	(2.24)	(1.23)	

Note: Numbers in parentheses are the *t*-values. Coefficient of determination is adjusted for degrees of freedom (OLS), or is the square of the correlation coefficient between actual and predicted values of the dependent variable (TSLS).

Table 1.3b: Regression results: dependent variable, Pa/Pna

Equation No.	Estimation technique	Constant	Coefficients of: S_a	CT	G_c	POP	Coefficient of determination
All countries							
(1)	OLS	0.141	−0.456	−0.170	0.216	0.792	0.233
		(0.09)	(−1.50)	(−1.28)	(0.81)	(1.32)	
(2)	TSLS	0.197	−0.589	−0.185	0.289	0.835	0.357
		(0.13)	(−1.95)	(−1.26)	(0.72)	(1.24)	
Sub-Saharan Africa							
(3)	OLS	−0.968	−0.723	−0.263	0.269	1.473	0.294
		(−0.41)	(−1.36)	(−1.16)	(0.64)	(1.50)	
(4)	TSLS	−0.924	−0.288	−0.209	0.103	1.111	0.403
		(−0.39)	(−0.27)	(−0.81)	(0.19)	(0.88)	

Note: Numbers in parentheses are the t-values. Coefficient of determination is adjusted for degrees of freedom (OLS), or is the square of the correlation coefficient between actual and predicted values of the dependent variable (TSLS).

source of time series data for developing economies 'intended to be suitable for cross-country analysis'; while 'considerable effort has been made to standardise the definitions, coverage, time, valuation, and other characteristics of the basic data,' it is admitted that 'this has not been possible for all countries' (World Bank, 1983, p. vii). A particularly relevant question to investigate is how closely the implicit price deflators for value added obtained from the World Bank tapes reflect the actual prices facing agricultural and non-agricultural producers in the sample developing countries (especially countries in Sub-Saharan Africa).

We consider the results of our empirical investigation to be significant enough to warrant further examination of the relationship between terms-of-trade changes and agricultural growth based on the analytical framework developed above. It would indeed be interesting to undertake individual country analysis, using annual time series data from the *World Tables* or from any alternative sources of the various hypotheses explored above, taking into account dynamic considerations (such as intersectoral resource flows) and short-term disturbances. Such in-depth studies would also provide ample scope for incorporating individual peculiarities of, and exogenous factors impinging on, the workings of each country's market for agricultural products as they affect the terms of trade and aggregate output; this will serve to improve the statistical fit of the estimated equations. Finally, enlarging the framework of analysis so as to be able to examine the macroeconomic and income distribution effects of agricultural growth and terms-of-trade changes would also seem a useful direction for further work to take.

Government policies can significantly affect the relative domestic price of agricultural products *vis-à-vis* non-agricultural products. As recognised in the analytical framework developed above, foreign trade provides a mechanism for influencing the agricultural terms of trade, implying that trade policy is an integral part of agricultural pricing policy. A further implication is that, in the evaluation of the distortionary effects of agricultural pricing policy, what is relevant is not so much the temporal movements of the domestic terms of trade from some base year level, but the structure of domestic prices relative to foreign prices (or marginal revenues if import supply and export demand elasticities are not infinite). Past prices are an inferior reference in so far as they do not represent an alternative set of prices concurrently available to which can be related the scope for policy action.

The distinction between negative and positive agricultural price policy made by Krishna as quoted above is unclear on the reference price structure with which to compare the domestic terms of trade at a given point in time. If negative agricultural price policy means deliberately depressed terms of trade, the question arises: depressed with respect to what? Similarly, does an improvement in the terms of trade from some past period's level (which can be very 'depressed') necessarily imply a positive agricultural price policy? A rise in the terms of trade from some base year value only means that the prices paid and received by agricultural producers have improved; however, this could have been due to a favourable movement in international prices, not to an improvement in agricultural price policy.

There is a growing body of empirical evidence that government price interventions in developing countries have tended to discriminate against agricultural production (cf World Bank, 1986). The strong policy bias toward rapid industrialisation – in the 1950s via import substitution in most developing countries and since the early 1960s via industrial export expansion in an increasing number of developing countries – meant higher levels of protection to industry relative to agriculture. Such development strategy entailed the artificial lowering of the relative prices of agricultural products *vis-à-vis* industrial products, penalising farm producers in two ways: (1) they received lower than international prices for their products; and (2) they paid higher than international prices for industrial inputs such as fertiliser and pesticides.

Differences in relative prices can lead to significant resource transfers between sectors (Bautista, 1987). While the need to extract agricultural surplus to finance capital formation in the rest of the economy during development is a widely accepted proposition in development economics, one has to be concerned about the possible inefficiency with which the transferred resources are used in the non-agricultural sectors. In most developing countries where the industrial sector has been highly protected, the distortions in product and factor markets have led to the inefficient use of investment resources for non-agricultural production and the inability to compete in international markets. Unless such policy-induced distortions are corrected, and given the opportunities for rapid productivity growth in agriculture provided the capital requirements for technological change and rural infrastructure development (among other needed investments) are met,[10] there is cause for scepticism as to whether agricultural resource transfers can help accelerate the development

process. An additional consideration, of course, is that the increased rural incomes due to rising agricultural productivity can provide the stimulus to the expansion of non-agricultural production. This form of 'rural growth linkage' is at the heart of some proposals for an agriculture-based development strategy (Mellor, 1976; Adelman, 1984).

Notes

Discussions with Yair Mundlak and Tshikala Tshibaka were helpful in the preparation of this paper. Valuable research assistance was provided by James Gilmartin.

1. More precisely,

$$Pa/Pna = \frac{AVA^c/AVA^k}{(GDP^c - AVA^c)/(GDP^k - AVA^k)}$$

where the superscript c and k denote, respectively, current and constant prices in domestic currency units. This terms-of-trade measure has been used in previous studies; see, for example, Timmer (1984). It should be noted that the agricultural sector is defined here broadly, as in the national accounts, to include not only crops and livestock, but also fishery and forestry.

2. Following Della Valle (1978), the instability measure (I_s) is given by

$$I_s = \frac{100 \,.\, SEE}{\bar{P}} \sqrt{\frac{1 - R_u^2}{1 - R^2}}$$

where SEE is the standard error of estimate in the linear trend regression, $\bar{P}$ is the mean value of Pa/Pna, and R^2 and R_u^2 are the coefficients of determination in the linear and logarithmic trend regressions, respectively.

3. Based on the classification in the *1986 World Development Report*, per capita GNP of US $380 or lower in 1984 defines the low-income countries.

4. For instance, in the context of East African countries, Lele and Candler (1981, p. 114) state that 'although official agricultural prices are known, actual prices . . . faced by the majority of rural producers and consumers are not known'.

5. To be sure, one cannot always associate rising terms of trade with improving production incentives. For example, lengthy periods of civil disturbances (as have occurred in Uganda since the early 1970s) can lead to food scarcity due to disruption in domestic supply and impaired capacity to import. Food prices increase, to which agricultural producers

cannot respond; indeed they may be forced to leave the farms and get into some informal non-agricultural production activities. Under such conditions the domestic terms of trade improve but not agricultural production incentives.

6. A negative output response to agricultural prices is, of course, possible – if leisure is valued very highly or if agricultural producers have rigid income targets. We do not consider this possibility in the present study.
7. For an analytical discussion and application to Philippine food imports, see Bautista (1978).
8. For recent reviews, see Food and Agriculture Organization (1985) and Binswanger *et al.* (1985).
9. Dummy variables for (i) oil-exporting and (ii) low-income countries were included in the preliminary runs of terms-of-trade regression, which however did not yield significant coefficient estimates.
10. For historical evidence of relatively large investment requirements for agricultural development (in terms of the incremental capital–output ratios in agriculture and in mining and manufacturing), see Krishna (1982).

References

Adelman, I. (1984) 'Beyond Export-Led Growth', *World Development* vol. 12, pp. 937–49.

Bautista, R.M. (1978) 'Import Demand in a Small Country with Trade Restrictions', *Oxford Economic Papers* vol. 30, pp. 199–216.

Bautista, R.M. (1987) *Production Incentives in Philippine Agriculture: Effects of Trade and Exchange Rate Policies*, Research Report 59 (Washington DC: International Food Policy Research Institute).

Binswanger, H., Mundlak, Y., Yang, M.C. and Bowers, A. (1985) 'Estimation of Aggregate Agricultural Supply Response from Time Series of Cross-Country Data', Report ARU 48 (Washington, DC: The World Bank, Agriculture and Rural Development Department).

Boserup, E. (1965) *Conditions of Agricultural Growth* (Chicago: Aldine Publications).

Delgado, C.D. and Mellor, J.W. (1984) 'A Structural View of Policy Issues in African Agricultural Development', *American Journal of Agricultural Economics* vol. 66, pp. 665–70.

Della Valle, P.A. (1978) 'On the Instability Index of Time-Series Data: A Generalization', *Oxford Bulletin of Economics and Statistics* vol. 40, pp. 247–9.

Food and Agriculture Organization (1985) 'Agricultural Price Policies' (Rome, mimeographed).

Krishna, R. (1967) 'Agricultural Price Policy and Economic Development', in H.M. Southworth and B.F. Johnston (eds) *Agricultural Development and Economic Growth* (Ithaca: Cornell University Press).

Krishna, R. (1982) 'Some Aspects of Agricultural Growth, Price Policy, and Equity in Developing Countries', *Food Research Institute Studies* vol. 18, pp. 219–60.

Lele, U. and Candler W. (1981) 'Food Security: Some East African Considerations', in A. Valdés (ed.) *Food Security for Developing Countries* (Boulder: Westview Press, Inc.).

Mellor, J.W. (1969) 'Agricultural Price Policy in the Context of Economic Development', *American Journal of Agricultural Economics* vol. 51, pp. 1413–20.

Mellor, J.W. (1976) *The New Economics of Growth* (Ithaca: Cornell University Press).

Mundlak, Y. and Hellinghausen, R. (1982) 'The Intercountry Agricultural Production Function: Another View', *American Journal of Agricultural Economics* vol. 64, pp. 664–72.

Timmer, C.P. (1984) 'Energy and Structural Change in the Asia-Pacific Region: The Agricultural Sector', in R.M. Bautista and S. Naya (eds) *Energy and Structural Change in the Asia-Pacific Region* (Makati: Philippine Institute for Development Studies and Asian Development Bank).

World Bank (1983) *World Tables* (3rd edn, vol. I) (Baltimore: Johns Hopkins Press).

World Bank (1986), *World Development Report 1986* (Oxford: Oxford University Press).