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Ecological and Socioeconomic Conflicts in Brazilian Reforestation Policies

INTRODUCTION

This paper evaluates the socioeconomic impacts and allocation effects of reforestation policies in Brazil. Reforestation is understood to be the activity of planting trees, regardless of purpose. Brazil introduced reforestation incentives in 1961 as native forest supplies became even more distant and costly. These incentives – tax exemptions, credits and input subsidies – were designed to make reforestation more profitable by reducing the typically high cost of planting new forests (Bacha, 1993). Boosted by these incentives, reforestation increased more than elevenfold, from 500 000 ha in 1964 to 5.9 million ha in 1984, at an annual geometric growth rate of 13 per cent. Minas Gerais and São Paulo states had the most active fiscal incentives programmes. However, the effectiveness of all such programmes was curtailed by problems such as credit diversion to other activities, projects being abandoned as the result of improper management or poor localization, capital loss due to late credit outlay in an inflationary economy, and income concentration following tax exemptions and subsidies that discriminated against small and medium land owners.

The paper deals with the influence of fiscal incentives on the dynamics of the Brazilian reforestation programme, following with an analysis of the socioeconomic impacts of reforestation policies and finally commenting on the impacts of the Brazilian reforestation programme on the Amazon region.

INFLUENCE OF FISCAL INCENTIVES ON THE REFORESTATION PROGRAMME

The impacts of fiscal incentives on the dynamics of reforestation can be measured using an equation embodying partial adjustment, such as the Nerlovian model:

$$A_t = \alpha_0 + \alpha_1 P_{t-1}^{mp} + \alpha_2 P_{t-1}^{mn} + \alpha_3 I_t + \alpha_4 A_{t-1} \qquad (1)$$

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where A_t is the reforested area in year t, in hectares; A_{t-1} is the reforested area in the previous year; P_{t-1}^{mp} is the price of one log stere from a planted forest in year t–1, in cruzados (CZ$) of March 1986 value; P_{t-1}^{mn} is the price of one log stere cut from native forest, again in CZ$ of March 1986; and I_t is the value of governmental incentives to reforestation (CZ$ of March 1986).

Positive signs are expected for all estimated coefficients, showing that reforestation is a positive function of the price of logs and governmental incentives. The coefficient of the variable A_{t-1}, by hypothesis, should remain between zero and one, converging to the long-run equation for reforestation.

Generalized least squares (GLS) are used to estimate equation (1) for the 16-year period 1970–85. The resulting expression is:

$$A_t = 7.97 + 0.24P_{t-1}^{mp} + 0.25P_{t-1}^{mn} + 0.16I_t + 0.13A_{t-1} \qquad (2)$$
$$R^2 = 0.64$$

The signs of the estimated parameters are consistent with expected logic for forestry activity. Every estimated coefficient is statistically different from zero (t test at 5 per cent probability). An F statistic of 13.691 differs significantly from zero and indicates that the model provides a satisfactory fit for this type of problem. Autocorrelation is checked using the 'runs' test developed by Gujarati (1992), which shows that the model presents no autocorrelation problem at 5 per cent probability.

Since the variables in equation (1) are measured in the natural logarithm of their original values, the regression parameters are elasticities of reforestation area relative to each explanatory variable. Thus the price elasticity of the reforestation area with respect to the stere price of logs coming from planted forests (0.24) and from native forests (0.25) is statistically the same. However, those elasticities differ from the reforestation elasticity with respect to fiscal incentives (0.16), as indicated by an F statistic of 20.19. In short, the prices of material derived from planted forests and from natural forests explain the increase in the reforested area to a similar extent. However, their explanatory power is greater than that of fiscal incentives. A 10 per cent change in the pervious year's reforested area (A_{t-1}) suggests a 1.3 per cent change in the new reforestation area (A_t). The long-run equation presents greater elasticities for all variables, implying theoretical coherence in choosing this model. The estimated long-run equation is:

$$A_t = 9.14 + 0.28P_{t-1}^{mp} + 0.28P_{t-1}^{mn} + 0.19I_t \qquad (3)$$

The long-run adjustment for one period becomes $1 - \alpha_4$, giving a value of 0.87. Thus the period of time required for a long-run adjustment of 95 per cent is approximately 1.5 years.

SOCIOECONOMIC IMPACTS OF THE REFORESTATION PROGRAMME

This section evaluates the impacts of the reforestation programme on employment, land ownership, wealth distribution and overall gross social benefits. Even though reforestation activity expanded rapidly in Brazil, its relative importance to agriculture and livestock activities is small. Reforestation industry participation in the value of agriculture production was only 1.56 per cent in 1970 and 2.32 per cent in 1985. The share of logging extraction from native forest in the value of agriculture production, during the same period, declined from 6.57 per cent to 2.19 per cent.

Another reforestation characteristic is that average area of reforested properties increased from 312 ha in 1970 to 512 ha in 1975, and to 663 ha in 1980, though it did fall to 572 ha in 1985. Properties whose owners extract logs from natural forest tend to be smaller and more numerous than the properties harvesting from reforested areas (Bacha, 1993).

Impacts on employment

Cultivated forests employed 95 691 people in 1980, increasing to 117 249 in 1985. Forest cultivation tends to employ very few people relative to the whole agricultural sector. For example, reforestation employed 0.013 person per hectare in 1985, the figure for agriculture being 0.062 person per hectare. Low labour intensity is explained by reforestation's long biological cycle, since work is needed mainly for preparing terrain and planting operations, whereas the growing period (five to ten years) requires less labour input. The permanent labour force has surpassed temporary labour in importance. In 1970, permanent and temporary workers, respectively, constituted 46.8 and 26.6 per cent of the labour force. By 1980, permanent labour had increased to 64.9 per cent while transient labour had declined to 15.5 per cent. Owing to the use of non-paid family members (who make up the remainder of the labour force) increasing over the period from 1980 to 1985, the share of the permanent labour was reduced in 1985 to 59.7 per cent and to 13.4 per cent for temporary workers. Greater participation by permanent workers in the labour force is explained by the small demand for labour during the year. Another reason is that forest plantations are organized as specialized enterprises, unlike the traditional multi-product farms. The conclusion is that most changes in forest plantation employment were due to governmental incentives in the 1970s and 1980s.

Impacts on agrarian structure

Forest plantations tend to be concentrated in just a few states. Given this geographic framework, two hypotheses are developed: first, there is an expected increase in the concentration of landed property when forest plantations consist of very large farms, occupying a large proportion of the region's

cultivated land. Secondly, only small changes in landed property inequality are expected when cultivated forests expand into areas already allocated to this activity or into only a small portion of the total county land area.

To test these hypotheses, data at county level from Minas Gerais and São Paulo states (15 counties) are used. The analytical model, taken from Bacha (1993) is:

$$C_{85} = \beta_0 + \beta_1 C_{70} + \beta_2 \Delta F \tag{4}$$

where $\beta_1 > 0$; $\beta_2 > 0$; C_{70} and C_{85} are the measures of inequality for the agrarian structure in 1970 and 1985; and ΔF is the absolute percentage variation in the reforested area.

Inequality in land distribution is measured by the percentage of the land area occupied by the top 10 per cent of the large agricultural properties. This variable is used because the Gini index did not behave as expected. The estimated regressions for the states of Minas Gerais and São Paulo respectively are:

$$C_{85} = 34.17 + 0.41 C_{70} + 0.72 \Delta F$$

$$C_{85} = 1.00 C_{70} + 0.18 \Delta F$$

The estimated coefficients for both states have the expected signs and are statistically different from zero at 5 per cent probability. The estimated coefficient for ΔF is positive in both cases. Thus an increase in reforestation apparently causes an increase in the inequality of landed property distribution. Since this estimated parameter is lower for São Paulo, the reforestation impact on the inequality of land distribution appears to be greater in the Minas Gerais counties. Reality confirms this, since reforestation rapidly expanded over new areas in Minas Gerais, while mostly occurring in previously reforested regions of São Paulo.

Impacts on wealth distribution

Reforestation programmes based on fiscal incentives are likely to promote wealth redistribution. This happens because the economic agents are allowed to invest a portion of their income tax for their own benefit, thereby decreasing society's public investment share. Public investment that should benefit the whole society is instead allocated to small economic groups. Governmental fiscal incentives allocated to the forestation and reforestation programme from 1967 to 1985 reached US$ 3468.24 million. From 1971 to 1982, US$ 2700 million of public resources were appropriated by 1336 firms, which should have reforested 3 448 531 ha. The 60 largest firms (4.5 per cent of all the firms) approved projects to reforest 55.7 per cent of the whole area to be reforested (Prado, 1990). Thus a large share of public resources was appropriated by the reforestation sector (a small economic sub-sector) and that in effect benefited only a few economic agents.

The conclusion is that Brazil's fiscal incentives for forestation and reforestation dramatically increased inequality in wealth distribution during the period this study examined.

Allocation of social benefits

An economic surplus model is used to measure the distributive effects of the reforestation programme in Brazil (Santana and Khan, 1992). Figure 1 illustrates gross social benefits as the area between the two supply curves and below the demand curve. The following expressions are instrumental to compute gross social benefits and the share of the benefits appropriated by consumers and producers of logs.

Total gross social benefit:

$$TGSB = 0.5KP_0Q_0(1 + Z\eta)$$

Total consumer benefit:

$$TCB = ZP_0Q_0(1 + 0.5Z\eta)$$

Total producer benefit:

$$TPB = TGSB - TCB$$

Here K is the supply curve shifter, measured by the ratio of proportional change in production relative to the supply elasticity; that is, P_0 and Q_0 are the average equilibrium prices and quantities without the reforestation programme; η and ε are the demand and supply price elasticities for logs; $Z = K\varepsilon/(\eta + \varepsilon)$; and Q_t is the total average production of logs from native and cultivated forests.

The demand price elasticity for wood is estimated from equation (5) in which Y is the national gross domestic product (GDP) per capita at March 1986 prices, in CZ$; and Q^m is wood production from native forests:

$$Q_t^m = 10.52 - 0.07P_t^{mn} + 0.0007Y + 0.13Q_{t-1}^m \tag{5}$$

The estimated coefficients have the anticipated signs. They are consistent with theory and are statistically different from zero at 5 per cent probability, while the R^2 value indicates that the independent variables explain 48 per cent of variation in the demand for wood from native forests. The demand for native wood is inelastic; a 10 per cent increase in its price would reduce quantity demanded by 0.7 per cent. Income variation does not alter the demand schedule and any shifting which occurs is caused uniquely by the lagged production of native wood or by factors exogenous to the model.

The computed total gross social benefit (TGSB) from the reforestation programme is US$ 61.95 million for 1975; US$ 75.28 million for 1980; and

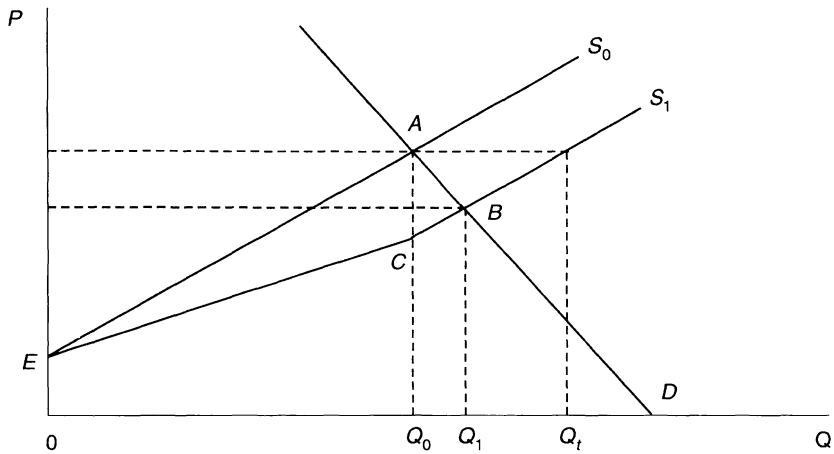

FIGURE 1 *Gross social benefits*

US$ 118.36 million for 1985 (Table 1). Owing to the inelasticity of demand, the reforestation programme benefited only consumers. Producers, in contrast, clearly did not benefit, and this could partially explain why the programme of fiscal incentives had to be used as a means of promoting reforestation.

TABLE 1 *Social benefit estimates for the Brazilian forestation and reforestation programme*

Year	Supply shifter (K)	$Z = K\varepsilon(\eta + \varepsilon)$	Total benefit US$ 1000	Consumer benefit US$ 1000	Producer benefit US$ 1000
1975	0.708	0.555	61 945	95 351	(33 406)
1980	0.854	0.670	75 281	115 550	(40 268)
1985	1.312	1.029	118 355	179 582	(61 226)

REFORESTATION IN THE AMAZON REGION

Despite much outcry about forest devastation in the Amazon Region, few studies have evaluated its socioeconomic impacts. Since the logging industry is largely controlled by a few large firms, a reforestation programme, based on fiscal incentives, would have a stronger impact in terms of landed property and wealth concentration than that observed in the states of Minas Gerais and São Paulo. Large firms could be expected to appropriate a large share of subsidies

because they could design reforestation projects and have them approved by government much more quickly than small firms. Despite this obvious danger of concentration of wealth in the hands of a few, the government went ahead and financed several enormous Amazon projects.

Reflecting on this adverse past experience, some specialists now propose so-called 'social' reforestation for the Amazon region. This initiative is expected to spread benefits to smaller firms including guarantees of production diversity to meet family needs. Furthermore, as an indirect effect, this initiative is supposed to maintain biodiversity and preserve the germ-plasm of local species. Social reforestation, if successful, might help to preserve large portions of the rain forest, given the predominance of small farms in the Amazon Region and considering that their shifting agriculture accounts for most of the deforestation. It is argued that social reforestation need not be based on financial incentives: government should instead promote the distribution of seedlings of selected endangered species, followed by an extension programme emphasizing environmental management.

As of 1988, the new Brazilian constitution requires logging firms to practise sustainable forest management. Firms oppose this requirement because of its high cost and because it requires large land areas. Given that the density of commercial species in native forests is low, logging firms would need large land areas in order to practise sustainable forest handling. Putting large land areas in the hands of the logging firms, however, would once again concentrate landed property.

CONCLUSIONS

In the 1970s and 1980s, a much greater area was deforested than was reforested in Brazil. From 1981 to 1988, the average annual cutting rate in the officially designated Amazon Region was 2.1 million hectares against an existing total reforested area of 5.9 million hectares (1984) for the entire country. That is, only three years of deforestation in the Amazon Region by far exceeded all the reforestation done in Brazil up to 1984. Reforestation in the Amazon Region is, in fact, an ignored practice.

Most of the reforested area in Brazil belongs to large firms and is used for own consumption. Nevertheless, only the Brazilian cellulose enterprises are totally self-sufficient in raw material from reforested areas. Even though Brazil has invested heavily in reforestation, approximately 70 per cent of all wood consumed (mostly charcoal) still came from native forests at the end of the 1980s.

The fiscal incentive programme was envisioned as the financial arm of the Brazilian reforestation policy. Indeed, rapid geographic expansion of reforestation, mainly for steel making and producing cellulose, has made an important national contribution. Log prices have also had an important effect upon the area reforested , owing to scarcity of native forest wood.

In terms of socioeconomic impact, the Brazilian reforestation programme has created few jobs. However, its impact on the inequality of landed property and wealth distributions has been very strong. The shift in wood supply as a

result of the reforestation programme benefited society as a whole, but only consumers appropriated the benefits. Producer loss was compensated by fiscal incentives.

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