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THE USE OF NATIVE FORESTS *VERSUS* ECONOMIC GROWTH IN BRAZIL: IS POSSIBLE TO REACH A BALANCE?

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Abstract:

This article analyzes how native forests have been unsustainably used or chopped down in Brazil since 1930 and the relationship between these processes and the Brazilian economic growth. Two hypotheses are proposed to explain what has happened in Brazil. The first one is that the destruction of Brazilian native forests and the unsustainable use of the remaining native forests have always been linked to the developmental policies adopted in Brazil. These policies, in their turn, have been based on the main economic models in vogue each period of time. The second hypothesis is that, even recognizing the ineffectiveness of only adopting policies to regulate and control deforestation, policy-makers have only broadened and make more restrictive this type of policy over time (through the forest legislation), without creating meaningful monetary incentives to preserve and/or conserve forest resources. The two hypotheses have been proved along the paper as it discusses the importance of forests to a nation and emphasizes that Brazil is destroying them on a large scale, but in different intensities among the Brazilian states. Finally, the paper discusses some policies that would allow the rational use of native forests in Brazil without hindering the growth of other economic activities and considering the Brazilian states differences.

Key words: forests, destruction, policies, states' differences, economic models.
JEL Classification: Q01, Q13, Q23

1 - Introduction

This paper aims to analyze the unsustainable use or the chopping down of native forests in Brazil and how these processes are associated with the Brazilian economic growth. For this purpose, the article focuses these issues during the time period from 1930 through 2011.

The use of native forests in Brazil is regulated by forest policy, what is implemented through a series of acts intended to control the deforestation process, regulate the sustainable use of the remaining native forests and to encourage reforestation. Brazil's forest policy has been systematic since 1934, when the first forest code came into effect and was strengthened in the 1960s and the 1990s, when new amendments to the forest policy were issued and specific legislation concerning the use of water resources and environmental crime in connection with forest legislation came into effect. Together, the three above legislation have created a complex lawful

framework that, in principle, would control deforestation in Brazil if all the aforementioned legislation were obeyed in full. However, deforestation has taken place in different paces among the Brazilian states, without respecting forest legislation.

The forest policy for the control of deforestation is classified as an *incomes policy*, which is constituted in a series of regulations that restrict the production and trade of products and the use of factors of production and/or establish minimum and maximum prices for the use of these factors or products generated in an economy. Other examples of incomes policies are: labor legislation, defining rules for the use of the workforce and wages; zoning policies for the use of land, defining what share of a physical territory can be used and how it can be used; and price-setting policies (such as price freezing plans). An incomes policy is established by legislation that defines *what, when and how* something can be done.

The goal of the forest policy is not to eliminate totally the deforestation in Brazil, but rather to control it. Nevertheless, this policy has not been satisfactorily complied with, and deforestation has reached high paces in some Brazilian states than would have been the case had the legislation been fully obeyed. For this reason, this paper seeks to demonstrate that the forest policy to control deforestation has only been partially effective and explain the causes of its failure.

The study suggests two hypotheses to explain the partial ineffectiveness of the forest policy in Brazil[1]:

1st hypothesis) the destruction of forest resources in Brazil and the unsustainable use of the remaining native forests have always been connected with the developmental policies in course in the county which, in turn, have been based on the main macroeconomic models in vogue each time among the Brazilian police makers.

2nd hypothesis) even with the ineffectiveness of measures to control and regulate deforestation, those responsible for defining the forest policy have continued to issue increasingly detailed and restrictive legislation without creating significant monetary stimulus that make the preservation and conservation of native forest a profitable and competitive activity in relation to other types of economic exploration of the land.

[1] The first hypothesis has already been examined by Bacha (2004a), but the second one has not. Therefore, the present article expands the analysis of the former paper, focusing only on the use of native forests and broadening the discussion of policies that enable balance between economic growth and the sustainable use of native forests.

This paper is made up of five sections, including this introduction. Section 2 discusses the importance of native forests to a country, justifying the maintenance of a certain amount of forest coverage into the country. Section 3 analyzes the evolution of deforestation in Brazil, discussing its causes and examining how it has developed differently from one Brazilian region or state to another. Section 4 contains an analysis of the evolution of the forest policy for the control of deforestation in Brazil and its theoretical background, showing how the destruction of native forests is connected with the style of development adopted by the country, which in turn is based on the main economic framework in course each period of time. It is emphasized that every time the forest policy was concerned only with the purpose to control and regulate deforestation and did not create monetary reward to preserve and conserve the native forests in a way that would be profitable to their landowners. Therefore, Section 4 proves the two hypotheses outlined above. To conclude the article, Section 5 discusses some policies that could be adopted to enable balance between economic growth and the sustainable use of native forests.

2 – The importance of forests to a nation

Forests can be used to produce ecological benefits (that are not always necessarily tradable), as a source of ecotourism and also to produce forest commodities.

According to Camino (1999, p. 101), “non-market ecological benefits produced by forests include carbon storage and fixation from the atmosphere, preserving water resources and watersheds, protecting species with pharmaceutical values, and regulating the climate.” These services are provided free of charge; but if a charge could be applied, the revenue derived from native forests would increase substantially. According to Camino (1999, p.101-102), “Owners of private forests in Mexico are losing a minimum of $ 4 billion every year of the nonmarket components of the forest’s total economic value . . . Estimates of the total economic value of Costa Rican forests . . . show that owners of forested areas (including the state) fail to receive approximately 82 percent of the value of all forests (including protected areas), and 72 percent of the value per hectare from productive forests ...”.

Ecotourism brings travelers to tropical forests, preserved flora and fauna sites, beaches and other places with their little changed natural vegetation. This type of tourism has been shown to be economically viable in a number of cases. In 1992, it accounted for 7% of the international tourism. Furthermore, it helps to preserve natural

forests (Dourojeanni, 1999, p. 90). In Brazil, there are now farms dedicated to ecotourism.

Tradable forest-based products are divided into two groups: a) wood and paper-based products; b) non-wood-based products (Simula, 1999, p. 197). The first group includes: 1) low-processed goods such as firewood, charcoal, roundwood and wood chips; 2) Products resulting from the first industrial handling of roundwood, such as lumber, wooden panels, cellulose and paper; and 3) More elaborate and added-value products such as: lumber for construction, furniture, paper products and cardboard.

Non-wood-based forest products "include a wide range of items from medicinal and aromatic plants to nuts, fruit, resins, tannin, wax and handcraft products" (Simula, 1999, p. 200).

The importance of forests, as outlined above, has led many countries to make efforts to avoid losing them or to restore them. According to the FAO (2010), Canada and Japan did not alter their forest coverage between 1990 and 2010, which covered 34% of Canadian territory and 66.1% of Japanese territory in 2010. The USA had increased their forests during the same time, as forests increased from covering 30.8% of US territory in 1990 to 31.6% in 2010. European countries also increased their forest coverage (both native and planted) by 15.5 million hectares between 1990 and 2010. In 2010, forests covered 43.8% of European territory against 42.9% in 1990. Not only have the most developed countries increased their forests. China increased its forests by 49.7 million hectares between 1990 and 2010 and India by 4.5 million hectares during the same time period.

However, Brazil went down into an opposite path, with the country being the largest destroyer of native forests worldwide between 1990 and 2010, losing 55.3 million hectares. Indonesia came second on the list, with a loss of 24.1 million hectares (according to FAO, 2010).

It could be imagined that Brazil has an above average forest coverage in comparison with other countries, which could account for this loss of native forests. Indeed, in 2010, 61% of Brazilian territory was covered with forests (FAO, 2010). However, a high percentage of forest coverage can also be found in other countries that did not lose their forest coverage. In 2010, 65.5% of Finland was covered with forests. Sweden had 62.6% and Japan had 66.1% of their territories covered with forests. Even countries that are less developed than Brazil maintain a high percentage of forest coverage, such as French Guyana (96.3%) and Surinam (90.4%).

It could also be claimed that forests have no economic importance for Brazil. This is also incorrect. Wood-made products accounted for 8.7% of Brazilian exports in 1999, and were directly and indirectly responsible for 1.8 million jobs (Bacha, 2001).

From the above information, one can see that forests are not used in Brazil in such a way as to maximize their possible economic and environmental benefits. In order to understand this process, it is important to make a historical analysis of how deforestation in Brazil has taken place.

3 – The evolution of deforestation in Brazil

Brazil has destroyed its native forests throughout all of its economic development rather than only recently. Although most attention is currently paid to the Legal Amazon region, deforestation rates have actually been higher in other regions, where the ecological benefits of native forests and other natural vegetations have largely been lost.

Since the Portuguese discovered Brazil in 1500, the natural forests and other forms of natural vegetation have been removed to make way for farming, industry (including mining), economic infrastructure (roads, dams, etc.) or urban expansion. According to the SOS Mata Atlântica Foundation (1998), in 1912, the Southern and Southeastern Brazilian states had approximately 48.9 and 33.9 million hectares of forest coverage, respectively. By late 1950s and early 1960s, these numbers had fallen to 11.7 and 11.1 million hectares, respectively. During these almost five decades separating 1912 from late 1950s and early 1960s, the most developed regions of Brazil had lost 60 million hectares (an area almost equal to France).

Since the mid 1970s, deforestation has intensified in the Legal Amazon Region. Between 1975 and 2010, this region lost 62.7 million hectares (INPE, 2000, 2004, 2011), equal to another territory of France.

This loss of forest resources could be considered normal for a country that is expanding its farming, industry and urban areas. However, the intensity of the process, the way it has been carried out, the forecasts of further deforestation and no guarantee that the remaining forests will be used sustainably (or that they will not be chopped down in the future) are in absolute contrast with the importance that forests have to an economy.

Deforestation has different paces from one Brazilian state to another. Tables 1, 2 and 3 show the shares of the Brazilian states' surfaces that were covered with forests or other native vegetation in selected years.

Table 1 – Shares of the Southeastern and Southern Brazilian states covered with native forests in selected years (values in percentages)

State	**1500**	**1912**	**Late 1950's and early 1960s**	**2005**	**2010**
Minas Gerais	51.76	47.50	9.89[e]	4.55	4.47
Espírito Santo	86.81	64.98	29.69[d]	10.33	10.31
Rio de Janeiro	98.27	82.06	25.33[g]	18.51	18.48
São Paulo	82.39	58.42[a]	13.72[f]	9.30	9.29
Paraná	84.20	82.86	27.91[g]	9.77	9.71
Santa Catarina	81.48	78.65	29.99[c]	22.84	22.55
Rio Grande do Sul	39.76	35.13[b]	9.58[c]	3.58	3.56

Source: SOS Mata Atlântica Foundation (1998, 2002, 2009 e 2010)
Notes: **a** indicates data is for 1907; **b** indicates data is for 1940; **c** indicates data is for 1959; **d** indicates data is for 1958; **e** indicates data is for 1961; **f** indicates data is for 1962; **g** indicates data is for 1960.

Table 2 – Shares of Amazonian states covered with native forests in selected years (values in percentages)

State	**1500**	**1975**	**1990**	**2000**	**2010**
Acre	98.9	98.1	92.2	88.76	85.52
Amazonas	97.94	97.89	96.52	95.99	95.48
Roraima	76.85	76.82	75.16	74.06	72.93
Rondônia	95.93	95.42	81.88	71.57	62.27
Pará	92.77	89.52	81.20	77.04	72.27
Amapá	85.45	85.34	84.53	84.18	83.94
Tocantins	99.46	98.16	90.98	88.98	89.43
Maranhão	90.64	66.17	54.75	51.25	47.87
Mato Grosso	97.73	96.58	87.31	79.58	72.46
Legal Amazon Region	94.89	92.44	86.43	83.00	79.65

Source: INPE (2000 and 2011).

Table 3 – Shares of Northeastern and Center-Western states' territories covered with natural vegetation (forests, cerrado, caatinga, prairie and swamps)

State	**1500**	**1970s[a]**	**1980s**
Piauí	93.13	90.68	56.57[b]
Ceará	93.46	73.24	15.66[b]
Rio Grande do Norte	97.01	69.44	43.46[b]
Paraíba	98.98	53.55	30[b]
Pernambuco	96.30	58.27	49.41[b]
Sergipe	96.86	-	37.6[b]
Alagoas	98.69	-	22.8[b]
Bahia	95.29	64.53	48.08[b]
Goiás	-	-	27.1[c]
Mato Grosso do Sul	97.23	-	44.89[d]

Source: Bacha (1995), using data from different publications.
Notes: a) for Piauí and Paraíba, this information is for 1971-1973. For the other states, it is for 1977-1981; b) for 1988/89; c) for 1983; d) for 1982.

The data in these tables permit the following conclusions:

a) The Southern and Southeastern states were the ones that have lost more forest coverage (Table 1), in some cases with forest coverage below the minimum levels recommended by international agencies. The United Nations Environment Program (UNEP) suggests that at least 10% of a region's territory should be preserved with native vegetation. This does not include what should be maintained for sustainable forest exploitation. In the Southern and Southeastern regions, only states of Rio de Janeiro, Espírito Santo and Santa Catarina have this minimum of forest coverage.
b) The Northeastern states saw great changes in their natural coverage in the 1970s and 1980s (Table 3). This process has not been widely reported in the literature.
c) The states that make up the Legal Amazon region still have widespread forest coverage. However, there has been intense deforestation in some of these states, and they have faced a rapid drop in their forest coverage. States of Maranhão, Mato Grosso, Pará and Rondônia (where farming is expanding rapidly) are responsible for 89.1% of the deforestation in this region from 1991 through 2010, despite the fact that these states make up only 48.4% of the region's territory. This deforestation process is what has most attracted attention from the international community because what had happened in the rainforest (especially the Mata Atlântica) is now being repeated in the Legal Amazon (Viana, 2002. p. 4).
d) The aggregate deforestation at the state level does not reveal the inequality of this phenomenon within each state. For instance, in the Legal Amazon, "many districts and towns have already seen deforestation levels of over 50% and some have reached levels similar to those of the rainforest" (Viana, 2002. p. 1).

Deforestation has taken place in a disorderly manner. The richness of the native forest has mostly been burnt, without the wood being put to good use. Ecosystems have also been destroyed and can never be fully recovered. The abundance of land in Brazil, associated with the expanding transport system, has allowed increasing farming production in new frontier areas given over to crops, instead of making better use of already deforested land located in oldest deforested regions.

4 – Evolution and background of forest policy aiming to control deforestation

As emphasized in the introduction of this paper, the forest policy to control deforestation is an incomes policy that has been implemented through forest legislation. The latter has been systematically in course since 1934, and has been gradually improved over time, but not completely enforced. According to Alencar et al. (2004. p. 13), "... Brazilian environmental legislation is currently one of the most sophisticated in the world and provides a potentially very efficient legal basis for the occupation of new frontiers in an orderly manner and a reduction in deforestation, especially when it is illegal and inadequate". However, as showed in section 3, deforestation is not reducing and new frontiers have not been orderly occupied. Then, why is not the forest legislation is completely enforced in Brazil?

During colonial and imperial periods, Brazil's central governments were concerned with disciplining deforestation to avoid wasting logs that could be of interest to the Portuguese Crown or the sovereignty of the nation or to avoid scarcity of roundwood in the future. These factors account for a number of acts aimed at disciplining the use of native forests and a central government monopoly of the trade of some types of logs (see Castro, 1975; Zaniolo, 1988; and Azeredo, 1988). Nevertheless, the expansion of farming led to a great deal of deforestation in areas close to the Brazilian coast.

The building of houses in Brazil was the fruit of the Portuguese heritage, and since the days of the colonial era, preference has been given to stone, bricks and sand as the main building inputs. Timber was not used very much for building houses. Furthermore, the lack of knowledge concerning Brazilian trees led to the use of imported timbers. According to Zenid (1997, p. 16), "despite the fact that there were wide areas of forest available and production of pine lumber had begun, the first two decades of the twentieth century were marked by the significant amounts of imported and processed lumber from the Northern hemisphere to meet demand in the cities of Rio de Janeiro and São Paulo."

4.1 – Time period from 1930 to 1964

The first broader set of acts to protect the Brazil's natural resources was issued during the 1930s. The great depression, coupled with the skepticism of the main economic ideas of the time (which comprised macroeconomics before John Maynard

Keynes' General Theory) enabled the authoritarian government of Getulio Vargas to prepare a number of codes to protect natural resources, including: the First Forest Code (Decree # 23,793 of January 23rd, 1934), the Waters Code (Decree # 24,643 of July 10th, 1934), the Fishing Code (Decree-Law # 794 of October 19th,1938) and the Mining Code (Decree-Law # 1,985 of January 29th, 1940).

The idea behind these codes was to put limits on the use of natural resources, and these would be in accordance with what was discussed in the theory of externalities (discussed in Pigou's book[2]), with theoretical formulations concerning the limit of the natural resource use (such as the model prepared by Hotteling[3] in 1931) and recognizing that the price mechanism does not drive to a good allocation of abundant natural resources from the social point of view.

The 1934 Forest Code established the following measures aiming to control deforestation:

- Limits on the use of land within each farm, which would be divided into three areas: one of them is free for exploitation, other is kept as forest reserve (at least 25% of each rural property area) and the third one is comprises of forests around rivers and waterways (riparian forests) and can not be exploited.
- An obligation for rural landowners to request a prior license from the federal government forest bureau to exploit areas with native forests near to navigable rivers and lakes or railroads.
- An obligation for large consumers of forest products (such as steelmakers and railroad companies) to maintain their own forests for sustainable supply of firewood or charcoal. This meant that these companies had to replace the native trees that they had cleared cut from the natural forest.
- The creation of conservation units with a view to protecting certain ecosystems in areas undergoing rapid deforestation, including public wood forests (future national forests), parks and protective forests. The latter served to conserve the waterways, avoid land erosion by natural agents, fix dunes, help defend frontiers, ensure public health conditions, protect natural beauty spots and harbor rare species of native fauna.

Note that only bans and obligations involving land use were created, but no monetary stimuli to encourage landowners to maintain native forests were established.

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[2] A. C. Pigou The Economics of Welfare, Macmillan, London, 1932.

[3] H. Hotelling "The economics of exhaustible resources" in Journal of Political Economy, Chicago, 39: 137-175, April, 1931.

The National Pine Institute (INP in Portuguese) was the agency in charge of ensuring compliance with the 1934 Forest Code (also known as 1st Forest Code). This task was later turned to the Department of Renewable Natural Resources, a branch of the Ministry of Agriculture.

Regardless of its amplitude, there was little enforcement of the 1934's 1st Forest Code. The reason for this lies in the way that the country was growing, with preference being given to industrial and urban activities, which required a certain amount of deforestation. To finance these activities, the state adopted exchange rate and taxation policies that transferred a share of potential farmer's income to industry (see Baer, 2001). Ensuring the expansion of farming (and the occupation of land previously covered with forests) was, within this developmentalist policy, an important element[4], which explains why the federal government did not allocate resources to ensure compliance with the regulations of the 1934 Forest Code.

It is important to point out that during the 1940s, 1950s and 1960s, the main macroeconomic model backing the macroeconomic policy-makers was the Keynesian theory (today a part of the Neoclassical Synthesis). It divides the economy into five markets (product, money, bonds, labor and foreign currency exchange market), paying no attention to the role of natural resources within the economy.

The product market balance equation is:

$$Y = C + I + G + X - M$$

Where Y is the GDP, C is private sector consumption, I is private sector investment, G is government expenditure, X refers to exports and M for imports.

Taking into account only the product market, the following developmentalist policies were coherent with this model:

- New investments (increase in I) for the purpose of converting forest-covered land into farmland.
- Increased government expenditure (increase in G) necessary to build new roads and power plants (leading to further deforestation).
- Companies exploiting forests in an unsustainably way and obtaining more products to increase exports (X) or reduce imports (M).

[4] The colonization of the north of Paraná State in the 1950s and 1960s, sponsored by the government at the time, is an example of how native forests in this state were substituted by coffee plantations to generate exports.

Consequently, farming land increased over forestland. According to Brazilian agricultural census data, three million farming establishments were created between 1940 and 1970, and the total area given over to farming rose by a hundred million hectares. The style of growth in farming production contributed significantly to deforestation in Brazil. Between 1940 and 1970, the expansion in farming was basically due to the growth in farmland. Goldin & Rezende (1993. p. 15-16) – based on Melo[5] (1987) – claim that the growing area of farmland was responsible for 72% of the growth in the agricultural production in the 1950s and 65% in the 1960s. From 1938 to 1964, 356,000 km of roadways were built (an increase[6] of 185%), due to government investments in this type of infrastructure. And, exports were encouraged by activities that could deplete forest resources, such as mining, farming and forest exploitation. Concerning the latter, the exploitation of pine in the South generated foreign currency for the country through exports.

4.2 – Time period from 1965 to 1988

This period faced a new phase of acts to monitor and control deforestation, without creating any monetary stimuli to preserve native forests.

On September 15th, 1965, Law number 4,771 (also known as the 2nd Forest Code) was issued, aiming to create more detailed and stricter rules than the 1934's Forest Code. The main changes can be seen in Figure 1. The most important are: a) an increase in the areas given over to permanent preservation; b) different sizing of legal reserves according to the location of the property among the Brazilian regions; c) a requirement of government license to exploit all remaining native forests; d) a requirement of management plans prior to exploiting forests in the Northeastern, Northern and Central-Western regions; e) a requirement for all consumers (rather than the largest ones) of forest products to replace forests that they have exploited.

Forest policy was implemented by the Brazilian Forest Development Institute (IBDF), what was created on February 28th, 1967 and had succeeded the Renewable Natural Resources Department of the Ministry of Agriculture.

[5] MELO, F. H. Export-orientated agricultural growth: the case of Brazil. Genebra: September 1987 (World Employment Programme Research Working Paper).

[6] According to the Brazilian Statistics Yearbook, on 31/12/1938 there were 192,612 km of roadways in Brazil, ando n 31/12/1964 there were 548,510 km.

Although stricter, the 2nd Forest Code rules were largely overlooked as they were not in accordance with other measures adopted by the federal government to stimulate economic growth, such as:

- Monetary stimuli (through rural credits and a guaranteed prices policy) to expand farming in the 1970s and early 1980s. This accounts for the growth in farming in the Central-West region, which automatically increased deforestation in this region.

Figure 1 – Comparison between the 1934 and 1965 Forest Codes

Topic	**1934's Forest Code**	**1965's Forest Code**
Types of area inside each farm	Three areas: one is for free exploitation, other is maintaining with native forests on at least 25% of the total farmland (called as forest reserve), and the third one is the riparian forests (not allowed to be exploited).	Three areas: permanently preserved forests (which include riparian forests and others), the legal reserve (formally called forest reserve) and areas for free agricultural exploitation.
Size of legal reserve	At least 25% of each farm formerly covered with native forests. This percentage was unique for the entire country.	At least 20% of property in the Southeast and South and part of the Central-West, and at least 50% of property located in the Northern part of the Central-West region and the North region. Initially, this restrictive zoning was established for farms previously covered with native forests, but latter this zoning was extent for all farms independently of their former native vegetal coverage.
Requirement for management plan	None	Required for exploiting native forests in the Northeast, North and Central-West.
License requirement to exploit the remaining native forests	For forests located near rivers and railroads	Required for exploiting *all* native forests.
Replacement of native forests	Required only for large consumers of forest products	All consumers of forest products should replace the forests that has been exploited. Large consumers should have their own sustainably managed plantations of trees or native forests.
Areas for preservation	Riparian forests	Riparian forests, areas on hilltops and steeped side of mountains.

Source: prepared by the author based on Decree 23.793/34 and Law 4.771/65.

- Governments (at the federal, state and local levels) built more roads, jumping from 548,000 km in 1964 to 1,502,000 km in 1988. The new roads provide access to previously isolated and forest-covered areas.

- The federal government provided monetary incentives to agricultural and industrial projects in the Amazon and the Northeast region. These projects received incentives from SUDAM and SUDENE[7] and implied further deforestation.
- Several conflicts arose between forest legislation and other federal legislation. For instance, the Land Statute Act (Estatuto da Terra in Portuguese) assures ownership to those who has improved the land. One definition of improvement was clearing the land, i.e., chopping down native forests covering the land.

In the early 1970s, criticisms of the previously dominant theory (the Keynesian one) concentrated on the lack of microeconomic bases in macroeconomic framework and the lack of rational expectations in the same framework. The new classic and new Keynesian models arose to overcome these deficiencies, but they did not consider natural resources to be significantly relevant, the same applying to the Neoclassical Synthesis Model[8]. Natural resources were included in supply shock models (e.g., an exogenous oil price shock), which accounted for the stagflation that the developed countries faced during the 1970s (Blanchard, 2006, chapter 7).

During this period (1970s and early 1980s) there were at least two attempts to incorporate natural resources into macroeconomic models. The first had to do with introducing natural resources into the neoclassical growth model. Stiglitz (1974) claimed that this model had no equilibrium, while Cigno (1981) proved that it has. The second was Sachs (1990)'s proposal that has used Michael Kalecki's growth equation to show how the rational use of natural resources can permit the product to increase. However, neither of these two models was considered fundamental for policy markers when defining macroeconomic and sector policies.

4.3 – Period After 1988

In October 1988, the new Brazilian Constitution was drafted and approved, guaranteeing to the Brazilian states the right to legislate stricter rules than the Federal Government's regulation concerning forest resources. This enabled the Brazilian states to create their own forest legislation which, like the federal legislation, have mostly emphasized controls over deforestation. However, a new instrument was created to

[7] SUDENE and SUDAM (Development Agencies for the Northeast and North Regions of Brazil, respectively) handled fiscal incentives programs during the 1970s and 1980s to promote economic growth in Northeast and North of Brazil in order to reduce inequality among the Brazilian regions. Among these projects were farming and livestock ones, conducting to more deforestation.

[8] The Neoclassical Synthesis incorporated some of the criticisms of the New-classics to the constructions of the Keynesian Theory.

encourage towns to preserve riparian forests or conservation units. This instrument is the State-charged Added Value tax (know as ICMS Ecologico in Portuguese) what allocates a share of the tax money collected by state governments to cities where farmers are allowing areas to protect commonly used resources, such as conservation units and riparian forests surrounding water reservoirs and their tributary rivers. ICMS Ecologico is a form of compensation for cities due to the ecological benefits that their forests provide to their neighbors.

The ICMS Ecologico was first implemented in the state of Paraná in 1992, followed[9] by states of São Paulo in 1994. Minas Gerais (1996), Rondônia (1997), Rio Grande do Sul (1999) and Mato Grosso do Sul (2002), with other states considering it (Bacha & Shikida. 1999). The results of this measure are not extraordinary, but they are helping to preserve native forests both inside and outside of the conservation units.

Despite its creativity at the state level, the federal government maintained its policy of controlling deforestation, broadening previously established measures and seeking to make them more restrictive, despite law enforcement continues to be uncompleted.

Eight important measures were taken after 1988:

1) Definition of a global policy for the environment, recognizing that all natural resources interact among them. It is behind the creation of Environmental and Natural Resources Ministry (MMA in Portuguese).
2) Reorganization of federal environmental agencies. In February 1989, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) was created to unite the responsibility of the federal agencies that monitored specific resources, such as the Brazilian Institute for Forest Development (IBDF), the Rubber Inspectorate (SUDHEVEA), Fishing Inspectorate (SUDEPE) and the Special Environmental Secretariat (SEMA). In November 1992, the Ministry of the Environment and Natural Resources (MMA) was created, and IBAMA became a branch of MMA. In August 2007, the Chico Mendes Biodiversity Conservation Institute was created, also connected to the MMA, and it has managed and monitored the conservation units since them.

[9] The years mentioned in this paragraph are the ones when the ICMS Ecologico was implemented in each mentioned Brazilian state. The laws that created this tax stimulus were issued in earlier years.

3) Requirement of Environmental Impact Reports (EIR) on projects affecting the environment, such as the building of roads and power plants, mining and large farming projects. EIR is a way to impose measures to be taking by large economic projects in order to minimize damages to environment.
4) New forest legislation was issued making compulsory the replacement of native forestland that could not be depleted, but was. It is the case of riparian forests surrounding water reservoir (Law # 7,754 of April 14th, 1989) and Legal Reserve (Law # 8,171 of January 17th, 1991 and Decree # 2,166). Both acts together with the Environmental Crime Law (Law # 9,605 of February 12th, 1998) define more clearly the individualization of environmental crime responsibility. The latter law was sanctioned eight years after its introduction in Congress and regulated only in 2000.
5) Abolition of SUDAM and SUDENE tax incentives for farming involving deforestation in the Legal Amazon.
6) Increase of the legal reserve sizing. From July 25th 1996 to August 24th 2001, 67 Medidas Provisorias (a kind of preliminary law issued by Federal Government and what should be in course until approved or not by Congress) were issued, increasing the size of legal reserve. The last Medida Provisoria, number 2,166-67, what has been in force since August 24th 2001, states that a legal reserve is required in all farms in Brazil, irrespective of the region's native vegetation and the size of the farms. The size of the legal reserve was increased to 80% of the total area of each farm originally covered with forest and situated inside the Legal Amazon Region (possibly reduced to 50% if the farm is located inside regions subject to ecological-economic zoning), 35% in areas covered by cerrado vegetation inside the Legal Amazon, and 20% for other rural properties in the rest of Brazil (covered with cerrado, prairie, forests or caatinga). If a rural property has no legal reserve, the owner has up to 30 years to replace it, planting at least one tenth of the required missing forestland every three years.
7) Establishment of criminal procedures and fees for environmental negative attitudes adopted by farmers and other perpetrator, improving Environmental Crime Law (Law # 9,605 of February 12th, 1998). Decree # 6,514 issued on July 22nd, 2008, clearly define the fees for any person that chopped down trees inside preservation areas or without government license for doing it in other parts of the farm. Fees are also established if the farmer does not reestablished legal reserve and other preservation areas (cited in item 4 and 6 above). Enforcement

of Decree 6,514's rules was postponed to start on December 13th, 2010 and again to June 13th, 2011. In middle 2011, Brazilian Congress was discussing amendments to the 2nd Forest Code in order to ease the replacement of preservation areas and legal reserve as well as to reward farmers to replace them. Among the ideas discussing are: small-family-farmers (which farming land varies from 20 to 400 hectares) would be exempted to replace legal reserve if they had chop down all their native forests before 2008; perennial crops such as coffee and apple trees that have been planted in the past in the steeped side of mountains classified as permanent areas would be allowed to keep their crops; and a proposal to farmers deduct from their banking rural loans the amount spent in replacing riparian forests. These and other amendments will imply to issue the 3rd Forest Code, probably in the second semester of 2011.

8) Creation of a specific federal file for each farm concerning its environmental areas. Decree # 7,029, issued on December 10th, 2009, created the Federal Program to Support Environmental Regulation of Rural Properties, called Environmental Program (Programa Mais Ambiente, in Portuguese), adding to the farmer the obligation to register Preservation Areas and Legal Reserve and firming a liability to replace areas cited in item 4 and 6 above.

Note that forest legislation running until 2010 requires replacement of land that should never have been deforested. Fees would be charged if the farmer does not fulfill the forest legislation, no monetary reward has been created to help farmer to fulfill forest legislation such as seedling grants, free technical assistance or monetary payments for the areas to be given over to native forests instead of farming them. There is also no incentive to integrate farming and industry to make the replacement of the legal reserve viable and ensure its use in the future.

The measures to monitor and control deforestation do not always reach the expected results in Brazil. One example of the ineffectiveness of forest legislation in Brazil has to do with the enforcement of legal reserve. At least in the Legal Amazon, all properties should have had a legal reserve (before was called forest reserve) since 1934, as they have forest coverage. However, this has never happened. There has been a drop in the number of properties with legal reserves. According to Incra's Registration Statistics, in 1978, 93.03% of rural properties in the state of Rondônia had a legal reserve. In 1998 only 5.02% of these properties had one.

In 1998, only 7.04% of rural properties in Brazil had a legal reserve. Therefore, around 93% were legally responsible to replace it. In 1998, 39.8 million hectares were declared as a legal reserve. If on average properties in the North should have 50% of their areas given over to the legal reserve and 20% in other regions, there would have to be 111 million hectares of legal reserve (according to INCRA dataset). Therefore, 71.2 million hectares of arable farming land have to be transformed into legal reserves. On the whole, this is not impossible to achieve because 73.4 million hectares of arable farming land located inside the Brazilian farms was declared exploitable but was left unused in 1996. Therefore, all that has to be done is to plant forests in these areas in order to recuperate the legal reserve.

But this situation can vary from one region to another and implies an alteration in the technology used in farming to replace the legal reserve. Bacha (2004b), considering the 48 cities that make up the Piracicaba River Basin (a strip stretching from São Paulo state to Minas Gerais state) was found that replacement of the legal reserve could be done by reducing by 32.8% the grassland area. This could be achieved if the number of cows per hectare of pasture could increase by 48.8%, which was not impossible at the beginning of 2000s considering the existing technological pattern of livestock grazing in Brazil.

Emphasis on these control measures, focusing on disciplining deforestation in terms of each farm, did not halt deforestation in Brazil. What has attracted the attention of the domestic and international community is the destruction of 32.17 million hectares of native forests in the Legal Amazon between 1991 and 2010 (equivalent to half of the French territory). Nevertheless, of no less importance are the 11.5 million hectares of forests lost in the South and Southeast between late 1950s and early 1960s and 2010.

But, why does a country with detailed and stricter forest legislation like Brazil could not achieve its goals? Basically, because these goals are not in tune with other developmentalist goals and policies, that have been adopted by policy-markers in power.

In the 1990s, Brazil adopted measures in line with the Washington Consensus (policies with a neo-liberal nature). These policies sought: a) fiscal discipline, redirecting public expenditure priorities to health, education and infrastructure; b) tax reforms; c) a flexible Exchange rate; d) a guarantee of property rights; e) deregulation of the some sectors that have been driven by the state; f) a reduction of the state's participation in production by privatizing state-owned companies; g) capital flow

liberalization among the countries (see Baumann, 2000, p.13). These reforms were to take place gradually, with item e thru g to be the first to achieve and the others following them.

Note that the Washington Consensus makes no reference to the preservation or conservation of natural resources. Indeed, some of its measures mean further destruction of natural resources in developing countries. Also note that the guarantee of property rights (item d), capital flow liberalization (item g) and flexible exchange rate (item c) in Brazil would mean increased exports of minerals and agricultural commodities, due to Brazil's comparative advantage in those products, resulting in further deforestation. According to Prates (2008), expanding production of these products would imply further deforestation of the Amazon Region, specially.

At the same time, the need to control the public deficit and the need to increase Brazilian exports led to the weakening of public agencies that inspect the destruction of natural resources, such as forests. Thus, priority was given to activities that would increase exports, such as the expansion of farming in the Central-West and North, even though this would lead to more deforestation.

Natural resources had still not been given an important role in the mainstream macroeconomic models, despite being an important part of other economic models.

The main macroeconomic models in course after 1988 continued to be the Monetarist, the New-classical and the New-Keynesian ones, now paying more attention to long-term equilibrium, rates of unemployment (such as the Insider-Outsider model), nominal price rigidity (such as Menu Cost), real wage rigidity (Efficiency Wage and Labor Contract models) and economic growth models (Real Business Cycle Model). Again, natural resources are not taking a significant importance in these models (Dornbusch et al, 2009, chapter 21; and Blanchard, 2006, chapter 26).

However, in parallel with these mainstream macroeconomic models, a wide range of literature on sustainable development and sustainability has arisen (see Rocha, 1999, p.16-24). This literature offered no consensus on how to achieve sustainable development, but it made an impact by raising awareness of economic policy-makers concerning the sustainability of economic development. And this is what explains the reformulation of the forest legislation, increasing the size of the legal reserve and transforming it from a forest reserve into a reserve for sustainable use. This literature on sustainable development also had an influence on the creation of the National Water Resources Policy (Law # 9,433 issued on August 1st, 1997). This normative act states

that “water is a public domain commodity” (Article 1, paragraph I) and the National Water Resources Policy should “guarantee that current and future generations will have access to water of adequate standard and quantity for their respective uses” (Article 2. paragraph I).

Efforts have been made to change how macroeconomic variables have been measured in order to calculate sustainable income. The latter is estimated by deducting the depreciation of natural resources and the environment from the conventional measures of income. Daly (1992), Harrison (1992) and El Serafy (1992) propose different methodologies for calculating sustainable income. Some studies have been done for Brazil considering specific sectors (such as Motta & Young, 1991; and Bastos Filho, 1995) and have found that sustainable income is lower than the one obtained by the traditional System of National Accounts. Nevertheless, the values calculated by the System of National Accounts are the most frequently used when evaluating economies.

5 – Final considerations

From all that has been discussed until now, the hypotheses of this article have been confirmed, i.e., (1^{st}) the destruction of forest resources in Brazil and the unsustainable use of the remaining forests have always been associated with the developmentalist policies in course which, in turn, have been backed on the mainstream macroeconomic models in vogue each time; (2^{nd}) even with the ineffectiveness of measures to control and regulate deforestation, those responsible for defining the forest policy have continued to issue increasingly detailed and restrictive legislation without creating monetary stimulus that makes the preservation and conservation of forest resources profitable and competitive for farmers in relation to other types of economic exploitation of the land.

It is true that the preference for the developmentalist policies adopted over time can be accounted for the fact that interest groups dominated the agencies that formulated economic policy. But how change this situation? Five propositions can be considered.

The first would be to change the economic models on which macroeconomic policies are backed, giving priority to those that consider the rational use of natural resources, such as forests. So far, no widely accepted macroeconomic model has been developed that includes natural resources among its main macroeconomic variables (such as product, prices, interest rates, exchange rates, for example). Nevertheless,

current models can be reworked to include natural resources as a variable that restricts aggregate supply curve.

Most of the macroeconomic aggregate supply curve models consider labor market equilibrium, taking a production function where the natural resources are not explained or appear to be added to the capital, for which there is no restricted use (see Branson & Litvack, 1981; and Dornbusch et al, 2009). One alternative to clearly consider natural resources in these models is to include them in the production function alongside the labor and capital as production factors. Furthermore, one can consider that the cost of natural resources will increase as more they are used, because control policies limit their exploitation. Therefore, an aggregate supply curve that grows steeper at every point until it becomes totally vertical will take place.

The second possibility would be to focus on the control of deforestation not in terms of each farm but considering each Brazilian region. In this sense, ecological-economic zoning (EEZ) would be an alternative because it can define regions due to their economic aptitude and the ecological benefits that stem from the vegetation. By using this zoning, economic policies could differ from one region to another depending on how they are defined by EEZ.

EEZ on a nationwide scale in Brazil could define at least three areas: area for free exploitation, forest area for sustainable exploration and a share for preservation. To this end, one can consider the current experiments and proposals of EEZ in order to learn more about its positive and also its weaker points. There are some EEZ proposals for Brazil, such as the Planafloro in the state of Rondônia and a system of national forests in the Amazon Region (Veríssimo et al, 2000). The Planafloro has not had satisfactory results, partially because federal policies do not adopt it. The National Forest proposal for the Legal Amazon (Flonas) has identified 1.15 million km^2 in the Legal Amazon (23% of the region) that are not protected areas and remain untouched, but have a high potential for wood. These areas, if transformed into national forests, will enable roundwood production in a sustainable system capable of meeting the demand for roundwood in the forest industry of the Legal Amazon and enable a rise of 60% in this industry's production capacity.

To adopt EEZ in Brazil, farming policy can differ from one region to another. For example, if a certain region in the Amazon is given over to conservation or preservation of native forest resources, rural credits, minimum pricing of agricultural products and infrastructure for transport and storage should not be offered for farming

activities. However, these services and products should be offered in areas where farming is already under way. To compensate some states and districts for preserving the forests and the environmental benefits, a special environmental allowance could be given when it comes to distributing federal taxes among the states. Similar to ICMS Ecologico System, states and cities would receive a larger share of national income tax revenue and taxes charged on industrial goods due to their preservation and conservation of native forests. To achieve this, the INCRA's files about farms could be used to compute how much of each city has given over to its legal reserve and permanent preservation in Brazil.

The third possibility is to make the enforcement of forest legislation more effective. This could be done without allocating a great additional amount of money to environmental agencies. All that is required is further integration of the information systems of federal agencies.

It has been claimed that greater enforcement can only be achieved with further financial and human resources for the agencies involved in establishing and enforcing forest policy. According to Alencar *et al*. (2004. p. 13), "... What has hindered effective action against deforestation is the weakness of the institutions responsible for monitoring the frontier, victims of over ten years of policies to curb federal government expenditure. The National Institute of Colonization and Agrarian Reform (INCRA) and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) are unable to carry out their job adequately. Massive long-term investments will be required, investments in manpower, equipment and funding in the field to guarantee the effective presence of the government on the expanding pioneer fronts. Without strengthening these institutions, there is no chance of ordering the expansion of the frontier and reducing deforestation".

However, an examination of the degree of computerization of the activities of the environmental agencies and their interrelations shows that they are rudimentary and could be improved with few additional resources in order to facilitate electronic checking and avoid falsification of document issued by IBAMA.

Another flaw in the inspection system is that the farmers' files of public agencies, such as the IBAMA (and its similar or correlated state agencies), INCRA and Brazil's Internal Revenue Service are not interconnected. When registering with the INCRA, landowners have to declare whether or not they have a legal reserve. If a landowner declares that he does not have a legal reserve, then the IBAMA would know

that the landowner has admitted that he is not complying with forest legislation. Furthermore, when dealing with the Internal Revenue Service, the landowner has to declare his Rural Land Tax (ITR in Portuguese) and already income tax. The Rural Land Tax on the legal reserve is not charged and depends on how the land is being used. If the landowner declares on his Land Tax form that he has a legal reserve (so that he can pay less tax) and does not declare it to the INCRA, this is a tax fraud. As a result, he will be automatically fined. Therefore, electronic inspections can be conducted and would be a powerful instrument to bring farmers into line when it comes to complying with forest legislation. To make this system workable, all that is required is an interconnection and exchange of information among federal public agencies.

Last but not least, on-site inspections have been hindered by inadequate and ludicrous procedures on the part of the IBAMA. This agency, when confiscating illegally harvested roundwood, has nominated the person responsible for this illegal act as the trustee, and this person ends up "doing away with" the roundwood. According to Veja (2004. p. 33), "around 48,000 cubic meters of logs, confiscated by the IBAMA last year during the Forever Green operation, disappeared from the yards of five lumber companies charged with illegal deforestation in the state of Pará. The thousands of logs were stored in the yards of the same companies that were being fined..." The IBAMA claims that it does not have enough resources to store the logs by itself. So why not auction it and deposit the money in escrow until the case comes to trial? In the example given above, the logs that vanished away had an estimated value of R$ 10 million, equivalent to two thirds of the money that IBAMA spent on airline tickets in 2003.

The fourth possibility is to provide monetary compensations for rural landowners to protect forests. The introduction of monetary rewards to preserve and/or conserve forests is already a reality in countries such as the USA, Finland, Austria and UK, despite similar reward is only experimental in Brazil.

The fifth possibility is to change the concept and valuation of farmers and consumers concerning the importance of natural resources such as forests. This is already the case for farmers who seek environmental certification and consumers who favor ecologically correct products. Some European countries are already more focused to consume sustainably forest products. This awareness has to be heightened in Brazil's domestic market. Demand for certification is high. The SC-Brasil, in May 2004, had 1,578,213 hectares of certified forests in Brazil, of which 38.6% (608,678 hectares) were native forests. The certification process facilitates the enforcement of forest

legislation because the certification process evaluates the compliance with this legislation.

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