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**National Factor Markets and the Macroeconomic  
Context for Environmental Destruction in  
the Brazilian Amazon**

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**NATIONAL FACTOR MARKETS AND THE MACROECONOMIC  
CONTEXT FOR ENVIRONMENTAL DESTRUCTION  
IN THE BRAZILIAN AMAZON**

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## ABSTRACT

This paper discusses Amazonian agricultural development with emphasis on the interrelations between regional conditions and the economic context represented by the national economy. The extreme abundance of land relative to complementary factors together with the position of the region as a price taker in both factor and output markets create the conditions for environmentally destructive expansion of cultivation at the extensive margin. We argue that policies to promote a more ecologically sensitive pattern of development must take into account these links with the larger Brazilian economy and society as well as conditions within the region itself.



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**I - INTRODUCTION**

1. The High Cost of Amazon Occupation

The pace of Amazon deforestation over the past decade has become the object of worldwide attention and concern. While the results of unconstrained development are readily evident, the causes of deforestation on such a massive scale are less obvious, and even more elusive are the policy prescriptions to deal effectively with the problem. Brazil and other Amazon basin countries insist on the right to tap the resources of the Amazon for the sake of national development unimpeded by external considerations. The tragedy, however, is that the goal of national development has not been pursued in ways congenial to conservation.

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If the Amazon is to be occupied at all, it is inevitable that parts of the forest give way to other activities. What does

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not make economic sense is to destroy the forest in favor of unsustainable low productivity agriculture and extensive cattle ranching. With very few exceptions, development projects so far implemented in the region would not pass a cost/benefit test if it were not for heavy subsidies, immensely distorted prices, private appropriation of public goods, and society's underwriting of external diseconomies.<sup>1</sup>

The losses resulting from Amazon occupation to date have been enormous. Valuable timber and forest products have been lost, myriad species and the genetic information they contain have become extinct, the local ecosystem and global environment have all suffered extensive and, in some cases, irreversible damage.<sup>2</sup> Worse, this damage is rarely recognized or accounted for by economic planners or policy makers since most Amazon development projects start from the false assumption that the region is demographically and economically "empty." Although population is indeed sparse, 740,000 non-indigenous inhabitants in the area, mostly gatherers (IBGE, 1983).<sup>3</sup> These people are in danger of physical elimination or loss of their cultural identity, as in the case of the Indians, or loss of their means of subsistence, as in the case of settlers. But for many Brazilian developmentalists these concerns are secondary at best. In a tropical reenactment of "manifest destiny" the forest and its inhabitants have already been condemned: their loss is not computed as a cost in development projects.<sup>4</sup>

It often seems that the supposed "beneficiaries" of Amazon occupation are in many ways victims instead. The harsh living conditions of the frontier imply sizeable personal costs to the settlers.<sup>5</sup> It is often said that people lured into the area would be willing to put up with this relative deprivation if it meant access to land ownership and freedom from exploitation as farm workers. But this goal will be denied to most as they are



unable to make it on their own on rapidly degrading soils and are compelled to work as wage laborers. (Turchi, 1980)

Nevertheless, there have been a few isolated success stories such as the private colonization projects in Northern Mato Grosso.<sup>6</sup> By and large, however, Amazon occupation has been seen as a way to "buy time" for farm workers displaced from other regions and has served to enrich a handful of land speculators who profit from government incentives to occupy the area. In exchange for ephemeral gains, an enormous amount of potentially valuable resources are being destroyed and the prospects for actual development of the region are being compromised. Certainly, what is being done in the Amazon would not fit anybody's idea of "sustainable" development.<sup>7</sup>

## 2. The Questions

This harsh judgement on the efforts to develop the Brazilian Amazon region leads to several questions:

- (a) Why would settlers, adopt, and the government condone, wasteful methods of agricultural expansion in the fragile ecosystems of the Amazon?

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Economists like to think of "menus" of activities and production techniques, and of choice being determined by the desire of "rational" agents to maximize economic gains. If rational decision makers have opted for untimely destruction of the forest and have chosen activities and techniques that will ultimately defeat their own profit maximizing objectives by promoting environmental degradation, something must be wrong with the conditions under which settlement is taking place. The literature on Amazonian issues finds fault in the government policies which create artificial incentives for land ownership and/or

deforestation (Binswanger, 1987 and 1989, Mahar, 1988); in defective planning and attendant unavailability of complementary factors of production and services; in the government's inability to conduct the settlement process in face of pressure from the very large number of immigrants pouring into the area; in the inadequacy of technology; in the greed of the rich; in the incompetence of the poor; or in the vested interests of politicians. Although there is truth in these assertions, they do not constitute a complete analysis.<sup>8</sup>

- b) What can be done to reduce waste of resources and promote sustainable growth in the region?

Recommendations as to what to do about the Amazon follow from identification of the defects in the region's processes of occupation and settlement. To check deforestation and promote other conservation measures, the following have been recommended: (a) strengthen the planning process, including the use of privately owned companies and cooperatives to organize the settlement; (b) strengthen government regulatory agencies (e.g., environmental protection and land reform agencies); (c) correct institutional distortions that stimulate deforestation; (d) expand transportation network and marketing facilities; (e) conduct research on plant varieties as well as on combinations of activities fitted to local conditions; (f) provide extension services and credit to compensate for the shortcomings of the small settlers; (g) eliminate subsidies and price distortions; and (h) pursue land reform elsewhere to retard the inflow of poor migrants. These proposals, as well as the diagnosis on which they are based, have merit. Nevertheless, it is hard to imagine how implementation of any or all of them together can provide a comprehensive solution to the problem of how to develop the Amazon frontier without destroying it, since with only one

exception they fail to address the larger economic context within which Amazonian development takes place.

c) How can the Amazon contribute to Brazilian economic development?

The ideal of the Brazilian elite is to see the Amazon transformed into another São Paulo or Paraná, if not Iowa, with extensive fields of mono-cultivated land crisscrossed by roads and all the necessary infrastructure for the achievement of its vision of what "modern" agriculture should be. A modern, mechanized agriculture does not employ much direct labor, but this shortcoming would be offset by the positive impact it would have on indirect labor requirements. This, in a nutshell, is the "ideology of modernization." An opposing view, rejected by the elite, is to keep the Amazon, which occupies about 40% of the country's territory, as a nature preserve, a kind of huge botanical and zoological garden for the benefit of humankind.

More down to earth objectives are singled out by those who wish to see the Amazon occupied. The Brazilian military favors it as a way to enhance national security (Becker, 1982); the Federal and State bureaucracies want opportunities to extend control over a vast new territory (Norgaard, 1984); entrepreneurs want to tap the resources the Amazon could provide; conservation-minded intellectuals dream of sustainable yield exploitation as a compromise solution to restrain the impulses of developmentalists; the political right sees the Amazon as a convenient escape valve for social tensions and a dumping ground for "trouble makers" (landless farm workers) pressing for land reform (Ianni, 1979); while society's mainstream favors the enlargement of the country's frontier as one more alternative for growth and employment creation (II PND, 1974). Nevertheless, whatever hopes Brazilians may have had for Amazonian development, those hopes

are fading. The fragility of the environment has proven to be a major obstacle to monoculture, including pasture (Fearnside, 1980, Goodland, 1975). The bureaucracy has been unable to direct the settlement in a rational manner and financial costs have proven a drain on the fiscal budget while the response to investments has been uncertain and slow in coming. Finally, the growing phenomenon of "reverse" or out-migration indicates that luring displaced farm workers into the Amazon may be easier than keeping them there (Martine, 1982, Carvalho et al, 1979). With few successes to show, opinion is building that short of radical change in Amazon policy, the "green hell" will surely give way to the "red desert".

This paper argues that understanding the causes of environmental degradation in the Amazon requires an evaluation not only of economic conditions within the region, but also of the links between the regional and national economies. The dependence on national markets for determination of factor and output prices combines with existing technology and resource availability to produce the cycle of destruction seen in the area. The next section discusses important aspects of regional and national factor markets. This is followed by an analysis of the interrelationship between these and the pattern of development in the region. Finally, policy implications and recommendations are presented.

## II. A NEOCLASSICAL HYPOTHESIS; UNBALANCED FACTOR PROPORTIONS

Predatory occupation such as that in the Amazon basin is neither new nor peculiar to that region. Rather, it is the result of extension into the area of the familiar pattern of agricultural expansion at the extensive margin that has characterized the growth of Brazilian agriculture since the 16th century (Nicholls, 1972, Pastore et al, 1974, Schuh, 1975, Alves,

1983, Cunha and Daguer, 1983).<sup>9</sup> What makes the Amazon different is an ecosystem that is more fragile than that of most other places, a pace of occupation more intense than in other areas, and an especially adverse macroeconomic environment in the 1980's. In the Amazon, it takes three to four years for the consequences of improper use of the soil to become apparent compared to decades in places with a less fragile environment, although the underlying reasons for resource and environmental destruction are in many ways the same. An exacerbating factor is the extreme austerity, instability and lack of investment that have characterized Brazil in the past ten years.

Expansion of agriculture at the extensive margin is a consequence of economic conditions resulting from an abundance of land and scarcity of almost every other complementary factor, the most important of which are labor and capital. In this sense, it is a problem of unbalanced factor proportions, which result in extremely low cost for private use of resources and so do not provide incentives for conservation. Producers are induced to economize on the use of scarce factors by substituting them for the more abundant one. Or, in terms of the problem's dual, the producers' objective is to maximize returns to labor and capital, which can be accomplished through the extensive use of land. Given the technology, the fact that land is abundant (and cheap) is what accounts for its being extensively and carelessly used.<sup>10</sup>

An added difficulty is that technological innovations, if and when they come about, will tend to reflect, and therefore reinforce rather than change relative factor scarcities. The direction of technological change which is most beneficial in light of environmental considerations is, unfortunately, not that which is most likely to be induced by relative factor endowments and prices in the Amazon. A situation of abundance of land and scarcity of labor is depicted graphically in Figure 1 by the

steep slope of the isocost lines. Current production technologies make extensive use of abundant land, and use relatively little labor, as shown by isoquant 1. In order to avoid the destructive consequences of this production technology, it is necessary to promote technological change of the sort shown by isoquant 2, with a much higher man/land ratio.

Table 1 presents figures demonstrating the extent to which relative factor scarcity in the Amazon region differs from national totals. While the region contains 42% of national land area, only four percent of the economically active population lives there. The position of the Amazon as a price taker in both output and factor markets is due mainly to its relatively small weight in national income (3%) and agricultural product (5%).

Here is the crux of the problem. It has been shown that the nature of economic activities and technological innovation to be expected in such a land-abundant situation are of a land using nature; i.e. left to its own devices, the market will not promote land saving technological innovations since land availability is not a constraint to individuals at the micro level.<sup>11</sup> It is tempting to suppose that the government could improve on this situation due to its ability to take a more macro view in the context of a longer term strategy. Unfortunately, it is more likely that government conducted research will not fare any better. Public research agencies, such as EMBRAPA, calculate the return to research resources using relative factor prices generated by the imbalanced endowment which causes the problem in the first place. The technology which EMBRAPA is likely to produce will favor the intensive use of the cheaper factor, once again illustrating Hayami and Ruttan's hypothesis. Unless the government adjusts its research objectives, expansion of Amazonian agriculture will continue in its historic pattern.<sup>12</sup>

Specifically, there are two choices facing policy makers interested in promoting a more environmentally sensitive outcome to Amazonian occupation: First, they can try to alter the apparent relative factor prices by, for example, limiting the land allotted to each farm. Second, rather than relying on market mechanisms, they can actively promote research into the types of technologies needed. This is likely to produce better results for several reasons. One is that markets cannot be depended on to function as desired in the relatively primitive conditions of the Amazon. Second, is the fact that the prevailing extractive mode of development gives little incentive to individuals to invest in the needed research. Finally, individual innovators are likely to produce changes on an incremental basis starting from the technological base they already possess while what is desired involves a relatively radical break with past techniques. So it is important for government not just to be aware of the nature of the "mismatch" between technology and resource base - it must actively promote alternatives.

Rather than take the route of promoting the correct type of technical change to redress the imbalance between endowments of land and other factors, Brazilian policy has consistently pursued the shorter path of subsidizing capital and stimulating migration to relieve local labor scarcity.<sup>13</sup> Nothing has been done to restrict the amount of land owned or operated by single producers. On the contrary, policies have stimulated demand for land by making ownership not only a condition of eligibility for government programs but also by making the size of the benefits directly proportional to the area owned.<sup>14</sup> This type of policy has helped give Brazil one of the highest indices of land concentration in the world; it has also ensured that farmers face an imbalanced ratio of land to capital and labor for a long period.

The important policy question is whether Brazil should allow this process to continue by acquiescing in the use of the Amazonian frontier for agricultural expansion at the extensive margin, or whether the country should instead take steps to actually promote growth at the intensive margin. The thesis proposed by this study is that nothing short of a radical change in the pattern of agricultural growth inside and outside of the Amazon can have any impact on the pattern of destruction seen in that region.

### III - DEVELOPMENT WITH ABUNDANCE OF NATURAL RESOURCES

#### 1. Resource Endowments

The discussion in the previous section indicates that it is no surprise that a region with an abundance of natural resources and a shortage of almost everything else bases its development on intensive exploitation of its only abundant factor. However, that exploitation should go to such extremes as to become self-defeating is more difficult to explain. Agricultural expansion has been the goal of most Amazonian occupation projects and, so far, the main cause of deforestation.

Undeniably, many other activities take a toll on the Amazonian environment. Chief among those is widespread gold prospecting over the entire region, a highly polluting and socially destabilizing activity. Other important activities are indiscriminate logging, which employs more than 300,000 people, and hydro-electric generation. Because flooded areas in the flat Amazon region are very large, hydro-electric production is potentially a major environmental threat.<sup>15</sup> Three dams have so far been built but additional 76 projects with total production capacity of 85900 MW are on the drawing boards.<sup>16</sup> Mining (bauxite, iron ore), oil and natural gas exploration, and



charcoal production are also expanding. In an attempt to develop a metallurgical sector, fiscal incentives for fifteen charcoal operated iron projects have been approved for plants along the Carajas-Sao Luis railway corridor (Mahar, 1988), two of which are already in operation. Though these problems are important, extension of agricultural production remains the most important activity in terms of environmental effects.

a) Labor Markets on the Open Frontier

Amazonian soils are notoriously infertile. It is estimated that only 8.4% of Amazon soils are fit for agriculture.<sup>17</sup> In addition, the patches of usable land are scattered throughout the region and most are inaccessible without heavy investments in transportation. The exact location of these patches is largely unknown and practically no commercial value can be attached to such land. Still, the area of "moderately fertile" soils in the Amazon Basin has been estimated at 40.5 million hectares, of which Brazil has the largest part (Moran, 1984).

For this analysis however, the total amount of land available matters less than the fact that the Amazon is an "open frontier." More than a question of geography (total land endowment) it is the conditions of access to land, the size of farms, and how land is distributed that matter. The amount of land in individual production units is rather large, and possibilities are still open for establishment of new farms.<sup>18</sup> Table 2 presents estimates of potential land use in the region. EMBRAPA estimates that more than two million square kilometers, or nearly a quarter of national land area, can be used for extractive purposes while an additional 384,000 square kilometers can be put into agricultural production.

A typical farm in an Amazon settlement project has 100 ha and a cattle ranch at least 3000 ha.<sup>19</sup> In either case, 50% of the available area may legally be cleared, the remaining 50% being left as forest reserve. However, a typical settler, with the limited means at his disposal, can work little more than one or two ha per year. Similarly, cattle ranchers depend heavily on labor to clear and maintain the 1500 plus ha allowed for pasture. Such labor, by and large, is not available so that prospective ranchers often acquire land already cleared from failed settlements in order to establish themselves, instead of bringing in workers from other parts of the country. Even then, the shortage of labor makes upkeep difficult so that both small settlers and large ranchers have far more land than they can use productively.

The high degree of mobility of Brazilian labor is shown by statistics on internal migration and by agricultural labor supply studies.<sup>20</sup> In this context, regional labor shortage is defined in relation to the wage rate. At going wages it is very difficult to attract workers to the Amazon. The low value product of labor effectively sets a ceiling on wages, thus limiting employment. The problem is not that labor is not available but that the demand for labor is too limited.

In the open Amazon frontier workers have the possibility of off-farm income, such as hunting, gathering, and subsistence production of foodstuffs. For this reason, the opportunity cost of farm employment, or workers' reservation wage, may be quite high. The labor supply curve would thus be located to the left and above the one that would prevail if the frontier were "closed." Open access to natural resources effectively reduces the supply of labor.<sup>21</sup> With both demand and supply restricted, nonexistence of market equilibrium is a possibility (if not in the aggregate, at least locally). In this sense, what appears as

labor "shortage" has less to do with demographic dynamics than with the nonexistence of equilibrium in the labor market. The situation is illustrated in Figure 2. The labor supply function (S) lies entirely above the labor demand function and no level of employment is possible at any wage rate. Table 3 presents data on wages in the Amazon region compared with national averages. It is clear that remuneration is higher in the labor-scarce Amazon and particularly so for skilled workers such as tractor operators.

#### b) Capital and Investment

Capital scarcity for agricultural production is probably as acute as that of labor in the Amazon. In relation to the size of the area opened to settlement, few physical resources (equipment, cattle, etc.) have been brought in, due either to the poverty of immigrants or failure to invest on the part of landowners and entrepreneurs. Capital scarcity can also result from failure to generate an economic surplus, or from failure to reinvest locally. In the latter case the region would be exporting capital, a not unlikely hypothesis in the present case.

Working capital is also scarce; credit is not available or, more precisely, given the level of risk prospective borrowers cannot afford the interest rate required to induce lenders to come forth with money. Shortage of capital can also be understood as incapacity to wait. For example, waiting for tree crops to grow, for cattle herds to reproduce, for timber prices to rise, or for research to produce results implies relatively long horizon investments. This means that future income flows are heavily discounted and that producers take a short term outlook. Real interest rates have been high and volatile in Brazil, often above 30% per year due mainly to central government actions with respect to fiscal and monetary policy, and debt

management. Credit for periods longer than one year must normally be obtained via administrative allocation; long-term capital markets are thin or non-existent. Inadequate infrastructure can increase marketing costs and reduce the economic value of goods and take economic stimulus out of conservation. Finally, because capital is mobile a shortage of capital is equivalent to inability to compete for capital with other regions.

This discussion indicates that capital markets may be facing a problem of nonexistence of equilibrium similar to that of labor. Because of lack of infrastructure, very high marketing costs, complete absence of "economies of concentration", lack of proven production technology, and high risk, the rate of return to agricultural investments in the region is likely to be low. Likewise, the region's inability to attract private voluntary savings and to retain locally generated surpluses account for the small supply of investible resources but also serve as evidence of the relative attraction of alternative investments.

## 2. Equilibrating Mechanisms

If employment is not possible at any positive wage rate and if the market for investible resources does not clear at any positive rate of interest, the inevitable conclusion is that commercial agriculture in the Amazon presently may not be economically viable in the absence of government interference. However, the existence of subsistence and commercial agriculture shows that settlers adapt to the imbalanced factor markets.

For equilibrium in the labor market the labor supply curve must be shifted downward and/or the labor demand curve shifted upward. There are several ways to achieve this.

Employers have several means of dealing with labor scarcity under the described conditions. Legalized coercion through slavery and serfdom were used in the past,<sup>22</sup> but extra-legal forms of bondage can also be effective and are widely practiced throughout the Amazon. The most common is locally called aviamento, a system of debt peonage through which employers advance workers basic goods and foodstuff, sometimes cash, keeping them in debt and tied to the farm (Neto, 1979, Chapter 6). Another possibility is a settlement scheme to lure workers into the area with the promise of land ownership. However, this has met with only temporary success since workers are free to move with the frontier as it keeps expanding. A more permanent solution would be to "enclose" the area, thereby eliminating free land and denying workers the possibility of subsistence outside farm employment. However, the vastness of the area, political difficulties of implementing the idea, and the huge costs of policing enclosing regulations restrict the practical applicability of this option to fairly small areas. The cheapest alternative is to destroy alternative means of subsistence apart from wage labor. There are areas where farmers actually burn vast patches of forest to eliminate the possibility of most extractive activities.<sup>23</sup> By eliminating alternative forms of employment for wage labor the worker's reservation wage can be depressed, lowering the labor supply curve, and eliminating the possibility of a nonexistent equilibrium. It is important to note, however, that in the long run this will promote outmigration from the region.

An alternative/complementary solution to lack of labor market equilibrium can be reached through government interference. Subsidies to farming or ranching effectively raise the value of marginal productivity of labor schedule ( $VMP_L$ ), that is, the labor demand curve. A sufficiently large subsidy can eliminate

the problem of nonexistent equilibrium shown in Figure 2. Similar reasoning applies to the capital market.

### 3. Links Between Regional and National Markets

Unfortunately, efforts to subsidize local factor markets are not likely to be enough. The apparent paradox between labor scarcity and the inability of landowners to pay a competitive wage can be explained by closer examination of the Amazonian labor market and the conditions of production. Panel (a) of Figure 3 depicts the regional labor market after the equilibrating mechanisms of government subsidies and lowering of worker's reservation wage were put into effect.  $W'$  is the "equilibrium" wage rate.

The key to landowner inability to pay competitive wages can be found in the conditions of production and in the fact that the Amazon must compete for capital with other regions of Brazil, rendering it a price taker in the capital market. A useful device to illustrate these relations is the factor price frontier (Panel (b)), defined as all those combinations of factor prices which are consistent with a given output price, based on available technology (See Mussa, 1978).

This schedule tells us what the maximum wage can be for any given rental rate and output price. The crucial aspect of this for the present analysis is the fact that both rental rates ( $r^*$ ) and output prices ( $P^*$ ) are fixed for the Amazonian region by conditions in the rest of the country. If, as has been the case in recent years, interest rates are at high levels, and output prices for agricultural products are at relatively low levels, the maximum wage that can be paid (given available technology) may well fall short of that needed to attract workers. In the case illustrated by Figure 3, the equilibrium local wage rate,

$W'$ , is inconsistent with the rental rate,  $r^*$ , which prevails in the rest of the country. In other words given output prices,  $P^*$ , for the equilibrium wage rate  $W'$  to be acceptable to local employers the rate of return on the investment would have to be equal to  $r$  (Panel b). A higher rate of interest in the national capital market, say  $r^*$ , would require the local wage rate to be less than the equilibrium rate,  $W'$ . Low food prices (meaning a low  $P^*$ ) would have the similar result of making it impossible for Amazon employers to pay the minimum wage workers would demand.

Technological change can, by moving the factor price frontier out from the origin, create opportunities for non-subsidized production. However, as we have argued above, lack of support for research and lack of incentives at the micro level result in continuation of current land using techniques. The ability to use land costlessly (or nearly so) has an effect on the factor price frontier which is analytically similar to that resulting from technological change: the frontier is shifted out as the ability to extract surplus from the land raises the potential returns to the other factors, capital and labor.

#### 4. Factor Proportions and Pattern of Growth

The result of this situation is a built-in incentive to minimize labor use and maximize extensive use of land. To cope with the labor shortage farmers choose activities which require the least amount of labor. Hence the preference for extensive ranching and extraction of resources in once-and-for-all operations. Agriculture is turned into an extractive activity, similar to mining. In Marxist terminology, because they are unable to go for "extended reproduction", farmers have to settle for "primitive accumulation" of capital. At present, this is the only way Amazonian agriculture can be competitive.

The choice of activity and production technique is also influenced by capital scarcity. Temporary crops are given preference over more capital-intensive permanent ones. Large land owners adjust to capital and labor scarcity by concentrating on government subsidized, low productivity cattle ranching. Small settlers do the same by slashing-and-burning (or shifting field cultivation).<sup>24</sup>

The analysis leads to the conclusion that scarcity of labor and capital is but a symptom of the economic unworthiness of projects undertaken in the Amazon. Government support for regional development through funding of unsound projects has not attracted labor or capital on a permanent basis, hence the strong reliance on natural resources. A corollary to this conclusion is that the starting point of a program to stimulate resource-saving practices is to stop throwing money into economically inviable projects. The challenge of Amazon development is not to channel resources into the region but to keep capital and labor from fleeing it.

#### IV - POLICY IMPLICATIONS

##### 1. Conditions of Amazon Occupation

The picture of Amazon occupation which underlies the analysis is one that combines:

a) A large "open frontier," rich in timber, agricultural land, and other resources. But the resources are expensive to tap, there is not enough information for planned exploitation, and the market value of one of the most important these resources - timber - is unknown.



b) Lack of infrastructure, distance from markets, and environmental conditions favoring biological diversity over uniformity. Such constraints tend to limit agriculture to either small scale subsistence activities or to commercial production of just a few high-valued permanent tree crops (cocoa, black pepper, rubber, coffee), provided that varieties adapted to local conditions can be found.

c) Large numbers of dislocated people seeking land and a system of government incentives that fuels speculative demand for land. These two factors combined promote the outward expansion of the frontier. They also create political pressure for the government to facilitate the process through the opening of access routes.

d) A government too willing to foot the costs of opening up of the frontier. Under pressure to relieve social tensions (particularly through land reform) in the long settled areas, and under political pressure from poorer states for a larger share of federal spending, the government has tended to compromise. The attractiveness of development projects in the area is made even greater since they have provided a mean of obtaining loans from international lending agencies.

e) Finally, the Amazon is not the agricultural "Eldorado" that it has been made out to be. The experience of numerous agricultural and cattle ranching projects attempted in the area provides grounds for questioning the economic viability of such projects. The hiring of labor under capitalist-type contracts does not seem viable (on a permanent basis) and neither do non-subsidized investments. Under these conditions, the expansion of the agricultural frontier must continue indefinitely if production is to be maintained in the face of declining land quality. Failure in one area stimulates new attempts in another further ahead.

## 2. Recommendations

What can be done to reverse the trend of reckless exploitation of Amazon resources and promote sustainable development in the region?

The main goal of Amazon policy should be to break the pattern of agricultural expansion at the extensive margin and to stimulate modernization in the Amazon and elsewhere. Extensive expansion of agriculture can only be considered "economical" under three circumstances: (i) the costs of environmental degradation as well as of provision of social overhead (since both are public goods) are not accounted for or are negligible, (ii) discount rates are high, or (iii) alternative means of production expansion are not within reach.

To change the pattern of agricultural growth from extensive to intensive margin, it is recommended, first, that the process of "closing" the agricultural frontier be accelerated. Problems of surplus population and unemployment can be more cheaply and effectively dealt with in their place of origin. Escape valves may be convenient but in the case of the Amazon are not effective.

Second, the conditions which account for the speculative demand for land should be eliminated. Measures include: elimination of subsidies to agricultural credit and inputs, an end to agricultural tax breaks, introduction of a more effective land tax, and to stimulate agricultural production, a policy of high agricultural prices through a more aggressive commercial policy both externally and domestically (real devaluation of the exchange rate, investments in marketing infrastructure, food subsidy programs to low income classes).

Third, it is important to conduct research on tropical agricultural production, on evaluation of the Amazon resource base, and on the environmental impact of possible development projects. Unless more information is gained about the region's resources and about the dynamics of its ecosystem no rational development strategy can be formulated.

One question remains: How does one accelerate the process of closing the frontier?

We are referring to both the "internal" frontier of the farm, or unused land within the farm's boundaries; and the "external" (to the farm) frontier still open to the establishment of new farms.

To expedite the closing of the frontier, three sets of measures are envisioned: restriction of the total area that can be claimed for agricultural expansion, reduction in the size of the plots in colonization projects, and restrictions on free access to land.

Restriction of the potential agricultural area can be done through creation of national parks, demarcation of Indian land, creation of extractive reserves, and delimitation of areas that, because of the fragility of the ecosystem, should be declared off limits to agriculture. It also includes the agricultural "zoning" of the region. The environmental constraints on monoculture, cattle ranching, and on permanent crop cultivation should be mapped out and translated into regulations concerning the spatial distribution of activities. However, though these measures can protect some areas, they cannot by themselves address the larger problem of the open frontier.

The size of plots in settlement projects should be limited to something closer to the economically optimum scale of production for the technology recommended, in effect redressing the imbalance of factor proportions in settlement projects. Our proposal is that plots should be just large enough to fully occupy the available labor for each household under technically recommended farming methods. Instead of providing the colonist with a surplus of land (which will be used as a reserve of value), he should be provided with capital and technology since that is what is needed to expand production at the intensive margin. In addition to increasing yields and sustainability, limiting the size of plots has another effect that should not be taken lightly: by providing less land to each settler, more settlers can benefit.<sup>25</sup> It is important to realize that many areas currently being cleared will not support economically viable units under these circumstances. This is precisely the point; these areas are not generally suitable for long-term cultivation anyway.

Restriction on free access is admittedly a more controversial and difficult proposition to implement. Ideally, buying should replace squatting as the usual way of establishing an agricultural concern. The idea is not to restrict a person's access to an important form of wealth but to check the cycle of failure and destruction promoted by the present system of open access. To have all agricultural land divided up, fenced off, and titled would be one way to provide a foundation for agricultural development. To do so, however is extremely unpopular politically and would take decades to accomplish at best even if it were politically popular. In the meantime, what can realistically be done?

To restrict access to land in the Amazon is tantamount to restricting access to the area since many settlers will continue

to pursue land using methods of cultivation even without official sanction. Short of major reforms in the places where flows originate, the only cost effective way of reducing the number of migrants is to stretch out the schedule of road construction projects. Projects already under way should be consolidated but a moratorium on new projects should be imposed at least until the overall economic conditions improve enough to alleviate the "push factors" of migration.

#### V - AMAZONIAN AND BRAZILIAN DEVELOPMENT

One question supersedes all others when it comes to the discussion of the role the Amazon should play in the Brazilian economy: Should that region be a resource frontier to be exploited for the primary benefit of the rest of the country, or should local development be paramount? The Amazon region is viewed as a resource frontier by policy makers. The resources are in the Amazon but the centers of power are elsewhere. It is our belief that many of the problems of Amazon exploitation arise from its treatment as pool of resources to be mined. The links between the Amazon and the rest of the country in both factor and output markets not only retard regional development but are detrimental to the sustainability of resource exploitation with available technologies.

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Treating the Amazon as a resource frontier weakens the institutional and economic barriers which limit the intensity of resource exploitation which is the essence of sustainability.<sup>26</sup> Finally, the "colonial" status of the region and the desire of developers to extract surplus rather than reinvest retards the very economies of concentration which provided the rationale for the government's subsidized projects.

Local development is the only objective of Amazon projects that is compatible with natural resource conservation. As the country opens up its Amazon frontier, it is not the cultivated area alone that is being expanded. On the contrary, it is the entire breadth of Brazilian society that reaches out to the vast new region. As the agricultural frontier expands, Brazilian society with its strengths but also with its poverty, its internal conflicts, and its contradictions penetrates the Amazon.

There is no new start, as a planner would dream, but an extension into the region of what exists in the country both in terms of societal structure and economic conditions. However, there is one aggravating circumstance: in the peripheral areas, far away from the regulatory power of the state's bureaucracy and system of justice problems often progress to greater extremes than in the "center."<sup>27</sup> In most Amazon development projects likely to be implemented at the present time, we shall see Brazil exporting its problems to the Amazon rather than the Amazon contributing to Brazilian progress.

## Notes

1. Investigation of the cost effectiveness of Amazon agricultural development projects has been the object of numerous studies. The more detailed include those of Hecht et al (1988), Browder (1988), and Gasques and Yokomizo (1986). All of these studies focus on cattle ranching. Cunha (1988) presents theoretical reasons for the economic inviability of constant yield timber extraction under conditions prevailing in the Amazon.

2. The waste of valuable timber is illustrative of the kind of predatory exploitation that is taking place in the Amazon. The volume of standing timber in R ndonia, for instance, has been estimated at between 100 and 170 m<sup>3</sup> per hectare. "However, the effective yield per hectare is seldom more than 5 m<sup>3</sup> of timber, and sometimes as little as 1 m<sup>3</sup>" (World Bank, 1979, p. 63). Similar evidence is presented by Browder (1988): In a survey of 25 ranches benefitting from SUDAM incentives (Superintendence for Development of the Amazon) and 34 non-SUDAM ranches, he found that "only 35.6% of the ranches recovered merchantable timber in clearing forests. The other ranchers simply destroyed the timber" (p. 63). The social costs of Amazonian occupation have been discussed in numerous studies. A selection of the wealth of references on this subject can be seen in Hecht (1985), Mahar (1988), Goodland and Irwin (1975), and, especially, Fearnside (1986).

3. This figure is for "extractive activities" in the northern region (Grande Região Norte) which includes agriculture, logging, rubber tapping, and gathering of forest products, though this probably underestimates the actual population. According to Schwartzman and Allegretti (1987) the rubber tappers alone would comprise about 500,000 people.

4. Of course, lip service is paid to protection of Indians, largely under pressure from financing agencies. The delays in demarcation of Indian land and failure to enforce protection of demarcated reserves show what little regard the government has had for effective protection. For a detailed report on the situation of Indian tribes in face of Amazon occupation see CEDI (1986). The struggle of rubber tappers for establishment of extractive reserves is another illustration of the case (Schwartzman and Allegretti, 1987).

5. Statistics on malaria, mortality, and general living standards in the region of the POLONOROESTE project are presented in several evaluation assessments of the Project's monitoring commission. See for example, Sant'Ana (1985). A more comprehensive study is presented by Davis (1977). For a specific analysis of the malaria problem, see Vosti (1985).

6. These projects include Sinop, Cotia, Alta Floresta, Juruena, Cotrijui, Tucuma, and others, covering more than 2 million ha, mostly in northern Mato Grosso. As reported by Hall (1986. p. 413), "... despite many initial conflicts, difficulties and failures, [such projects] started to make a success of producing food and agricultural goods for export in what are growing into thriving communities."



7. "Underdeveloping," as Bunker (1985) calls it, is a more appropriate term to describe the process.

8. All these factors have indeed contributed to the environmental degradation of the region, which, however, does not mean that they constitute theories or explanations of root causes. Basically, they tend to treat the problems as the result of individual or policy mistakes. For instance, the issue of inappropriate technology, as Hecht (1985, p. 666) points out, has been called by Todaro (1977) "the false paradigm model," in which blame is put on "wrong" decisions. The same can be said of "defective planning" or of the "incompetence" of the poor. The "greed of the rich" is just a layman's expression for a common ownership externality, the so-called tragedy of the commons. "Vested interests of politicians" is admittedly a narrow interpretation of the political forces determining regional policies. Legitimate concerns, such as the desire to fully integrate the Amazon in the national economy as well as internal and external pressures (Hecht, 1985) have played important role in the design and implementation of Amazon policies. Finally, the "incompetence of the poor" metaphor is a typical case of blaming the victim (Wood and Schmink (1979)).

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9. Cultivated area in Brazil grew from 17.6 million ha in 1950 to 50 million ha in 1980. Increases in yields were modest throughout the entire period. Only in the present decade have sharp gains in yields been observed (IBGE, Anuario Estatístico do Brasil, various issues).

10. This, in fact, is the essence of the neoclassical explanation of why it has taken Brazil so long to modernize its agriculture. See, in particular, Nicholls (1972) Pastore et. al. (1974) and Alves (1983). A critical view of neoclassical arguments is presented by Santos (1986).

11. See Hayami and Ruttan (1985) for an exposition of theory and evidence supporting the idea of factor-price-induced innovation.

12. For a detailed and interesting description of agricultural technologies recommended for the Amazon, see Nascimento and Homma (1984).

13. According to neo-Marxist arguments, the ultimate objective of Amazonian colonization projects is to attract labor to the area. The colonists would then, through market or non-market mechanisms, be transformed into wage-earners (Ianni, 1979, Sawyer, 1979, Turchi, 1980, Brandford and Glock, 1985). In this regard, Hall (1986, p. 412), declares: "Thus, the increased level of state intervention in Amazonia has served to attract cheap labor to the region (to prepare the rainforest for agricultural use by later incoming livestock and other farmers, as well as to supply temporary wage labor on estates) without allowing substantial small-scale ownership to take hold in a 'preemptive' process of settlement by government and allied business interests." This argument is disputed by e.g., Bunker (1985), who, however, does not question either the overwhelming evidence of the pro-big business bias of the official colonization schemes or the fact that proletarianization of settlers is taking place at an enormous rate.

14. As Binswanger (1989, p. 20) notes, "Rules of public land allocation provide incentives for deforestation because the rules solidifying claims and ensuring maximum land areas encourage land clearing. A claimant is allocated two to three times the amount of land cleared of forest." Binswanger presents a detailed account of institutional, technological, and economic factors which provide incentives for deforestation.

15. Major sites include Tucuruí (Rio Tocantins), Balbina (Rio Uatuma) and Samuel (Rio Jamari, Bacia do Madeira).

16. Plano de Recuperação Setorial, ELETROBRAS (1986). Quoted from Seva, Oswaldo (1988).

17. Our source is Moran (1984), Table II, p. 378. The 8.4% figure refers to the category of "moderately fertile, well-drained soils," and encompasses the entire Amazon Basin, not only Brazilian Amazon. For more details on the controversial question of Amazon soil quality see van Wambeke (1978), and Herrera et al. (1978). Data for the POLONOROESTE region suggest a rosier picture. According to The World Bank (1981), quoting RADAMBRASIL, FAO, UNESCO, and the Bank's own mission estimates, 7.1% of the soil is classified as "good," 44.4%, "moderately so," and only 28.5% is considered "unsuitable" for agriculture (The World Bank, 1981, Table 12, p.58). The truth, however, is that all of these soil quality estimates are based on very small samples (which accounts for the widely ranging estimates). Nascimento and Homma (1984) cite research according to which good quality, eutrofic, Amazon soils would reach 12% of the total area. In this case, 50 million ha, roughly the area presently under cultivation in Brazil, would be available for expansion of cultivation.

18. To this day, squatting is still the most common way of obtaining land in the Amazon. A squatter who lives on unclaimed public land and has used it for at least one year and one day has a usufruct right over 100 ha. After five years he has the right to acquire a title. If the squatter lives on private land for five years without being challenged by the owner he can also lay claim to the occupied area (Binswanger, 1989).

19. For details on the size of plots in settlement projects of POLONOROESTE, see The World Bank (1981). The figures quoted are for the Oriented Settlement Projects (or Projetos de Assentamento Dirigido - PADs). Ten PADs were implemented in an area of nine million ha (Ianni, 1979, pp. 100-101). The figures are the same for projects implemented in the GETAT (Grupo Executivo de Terras do Araguaia-Tocantins, an executive group in charge of clearing land titles) area of Southern Pará. SUDAM projects are much larger, with farms averaging 23.600 ha (Gasques and Yokomizo, 1986).

20. Graham and Hollanda (1971), Cunha and Maia (1984). Specific information on rural labor mobility, although for the state of São Paulo, is provided by Saylor (1974). Saylor estimates the long run labor supply elasticity in São Paulo agriculture to be equal to three.

21. This discussion brings to mind what is known in the literature as the "Domar-Wakefield hypothesis," which says that you can have either free labor or free land, but not both. See Wakefield (1967 and 1969). Domar (1970) elaborated on Wakefield's ideas. It is interesting to note that an entire chapter of Marx's Capital (Chapter 33, Vol. 1) is devoted to a discussion of Wakefield. In Brazil, Martins, R. (1980) and Martins, A. and Martins, R. (1983), use Wakefield's hypothesis to explain the

expansion of slavery in the state of Minas Gerais (in the XIX century), a region which had retreated into subsistence economy. Abundance of land and shortage of labor are what, according to those authors, account for the vigorous expansion of slavery in that State when neither mining nor an export boom were taking place. We are thankful to Tom Holloway for calling our attention to this point.

22. Actual cases of "slavery" have occasionally been reported in the Brazilian press in recent times.

23. This practice has been observed by the author in Eastern Pará (near Marabá), an area rich in brazil nuts which can provide an alternative to wage labor on cattle ranches.

24. Binswanger (1989) calls attention to the high cost effectiveness of shifting field systems of cultivation under prevailing conditions.

25. Binswanger (1989), proposes a lower ceiling for land allocated to a single owner.

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26. The role of institutional barriers in reducing the intensity of resource exploitation is pointed out by Perrings (1989).

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27. This point is taken up by Bunker (1985).

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Table 1. Population, Land and Income (all figures in millions except where noted).

	<u>North</u> <sup>1</sup>	<u>Brazil</u>	<u>Percent</u>
Population in 1980 <sup>2</sup>	6.1	121.3	5.0
Economically Active Population in 1989 <sup>3</sup>	2.3	58.5	4.0
Land Area in Km <sup>2</sup>	3.6	8.5	42.0
GDP in 1980	Cr. 367	Cr. 11,375	3.0
Agricultural Product	Cr. 61.1	Cr. 1,232.1	5.0
Per Capita Income	Cr. 60.35 (per person)	Cr. 93.78 (per person)	64.0

1 Rôndonia, Acre, Amazonas, Roraima, Pará, Amapá.

2 Source - IBGE.

3 Source - Contini and Oliveira (1984).

Table 2. Potential Land Use (in 1000's of km<sup>2</sup>).

	<u>North</u>	<u>Percent of National Total</u>
Total Area	3,607	42.3
Area to be Preserved	804	9.5
Area to be Preserved (with some secondary exploitation)	332	3.9
Area for Extractive Activities	2,089	24.5
Pasture	69	0.8
Crops	315	3.7

Source: EMBRAPA

Table 3. Wages in Northern Region and Brazil in 1986.

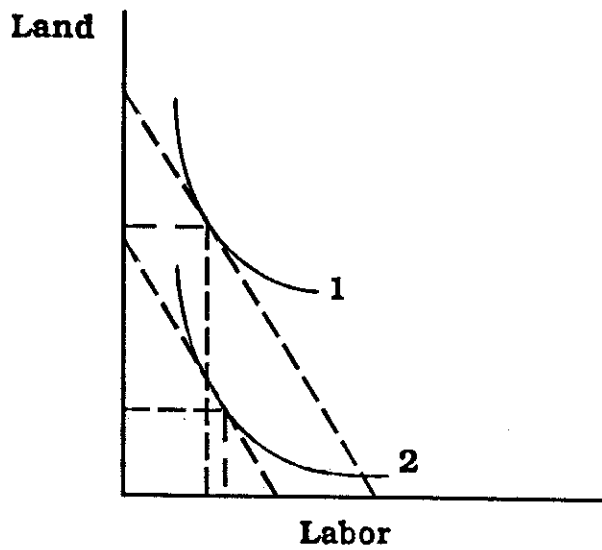
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	<u>North</u>	<u>Brazil</u>
Temporary Daily Labor	Cz 49.17	Cz 42.95
Permanent Monthly Salary	1,031.71	926.47
Tractor Operators	2,231.38	1.432.63

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Source: Fundação Getulio Vargas, Conjuntura Economica, various issues.

**FIGURE 1.**



**FIGURE 2.**

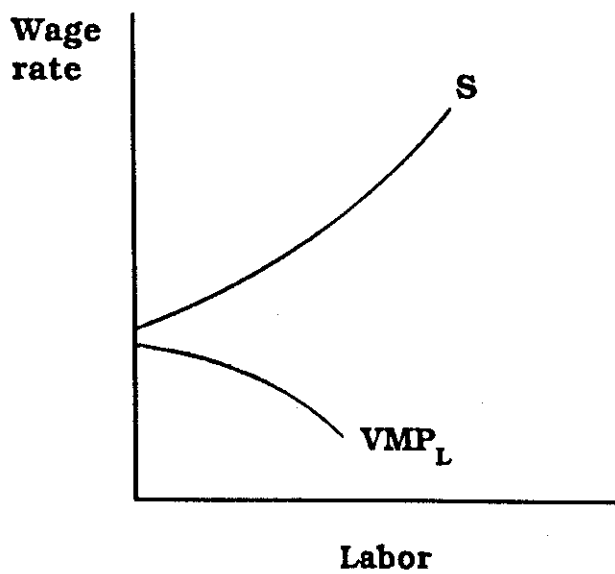
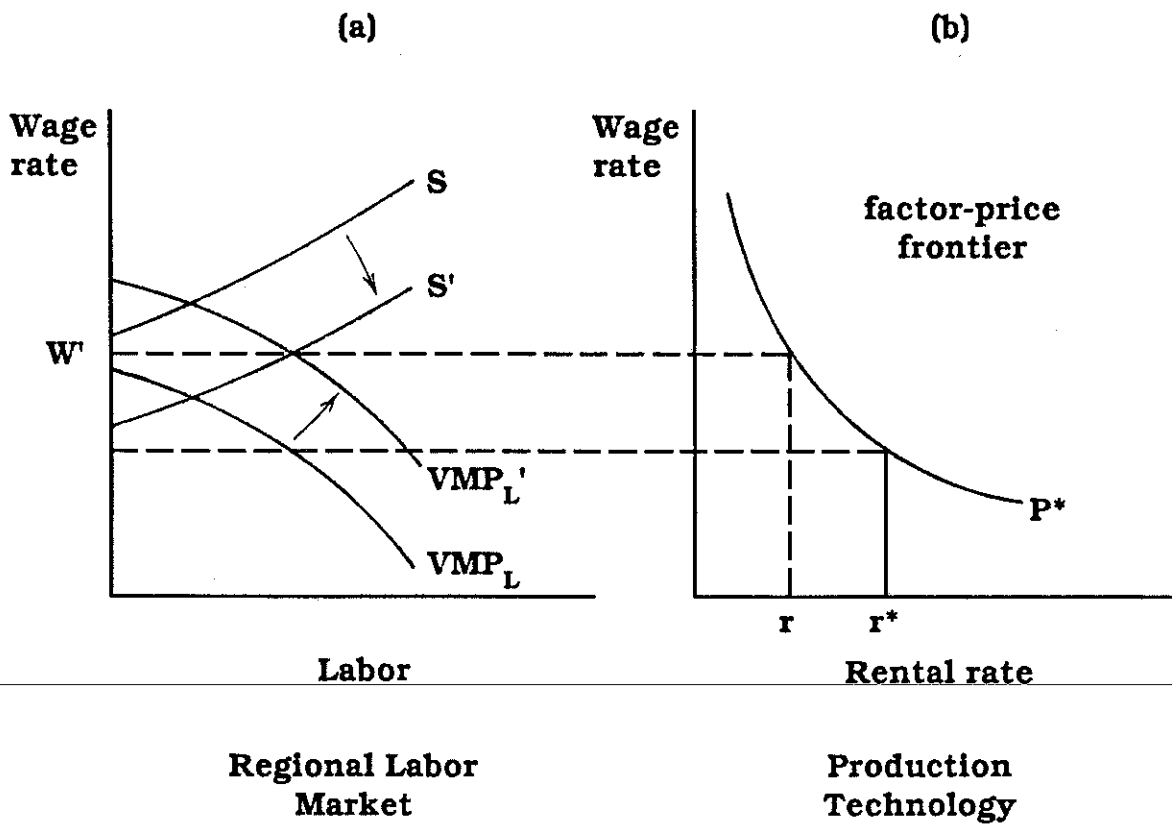


Figure 3.







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