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External Adjustment, Production Subsidies and Agricultural Growth in Brazil

INTRODUCTION

At the beginning of the 1980s, the Brazilian economy experienced a drastic change in its pattern of development. The appearance of the external debt crisis, together with the continuing effects of the world oil crisis of the late 1970s, saw the end of the import substitution model, which had been financed by massive external capital inflows. The interruption of these financial flows, together with increased international interest rates, made it necessary for Brazil to rely increasingly on domestic saving to service the external debt and to meet growth targets.

For the farm sector, this saw the end of agricultural subsidies and the introduction of indexation on rural credit contracts. The drastic reduction in agricultural support, in a very short time period, lowered expectations about the growth possibilities of the agricultural sector. That fear was sustained by the fact that agricultural subsidies amounted, in 1980, to about 22 per cent of agricultural GDP, or about 2.4 per cent of total GDP. Corresponding figures were, respectively, 14.0 and 1.41 per cent in 1981, 16.0 and 1.4 per cent in 1982, 10.0 and 1.1 per cent in 1983, going down to 0.78 and 0.09 per cent in 1985 (Shirota, 1988). The effects of the reductions were even more drastic than they might appear since total GDP experienced a fall of 8 per cent between 1980 and 1984.

But the Brazilian agricultural sector, unexpectedly, grew in that period, despite the fall in agricultural subsidies. The real GDP contributed by agriculture expanded by about 10 per cent between 1981 and 1984, and by about 20 per cent between 1980 and 1985. In fact, Brazilian agriculture not only grew throughout the entire decade of the 1980s, but its rate of growth was faster than that of the industrial sector (Ferreira Filho, 1996a). This phenomenon is exactly contrary to what would be expected by looking at the issue in a partial equilibrium framework. In that case, the reduction of agricultural subsidies would cause a movement of the supply curve to the left, thus reducing agricultural output. It will be argued here that the problem is too complex to be analysed in partial equilibrium models. The amount of subsidies involved is large enough to have generated macroeconomic effects which could have been dampened the microeconomic ones. The purpose of this paper is to evaluate the problem in a general equilibrium framework, using a computable general

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equilibrium model (CGE) to perform counterfactual simulations in order to analyse the linkages and feedbacks relating to the fall in agricultural subsidies and the simultaneous agricultural growth.

THE CGE MODEL[1]

The CGE model used in this study is based on the structure of the RUNS model (Burniaux *et al.*, 1990). However, a number of important modifications were made to the model to make it match the Brazilian economy in the 1980s and to focus on the problem at hand. To avoid confusion, the model presented here is the 'Megabrás' version. In the following summary, the model presented is a static one, with the simulation for each year being linked to the others through exogenous growth rates attributed to factors and capital stocks.

The economy is divided into two distinct sectors: rural and urban. The rural sector has 11 activities, producing soybeans, sugarcane, corn, coffee, rice, cotton, wheat, other agricultural products, livestock, milk and poultry. Urban sector efforts are separated into seven typical activities (transport, engineering, fertilizers, chemicals, energy, services and others), but also covers 10 agroindustries dealing with the processing of coffee, sugar (including alcohol), rice, wheat, fibres, vegetable oils, meat (excluding poultry), poultry and milk, plus the feed-producing industries. There are, thus, 28 productive activities in the model, each dealing with only one 'product'.

There are four institutions in the economy – rural and urban families, enterprises (investment) and government – and three primary factors of production: labour, capital and land. Only the agricultural sector utilizes land. Owing to their great degree of homogeneity the domestically produced agricultural products are assumed to be perfect substitutes for imports. Note that this does not refer to processed goods. The 'small country hypothesis' is also used so that agricultural tradable prices are defined by the exogenous world prices and import or export tariffs, while agricultural non-tradable prices are defined by excess demand in each market. For the period considered in the analysis (which is the first half of the 1980s) there are only three agricultural tradables in the model: coffee, soybeans and wheat.

For processed agricultural products, as well as the non-agricultural products, on the other hand, there is imperfect substitution between domestic production and imports, which is modelled through a CES formulation which defines a composite good for those activities. The prices of urban domestic production are defined by costs of production, while import prices are dependent on exogenous external prices and tariffs. Urban export prices are 'made' internally, through domestic prices and taxes on exports. The demand for these goods is not perfectly elastic, though it can be high in some cases.

In the agricultural sector, the production structure is specific to vegetable and animal products, both experiencing decreasing returns relative to an aggregate input, made up of urban and rural products, land and labour. The model seeks to keep track of complementarity and substitution patterns in the way primary factors and intermediates combine in the production process. This is done through a CES-linked structure, specific to the types of production

activity, with two levels of linkages and two substitution elasticities. This kind of structure divides the cost minimization problem into two sub-problems, separating inputs in each level of production from those in other levels.

Production in the urban sector displays constant returns, through a Leontief formulation for intermediate inputs and a value-added aggregate that is a CES combination of capital and labour. The nominal urban labour wage is considered rigid, parameterized to reproduce the trend of urban unemployment in the period under analysis. Agricultural wages are flexible and adjust to clear the rural labour market in each period.

The model has a neoclassical closure, in which total investment is given by saving. The nominal exchange rate is flexible and external capital flows are exogenous, so providing external sector closure. Imports, however, are subject to quantitative restrictions, in proportion to the desired imports. Government consumption is exogenous and public tax revenues endogenous, thus making the aggregate government current account endogenous. The closure of the government sector simulates an important mechanism used by the Brazilian government, in the relevant period, to finance its deficits, namely 'money creation'. The equilibrium between receipts and expenses is obtained through a type of 'seigniorage', that is, a variable that ensures the equilibrium in the government current account. This mechanism of transfer of funds between institutions is used to simulate the effects of a particular monetary phenomenon.

CALIBRATION AND THE BASE RUN

Having defined the theoretical model to be used the next step was its calibration. This was done through the construction of a social accounting matrix (SAM) for Brazil for 1980. There was a complication since the 1980 input–output matrix treated the agricultural sector as a single activity, although production was disaggregated. It was necessary, therefore, to split agriculture up into the 11 activities used in the study in a way described elsewhere (Ferreira Filho, 1996b). The resulting SAM for Brazil in 1980, evaluated at consumer prices, appears in Table 1 in a summarized form with products and activities aggregated to save space.[2] This provides a broad outline of the nature of the magnitudes involved within the economy and need not be discussed in more detail.

When the model was satisfactorily reproducing the observed pattern of the variables in the base year (1980) it was then run for the period 1981 to 1985, solving for the endogenous variables given the exogenous (observed) ones, so building the base run against which counterfactual analysis could be done. The model was solved as a non-linear optimization problem, using the General Algebraic Modelling System (GAMS) with MINOS5 (Brooke *et al.*, 1988). The price of urban value added is the *numéraire* of the model.

TABLE 1 *Social accounting matrix, Brazil, 1980 (millions of 1980 cruzeiros)*

	Activities				Products				Labour
	agritrad	agrinont	agroind	urbind	agritrad	agrinont	agroind	urbind	Rural
Activities									
agritrad	0	0	0	0	325 225	0	0	0	
agrinont	0	0	0	0	0	1 743 900	0	0	
agroind	0	0	0	0	0	0	1 896 170	0	
urbind	0	0	0	0	0	0	0	22 503 422	
Products									
agritrad	15 945	56 563	254 163	12 917	0	0	0	0	0
agrinont	1 101	185 146	572 729	261 758	0	0	0	0	0
agroind	1 921	126 356	360 497	457 983	0	0	0	0	0
urbind	137 845	449 735	586 367	12 640 564	0	0	0	0	0
Factors									
Rural labour	29 081	194 822	0	0	0	0	0	0	0
Urban labour	0	0	116 670	4 579 481	0	0	0	0	0
Rural capital	179 544	733 804	0	0	0	0	0	0	0
Urban capital	0	0	210 835	4 210 747	0	0	0	0	0
Institutions									
Rural families	0	0	0	0	0	0	0	0	224 031
Urban families	0	0	0	0	0	0	0	0	0
Government	−15 609	35 162	178 370	1 135 422	0	0	0	0	0
Capital account	0	0	0	0	0	0	0	0	0
Stocks	0	0	0	0	0	0	0	0	0
ROW	0	0	0	0	35 825	24 750	26 527	1 520 480	0
Total expenses	349 828	1 781 588	2 279 632	23 298 871	361 050	1 768 650	1 922 697	24 023 901	224 031

Notes: agritrad = agricultural tradables; agrinont = agricultural non-tradables; agroind = processed agricultural products; urbind = urban industry.

EMPIRICAL RESULTS

For the counterfactual analysis, the model was run again for the 1981–5 period, but the values of the agricultural subsidies were adjusted to fit the value observed in 1980, taken as 2.4 per cent of total GDP. The results were then compared with the base run. Table 2, for example, shows the results of the

TABLE 2 *Macroeconomic aggregates as relative variations from the base run*

Year	GDP	EXP	IMP	CONS	INV	RER1	RER2
81	–0.020	–0.027	–0.017	–0.003	–0.062	–0.009	–0.008
82	–0.025	–0.035	–0.021	0.000	–0.083	–0.012	–0.010
83	–0.021	–0.020	–0.019	–0.013	–0.046	–0.008	–0.006
84	–0.044	–0.037	–0.040	–0.027	–0.092	–0.015	–0.011
85	–0.039	–0.031	–0.037	–0.024	–0.086	–0.013	–0.009

Labour	Capital		Institutions						
Urban	Rural	Urban	Rural families	Urban families	Government	Capital	Stocks	ROW	Total receipts
								24 615	349 840
								37 703	1 781 603
								383 591	2 279 761
								795 517	23 298 939
0	0	0	6 663	4 105	0	0	10 528	0	360 884
0	0	0	136 945	355 808	2	108 943	145 913	0	1 768 344
0	0	0	278 772	692 559	217	1 076	3 152	0	1 922 532
0	0	0	643 559	5 270 339	1 269 531	2 921 169	103 846	0	24 022 955
0	0	0	0	0	0	0	0	0	223 903
0	0	0	0	0	0	0	0	0	4 696 151
0	0	0	0	0	0	0	0	0	913 348
0	0	0	0	0	0	0	0	0	4 421 582
0	913 872	0	0	0	168 212	0	0	0	1 306 115
4 697 189	0	4 422 737	0	0	1 513 848	0	0	0	10 633 774
0	0	0	137 956	1 243 054	0	626 467	0	0	3 340 821
0	0	0	101 909	3 065 162	112 107	0	0	639 414	3 918 593
0	0	0	0	0	3 376	260 161	0	0	2 63 537
0	0	0	0	0	273 319	0	0	0	1 880 900
4 697 189	913 872	4 422 737	1 305 803	10 631 026	3 340 611	3 917 816	263 440	1 880 840	

experiment concerning some macroeconomic aggregates and the exchange rate. The values are shown in relation to the base run, being expressed in the form of relative variations (that is, multiplication by 100 provides percentage changes). Aggregates covered are GDP, exports (EXP), imports (IMP), consumption (CONS) and investment (INV), plus two concepts of real exchange rates. These are the nominal exchange rate (RER1), which can be seen as a real (deflated) exchange rate since the price of urban value added is the *numéraire*, while the other is deflated by an index price of domestic products (RER2). It can be seen that the volume of subsidies is large enough to cause macroeconomic effects in the model.

It is interesting that the maintenance of agricultural subsidies at the levels observed in 1980 causes a general fall in macroeconomic aggregates in the model. To give one example, GDP could have fallen by as much as 4.4 per cent in 1984 and by 3.9 per cent in 1985. The 'increase' in agricultural subsidies, for that is what is implied, is also associated with a larger drop in aggregate investment, meaning that aggregate saving would have fallen, since, by the neoclassical closure of the model, investment is determined by the amount of saving. This happens because the income transfer to agriculture is made, in the main, through a reduction in urban income. The transfer is financed by

government through seigniorage, extracted from rural and urban sectors in proportion to the share of each in GDP. Thus the urban sector contributes the bulk of the agricultural subsidy. Since rural families have a greater marginal propensity to consume than urban families, the transfer affects consumption more than saving, thus reducing aggregate saving and investment.

The government deficit (which is not shown in Table 2) would have considerably worsened in the period. Seigniorage needs would have risen from 4.23 to 4.95 and 9.5 per cent, respectively, in 1983, 1984 and 1985 (in the base run), and from 5.87 to 8.44 and 12.9 per cent (in the simulations), for the corresponding years. This, of course, should be interpreted as an indication that government income, as determined in the model, would not be enough to meet its expenses.

The reduction in aggregate saving leads to a drop in investment, mainly because investment absorption is concentrated in some urban industries, notably manufacturing and services which have a high value-added coefficient in production. With the drop in investment, there is a fall in the demand for those composite products, reducing both domestic production and imports. As a consequence, the 'price' of domestic production falls and imports are reduced, resulting in the 'fall' in the equilibrium exchange rates (defined as Cr/US$, so that revaluation is involved). The changes in the composition of internal absorption, from high value-added activities to relatively low ones, is then associated with a fall in GDP (and then in imports).

Turning now to variables more closely related to agriculture, the evolution of agricultural production and prices appear in Tables 3 and 4. It can be seen that only wheat, soybean and corn show important increases in production in the 'high subsidies' experiment. These are three of the four agricultural tradables in the model, along with coffee. As regards the latter, however, production would have fallen. That would have been the result because the agricultural production function is defined in terms of the relative prices of products and

TABLE 3 *Changes in agricultural production as relative variations from the base run*

Year	81	82	83	84	85
Coffee	–0.002	–0.020	–0.002	–0.002	–0.001
Sugarcane	–0.006	–0.008	–0.005	–0.007	–0.003
Rice	0.004	0.005	0.004	0.010	0.011
Wheat	0.130	0.168	0.169	0.366	0.374
Soybean	0.033	0.043	0.044	0.107	0.113
Cotton	–0.004	–0.004	–0.002	0.003	0.009
Corn	0.017	0.030	0.012	0.024	0.033
Other agric.	–0.010	–0.014	–0.009	–0.019	–0.018
Poultry	0.005	0.009	0.002	0.003	0.004
Livestock	0.004	0.008	0.002	0.003	0.004
Milk	0.002	0.005	–0.004	–0.008	–0.006

TABLE 4 *Evolution of agricultural prices as relative variations from the base run*

Year	81	82	83	84	85
Coffee	–0.009	–0.012	–0.008	–0.015	–0.013
Sugarcane	–0.031	–0.040	–0.030	–0.063	–0.059
Rice	–0.074	–0.095	–0.095	–0.200	–0.205
Wheat	–0.009	–0.012	–0.080	–0.015	–0.013
Soybeans	–0.009	–0.012	–0.008	–0.015	–0.013
Cotton	–0.091	–0.114	–0.108	–0.220	–0.218
Corn	–0.171	–0.190	–0.236	–0.416	–0.403
Other agric.	0.009	0.012	0.025	0.050	0.046
Poultry	0.017	0.026	0.010	0.020	0.019
Livestock	0.019	0.029	0.013	0.026	0.024
Milk	0.016	0.026	0.004	0.008	0.009

inputs. For coffee, the fall in input prices, as a result of the subsidy, would not have compensated for the drop in its price caused by the revaluation in the exchange rate. So, despite the subsidy, the coffee/input relative price would have fallen, reducing production.

For soybeans and wheat, on the contrary, *relative* prices would have been greater with heavier subsidization. Although their market prices would have been affected in the same proportion as that of coffee owing to the exchange rate effect, the rate of subsidy in the cost of the composite input in those cases is considerably higher than for coffee. The rate was about 7 per cent for coffee, but 32, 30 and 25 per cent for wheat in 1981, 1982 and 1983, respectively, and 18, 17 and 14 per cent for soybeans. Similar influences would have affected corn, although it is not a tradable product in the model, with production rising as a result of high subsidies on input prices. Cotton and sugarcane, which are also non-tradable products in the model, have their prices reduced. Since they are mainly inputs to the export agroindustries, their prices are strongly linked to exchange rate movements, though they benefit less from input subsidies.

The three animal production activities, dealing with poultry, livestock and milk, would have experienced higher prices. This is a consequence of redistributive effects raising demand for those products, notably working through increasing rural disposable incomes, as shown in Table 5. In effect, the financing mechanism assumed to be adopted by government for the model (it mirrors what happened in the 1980s) is, in fact, a mechanism that redistributes income from the urban to the rural sector.

The rise in the production of soybeans and wheat would have had a marked impact on external trade. Soybean exports would have risen substantially in value, while wheat imports would have fallen. However, raw coffee exports would also have risen, though not as a consequence of any increase in production. There would have been a decline in urban consumption, not matched by

TABLE 5 *Changes in rural and urban disposable income as relative variations from the base run*

Disposable income	Years				
	81	82	83	84	85
Rural	0.067	0.099	0.083	0.194	0.186
Urban	–0.024	–0.024	–0.038	–0.089	–0.073

expansion in rural consumption, allied to a fall in processed coffee exports caused by the revaluation of the equilibrium exchange rate.

The maintenance of rural subsidies at levels observed in 1980 would have generated a strong rise in rural wages. As a result, their share in disposable income would have improved, with the positive variation reaching a maximum of 12 per cent, in 1984. This is shown in Table 6. In effect, rural wages would have appropriated a considerable share of the subsidies. It should be noted, however, that these results depend strongly on the hypothesis made about the evolution of the stock of agricultural machinery ('tractors'). Observed values for the 1980s showed a yearly rate of growth of 4 per cent, with that rate being used in the base run. But it has to be recognized that the size of the stock is not independent of the size of the subsidy programme. To explore the extent to which the results are affected, a rate of growth of 7 per cent, which was actually still below the growth rate of 10.3 per cent in the period 1975–80, was inserted to obtain a new solution. The results appear in Table 7.

TABLE 6 *Value added, real wages and labour shares relative to the base run*

Year	Value added		Real wages		Rural labour share in agricultural disposable income
	rural	urban	rural	urban	
81	0.000	–0.023	0.094	–0.024	0.025
82	0.000	–0.028	0.133	–0.031	0.031
83	0.000	–0.023	0.141	–0.026	0.054
84	0.001	–0.048	0.342	–0.053	0.124
85	0.005	–0.043	0.314	–0.048	0.108

The new results suggest that a higher rate of growth of mechanization would modify the earlier results. Although rural wages would still have risen in some years, the greater availability of tractors would have favoured substitution towards their use, generating a net fall in the rural wage share in total rural income.

TABLE 7 *Alternative scenario with tractor stock increasing at 7 per cent annually, variations from the base run*

Year	Value added		Real wages		Rural labour share in agricultural disposable income
	rural	urban	rural	urban	
81	0.0	–0.023	0.027	–0.025	–0.038
82	0.0	–0.026	0.014	–0.028	–0.074
83	0.0	–0.020	–0.023	–0.022	–0.095
84	0.0	–0.044	0.093	–0.048	–0.080
85	0.0	–0.038	–0.021	–0.042	–0.134

CONCLUSIONS

The CGE results provide interesting insights that would not have been obtained from partial equilibrium analysis. In a programme of agricultural subsidies, which is large enough to generate macroeconomic effects, the sources of funding are important. Though they are always dependent on the various hypotheses made about the structure of the economy, as well as on the parameter values chosen, CGE results make it possible to analyse the various links and feedbacks observed in a highly complex and interdependent economy. Perhaps of greater importance than the particular solution magnitudes for any of the variables is the demonstration of the possibility that a programme of agricultural subsidies can, in some circumstances, have unexpected results. Our results can help understand why the halting of the Brazilian agricultural subsidy programme in the 1980s, unexpectedly, did not have any significant impact on agricultural production. One popular explanation is that productivity gains would have offset the apparent fall in direct incentives in the relevant period. The results obtained with the Megabrás model, however, suggest that other forces, working through market mechanisms in a general equilibrium situation, could also have played their part.

NOTES

[1]The complete system of equations will be omitted, since it is too large. The interested reader should refer to Ferreira Filho (1995), for the complete system used, or consult Burniaux *et al.* (1990) for the basic structure of the RUNS model. Alternatively, the author can be contacted directly for additional information.

[2]The original disaggregated SAM can be obtained from the author upon request.

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