Supply and Demand Shocks and the Growth of the Brazilian Agriculture

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Abstract

In the last decades the Brazilian agriculture had a strong growth. Our hypothesis is that most of that growth may be attributed to two general factors, which may conveniently be related to two types of shocks acting upon agriculture: demand-related and technological supply-related shocks. Demand shocks are originated both from domestic economy but also from external markets. We use Blanchard & Quah (1989) type of methodology to test the relative importance of supply and demand shocks on Brazilian agricultural growth.

Our results indicate that supply and demand shocks have permanent effects upon agricultural output and prices. We estimate that the agricultural output growth in Brazil is attributed in large proportion to yield increases. We argue that integration to international markets was essential to assure the profitability of continuous use of new technology that led to yield improvements. This is why exchange rate plays a key role in explaining the performance of the Brazilian agriculture.

We anticipate that, if investments in science and technology are maintained and international integration expanded, Brazil will be able to substantially increase its supply of agricultural products both domestically and in foreign markets.

Key Words: supply and demand shocks, agricultural growth

1. Introduction

The excellent performance of the Brazilian agriculture in the last decade has drawn the worldwide attention. In this paper we intend to measure the driving forces behind this performance. We believe that Brazil is reaping the results of long-term investments in agricultural technology and productivity as well in land use so to explore related economies of scale. These transformations began after the World-War II, when it became clear that high food cost and low importing capacity could frustrate any effort towards planned industrialization. The public decision was to stimulate agricultural production through a package of policy instruments including cheap and abundant rural credit, subsidized price support and storage programs. As a matter of fact, this package was an important part of the more general strategy of pursuing national economic growth through import substitution. These agricultural programs warranted a rapid growth based mostly on extensive use of land at constant productivity. Special public programs along with foreign investments created the necessary conditions for a rapid occupation of new "cerrado" lands in the center-west of Brazil. The public research and extension system created on the early seventies permitted that new technologies could be produced particularly for poor acid soils in frontier lands.

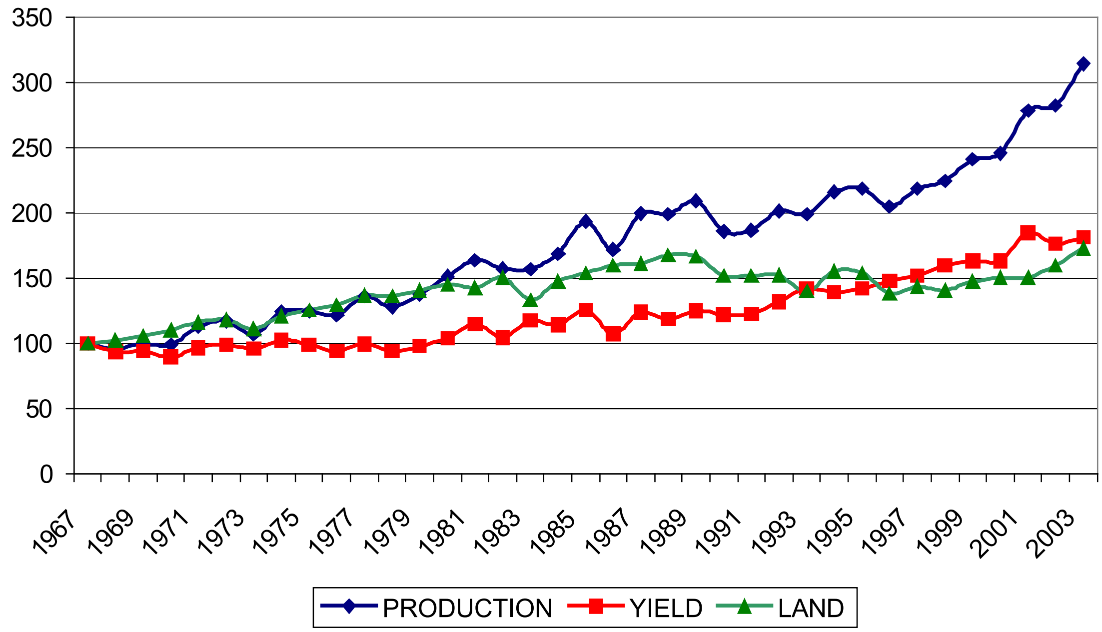
By the mid-1980, however, public resources were largely exhausted and – because of foreign debt default - so were the possibilities of attracting foreign capital. The agricultural sector growth strategy had to change from one based on central government incentives to other based on market-oriented mechanisms.

Apparently most of the research investments began to produce concrete results in the second have of the eighties. Since then agriculture growth tended to respond to national and international demand, being based mostly on yield increases than on land expansion. In addition, efficiency became essential to stay in business in a highly integrated and competitive world market.

We hypothesize that integration to external markets was fundamental to assure a continuous modernization of the agricultural sector since domestic GDP behaved rather poorly over the last two decades. Productivity increases would be self-deterrent if agriculture depended only on domestic demand because the inevitable severe price decreases would soon eliminate the profitability of modern techniques. Because external demand tend to be more elastic than domestic demand, productivity-induced price reductions could be mitigated if part of increased production was deviated to international markets.

This evolution is in accordance with information in Figure 1 which shows that from the sixties to the early eighties agricultural crops output growth is closely associated with land use growth. Afterwards cropland use stagnated and output growth strongly relates to yield increases. In the two last years there are indications that yield somewhat stabilized and land expansion began to be observed again.

Figure 1. Agricultural Land, Yield and Output – Brazil, 1967-2003

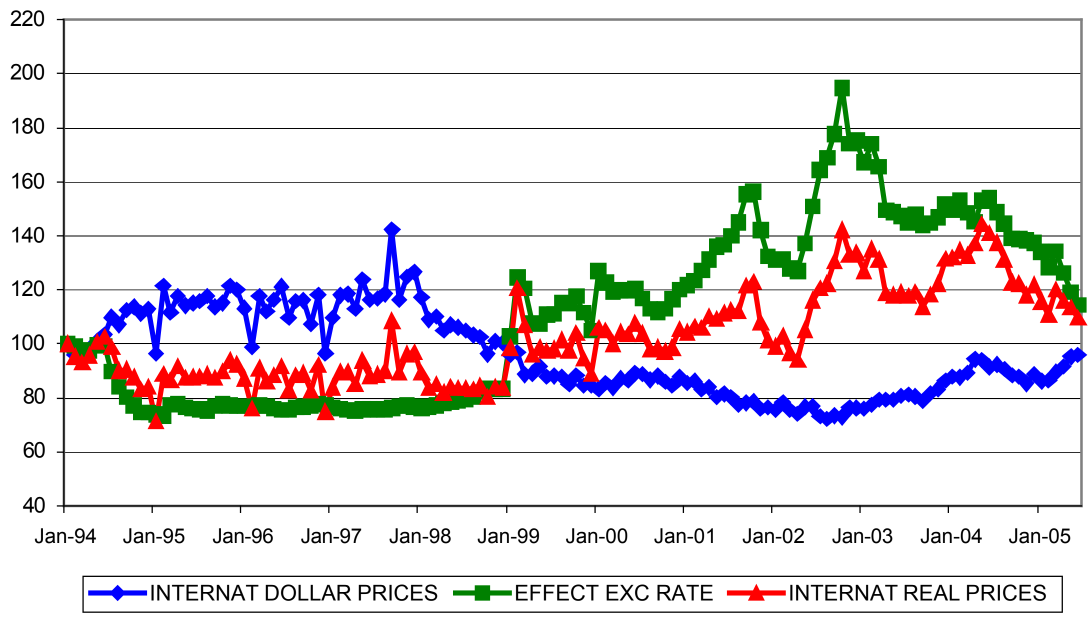


Source: IBGE

Over the last ten years, Brazil's agriculture was able to amplify its degree of integration to international markets even though international dollar prices and the effective exchange rate were not both favoring such integration (Figure 2). From 1994 to 1999, exchange rates were excessively overvalued and international prices were relatively high;

from 1999 (when Brazil devalued its currency – the real - and adopted a flexible regime) on, the exchange rates became more favorable but international prices tended to be relatively low. The conversion of external to international real prices, however show that in the last 5 years exports has been relatively attractive – compared to previous 5 years - to Brazilian farmers.

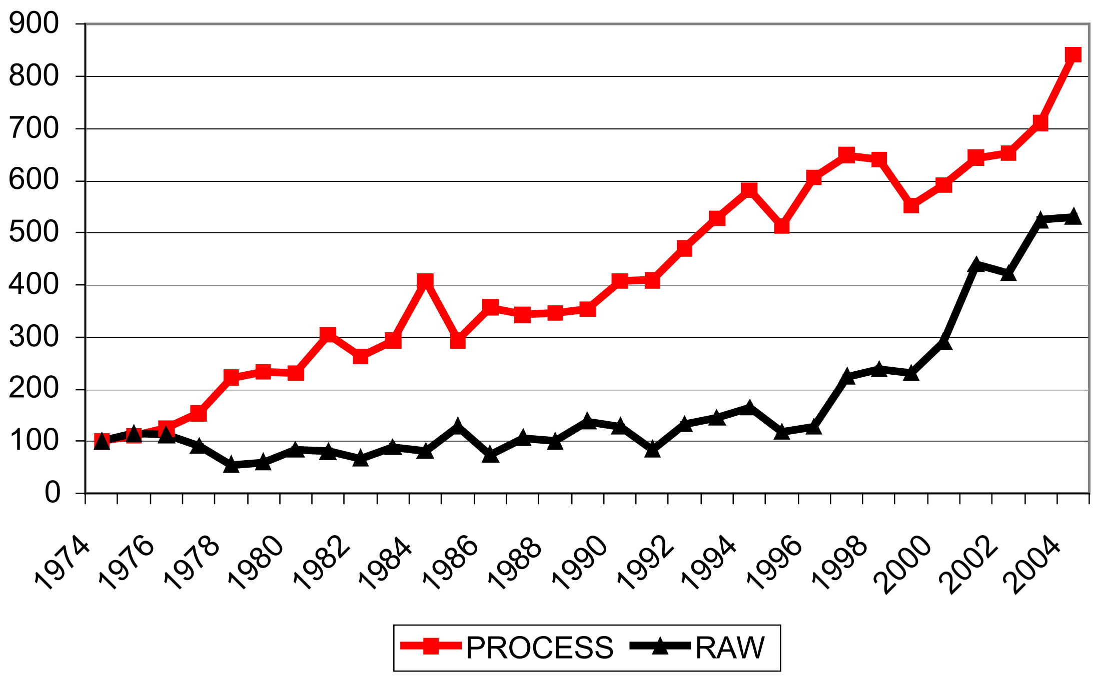
Figure 2. Effective Exchange Rates, International Dollar and Real Prices – 1994/2005



Source: FGV and CEPEA

Figure 3 shows that *quantum* indexes of agricultural exports by Brazil have been growing expressively over the last 30 years, particularly for processed products. During the last 7 years, the growth rate of these exports became even higher. The overall performance may be attributed to productivity growth and exchange rate adjustments. Anyhow, it is quite evident that an important integration of the Brazilian agriculture to international market occurred in the considered period.

Figure 3. Exports of Raw and Processed Agricultural Products (Quantum Indexes) – 1974/2004



Source: IPEA

In what follows we present a model and empirical procedures to measure the effects and relevance of domestic demand and supply shocks to explain the evolution of the output of agricultural crops in Brazil. We intend to check the pattern of these effects and whether these shocks have permanent or temporary impacts on output.

2. The Economic Model

Blanchard and Quah (1989) presented a model to explain how demand and supply shocks affected the US GDP growth and unemployment rate. Changes in these variables were derived as moving averages of random shocks associated to monetary (demand) and productivity (supply). Blanchard & Quah (1989) obtain the relations between shocks and changes in GDP growth and the level of unemployment by appropriately restricting the moving average coefficients.

We intend to explain agricultural output growth as a result of productivity or yield (supply) and demand shocks (related both to GDP and exchange rate shocks). Following Blanchard and Quah we simplify the analyses by assuming unitary elasticity everywhere.

Total demand for the agricultural product (Y^D) is the summation of domestic demand (Y^d) plus external demand (Y^x) and

$$Y_t^d = \frac{M_t}{P_t}$$

where M is domestic GDP and P is agricultural relative price. Also

$$Y_t^x = \mathrm{f}_t Y_t^d$$

where f is the relationship between external and domestic demand such that

$$\mathrm{f}_t = e^{u_t}$$

and m is the real exchange rate (domestic currency price of foreign currency).

The total demand for agricultural products is given by:

$$y_t^D = m_t - p_t + \mathrm{m}_t \qquad (1)$$

where minuscule letters stand for variables in logarithmic form.

The agricultural output supply (in log) is expressed by:

$$y_t^s = n_t + \mathrm{q}_t \qquad (2)$$

where n is the harvested area, q is the land productivity.

The relationship between harvested area and agricultural prices is:

$$n_t = E(p_t) \qquad (3)$$

Finally, the model is affected by three exogenous auto-regressive shocks:

(a) Domestic demand shocks (e_1^d):

$$m_t = m_{t-1} + e_{1t}^d \qquad (4)$$

(b) External demand shocks (e_2^d):

$$\mathsf{m}_t = \mathsf{m}_{t-1} + e_{2t}^d \qquad (5)$$

(c) Productivity (supply) shocks (e^s):

$$\mathsf{q}_t = \mathsf{q}_{t-1} + e_t^s \qquad (6)$$

The elements e_1^d, e_2^t and e^s have zero mean, are uncorrelated among each other and present no autocorrelation. Equations (4), (5) and (6) indicate that we assume that the farm sector has a small impact upon GDP, external demand for agricultural products and productivity. That is, the farm sector is (a) a small fraction of the Brazilian economy (actually it represents around 8% of GDP), (b) a price taker in international markets and (c) not capable of affecting productivity (affected by past investments in R&D and weather conditions).

2.1 The growth rates of agricultural output and price

Using (1):

$$\Delta y_t = y_t - y_{t-1} = (m_t - m_{t-1}) - (p_t - p_{t-1}) + (\mathsf{m}_t - \mathsf{m}_{t-1})$$

And using (4) we obtain:

$$\Delta y_t = e_{1t}^d - (p_t - p_{t-1}) + e_{2t}^d$$

To find (p_t - p_{t-1}) we substitute (3) into (2):

$$y_t = E(p_t) + \mathrm{q}_t$$

so that

$$E(y_t) = E(p_t) + \mathrm{q}_{t-1} \quad (7)$$

Furthermore, from (1):

$$E(y_t) = E(m_t) - E(p_t) + E(\mathrm{m}_t) \qquad (1')$$

Therefore, from (7) and (1'):

$$E(p_t) = \frac{1}{2}[E(m_t) + E(\mathrm{m}_t) - \mathrm{q}_{t-1}]$$

Then (3) becomes:

$$n_t = \frac{1}{2}[E(m_t) + E(\mathrm{m}_t) - \mathrm{q}_{t-1}] \qquad (3')$$

Using (3') in (2):

$$y_t = \frac{1}{2}[E(m_t) + E(\mathrm{m}_t) - \mathrm{q}_{t-1}] + \mathrm{q}_t \qquad (8)$$

or

$$\Delta y_t = \frac{1}{2}e^d_{1,t-1} + \frac{1}{2}e^d_{2,t-1} - \frac{1}{2}e^s_{t-1} + e^s_t \qquad (8')$$

Then, applying (8) into (1):

$$p_t = m_t + \mathrm{m}_t - \quad \{\frac{1}{2}[E(m_t) + E(\mathrm{m}_t) - \mathrm{q}_{t-1}] + \mathrm{q}_t\} \qquad (9)$$

or

$$\Delta p_t = e^d_{1,t} + e^d_{2,t} - \frac{1}{2}e^d_{1,t-1} - \frac{1}{2}e^d_{2,t-1} + \frac{1}{2}e^s_{t-1} - e^s_t \qquad (9').$$

and from (3'):

$$\Delta h_t = \frac{1}{2}(e^d_{1,t-1} + e^d_{2,t-1} - e^s_{t-1}) \quad (3'')$$

The theoretical results in (8'), (9') and (3'') indicate that demand shocks – either domestic or external – tend to contemporaneously affect domestic prices and, with a lag, the land use and the output. Two important aspects of these effects are worth emphasizing: (a) demand effects on prices are partially reduced with a lag, due to supply response increasing land use and output, (b) all demand effects are permanent.

Productivity increasing (supply) shocks tend to raise output and reduce prices contemporaneously. Then, with a lag, we expect a reduction in land use (due the decreases in price in the previous period) and, as a result, in output. But the net effect of the productivity increase is to permanently reduce price and raise output.

We conclude that shocks to domestic demand and exchange rate play similar roles in explaining output growth. In addition, a negative domestic demand shock, for instance, can be offset by a rise in exchange rate. An increase in productivity will have a larger effect in output if domestic and/or foreign positive demand shocks totally or partially offset the its decreasing price effect upon land use.

3. Methods

A Structural VAR system (Vector Auto Regression)[1] in the Brazilian real GDP, real exchange rate, the agricultural yield, output and real price is estimated using annual observations from 1967 through 2003. The Brazilian research institutions IPEA (Instituto de Pesquisas Economicas Aplicadas) and Fundacao Getulio Vargas (FGV) publish all the information. The annual value of the crop output variable was calculated by adding up the annual outputs of the 18 major Brazilian crops multiplied by a constant price vector for the

[1] See Sims (1980) and Sims (1986) for presentations of the recursive and structural (Bernanke's procedure) VAR methods.

whole time period[2]. This procedure intends to capture the growth in output avoiding the price-change effects associated with individual crop output changes.

Impulse responses and the variance decompositions are obtained under the assumption that those five variables are endogenous in principle. Contrary to Blanchard and Quah (1989), we try to have our working hypotheses empirically confirmed and do not impose restrictions on the coefficients of moving average representation of the impulse response. Following Bernanke's procedure our restrictions apply to the matrix of contemporaneous relations among endogenous variables (A_0 below). We follow the RATS software and procedures suggested by Enders (2004).

We consider the following Vector Auto Regression System

$$A_0 x_t = \alpha + \sum_{i=1}^{p} A_i x_{t-i} + \varepsilon_t \qquad (10)$$

where A_0 , 5×5, is a matrix contemporaneous relations among the 5 endogeneous variables (x_t). ε_t is a ($5x1$) vector of white-noise uncorrelated disturbances. The variance-covariance matrix Σ_ε of these disturbances is diagonal. According to the economic model, we define

$$x_t = [m_t, \mu_t, \theta_t, y_t, p_t]'$$

and

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix}$$

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2 The crops are: cotton, peanut, rice, potato, cocoa, coffee, edible beans, tobacco, castor beans, manioc, corn, soybean, tomato, wheat, grapes. Each element of the price vector was the simple average of the deflated prices of each crop.

meaning that GDP (m), exchange rate(μ) and productivity (θ) are not contemporaneously related; but the three of them contemporaneously affect agricultural output (y) and price (p), and output is not contemporaneously affected by price[3].

Given that we use annual data and our sample is relatively small we predefine the lag order of the auto-regression as being one. Dickey- Fuller's unit root tests and Johansen's cointegration tests indicate that the series were integrated of order one and presented two cointegrated vectors. So an error-correction procedure was applied to the VAR model (Enders, 2004).

From (10) we obtain the reduced form:

$$\mathbf{x_t} = \mathbf{A_0^{-1}\alpha} + \sum_{i=1}^{p} \mathbf{A_0^{-1}A_i x_{t-i}} + \mathbf{A_0^{-1}\varepsilon_t}$$

or

$$\mathbf{x_t} = \mathbf{B_0} + \sum_{i=1}^{p} \mathbf{B_t x_{t-1}} + \mathbf{e_t} \qquad (11)$$

and $\mathbf{\Sigma_e}$ is the variance –covariance matrix of the reduced form disturbances.

Under stability conditions (Enders, 2004, 381-386),

$$\mathbf{x_t} = \mathbf{\lambda} + \sum_{i=0}^{\infty} \mathbf{\varphi_i \varepsilon_{t-i}} \qquad (12)$$

can be obtained and taken as the impulse response function. From (12) is possible to calculate the forecast error variance decomposition. For instance, the n-step-ahead forecast error is:

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[3] In an alternative empirical model we substitute land use (area) for output in vector x_t. We will be mentioning some the results for this model bellow.

$$\mathbf{x}_{t+n} - \mathbf{E}_t \mathbf{x}_{t+n} = \sum_{i=0}^{n-1} \boldsymbol{\varphi}_i \boldsymbol{\varepsilon}_{t+n-i}$$

from which is possible to calculate the n-step-ahead forecast variances and the for each variable the contribution of shocks in each variable on those variances.

Since we have an over-identified system in (10) considering $\mathbf{A_0}$, we use a four-step estimation procedure known as Generalized Method of Moments (Enders, 2004): (a) estimate the unrestricted VAR in (11), (b) obtain the unrestricted variance-covariance matrix $\boldsymbol{\Sigma}_e$ and construct $\sum_{\varepsilon} = \mathbf{A_0}\boldsymbol{\Sigma}_{\varepsilon}\mathbf{A_0}'$, (c) maximize the log likelihood function:

$$-\frac{T}{2}\ln\left|\mathbf{A_0}^{-1} \Sigma_{\varepsilon} (\mathbf{A_0}')^{-1}\right| - \frac{1}{2}\sum_{t=1}^{T} \hat{\mathbf{e}}_t \mathbf{A_0}' \sum\nolimits_{\varepsilon}^{-1} \mathbf{A_0} \hat{\mathbf{e}}_t)$$

If the tests of unit root and co-integration indicate that the series are integrated and cointegrated, an error-correction model, as the presented in equation (13), must be used.

$$\mathbf{A_0}\Delta\mathbf{x}_t = \boldsymbol{\alpha}^* + \sum_{i=1}^{p-1} \mathbf{A}_i \Delta\mathbf{x}_{t-i} + \boldsymbol{\beta}\mathbf{z}_{t-1} + \boldsymbol{\varepsilon}_t^* \qquad (13)$$

where: Δ is a difference operator, such that $\Delta\mathbf{x}_t = \mathbf{x}_t - \mathbf{x}_{t-1}$, and $\mathbf{z}_{t-1}$ is an error correction vector.

4. Results and Discussion

Dickey- Fuller's unit root tests indicate that the series were integrated of order one, except GDP that is stationary around a trend (Table 1). Although the tests of unit root have indicated that variable GDP is stationary, it was used as being integrated of first order taking account that: (i) frequently the tests of unit root do not allow a clear distinction between a stationary process in the differences and a stationary process around a trend; (ii) the results of this test is not reliable for the small samples, (iii) the results of a adjusted VAR model with the original series GDP had shown no long run convergence for the impacts of shocks. The Johansen's procedure for the cointegration test showed that the null hypothesis that the variables are not cointegrated must be rejected (Table 2) and that the variables presented one cointegrated vector. Therefore an error-correction procedure was applied to the VAR model (Enders, 2004). The criteria of AKAIKE and SCHUARZ had indicated that one lag would have to be used in the model (13).

We now report the estimates of the elements of A_0 in Table 3, where we notice that all coefficients – except a_{53} that presents a relatively high standard error - have the right sign[4]. The negative relationship between price and output suggests that the desired demand relationship was captured by the model[5].

Before we examine the impacts of supply and demand shocks, it is interesting to check the nature of these shocks themselves. Effects are estimated as elasticities (relation between each step log change and the initial log change). To better evaluate the results we report cumulative impacts (sum of each step elasticity).Thus in Figure 4 we see that all three shocks are permanent. GDP shocks tend to be cumulative in such way that a given initial increase in the growth rate would almost double within 5 to 6 periods. That is, after 5 to 6 months the GDP growth stabilizes at a new rate twice as large as the initial shock[6]. Exchange rate shocks are rather persistent, experiencing a very mild change following an initial shock. Productivity shocks, on the other hand, is also permanent but ends up loosing almost 40% of initial impact, after some oscillatory pattern.

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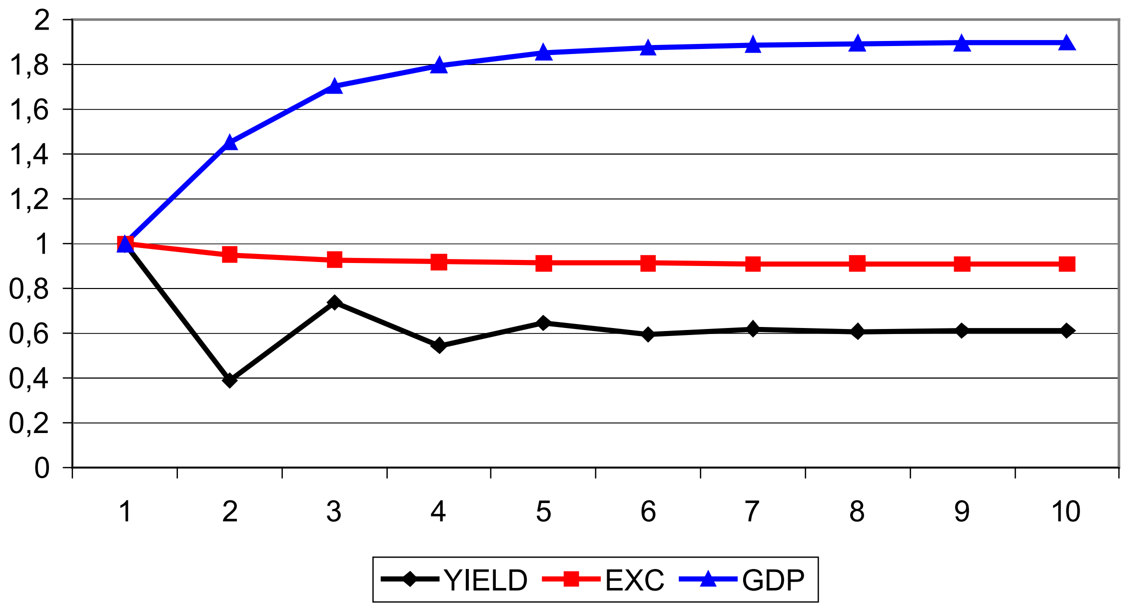
[4] It is important to remind that the coefficients in A_0 will present the opposite signs when the system is expressed in the reduced form (11).

[5] For the alternative model with land use instead of output, the estimates for the A_0 are presented in Table 4. All coefficients present the right sign and are more precisely estimated.

[6] For example, if the real GDP has been growing at 2% per year, then if –due to an unexpected shock - this rate changes to 2,2%, it will converge to 2.4% after 5 years. Similarly, if the real exchange rate has been devaluing at 2% and moves to 2.2%, it will stabilize at devaluation rate of 2.18%. For productivity the rate would go from 2% to 2.2% and to 2.12%.

Figure 4. Evolutions of Yield, Exchange Rate and GDP Shocks



Source: The Authors

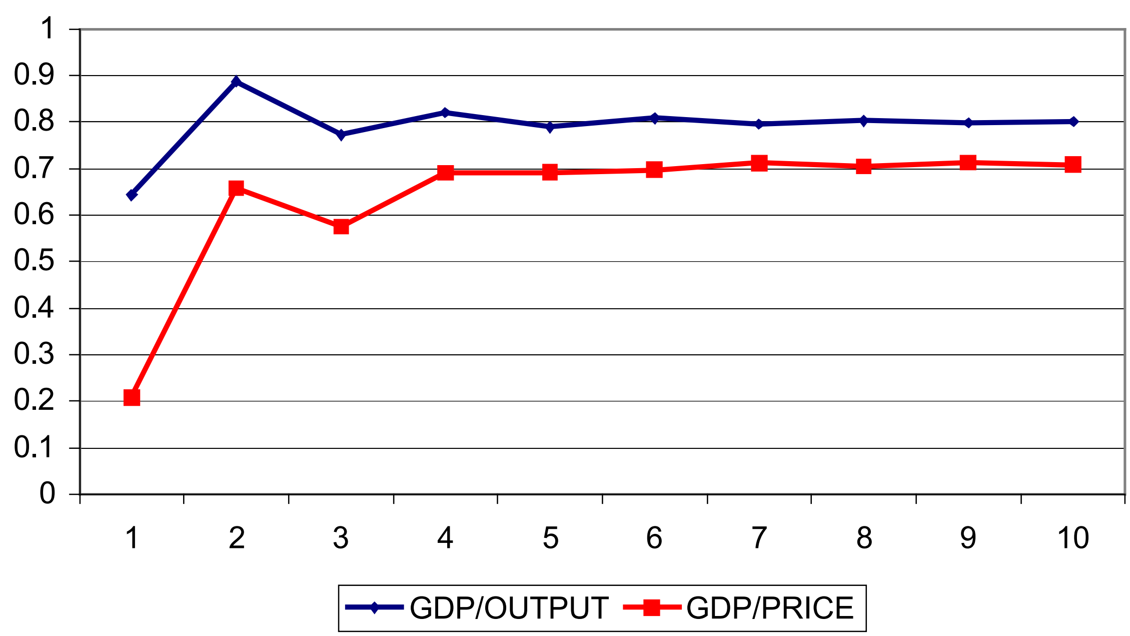
Next we report the variance of the one to ten step-ahead estimated forecast variance decomposition. In Table 5 and Table 7 we see that the GDP (m) and yield (θ) behave as exogenous variables, in the sense that most (more than 90%) of their forecast error variances are explained by shocks in themselves. These facts are in accordance with our model's assumptions. In Table 6 we see that, although a high proportion of the error variance of the exchange rate (μ) is attributable to shocks in itself, around 20% of the variance is due to shocks in the GDP. The model's assumption in this case can be taken as approximately acceptable.

Table 8 shows a small proportion (less than 20%) of the agricultural output (y) forecast variance being attributable to own shocks. Between 50% and 60% of the output variance are due to shocks in the yield. In addition around 10% of the variance is related to GDP variations and around 16% to exchange rate variations. These results suggest that agricultural output is highly dependent on supply shocks; but demand shocks impacts are not negligible.

In Table 9 we see that the largest portion of the variance of the forecast errors of agricultural prices is due to own shocks while around 20% is attributable to shocks in the yield. These results suggest that – contrary to our assumption – agricultural prices have a strong exogenous component. [7]

Figure 5 shows the impulse effects of demand (GDP) shocks on agricultural output and price. Results are expressed as elasticities, indicating that a 10% unexpected positive shock in GDP growth rate will immediately raise agricultural output and price growth rates by 6.5% and 2%, respectively. Long run effect will be an 8% and a 7% rise, respectively.

Figure 5. Impacts of shocks in GDP on Agricultural Output and Price

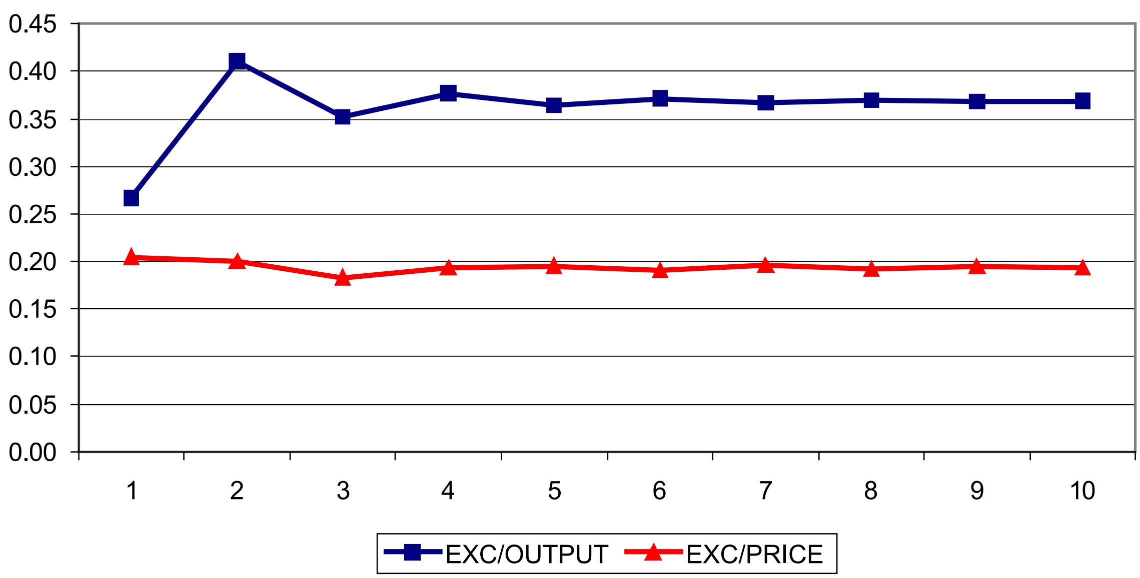


Source: The Authors

[7] Other results, not reported in these notes, indicate that domestic prices are strongly affected by international prices, what would make them exogenous with respect to our model.

Figure 6 reports results for demand shocks associated with exchange rate changes. A 10% unexpected increase in the devaluation of the exchange rate will immediately increase agricultural output and price growth rates by 2.7% and 2% respectively. The long run effects will be same as the immediate one for price and 3.5% for output.

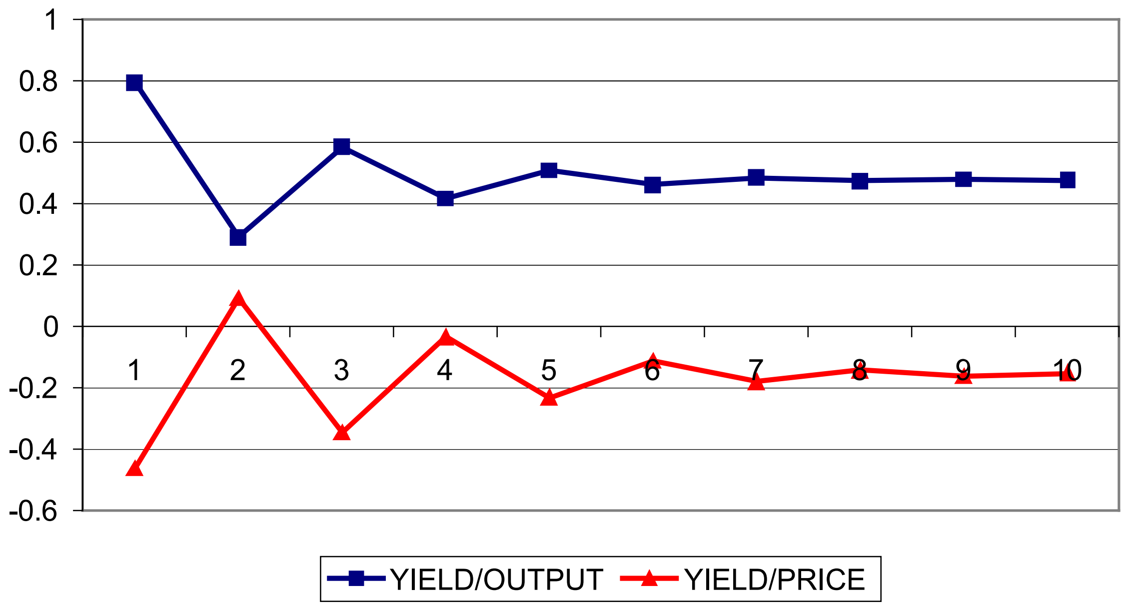
Figure 6. Impacts of shocks in Exchange Rate on Agricultural Output and Price



Source: The Authors

In Figure 7 we see that a 10% increase in crop yield growth rate will immediately increase output rate of growth by 8% and reduce price rate by 4%. Long run effects will be a 4.2% rise in output rate and a 0.18% reduction in price growth rate. It is interesting to notice that the moderate impact on price is possibly due to the alternative of exporting the additional output. That this might really be the case is indicated by a mild appreciation of the domestic currency that follows the typical positive shock in productivity. This appreciation would hypothetically be the result of an expansion in the trade balance after a positive productivity shock. Anyhow, a small fall in price – possibly due an increase in exports – is the factor warranting the profitability of the new technologies associated with yield increases[8].

Figure 7. Impacts of shocks in Yield on Agricultural Output and Price



Source: The Authors

5. Conclusion

The performance of the Brazilian agricultural sector - over the last 40 years - is in a large proportion (more than 50%) explained by productivity or yield increases, which result in moderate reduction in prices. We could measure that a 10% increase in yield growth rate would – in the long run - raise output growth rate by 4.8% and reduce price growth rate by 1.6%, so that farm income would end up being increased by around 3.2%. This of course stimulates the continuous use of new yield improving technologies.

[8] In the alternative model – with area instead of output – the effect of yield change on price is almost identical as the one presented in the text. But it is possible to detect a small negative effect (around - 0.1) of yield on the land use, meaning that there exists a small land-saving impact of yield-improving technology.

Since domestic demand is certainly inelastic, we attribute the continuous growth of agricultural output to integration to international markets. This, of course, makes the exchange rate a major factor in the agricultural price formation process. We measured that a 10% increase in the devaluation of the exchange rate would – in the long run - raise agricultural output by 3.7% and price by 2,0% and farm income by 5.8%. It is interesting to see that a 10% increase in devaluation is equivalent to an 18% increase in yield growth rate in terms of farm income.

We also verified that GDP growth can potentially have very expressive effects on output and prices; we believe, however, that these effects may have been important up to the nineteen seventies when Brazil was a leading country in terms of economic growth. If Brazil is able to recover high GDP growth rates, a strong growth of demand for agricultural products is expected. There is no indication, however, that this will be a problem, but rather a new opportunity of expansion to be explored by farmers and the agribusiness sector. We anticipate that, if investments in science and technology are maintained and international integration expanded, Brazil will be able to substantially increase its supply of agricultural products both domestically and to foreign markets.

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Table 1. Results of Unit Root Tests

Variáveis	Model 1*					Model 2**
	τ_τ	$\tau_{\beta\tau}$	τ_μ	$\tau_{\alpha\mu}$	τ	τ
GDP	-2,788	1,400	-3,559##	3,750#	1,636	-1,800
Yield	-1,123	1,578	1,523	-1,405	3,537	-2,990#
Output	-1,906	1,927	-0,034	0,092	3,924	-3,693#
Exc. Rate	-2,408	-0,265	-2,500	2,392	-0,668	-2,102##
Price	-2,242	-2,307	-0,600	0,353	-0,839	-3,999#

Significance at 1%, # # significance at 5% [critical values in Fuller (1976) and Dickey-Fuller (1981)].

Table 2. Results of Cointegration Tests between GDP, Yield, Output, Exchange Rate and Price

Null Hypothesis	Alternative Hypothesis	λ_{trace}	λ_{max}
R = 0	r > 0	92.80	44.44
r ≤ 1	r > 1	48.36	25.54
r ≤ 2	r > 2	22.82	14.98
r ≤ 3	r > 3	7.84	4.97
r ≤ 4	r > 4	2.88	2.88

Table 3. Coefficient and Standard Error Estimates for Matrix A_0 (output as the 4th variable)

Coefficient	Estimates	Standard Error
A_{41}	-0.643	0.143
A_{42}	-0.267	0.051
A_{43}	-0.794	0.087
A_{51}	-0.717	0.658
A_{52}	-0.416	0.244
A_{53}	-0.169	0.586
A_{54}	0.791	0.622

Table 4. Coefficient and Standard Error Estimates for Matrix A_0 (area as the 4th variable)

Coefficient	Estimates	Standard Error
A_{41}	-0.642	0.156
A_{42}	-0.266	0.051
A_{43}	0.026	0.093
A_{51}	-0.703	0.640
A_{52}	-0.413	0,238
A_{53}	0.612	0.340
A_{54}	0.776	0.604

Table 5. Decomposition of Variance of the GDP Forecast Errors

Step	Std Error	GDP	EXC.RATE	YIELD	OUTPUT	PRICE
1	0.032	100.0	0.0	0.0	0.0	0.0
2	0.036	93.8	0.2	0.0	0.2	5.8
3	0.037	93.7	0.3	0.2	0.2	5.6
4	0.037	93.6	0.3	0.2	0.2	5.7
5	0.037	93.5	0.3	0.3	0.2	5.7
6	0.037	93.5	0.3	0.3	0.2	5.7
7	0.037	93.5	0.3	0.3	0.2	5.7
8	0.037	93.5	0.3	0.3	0.2	5.7
9	0.037	93.5	0.3	0.3	0.2	5.7
10	0.037	93.5	0.3	0.3	0.2	5.7

Table 6. Decomposition of Variance of the Exchange Rate Forecast Errors

Step	Std Error	GDP	EXC.RATE	YIELD	OUTPUT	PRICE
1	0.088	0.0	100.0	0.0	0.0	0.0
2	0.098	18.0	80.3	1.7	0.0	0.0
3	0.100	19.8	77.0	2.2	0.0	1.0
4	0.101	20.4	76.0	2.6	0.1	1.0
5	0.101	20.4	75.8	2.7	0.1	1.0
6	0.101	20.5	75.7	2.8	0.1	1.0
7	0.101	20.5	75.7	2.8	0.1	1.0
8	0.101	20.5	75.7	2.8	0.1	1.0
9	0.101	20.5	75.6	2.8	0.1	1.0
10	0.101	20.5	75.6	2.8	0.1	1.0

Table 7. Decomposition of Variance of the Yield Forecast Errors

Step	Std Error	GDP	EXC.RATE	YIELD	OUTPUT	PRICE
1	0.051	0.0	0.0	100.0	0.0	0.0
2	0.060	0.0	0.1	99.5	0.0	0.3
3	0.063	0.2	0.3	99.0	0.1	0.5
4	0.063	0.2	0.3	98.8	0.1	0.6
5	0.064	0.2	0.4	98.7	0.1	0.6
6	0.064	0.3	0.4	98.6	0.1	0.6
7	0.064	0.3	0.4	98.6	0.1	0.6
8	0.064	0.3	0.4	98.6	0.1	0.6
9	0.064	0.3	0.4	98.6	0.1	0.6
10	0.064	0.3	0.4	98.6	0.1	0.6

Table 8. Decomposition of Variance of the Agricultural Output Forecast Errors

Step	Std Error	GDP	EXC.RATE	YIELD	OUTPUT	PRICE
1	0.056	13.2	17.4	51.9	17.4	0.0
2	0.065	11.3	16.8	54.4	15.6	1.9
3	0.067	10.9	16.3	56.1	14.9	1.8
4	0.068	10.7	16.1	56.7	14.7	1.8
5	0.068	10.7	16.1	56.8	14.6	1.8
6	0.068	10.7	16.1	56.9	14.6	1.8
7	0.068	10.7	16.1	56.9	14.6	1.8
8	0.068	10.7	16.0	56.9	14.6	1.8
9	0.068	10.7	16.0	56.9	14.6	1.8
10	0.068	10.7	16.0	56.9	14.6	1.8

Table 9. Decomposition of Variance of the Agricultural Price Forecast Errors

Step	Std Error	GDP	EXC.RATE	YIELD	OUTPUT	PRICE
1	0.090	0.5	4.0	6.8	4.3	84.3
2	0.098	2.6	3.3	14.0	3.6	76.6
3	0.101	2.5	3.2	18.0	3.4	72.9
4	0.103	2.6	3.1	19.9	3.3	71.1
5	0.103	2.5	3.1	20.7	3.3	70.4
6	0.103	2.5	3.1	21.0	3.3	70.2
7	0.103	2.5	3.1	21.1	3.3	70.1
8	0.103	2.5	3.1	21.1	3.3	70.0
9	0.103	2.5	3.1	21.1	3.3	70.0
10	0.103	2.5	3.1	21.1	3.3	70.0