

The Evolution of Reforestation in Brazil

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Abstract:

This paper analyzes the evolution of reforestation in Brazil and makes an evaluation of federal government policies used to stimulate that activity. Despite the huge increase of reforestation areas in Brazil since the 1970s, what put up Brazil as the sixth large country with reforested areas in 2000, a scarcity of roundwood from reforested area is happening in that country during the first decade of the 21st century. Federal government implemented three programs to foster reforestation in Brazil during the 1960s, 1970s and 1980s. However, nothing was implemented during the 1990s, when demand of roundwood increased, but not its production. Nowadays, Federal Government recognizes the need of stimulating again reforestation in Brazil. This paper analyzes those programs using a traditional cost-benefit approach. The results of that evaluation are used to suggest new federal government policies to foster the enlargement of reforestation in segments where price mechanism has not working well.

Key words: reforestation, forest policies, Brazil

1 – Introduction

Despite its huge natural forests and large planted forests, Brazil is suffering, during this decade, a scarcity of roundwood, especially a lack of roundwood from planted forests. Due to this situation, the study of new policies that are directed to increase the reforestation in Brazil (chiefly in segments where price mechanism has not worked well) becomes imminent. However, that sort of discussion cannot be driven before evaluating what has been done in the past.

In relation to that issue, the objective of this paper is to analyze the evolution of reforestation in Brazil and evaluate the role of federal policies established in order to stimulate that activity. In specific, three programs will be analyzed: the Program of Fiscal Incentives for Afforestation and Reforestation, the Program of Reforestation in Small and Medium Farms, and the Algaroba Project. These programs had significant impact on the planted forests in Brazil.

2 – The Brazilian Forest Issues

Despite its huge natural forests (527 million hectares in 2000, according to Cofu, 2001, p.34), Brazil's roundwood production from natural forests has fallen since 1991 (graph 1). In 1990, 225.61 million cubic meters of roundwood (under the forms of firewood, charcoal, or logs) were extracted from natural forests. In 2001, 81.18 million cubic meters had been extracted, with

64% of reduction in relation to the production reached in 1990. That reduction was the result of, on the one hand, enforcement of laws against unsustainable exploitation of natural forests and, on the other hand, the exhaustion of natural forests located next to consuming centers.

Insert graph 1 here

At the same time, the roundwood production from planted forests has been increasing. This expansion has gone through two phases: from 1974 to 1987 and from 1990 to 1996. According to the Brazilian Institute of Geography and Statistics (IBGE), that production had a significant reduction in 1988 and 1989, and it has been stagnated since 1998.

Keeping the attention on the time period from 1990 to 2001, an increasing substitution from native roundwood to planted roundwood¹ can be noticed. In 1990, the roundwood production from planted forests represented 26.8% of the total roundwood produced in Brazil. It rose to 58.5% in 2001.

The expansion of roundwood production from planted forests until middle 1990s is, in part, a consequence of the fiscal incentive policies adopted to foster the reforestation in Brazil from 1966 to 1988. Graph 2 shows a positive relationship between areas planted with fiscal incentives when they are seven year old² and the roundwood production from reforestation. For example, in the time period from 1974 to 1987 both variables raised, from 1988 to 1990 both variables decreased, and from 1991 to 1994 they started to grow again. The correlation coefficients between these two variables (roundwood production and annually planted forests at the age of their first clearcutting) were 0.848, 0.998, and 0.954, respectively, in these three time periods.

Insert graph 2 here

The problem was the reduction of annually planted surface in Brazil during the 1990s. It engendered impracticable the continuity of roundwood production expansion at the end of 1990s. Graph 3 shows the evolution of the annually planted forests in Brazil sponsored by the main roundwood producers (paper and pulp companies, pig iron makers, and small and medium farmers³). From 1993 to 1997, the average of annually planted forests was below the average obtained in previous years. The annual average area reforested from 1987 to 1992 was 197.7

thousand hectares, which decreased to 162.9 thousand hectares per year from 1993 to 1998. Beginning in 1999, the annually planted forest acreage is increasing, but that cannot avoid the current scarcity of roundwood.

Insert graph 3 here

In part due to the reduction of reforestation acreage during the 1990s, there was a decrease in the stock of planted forests as well as the planted tree inventory between 1985 and 1995 (table 1). In 1985 Brazil had 5.97 million hectares of planted forests, what decreased to 5.4 million in 1995. That reduction continued until the late of 1990s. Cofu (2001, p. 34) states the planted forests were 4.9 million hectares in 2000.

Insert table 1 here

Several authors, such as SBS (2000) and Bacha et al (2000), had predicted the scarcity of roundwood from planted forests. However, that scarcity was more visible after September 2002. From September 2002 to May 2003, roundwood prices rose from 63% to 130%, depending on the sort of roundwood and the place where it was sold⁴. For comparison, Brazilian inflation was 11.6% at the same period.

Advancing that problem, large roundwood consumers, such as pulp industries and pig iron makers, enlarged their annually planted acreage since 1999, notably since 2001. However, there are a lot of small consumers of roundwood (such as small sawmills, plywood makers, pottery mills, bakeries, for example) that do not have enough capital to plant forests. It is not sure, one on hand, that pig iron and pulp makers will establish planted forests in order to offer roundwood for these small consumers⁵; and, on the other hand, large planted forests are not placed necessarily near to small consumers of roundwood.

Due to the current roundwood scarcity in Brazil, which affects primarily small consumers of that raw input, it becomes necessary the discussion of policies to foster the enlargement of reforestation in that country. Currently, there are social and political demands for these policies, especially because neighboring countries (such as Argentina, Uruguay, Paraguay and Chile) have been granting these incentives (SBS, 2000). However, the discussion needs to take into account what was done in Brazil in the past.

3 – The phases of Brazil’s reforestation expansion

According to Antonangelo & Bacha (1998), the expansion of reforestation in Brazil had three phases⁶. The first corresponded to the period ranging from the discovery of Brazil to the beginning of fiscal incentives granted to reforestation or afforestation projects (it was the period from 1500 to 1965). The second phase happened when fiscal incentives were granted to the reforestation or afforestation projects, from 1966 to 1988. The third phase was initiated after the fiscal incentives granted to the reforestation/afforestation were finished and no other stimulus was granted (from 1989 to 2001). A fourth phase can be added. Beginning in 2002, Federal Government recognized the scarcity of roundwood in Brazil and it is trying to implement new policies to stimulate reforestation. The following four sections analyzes each phase above mentioned.

3.1 – The period before to the fiscal incentives granted to the reforestation/afforestation⁷

When Brazil was discovered, the destruction of its natural forests started; meantime, few reforestations took place until 1965. During that period, the nation watched this process with relative passivity. Everything that was implemented in terms of tree plantation and reconstitution of Brazil’s forest patrimony was always insignificant in relation to what was done in terms of deforestation.

Until the 1940s, there were mainly pioneering efforts in the introduction of homogeneous eucalyptus or pines plantations. A large part of these plantations had scientific or ornamental intentions. The main foresters were railroad and paper companies, as well as forest research institutes. They established large reforested areas.

3.1.1 – The reforestation in the 1950s and the 1960s

In 1950, Brazil had a significant inventory of planted forests (1,128,994 hectares). It was a result of scientific activities and the pioneering efforts of public agencies, such as the Forest Service of the State of São Paulo, as well as from state enterprises, such as the São Paulo’s Railroad Company. Moreover, there was a significant growth in the reforestation during the 1950s. Consequently, the reforested area inventory achieved 2,069,806 hectares in September 1st,

1960. However, such performance was reduced in the following decade. At the end of the year 1970, the inventory of planted forests had dropped down to 1,658,225 hectares.

3.2 - The period of fiscal incentives granted to the reforestation/afforestation

Due to fiscal incentives granted to reforestation, Brazilian forestry turned into a new phase. It was characterized by: a) an increase in the entrepreneurial activity concerning forestry; b) an enlargement of the number of skilled workers working in that activity; c) a great evolution of forest science; and, d) a large growth of Brazil's planted forests.

In the 1960s, when the forest sector began to be considered with more attention, the Brazilian Institute of Forest Development, IBDF, was created (it was founded in 1968, and became part of the Brazilian Institute of Environment and Natural Resources, IBAMA, in 1989). In that decade, the first Forest Engineering Colleges were created and were implemented fiscal facilities, which fostered reforestation projects on a wide scale (Antonangelo, 1996).

3.2.1 - Federal policies to stimulate the reforestation in Brazil

According to Bacha (1993), two basic mechanisms exist to stimulate reforestation: the first one is the increasing exploitation cost of natural forests, and the second one is the grants of monetary incentives to foster tree plantations, such as subsidized credit, fiscal incentives, and the donation of inputs. These incentives act by reducing the cost of homogeneous forest implantation.

From the 1960s to the 1980s, the Brazil's federal government accomplished three programs to encourage reforestation projects. From 1965 to 1988, the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) was carried out. In the second half of the 1970s, a new program to foster reforestation in small and medium farms (REPEMIR) was implemented. REPEMIR run until the first half of the 1980s. Finally, from 1985 to 1988, a program of reforestation with algarobeira in the Brazil's northeast arid climate region (the Algaroba Project) was executed.

These three programs resulted in the grants of monetary resources or inputs to agricultural producers, who could then carry out reforestation in Brazil. Clearly, subsidies were granted to the producers, but their mechanisms of donation were different.

The Program of Fiscal Incentives for Afforestation and Reforestation⁸

The Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) was a set of federal normative acts (that included laws, decree-laws, decrees and other norms), elaborated from 1965 to 1988, which instituted and regulated the fiscal incentives granted to that activity. That kind of fiscal incentive was foreseen previously in the Forest Code on September 15th 1965 (Law 4,771), but they were regulated only one year later (by Law 5,106 on September 2nd, 1966).

Fiscal incentives occur when an entrepreneur or person who is a taxpayer (named taxpayer-investor) destines a share of his income tax to invest in a specific project elaborated by another firm, called beneficiary firm⁹. In the PIFFR, the same person or group of persons could be both taxpayer-investor and beneficiary firm owner.

Fiscal incentives were granted to establish homogeneous tree plantation, but not necessarily woody tree plantation. There were many projects of reforestation that had gotten fiscal incentives to plant fruit trees (such as apple, mango, cashew, coconut, and others), palm-trees, *Prosopis juliflora* (“algarobeira”), and bamboo. Table 2 shows the total areas of homogeneous forests that should have been planted per year with fiscal incentives and the annual areas that should have been planted only with woody tree species (pines, eucalyptus, *Angustifolia brasiliense*, and other trees). There was a great difference between these two areas after 1973, which indicates that policy changed in order to stimulate the implantation of trees that were not woody species.

Insert table 2 here

Despite the fiscal incentives for reforestation had been granted up to 1988, no new areas for planting were approved in 1987 and 1988. In these years, there were only payments for previously approved projects of reforestation.

There is no agreement about how many fiscal incentives were granted to reforestation projects. Table 2 shows two annual series concerning these values. According to the Brazil’s Northeast Bank (BNB), in the time period from 1968 to 1988, US\$ 10.86 billion (December 1998 dollars¹⁰) had been granted as fiscal incentives for reforestation projects. That amount of money should result in 6,217,723 hectares of tree plantation in the period from 1968 to 1986 (table 2). However, some frauds and badly managed plantations had occurred, so that amount of area was

not totally materialized. Notwithstanding, a significant part of the real expansion in the reforestation areas in Brazil during that period was due to the fiscal incentives.

The Program of Reforestation in Small and Medium Farms (REPEMIR)

The first oil shock in 1973 motivated the Brazilian federal government to create mechanisms that saved inputs elaborated from petroleum. Beginning in 1974, the previous Brazilian Institute of Forest Development (IBDF) searched to implant a program to stimulate the reforestation in small and medium farms. The IBDF's objective was to provide these farmers with a source of roundwood, which could be used on their farms or be sold in the form of firewood as well as charcoal. The last two alternatives could substitute the energy originated from petroleum. The first IBDF's intention was to create a program based on subsidized loans. However, that institute faced restrictions of resources to put in action that intention until the end of 1976. In the previous two years, only demonstration projects were established in the Santa Catarina and Minas Gerais states (IBDF, 1980, p. 2-3).

From 1974 to 1976, the Mines and Energy Ministry had been stimulating some economic activities to substitute the combustible oil or another derivative of petroleum, as source of energy, from the use of firewood or charcoal. However, both public agents (the Mines and Energy Ministry and IBDF) had been working independently until 1976.

On December 30th 1976, the Inter-ministerial Act number 934 permitted ceramics, pottery factories, bakeries and other industries to be free of the obligation to plant the equivalent of roundwood that they consume¹¹. Rewarding that exemption, the National Council of Petroleum (CNP) granted resources to the Brazilian Institute of Forest Development (IBDF). That amount of money would be used to foster the reforestation on small and medium farms.

Using the monetary resources from the National Council of Petroleum, the IBDF instituted the Program of Reforestation in Small and Medium Farms (REPEMIR). The objective of that program was, according to IBDF (1980, p. 5):

"... to magnify the supply of firewood and charcoal as well as to offer to small and medium farmers timber to agricultural buildings, which would have positive impacts in the agricultural economy and environment. "

In order to start the REPEMIR, the Brazilian Institute of Forest Development (IBDF) established agreements with the state departments of agriculture. These departments elaborated reforestation projects and received monetary resources from IBDF in order to execute them.

Different schemes of incentive donation occurred in REPEMIR, because each state department of agriculture was authorized to elaborate distinct mechanisms to stimulate reforestation. The two basic models were: free grants of seedlings, agricultural inputs, and technical assistance; or the supply of loans at subsidized interest rates.

The first version of REPEMIR (based on the free donation of seedlings, agricultural inputs, and technical assistance) was executed, for example, in the State of Paraná. The IBDF established an agreement with the Paraná's Department of Agriculture, in the period from August 1980 to July 1981, with the purpose to plant 2,500 hectares of forests inside farms with total surface ranging from 2 to 100 hectares. The minimum requirement for planting should be 1 hectare per farm and 3 hectares per farm were the maximum-planted areas permitted. In that program US\$ 84.46 was spent¹² per hectare, which covered the expenses of donation of seedlings, insecticide and technical assistance (IBDF-SEAG, 1980).

In the State of São Paulo, two agreements were established between the Brazilian Institute of Forest Development and the São Paulo's Department of Agriculture with the purpose to foster the reforestation in small and medium farms. These agreements had been signed on June 1st 1978 and July 6th 1982, respectively. The scheme adopted in the state of São Paulo was to grant loans to farmers whose farms' total area did not exceed 300 hectares, and for planting at most 20 hectares per farm (since that amount has been equal or less than 20% of the total surface). These loans financed 100% of the project budget (adding 1% of the value of the loan for supporting the expenditures with the project elaboration and technical assistance). The interest rate was 18% per year, without indexation, and the farmers had eight-year deferment (Bergamasco & Bergamasco, 1988; and Yamazoe *et al.*, 1988). In order to evaluate that loan conditions, it can be stated that in the time period from 1978 to 1982 the annual average inflation rate was 85%. Therefore, it was a subsidized loan, with negative real interest rate.

The REPEMIR was implemented in the state of São Paulo from 1978 to 1983, having been benefited 565 farmers and 5,831 hectares were reforested (Yamazoe¹³ *et al.*, 1988, p. 4-5). According to Bergamasco & Bergamasco (1988) some unexpected incidents happened in that program, such as the fact of some farms with more than 300 hectares had used resources from

REPEMIR, and some cases of bad management of reforestation projects. The last were mainly observed in low profitable projects and in projects where seedlings died and were not replaced.

Unfortunately, there is little information about the monetary resources used in the REPEMIR as well as concerning its results. During the Fourth Brazilian Forest Congress (that occurred on May 10-15, 1982), the president of the extinct Brazilian Institute of Forest Development, Mauro Silva Reis, made the following statement (Reis, 1982, p.15-16):

"The REPEMIR reaches the great part of the Brazilian states, having already been applied, until that time, resources that amount Cr\$ 400 million. They are sufficient for planting almost 80 thousand hectares of forests and for the production of 130 million of fast-growing tree seedlings. These resources are granted to the state departments of agriculture, which, in turn, foster small and medium farmers to plant forests. In the state of Minas Gerais, that program has had a great performance. In that state, five agreements were established between the State Forest Institute (IEF) and the Brazilian Institute of Forest Development (IBDF). They sum approximately Cr\$ 100 million, which is sufficient to plant 18 thousand hectares of forests, and to produce 35 million of seedlings."

From the above statement and considering the average Exchange rate in Brazil from 1978 to 1982 (it was Cr\$ 74.01 per US\$ 1.00), it can be concluded that the average cost of the tree planting in REPEMIR was US\$ 67.56 per hectare, considering the period from 1978 to 1982, in the whole Brazil. In the state of Minas Gerais that cost was US\$ 75.06 per hectare from 1978 to 1982. According to what was seen before, that cost was US\$ 84.46 per hectare in the State of Paraná in the time period from August 1980 to July 1981.

In relation to the total reforested area achieved by REPEMIR, there is the following affirmation in IPEA/COMIF (1986, p. 91):

"... In relation to the reforestation in small and medium farms, the resources granted by the National Council of Petroleum, from 1978 to 1982, were sufficient for implanting from 80 to 100 thousand hectares of forests. It represented only 1.8% of the total area planted with fiscal incentives."

From that statement, it can be concluded that the REPEMIR was little important, in relation to the Program of Fiscal Incentives for Afforestation and Reforestation, in generating the great expansion of the planted forests in Brazil during the 1970s and the 1980s (as showed in table 1).

The Algaroba Project

There are trees that flourish in Brazil's northeast arid climate region as well as breed quickly and supply wood and food to both cattle and human consumption. One of these trees belongs to the *Prosopis*' genus. *Prosopis juliflora* (SW) DC, known generically as algarobeira, is the most prospect specie that grows in Brazil's Northeast region. According to Lima (1985, p.30) the algarobeira:

"Grows in sandy ground, in regions where rain precipitation varies from 150 to 600 mm annually. Its roundwood is used to produce pegs, farm post, firewood, and charcoal. Its broad bean, with high protein concentration, is an excellent source of food for both cattle and human consumption. "

Given the advantages of the algarobeira, and the advances of technology for processing its wood and beans, the Brazilian federal government decided to stimulate its implantation through the Program of Fiscal Incentives for Afforestation and Reforestation. According to Reis (1985, p.34), that program authorized the planting of 93,252 hectares with algarobeira from 1979 to 1984. It represented 11.9% of the total tree plantations approved by IBDF, using fiscal incentives, in the Brazil's Northeast region in that period.

Besides the grants of fiscal incentives for planting algarobeira in Brazil's Northeast region, there was another program that was elaborated by the federal government to foster the planting of that tree in the same region. It was the Algaroba Project.

The motivation for establishing that project was the severe drought that occurred from 1979 to 1983 in Brazil's Northeast region, and the good performance of the algarobeira in that region. The Algaroba Project lasted from 1985 to 1988 and was consisted of the production and free distribution of *Prosopis juliflora* seedlings, grants of free technical assistance, and financial support to the farmers placed in SUDENE's jurisdiction (all Brazil's Northeast region plus the Northern part of Minas Gerais state).

Resources from FINSOCIAL and BNDES supported the Algaroba Project, and it was coordinated by the National Department of Agricultural Production (SNAP), a member of the Ministry of Agriculture, with the participation of the Departments of Agriculture from Brazil's Northeast States. According to Silva (1989, p. 23), the Algaroba Project benefited 8.3 thousand small agricultural producers, implanting 18.8 thousand hectares of forests in 540 cities of

SUDENE's jurisdiction. Unfortunately, there is not any information about the monetary resources used in that project.

The acreage reforested by the Algaroba Project was small in relation to the one carried through the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) in the Brazil's Northeast States. Just in 1985 and 1986, PIFFR granted resources for reforesting 260,603 hectares in those states¹⁴.

3.3 – Time Period from 1989 to 2001

From 1989 to 2001, the Federal Government do not conducted any program to stimulate the reforestation. The end of federal stimulus, especially the end of fiscal incentives, to plant trees at Brazil was first seen as the end of reforestation expansion. But this prediction did not show true. From 1987 to 1992, when no fiscal incentive was granted to new reforestation projects, annually average of reforested area (197.7 thousand hectares) was near the one reached from 1983 to 1986, 204.4 thousand hectares. During this latter period, fiscal incentives were granted. It proves that farmers and enterprises could support reforestation expansion in Brazil without fiscal incentives. But not as much as it would be necessary in order to avoid roundwood scarcity in Brazil (as it was commented at the first section).

Partially compensating the lack of federal stimulus to reforestations, some states governments, mainly the states of Minas Gerais, São Paulo and Paraná and also large consumers of forest raw inputs (such as pulp industry and pig iron makers) have elaborated some programs to foster small and medium farmers to reforest fallow areas of their farms. These programs grant seedlings and, in some cases, agricultural inputs and technical assistance are also given freely.

Private and state fomentation programs are very important in terms of reforestation expansion. From 1991 to 2001, these programs were responsible for 33 thousand hectares reforested annually, which represented 19% of the total surface reforested annually in Brazil at the same period. According to BACHA *et al.* (2000), these programs allowed farmers to yield high profits in reforestation projects, especially when these programs offer arrangements to farmers not only to make clearcuttings, but also to sell the roundwood. It is the case of the Forest Farmer Program in the state of Minas Gerais. Into this Program, small farmers can reach 30% as internal rate of return in their reforestations. However, the actual dimensions of those private and state programs cannot solve the scarcity of roundwood in Brazil in next few years.

3.4 – Time period beginning in 2002

In July 2002, Federal Government recognized the threat of roundwood scarcity at Brazil and initiates two programs of rural credit to stimulate reforestation: one direct to small farmers and other to medium and large farmers. Both programs are based on grants of low interest rate loans to plant trees. However, preliminary results suggest they are not reaching their goals.

PRONAF-Florestal is a subsidized loan-based program¹⁵ what attends small farmers and grants loans sufficient to plant from 2.5 to 4 hectares per farm. From July 2002 to June 2003 was allocated resources sufficient to plant around 4 thousand hectares. However, until April 2003, no loan was release. This program will be hold next agricultural year, i.e., from July 2003 to June 2004, when resources will be enough to plant from 13 to 15 thousand hectares. Someone can observe that amounts of potential reforested areas are below the amount reached by private and state programs (as it was demonstrated at item 3.5).

PROPFLOR (Programa de Plantio Comercial de Florestas) was also created in July 2002, and it is driven to medium and large farmers. It grants low-rate loans to farmers to plant up to 100 hectares. There is resource to finance 40 thousand hectares from July 2002 to June 2003, but it will not be done¹⁶. The conditions of these loans are more appropriate for large forest firms (such as pulp enterprises, wood-based panels producers and pig iron makers), but they are not qualified for these loans.

It is important to notice that these programs are the same used to stimulate crop expansion in Brazil, what have different biological features of tree planting. Moreover, these programs were launched without a precise evaluation about the faults of previous programs conducted by Federal Government and other alternatives to stimulate reforestation. That evaluation is conducted in the following section.

4 - Social evaluation of the federal policies implemented to stimulate the reforestation

It was observed above that fiscal incentive policy had a positive impact on the expansion of reforestation in Brazil. However, it is necessary to make a social evaluation of that program. In order to fulfill that task, first the implantation costs per hectare between REPEMIR and PIFFR are compared. After that, the equitable and distributive effects of the PIFFR are analyzed.

4.1 - Comparing the implantation costs of 1 hectare between the PIFFR and REPEMIR

Several information exist about the resources used by the Program of Fiscal Incentives for Afforestation and Reforestation, but otherwise there is little information concerning monetary resources allocated to REPEMIR, and no information about Algaroba Project. Table 3 shows the values granted to each hectare in the first two programs, for Brazil and for two specific states.

Insert table 3 here

The data on Table 3 show that the costs per hectare reforested through the Program of Fiscal Incentives for Afforestation and Reforestation were from 10 to 15 times larger than the costs faced by REPEMIR. It occurred because REPEMIR subsidized fewer items and for shorter duration than PIFFR did. Berger (1979) showed that the Federal Government was granting during the 1970s more fiscal incentives per hectare of planted forests than what would be necessary. The reason for that, probably, were the influences performed by specific social groups¹⁷ that took advantages of fiscal incentives (Soto B., 1992).

4.2 – The evaluation of the equitable and distributive effects in the PIFFR

Fiscal incentives are a form of indirect subsidy that allows the reduction of implantation costs of investment projects. Consequently, a reduction in the production costs of goods and services will happen. However, fiscal incentives cause three negative effects: *i*) they diminish the progressive tax rates in the national tariff system, *ii*) they treat in different forms economic agents with the same income, and *iii*) economic agents who are not taxpayers cannot use that subsidy.

These negative effects occur with any program of fiscal incentives. Below, some aspects of equity loss that happened in the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) are analyzed. That program, besides contemplating only the economic

agents who were income taxpayers (excluding, thus, the great majority of farmers), established, several times, minimum sizes for tree plantation that were so large in relation to the average surface of Brazil's farms. As an example, the Decree 79,046 (on December 27th, 1976) defined that the private projects¹⁸ would have 1,000 hectares as a minimum area of tree plantation, except for the private project with fruit trees. Later, that minimum size of projects was reduced.

In relation to the effectiveness aspects, the productive results gotten with the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) must be analyzed, and they must also be compared with their costs. From 1968 to 1988, US\$ 10.86 billion (December 1998 dollars) were granted in the form of fiscal incentives for reforestation projects (last column of table 2). In part, due to these subsidies, a great growth in the reforested area inventory in Brazil occurred. That increased from 1.66 million hectares in 1970 to 5.97 million hectares in 1985 (table 1).

However, several projects received fiscal incentives but they did not plant trees. The "Report about the situation of the projects authorized by law 5,106" concluded that only 72.2% of all reforestation projects approved under the support of that normative act (which had been in force from September 2nd, 1966 to December 31st, 1976) had been implanted. It corresponded to 74.3% of the area that should be reforested. Considering only the projects implanted, the same report concluded their forestry situations were not good.

Some projects established tree plantation in areas far away from consuming centers; consequently, these reforestation projects became useless. An article from EXAME (1980, p. 32) affirmed there was 300 thousand hectares of reforested area located in the state of Mato Grosso do Sul and another 400 thousand hectares in the state of Minas Gerais without specific economic purpose in 1980. The Brazil's Federal Accounting Court elaborated another evaluation about the economic destination of reforestation areas in March 1985 (PRADO, 1990, p. 10-11). That court concluded that 50% of the reforestation areas stimulated by PIFFR, around the whole country, were older than the optimum age to be clearcut. Besides, these clearcuttings were unprofitable. These situations occurred because there is not a consuming market or because the costs of roundwood transportation from these projects to the consuming markets were so large, due to the long distances between both.

4.2.1 – Cost/benefit analysis of the Program of Fiscal Incentives for Afforestation and Reforestation

In competitive markets, as the case of the majority of *in nature* forest products, the equilibrium price is established by the crossing of the supply and demand curves (case of Figure 1). In other words, the equilibrium price is the one that equals the wishes of consumers and producers.

Insert figure 1 here

In the case of Figure 1, the consumers are paying P_0 per unit of product consumed. However, examining its demand curve (D_0D_0), it can be observed that consumers would be willing to pay a unitary price above P_0 for quantity less than Q_0 . That difference, equivalent to the area BEP_0B , is called consumer surplus, and it represents the difference between what consumers effectively pay (equal to the area $P_0EQ_0OP_0$) and the maximum that they would be willing to pay (equal to the area BEQ_0OB).

Again in Figure 1, it can be observed that producers are receiving P_0 per unit of product to offer Q_0 . However, for smaller amounts, producers would accept a smaller unitary price than P_0 . Then, producers are receiving the revenue equivalent to the area $P_0EQ_0OP_0$, but the area AEQ_0OA is sufficient for them to offer Q_0 . The difference between what they receive and what would be enough is the area P_0EAP_0 (which is the producer surplus).

Adding both economic surpluses (consumer and producer surpluses) the total economic surplus (equal the area $BEAB$ in Figure 1) is obtained.

The fiscal incentives have the effect of reducing the production cost, shifting the supply curve to the right. When this occurs, an increase in the total economic surplus appears. That increase can be understood as a social benefit from the policy that shifts the supply curve to the right. The dimensions of the social benefit can be different according to the type of shift in the supply curve (if parallel or pivotal).

In Figure 2, the pivotal shift of the supply curve is showed, i.e., the supply curve was shifted to the right, but keeping constant its intercept with vertical axis. The enlargement of the total economic surplus is given by area $EABCE$.

Insert figure 2 here

In Figure 3, the parallel shift of the supply curve of roundwood from reforestation is showed. The enlargement of the total economic surplus is given by area EABCFE.

Insert figure 3 here

The increase of the economic surplus is a measure of the total social benefit that came from fiscal incentives granted to stimulate reforestation.

To measure the Total Social Benefit (TSB), the following equations can be used (according to LINDNER & JARRET, 1978; and, ROSE, 1980):

$$TSB = 0.5 K P_0 Q_0 (1+Z\epsilon^d) \quad (1) \quad \text{for the pivotal shift of the supply curve}$$

or

$$TSB = 0.5 K P_0 Q_0 (2+Z\epsilon^d) \quad (2) \quad \text{for the parallel shift of the supply curve}$$

Where:

P_0 and Q_0 are the price and quantity of equilibrium for roundwood from reforestation, respectively, before the grants of fiscal incentives.

ϵ^d = price-elasticity of the demand for roundwood from reforestation (in absolute value);

ϵ^s = price-elasticity of the supply for roundwood from reforestation;

K = is the size of supply curve shift (see figures 2 and 3) and it is measured by the proportional reduction of costs. Its equation is:

$$K = \frac{\overline{AC}}{P_0} \quad (3)$$

According to ROSE (1980), Z is calculated by the following equation:

$$Z = \frac{K \cdot \epsilon^s}{(\epsilon^s + \epsilon^d)} \quad (4)$$

Taking the point (Q_{2t}^s , P_0) in Figure 2, the price-elasticity in the supply curve (ϵ^s) can be calculated using:

$$\varepsilon^s = \frac{\left(\frac{Q_{2t}^s - Q_0}{Q_{2t}^s} \right)}{\left(\frac{AC}{P_0} \right)} \quad \therefore \quad \varepsilon^s = \frac{\left(1 - \frac{Q_0}{Q_{2t}^s} \right)}{K} \quad \therefore \quad K = \frac{\left(1 - \frac{Q_0}{Q_{2t}^s} \right)}{\varepsilon^s} \quad (5)$$

Equation (5) shows that K can be measured by the proportional change in the production divided by the price-elasticity of supply (ε^s). Therefore, in order to calculate K it is necessary to have an estimate of the supplied product before and after the grant of fiscal incentive and keeping the price in P_0 .

To calculate the price-elasticity of the demand and supply for roundwood from reforestation (ε^d and ε^s , respectively), the following model is suggested¹⁹:

$$L QMP_t^D = a_0 + a_1 \cdot L PMP_t + a_2 \cdot L PMN_t + a_3 \cdot L R_t \quad (6) \text{ Demand equation}$$

$$L QMP_t^S = b_0 + b_1 \cdot L PMP_t + b_2 \cdot L IF_{t-5} + b_3 \cdot L QMP_{t-1}^S \quad (7) \text{ Supply equation}$$

Where:

QMP_t^D = quantity demanded of roundwood from reforestation at the time t.

QMP_t^S = quantity offered of roundwood from reforestation at the time t.

QMP_{t-1}^S = quantity offered of roundwood from reforestation at the time t-1.

PMP_t = price of one unit of roundwood from reforestation at the time t.

PMN_t = price of one unit of roundwood from natural forest at the time t.

R_t = Gross Domestic Product at the time t.

IF_{t-5} = the amount of fiscal incentives granted to the reforestation at the time t-5.

Equation (6) is a traditional demand equation. The determinants of quantity demanded of roundwood are its price, the price of substitute goods, and the income of consumers. Otherwise, in equation (7) the determinants of quantity offered of roundwood are its price, the fiscal incentives granted in the past to foster the reforestation, and the previous production of

roundwood. This last variable represents the effect of productive capacity of planted forests on the current production.

L indicates that the variable has its value taken in logarithm. So, the price-elasticity can be obtained directly from the equations (6) and (7), respectively.

The signs expected for the coefficients of equation (6) and (7) are: $a_1 < 0$, $a_2 > 0$, $a_3 > 0$, $b_1 > 0$, $b_2 > 0$ e $b_3 > 0$. It is known that $\varepsilon^d = |a_1|$ and $\varepsilon^s = b_1$.

The two-stage least square method was used to estimate the demand and supply equation of roundwood from reforestation [equation (6) and (7)]. The RATS was the program used.

Firewood quantities and prices have been used as *proxy* for quantity and price of roundwood from reforestation, respectively. These information and others that are necessary to estimate equations (6) and (7) are on table 4. Data set is for the period²⁰ from 1971 to 1990. During that period, the effect of fiscal incentives on the roundwood production happened. If a more recent data set is used, the values of ε^d e ε^s would be different.

Insert table 4 here

The estimates obtained are (the numbers in parentheses below the coefficient are the t-Student statistic):

$$L QMP_t^D = -15.16694 \quad -3.107283 \cdot L PMP_t \quad + 2.914099 \cdot L PMN_t \quad + 4.263626 \cdot L R_t \quad (8)$$

(-2.8372)* (-1.0388)**** (1.1845)**** (6.4621)*

R-squared = 0.7106 number of observations = 20 Q(10) = 6.9962^{ns}

$$L QMP_t^S = 2.806303 \quad + 1.798338 \cdot L PMP_t \quad + 0.003404434 \cdot IF_{t-5} \quad + 0.00003379 \cdot QMP_{t-1}^S \quad (9)$$

(1.1499)**** (1.9365)** (2.785)* (1.7081)***

R-squared = 0,7482 number of observations = 20 Q(10) = 13.346^{ns}

Where: the subscript * indicates the coefficient is significant at 1% level; **, significant at 5%; ***, significant at 10% level; ****, significant at 25% level; n/s, not significant; s/a, without residual auto-correlation;

According to equations (8) and (9), $\varepsilon^d = 3.107283$ and $\varepsilon^s = 1.798338$.

The value of K is calculated per year, and a different value of Q_{2t}^S for each year is obtained. Considering 1971 as being the period zero, the following equation is used to calculate Q_{2t}^S per year:

$$L QMP_t^S = 2.806303 + 1.798338 \cdot L(9.61) + 0.003404434 \cdot IF_{t-5} + 0.00003379 \cdot QMP_{t-1}^S \quad (10)$$

or

$$L QMP_t^S = 6.8755898 + 0.003404434 \cdot IF_{t-5} + 0.00003379 \cdot QMP_{t-1}^S \quad (11)$$

In equation (10), 9.61 is the price per unit of roundwood at the time zero (it is P_0). So, using the equation (11) it is possible to measure the shift of supply curve of roundwood due to fiscal incentives.

Using the different annual values of Q_{2t}^S , obtained from the equation (11), and the annual data of the P_t and IF_{t-5} (according to Table 4), the annual values of K are calculated (these values are put on Table 5). The latter are used together the values of price-elasticity of demand (ϵ^d) and supply (ϵ^s) in order to calculate the values of Z (also put on Table 5).

Insert table 5 here

Finally, using the annual values from 1972 to 1990 of K and Z , and also using ϵ^d , P_0 and Q_0 , the annual values of the total social benefit generated by fiscal incentives are calculated. Two different estimates are obtained: considering a pivotal shift of the supply curve, and a parallel shift of that curve (these values are on Table 5).

According to the values from Table 5, it can be observed that the values of social benefit each year were generally less than the value of social cost. For the entire period from 1972 to 1990 the social benefits²¹, considering the pivotal shift, were US\$ 15.49 million and according to the parallel shift, those benefits were US\$ 25.97 million (December 1998 dollars). However the social costs of the fiscal incentives²² amounted to US\$ 9.77 billion (December 1998 dollars).

From the above information, it can be concluded²³, first, the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) had, in the best situation, US\$ 389.69 as social cost per US\$ 1.00 as social benefit (December 1998 dollars). Second, significant part of monetary resources granted by PIFFR was invested in other activities not attached to the reforestation.

Third, the number of firms and farmers awarded with fiscal incentives was limited due to the minimum area size established to approve the reforestation projects.

4.2.2 – The Distribution of resources among the beneficiary firms

As already commented, just the income taxpayers had been able to apply for deduction and application of fiscal incentives. Due to it, the majority of the farmers (who do not pay income tax in Brazil) had not been able to assume the position of the taxpayer-investor. Moreover, the available information suggests that the most part of beneficiary firms was not also agricultural producers.

According to IPEA/COMIF(1986, p. 94-96), from 1971 to 1982 roughly 53% of the total reforested area stimulated by fiscal incentives had belonged by only 99 beneficiary firms. Among these firms, about 40% were subsidized enterprises of other companies operating in sectors as pig iron, paper and pulp, lumber and wood-based panels, and production of energy. Among these 99 beneficiary firms there is a concentration in relation to fiscal incentives received. The 10 largest companies of reforestation, among the 99 large beneficiary firms, had been responsible for 24.5% of the total reforested area established by those beneficiary firms.

Thus, it can be concluded that the fiscal incentives granted to the reforestation had benefited, in a larger ratio, large firms, which in many times were subsidiaries of other companies operating in activities where the forest raw material is used as an input in the process of production. Consequently, wealth concentration happened among companies located in Brazil, because part of them could invest share of their income tax as capital investment in their subsidiary firms.

5 – Conclusions

The reduction of the annual average area of homogeneous reforestation from 1993 to 1997 resulted in a scarcity of roundwood production from planted forests in Brazil during the first decade of the 21st century. That situation put in a high position the discussion about new policies to foster the enlargement of reforestation in Brazil.

The fiscal incentives to the reforestation had a positive effect on the homogeneous reforestation expansion from 1966 to 1986, but its social costs were very large in relation to its social benefits. The ample grants of fiscal incentives resulted in a bad use of them. Low interest

rate loans to stimulate reforestation were tried in the past and they are tried nowadays. Alike as it happened in the past, the results of these loans are small in terms of reforested areas. Otherwise, federal and state experiences in the promotion of reforestation in small and medium farms since the 1990s have been showed an alternative with low costs per reforested hectare. However, the dimensions of these programs are not sufficient to solve the scarcity of roundwood in Brazil in the next few years.

Fomentation programs consisted of the donation of seedlings and, some times, agricultural inputs and technical assistance are offered freely. The case of the Forest Farmer Program in the state of Minas Gerais showed that kind of reforestation program has allowed the farmers to make larger profit when the industrial firm gives the adequate support to the farmers during the clearcutting of forest, and in the commercialization of the roundwood. In addition, the reforestation in small and medium farmers does not result in land ownership concentration like the large reforestation does.

Basing on the above showed, new policies centered in the promotion of reforestation in small and medium farms can be suggested to solve the roundwood scarcity in Brazil. The free donation of seedlings, agricultural inputs (as insecticides) and technical assistance has low cost per reforested hectare and also presents larger social return than the use of fiscal incentive. However, these programs need to be followed by some mechanisms that give to farmers an adequate support during the clearcutting of forests, and in the commercialization of the wood to be produced.

It can appear at the first glimpse an out-of date proposal to give new stimulus to plant forests in Brazil. However, this impression is not true. First, the price mechanism is not solving the current scarcity of roundwood. Second, the government would work together to consumers of roundwood in order to make farmers more sensible to the signals of market. Third, there is social demand for new reforestation policies, especially because they exist in other South American countries. Forth, increasing the offer of roundwood, new industrial activities would be held, and social benefits such as the enlargement of income and job will happen.

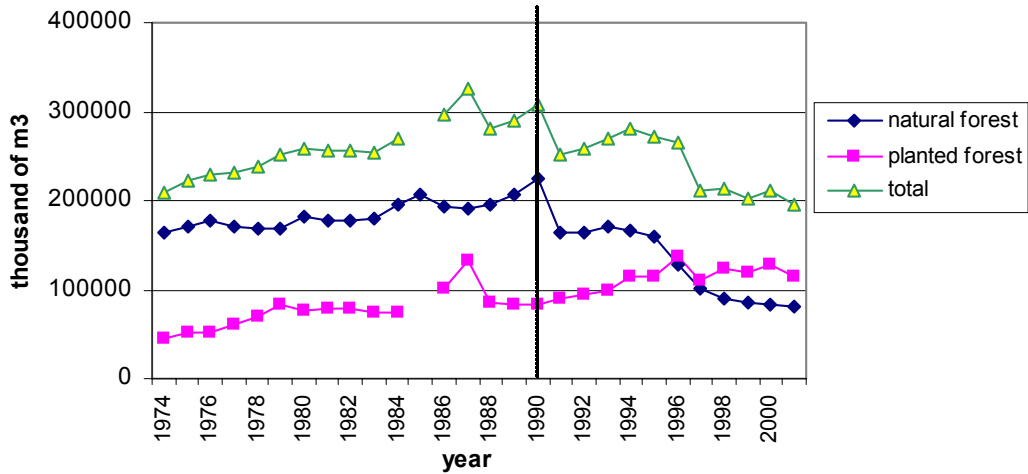
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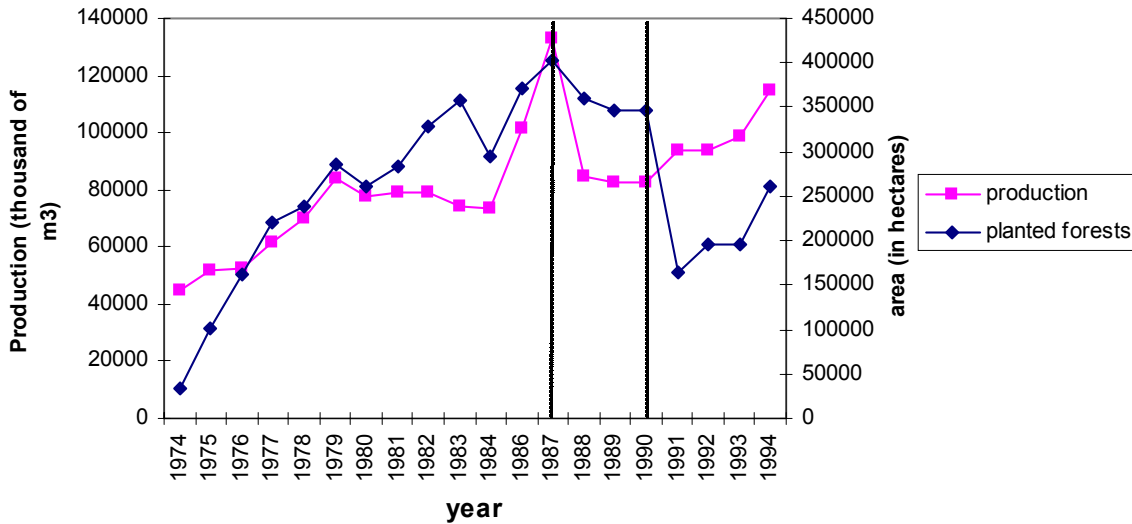
Graph 1 - Brazilian production of roundwood - from 1974 to 2001



Source: Statistical Yearbook of Brazil and IBGE homepage

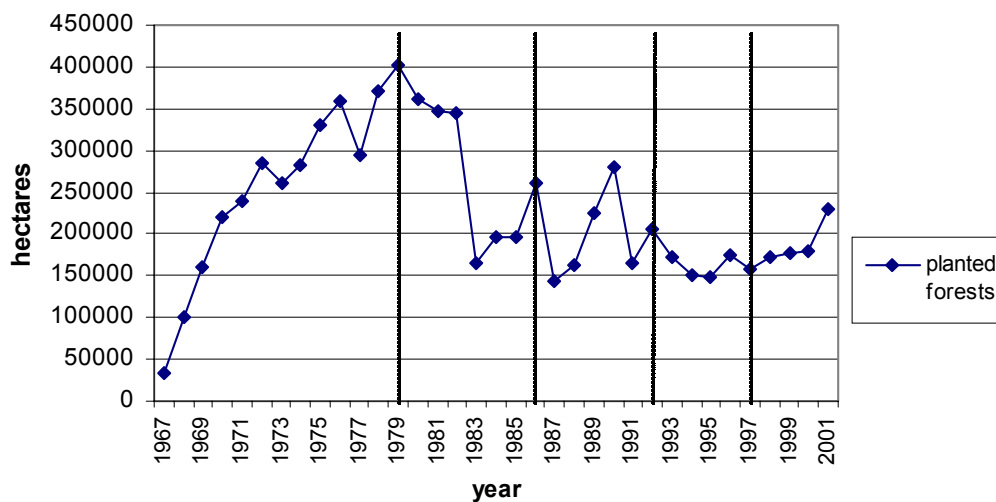
Note: roundwood is the total equivalent of firewood, charcoal and logs

Graph 2 - production of roundwood and planted forests (7 years old before its first clearcutting) - Brazil



Source: data set from IBDF and IBGE.

Graph 3 - Minimum annual planted forests with wooden trees in Brazil - from 1967 to 2001



Source: updating of dataset showed by Bacha *et al.* (2000).

Table 1 – inventories of planted forests and number of growing trees in Brazil (stock variables)

	12/31/70	12/31/75	12/31/80	12/31/85	12/31/95*
Planted forests in hectares	1,658,225	2,864,298	5,015,713	5,966,012	5,396,016
Number of reforested trees (thousand)	2,585,984	5,371,340	9,227,460	9,690,493	7,065,381

Source: Agricultural Census of Brazil

Note: * that area was computed in 12/31/95 and the number of trees was computed in 07/31/96. The number of trees includes all planted species and the data was collected from the CD-ROM of Agricultural Census. That value is larger than the similar one that exists in printed edition of the same Census. This is because the printed edition of Agricultural Census did not compute all planted species of trees.

Table 2 – Monetary resources and area that should be reforested with fiscal incentives in Brazil

Year	Total area (hectares)	Area with wooden species (hectares)	Amount of fiscal incentives (million of December 1988 dollars) according to IBDF	Amount of fiscal incentives (million of December 1988 dollars) according to BNB
1967	34,760	34,587	65.70	
1968	102,910	100,178	276.47	19.28
1969	162,383	160,985	172.07	67.11
1970	222,005	220,002	447.84	128.22
1971	248,478	239,029	506.08	308.46
1972	304,357	284,704	551.17	345.08
1973	294,153	261,677	560.17	423.79
1974	324,379	282,915	415.69	522.87
1975	398,240	329,449	436.70	473.63
1976	449,249	358,685	617.16	831.99
1977	346,432	295,238	724.05	995.33
1978	411,737	370,732	894.55	1,193.96
1979	473,718	401,924	820.95	1,434.32
1980	435,575	360,400	686.96	818.17
1981	417,875	347,185	713.03	711.54
1982	430,985	345,655	675.06	673.97
1983	215,000	164,830	490.15	499.04
1984	286,200	195,610	378.61	365.59
1985	285,032	196,654	337.20	338.77
1986	409,015	260,540		427.49
1987				248.17
1988				31.64

Source: BACHA (1993 and 1995).

Table 3 – Amount of money granted to stimulate the reforestation of 1 hectare in the Program of Fiscal Incentives for Afforestation and Reforestation (PIFFR) and in the Program of Reforestation in Small and Medium Farms – Brazil and two specific states

Region	Period	PIFFR (US\$ nominal per hectare)*	REPEMIR (US\$ nominal per hectare)**
Brazil	1978 to 1982	659.06	67.56
State of Minas Gerais	1978 to 1982		75.06
State of Paraná	1980 to 1981	1,266.45	84.46

SOURCE: (*) files of IBDF.

(**) These values were commented in the paper.

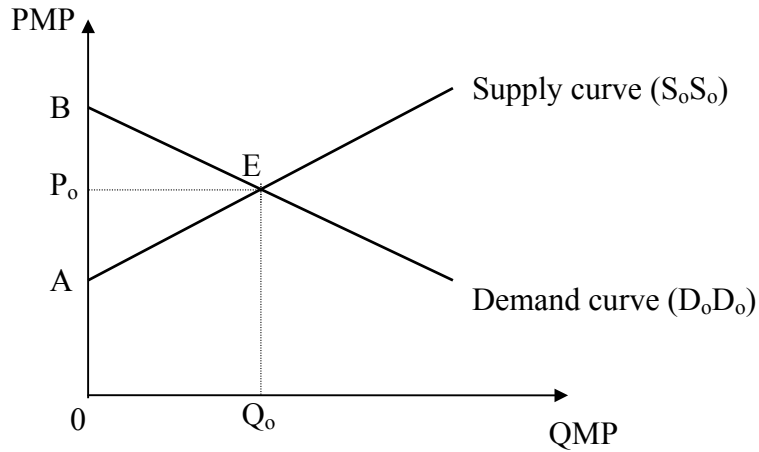


Figure 1 – Equilibrium in roundwood market
 where: PMP is the price of stereo of roundwood from planted forest e QMP
 is the quantity of roundwood from planted forest

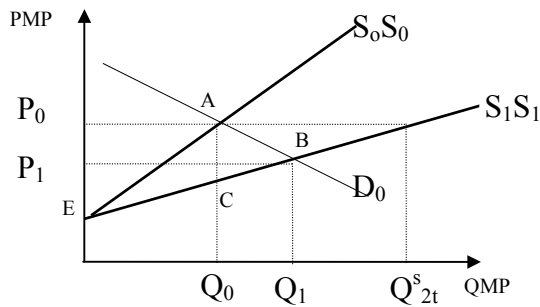


Figure 2 – Pivotal shift of the supply curve
 Where: S_0S_0 is the supply curve before the grant of fiscal incentives
 S_1S_1 is the supply curve after the grant of fiscal incentives

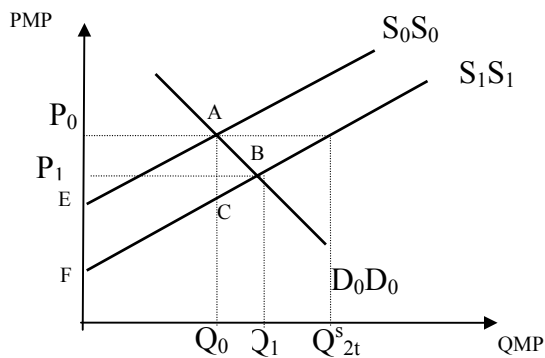


Figure 3 – Parallel shift of the supply curve
 Where: S_0S_0 is the supply curve before the grant of fiscal incentives
 S_1S_1 is the supply curve after the grant of fiscal incentives

Table 4 – Data set used to estimate demand and supply equations of roundwood from reforestation

Year	QMP _t (in thousand of cubic meters)	PMP _t (in December 1998 dollars per m ³)	PMN _t (in December 1998 dollars per m ³)	R _t (in billion of December 1998 dollars)	IF _{t-5} (in million of December 1998 dollars)
1971	194.01	9.61	5.70	262.86	0
1972	914.82	11.19	6.64	300.68	65.70
1973	4,313.69	12.77	7.57	386.40	276.47
1974	22,958.54	14.51	8.60	437.18	172.07
1975	30,011.42	16.00	9.49	481.43	447.84
1976	28,190.81	14.57	8.64	530.74	506.08
1977	30,603.85	12.85	7.62	567.63	551.17
1978	34,412.17	13.29	7.72	593.73	560.17
1979	35,972.38	15.45	8.36	635.57	415.69
1980	30,961.06	12.41	7.40	663.00	436.70
1981	30,248.48	11.07	6.32	619.35	617.16
1982	28,564.39	10.16	6.34	644.89	724.05
1983	25,486.68	9.84	5.86	581.50	894.55
1984	26,680.80	8.26	5.42	587.24	820.95
1985	37,587.21	8.53	5.29	677.59	686.96
1986	46,404.16	8.80	7.10	740.96	713.03
1987	45,908.07	13.80	6.89	718.77	675.06
1988	23,361.43	12.21	6.36	685.11	490.15
1989	23,622.90	20.81	16.57	709.07	378.61
1990	22,738.54	9.80	4.72	642.46	337.20

SOURCE: QMP_t, PMP_t, PMN_t and R_t are from Statistical Yearbook of Brazil and IF_{t-5} is from IBDF (see table 2).

Table 5 – total social benefit (TSB) and total social cost (TSC) in the Program of Fiscal Incentives for Afforestation and Reforestation

Year	K	Z	TSB (in thousand of December 1998 dollars) – pivotal shift	TSB (in thousand of December 1998 dollars) – parallel shift	TSC (in million of December 1998 dollars)
1972	0.4675704	0.1714054	668.03	1,103.91	65.70
1973	0.5139255	0.1883985	759.55	1,238.64	276.47
1974	0.5024625	0.1841963	736.50	1,204.90	172.07
1975	0.5449406	0.1997683	823.34	1,331.34	447.84
1976	0.5488527	0.2012024	831.53	1,343.18	506.08
1977	0.5494869	0.2014349	832.86	1,345.10	551.17
1978	0.5501853	0.2016909	834.33	1,347.22	560.17
1979	0.5476087	0.2007463	828.92	1,339.41	415.69
1980	0.5485971	0.2011087	830.99	1,342.41	436.70
1981	0.5512811	0.2020926	836.63	1,350.55	617.16
1982	0.5526605	0.2025983	839.53	1,354.73	724.05
1983	0.5540498	0.2031076	842.46	1,358.96	894.55
1984	0.5531905	0.2027926	840.65	1,356.34	820.95
1985	0.5517064	0.2022485	837.53	1,351.84	686.96
1986	0.5533073	0.2028354	840.90	1,356.70	713.03
1987	0.5537358	0.2029925	841.80	1,358.00	675.06
1988	0.5516164	0.2022155	837.34	1,351.56	490.15
1989	0.542126	0.1987365	817.47	1,322.85	378.61
1990	0.5401562	0.1980144	813.37	1,316.91	337.20

SOURCE: the values of K, Z and BST were calculated basing on LQ₂ equation and using data set from table 4. The values of TSC are from table 2

¹ That wood is in the forms of firewood, charcoal and logs.

² That is the age when normally trees are clearcut to produce chips. However, in some Brazil's regions it is possible to make the first clearcutting when forest is five year old in order to produce firewood.

³ It was considered the reforestation made in small and medium farmers fostered by public programs in Minas Gerais and Paraná states, special programs in the state of São Paulo and those stimulated by pulp and pig iron makers. The small and medium reforestation fostered by other enterprises and states as well as the reforestation established by small and medium farmers without any incentive could not be computed.

⁴ This information refers to roundwood sold at the state of São Paulo. Prices of firewood had large increase than prices of pulpwood, for example.

⁵ Bacha (2003) showed pulp industries and pig iron makers decide how much to plant considering their demands of logs more than the prices of roundwood.

⁶ Due to the importance of fiscal incentives to the reforestation, Leite (1979) had considered, at the end of 1970s, two phases in the evolution of Brazil's forest sector: before 1965 and after 1965. Here, we add to the Leite's division a new phase, what started after the end of fiscal incentives granted to the reforestation.

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- ⁷ There are some papers that have analyzed partially the forest activity in that period. See: Andrade (1961), Cianciulli (1954), Gurgel Filho (1962), Pereira (1990), Prates (1979) and Siqueira (1990).
- ⁸ Some authors have already analyzed that program. See, for example: Arienti (1983), Bacha (1993 e 1995), Beattie (1975), and Berger (1979).
- ⁹ When a taxpayer was filling his income tax report, he informed the Tax Revenue Service about the amount of his income tax that would be allocated to a specific project. After the taxpayer had paid his income tax balance, the Tax Revenue Service allocated the authorized amount to the beneficiary firm. The latter then issued a Reforestation Certificate (a title of property) to the taxpayer-investor.
- ¹⁰ It is important to say there was a valorization of Brazil's currency from December 1992 to December 1998. So, the selection of different times in order to calculate the amount of resources granted as fiscal incentive can produce significant differences. Example given is the same value calculated considering purchasing power of the currency in December 1992, it was US\$ 7.05 billion (according to BACHA, 1995, p. 51).
- ¹¹ This obligation was established by 1965 Forest Code (Law 4,771).
- ¹² It was spent Cr\$ 6.000,00 per hectare. Considering the average of Exchange rate in the period from August 1980 to July 1981 (Cr\$ 71,04 per US\$ 1.00) the value above is obtained.
- ¹³ Differences exist between Bergamasco & Bergamasco (1988, p. 89) and Yamazoe *et al.* (1988) about the number of projects and total area achieved by REPEMIR in the state of São Paulo. In this paper, Yamazoe *et al.* (1988) data set was chosen because these authors made a research and Bergamasco & Bergamasco (1988) based on that research to prepare their article.
- ¹⁴ That information is from IBDF's files.
- ¹⁵ It offers loans at 3% interest rate per year with 8-year deferment and 12 years to pay the loan. That interest rate is below Brazil's inflation rate. In 2002, inflation rate was 25% in Brazil.
- ¹⁶ No loan was granted in 2002.
- ¹⁷ It is important to point out that during the 1960s, 1970s and the first half of the 1980s there was a wide use of fiscal incentives to promote economic activities in Brazil. It implied a subsidy virus argument.
- ¹⁸ Article 18th in Decree 1,376 (on December 12th, 1974) regulated it. In that case of project, both taxpayer-investor and beneficiary firms have the same owners.
- ¹⁹ These equations were estimated using the quantities and prices of firewood. So, the lag of five years was considered between the time of forest implantation and the time of its first clearcutting. It is the minimum time lag demanded to produce firewood after the reforestation had been implanted.
- ²⁰ This paper uses that time period because it reflects the period when fiscal incentives were granted.
- ²¹ These values are sub-estimates of the true social benefits because in this paper only roundwood from the first clearcutting of planted forest are being taken into account.
- ²² Actually, these fiscal incentives were granted from 1967 to 1985, but their effect on the supply curve has arisen from 1972 to 1990.
- ²³ It is important to point out that the model used here [equations (1) and (2)] do not take into consideration other social benefits provided by reforestation, such as job creation and enlargement of industrial activity (the case of pulp production, for example).