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Southern Africa Department
Africa Regional Office
The World Bank
July 1991
WPS 719

How Trade and Economic Policies Affect Agriculture

A Framework for Analysis Applied to Tanzania and Malawi

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and
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This general equilibrium model shows that agricultural exports are highly responsive to price incentives — and that the most effective policy instruments for expanding agricultural exports are direct export incentives and devaluation of the exchange rate.

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Lopez, Ali, and Larsen provide a general equilibrium model for analyzing the mechanisms by which macroeconomic, trade, price, and exchange rate policies affect agricultural export sectors. They estimate the model empirically for Tanzania and Malawi to measure the supply responses of agricultural exportables. They find that:

- Agricultural exports are highly responsive to price incentives.
- The most effective policy instruments for promoting the expansion of agricultural exports are direct export incentives and devaluation of the exchange rate.
- Fiscal policies are not neutral with respect to the structure of agricultural production.

Table of Contents

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A Framework for the Analysis of Trade and Macroeconomic Policies in Agriculture with Applications to Tanzania and Malawi

I. Introduction[1]

Many countries in Sub-Saharan Africa have gone through dramatic structural adjustments during the second half of the eighties. The adjustment policies implemented have generally pointed toward decreasing the antiexport biases and to reduce macroeconomic disequilibria. Among these policies the most important were a decrease in the degree of protection to the import substitution sector, reduction or even elimination of export restrictions and taxes, improved fiscal balances and exchange rate devaluations oriented to reduce overvaluation of the real exchange rate.

These policies have been implemented under the assumption that the fall of output in the import substitution sector and in the non-tradable sectors associated with the decreased import protection and real exchange rate adjustment, respectively, would be more than compensated by an expansion of the agricultural sector, in particular the agricultural exportable activities. Decreased protection to import substitution sectors, a more realistic real exchange policy and the removal of export

[1]The findings, interpretations and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Bank, its affiliates or its member countries.

The research was funded with a grant from the Africa Region Front Office of the World Bank.

restrictions and taxes all point toward an increased relative profitability of the agricultural exportable sector vis-a-vis the rest of the economy. This implies that the exportable sector is likely to be in a better situation to attract scarce resources and thus initiate rapid growth. In fact, the average domestic relative prices of agricultural exports vis-a-vis food prices (which are mostly importables or non-tradables) have increased by more than 30% in 18 Sub-Saharan countries between 1984 and 1988 (Jaeger, 1989).

The agricultural exportable sector performance during the 2nd half of the eighties in most Sub-Saharan African countries has been mixed, with some countries showing an important expansion while in others the sector has remained relatively stagnant. In Tanzania, for example, the agricultural exportable sector has expanded very fast since 1985, but starting from very depressed levels has only recently reached the levels of output prevailing in the early seventies.

In general most of the reforms have been implemented only in the last few years and hence it is presumably too early to evaluate the impact of the policies on the agricultural exportable sector. Moreover, it is possible that the relatively small observed supply response to structural reform so far be due to unfavorable developments in other areas that have occurred more or less simultaneously with the reforms. For example, it appears that the external terms of trade for most Sub-Saharan exports have deteriorated between 1985 and 1988. It is possible that the structural reforms may have large effects on the agricultural exportable sector but that these effects remain hidden due to other unfavorable events. Without the reforms, the sector might

have exhibited an even poorer performance. Finally it is not clear what specific policies are most effective in inducing a strong response from the agricultural exportable sector. In particular, an important question concerns the relative importance of trade, exchange rate and macro expenditure policies in affecting supply of the agricultural exportable sector.

The objectives of this paper are: (i) to provide a systematic macro- sectoral framework that will permit to analyze the various mechanisms by which macroeconomic, trade, price and exchange rate policies may affect the agricultural exportable sector and (ii) to empirically estimate a simple general equilibrium model that allows us to provide insights about the quantitative importance of the various channels by which government policies have affected the agricultural exportable sector in two Sub-Saharan countries, namely, Tanzania and Malawi. This analysis allows us to measure supply responses of the agricultural exportable subsector from a general equilibrium perspective. That is, considering not only the direct effects of a particular policy on supply of exportable agricultural commodities but also its indirect effects that take place via additional changes in prices, wages and expenditures induced by general equilibrium interdependencies.

II. The Model

We consider three types of agricultural goods, namely, agricultural exportables, agricultural importables and agricultural non-tradables. Domestic production of agricultural exportables competes directly with the other two agricultural sectors for sector specific resources. We assume that a labor market exists and that competition for labor is entirely reflected

in the wage rate. The major interactions between the agricultural subsectors and the rest of the economy take place essentially through two mechanisms, the level of the real wage and the relative price of agricultural non-tradables (Lopez, 1989). An expansion of the non-agricultural sector, for example, would cause greater demand for labor and for agricultural non-tradable goods[2]. This, would lead to higher wages and higher prices of agricultural non-tradables which, in turn, would cause a fall in the domestic supply of agricultural exportables. Higher wages reduce the international competitiveness of the agricultural exportables and a higher price for agricultural non-tradables would induce a switching of other sector specific agricultural resources from production of exportables to production of agricultural non-tradables.

Thus, domestic supply of agricultural exportables, Q^{AX}, can be represented as follows:

$$Q^{AX} = F(\tilde{p}^{AX}, \tilde{p}^{AN}, \tilde{p}^{AM}, \tilde{w}; k, h, t) \tag{1}$$

where $\tilde{p}^{AX}$ is the price of agricultural exportables, $\tilde{p}^{AN}$ is the price of agricultural non-tradables, $\tilde{p}^{AM}$ is the price of agricultural importables, $\tilde{w}$ is the wage rate, k is capital stock in agriculture, h is an index of weather and t is an index of technical change. According to the previous discussion we expect that $\partial Q^{AX}/\partial\tilde{p}^{AX} \equiv F_1(\cdot) > 0$, $\partial Q^{AX}/\partial\tilde{p}^{AN} \equiv F_2(\cdot) < 0$, $\partial Q^{AX}/\partial\tilde{p}^{AM} \equiv F_3(\cdot) < 0$, $\partial Q^{AX}/\partial\tilde{w} \equiv F_4(\cdot) < 0$, $\partial Q^{AX}/\partial k \equiv F_5(\cdot) > 0$, $\partial Q^{AX}/\partial h = F_6(\cdot) > 0$, and $\partial Q^{AX}/\partial t = F_7(\,) > 0$.

The supply equation (1) is homogeneous of degree zero in $\tilde{p}^{AX}$,

[2]Demand for tradable agricultural goods would also increase but since their prices are more closely linked to world prices, we can expect that their prices would not be affected unless there is a simultaneous change in their protection rates.

$\tilde{p}^{AN}$, $\tilde{p}^{AM}$ and $\tilde{w}$ and therefore we can normalize by any one of these four prices to express the others in real form. We choose to normalize all prices and wages by $\tilde{p}^{AM}$ and thus, the agricultural exportable supply equation can be written as:

$$(2) \qquad Q^{AX} = F(p^{AX}, p^{AN}, w;\ k,\ h, t),$$

where $p^{AX} \equiv \tilde{p}^{AX}/\tilde{p}^{AM}$, $p^{AN} \equiv \tilde{p}^{AN}/\tilde{p}^{AM}$, and $w \equiv \tilde{w}/\tilde{p}^{AM}$. Of course the sign pattern of (1) is fully conserved in (2). The response of Q^{AX} to a change in the price of agricultural importables is now

$$(3) \qquad \frac{\partial Q^{AX}}{\partial \tilde{p}^{AM}} = -\frac{1}{\tilde{p}^{AM}}\left[\frac{\partial Q^{AX}}{\partial p^{AX}} p^{AX} + \frac{\partial Q^{AX}}{\partial p^{AN}} p^{AN} + \frac{\partial Q^{AX}}{\partial w} w\right],$$

which according to the previous discussion should be negative. That is, an additional empirically testable restriction is that the sum of the elasticities of Q^{AX} with respect to p^{AX}, p^{AN} and w (which is equal to minus the elasticity of Q^{AX} with respect to $\tilde{p}^{AM}$) should be positive. We assume that the stock of capital in agriculture is fixed and that the sector as a whole competes with the rest of the economy only for the allocation of labor (as seen below, the wage rate is endogenous thus reflecting there is competition for labor between agriculture and the rest of the economy). Therefore the estimates should be interpreted as short and intermediate run responses given a stock of capital in agriculture. We distinguish between short and medium run according to the degree of adaptation of price expectations. In the empirical model we allow for lagged prices as well as current prices to affect agricultural exportable supply. Thus, the short run response will correspond to the effect of the current price on supply. The intermediate run effect will correspond to the sum of

the effects of the current and lagged prices. That is, the intermediate run effect is assumed to occur when the price expectations are fully adapted to the new levels.

There are two endogenous variables in equation (2) that need to be explained, namely p^{AN} and w. The price of agricultural non-tradables is largely dependent on supply conditions prevailing in agriculture as well as on domestic demand conditions. We assume that the market price of agricultural non-tradables adjusts to clear the domestic market for agricultural non-tradables,

$$Q^{AN}(p^{AN}, p^{AX}, k, w; h, t) = D^{AN}(p^{AN}, p^{AX}, p^{N}; E), \tag{4}$$

where $Q^{AN}(\cdot)$ is the supply function of agricultural non-tradables, $D^{AN}(\cdot)$ is the domestic demand function for agricultural non-tradables, p^{N} is the price of non-agricultural goods and E are total domestic expenditures. Both p^{N} and E are also normalized by the price of agricultural importables.

Consistent with the previous discussion we expect that $\frac{\partial Q^{AN}}{\partial p^{AN}} > 0$, $\frac{\partial Q^{AN}}{\partial p^{AX}} < 0$, $\frac{\partial Q^{AN}}{\partial w} < 0$, $\frac{\partial Q^{AN}}{\partial h} > 0$, and $\frac{\partial Q^{AN}}{\partial t} > 0$. Moreover, the demand for agricultural non-tradables is expected to be decreasing in the price of agricultural non-tradables and increasing in expenditures, i.e., $\frac{\partial D^{AN}}{\partial p^{AN}} < 0$, and $\frac{\partial Q^{AN}}{\partial E} > 0$,. The effect of p^{AX} and p^{N} on the demand for agricultural non-tradable is ambiguous, depending on whether agricultural exportable and non-agricultural consumer goods are complements or substitutes with agricultural non-tradables.

From (4) one can now derive a price equation for the agricultural non-tradables,

$$p^{AN} = \psi(p^{AX}, p^{N}, w, E; k, h, t). \tag{5}$$

According to the sign pattern of (4) we expect that p^{AN} be

decreasing in h and t and increasing in w and E. The effects of p^{AX} and p^{N} in (5) are ambiguous depending on the demand complementarity/substitutability relationships indicated above. If agricultural non-tradables and non-agricultural goods are complements in demand then $\frac{\partial p^{AN}}{\partial p^{N}} > 0$ and $\frac{\partial p^{AN}}{\partial p^{N}} < 0$ under demand substitutability. If agricultural non-tradables and exportables are substitutes or weak complements in demand, $\frac{\partial p^{AN}}{\partial p^{AX}} > 0$ and $\frac{\partial p^{AN}}{\partial p^{AX}} < 0$ only if these goods are sufficiently complement in demand to off-set the cross supply effects between the two.

Since p^{N} is the price of non-agricultural goods at the consumer level, we assume that this price is largely endogenously determined by their prevailing supply and demand conditions[3]. Thus, the market for the non-agricultural good can be represented by,

$$Q^{N}(p^{N},w;\ t) = D^{N}(p^{N},p^{AN},p^{AX};\ E), \tag{6}$$

where the left-hand in (6) represents the domestic supply of non-agricultural goods and the right-hand their demand. Note that consistent with the assumption that all factors of production in agriculture with the exception of labor are sector specific, the prices of agricultural goods do not directly affect the supply of non-agricultural goods. The effect of agricultural good prices on $Q^{N}(\cdot)$ is indirect via their effect on the wage rate, w. On the demand side we expect that $\frac{\partial D^{N}}{\partial p^{N}} < 0$, $\frac{\partial D^{N}}{\partial E} > 0$ and an ambiguous effect of p^{AN} and p^{AX}.

[3]The non-agricultural good is of course a composite of tradable and non-tradable goods. However, the fact that we are considering their prices at the retail level makes the non-tradable component much more influential because retailing activities are essentially non-traded.

From (6) it follows that,

$$p_N = \phi(p^{AN}, p^{AX}, w, E; t). \tag{7}$$

According to (6), p_N should be increasing in w and E, decreasing in t if productivity has increased through time in the non-agricultural sector, and the effects of p^{AN} and p^{AX} are ambiguous depending on the demand substitutability relationships.

The wage rate is assumed to be determined by a combination of market as well as institutional factors. The reduced form wage equation specified is the following,

$$w = \Omega(p^{AN}, p^{AX}, p^N, w_M; t), \tag{8}$$

where w_M is the minimum wage (also normalized by $\tilde{p}^{AM}$). It is expected that w be increasing in p^{AN}, p^{AX}, p^N and w_M. The minimum wage variable is likely to capture several aspects of the process of wage determination. First is its direct effect on those wages for which the minimum wage is binding and enforced. Second, changes in the minimum wage are probably good proxies for changes in public sector wages which are a relatively important component of the average economy-wide wage. Third, it has been shown in several countries that adjustments of the minimum wage convey an important information for wage setting in all sectors of the economy whether the minimum wage is binding or not. Adjustments in the minimum wage provide an indication of the government's goals in terms of wage changes that are taken into consideration by both unions and employers.

Finally, aggregate real expenditures are also affected by both policy and external variables. We postulate the following reduced form equation for domestic expenditures,

(9) $$E = g(p^{AX}, q, w_H, E^g, t),$$

where q are the external terms of trade of the country (excluding agricultural export prices), and E^g are government expenditures normalized by p^{AM}. We expect that domestic expenditures are increasing in all variables except in w_H which may have an ambiguous effect. An increase of domestic agricultural export prices is likely cause an increase in real income mostly because the agricultural exportable sector is discriminated against. Hence, any domestic increase in p^{AX} associated with a reduced taxation of the sector implies a reduction of the distortion causing the antiexport bias. This in turn leads to higher real income and hence to increase expenditures. If the increase in p^{AX} is due to an increase in the world price rather than to a reduction in the antiexport distortion, real income will also increase triggering higher expenditures.

Similarly, an improvement of the external terms of trade, q, also increases the country's real income and hence expenditures. The effect of the minimum wage is ambiguous because an increase in the minimum wage may imply greater unemployment which causes a fall of income and, hence, of expenditures. However, higher minimum wages may also imply a redistribution of income from higher income workers to those (low income) workers that remain employed. If the latter group has a higher propensity to spend one would expect a positive effect on expenditures. The net effect is, therefore, ambiguous. The positive effect of E_g on E is due to the fact that the government needs to finance its expenditures by one way or another reducing the income of the private sector. If the private sector saves a proportion of its income, the income transfer from the private sector to government

expenditures must imply greater total expenditures.

III. Recent Economic Performance and Structural Adjustments in Tanzania and Malawi

Tanzania experienced severe economic declines from the mid-70's to the mid-80's with falling GDP per capita. Production of traditional agricultural exortables[4] decreased substantially (40% from 1970 to 1984) as producer prices of exportables relative to market prices of food crops[5] fell proportionately (60% over the same period). Inflation rates averaged 25-30% since 1980, causing a more than 100% appreciation of the real effectiveexchange ratefrom 1980 to 1985. The ratio of fiscal deficit to GDP rose from about 5% in 1974 to 13-14% in the early eighties.

Policy reforms in Tanzania were introduced in 1984 with a trade liberalization program. The Economic Recovery Program (ERP) was initiated in 1986. The policy package included exchange rate devaluations, a tightening of fiscal and monetary policies, improved agricultural incentives and trade liberalization.

Large exchange rate devaluations from 1985 to 1990 brought the real effective exchange rate down far below the pre-1980

[4]Traditional agricultural exportables are here cotton, tobacco and cashewnuts. Coffee is not included due to highly inaccurate official estimates because large quantities are smuggled to Kenya.

[5]Food crops are here maize and rice (being the two most important). See Malyamkono & Bagachwa (1990) for market prices of food crops.

level, substantially improving the external terms of trade for agricultural exportables. The ratio of fiscal deficit to GDP has been reduced to about 8% (1988), but this figure understates the level of actual public expenditures (and deficit) because a large portion has been shifted to the financial sector. Inflation rates remained high at the 30% level primarily due to money supply increases of 35-40% per year since 1986 and high levels of public expenditures.

The Tanzanian economy has responded positively since the mid-80's, at least in part due to the policy reforms. Real GDP growth averaged 4% in 1986-90, with the highest growth in the agricultural sector. Production of traditional exportables (cotton, tobacco and cashewnuts) reached 1970-levels in 1988, a 60% increase from 1984 . Non-traditional agricultural exportables have also performed well. Despite these improvements, the current account deficit has not declined since 1983 due to large increases in imports.

Malawi experienced an average real GDP per capita growth of 3% in the period 1964-1979, driven primarily by high growth in the estate agricultural sector. The 1980's was a period with setbacks due to worsening external terms of trade, droughts and external transportation problems due to unrest in neighboring Mozambique. Real GDP per capita was 20% lower in 1989 compared to 1979 and substantial fiscal deficits emerged.

Agricultural production of traditional exportables (tobacco, sugar and tea) peaked in 1983. Production marginally surpassed that level only in 1989. Land is scarce and population growth is high in Malawi, implying that continued agricultural growth most

primarily come through improved productivity.

Stuctural adjustment programs in Malawi were implemented since the early eighties. Policies included tighter fiscal and monetary controls, trade liberalization and sectoral policies. Agricultural policies aimed at increasing production of traditional exportables, export diversification and productivity increases to achieve food security. Nominal exchange rate devaluations were only moderate because inflation rates were relatively low (10-15%), except in a few years. The real effective exchange rate appreciated 14% during the period 1980-85. Devaluations in 1985-89 brought it slightly below the 1973-79 level.

The Malawi economy experienced some turnaround in 1988-89, with increases in real GDP per capita in 1989 after declines in 1986-87. The current account deficit has improved somewhat.

IV. Agricultural Exportable Supply Responses

The model in section II provides the basis for the empirical model estimated and also allows us to identify the key mechanisms and channels by which microeconomic and macroeconomic policy changes may affect supply of agricultural exportables. In this section we discuss the channels by which trade, wage, fiscal and exchange rate policies exert their influences on the agricultural exportable sector.

1. Trade Policies. Consider first a reduction of agricultural export taxes (or the equivalent effect of a reduction of agricultural export quantitative restrictions) not accompanied by import liberalization. A reduction of export taxes will cause an increase in the domestic price of agriculture exportables which

will exert a direct positive effect on agricultural exportables (this effect is equal to $f_1(\cdot)$ in Equation (2)). This is not, however, the end of the story because an increase in p^{AX} will induce changes in the price of agricultural non-tradables and wages which in turn will induce 2nd round effects on agricultural exportable supply according to Equation (2). An increase of p^{AX} will cause the wage rate to increase because labor demand is likely to increase if agricultural exportable production is more labor intensive than most other activities (Equation (8)). Furthermore, increasing p^{AX} will also cause an expansion of aggregate expenditures which, in turn, will cause the price of non-tradables to increase. Also, because of production substitutability, an increase of p^{AX} is likely to have a direct positive effect on p^{AN} (see Equation (5)). Both the increase in p^{AN} and w caused by the export liberalization will have negative indirect effects on supply of agricultural exportables which will dampen the direct positive effect of the policy. It can be shown, however, that the indirect effects can never completely off-set the direct effects. That is, export liberalization will have a net positive effect on agricultural exportables. However, from the standpoint of policy analysis it is important to verify the quantitative importance of the indirect effects. If the indirect effects turn out very important, one should not expect very dramatic effects of export liberalization.

Import liberalization (i.e. import tariff reduction) will cause the price of importables $\tilde{p}^{AM}$ to fall which implies an equivalent increase of p^{AX} inducing a direct positive effect on agricultural exportable production. What happens is that agricultural import substitutes compete with agricultural

exportables for sector specific resources. Thus a fall in the price of importables causes part of these resources to be released from the import substitution sector which in part go to agricultural exportable production. Import liberalization has also indirect effect by inducing higher prices of agricultural non-tradables and higher wages. Higher prices of non-tradables may imply an expansion of agricultural non-tradables that also compete with agricultural exportable production for scarce resources and higher wages forces lower employment in the export sector. Both effects will partially off-set the direct effect but are not likely to revert it. Since we are not assuming permanent current account equilibrium the Lerner symmetry condition does not necessarily apply. That is, in this case the real effects of removing export taxes or decreasing import tariffs by the same proportion will not be the same. The lack of applicability of the Lerner symmetry condition is also consistent with the fact that exchange rate devaluation (an equal increase of the prices of exportables and importables) do have real effects.

2. Wage policies. Consider now an increase in the minimum wage rate or any government induced wage increase (i.e., increase of government employment). An increase of the minimum wage is likely to cause the average wage to increase (Equation 8) which has a direct negative impact on the supply of agricultural exportables. The wage increase on the other hand, will lead to higher domestic expenditures and thus to rising prices of non-tradables, which in turn will induce an additional negative effect on supply of agricultural exportables.

3. Macropolicies. Exchange rate devaluation will not affect the relative price of agricultural exportables p^{AX} because both

the price of agricultural exportables and importables increase by the same proportion (remember that $p^{AX} = \frac{\tilde{p}^{AX}}{\tilde{p}^{AH}}$). The key effect of devaluation is to reduce domestic expenditures in units of the importable commodities, i.e., E in equations (5) and (7) decreases. This will happen only if the fiscal and monetary policies are sufficiently restrained to force domestic nominal expenditures to remain constant or at least to increase less than the rate of devaluation. If nominal expenditures increase by the same percentage as devaluation and if the nominal minimum wage is proportionally increased, nothing happens. The level of E in this case would remain constant. If, however, devaluation is accompanied by sufficient fiscal/monetary discipline so that E falls, then devaluation will have real effects by directly inducing a fall of the price of non-tradables (Equations (5) and (7)). Moreover, if the nominal minimum wage is not adjusted by the same proportion as the rate of exchange devaluation, the real minimum wage will fall leading to a reduction of the average real wage (see Equation (8)). Devaluation of the exchange rate will, hence, affect agricultural exportable supply by reducing p^{AN} and w. The elasticities of Q^{AX} with respect to p^{AN} and w are, therefore, key parameters in determining the efficiency of devaluation in promoting greater agricultural export supply.

Another macropolicy that is analyzed with the model is the effect of expanding fiscal expenditures. An increase of fiscal expenditures will cause a rise in total domestic expenditures which in turn leads to higher prices of non-tradables and to wage increases. This reduces supply of agricultural exportables.

V. The Empirical Model and Results

Table 1 presents the empirical model derived from equations (2), (5), (7), (8) and (9). One modification introduced in the empirical model is the use of one year lagged as well as current values for the variables p^{AX} and p^{AN}. This will allow us to distinguish between short-run and intermediate-run supply responses. We specify a double-log empirical model with additive disturbances. The model has a simultaneous component (equations (2) to (4)) and two recursive equations (equation 1 and 5). The simultaneous equation component solves for the three endogenous variables p^{AN}, p^{N} and w as a function of the exogenous variables. The equation system (A) to (E) in Table 1 is estimated using Two-stage Least Squares.

We estimated the above model for Tanzania and Malawi using data for the period 1970-1988/87. A description of the data set and sources is provided in the appendix. Table 2 provides the complete set of econometric estimates for Tanzania and Table 3 shows the estimates for Malawi. In general the goodness-of-fit of the estimates for both countries is very satisfactory as reflected by the pattern of the t-statistics and adjusted R^2. The sign pattern of the coefficients is highly consistent with the theoretical analysis of the previous section. There are three exceptions, however. One of them is the effect of real wages on the price of agricultural non-tradables, which appear negative in the case of Tanzania (Table 2). The other one is the effect of aggregate expenditures on the price on non-agricultural goods which we expected to be positive but turned out negative for Tanzania. The third one corresponds to the effect of the wage rate on supply of agricultural exportables in Malawi (Table 3)

which was expected to be negative. These "wrong" signs are not, however, statistically different from zero. Furthermore, the very large negative effect of the price of agricultural exportables on the price of agricultural non-tradables in Tanzania is also quite worrisome. Although theoretically one may not rule a negative sign, the large value of the coefficient would suggest a very strong demand complementarity relationship between agricultural exportables and non-tradables.

In general the coefficients tend to be quite robust to changes in the model specification in all equations with the exception of the price equation for non-agricultural goods. In this equation, the coefficients associated with p^{AN}, E and q tended to show a relatively higher degree of instability.

Another potential problem is the values of the D-W statistics particularly for Tanzania,where most D-W are substantially greater or lower than 2,and in one case for Malawi. We also estimated the model allowing for 1st and 2nd order autocorrelation for all equations and found, however, that none of the autocorrelation coefficients were significant even at 10% level of significance (see Table 1A & 2A in appendix). Moreover,as can be seen in the appendix,the actual value of the other parameters were very similar to those reported in Tables 2 and 3. We therefore use these estimates in the ensuing analysis.

V.1 Supply Responses in Partial Equilibrium

The coefficients of the equations Q^{AX} in Tables 2 and 3 provide the partial equilibrium elasticity of changes in the various variables on the supply of agricultural exportables. That is, the elasticities for given levels of the other endogenous variables, namely, P^{AN}, w, P^{N} and E. The estimates of the

equations for Q^{AX} suggest a relatively high degree of responsiveness of the agricultural exportable sector to changes in relative prices in both countries.In particular, the own price short-run and intermediate-run elasticities are highly significant, with a short-run response of about 0.5 in both countries and an intermediate-run elasticity of approximately 0.8 for Tanzania and 0.7 for Malawi. Supply of agricultural exportables does not appear to compete with agricultural non-tradables in the short-run as reflected by the lack of significance of the sign of the current price of agricultural non-tradables in both countries. However, the significant negative effect of the coefficient of the lagged price of agricultural non-tradables does suggests an important degree of competition for scarce resources between the two sectors in the intermediate-run in both Tanzania and Malawi. The estimates suggests that the partial effect of a 10% increase in the relative price of agricultural non-tradables may induce a fall of the supply of agricultural exportables of about 3% in the intermediate-run in the case of Tanzania and of about 4.5% in the case of Malawi. Thus, the bahavior of agricultural exportables in the two countries under consideration is remarkably similar with Tanzania showing a slightly greater partial supply response to the price of exportables than Malawi and the latter being more responsive to agricultural non-tradables than Tanzania. This is consistent with the fact that in Malawi land is more scarce than in Tanzania. In the case of Malawi one would expect a more intense competition for land between exportables and other agricultural commodities. This is reflected in the higher values of the cross-price elasticities in the equations for Q^{AX}.

The effect of real wages on Q^{AX} is negative for Tanzania as expected although the degree of significance of the coefficient is not very high. In any case, the value of the coefficient appears quite plausible, suggesting that a 10% increase in real wages would cause a fall in agricultural exportables of about 2.3%. This coefficient has the "wrong" sign for Malawi, although it is not significant. The effect of changes in the price of agricultural importables on the supply of agricultural exportables is equal to minus the sum of the coefficients of the prices and wage variables in equation A.[6] Thus, in the short-run this elasticity for Tanzania is about -0.21 while the intermediate-run elasticity of Q^{AX} with respect to the price of agricultural importables is -0.22.

In the case of Malawi, there are no import substitution crops (see data description in appendix), and thus we normalize by the prices of fertilizers. This is justified because in contrast with the case of Tanzania, farmers in Malawi use fertilizers quite intensively. In Malawi the short-run elasticity of agricultural exportables with respect to importables is -0.29 while the intermediate-run elasticity is only -0.06. The fact that the intermediate-run elasticity is absolutely lower than the short run one is quite surprising. One interpretation of this is that in Malawi expectations with respect to exportable prices adapt almost immediately after a change in such prices have ocurred. This explains the lack of significance of the coefficient of P_{-1}^{AX}. However, the expectations about agricultural non-tradable prices

[6]Remember that all prices and the wage rate in (A) are normalized by the price of agricultural importables.

do not adapt very rapidly, meaning that producers trust less in the sustainability of agricultural non-tradable prices than that of the exportable prices. This is reflected in the lack of statistical significance of coefficient of the current P^{AN}variable and large significance of the coefficient of the lagged P^{AN}variable. This implies that the intermediate-run elasticity of Q^{AX} with respect to a third price (i.e. the price of importables) will necessarily be less negative in the intermediate-run.

V.2 Supply Responses in General Equilibrium

The general equilibrium effects of changes of agricultural exportable prices and changes of importable prices are obtained by explicitly accounting for the impact of these changes on real wages and prices of agricultural non-tradables and thus for their indirect effects on Q^{AX}. The general equilibrium effects on real wages and prices of agricultural non-tradables are estimated by simultaneously solving equations (B) to (E) in Table 1 for the endogenous variables. The general equilibrium effects are expected to be smaller than the partial ones because the wage and price of agricultural non-tradable effects are opposite to the partial effects. The increase in p^{AX}, for example, causes general equilibrium effects leading to higher w and p^{AN} and thus to off-set in part the partial equilibrium effects.

Tables 4 and 5 show the general equilibrium effects of various policy changes for Tanzania and Malawi, including I. - trade policies alternatively consisting of (1) an increase of agricultural exportable price (an increase of p^{AX}) and (2) a reduction of import tariffs (i.e., a fall of the price of agricultural importables); II. - Macro policy including (1) exchange rate devaluation and (2) an increase of public

expenditures; III. - wage policies consisting in an increase of the minimum wages. As can be seen in Table 4, the general equilibrium own price supply responses of agricultural exportables for Tanzania are still positive and substantial but lower than the partial equilibrium effects (which are provided in brackets in row 1 of Table 4). The general equilibrium dampening effects are small in the short-run but in the intermediate-run are significantly more important. The intermediate-run own price supply elasticity falls from 0.77 in a partial equilibrium context to 0.64 in a general equilibrium framework. The general equilibrium effects of a reduction of importable prices on Q^{AX} are also smaller than the partial cross-price elasticities but the dampening effect is in this case quite smaller than that for the exportable price change.

An important implication from the analysis of trade policies for Tanzania and Malawi (Table 3) is the dramatically different effects of direct export promotion (i.e., increasing domestic prices of exportables) vis-a-vis import substitution policies. It appears that policies oriented to reduce protection of the import substitution sector are dramatically less effective in generating a supply response in the agricultural exportable sector than direct export incentives. In fact, direct export promotion policies are three to five times more effective in this respect than policies that reduce import protection by the same proportion.

The general equilibrium effects of trade policies for Malawi are quite similar to those in Tanzania in the short-run. A major difference is, however, that the intermediate-run responses are substantially smaller in Malawi than in Tanzania. In particular

the lower supply response in the intermediate-run than in the short-run is quite surprising. What happens is that the effect of an increase in the exportable price on the price of non-tradable agricultural goods is positive and quite large. Since, as discussed before, the expectations about the price of non-traded commodities are adapted very slowly, the increased price of non-tradables induced by the rise in P^{AX} has almost a negligible effect on production of non-tradables in the short-run. However, in the intermediate-run the non-tradable sector does expand very significantly. This causes the non-tradable sector to compete more intensively for scarce resources with the exportable sector in the intermediate than in the short-run. This, in turn, has a large off-setting effect on exportable production in the intermediate-run. Thus, it appears that in contrast with Tanzania, in Malawi one cannot expect a very robust agricultural export supply response to trade policy incentives. It is possible that the agricultural sector in Malawi has been seriously constrained by factors other than only inadequate prices. For example,it is possible that the rural infrastructure capacity of thecountry is too limited to permit a sustained export response in the intermediate-run when the expectations about the price of non-tradables have been adapted and thus lead to a recovery of the agricultural non-tradable sector that competes more intensively for infrastructure resources than in the short-run.

Among the macropolicies, the most dramatic effects are related to exchange rate devaluation. The effect of devaluation shown in Table 4 and 5 assumes a nominal devaluation <u>without</u> adjustments of either nominal expenditures and nominal minimum wages. That is, we assume complete monetary/fiscal and wage

discipline and that initially there is a current account deficit which is in part corrected via nominal devaluation. In this case by devaluing the government is simply speeding-up the adjustment of the real exchange rate that would otherwise take place via a reduction of foreign reserves, monetary contraction and eventual reduction of nominal expenditures. Of course this "perfect" devaluation with complete fiscal/monetary/wage discipline is highly unlikely to occur in reality. The purpose of the figures in Table 4 and 5 is to only illustrate the potential effect of devaluation on agricultural exportables if the government is able to maintain nominal expenditures and minimum wages constant. In this case a 10% devaluation in Tanzania would lead to about 4% expansion of agricultural exportables in the short-run and to about 10% in the intermediate-run, while in Malawi the effects are only 0.6% and 3.5%, respectively. If the government due to political pressures or other reasons allows total nominal expenditure (i.e. both private and public) and minimum wages to adjust by say 5% then the real effects devaluation on Q^{AX} is halved.

The large effects of devaluation particularly for Tanzania in this case is of course not surprising. Nominal devaluation reduces real aggregate expenditures which cause the prices of non-tradables to fall. Moreover, the fall of the prices of non-tradables and the reduction of the real minimum wage also lead to a large decrease of real wages. Both the decrease of the real price of non- tradables and wages will induce the agricultural exportable sector to expand because it now faces less competition from agricultural non-tradables and lower real wages making exports more competitive in international markets.

Fiscal expenditures may also have a detrimental effect on the agricultural exportable sector. Increasing fiscal expenditures when not financed by higher taxes will induce an increase in aggregate expenditures although by a smaller proportion. The elasticity of aggregate expenditures will be equal to the share of government expenditures in total expenditures if public expenditures do not affect private expenditures. In fact, however, government expenditures will induce both positive "multiplier" effects on private sector expenditures (particularly in the presence of unemployment) as well as (negative) crowding-out effects. Since in both Tanzania and Malawi the elasticity of government expenditure on total expenditures is greater than its share (see Tables 2 and 3) one can conclude that the multiplier expenditure effects tend to dominate the crowding-out effects. It is important to note, however, that the negative effects of government expenditures on the agricultural exportable sector in Tables 3 and 4 may be exaggerated. The reason for this is that we are not considering the effects of increasing government expenditure on agricultural and export infrastructure which are likely to have positive effects on Q^{AX}. The results in Tables 3 and 4 correspond to the effect of increases of non-agricultural public expenditures.

Finally, minimum wage policies also appear to have some moderate effects on the agricultural exportable sector in Tanzania. A 10% increase in the minimum wage has as large an effect on Q^{AX} as a 10% increase in protection to importables. This result may seem surprising. However, it is important to note that increasing the minimum wage not only has a large effect on the average agricultural wage but also on the price of

agricultural non-tradables. Both factors explain the fall of agricultural exportables.

The effects of macropolicies in Malawi are much smaller than in Tanzania although quite sizable. In particular, the effect of devaluation can cause a large effect on agricultural exportables in Malawi, and specially in the intermediate-run. In general, however, as with the case of trade policies, it appears that prices play a less vital role in inducing exportable supply responses in Malawi than in Tanzania. This does not mean that policies that affect agriculture through price incentives are not important in Malawi. All what this means is that the general equilibrium mechanisms tend to be more off-setting in Malawi than in Tanzania.

VI. Conclusions and Policy Implications

The most important conclusion of this paper is that the agricultural exportable sector in Tanzania is highly responsive to price incentives. Production of agricultural exportables is not only responsive to price changes of the exportable commodities but also to price changes of competitive agricultural commodities, namely agricultural importables and in particular agricultural non-tradable commodities. The agricultural exportable responsiveness in Malawi is still significant but not as large as in Tanzania.

The effectiveness of direct export incentives (i.e., removal of export taxes and relaxation of export restrictions) is dramatically higher than import liberalization in promoting increased production in the agricultural exportable subsector in both countries. A reduction of export taxes and a proportionally

identical tariff cut will both expand production of agricultural exportables. However, the quantitative effect in both countries of the export tax reduction on production of agricultural exportables is more than twice the size of a similar tariff cut for importables in the short-run and four times as large in the intermediate-run. An important policy implication of this is that trade reform should eliminate export restrictions and export taxes at the same time or even before proceeding with import liberalization. Import liberalization is likely to reduce production of agricultural importables thus inducing imports to expand rather quickly. If exports are not simultaneously liberalized, the country would run the risk of suffering external disequilibria due to the fact that the expansion of imports would not be matched by a corresponding increase in exports. Moreover, the results also confirm the lack of applicability of the Lerner symmetry condition in the countries under analysis.

Another important result is the high degree of effectiveness of devaluation as an instrument to promote expansion of the agricultural exportable sub-sector specially in Tanzania. This effectiveness can of course be largely dissipated if devaluation is not accompanied by tight fiscal, monetary and wage discipline. Devaluation has real effects if there exist external disequilibrium that would have caused a real devaluation anyway. What nominal devaluation does is to speed-up the process thus permitting the country to avoid continued losses of foreign exchange reserves (or increasing dependence on foreign lending). Once the external equilibrium has been restored, devaluation is more likely to fuel inflation with little real effects unless the government is able to strictly sterilize the monetary pressures

that arise from the trade surpluses that in this case a devaluation would originate.

Finally, the results presented in the previous section help to illustrate the fact that fiscal policies are not neutral with respect to the structure of production. Expansive fiscal policies are likely to favor the non-tradable sector by inducing their prices to increase relatively to those of tradable goods (or, equivalently, expansive fiscal policies lead to real appreciation of the exchange rate). Moreover, these policies also cause real wages to increase. The impact of this for the agricultural exportable sector is quite negative. In Tanzania a 10% increase of real public expenditures without a corresponding increase in taxes leads to a fall of production in the agricultural exportable sector of about 3.5%, in the long-run, an effect equal to a reduction of agricultural exportable commodity prices of about 5%.

Table 1. <u>The Empirical Model</u>

(A) $$\ell nQ^{AX} = \alpha_0 + \alpha_1 \ell np^{AX} + \alpha_2 \ell np^{AX}_{-1} + \alpha_3 \ell np^{AN} + \alpha\ \ell np^{AN}_{-1} + \alpha_5 \ell nw + \alpha_6 h + \alpha_7 t + \mu_1$$

(B) $$\ell np^{AN} = \beta_0 + \beta_1 \ell np^{AX} + \beta_2 \ell np^{AX}_{-1} + \beta_3 \ell nw + \beta_4 \ell n\hat{E} + \beta_5 p^N + \beta_6 h + \beta_7 t + \mu_2$$

(C) $$\ell np^N = \gamma_0 + \gamma_1 \ell n\ p^{AX} + \gamma_2 \ell n\ p^{AN} + \gamma_3 \ell nw + \gamma_4 \ell n\ \hat{E} + \gamma_5 \ell nq + \gamma_6 t + \mu_3$$

(D) $$\ell nw = \varepsilon_0 + \varepsilon_1 \ell np^{AX} + \varepsilon_2 \ell np^{AX}_{-1} + \varepsilon_3 \ell np^{AN} + \varepsilon_4 \ell np^{AN}_{-1} + \varepsilon_5 \ell np^N + \varepsilon_6 \ell nw_M + \varepsilon_7 t + \mu_4$$

(E) $$\ell nE = \eta_0 + \eta_1 \ell np^{AX} + \eta_2 \ell nq + \eta_3 \ell nw_M + \eta_4 \ell nE^g + \eta_5 t + \mu_5$$

Note: μ_i (i = 1,...,5) are the additive stochastic disturbances assumed to be normally distributed with zero means.

Taole 2. Two-Stage-Least Square Estimates of the Model, Tanzania 1970-88

Dep. Variable	Constant	p^{AX}	p^{AX}_{-1}	p^{AN}	p^{AN}_{-1}	w	p_N	E	q	W_M	E_g	h	t	R^2	DW
Q^{AX}	9.96 (6.80)	0.47 (2.53)	0.30 (1.94)	-0.03 (-0.09)	-0.29 (-1.82)	-0.23 (-0.61)	-	-	-	-	-	0.59 (0.99)	-0.01 (-0.91)	0.83	2.24
p^{AN}	-3.08 (-2.06)	-2.67 (-1.72)	-0.19 (-1.11)	-	-	-0.99 (-0.95)	1.34 (1.32)	2.83 (1.71)	-	-	-	0.09 (0.13)	-0.24 (-1.56)	0.92	2.62
w	2.24 (2.83)	0.29 (1.10)	0.12 (1.23)	0.38 (2.78)	0.01 (0.09)	-	-0.07 (-0.15)	-	-	0.74 (2.84)	-	-	0.006 (0.23)	0.99	2.76
p^N	2.28 (2.90)	0.53 (6.69)	-	-0.01 (-0.08)	-	0.32 (2.55)	-	-0.07 (-1.28)	-0.41 (-4.08)	-	-	-	0.04 (4.96)	0.99	1.74
E	1.03 (1.38)	0.61 (9.18)	-	-	-	-	-	-	0.18 (1.56)	0.09 (0.81)	0.39 (4.27)	-	0.04 (2.94)	0.98	2.21

Table 3. Two-Stage-Least Square Estimates of the Model, Malawi 1970-87

Dep. Variable	Constant	p^{AX}	p^{AX}_{-1}	p^{AN}	p^{AN}_{-1}	w	p_N	E	q	W_M	E_g	h	k	t	R^2	DW
Q^{AX}	-3.16 (-1.19)	0.56 (3.31)	0.12 (0.79)	-0.27 (-1.47)	-0.44 (-5.35)	0.10 (0.79)	-	-	-	-	-	0.93 (2.16)	1.06 (2.67)	0.03 (0.97)	0.98	1.97
p^{AN}	-2.90 (-0.94)	0.38 (0.99)	-	-	-	0.65 (0.79)	0.93 (0.69)	-0.99 (-1.20)	-	-	-	-0.81 (-0.62)	-	0.05 (1.85)	0.57	2.34
w	-0.15 (-0.14)	-	0.44 (4.41)	0.02 (0.17)	-	-	1.02 (6.17)	-	-	0.13 (0.95)	-	-	-	-0.01 (-1.64)	0.96	1.78
p^N	3.12 (1.71)	-0.09 (-0.79)	-	0.29 (2.46)	-	0.09 (0.53)	-	0.68 (3.74)	-0.39 (-1.12)	-	-	-	-	-0.03 (-1.71)	0.94	0.85
E	-1.54 (-1.16)	0.197 (2.17)	-	-	-	-	-	-	0.83 (3.32)	-0.012 (-0.16)	0.71 (9.90)	-	-	0.02 (1.94)	0.94	2.00

Table 4. General Equilibrium Agricultural Exportable Supply Responses (In Elasticity). Tanzania 1970-88.

Policy Change	Net Effects: Short-run	Net Effects: Intermediate-run
I. Trade Policies		
I1. Domestic Export Price Increase (export tax reduction)	0.43 (0.47)	0.64 (0.77)
I2. Reduction of Domestic import prices (tariff cut)	0.16 (0.21)	0.18 (0.22)
II. Macro Policies		
II.1. Exchange rate devaluation	0.41	1.01
II.2. Increase of real public expenditures	-0.11	-0.35
III. Wage policies		
III.1 Increase of minimum wage	-0.16	-0.17

Note: Numbers in brackets correspond to the partial equilibrium effect

Table 5. General Equilibrium Agricultural Exportable Supply Responses (In Elasticity). Malawi 1970-87.

Policy Change	Net Effects	
	Short-run	Intermediate-run
I. Trade Policies		
I1. Domestic Export Price Increase (export tax reduction)	0.42 (0.56)	0.16 (0.67)
I2. Reduction of Domestic import prices (tariff cut)	0.21 (0.29)	0.05 (0.06)
II. Macro Policies		
II.1. Exchange rate devaluation	0.06	0.35
II.2. Increase of real public expenditures	-0.02	-0.15
III. Wage policies		
III.1 Increase of minimum wage	-0.05	-0.09

Note: Numbers in brackets correspond to the partial equilibrium effect

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APPENDIX

TANZANIA

Definition of variables used in the model:

Sample period: 1970-88.

Years 1970-88 refer to crop seasons 1969/70 - 1987/88 for production and prices of all crops.

Q^{AX} - Aggregate quantity index for production of agricultural exportables cotton, tobacco and cashewnuts.
The index was constructed with fixed weights based on average value of each crop in 1986-88. Coffee is excluded because significant quantities are smuggled to Kenya.
Note that the offical volume of marketed output of cotton is an extreme outlier in 1976, being only 1/2 of output in 1975 and 1987. The 1976-observation is therefore smoothed to the average of volumes in 1975 and 1977.

Source: 1) Annual Review of Agricultural Markets, 1988
2) Harvey, C.: Agricultural Pricing Policy in Africa, 1988

P^{AX} - Aggregate price index for the same agricultural exportables as above. The weights are the same as used in the quantity index. Prices are average producer prices.

Source: Same as for QAX

q - External terms of trade index for both agricultural and non-agricultural goods.

Source: CECTP, The World Bank

Wm - Minimum monthly urban wage.

Actual values were not found for 1970-72 and 1987-88. Values used are obtained by applying a linear trend on actual observations.

Source: Maliyamkono & Bagachwa: The Second Economy in Tanzania, 1990

W - Average monthly wages in the agricultural sector. Actual values were not found for 1970-72 and 1981-82. Values used are obtained by applying a linear trend on pre- and post- actual observations.

Source: 1) Bureau of Statistics: Statistical Abstract 1979
2) IMF data sources

Eg - Central government total annual expenditure, including both recurrent and capital expenditures .

Source: Bank of Tanzania: Economic & Operations Reports

E - Total domestic absorption (private and public consumption and investments).

Source: 1) National Accounts of Tanzania 1966-80
2) IMF: International Financial Statistics

P^N - Price index of non-agricultural goods.
The all items CPI was considered the most appropriate approximation of this measure.
An alternative index would be the non-food CPI, but the food component of the all items CPI contains far more agricultural goods than used in P^{AN}, P^{AM} and P^{AX} in this model.

Source: Bank of Tanzania: Economic & Operations Reports

P^{AN} - Price index of agricultural non-tradables.
PAN is defined as the parallell market price of maize. Extensive parallell markets for non-tradables existed during the sample period. The opportunity cost to the farmer is considered to be the parallell market prices rather than the official producer prices. Data on parallell market prices were found only for maize. Fortunately, maize is by far the most important non-tradable crop.

Parallell market prices were not found for 1970-72. Values used were obtained by applying a linear trend to actual observations.

Source: Maligamkono & Bagachwa: The Second Economy in Tanzania, 1990

P^{AM} - Price index for agricultural importables.
P^{AM} is defined as the parallell market price of rice. Rice and wheat may be considered importables, though domestic production of wheat relative to rice is insignificant. As for maize, extensive parallell markets existed for these crops during the sample period, but parallell market prices are only available for rice.

Parallell market prices were not found for 1970-72. Values used were obtained by applying a linear trend to actual observations.

Source: Maligamkono & Bagachwa: The Second Economy in Tanzania, 1990

h - Rainfall factor calculated as the deviations from the trend of yields of cereals.

Source: W. Jaeger: The Impact of Policy on African Agriculture: An Empirical Investigation, 1989

t - Timetrend (not in logs).

All variables, except Q^{AX}, h (rainfall factor) and q, are normalized by P^{AM}.
All variables are in logs (except t).

MALAWI:

Definition of variables used in the model:

Sample period: 1970-87.

Q^{AX} - Aggregate quantity index for production of agricultural exportables tobacco, tea and sugar.
The index was constructed with fixed weights being value shares of each crop in 1987.

Source: Malawi Monthly Statistical Bulletins

P^{AX} - Aggregate price index for the same agricultural exportables as above.
Prices for tea and tobacco are average domestic auction prices. Prices for sugar are export prices received by sugar producing estates.

Source: Malawi Monthly Statistical Bulletins

q - External terms of trade index for both agricultural and non-agricultural goods.

Source: CECTP, The World Bank

Wm - Minimum monthly urban wage.

Source: Malawi Statistical Yearbooks

W - Average monthly wages in the agricultural sector.

Source: Malawi Monthly Statistical Bulletins

Eg - Central government total annual expenditure, including both recurrent and capital expenditure.

Source: Malawi Monthly Statistical Bulletins

E - Total domestic absorption (private and public consumption and investments).

Source: Malawi Monthly Statistical Bulletins

P^N - Price index of non-agricultural goods.
The all items CPI was considered the most appropriate approximation of this measure. An alternative index would be the non-food CPI, but the food component of the all items CPI contains far more agricultural goods than used in P^{AN} and P^{AX}.

Source: Malawi Monthly Statistical Bulletins

P^{AN} - Price index of agricultural non-tradables.
P^{AN} is defined as the market price of maize.
The most important non-tradable in terms of production is maize. The opportunity cost to the farmer is the market price of maize rather than the official prod cer price.

Source: Malawi Statistical Yearbook

P^F - Aggregate price index of fertilizer prices paid by farmers.

Source: FAO Fertilizer Yearbooks

k - Stock of infrastructure (calculated based on annual investments in roads and bridges)

Source: Malawi Statistical Yearbooks

h - Rainfall factor calculated as the deviations from the trend of yields of cereals.

Source: W. Jaeger - The Impact of Policy on African Agriculture: An Empirical Investigation, 1989

t - Timetrend (not in logs).

All variables, except Q^{AX}, h (rainfall factor) and q, are normalized by P^{F}. No agricultural good could be considered an importable because no crop is produced <u>and</u> imported in significant quantities in Malawi.

All variables are in logs (except t).

Table 1A. Tests for Autorcorrelation, Tanzania

Equation	Durbin-Watson Statistic	Yule-Walker $\varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + \mu_t$	
		$\hat{\rho}_1$	$\hat{\rho}_2$
Q^{AX}	2.24	0.16 (0.47)	0.31 (0.91)
P^{AN}	2.62	0.47 (1.38)	0.26 (0.75)
W	2.76	0.49 (1.41)	0.19 (0.55)
P^{N}	1.74	-0.07 (-0.23)	-0.08 (-0.25)

Durbin-Watson Test: The DW-values are all in the region of inconclusiveness, implying that the hypothesis of no first order autocorrelation cannot be rejected.

Yule-Walker Test: The low t-statistics (in parentheses) imply that the hypothesis of no first and/or second order autocorrelation cannot be rejected.

Table 2A. Tests for Autorcorrelation, Malawi

Equation	Durbin-Watson Statistic	Yule-Walker $\varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + \mu_t$	
		$\hat{\rho}_1$	$\hat{\rho}_2$
Q^{AX}	1.97	0.06 (0.17)	0.06 (0.17)
P^{AN}	2.34	0.24 (0.70)	0.25 (0.73)
W	1.78	-0.02 (-0.06)	-0.12 (-0.35)
P^{N}	0.85	-0.33 (-0.93)	-0.05 (-0.15)

Durbin-Watson Test: The DW-values are all in the region of inconclusiveness, implying that the hypothesis of no first order autocorrelation cannot be rejected.

Yule-Walker Test: The low t-statistics (in parentheses) imply that the hypothesis of no first and/or second order autocorrelation cannot be rejected.

Table 3A. Two-Stage-Least Square Estimates of the Model, Tanzania 1970-88

Corrected for first and second order autocorrelation in the error term

Dep. Variable	Constant	p^{AX}	p^{AX}_{-1}	p^{AN}	p^{AN}_{-1}	w	p_N	E	q	W_M	E_g	h	t	R^2
Q^{AX}	10.19 (6.80)	0.56 (3.02)	0.25 (1.49)	-0.11 (-0.25)	-0.28 (-1.74)	-0.23 (-0.58)	-	-	-	-	-	0.80 (1.29)	-0.01 (-1.11)	0.87
p^{AN}	-3.05 (-2.45)	-2.78 (-1.83)	-0.25 (-1.58)	-	-	-1.15 (-1.10)	1.21 (1.12)	3.21 (2.02)	-	-	-	-0.11 (-0.19)	-0.27 (-1.73)	0.95
w	2.02 (3.08)	0.21 (0.86)	0.13 (1.51)	0.40 (3.00)	-0.04 (-0.32)	-	-0.004 (-0.01)	-	-	0.77 (2.74)	-	-	0.005 (0.20)	0.99
p^N	2.24 (2.68)	0.53 (5.96)	-	0.007 (0.06)	-	0.32 (2.37)	-	-0.06 (-1.11)	-0.40 (-3.70)	-	-	-	0.04 (4.69)	0.99
E	1.03 (1.38)	0.61 (9.18)	-	-	-	-	-	-	0.18 (1.56)	0.09 (0.81)	0.39 (4.27)	-	0.04 (2.94)	0.98

Table 4A. Two-Stage-Least Square Estimates of the Model, Malawi 1970-87

Corrected for first and second order autocorrelation in the error term

Dep. Variable	Constant	p^{AX}	p^{AX}_{-1}	p^{AN}	p^{AN}_{-1}	w	p_N	E	q	W_M	E_g	h	k	t	R^2
Q^{AX}	-3.44 -0.74	0.58 (3.05)	0.11 (0.67)	-0.28 (-1.33)	-0.45 (-4.94)	0.09 (0.64)	-	-	-	-	-	0.95 (1.93)	1.12 (2.52)	0.025 (0.77)	0.98
p^{AN}	-1.19 (-0.39)	0.50 (1.23)	-	-	-	1.05 (1.39)	0.40 (0.33)	-1.04 (-1.52)	-	-	-	-1.01 (-0.82)	-	0.06 (2.53)	0.64
w	-0.36 (-0.33)	-	0.43 (3.97)	-0.005 (-0.04)	-	-	1.00 (5.44)	-	-	0.15 (0.98)	-	-	-	-0.01 (-1.4)	0.96
p^N	2.76 (1.70)	-0.03 (-0.34)	-	0.23 (2.14)	-	0.07 (0.38)	-	0.74 (4.06)	-0.38 (-1.32)	-	-	-	-	-0.03 (-1.82)	0.95
E	-1.54 (-1.16)	0.197 (2.17)	-	-	-	-	-	-	0.83 (3.32)	-0.012 (-0.16)	0.71 (9.90)	-	-	0.02 (1.94)	0.95

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