AGRICULTURE AND SHORT RUN MACROECONOMICS*

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RESUMO

Neste trabalho, formula-se um modelo macroeconômico de curto prazo a fim de se derivar as interações entre os setores agrícola e não-agrícola por ocasião da aplicação de políticas de estabilização. As variáveis exógenas são mudanças nas políticas fiscal, monetária e cambial e nos preços internacionais. As variáveis endógenas explicitamente analisadas são renda real para cada setor e preços relativos. Os principais resultados são: (a) os preços relativos tendem a variar quando as variáveis exógenas variam; (b) a produção agrícola e os preços relativos da agricultura tendem a se reduzir face a políticas fiscais e monetárias expansivas mesmo quando a elasticidade-renda de demanda para produtos agrícolas for zero; (c) embora o efeito inflacionário de políticas mone-

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târias e fiscais expansivas seja maior quando a elasticidade de oferta de produtos agrícolas é baixa, os preços nominais da agricultura tendem a crescer no máximo tanto quanto os preços nominais não-agrícolas. Os efeitos de diversas pressuposições a respeito da elasticidades de demanda e de oferta sobre os resultados do modelo são também derivados.

INTRODUCTION

Short term macroeconomic questions, such as those relating agriculture to the performance of stabilization policies, have not been frequently analyzed within explicit theoretical models. Short run macro-models built by economists from less developed countries were important exceptions. For instance, the relatively low elasticity of supply of agricultural products has been for a long time pointed out as a major factor explaining chronically high inflation rate in that part of the world. In the decade of the seventies, developed nations were also plagued with high rates of inflation coupled with high levels of unemployment. Several papers connecting agriculture with macro-problems have been produced (SCHUH, 1974, 1976; GARDNER, 1981; STARLEAF, 1982; McCALLA, 1982). Many contributions, however, stand only at an empirical level.

The objective of the present paper is to develop an alternative model to integrate agriculture into a short-run macro-model to explain the interactions between some macroeconomic events - such as changes in fiscal and monetary policies, exchange rate, international prices - and the agricultural sector.
AGRICULTURE AND MACROECONOMICS EVENTS

One basic question dealt with in macro-models involving agriculture is related to possible changes in relative prices resulting from macro-policies — mainly the monetary policy. It is the case, for instance, of the debate as to whether inflation is neutral or not. BORDO (1980) indicates rather stringent conditions under which monetary changes would not produce any "real" effect. To account for possible short run relative price changes due to monetary policies, BORDO indicates the limits to supply elasticities attributed to technological and institutional factors.

An interesting approach to these questions is to assume a two-sector economy, one of them nonfarm sector — is subject to macroeconomic policies which end up affecting the other sector-agriculture — through several possible channels of intersector influences. One justification for this approach is presented by STARLEAF (1982): "the nonfarm sector is so massive that for all practical purposes it is the macroeconomy" (STARLEAF, p. 858).

Studies of the effects of macro-events upon agriculture present some opposing points of view. TWEETEN (1980) pointed out the relatively low importance of business cycle upon agriculture in the present days. This would be due to the low income elasticity of domestic food demand and to the growing importance of foreign demand for agricultural products. GARDNER (1981) added the observation that economic recessions have not been important since 1950 and, therefore, could not affect agriculture anyway. Contrary to this view, STARLEAF (1982) presented evidences supporting the argument that if macroeconomic policy actions can have at least short-run impacts upon real output of the macroeconomy it can also influence the short-run performance of the farm economy, particularly through farm output price level.
On the other hand, there is almost a consensus as far as international macro-variables as concerned. McCALLA (1982) explored international monetary linkages which transmit domestic policies between countries. The income effects of worldwide growth and recession, the exchange rate and interest rate effects upon agriculture trade are stressed. Nonmoneratist economists tend to recognize the importance of these variables too, although some emphasize their effect through the cost, and not demand, side.

BACHA (1982) presented an interesting model in which agriculture appears as a factor conditioning the degree of inflation associated with macro-policies designed to reduce unemployment. SAYAD (1979) presented a two-sector model to demonstrate the cyclical character of relative prices in the economy. However, their models strongly rely on hypotheses concerning the noncompetitive nature of the industrial sector and the presence of fixed coefficient production function. In addition, labor is supposed to be perfectly elastic in supply and the demand for agricultural product is assumed to be of unitary income and price-elasticities.

The main differences between the paper's model and those formulated by BACHA and SAYAD\(^1\) are: (a) agriculture is modeled as a macro-sector in the same way as the business sector; (b) competition is assumed in both sectors; (c) sectoral production functions are assumed to be of the neoclassical, diminishing returns, type; (d) no restrictions are imposed upon elasticities of labor supply and of demand for products; (e) both sector's labor supplies are functions wage rate deflated by worker's price index, including farm and nonfarm output prices; (f) a money market is explicitly defined.

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\(^1\) See BACHA (1982) and SAYAD (1979).
THE MODEL

Assumptions and Structural Equations

Agriculture is characterized by:

(a) an aggregate diminishing return production function relating output \( Y_1 \) to employment level \( N_1 \), fixed capital stock \( K_1 \) and an exogenous shifter \( S \):

\[
Y_1 = Y_1(N_1, K_1, S) \tag{1}
\]

(b) an aggregate demand function given by the summation of: sectoral consumption function \( C_1 \) depending on \( Y_1 \); sectoral investment function \( I_1 \) depending on interest rate \( r \); plus exports to the nonfarm sector \( A \) depending on nonfarm income at agricultural prices \( Y_2P_2/P_1 \), where \( Y_2, P_2 \) and \( P_1 \) are real nonfarm income, nonfarm price and farm price; plus foreign exports \( X_1 \) depending on \( P_1 \), international commodity price \( P_b \) and exchange rate \( \rho \); minus consumption imports from nonfarm sector \( D \) at farm prices, depending on farm income at nonfarm prices; and minus imports for farm investment depending on \( r^1 \).

\[
Y_1 = C_1(Y_1) + A\left(\frac{Y_2P_2}{P_1}\right) + X_1(P_1, P_b, \rho) - \frac{P_2}{P_1} D \frac{Y_1}{P_2} \tag{2}
\]

(c) a labor supply function where nominal farm wage rate \( W_1 \) is a function of \( N_1 \), \( h_1(N_1) \), multiplied by farm worker's price index, where \( \theta_1 \) is the farm product weight:

\[
W_1 = C_1(N_1) + A\left(\frac{Y_2P_2}{P_1}\right) + X_1(P_1, P_b, \rho) - \frac{P_2}{P_1} D \frac{Y_1}{P_2} \tag{2}
\]

\(^1\) Farm investment does not appear in (2) because it is totally imported from the nonfarm sector.
\[ W_1 = \left[ \theta_1 P_1 + (1 - \theta_1) P_2 \right] h_1(N_1) \]  

(d) a demand side optimum condition equating \( W_1 \) to \( P_1 \) times the marginal product of labor \( \frac{\partial Y_1}{\partial N_1} \):

\[ W = P_1 \frac{\partial Y_1}{\partial N_1} \]  

Nonfarm sector is characterized by:

(a) an aggregate diminishing returns production function relating output \( Y_2 \) to employment level \( N_2 \) and capital stock \( K_2 \):

\[ Y_2 = Y_2(N_2, K_2) \]  

(b) an aggregate demand function given by the summation of: sectoral consumption \( C_2 \) depending on disposable nonfarm income, \( Y_2 \) minus taxes \( T \); plus sectoral investment depending on \( r \); plus government expenditures \( G \); plus consumption exports to the farm sector \( D \); plus exports for farm investment \( I_f \) at nonfarm prices; foreign exports \( X_2 \) depending on \( \rho \) and \( P_2 \); minus imports from farm sector \( A \) at nonfarm prices; minus foreign imports \( M \) depending on \( \rho \) and nonfarm income deflated by international imports price \( P_m \).

\[ Y_2 = C_2(Y_2 - T) + I_2(r) + G + D(\frac{Y_1 P_1}{P_2}) + \frac{P_1}{P_2} l(r) + X_2(\rho, P_2) - \frac{P_1}{P_2} A \frac{Y_2 P_2}{P_1} - M(\rho, \frac{P_2 Y_2}{P_m}) \]
(c) a labor supply function where nominal nonfarm wage rate is a function of $N_2$, $h_2(N_2)$, multiplied by nonfarm worker's price index, where $\theta_2$ is the farm product weight:

$$W_2 = \left[ \theta_2 P_1 + (1 - \theta_2)P_2 \right] h_2(N_2) \tag{7}$$

(d) a demand side optimum condition equating $W_2$ to $P_2$ times the marginal product labor

$$W_2 = P_2 \frac{\partial Y_2}{\partial N_2} \tag{8}$$

The money market is defined by equating the exogenous nominal money supply ($L_0$) to the nominal money demand, that is, price level ($P$) times real demand ($L$), which is a function of interest rate and real aggregate output. The later is equal to nominal output deflated by aggregate price level.

$$L_0 = P L \left( r, \frac{Y_1 P_1 + Y_2 P_2}{P} \right) \tag{9}$$

and

$$P = a_1 P_1 + a_2 P_2 \tag{10}$$

where $a_1$ and $a_2$ are the weights of $P_1$ and $P_2$ respectively, in the aggregate price level ($P$).

The system of equations (1) to (10) include 10 endogenous variables ($Y_1$, $Y_2$, $P_1$, $P_2$, $W_1$, $W_2$, $N_1$, $N_2$, $r$ and $P$). Exogenous variables, the effects of which will be studied, are: $S$, $Pb$, $\rho$, $T$, $G$, $L_0$. Given the objectives of the paper the strategy used was to eliminate $W_1$, $W_2$, $N_1$, $N_2$, $r$ and $P$, so as to remain in with four equations relating changes in $Y_1$, $Y_2$, $P_1$ and $P_2$ to changes in the exogenous variables.
Equating (3) and (4), expressing in terms of relative rate of change, one obtains

$$\bar{N}_1 = \frac{\gamma_2}{\phi_1 - \sigma_1} (\hat{p}_1 - \hat{p}_2)$$  \hspace{1cm} (11)

$\gamma_2$ is the share of nonfarm product in the farm worker's index \(\frac{(1 - \theta_1)p_2}{\theta_1p_1 + (1 - \theta_1)p_2}\), $\phi_1$ is the inverse of the labor supply elasticity \(\frac{d\ell_1}{dN_1} \frac{N_1}{h_1}\), and $\sigma_1$ is the elasticity of the marginal product of labor with respect to the employment level.

Expressing (1) in terms of relative rates of change and using (11) results in

$$\bar{Y}_1 = \epsilon_1 (\hat{p}_1 - \hat{p}_2) + \epsilon_s \tilde{S}$$  \hspace{1cm} (12)

where $\epsilon_1 = \frac{\eta_1 \gamma_2}{\phi_1 - \sigma_1}$ with $\eta_1$ being the agricultural output elasticity with respect to the level of employment. $\epsilon_1$ is the aggregate elasticity of supply of the agricultural sector. $\epsilon_s$ is the elasticity of $Y_1$ with respect to $S$.

It can be shown that $\epsilon_1$ goes to zero if one of the following conditions occur: (a) $\gamma_2$ goes to zero, that is, nonfarm goods are not included in the farm worker's
prices index; (b) \( \phi_1 \) goes to infinity, that is, labor
supply is perfectly inelastic with respect to wage rate;
(c) \( 1/\phi_1 \) goes to zero. On the other hand, \( \varepsilon_1 \) goes to
infinity if \( \phi_1 \) to zero, that is, labor supply is
perfectly elastic.

By a procedure analogous to the previous one, one
can obtain

\[
Y_2 = \varepsilon_2 (\hat{P}_2 - \hat{P}_1)
\]

(13)

using equations (7) and (8) to obtain \( \hat{N}_2 \), which is
substituted into (5).

In (13) \( \varepsilon_2 = \gamma_2 \gamma_1/(\phi_2 - \sigma_2) \), where \( \gamma_1 \) is the share
of the farm output in nonfarm worker's price index.
Other symbols have analogous meanings as those appearing
in \( \varepsilon_1 \).

Expressing (2) in terms of relative rates of
change one obtains

\[
Y_1 = \alpha_Y \hat{Y}_2 + \alpha_1 \hat{P}_1 + \alpha_2 \hat{P}_2 + \alpha_b \hat{P}_b + \alpha_p \hat{P}_p
\]

(14)

where:

\[
\alpha_Y = \frac{k_a \eta_Y}{1 - C_1 + k_d \eta_{dy}}, \quad \alpha_1 = \frac{k_x x_1 P_1 - k_a \eta_Y + k_d (1 - \eta_{dy})}{1 - C_1 + k_d \eta_{dy}}
\]

\[
\alpha_2 = \frac{k_a \eta_Y + k_d (\eta_{dy} - 1)}{1 - C_1 + k_d \eta_{dy}}, \quad \alpha_b = \frac{k_x x_1 P_b}{1 - C_1 + k_d \eta_{dy}}
\]

\[
\alpha_p = \frac{k_x x_1 P_p}{1 - C_1 + k_d \eta_{dy}}
\]
where \( k \) stands for the share of each item in the aggregate farm demand, \( \eta \) stands for the demand elasticity of each item \((1\text{st subscript})\) with respect to the variable represented by the second subscript, and \( C \) is the marginal propensity to consume in the farm sector. Most probable signs are: \( \alpha_y > 0, \alpha_b > 0 \) and \( \alpha_c < 0; \alpha_2 > 0 \) and \( \alpha_1 < 0 \) will hold more probably the higher the share of farm goods sold to nonfarm sector, the higher the income elasticity of the nonfarm demand for farm goods, the higher the income elasticity of farm demand for nonfarm goods, and the higher the price-elasticity of foreign demand for farm goods.

Expressing equation (9) in terms of relative rates of change, and using (10), one obtains:

\[
\hat{r} = \frac{\hat{L}_0 - \eta_L (\hat{Y}_1 + \hat{Y}_2) - \Delta_1 \hat{P}_1 - \Delta_2 \hat{P}_2}{\eta_L} \tag{15}
\]

where \( \eta_L \) and \( \eta_L \) are the income and interest elasticity of money demand and \( \Delta_1 \) stands for the share of one sector in the price level index e.g., \( \Delta_1 = \frac{a_1 P_1}{p} \).

Expressing (6) in terms of relative rates of change and using (15) results in:

\[
\hat{Y} = \beta_t \hat{T} + \beta_L \hat{L} + \beta_g \hat{G} + \beta_\rho \hat{P} + \beta_2 \hat{P}_2 + \beta_1 \hat{P}_1 + \beta_m \hat{P} + \beta_\gamma \hat{Y}_1 \tag{16}
\]

where

\[
\beta_t = \frac{-c_2 k_t^l}{\mu}, \quad \beta_L = \frac{\eta_{ir}/\eta_{Lr}}{\mu}, \quad \beta_g = \frac{k_g}{\mu}, \quad \beta_\rho = \frac{k_\rho x_2 \rho - k_\rho \eta m \rho}{\mu}
\]
\[
\beta_2 = \frac{k^I \eta \times 2P2 - k^I m^2 y + k^I a(1 - n^ay) - k^I l^1 - k^I d^i - k^I l^i n^i L^r}{\mu} \Delta_2
\]

\[
\beta_1 = \frac{k^I a(n^ay - 1) + k^I l^1 + k^I d^i n^dy - K^I l^i n^i L^r}{\mu} \Delta_1
\]

\[
\beta_m = \frac{k^I m^2 y}{\mu}, \quad \beta_y = \frac{k^I d^i n^dy - k^I l^i n^i L^r}{\mu} n^L y
\]

and \(\mu = 1 - c^2 + k^I m^2 y + k^I a^i n^ay - k^I l^i n^i L^r\)

where \(c^2\) is the marginal propensity to consume in the nonfarm sector; \(k^I\) is the share of each item in aggregate nonfarm demand, and \(n^i\) as defined previously. The following signs are expected to hold: \(\beta_f < 0, \beta_L > 0, \beta_\rho < 0, \beta_m > 0\).

It is expected that \(\beta_2 < 0\). However it is possible that \(\beta_2 > 0\) if \(k_a\) is too high and/or \(n^ay\) too small. \(\beta_1\) is also expected to be positive. However, the opposite may occur if \(k^I\) is too high and \(n^ay\) too small or if the impact of a change in agricultural prices on liquidity and, therefore, on investment is very important. The sign of \(\beta_y\) is also dubious. It would be positive unless a rise of the farm income and, therefore, of the interest rate (in the money market) can strongly reduce the level of investment.
Theoretical Results

Equations (12), (14), (13) and (16) can be seen as a system of aggregate demands and supplies for agriculture and nonfarm sectors. In matrix notation it can be represented by:

\[
\begin{bmatrix}
1 & 0 & -\varepsilon_1 & \varepsilon_1 \\
1 & -\alpha_y & -\alpha_1 & -\alpha_2 \\
0 & 1 & \varepsilon_2 & \varepsilon_2 \\
-\beta_y & 1 & -\beta_1 & -\beta_2
\end{bmatrix}
\begin{bmatrix}
\hat{Y}_1 \\
\hat{Y}_2 \\
\hat{P}_1 \\
\hat{P}_2
\end{bmatrix}
= 
\begin{bmatrix}
\varepsilon & s \\
\alpha_b & \tilde{P}_b + \alpha_{ho} \tilde{P}
\end{bmatrix}
\begin{bmatrix}
\beta_t T + \beta_L \tilde{L} + \beta_g \tilde{G} + \beta_{\rho} \tilde{\rho} + \beta_m \tilde{m}_m
\end{bmatrix}
\]

and can be solved by Cramer's rule. Table 1 presents the signs of the effects of each exogenous variable on \(\hat{Y}_1\), \(\hat{Y}_2\), \(\hat{P}_1\) and \(\hat{P}_2\)\(^1\).

Except for changes in \(\tilde{S}\), it is to be noticed that \(\hat{Y}_1\) and \(\hat{Y}_2\) move in opposite direction. With regard to \(\hat{P}_1\) and \(\hat{P}_2\), in all cases in which definite signs were obtained, they move in the same direction.

A better understanding of the results can be reached by considering the effects of the exogenous changes upon relative prices.

When \(\hat{Y}_1\) increases due to an exogenous change in \(\tilde{S}\), there will be an increase in \(\hat{Y}_2\) as well. The later increase is attributed to the reduction in \(P_1/P_2\). In the economy as a whole, the output of agriculture grows relatively to nonfarm output.

An increase in \(P_b\) tends to increase agricultural

\(^{2}\) See appendix for derivations of these effects.
Table 1. Expected signs the effects of relative changes in the exogenous variables on the endogenous variables.

<table>
<thead>
<tr>
<th></th>
<th>( \hat{\delta} )</th>
<th>( \hat{p}_b )</th>
<th>( \hat{\rho} )</th>
<th>( \hat{T} )</th>
<th>( \hat{L} )</th>
<th>( \hat{G} )</th>
<th>( \hat{P}_m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{\gamma}_1 )</td>
<td>+</td>
<td>+</td>
<td>b</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( \hat{\gamma}_2 )</td>
<td>+</td>
<td>-</td>
<td>b</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>( \hat{\gamma}_1 - \hat{\gamma}_2 )</td>
<td>b</td>
<td>+</td>
<td>b</td>
<td>+c</td>
<td>-c</td>
<td>-c</td>
<td>-c</td>
</tr>
<tr>
<td>( \hat{p}_1 )</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>( \hat{p}_2 )</td>
<td>-</td>
<td>b</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>( \hat{p}_1 - \hat{p}_2 )</td>
<td>-</td>
<td>+</td>
<td>b</td>
<td>+</td>
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</tr>
</tbody>
</table>

a) The following signs were assumed: \( \alpha_1 < 0; \ \alpha_2 > 0; \ \beta_1 > 0, \ \beta_2 < 0; \ \beta_2 < 0; \ e_{\delta} > 0, \) except for results in the 3rd and 4th column.

b) Effect with dubious sign.

c) Assuming \( e_1 \cdot e_2 \)

demand. The resulting increase in \( P_1 \) is both absolute and relative to \( P_2 \). Therefore \( \gamma_2 \) decreases and farm's share in total output increases.

Increases in \( \rho \) tend to reduce both \( P_1 \) and \( P_2 \). Other absolute and relative results are indeterminate.

Changes in \( T, L_0, G \) and \( P_m \) can be analysed jointly. Anyone of these variables affects nonfarm aggregate demand. Take the case of an increase in \( L_0 \). This tends to stimulate nonfarm demand and, therefore to increase
relative to $P_1$. As a result $Y_2$ increases and $Y_1$ decreases, each change being proportionate to the respective sector's supply elasticity.

**Interpretation of The Results**

The model presented in this paper revealed several interesting aspects which are discussed below.

Why do relative prices change when exogenous variables change? When the causal change is due to a nonfarm demand shifter, the key factor allowing relative price changes is the price-elasticity of farm exports. For example, if $L_0$ increases, both $P_1$ and $P_2$ also increase; however, if $\eta_{X1}P_1 < 0$, $P_1$ will increase less than $P_2$. In the limit, with $\eta_{X1}P_1 \to -\infty$, $P_1$ will not change and $P_2$ will increase.

When the causal change is due to a farm demand shifter, the key factors are $\eta_{X2}P_2$, $\eta_{MY}$ and $\eta_{MY}/\eta_{LR}$. Again we have three factors not belonging to either farm or nonfarm sector. In this case, $P_2$ will not grow as much as $P_1$ (when $P_1$ increases, for instance), due to the possibility of reduction in exports and investment and of increase in imports.

Second, why is farm output reduced by expansive fiscal and monetary policies designed to increase employment in the nonfarm sector? The shortest answer to this question is that the increase in $P_2/P_1$ needed to stimulate nonfarm output will necessarily reduce farm output. In this model relative prices affect aggregate supply through the labor markets. When $P_2/P_1$ increases, in the nonfarm labor market demand displaces to the right more than supply goes to the left. As a result the employment level is increased in the nonfarm sector, the opposite occurring in the farm sector. The relative effect on outputs depends on supply elasticities. If this elasticity is higher in the nonfarm sector, $Y_2$ will
grow proportionately more than the decrease in $Y_1$.

It should be emphasized at this point that, contrary to usual thinking, agricultural relative price should present an anti-cyclical behavior, so that an expansion in the nonfarm sector should be followed by a fall in $P_1/P_2$.

How are the results affected by assumptions regarding the income-elasticity of nonfarm demand for farm products ($\eta_{A_Y}$)? What are the roles of supply elasticities?

It is usual to think that interactions between agriculture and nonfarm sector are important only if $\eta_{A_Y}$ is different from zero. To examine this aspect, we consider $\eta_{A_Y} = 0$ which implies $\alpha_Y = 0$. In this case, an expansive monetary or fiscal policy will still affect agriculture. It is possible to show that the increase in nonfarm demand increases $P_2$ relative to $P_1$ (unless $e_2 \to \infty$) and then, by the supply side, will reduce farm output. The difference is that now the larger nonfarm output will not stimulate aggregate farm demand (because $\alpha_Y = 0$) and, therefore $P_1/P_2$ will decrease more than when $\alpha_Y < 0$. One could even say that the intersector interaction can be stronger when $\eta_{A_Y} = 0$.

We now turn to the roles of supply elasticities. One of structuralist hypothesis is that $e_1$ is low and $e_2$ is relatively high. Let's take then two limit cases: $e_1 \to 0$ and/or $e_2 \to \infty$. If $e_2 \to \infty$, an increase in nonfarm demand, by monetary or fiscal policy, will increase nonfarm output with no change in relative price. As far as $\eta_{A_Y} > 0$, nominal agriculture price will grow, but this increase will be followed by nominal nonfarm

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3 See, for instance, SAYAD (1979).

4 See, for instance, TWEETEN (1980).
prices, so as to leave relative prices unchanged. This means that, when \( \varepsilon_2 \to \infty \), only nonfarm output and employment will increase; farm output and employment will not be affected by that policy. Nominal prices will increase and an inflationary effect may result. This latter effect will not happen if \( \eta_{Ay} = 0 \).

When \( \varepsilon_1 \to 0 \), expansive monetary or fiscal policies will increase nonfarm output and employment more than otherwise, farm output and employment will remain unaffected, nominal prices will increase more than before, but \( P_1/P_2 \) will fall to permit the nonfarm expansion.

CONCLUDING REMARKS

One important result of this paper is the fact in the short run agricultural and nonfarm business sectors compete with each other when one of them is subject to demand stimulus. Although this may appear an obvious conclusion, it is very usual to find analyses suggesting that the economy can be expanded by stimulating either agriculture or nonfarm business. Since the major factor determining short run growth is the relative price, it easy to understand, except for supply side shocks, that a sector can expand only if the other reduces its output and employment. If the responsiveness to relative price changes differs between sectors, a net rise in aggregate income and employment is possible to be attained however.

A final important aspect relates to the association between agriculture and inflation. In general agriculture is said to directly contribute more to inflation when agricultural prices rises more than nonfarm prices. This paper shows that this happens
when supply shocks (like a rise in $P_b$) occur but not when nonfarm demand is expanded by monetary or fiscal policies.

Of course agriculture plays a role as a conditioning factor during the process of nonfarm expansion. For instance, even if nonfarm aggregate supply were perfectly elastic, an expansion in this sector's demand can be inflationary because agriculture's supply is inelastic, and would start a process of rising nominal prices. But this process would end up with nominal nonfarm prices rising as much as agricultural prices. It is not perfectly clear that agriculture is the inflationary sector in this case. Indeed, it is even more difficult to accept agriculture as the inflationary sector in some structuralist models in which a competitive agricultural sector faces a monopolistic industry sector.

What seems to be implicit in many formulations regarding expansionary policy is that somehow agriculture is able to present short-run output growth. This short run is to be understood as the period of time needed for monetary or fiscal policy to have its effects spread over the economy. In many cases, this growth in agricultural output is attributed to weather conditions or to the continuous adoption of technological innovation by a growing number of farmers. It is possible to obtain the short-run rate of agricultural output growth needed to inhibit the inflationary effect of aggregate nonfarm demand expansionary policies. As an illustration, that rate is derived for the case of perfectly elastic nonfarm aggregate supply:

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5 This hypothesis is often made for an economy operating with excess capacity.
\[ \hat{Y} = \beta L \frac{\alpha_Y}{1 - \alpha_Y \beta_Y} \hat{L} \]

which is positive provided \( \alpha_Y \beta_Y < 1 \). It is easy to verify that given \( \beta_L \) and the rate of expansion of \( L \), the agricultural output will have to grow at a higher rate, the higher are \( \alpha_Y \) and/or \( \beta_Y \). Only if \( \alpha_Y = 0 \), that is, only the nonfarm income elasticity of the demand for farm goods is zero – a hypothesis definitely unrealistic for less developed countries – would monetary and fiscal policies be independent of agricultural behavior in terms of their inflationary effects. This result would hold if \( \epsilon_2 \to \infty \), that is, nonfarm aggregate supply if perfectly elastic. Otherwise, the supply side farm-nonfarm interactions would reestablish the above mentioned dependency.

SUMMARY

AGRICULTURE AND SHORT RUN MACROECONOMICS

A short run macro-model is formulated to derive the interactions between farm and nonfarm sector in response to stabilization policies. Exogenous variables are changes in fiscal and monetary policies, exchange rate, and international prices. Endogenous variables explicitly analyzed are farm and nonfarm real incomes and nominal and relative prices. Main results of the model are: (a) relative prices tend to change when exogenous variables change; (b) farm output and relative price tend to be reduced by expansive fiscal and monetary policies even if income elasticity of demand for farm products is zero; (c) although the inflationary effect of expansive monetary or fiscal policy is higher the lower the elasticity of supply of farm products, farm
nominal prices tend to increase at most as much as nonfarm nominal prices. The effects of several different assumptions regarding supply and demand elasticities upon the model results are derived.

REFERENCES


APPENDIX

In this appendix the effects of relative changes in the exogenous variable on $\tilde{Y}_1$, $\tilde{Y}_2$, $\tilde{P}_1$ and $\tilde{P}_2$ are presented.

Effects of Changes in $\tilde{S}$

(a) $\frac{\delta \tilde{Y}_1}{\delta \tilde{S}} = \epsilon_s \frac{|\Gamma_{11}|}{|\Gamma|}$

\[= \epsilon_s \frac{\epsilon_2 (a_1 + a_2) + \alpha \epsilon_2 (\beta_1 + \beta_2) + \alpha_2 \beta_1 - \alpha_1 \beta_2}{\epsilon_1 [(\beta_1 + \beta_2) + \beta_y (a_1 + a_2)] + \epsilon_2 [a_1 + a_2] + \alpha_2 \beta_1 - \alpha_1 \beta_2} \]

where $|\Gamma|$ is the determinant of the matrix in (17) and $|\Gamma_{ij}|$ and is the matrix minor $ij$. The signs of these determinants are $|\Gamma_{11}| < 0$ and $|\Gamma| < 0$. Then if $\epsilon_s > 0$, $\frac{\delta \tilde{Y}_1}{\delta \tilde{S}} > 0$.

(b) $\frac{\delta \tilde{Y}_2}{\delta \tilde{S}} = -\epsilon_s \frac{|\Gamma_{12}|}{|\Gamma|} = -\epsilon_s \frac{-\beta_2 \epsilon_2 (a_1 + a_2) - \epsilon_2 (\beta_1 + \beta_2)}{|\Gamma|} > 0$

(c) $\frac{\delta \tilde{P}_1}{\delta \tilde{S}} = \epsilon_s \frac{|\Gamma_{13}|}{|\Gamma|} = \epsilon_s \frac{\epsilon_2 - \beta_2 - \alpha \beta_2 \epsilon_2 - \alpha_2 \beta_2}{|\Gamma|} < 0$

unless $\alpha \beta_2 \epsilon_2 > 1 - \frac{\beta_2 + \alpha_2 \beta_2}{\epsilon_2}$
Effects of Changes in $\hat{P}_b$

(a) \[ \frac{\delta \hat{Y}_1}{\delta \hat{P}_b} = -\alpha_b \frac{|\Gamma_{21}|}{|\Gamma|} = -\alpha_b \frac{-\varepsilon_1 (\beta_1 + \beta_2)}{|\Gamma|} > 0 \]

(b) \[ \frac{\delta \hat{Y}_2}{\delta \hat{P}_b} = \alpha_b \frac{|\Gamma_{22}|}{|\Gamma|} = \alpha_b \frac{-\varepsilon_2 (\beta_1 + \beta_2)}{|\Gamma|} < 0 \]

(c) \[ \frac{\delta \hat{\rho}_1}{\delta \hat{P}_b} = -\alpha_b \frac{|\Gamma_{23}|}{|\Gamma|} = -\alpha_b \frac{-\beta_2 + \varepsilon_2 + \beta \varepsilon_1}{|\Gamma|} > 0 \]

(d) \[ \frac{\delta \hat{\rho}_2}{\delta \hat{P}_b} = \alpha_b \frac{|\Gamma_{24}|}{|\Gamma|} = \alpha_b \frac{-\beta_1 - \beta \varepsilon_1 - \varepsilon_2}{|\Gamma|} > 0 \]

unless $\beta_1 < -\beta \varepsilon_1 - \varepsilon_2$

Effects of Change in $\hat{\rho}$

(a) \[ \frac{\delta \hat{Y}_1}{\delta \hat{\rho}} = -\alpha \rho \frac{|\Gamma_{21}|}{|\Gamma|} - \beta \rho \frac{|\Gamma_{11}|}{|\Gamma|} = \frac{\alpha \rho \varepsilon_1 (\beta_1 + \beta_2) - \beta \rho \varepsilon_1 (\alpha_1 + \alpha_2)}{|\Gamma|} \]

with indeterminate sign.

(b) \[ \frac{\delta \hat{Y}_2}{\delta \hat{\rho}} = \alpha \rho \frac{|\Gamma_{22}|}{|\Gamma|} + \beta \rho \frac{|\Gamma_{24}|}{|\Gamma|} = \frac{\alpha \rho \varepsilon_2 (\beta_1 + \beta_2) + \beta \rho \varepsilon_2 (\alpha_1 + \alpha_2)}{|\Gamma|} \]

with indeterminate sign.
Effects of changes in $\hat{T}$, $\hat{L}$, $\hat{G}$ or $\hat{P}_m$

Changes in $\hat{T}$, $\hat{L}$, $\hat{G}$ or $\hat{P}_m$ can be analysed jointly. Let's consider a change in $\hat{L}$:

\[
\frac{\delta \hat{Y}_1}{\delta \hat{L}} = \beta_L \frac{|\Gamma_{41}|}{|\Gamma|} = -\beta_1 \frac{\varepsilon_1 (\alpha_1 + \alpha_2)}{|\Gamma|} < 0
\]

\[
\frac{\delta \hat{Y}_2}{\delta \hat{L}} = \beta_L \frac{|\Gamma_{42}|}{|\Gamma|} = \beta_2 \frac{\varepsilon_2 (\alpha_1 + \alpha_2)}{|\Gamma|} > 0
\]

\[
\frac{\delta \hat{P}_1}{\delta \hat{L}} = -\beta_L \frac{|\Gamma_{43}|}{|\Gamma|} = -\beta_1 \frac{\varepsilon_1 + \alpha_2 + \alpha_1 \varepsilon_2}{|\Gamma|} > 0
\]
\[
\frac{\delta \hat{P}_2}{\delta L} = \beta \frac{|\Gamma_{44}|}{|\Gamma|} = \beta \frac{-\alpha \varepsilon_2 - \varepsilon_1 + \alpha_1}{|\Gamma|} > 0
\]

Changes in \(T, G, \) or \(P_m\) are evaluated similarly considering \(\beta_T < 0, \beta_G > 0\) and \(\beta_m > 0\).

**Effects on Relative Prices**

The derivatives presented below indicate if a change in an exogenous variable increases or decreases the relationship between \(P_1\) and \(P_2\).

\[
\frac{\delta (\hat{P}_1 - \hat{P}_2)}{\delta S} = \varepsilon \frac{(\beta_1 + \beta_2) + \beta_1 (\alpha_1 + \alpha_2)}{|\Gamma|} < 0
\]

\[
\frac{\delta (\hat{P}_1 - \hat{P}_2)}{\delta \hat{P}_b} = \frac{\beta_1 + \beta_2}{|\Gamma|} > 0
\]

\[
\frac{\delta (\hat{P}_1 - \hat{P}_2)}{\delta \hat{P}_m} = \alpha \rho (\beta_1 + \beta_2) - \beta \rho (\alpha_1 + \alpha_2) \text{, sign}
\]

Indeterminate.

\[
\frac{\delta (\hat{P}_1 - \hat{P}_2)}{\delta \hat{L}} = -\beta \frac{(\alpha_1 + \alpha_2)}{|\Gamma|} < 0
\]

The signs of the derivatives with respect to \(\hat{T}, \hat{G}\) and \(\hat{P}_m\) are obtained substituting \(\beta_T, \beta_G\) and \(\beta_m\), respectively, for \(\beta_L\) in the last derivative above.
Effects on relative incomes

The derivatives presented below indicate if changes in exogenous variables increase or decrease $Y_1$ relative to $Y_2$. Since $\tilde{Y} = q_1\tilde{Y}_1 + q_2\tilde{Y}_2$, where $q_1$ and $q_2$ are the share of each sector's nominal income in the economy's nominal income, the effects on aggregate output depend on these shares.

$$\frac{\delta(\tilde{Y}_1 - \tilde{Y}_2)}{\delta \tilde{S}} = \frac{\epsilon_3}{|\Gamma|} \left| \frac{\Gamma_{11}}{|\Gamma|} + \frac{\Gamma_{12}}{|\Gamma|} \right|$$

with indeterminate sign

$$\frac{\delta(\tilde{Y}_1 - \tilde{Y}_2)}{\delta \tilde{P}_b} = \frac{\alpha_b}{|\Gamma|} \left| \frac{\Gamma_{21}}{|\Gamma|} + \frac{\Gamma_{22}}{|\Gamma|} \right| = \alpha_b \frac{(\epsilon_1+\epsilon_2)(\beta_1+\beta_2)}{|\Gamma|} > 0$$

$$\frac{\delta(\tilde{Y}_1 - \tilde{Y}_2)}{\delta \tilde{\rho}} = -\alpha_1 \frac{\Gamma_{21}}{|\Gamma|} + \frac{\Gamma_{22}}{|\Gamma|} - \frac{\Gamma_{11}}{|\Gamma|} + \frac{\Gamma_{42}}{|\Gamma|}$$

with indeterminate sign.

$$\frac{\delta(\tilde{Y}_1 - \tilde{Y}_2)}{\delta \tilde{L}} = \beta_L \frac{\Gamma_{41}}{|\Gamma|} + \frac{\Gamma_{42}}{|\Gamma|} < 0$$

Effects of changes in $\tilde{T}$, $\tilde{G}$ or $\tilde{P}_m$ are analysed substituting $\beta_T$, $\beta_G$ or $\beta_m$, respectively, for $\beta_2$ in the last derivative above.