AGRICULTURE AND SHORT RUN MACROECONOMICS*

Geraldo S. de Camargo Barros**

RESUMO

Neste trabalho, formula-se um modelo ma
croeconômico de curto prazo a fim de se
derivar as interações entre os setores
agrícola e não-agrícola por ocasião da
aplicação de políticas de   estabiliza-
ção. As variáveis exógenas são mudan-
ças nas políticas fiscal, monetária   e
cambial e nos preços   internacionais.
As variáveis endógenas explicitamente a
nalisadas são renda real para cada se-
tor e preços relativos. Os principais
resultados são: (a) os preços relativos
tendem a variar quando as variáveis exó
genas variam; (b) a produção agrícola e
os preços relativos da   gricultura ten
dem a se reduzir face a políticas fis-
cais e monetárias expansivas mesmo quan
do a elasticidade-renda de demanda para
produtos agrícolas for zero; (c) embora
o efeito inflacionario de políticas mone

tárias e fiscais expansivas seja maior
quando a elasticidade de oferta de pro-
dutos agrícolas é baixa, os preços nomi
nais da agricultura tendem a crescer no
máximo tanto quanto os preços nominais
não-agrícolas. Os efeitos de diversas
pressuposições a respeito da elastici-
dades de demanda e de oferta sobre   os
resultados do modelo são também deriva-
dos.

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 contries   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 macroeconomics 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 setor-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 consense 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 enphasize 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 hipotheses 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 bussiness sector; (b) competition is assumed
in both sectors; (c) sectoral production functions are
assumed to be of the neoclassical, dimminishing 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 explicity 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 $(\bar{K}_1)$ and an exogenous shifter (S):

$$Y_1 = Y_1 \, (N_1, \, \bar{K}_1, \, S) \tag{1}$$

(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 $(Y_2 P_2 / P_1)$, 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 (ρ); 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].

$$Y_1 = C_1(Y_1) + A\left(\frac{Y_2 P_2}{P_1}\right) + X_1 (P_1, \, P_b, \, \rho) - \frac{P_2}{P_1} D \, \frac{Y_1 P_1}{P_2} \tag{2}$$

(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 θ_1 is the farm product weight:

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[1] Farm investment does not appear in (2) because it is totally imported from the nonfarm sector.

$$W_1 = \left[\theta_1 P_1 + (1 - \theta_1) P_2 \right] h_1 (N_1) \tag{3}$$

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

$$W = P_1 \frac{\partial Y_1}{\partial N_1} \tag{4}$$

Nonfarm sector is characterized by:

(a) an aggregate diminishing returns   production function relating output Y_2 to employment level (N_2) and capital stock ($\overline{K}_2$)

$$Y_2 = Y_2 (N_2, \overline{K}_2) \tag{5}$$

(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_1 at nonfarm prices; foreign exports (X_2) depending on ρ and P_2; minus imports from farm sector (A) at nonfarm prices; minus foreign imports (M) depending on ρ and nonfarm income deflated by international imports price (P_m).

$$Y_2 = C_2 (Y_2 - T) + I_2 (r) + G + D \left(\frac{Y_1 P_1}{P_2} \right) + \frac{P_1}{P_2} I(r) + X_2 (\rho, P_2)$$

$$- \frac{P_1}{P_2} A \frac{Y_2 P_2}{P_1} - M \left(\rho, \frac{P_2 Y_2}{P_m} \right) \tag{6}$$

(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 θ_2 is the farm product weight:

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

(d) a demand side optimum condition equating W_2 to P_2 times the marginal product labor $\dfrac{\partial Y_2}{\partial N_2}$

$$W_2 = P_2 \frac{\partial Y_2}{\partial N_2} \qquad (8)$$

The money market is defined by equating the exogenous nominal money supply (L_o) 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.

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

and

$$P = a_1 P_1 + a_2 P_2 \qquad (10)$$

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, ρ, T, G, L_o. 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 remanin 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

$$\bar{N}_1 = \frac{\gamma_2}{\phi_1 - \phi_1} (\hat{P}_1 - \hat{P}_2)$$ (11)

γ_2 is the share of nonfarm product in the farm worker's
index $\dfrac{(1 - \theta_1)P_2}{\theta_1 P_1 + (1 - \theta_1)P_2}$, ϕ_1 is the inverse of the

labor supply elasticity $\dfrac{dh_1}{dN_1} \dfrac{N_1}{h_1}$ and σ_1 is the

elasticity of the marginal product of labor with respect
to the employement level.

$$\P_1 = \frac{d \dfrac{\delta Y_1}{\delta N_1}}{dN_1} \cdot \frac{N_1}{\dfrac{\delta Y_1}{\delta N_1}}$$

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

$$\hat{Y}_1 = \epsilon_1 (\hat{P}_1 - \hat{P}_2) + \epsilon_s \hat{S}$$ (12)

where $\epsilon_1 = \dfrac{\P_1 \gamma_2}{\phi_1 - \sigma_1}$ with $\P_1$ being the agricultural

output elasticity with respect to the   level   of
employment. ϵ_1 is the aggregate elasticity of supply of
the agricultural sector. ϵ_s is the elasticity of Y_1
with respect to S.

It can be shown that ϵ_1 goes to zero if one of the
following conditions occur: (a) γ_2 goes to zero, that is,
nonfarm goods are not included in the farm worker's

prices index; (b) ϕ_1 goes to infinity, that is, labor supply is perfectly inelastic with respect to wage rate; (c) $\P_1$ goes to zero. On the other hand, ε_1 goes to infinity if ϕ_1 to zero, that is, labor supply is perfectly elastic.

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

$$Y_2 = \varepsilon_2 (\hat{P}_2 - \hat{P}_1) \qquad\qquad (13)$$

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

In (13) $\varepsilon_2 = \P_2 \gamma_1 / (\phi_2 - \sigma_2)$, where γ_1 is the share of the farm output in nonfarm worker's price index. Other simbols have analogous meanings as those appearing in ε_1.

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

$$Y_1 = \alpha_\gamma \hat{Y}_2 + \alpha_1 \hat{P}_1 + \alpha_2 \hat{P}_2 + \alpha_b \hat{P}_b + \alpha_\rho \hat{\rho} \qquad (14)$$

where:

$$\alpha_\gamma = \frac{k_a \eta_{ay}}{1 - C_1 + k_d \eta_{dy}}, \quad \alpha_1 = \frac{k_x \eta_{x1} P_1 - k_a \eta_{ay} + k_d (1 - \eta_{dy})}{1 - C_1 + k_d \eta_{dy}}$$

$$\alpha_2 = \frac{k_a \eta_{ay} + k_d (\eta_{dy} - 1)}{1 - C_1 + k_d \eta_{dy}}, \quad \alpha_b = \frac{k_x \eta_{x1} P_b}{1 - C_1 + k_d \eta_{dy}}$$

$$\alpha_\rho = \frac{k_x \eta_{x1\rho}}{1 - C_1 + k_d \eta_{dy}}$$

where k. stands for the share of each item in the aggregate farm demand, η.. stands for the demand elasticity of each item ($1\underline{th}$ subscript) with respect to the variable represented by the second subscript, and C_1 is the marginal propensity to consume in the farm sector. Most probable signs are: $\alpha_\gamma > 0$, $\alpha_b > 0$ and $\alpha_\rho < 0$; $\alpha_2 > 0$ 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:

$$\hat{r} = \frac{\hat{L}_o - \eta_{Ly}(\hat{Y}_1 + \hat{Y}_2) - \Delta_1\hat{P}_1 - \Delta_2\hat{P}_2}{\eta_{Lr}} \qquad (15)$$

where η_{Ly} and η_{Lr} are the income and interest elasticity of money demand and Δ. stands for the share of one sector in the price level index eg., $\Delta_1 = \dfrac{a_1 P_1}{P}$.

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

$$\hat{Y} = \beta_t\hat{T} + \beta_L\hat{L}_o + \beta_g\hat{G} + \beta_\rho\hat{\rho} + \beta_2\hat{P}_2 + \beta_1\hat{P}_1 + \beta_m\hat{P}_m + \beta_y\hat{Y}_1 \qquad (16)$$

where

$$\beta_t = \frac{-c_2 k_t'}{\mu}, \qquad\qquad \beta_L = \frac{\eta_{ir}/\eta_{Lr}}{\mu}$$

$$\beta_g = \frac{k_g'}{\mu} \qquad\qquad\qquad \beta_\rho = \frac{k_s'\eta_{x2}\rho - k_m'\eta m_\rho}{\mu}$$

$$\beta_2 = \frac{k'_n\eta_{x2P2} - k'_m\eta_{my} + k'_a(1-\eta_{ay}) - k'_{l_1} - k'_d\eta - k'_l \frac{\eta_{ir}}{\eta_{Lr}} \Delta_2}{\mu}$$

$$\beta_1 = \frac{k'_a(\eta_{ay} - 1) + k'_{l_1} + k'_d\eta_{dy} - K'_l \frac{\eta_{ir}}{\eta_{Lr}} \Delta_1}{\mu}$$

$$\beta_m = \frac{k'_m\eta_{my}}{\mu} \ , \qquad\qquad \beta_y = \frac{K'_d\eta_{dy} - k'_l \frac{\eta_{ir}}{\eta_{Lr}} \eta_{Ly}}{\mu}$$

$$\text{and} \quad \mu = 1 - c_2 + k'_m\eta_{my} + k'_a\eta_{ay} - k'_l \frac{\eta_{ir}}{\eta_{Lr}} \eta_{Ly}$$

where c_2 is the marginal propensity to consume in the nonfarm sector; $k'_.$ is the share of each item in aggregate nonfarm demand, and $\eta_{..}$ is as definid previously. The following signs are expeted 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 η_{ay} too small. β_1 is also expected to be positive. However, the opposite may occur if k'_a is too high and η_{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 β_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: (17)

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

and can 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 $\hat{S}$, 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 it 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 $\hat{S}$, 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

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[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.

	$\hat{S}$	$\hat{P}_b$	$\hat{\rho}$	$\hat{T}$	$\hat{L}$	$\hat{G}$	$\hat{P}_m$
$\hat{Y}_1$	+	+	b	+	-	-	-
$\hat{Y}_2$	+	-	b	-	+	+	+
$\hat{Y}_1 - \hat{Y}_2$	b	+	b	+c	-c	-c	-c
$\hat{P}_1$	-	+	-	-	+	+	+
$\hat{P}_2$	-	b	-	-	+	+	+
$\hat{P}_1 - \hat{P}_2$	-	+	b	+	-	-	-

a) The following signs were assumed: $\alpha_1 < 0$; $\alpha_2 > 0$;
   $\beta_1 > 0$, $\beta_2 < 0$, $\beta_y > 0$ e $\varepsilon_s > 0$, except for results in
   the $3\underline{d}$ and $t\underline{th}$ rouge.

b) Effect with dubious sign.

c) Assuming $\varepsilon_1 < \varepsilon_2$

demand. The resulting increase in P_1 is both   absolute
and relative to P_2. Therefore Y_2 decreases and   farm's
share in total output increases.

     Increases in ρ tend to reduce both P_1 and P_2.
Other absolute and relative results are indeterminate.

     Changes in T, L_o, G and P_m can be analysed jointly.
Anyone of these variables affects nonfarm aggregate
demand. Take the case of an increase in L_o. This tends
to stimulate nonfarm demand and, therefore to   increase

P_2 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 bellow.

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_O increases, both P_1 and P_2 also increase; however, if $\eta_{x1P1} < 0$ P_1 will increase less than P_2. In the limit, with $\eta_{x1P1} \to -\infty$, 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 η_{x2P2}, η_{my} and η_{my}/η_{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_b 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 employement in the nonfarm sector? The shortest answer to this question is that the increase in P_2/P_1 needed 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 enphasized at this point that, contrary to usual thinking[3], 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 (η_{ay})? What are the roles of suppy elasticities?

It is usual to think that interactions between agriculture and nonfarm sector are important only if η_{ay} is different from zero[4]. To examine this aspect, we consider $\eta_{ay} = 0$ 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 nonfarm demand increases P_2 relative to P_1 (unless $\varepsilon_2 \to \infty$) 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 $\eta_{Ay}=0$.

We now turn to the roles of supply elasticities. One of structuralist hypothesis in that ε_1 is low and ε_2 is relatively high. Let's take then two limit cases: $\varepsilon_1 \to 0$ and/or $\varepsilon_2 \to \infty$. If $\varepsilon_2 \to \infty$, an increase in nonfarm demand, by monetary or fiscal policy, will increase nonfarm output with no change in relative price. As far as $\eta_{Ay} > 0$, 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 of fiscal policy 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 inovation
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[5]:

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[5] This hypothesis is often made for an economy operating
with excess capacity.

$$\hat{Y} = \beta_L \frac{\alpha_y}{1 - a_y \beta_y} \hat{L}$$

which is positive provided $\alpha_y \beta_y < 1$. It is easy to verify that given β_L and the rate of expansion of L, the agricultural output will have to grow at a higher rate, the higher are α_y and/or β_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 inflactionary effects. This result would hold if $\varepsilon_2 \rightarrow \infty$, that is, nonfarm aggregate supply if perflectly elastic. Otherwhise, the supply side farm-nonfarm interactions would restablish 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. Exagenous 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 a much   as nonfarm nominal prices. The effects of several different assumptions regarding supply and demand   elasticities upon the model results are derived.

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APPENDIX

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

Effects of Changes in $\hat{S}$

(a) $\dfrac{\partial \hat{Y}_1}{\partial \hat{S}} = \varepsilon_s \dfrac{|\Gamma 11|}{|\Gamma|} =$

$$= \varepsilon_s \frac{\varepsilon_2 (\alpha_1 + \alpha_2) + \alpha_y \varepsilon_2 (\beta_1 + \beta_2) + \alpha_2 \beta_1 - \alpha_1 \beta_2}{\varepsilon_1 [(\beta_1 + \beta_2) + \beta_y (\alpha_1 + \alpha_2)] + \varepsilon_2 [\alpha_1 + \alpha_2) + \alpha_y (\beta_1 + \beta_2)] + \alpha_2 \beta_1 - \alpha_1 \beta_2}$$

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 $\varepsilon_s > 0$, $\dfrac{\delta \hat{Y}_1}{\delta S} > 0$.

(b) $\dfrac{\delta \hat{Y}_2}{\delta \hat{S}} = -\varepsilon_s \dfrac{|\Gamma_{12}|}{|\Gamma|} = -\varepsilon_s \dfrac{-\beta_y \varepsilon_2 (\alpha_1 + \alpha_2) - \varepsilon_2 (\beta_1 + \beta_2)}{|\Gamma|} > 0$

(c) $\dfrac{\delta \hat{P}_1}{\delta \hat{S}} = \varepsilon_s \dfrac{|\Gamma_{13}|}{|\Gamma|} = \varepsilon_s \dfrac{\varepsilon_2 - \beta_2 - \alpha_y \beta_y \varepsilon_2 - \alpha_2 \beta_y}{|\Gamma|} < 0$

unless $\alpha_y \beta_y > 1 - \dfrac{\beta_2 + \alpha_2 \beta_y}{\varepsilon_2}$

Effects of Changes in $\hat{P}_b$

(a) $\dfrac{\delta \hat{Y}_1}{\delta P_b} = -\alpha_b \dfrac{|\Gamma_{21}|}{|\Gamma|} = -\alpha_b \dfrac{-\epsilon_1(\beta_1 + \beta_2)}{|\Gamma|} > 0$

(b) $\dfrac{\delta \hat{Y}_2}{\delta P_b} = \alpha_b \dfrac{|\Gamma_{22}|}{|\Gamma|} = \alpha_b \dfrac{-\epsilon_2(\beta_1 + \beta_2)}{|\Gamma|} < 0$

(c) $\dfrac{\delta \hat{P}_1}{\delta P_b} = -\alpha_b \dfrac{|\Gamma_{23}|}{|\Gamma|} = -\alpha_b \dfrac{-\beta_2 + \epsilon_2 + \beta_y \epsilon_1}{|\Gamma|} > 0$

(d) $\dfrac{\delta \hat{P}_2}{\delta \hat{P}_b} = \alpha_b \dfrac{|\Gamma_{24}|}{|\Gamma|} = \alpha_b \dfrac{-\beta_1 - \beta_y \epsilon_1 - \epsilon_2}{|\Gamma|} > 0$

unless $\beta_1 < -\beta_y \epsilon_1 - \epsilon_2$

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

(a) $\dfrac{\delta \hat{Y}_1}{\delta \hat{\rho}} = -\alpha_\rho \dfrac{|\Gamma_{21}|}{|\Gamma|} - \beta\rho \dfrac{|\Gamma_{11}|}{|\Gamma|} = \dfrac{\alpha_\rho \epsilon_1(\beta_1+\beta_2) - \beta_\rho \epsilon_1(\alpha_1+\alpha_2)}{|\Gamma|}$

with indeterminate sign.

(b) $\dfrac{\delta \hat{Y}_2}{\delta \hat{\rho}} = \alpha\rho \dfrac{|\Gamma_{22}|}{|\Gamma|} + \beta\rho \dfrac{|\Gamma_{42}|}{|\Gamma|} = \dfrac{\alpha\rho \epsilon_2(\beta_1+\beta_2) + \beta\rho \epsilon_2(\alpha_1+\alpha_2)}{|\Gamma|}$

with indeterminate sign.

(c) $\dfrac{\delta \hat{P}_1}{\delta \hat{\rho}} = -\alpha\rho\dfrac{|\Gamma_{23}|}{|\Gamma|} - \beta\rho\dfrac{|\Gamma_{43}|}{|\Gamma|} \qquad =$

$$\alpha\rho\dfrac{\alpha\rho(-\beta_2+\varepsilon_2+\beta_y\varepsilon_1) - \beta\rho(-\varepsilon_1+\alpha_2+\alpha_y\varepsilon_2)}{|\Gamma|} < 0$$

(d) $\dfrac{\delta \hat{P}_2}{\delta \hat{\rho}} = \alpha\rho\dfrac{|\Gamma_{24}|}{|\Gamma|} + \beta\rho\dfrac{|\Gamma_{44}|}{|\Gamma|} =$

$$= \dfrac{\alpha\rho(-\beta_1-\beta_y\varepsilon_1-\varepsilon_2) + \beta\rho(-\alpha_y\varepsilon_2-\varepsilon_1+\alpha_1)}{|\Gamma|} > 0$$

Effects of changes in $\hat{T}$, $\hat{L}$, $\hat{G}$ or $\hat{P}m$

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

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

$$\dfrac{\delta \hat{Y}_2}{\delta \hat{L}} = \beta_L\dfrac{|\Gamma_{42}|}{|\Gamma|} = \beta_L\dfrac{\varepsilon_2(\alpha_1 + \alpha_2)}{|\Gamma|} > 0$$

$$\dfrac{\delta \hat{P}_1}{\delta \hat{L}} = -\beta_L\dfrac{|\Gamma_{43}|}{|\Gamma|} = -\beta_L\dfrac{\varepsilon_1 + \alpha_2 + \alpha_y\varepsilon_2}{|\Gamma|} > 0$$

$$\frac{\delta \hat{P}_2}{\delta L} = \beta_L \frac{|\Gamma_{44}|}{|\Gamma|} = \beta_L \frac{-\alpha_y \varepsilon_2 - \varepsilon_1 + \alpha_1}{|\Gamma|} > 0$$

Changes in T, G, or Pm are evaluated similary considering $\beta_T <$, $\beta_G > 0$ 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.

$$\frac{\delta(\hat{P}_1 - \hat{P}_2)}{\delta \hat{S}} = \varepsilon_s \frac{(\beta_1 + \beta_2) + \beta_y (\alpha_1 + \alpha_2)}{|\Gamma|} < 0$$

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

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

Indeterminate.

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

The signs of the derivatives with respect to $\hat{T}$, $\hat{G}$ and $\hat{P}m$ are obtained substituting β_T, β_G and β_m. respectively, for β_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 $\hat{Y} = q_1\hat{Y}_1 + q_2\hat{Y}_2$, 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 depends on these shares.

$$\frac{\delta(\hat{Y}_1 - \hat{Y}_2)}{\delta\hat{S}} = \epsilon_s \frac{|\Gamma_{11}| + |\Gamma_{12}|}{|\Gamma|} \quad \text{with indeterminate sign}$$

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

$$\frac{\delta(\hat{Y}_1 - \hat{Y}_2)}{\delta\hat{\rho}} = -\alpha_\rho \frac{|\Gamma_{21}| + |\Gamma_{22}|}{|\Gamma|} - \frac{|\Gamma_{11}| + |\Gamma_{42}|}{|\Gamma|} \quad \text{with}$$

indeterminate sign.

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

Effects of changes in $\hat{T}$, $\hat{G}$ or $\hat{P}_m$ are analysed substituting β_T, β_G or β_m, respectively, for β_2 in the last derivative above.