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# Government and the Economy on the Amazon Frontier

Robert R. Schneider



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# **Government and the Economy on the Amazon Frontier**

Robert R. Schneider

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## EXECUTIVE SUMMARY

Inexpensive, relatively uninhabited land still exists in many Latin American countries. This land continues to act as a magnet for both squatters and entrepreneurs in search of new economic opportunity. The current pattern of development often results in violent conflict and wasteful environmental damage. For this reason, governments in Latin America are increasingly struggling to develop policies to rationalize the settlement and development of these areas. Should government enforce laws in remote, frontier areas? Should it provide schools? Health care? Should it create new states and provide representation in Congress? If so where, and how? These are the sorts of questions many governments are facing. The Bank is also involved: in policy development in the forest sector, in land use policy implemented through environmental and agroecological zoning projects, and through land tenure and land registration projects. Through its responsibilities in the Global Environment Facility and the Pilot Program to Protect the Brazilian Rainforest, the Bank is also forced to confront difficult tradeoffs concerning frontier policies. As manager of the Global Environment Facility, the Bank is regularly asked to create mechanisms to ensure that biodiversity reserves receive long-run protection against encroaching development. Similarly, under the Pilot Program to Protect the Brazilian Rainforest, the Bank and the Brazilian government are attempting to make "sustainable development" a reality.

This report addresses some of these issues. It is a first step only. It illuminates the special characteristics of the overall political-economic context confronting frontier governments. The report's motivation comes from concern that too many of the frontier policies currently promoted by the Bank and others are not politically sustainable. More attention must be given to the political environment on the frontier and how it is conditioned by economic interest. Frontier

economies have special characteristics determined largely by an abundance of land and a sparsity of people and capital. Frontier governments also have predictable characteristics, mostly determined by their economic context and physical remoteness. In large measure these features condition the outcome of government initiatives in frontier areas. Most of the data and observations in this report come from Brazil. Many of the arguments and conclusions are general, however, and rely on the economic logic of frontier settlement rather than on institution- and location-specific issues.

The main messages of the report are the following:

- Settlers in the Amazon *do* appear to be improving their standard of living compared to people with the same education and skills outside the Amazon.
- Transience and farm turnover on the frontier is due to powerful and fundamental economic forces. These forces can only be overcome by well-organized government policy.
- Transience, farm turnover, and even apparent land abandonment are *not necessarily* linked to degradation of the agricultural resource base.
- More attention needs to be given to the importance of reconciling the needs of local politicians with externally designed projects. Particularly important is the need to find ways to develop sustained support for the rural development services that encourage small farmer stability.
- Creating a political coalition to support policies for orderly frontier development is difficult. Because the interests in more rapid development are largely local and regional, and the benefits from

slower, more deliberate growth are national and global, greater political and economic autonomy at the local and regional level may tend to undermine better settlement policies.

- Roads are the fundamental determinant of settlement. An *extensive* road network erodes incentives for sustainable agriculture and silviculture. An *intensive* network of farm-to-market roads is the most important determinant of economic viability of small farmer agriculture.
- Allocating land initially to small farmers is not only a good policy from an equity standpoint, but in most cases it is the most efficient and orderly way to settle new lands.
- National governments must define their objectives carefully with regard to establishing government beyond the economic frontier.<sup>1</sup> Here also, local and national interest are unlikely to coincide.

These messages and their policy implications are outlined below.

**Standard of Living in the Amazon.** A number of studies on performance of Amazon colonization have recently been completed. They paint a picture of surprising agricultural and developmental success. Specifically, they show (a) better results in terms of incomes and asset growth from official colonization projects in the Amazon than from any region in Brazil other than the South, (b) evidence of increasing yields at the farm level, and (c) substantial investment in profitable new pasture technologies in consolidating areas. Measured by Gini coefficients, land distribution in the Amazon is substantially better than for Brazil as a whole and trending toward greater equality. Infant mortality in the Amazon remained higher than elsewhere, however.

**Economic Determinants of Transience and Farm Turnover.** Despite relatively good

economic performance, farm turnover in the Amazon remains high. Transience and instability on new frontiers primarily occurs because the earliest settlers, those extending the frontier at the extensive margin, tend to be relatively disadvantaged in terms of physical and human capital. People with low physical and human capital, and little opportunity to do well elsewhere, are most likely to endure the deprivation and health risks associated with opening new lands on the frontier. People with somewhat higher opportunity costs are likely to wait until the frontier is better established before they take the risk. Those who are fully incorporated in the national (or international) economy will generally wait until government is relatively well established, and until property rights are clarified and enforced, before they consider putting life and capital at risk.

As long as new roads are being built, and no program of well-articulated, offsetting policies is in place, early settlers will generally sell out to a better-endowed second-generation of (often urban-based) buyers. This probability grows with (a) increased availability of new land, (b) widening difference in access to credit between the early settlers and the second generation buyers, and (c) the difference in accessibility of government services (education, health, official credit, agricultural research and extension, marketing, and land tenure services) to the early settlers and the entrepreneurs. Later migrants (entrepreneurs) have lower discount rates due to better access to credit, and they are better able to take advantage of government services. These advantages are reflected in the purchase price they are willing to offer earlier settlers. These advantages virtually guarantee that the early settler can be bid off the land by newcomers.

**Determinants of Farm Turnover and Land "Abandonment."** Popular discussion of land abandonment in the Amazon tends to blame "land degradation" and falling yields. Undoubtedly some agricultural land is being degraded in frontier areas: the economics of

cheap, easily accessible land tends to promote mining of the nutrients. With land nearly free it is cheaper to move the farm to the nutrients than to buy fertilizers and carry them to the farm. Nevertheless, other explanations are more consistent with the available empirical evidence, which shows (a) relatively high income and asset growth combined with rapid farm turnover and apparent abandonment, and (b) generally increasing yields through time at the farm level. The paradox of rapid farm turnover and land abandonment is better explained by changes in property rights regimes than by land degradation.

In Brazil, there have been two periods of farm turnover and apparent land abandonment. The first occurred when entrepreneurs from the formal sector were encouraged by government to prematurely (relative to potential profitability) establish ranches in new frontier areas. These entrepreneurs became discouraged. They abandoned their claims when they realized that, due to remoteness, (a) cattle ranching did not pay as well as alternative investment, and (b) the government was not willing (or able) to protect property against invasion by squatters (who *did* find farming in the Amazon competitive with their alternatives elsewhere).

The second abandonment (a reverse of the first) is occurring now in many colonized areas of Pará and Rondônia. It occurs when property rights become secure enough for urban-based speculators to leave land idle without fear of invasion. Because of their superior access to credit and government services, it is relatively easy for these entrepreneurs to bid the earlier settlers off the land.

**Stability and the Needs of Local Politicians.** As outlined in an excellent OED review of the determinants of success in rural development projects in Brazil's Northeast, support from local and regional politicians for the *outcome* of the project is a critical determinant of success. Where project components could be timed to correspond with the electoral cycle, or could be visibly associated

with the individual leaders (e.g., the governor) the probability of success improved greatly. Where this was not the case, the project faced the risk of being diverted to fulfill short-term budget needs or used to pay off political debts. The challenge to the Bank and to national governments is to resolve possible conflict between the nature of initiatives most likely to increase electoral success, (e.g., infrastructure development) and activities that lead to the highest quality development (e.g., sustaining *recurrent costs* of rural education and health care, farm-level agricultural research, improved rural banking services). Where services required for stable frontier development *cannot* be structured to attract the necessary support, responsibility for these services should be moved to a level of government which faces more consistent incentives.

**Problems of Forming a Coalition for Sustainable Development.** When a frontier economy rests on mining the natural resource base (i.e., timber, minerals, nutrients), relatively few frontier people have an incentive to see the process slowed. Long-run benefits of "rational" development tend to accrue globally and to future generations. Where offsetting coalitions for sustainable development cannot be identified, the Bank and donors must be realistic about the political sustainability of reforms, especially those intended to reduce access to resources, such as zoning, land use planning, and logging or forest clearing restrictions. Decentralization worsens the prospect, especially if it increases untied transfers and reduces the leverage of central government over states and municipalities (as Brazil has been doing since 1989).

**New Roads and Land as Collateral.** By putting new land on the market, new roads tend to prevent agricultural land prices from rising. This effect is compounded, if (as is generally the case on the frontier) tenure is insecure, land cannot be used as collateral, and (therefore) credit is not available to bid away economic rent. This situation creates uneconomically

cheap land; it in turn promotes excessively extensive use of the land. This result has both negative equity effects and negative environmental effects. Negative equity effects arise because successful smallholders cannot use their proven success to purchase more land on a collateral basis, while relatively well-off outside entrepreneurs can use urban collateral or their own capital to purchase land cheaply without competition from local smallholders. Negative environmental effects accrue because (a) underpriced land encourages resource mining, and (b) the combination of insecure tenure and underpriced land encourages deforestation, cattle ranching, and other activities that effectively occupy the land at low cost.

#### **The Importance of Initial Land Allocation.**

Land allocation policy should promptly grant title to the initial smallholder occupants. This action promotes both equity and efficient occupation of frontier land. It is efficient because the low opportunity cost of initial squatters ensures that they are the first to actually *occupy* the land. The alternative policy of titling large formal sector entrepreneurs, who will *not occupy* the land (because it will not pay *their* higher opportunity cost), leads to inevitable conflict and uncertain land security for all involved. This lesson is clearly demonstrated by years of violent land conflicts in southern Pará. Allocating to early squatters is equitable because (a) if they stay, land security will allow them to

farm more rationally and profitably, and (b) if they sell out, they can bargain a better price.

#### **The National Interest in Imposing Government Beyond the Economic Frontier.**

Generally, frontier governments *emerge* as economic activity and population respond to new economic opportunity. In some cases, however, central governments decide to *impose* outposts of government beyond the economic frontier, generally for strategic or national security reasons. Where government expenditure creates the economy, nearly all economic activity responds to derived demand from the imposed government. The national interest that established these outpost economies should be kept firmly in mind, and the role of government should be limited to (a) the primary objective for which the outpost was created and (b) ensuring a reasonable quality of life for the population attracted by the government's activity. Investment in "development" in these areas, however, is premature, and almost never a good use of public resources.

#### **Notes**

1. For the purposes of this report the economic frontier is defined as the point where, as one moves from developed areas toward the unintegrated wilderness, the marginal laborer could just cover his opportunity cost (generally as a squatter).



# PART I

## GOVERNMENT, EQUITY, AND STABILITY ON THE AMAZON FRONTIER

### *Introduction*

Much has changed in the 23 years since Brazilian President General Medici launched the project that would "bring men without land to a land without people." Partially as a result of government's subsequent efforts, between 1970 and 1990 the population of Brazil's Amazonian states doubled to some 9 million inhabitants, more than half of whom live in cities. No one any longer considers Amazon colonization to be a panacea for problems of equity and development. In fact, the popular perception is that Amazon development in the Brazilian context has been an economic, distributional, and environmental disaster. This perception notwithstanding, Amazon states have developed increased financial and political autonomy to pursue economic development as they conceive it. In addition, the experience and perception of leaders of Amazon states is often at variance with that of the wider public.

The purpose of this report is threefold. First, it reviews the available evidence concerning the effectiveness of Amazon settlement and development in terms of generating incomes, equity, and stable growth. Surprisingly good results are currently being reported with regard to colonists' incomes, accumulation of assets, and trends in asset (land) distribution. Nevertheless, substantial land turnover is evident, and land degradation and abandonment continues to be reported. Chapter 2 analyzes the forces that promote turnover and abandonment, despite the relatively good economic results reported in Chapter 1. Chapter 3 introduces the role of government and analyzes the various forces that bring government to the frontier. It analyzes the implications for government as an investment in the development of the Amazon, as well as the role of government in stabilizing frontier land use.

### *Review of Recent Evidence on Farming and Ranching in the Amazon*

Much of the economic activity in the Amazon in the 1970s and 1980s was stimulated by government policies, in particular subsidized credit, regional fiscal incentives, and differential taxation (Binswanger, 1989; Mahar, 1989; Schneider, 1992). From this fact many observers have concluded that economic activity in the Amazon was *the result of* such government activity. More recent evidence, however, indicates that economic activity (particularly cattle ranching) in the Amazon is taking place on a scale larger than can possibly be explained by these incentives policies. The evidence also indicates surprisingly good economic success in agriculture sustained over a relatively long period. The following paragraphs review these findings.

### *Limited Role of Official Incentives*

Approximately 100,000 km<sup>2</sup> of native forest have been converted to pasture over the past 30 years, allowing the number of cattle in the north to grow from 1 million in 1950 to more than 5 million in 1985 (see Table 1.1).<sup>1</sup> Much of this growth was encouraged by government policies in the form of fiscal incentives, tax policy, and land tenure policy. It would seem logical that the recent policy changes, which have largely terminated subsidies to the cattle industry, would discourage ranching in the Amazon. However, data from the last agricultural census, discussed below, indicate that the most rapid growth has taken place in small farms unlikely to have received government assistance. This finding suggests that other factors besides government policies are currently likely to be responsible for the growth of ranching in the Amazon.

Table 1.1: Growth of Cattle in the Northern Region, 1920-85

	1920	1940	1950	1960	1970	1975	1980	1985
Head of Cattle								
NORTH	869,108	999,041	1,020,305	1,234,882	1,706,127	2,129,609	3,989,113	5,358,578
Pará	615,481	705,524	735,529	844,740	1,043,648	1,441,851	2,729,796	3,485,368
Amazonas	238,449	270,180	87,440	141,424	263,437	203,437	355,748	420,940
Acre	15,178	23,337	25,020	32,516	72,166	120,143	292,190	333,457
Amapá	--	--	31,010	45,476	64,990	62,660	46,079	46,901
Rondônia	--	--	2,052	3,475	23,125	55,392	251,419	768,411
Roraima	--	--	139,254	167,251	238,761	246,126	313,881	303,501
Average Annual Rate of Growth								
NORTH	--	0.7%	0.2%	1.9%	3.2%	4.4%	12.6%	5.9%
Pará	--	0.7%	0.4%	1.4%	2.1%	6.5%	12.8%	4.9%
Amazonas	--	0.6%	-11.3%	4.8%	6.2%	-5.2%	11.2%	3.4%
Acre	--	2.2%	0.7%	2.6%	8.0%	10.2%	17.8%	2.6%
Amapá	--	--	--	3.8%	3.6%	-0.7%	-6.1%	0.4%
Rondônia	--	--	--	5.3%	19.0%	17.5%	30.3%	22.3%
Roraima	--	--	--	1.8%	3.6%	0.6%	4.9%	-0.7%

Note: Rondônia, Roraima and Amapá were created in 1943. Previously, the data for the first two were incorporated in Amazonas and that of Amapá was incorporated in Pará. This explains the sudden fall for Amazonas between 1940 and 1950.

Source: Agricultural Census, 1940, 50, 60, 70, 80 and preliminary census for 85.

Table 1.2: Cattle in the Northern States: Composition by Size of Herd (1985) and Rate of Growth by Size of Herd (1980-85)

Comp.Growth	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Comp.Growth		Comp.Growth		Comp.Growth		Comp.Growth		Comp.Growth		Comp.Growth		Comp.Growth	
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<10	6	154	6	26	4	42	1	160	2	60	2	66	3	72
10 to <20	9	202	7	26	7	20	1	134	3	66	5	26	4	77
20 to <50	20	241	11	35	15	12	4	94	8	52	15	31	10	70
50 to <100	16	254	10	36	15	4	5	42	8	35	16	-7	10	51
100 to <200	13	248	9	28	15	-3	8	-8	12	61	16	-2	12	56
200 to <500	11	130	14	29	20	23	27	3	15	40	19	-11	16	37
500 to <1,000	7	111	10	9	9	18	30	-6	12	20	13	-37	12	18
1,000 to <2,000	6	254	10	-3	7	12	14	-36	10	3	15	432	9	6
2,000 and more	11	257	24	-5	9	169	8	26	30	14	0	-100	24	20
Total	100	206	100	14	100	18	100	-3	100	28	100	2	100	34
<b>Addendum:</b>														
1985 herd size														
(head)														
	768,411		333,457		420,940		303,501		3,485,468		46,901		5,358,678	

Source: 1985 Preliminary Agricultural Census.

Table 1.2 shows that for the north as a whole (far right column of the table) there is a clear inverse relation between the size of herd and the rate of growth. Herds smaller than 50 head represented (in 1985) 17 percent of all cattle in the north, and grew over 70 percent between 1980 and 1985. Cattle in herds of between 50 and 500 head represented 38 percent of all cattle and grew at an average of about 47 percent. More than 45 percent of all cattle in the north were in herds of 500 or more, but these grew by only 17 percent. Only in Rondônia, which had the highest rate of cattle growth in the region, did this inverse relationship not prevail. Roraima lost 2 percent of its total cattle population--all from herds larger than 200 head; the number of cattle in herds smaller than 200 grew by 80 percent.

The two forms of direct government incentives to livestock production in the north have been subsidized credit and regional fiscal incentives. Taken together, these have represented on the order of US\$300 million per year over the period 1970-88 (see Table 1.3). The fiscal incentive takes the form of a tax credit equal to the investment for firms willing to invest in approved projects in the north. *Unlike the fiscal incentive, agricultural credit is available throughout the country; the north region receives 3-4 percent of Brazil's livestock credit.*

Both forms of incentives are biased toward large farms. SUDAM-approved projects averaged 13,375 hectares in size in 1989. Pará, which received some 70 percent of the SUDAM livestock projects in the northern region, had an average project size of 9,500 hectares in 1988. According to the preliminary 1985 agricultural census, 289 of the 11,175 livestock operations in Pará were larger than 5,000 hectares. SUDAM-approved projects in 1985 numbered 253--suggesting that nearly 90 percent of the farms over 5,000 hectares received incentive payments. Although no comparable data is available for livestock credit, the large-farm bias of subsidized agricultural credit is well established. Demand for credit exceeds supply, and approval practices emphasize minimizing transaction costs, thus favoring fewer large loans over numerous small ones. In 1985, for example,

only about 6 percent of the livestock enterprises in the north received credit from official sources.

Based upon calculations in Annex A, Table 1.4 indicates the number of cattle likely to have been on ranches benefitting from subsidized credit and fiscal incentives in 1980 and 1985. The minimum farm size likely to have received credit subsidies is shown in bold. The minimum farm size for FINAM credits is underlined. This calculation is based on the assumption that fiscal incentives and subsidized credit go to the largest farms first.<sup>2</sup> For the north as a region, the results are as follows: subsidized credit covered 78 percent of cattle in 1980 and 63 percent in 1985 (on 13 percent and 6 percent of the ranches); SUDAM-FINAM incentives covered 17 percent of the cattle in 1980 and 25 percent in 1985 (on 0.2 percent and 0.4 percent of the ranches, respectively).

In view of the Amazon's future, Table 1.4 calculations draw this most important conclusion: The government's subsidy policy is unlikely to be currently playing an important role in the recent rapid growth of the cattle population. While Table 1.2 shows, on the one hand, that since 1980 the most dynamic sector of the north's livestock industry is farms with fewer than 100 cattle, Table 1.4 shows, on the other hand, that only in Amapá was it likely that FINAM credits reached farms under 1,000 head of cattle; furthermore, subsidized credit could not be expected to have gone to farms under 100 head. To account for this recent growth of cattle ranching in the Amazon it therefore is necessary to look beyond government transfers.

### *Reasonably Good Success*

**Mattos, Uhl, Goncalves Paragominas Ranching Study.** It has been 30 years since cattle were first introduced into the Paragominas (Pará) region of the eastern Amazon. During that time there has been much experimentation, research, and development and adaptation of both pasture grass varieties and cattle breeds. To assess the economic and agronomic viability of the current state of cattle ranching in the area, Mattos, Uhl, and Goncalves<sup>3</sup> surveyed both

**Table 1.3: Direct Incentives to Livestock  
Fiscal Incentives (FINAM) and Subsidized Credit, 1971-87  
(in millions of 1990 US\$)**

Year	Fiscal Incentive	Livestock Credit	Total	Real Interest (%)
1971	345	35	381	-5.8
1972	214	72	285	-2.7
1973	131	89	220	-2.6
1974	209	76	285	-16.4
1975	238	151	389	-13.0
1976	265	229	494	-23.0
1977	108	152	261	-17.8
1978	134	164	298	-19.0
1979	88	183	271	-35.6
1980	102	99	201	-38.8
1981	174	97	270	-25.6
1982	250	137	387	-27.3
1983	134	91	225	-36.1
1984	168	53	221	-1.6
1985	153	52	204	-3.8
1986	303	204	507	-35.5
1987	156	100	256	NA

Note: Deflated by IGP-DI to 1977. Then converted to 1990 US\$.

Sources: Central Bank of Brazil and "Anuário Estatístico do Brasil."

### Box 1.1: Fiscal Incentives and Deforestation

A direct measurement of pasture converted under fiscal incentives was carried out by INPE (under contract from SUDAM) for the two states which had received the bulk of the fiscal incentives, Mato Grosso and Pará (reported in Yokomizo, 1989). Out of the total of 84,000 km<sup>2</sup> of land occupied by FINAM-supported projects, 70,000 km<sup>2</sup> were these two states. Their study revealed that of the 70,000 km<sup>2</sup>, 40,000 was approved for pasture use, and in fact, slightly less than 20,000 km<sup>2</sup> was actually cleared. Total deforestation in these states since 1975 was on the order of 156,000 km<sup>2</sup>. Thus, in the area where fiscal incentives had been most concentrated, they accounted for approximately 16 percent of the deforestation--21 percent before 1970 in Mato Grosso and 7.5 percent in Pará (excluding deforestation before 1970). For Pará they accounted for approximately 20 percent (6,600 km<sup>2</sup>) of the growth of land in pasture over the period.

**Table 1.4: Approximate Number of Cattle on Farms Benefiting from FINAM Incentives and Official Credit, 1980 and 1985**

Minimum Farm Size (head of cattle)	Distribution of Establishments and Cattle (% of total)													
	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Estab. <sup>a</sup>	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle
<b>1980</b>														
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10	46.6	92.2	43.5	94.3	67.6	96.6	84.6	99.7	60.9	98.5	83.2	98.8	58.1	97.7
20	27.1	82.9	23.5	87.8	45.6	90.2	74.0	99.1	44.6	96.0	64.0	95.1	40.1	94.3
50	10.2	65.0	10.3	78.3	21.7	74.4	60.5	97.2	24.2	89.2	36.2	83.3	20.8	86.1
100	<b>4.4</b>	<b>51.1</b>	5.4	70.2	<b>10.1</b>	<b>57.5</b>	48.4	93.5	<b>13.8</b>	<b>81.5</b>	17.0	66.1	<b>11.6</b>	<b>77.3</b>
200	2.1	40.1	3.0	62.5	3.9	39.5	<b>34.2</b>	<b>84.8</b>	7.4	72.0	<b>8.2</b>	<b>49.7</b>	6.1	67.1
500	0.6	25.0	<b>1.3</b>	<b>50.2</b>	1.0	20.7	15.0	59.1	3.1	57.9	2.4	28.4	2.5	51.7
1,000	0.2	14.9	0.7	40.1	<b>0.3</b>	<b>11.4</b>	4.3	27.6	1.4	45.1	<b>0.3</b>	<b>7.4</b>	1.0	38.0
2,000	<b>0.1</b>	<b>9.6</b>	<b>0.4</b>	<b>28.7</b>	0.1	4.0	<b>0.6</b>	<b>6.3</b>	<b>0.6</b>	<b>33.3</b>	0.2	4.6	<b>0.4</b>	<b>26.4</b>
<b>1985</b>														
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10	54.2	93.6	44.2	93.7	61.4	96.0	75.5	99.2	61.7	98.1	78.1	98.0	58.3	97.1
20	32.8	84.3	24.5	86.6	40.2	89.5	59.8	97.7	43.5	94.9	57.9	93.5	38.8	92.6
50	12.3	64.3	10.3	75.3	18.3	74.4	41.4	93.9	22.5	86.7	27.1	78.3	18.5	82.2
100	<b>4.8</b>	<b>48.3</b>	<b>5.2</b>	<b>65.6</b>	<b>8.6</b>	<b>59.5</b>	29.9	88.5	<b>13.1</b>	<b>78.6</b>	13.3	62.6	9.9	72.3
200	1.8	35.7	2.8	57.1	3.8	44.8	21.2	80.2	6.4	66.6	6.1	46.7	<b>4.8</b>	<b>60.5</b>
500	0.6	24.3	1.1	43.1	1.0	25.2	<b>8.6</b>	<b>52.7</b>	2.4	51.2	<b>1.8</b>	<b>28.0</b>	1.7	44.7
1,000	0.2	17.4	0.5	33.5	<b>0.4</b>	<b>16.0</b>	1.9	22.3	1.0	39.2	<b>0.7</b>	<b>15.0</b>	0.7	32.7
2,000	<b>0.1</b>	<b>11.3</b>	<b>0.2</b>	<b>23.8</b>	0.1	9.0	<b>0.4</b>	<b>8.2</b>	<b>0.4</b>	<b>29.7</b>	0.0	0.0	<b>0.3</b>	<b>23.6</b>

Note: Shaded numbers indicate range where cutoff of subsidized credit was likely. Numbers inside double border indicate cutoff for FINAM incentives. See Annex A for calculations.

a. Establishments.

Source: 1985 Preliminary Census, SUDAM (in Yokomizo, 1989), Banco do Brasil, and Ministry of Finance and author's calculations.

large-scale and small-scale ranchers in the Municipality of Paragominas. For the survey of large-scale ranchers, 27 property owners were picked at random from a list of 300 ranches furnished by the National Institute of Colonization and Rural Reform (INCRA). These 27 ranchers owned a combined total of 223,200 hectares or 10 percent of the area of Paragominas. For the small-scale ranches, 22 small property holders (less than 100 ha.) were studied in the community of Uraim, located 10 km from Paragominas.

In summary, Mattos, Uhl, and Goncalves find that ranching, in a variety of circumstance, is economically viable in the Paragominas Region of the eastern Amazon. Rather than increasing degradation and abandonment, they find that ranchers with large and medium holdings are rejuvenating degraded pastures, which consists of removing debris, ploughing, fertilizing, and reseeded with improved forage varieties. The cost of pasture rejuvenation is reportedly \$260/ha. Live-weight production is increased from 45-65 kg/ha/yr to 150-250 kg/ha/yr. Profits are increased from \$8-\$24/ha/yr to \$50-\$100/ha/yr, and the return on investment is 13-14 percent. Small property holders are also intensifying, focusing on calf and dairy production. In this sector the capital investments are in the range of \$215/ha, generating profits of \$125/ha/yr and yielding a return on investment of 16 percent.

#### **Colonization and Settlement Schemes.**

Recent studies on settlement and agriculture in the Amazon (also see Annex B) indicate that, in economic terms, agriculture in the Amazon is also doing relatively well. Moran's analysis of settlement stages warns us to expect a period of "learning by doing" before judging the ultimate success of settlement. The recent survey of private and public colonization projects by Ozorio de Almeida finds relatively good economic success. A wider study by FAO finds Amazon projects competitive with similar projects in the South of Brazil and much more successful than those in the Northeast. An econometric study in Rondônia finds no loss of incomes or yields associated with length of stay

on plot, and no systematic relationship with soil classification. The following discussion reviews this evidence.

**Moran's Stages of Colonization.** In a review of experience with colonization programs in Latin America, Emilio Moran (1989a, 1989b) emphasizes that colonization is a process of adaptation to a new environment, of learning by doing. Moran's stages approach (see Annex B, Table B.1) emphasizes three important points: (a) it is inappropriate to judge the success of colonization efforts while farmers are still in the learning and adapting stage of settlement; (b) production and equity objectives are often inconsistent; and (c) the role of government in creating settlement projects is generally negative, encouraging migrants to act on government promises, too often broken, rather than on the basis of their own information and strategies.<sup>4</sup> Poverty and mobility are closely related: previous mobility is a strong predictor of future mobility, and crop yields are negatively related to the number of previous migrations of the owner.<sup>5</sup>

**Ozorio's Longitudinal Study.** Preliminary results of a recent study of five settlement projects in the Brazilian Amazon (Ozorio de Almeida, 1992) provides evidence surprisingly consistent with Moran's description. The study is based on field interviews in 1981 and 1991. Nearly 400 farmers were interviewed in 8 colonization schemes established in the 1970s. All of the settlement schemes originated as directed settlement. Four in Pará were established as government projects. The other four are in Mato Grosso; they originated as private settlement enterprises. Current occupants were interviewed, regardless of whether or not ownership had changed. This method permitted data to be collected on many factors, including rate of turnover, yield changes through time, and changes in land values (see Annex B, Table B.2).

Several conclusions emerge: First, consistent with Moran's stages thesis, there has been considerable turnover. Overall, 64 percent of the settlers who were on the farms in 1981 were

still there in 1991. Over a third moved in the 10-year period. Despite this turnover, a stable core population exists. The *average overall* length of time on the same farm was 13 years, varying from 25 years in Monte Alegre to 9.5 in Paranaita. Second, also consistent with Moran's thesis, yields are increasing. Overall, yields of rice have increased 29 percent over the 10-year period; corn production has increased by more than half. Finally, consistent with this record of success, land prices have also increased. The overall (unweighted) average real price increase was 15 percent, but this average masks a large variation between settlements--from nearly 200 percent in Anapu/Pacaja, to *minus* 44 percent in Alta Floresta. Land prices in the remaining settlements increased between 24 percent and 100 percent.<sup>6</sup>

**FAO/UNDP Evaluation of Settlement Projects.** In a study released in 1992, FAO/UNDP and the Brazilian Ministry of Agriculture review the experience with land settlement projects carried out under the federal land reform agency (INCRA). The study reviewed projects throughout the country--not solely in the Amazon. The purpose of the review is to evaluate the success of INCRA settlement projects established between 1985 and 1989. A population of 440 settlements was identified. Following stratification by state and microregion and subsequent random selection, 44 settlements were chosen for field visits (see Annex B, Table B.3).

In terms of incomes, settlement in the North generated incomes four times Brazil's minimum wage--larger than those in any region other than the South. The ability of settlers to accumulate household durable goods and productive capital (machinery, buildings, etc.) reflects these incomes, with the northern region again surpassed only by the South. Northern settlers more than tripled their initial assets (increased by 222 percent).<sup>7</sup> When gifts and loans are added to initial assets, the overall increase falls to 168 percent (see Annex B, Table B.4).

Although the North has the second highest rating in terms of economic performance, it has by far the lowest number of original settlers still

on the land--fewer than 80 percent, compared with 97-100 percent in the other regions. Even when comparing turnover and economic performance *within* the North, ranking the settlements in the order of 1990-91 incomes (see Annex B, Table B.5) there is no relationship between incomes and permanency on the plot.

**Jones, et al. Econometric Study of Farming in Rondônia.** Jones, et al. conducted an econometric study based on a sample of 91 family farms around the city of Ouro Preto, Rondônia. The sample was drawn from Ouro Preto do Oeste, a colonization project begun in 1970 and located along BR-365. Soils in the study area are primarily classified as good, but they range from moderate to unsuitable for either annual or perennial crops and from good to restricted for pasture. The study found that the average farm marketed half its output, and had one third of its area in pasture and 18 percent in cultivation, leaving half uncleared. The median farm was highly diversified, with at least 6 income sources. Some farms had as many as 10 categories of income sources. The median farmer occupied his lot for 10 years, with the longest time being 20 years. The following selected sections quote from the study's conclusion:

"... Although we have been unable to find a systematic relationship between length of time on lot and any of our measures of overall productivity, the soil classification we use predicts 20 years of "good" yields on "good" soils, 10 years of "good" yields on moderate soils, and that yields on "restricted" soils will decrease rapidly within ten years. The classification also predicts that yields will be low from the very first on the "restricted" soils. We have found scattered evidence of productivity effects on different soil types, but the effects have been crop specific and have not conformed to the rank predictions of the classification system. Per capita income is, *ceteris paribus*, higher on the "restricted" soils than on the higher grades. In unreported regressions we are unable to find any relationship between gross income per cleared

acre (in either crops or pasture) and time on lot, controlling for per cent of the lot cleared for use and soil type. Dividing the sample of farms into those occupying their lots ten years or less and over ten years yields the same results as the full sample.

"... The fact that our mean and median farmers have been on their current lots for a decade belies the mobility pattern described in the literature. These reports principally discuss an initial, entry effect which involved extensive clearing;<sup>8</sup> what the reports do not suggest is the possibility that the initial clearing was accompanied by learning through trial and error. However, our data yield a zero simple correlation between length of time on lot and percent of the lot cleared, which belies the pattern of clearing three hectares a year, abandoning previously cleared land, until the entire lot is cleared and abandoned. Instead, an initial period of rapid deforestation may be followed by a calmer period, closer to an equilibrium pattern of farming practices, during which some reforestation and regeneration of damaged soils occurs. This possibility bears examination."

**Evidence Concerning Equity and Quality of Life.** Has development in the North created substantial new opportunity for Brazilian citizens, particularly for the less privileged level of society? The anecdotal literature (and there is much of it) is replete with stories of abuse of power and exploitation and subjugation of the weak and the poor. Undoubtedly outrages occurred in the free-for-all development of the early-day frontier. We cannot generalize about the effect of frontier development on the poor from anecdotes, however. What is lacking is evidence that can provide the basis for generalization. Is exploitation and subjugation the rule, or is it the occasional good story? When a northeastern landless laborer attempts to become a landowner in the Amazon, is he walking into a labyrinth of failure and exploitation, or is he taking a positive step to take control of his life through hard work and entrepreneurship. These questions are

fundamental to an evaluation of the success of Amazon development, but unfortunately they cannot yet be answered. The tentative, partially subjective conclusion, based, *inter alia*, on the review of indicators and experience which follows, as well as the settlement data reviewed above (and in Annex B), is this: For a given income and educational level, a hard-working migrant is likely to improve his lot by migrating to the North. The health risk is high, however, and the deprivation endured in getting established is great.

The frontier tends to filter for human capital characteristics. Chapter 2 develops this theme in more detail. The more remote the frontier, the more likely that settlers will have low opportunity costs. This makes comparison of indicators at the aggregate level misleading. For example, according to aggregate indicators the literacy and health care standards of São Paulo, Rio Grande de Sul, or Minas Gerais are much higher than those for Rondônia or Pará. This trend reflects both the availability of these services *and the human capital characteristics of the incoming population*. It does not follow, therefore, that the average unemployed farm worker would get better education or health care in the South than in the North. Virtually the only way to answer the essential question of *availability to the relatively poor* is by comparing the experience of people with relatively similar characteristics in different locations. Fortunately, the FAO/UNDP/MARA study referred to above provides the basis for a number of these comparisons.

**Income Distribution and Comparison to Alternative Employment.** As discussed above, the FAO/UNDP evaluation of INCRA settlement projects found family incomes in Amazonian settlements four times the national minimum wage and higher than incomes in comparable settlement schemes in the Northeast, Centerwest, and Southeast. Table 1.5 below compares the average colonist's income with likely salary in alternative employment.

From Table 1.5 we conclude that on the basis of salary alone, a settler on an INCRA settlement scheme in the Amazon likely

Table 1.5: Employment Opportunities for a Rural Laborer

Region	Salary of an Average Monthly Worker (in minimum wages)	Salary of Skilled Monthly Worker <sup>a</sup> (in minimum wages)	Average Monthly Salary per Worker in INCRA Settlement Scheme
North	1.1	2.0	2.0
Northeast	1.1	1.2	0.9
Centerwest	1.1	2.1	1.7
Southeast	1.1	1.8	1.4
South	1.1	2.0	2.2

a. Average of the salaries of rural manager, foreman, tractor driver and monthly laborer.

Source: FAO/UNDP; FGV/IBGE (CEA)

improves his position relative to his alternatives. Comparing his income to either an average unskilled or semiskilled worker, or a colonist elsewhere in Brazil, reveals that only a colonist in the South receives a higher income. Thus on the basis of income alone, INCRA colonists appear to have improved their quality of life.

**Equity and Distribution.** Critics of development in the Brazilian Amazon often argue that development is creating the same skewed distribution of income, assets, and opportunity that characterizes the rest of the country. Highly skewed distributions of incomes tell us something about the probability of potential migrants being better off or worse off. Chapter 2 argues that in the absence of a strongly countervailing government policy, skewed distribution of incomes and assets is a natural outcome of Brazil's skewed human capital. Available data on income and asset distribution is reviewed below. Because of problems with recent Brazilian censuses, the most recent data for regionwide evaluation is 1985 for the agricultural data and 1980 for demographic data. Again, some relevant data is available from the FAO/UNDP study.

**Incomes.** Where is it most risky to be a small farmer (settler)? Where is it least risky? Where

is the probability of doing well the highest? According to Table 1.6, it is (not surprisingly) most risky to settle in the Northeast. Here, per capita income in 73 percent of settler households is less than one half of a single minimum salary, and it is extremely rare for that income to exceed 3 minimum salaries. Clearly the best area (if you can get it) is the South, where the probability of doing poorly is lowest, and the probability of doing well is highest. Following the South, the North and Centerwest are close competitors. The probability of doing poorly is slightly higher in the Centerwest than in the other regions, but so is the probability of doing well. In contrast, the North has a slightly lower probability than the Centerwest of doing poorly, and it also has a lower probability of doing well.

**Land Distribution.** Table 1.7 compares the Gini index of the regions and selected states.<sup>9</sup> This index of land concentration reveals that current land distribution in the Amazon is substantially more equitable than it is in Brazil as a whole. The index also shows that the trend of land distribution in the Amazon is toward greater equality than it is in Brazil. The Gini coefficient for the North has fallen from 0.86 in 1975 (compared with 0.85 for Brazil as a whole) to 0.79 a decade later. The North's relatively

**Table 1.6: Regional Comparisons of Per Capita Income Distribution  
1992 INCRA Settlements**

Region	Percent Families with less than 0.5 minimum salary per capita		Percent Families with between 0.5 and 1 minimum salaries per capita  INCRA Settlements	Percent Families with between 1 and 3 minimum salaries per capita  INCRA Settlements	Percent Families with over 3 minimum salaries per capita  INCRA Settlements
	All Rural Families	Rural Families in INCRA Settlements			
North	NA	42	24	31	3
Northeast	79	73	7	20	0
Centerwest	50	43	17	37	3
Southeast	55	42	23	33	1
South	43	31	33	31	5

Source: UNDP/FAO/MARA, 1992

equitable overall land distribution is predominantly the result of smallholder settlement in Rondônia (Rondônia's Gini coefficient is 0.65). Other northern states are also showing a substantial trend away from concentration, however, as *latifundias*, ex-crown lands (*sesmeiros*), and rubber plantations (*seringais*) all begin to be broken into economically viable units.

**Infant Mortality.** Infant mortality is an important indicator of health care status. The UNDP/FAO study also included questions concerning infant deaths and compared the results with IBGE/UNICEF studies carried out in the rest of Brazil. The results, shown in Table 1.8, indicate that (a) overall health care standards in the country improved significantly between 1980 and 1986, (b) improvement in the North was substantially slower than elsewhere in Brazil, and (c) that infant mortality on INCRA settlement projects in the North was substantially higher than INCRA settlement in other regions

and only slightly lower than the overall figure for the Northeast in 1986.

### *Relatively High Turnover*

The studies reviewed above show relatively good economic performance for agriculture in the Amazon, even when compared to the same types of settlement elsewhere in Brazil.<sup>10</sup> Despite this performance, turnover among colonists remains high and abandonment of agricultural land continues to be reported. This turnover has been that declining yields and increasing poverty interpreted by many observers as evidence force settlers to abandon their farms and seek new lands--in short, that Amazonian soils are unsuitable for sustainable agriculture.

In fact, the available evidence, most of which comes from the FAO/MARA study referred to above, shows no increase in farm turnover with poor economic performance. As will be discussed below, for the data from the Amazon

**Table 1.7: Indices of Concentration of  
Land Holdings (GINI)  
(1975-1985)**

Region/State	1975	1980	1985
North	0.86	0.83	0.79
Northeast	0.86	0.86	0.86
Centerwest	0.85	0.84	0.84
Southeast	0.75	0.76	0.77
South	0.73	0.73	0.74
Amazonas	0.92	0.87	0.82
Rondonia	0.62	0.64	0.65
Pará	0.86	0.84	0.81
Brazil	0.85	0.85	0.85

region alone, there is a statistically significant *positive* relationship between farm turnover and economic performance.

Tables 1.9 and 1.10 show income, asset, and farm turnover data from INCRA settlement projects. Table 1.9 compares INCRA settlement projects by region, ranking them by their ability to retain settlers as measured by the percent of initial settlers still on the plot<sup>11</sup>. The results are inconsistent with the belief that turnover is caused by low incomes. Although turnover was greatest in the Amazon (North)--with only 79 percent of the original settlers still on their plots compared with 98-100 percent in the other regions--the North's economic success was exceeded only by the South. By far the worst economic performance was in the Northeast, where average income was only 55 percent of that in the Amazon, and the rate of growth of assets less than one fifth of that in the Amazon. Yet 99 percent of the original settlers in the Northeast were still on their plots.

Table 1.10 isolates projects in the North. Again, settlement projects are ranked according to turnover, and the relationship between turnover and economic success are compared. This data shows the same pattern as among regions--higher farm incomes associated with higher farm turnovers.<sup>12</sup>

### *Summary: The Paradox*

This chapter has established a clear paradox. It has (a) provided evidence of surprisingly good economic performance of agricultural settlements and ranches in the Amazon, (b) shown that this performance cannot in general be explained by government incentive policies, and (c) shown that settlements with higher incomes tend to have higher farm turnover (less stability). The income evidence is clearly inconsistent with the popularly held opinions concerning agricultural potential in the Amazon. Paradoxically the data on turnover *is* consistent with popular belief.

The fact that we find the relationship between good incomes and high turnover to be a paradox is important for Bank and Government policy. It is important because it suggests that we have been making policy on the basis of a mistaken model of the causes of farm instability and farmer transience. The negative relationship between stability and incomes we have observed suggests that our most popular policy recommendation--to create stability by strengthening incomes--may be counter-productive. Without a much better understanding of the actual determinants of farm instability, our policy interventions are doomed to failure. Chapter 2 discusses the determinants

**Table 1.8: Infant Mortality Comparisons--Deaths per 1000 Births**

<b>Region</b>	<b>1980 IBGE/UNICEF<sup>a</sup></b>	<b>1986 IBGE/UNICEF<sup>a</sup></b>	<b>1990 FAO/MARA</b>
North	60	58	73
Northeast	120	75	58
Centerwest	59	41	29
Southeast	54	38	0
South	55	37	0
Brazil	76	53	50

a. Perfil Estatístico de Crianças e Maes no Brasil. Mortalidade infantil saúde na década de 80. IBGE/UNICEF-1989.  
 Source: FAO/UNDP/MARA, 1992

**Table 1.9: INCRA Settlement Projects  
Incomes, Asset Accumulation, and Time on Plot**

<b>Region</b>	<b>Percent Original Settlers</b>	<b>Average Incomes (numbers of minimum wages)</b>	<b>Average Time on Plot (yrs)</b>	<b>Annual Average Rate of Growth of Own Capital (in %)</b>
North	79	4.2	7	18
Northeast	99	2.3	15	3
Centerwest	98	3.8	5	15
Southeast	99	4.1	14	5
South	100	5.6	5	26

Source: Based on data in FAO/UNDP/MARA

**Table 1.10: FAO/UNDP/MARA Data--Relationship Between Economic Performance and Turnover of Settlers**

Settlement	Percent Initial Settlers Still on Land (in sample)	Incomes (numbers of minimum wages)	Average Time on Plot (yrs)	Annual Average Rate of Growth of Initial Assets
Pa5	47	5.51	6	25
Pa4	64	7.27	6	37
Pa1	67	5.79	6	22
To1	67	2.77	4	43
Ro2	78	3.08	3	10
To2	91	2.99	5	25
Ro1	92	4.03	4	47
Pa2	93	2.62	10	8
Ac	100	2.02	25	6
Pa3	100	1.68	8	46 <sup>a</sup>

- a. This high rate of growth reflects an extraordinarily low level of initial assets. Initial assets in this settlement were 4 percent of the mean level for the region as a whole, and 8 percent of the initial assets of the next lowest settlement. These numbers should be treated with reservation.

of farm instability and its relationship to incomes. It shows, *inter alia*, that the apparent paradox of higher incomes associated with more instability can be completely explained by changes in land security and differences in the characteristics of early settlers and those who arrive later.

#### Notes

1. Brazil's Legal Amazonia contains approximately 3,000,000 km<sup>2</sup> of upland dense forest, 1,200,000 km<sup>2</sup> of scrub forest, and 250,000 km<sup>2</sup> of other upland forest types (Fearnside, 1987).

2. This assumption is made because (a) it is consistent with observation of subsidized agricultural inputs (especially credit) worldwide, and (b) it yields an *upper bound* on the number of cattle subsidized.

3. "Economic and Ecological Perspectives on Ranching in the Eastern Amazon in the 1990s"; M. M. Mattos, C. Uhl, and Delman de Almeida Goncalves; Instituto do Homem e Meio Ambiente da Amazonia, Belém, Pará, Brazil, EMBRAPA, Penn State University; Submitted to *World Development*.

4. This latter point also emerges strongly in an excellent study by Nelson (1973) of settlement projects on tropical lands in Latin America.

5. This relationship could be explained by a) poor farmers being forced to move more often, or b) poor farmers being more attracted to capital gains and specializing in real estate transaction. It does not seem as if a class of people specializing in land clearing, selling, and moving on develops, however.

6. Alta Floresta, which showed a large loss in land values between 1981 and 1991, was the settlement area which had by far the highest land values in 1981. In interpreting these land values it is extremely important to note that a settler in Alta Floresta was buying not only land, but also a range of government and infrastructural services, including tenure security, all paid for by the colonization firm. As Ozorio de Almeida notes:

"Alta Floresta was initially considered by many to be the jewel of private directed colonization. Commerce, church, education, and several other institutions were brought in, together with migrants actively recruited almost exclusively from Paraná."

7. Importantly, asset growth excludes changes in the valuation of land.

8. e.g., Fearnside, *op. cit.*, 1984, reports that clearance was greatest during a colonist's first four years on a lot, levelling off after six years.

9. The Gini index ranges from zero to one. A Gini index of one implies that all land is concentrated in the hands of a single owner. An index of zero implies that all owners own equal-sized plots.

10. It is possible that the results of some of these studies are influenced positively by selectivity bias and problems of endogeneity. For example, farmers who settle on the best land may be expected to stay longer. Since they have the best land, their yields do not decline through time. Thus long length of tenure tends to be associated with non-declining yields. The wide variation in methods of the various studies, and

the fact that they all yield the same general conclusion, however, suggests that relatively good agricultural success might be quite common. It is important to note that the literature reviewed above reflects an exhaustive literature survey of farm-level field studies containing measurement of yield or income loss through time. *No* farm-level studies were found showing yield loss.

11. Note that this ranking is influenced somewhat by age of the settlement. Everything else being equal, older settlements will have retained fewer of their original settlers. In the Amazon data, however, this effect is clearly overwhelmed by other factors.

12. In a simple regression between turnover and incomes, the latter is a significantly negative predictor of the former at the 1 percent confidence level. Assets are not statistically significant.

## PART II

# THE DETERMINANTS OF FRONTIER INSTABILITY

### *Introduction*

The data of the preceding chapter suggests that however difficult life on the frontier may be for many rural-born, uneducated Brazilians, it probably offers better opportunities than the alternatives. Despite the evidence of relatively good incomes and accumulation of assets, however, rapid land turnover and land abandonment seems to pose a paradox.<sup>1</sup> On the one hand farmers seem to be well off relative to their alternatives, and on the other hand they seem to be selling or abandoning their farms and moving on. This chapter explores the motives behind this demographic mobility at the frontier. It shows that (a) there is no inconsistency between economic success and the observed mobility, and (b) it is not *necessary* to appeal to resource degradation arguments to explain it.

This chapter also explores three important factors leading to farm turnover, land abandonment, and economic expansion at the frontier. These factors are: (a) the effect of cheap land in encouraging the mining of the natural resource base ("nutrient mining"); (b) the combined effect of high interest rates, poorly developed credit markets, and a frontier culture of *immediatismo*; and (c) the opportunity cost effect caused by (i) the difference in education and other human capital attributes between early settlers and more recent arrivals, and (ii) the changing role of property rights.

### *Cheap Land and Nutrient Mining*

**Nutrient Mining.** Nutrient mining is the unsustainable extraction of nutrients from the forest soil through logging, cropping, and ranching. This process differs from agriculture (and silviculture) because it is fundamentally a mining activity; it requires that new land be constantly brought under production as nutrients are extracted in the forms of logs, crops, and

meat. As a result, old, mined land is abandoned. The process of nutrient mining varies from region to region along the frontier, depending on the quality of soils, ease of forest access, availability of labor, credit, and land tenure relationships. Nutrient mining in the Amazon is a market response to an abundance of accessible Amazonian land generated by new road building.

Classically, nutrients are extracted through a progression of activities that begin with logging, which often provides forest access. After logging comes annual cropping and, finally, ranching. When the ranching activity ends, the land is abandoned for an indeterminate period.<sup>2</sup> In some cases the cropping stage may be skipped if, for example, soils are particularly poor and markets for low-grade timber (or charcoal) have evolved. The various stages of production may also be carried out by different actors. Land may change hands numerous times during the various phases of extraction, or the land may be exhausted under one owner as part of an integrated operation. No matter what economic activities may evolve, the process is best understood as one tending to maximize the value of the nutrients mined, net of extraction costs.

As with any other form of mining, nutrient mining is not geographically sustainable. When the nutrients are depleted beyond a profitably extractable level, the activity must relocate to a new area. Complete profitable extraction may take 10-20 years, depending on the initial fertility of the soil. The perpetuation of this system depends on the continued expansion of the road system into new lands.

As discussed above, nutrient mining, low stocking rates, early land abandonment, and low pasture productivity are all rational, and profit-maximizing responses to free or cheap land, regardless of the underlying agronomic suitability of the soil. Intensification occurs only as land prices increase. For example, consider

the Mattos, Uhl, Goncalves data reviewed in Chapter 1. Ranchers are investing \$260/ha to increase live-weight production per hectare by a factor of three. This *may* represent technical progress; it *certainly* reflects increasing land prices. Any rancher who invests \$260/ha to treble per-hectare productivity either cannot find pasture land for less than \$130/ha (giving him two new hectares plus the existing one), or he is a poor businessman making a mistake. In short, the current intensification reflects the increase in land prices that comes with the closing of the frontier in the Belém-Paragominas area. The land has not improved; the incentive to invest in it has.

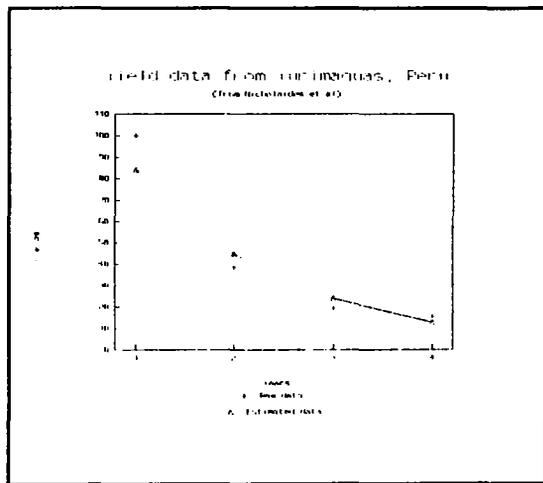
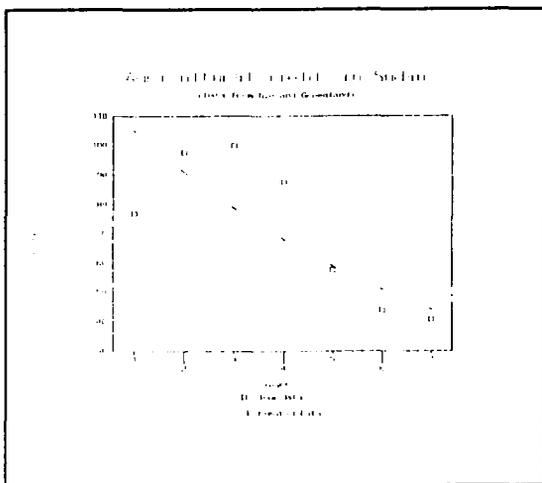
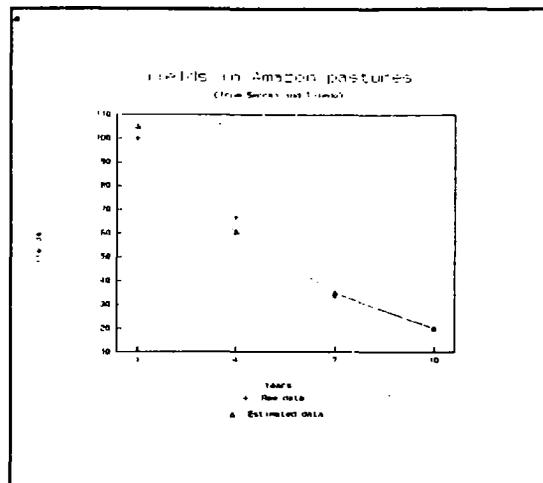
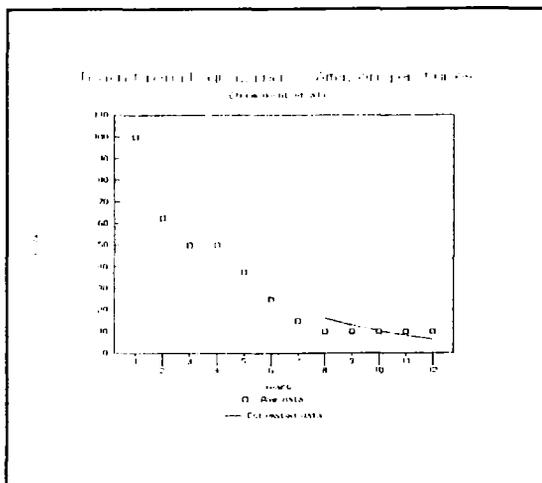
**The Importance of Road Building.** From the individual's point of view, nutrient mining is a rational approach to agriculture in a land-surplus (and land-accessible) economy. Mining nutrients will emerge as the most competitive form of agriculture wherever new roads make land abundant (and cheap). The price of new land becomes a bargain if we compare the costs of fertilizer and chemical pest control required to sustain existing land with the natural fertility and relative absence of pests in new lands (especially after burning). With accessible land sufficiently cheap, it is more profitable to move the farm to the nutrient-rich, pest-free environment, than to import the fertilizers and pesticides to the farm. Similarly, in the timber industry, what are commonly viewed by northern forestry experts as wasteful logging practices are actually a rational response to a situation where land is cheap relative to labor. Whether a farmer, rancher, or forester intends to remain geographically stable or not, economic forces

will probably force him to adapt to a land-surplus economic environment.<sup>3</sup>

### ***"Imediatismo" and High Interest Rates***

**The Farmer's Dilemma.** A farmer or extractive reserivist can choose between resource uses offering different degrees of "sustainability." Typically, however, in land-abundant frontier conditions, if he chooses the technique that will provide sustained yields in the future, he has to sacrifice income today. This tradeoff reflects the fact that higher current incomes come from mining the natural resource base. To slow down the rate of exploitation of the resource base and leave some for later, or to incur the expenses required to replace nutrients lost in agriculture, would require sacrificing current income for future incomes. Can constancy of yield be traded against immediate gain? Yes. This section explores how.

"Unsustainable" land use initially offers higher annual production and profits, but then it gives way to declining yields, i.e. mining the resource results in decreasing factor productivity and falling profits (assuming the farmer can't move to continue mining the resource elsewhere). The rate and behavior of yield loss depends on the nature of the resource being utilized (e.g., whether an agricultural field, a fishery, or a forest), certain other environmental factors (e.g., soil type), and the type and intensity of use. Yield loss through time can generally be expressed in terms of exponential rates. Figure 2.1 illustrates how exponential decay rates fit the yield data from several studies. Table 2.1 presents a review of the literature on crop yields through time on recently cleared tropical forest land for a wide range of crops.



**Figure 2.1: Agricultural Exponential Yield Data from Four Different Sources.**

**Table 2.1: Literature Values for Decay Rates of Yields Following Land Clearing<sup>a</sup>**

Reference	Grist <sup>b</sup> (1953)	Tondeur <sup>b</sup> (1956)			Nye and Stephens <sup>b</sup> (1960)	Charter <sup>b</sup> (1941)	Jordan (1987) <sup>c</sup>	Popenoe <sup>b</sup> (1957)	Fearnside (1987)
Crop	Paddy	Rice	Ground- nuts	Cas- sava	Maize and Cassava	Maize	Yucca intercropped with pineapple and plantain	Maize	Cattle
Location	Malay- sia	Zaire	Zaire	Zaire	Ghana	Honduras	San Carlos de Rio Negro, Venezuela	Guatemala	Eastern Amazonia
Yields	lb/acre	kg/ha	kg/ha	kg/ha	—	lb/acre	t/ha/yr		Head/ha
Year 1	1750	2341	1363	45000	X	900	5.1	X	0.4
Year 2	1200	565	191	30000		700		X/2	
Year 3	800	—	—	—	—	500	3.1		0.2
Year 8					X/2				
Decay Rate of Yield <sup>d</sup>	32%	76%	86%	33%	9%	26%	22%	50%	30%

- a. These values represent yields following forest clearing with no fertilizer added.  
 b. Cited in Nye and Greenland pages 73-74.  
 c. In Jordan, C.F. (Ed.) *Amazonian Rain Forests: Ecosystem Disturbance and Recovery*.

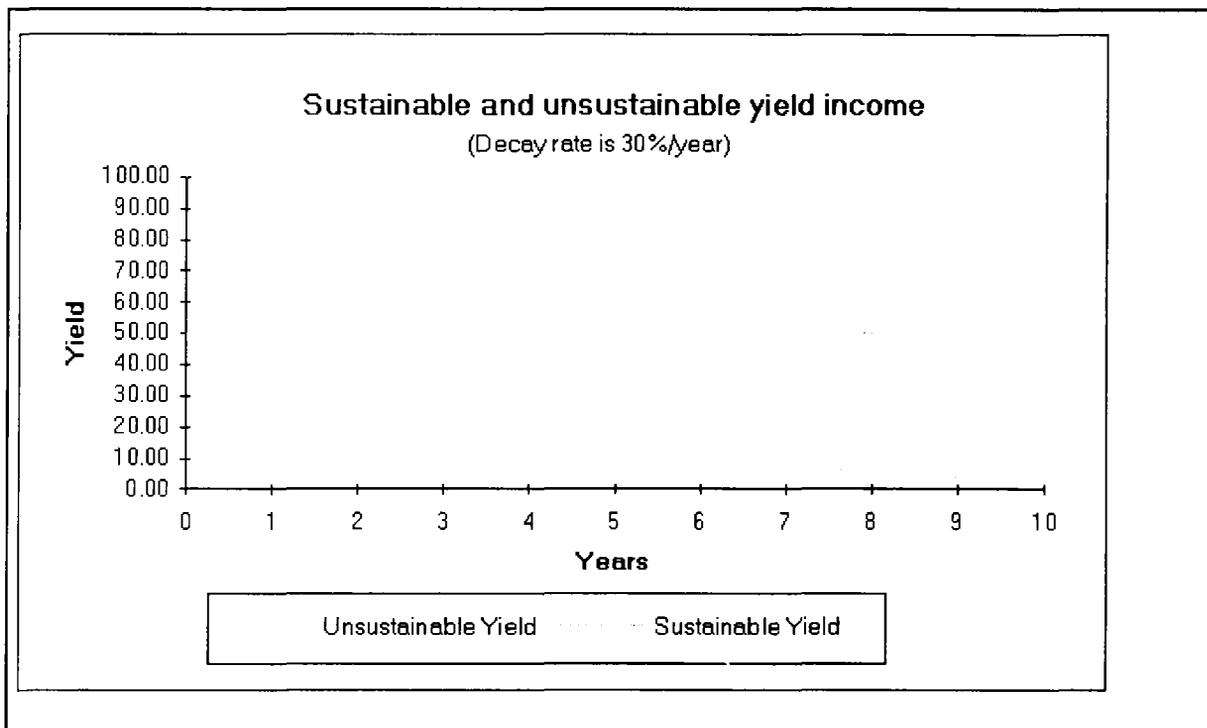
- d. Calculated according to:

$$\left( \sqrt[n]{\frac{\text{Yield}_n}{\text{Yield}_0}} - 1 \right) * 100$$

Consider a farmer trying to decide whether to put in place a sustainable system with low yield or an unsustainable system with a high yield.<sup>4</sup> Figure 2.2 illustrates the expected yield from the two techniques. For purposes of illustration, we assume that the first-year yield of the sustainable technique is half that of the unsustainable technique, and that the yield of the unsustainable

technique falls at 30 percent a year. If the farmer has no preference for current income relative to future income, a choice for the sustainable technique will be made, because for every year after year two the income derived from the sustainable technique exceeds that resulting from the unsustainable technique.

**Time Preference and Interest Rates.** Few



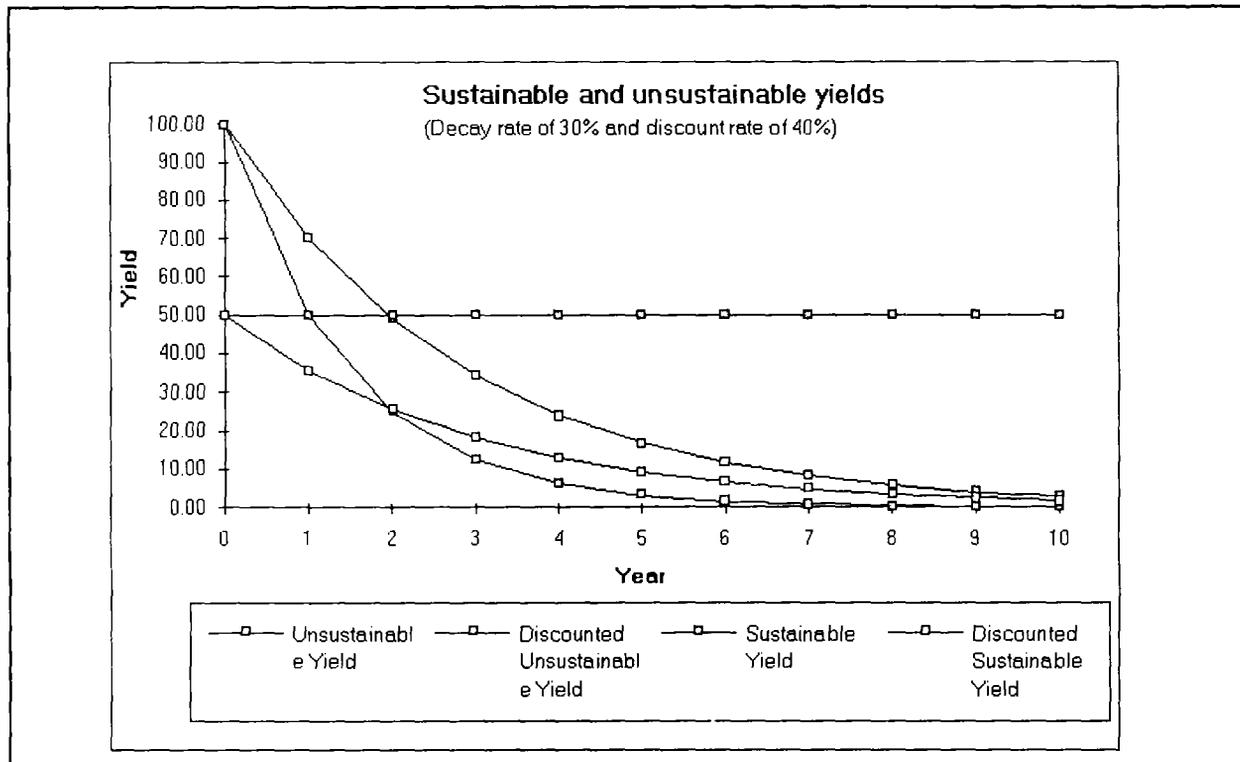
**Figure 2.2: Sustainable and Unsustainable Yields.**

people are indifferent about equal sums of money at different times, however. The ubiquitous existence of credit markets (whether formal or informal) teaches us that people with "excess" income require interest to induce them to loan it to others. Similarly, those requiring extra income are willing to pay interest to receive it. In a world where people loan and borrow money at interest, the difference between the value of the same sum of money at the present moment versus its value in the future is the interest that could be earned by loaning the sum for the time in question. This interest differential reflects the combined effect of the amount of money that is available for loans and the personal rates of time preference of the population.

In Brazil, real interest rates are currently extremely high, as they have been for much of the last decade. The most basic interest rate, the "Referential Rate" (*Taxa Referencial*), was just over 2 percent a month in real terms in

September 1992, while the real interest rate on 32-day government bonds was about 3 percent a month. These monthly rates translate to annual, real interest rates of about 27 percent and 43 percent respectively. (Note that the real interest rate on overnight accounts in the first week of September 1992 was considerably higher: 12 percent a month in real terms.)

These real interest rates establish the rate structure throughout Brazil.<sup>5</sup> With relatively low-risk investment in government bonds yielding more than 30 percent, individuals and firms needing to borrow money for the relatively high-risk activities of the Amazon typically must pay much more. Similarly, a farmer with excess capital is unlikely to loan it for less than the government yield. Therefore, a reasonable discount rate to apply to the income streams of Figure 2.2 is 30 percent or higher. Figure 2.3 has been drawn using a rate of time preference of 40 percent. This figure is the same as Figure 2.2 with the incomes reduced 2.2 with the



**Figure 2.3: Sustainable and Unsustainable Yields, With a Decay Rate of 30% and a Rate of Time Preference of 40%**

incomes reduced by the interest (discount) rate of 40 percent, roughly indicative of real interest rates in Brazil over the past several years.

Figure 2.3 contains all the elements of the farmer's decision. The initial incomes of the two techniques are 100 and 50 for unsustainable and sustainable techniques, respectively; the rate of decay of yield of the unsustainable activity is 30 percent, and the farmer's time preference (or interest rate) discounts both incomes at 40 percent a year. The farmer's choice between techniques can be visualized by comparing the area under the discounted yield of the unsustainable technique curve with that under the discounted yield curve of the sustainable technique, and then choosing the larger of the two. This choice can be visualized graphically

by comparing the two shaded areas (*A* & *B*) in Figure 2.3. If area *A* is larger the total income will be higher if the unsustainable activity is chosen, and vice versa.

Albeit a review of the literature on farming tropical forest land has not produced reliable income data, we can combine the data from Table 2.1 with the interest-rate information given above to calculate the relative first-year incomes that would be required to induce the farmer to adopt the sustainable technique. Although most Amazonian farmers do not conduct this type of financial analysis, the economic forces that would control how an actor in the Amazon would maximize financial well-being are the same elements highlighted in this calculation. These elements are (a) the relative

incomes of the two alternatives, (b) the discount (interest) rates available, and (c) the rate of loss (decay) of yield of the alternatives being considered.

In Annex C, a mathematical formula uses these three variables to equate the two discounted income streams and obtains the ratio of incomes at which both activities are equally profitable ("break-even points").

**Results.** The results are given in Table 2.2. This table shows how close first-year incomes of sustainable and unsustainable activities would have to be at varying interest and decay rates. When the return to a sustainable annual income is above this break-even point, the land owner will opt for the sustainable activity. When it is below, the unsustainable practice is preferred. For example, the table shows that at a 20 percent rate of preference for current income over future income (or prevailing interest rate) and a 25 percent rate of decay, the sustainable choice would have to render at least 44 percent or more of the initial annual profits of the nonsustainable use.

**Discussion.** The box superimposed in Table 2.2 shows productivity-decay rates in the range of 10-30 percent and interest rates of 30-40 percent. At these values, the resulting break-even ratios range from 50-80 percent. At conditions approximating those currently prevailing in Brazil (interest rate of 40 percent), net *initial* annual profits from sustainable use would have to be at least 80 percent of the unsustainable use (if decay rates from activities are as low as 10 percent). The required ratio of sustainable to unsustainable first-year profits falls to 50 percent if decay rates are believed to be as high as 30 percent per year. These steep ratios may help explain why the mining of resources is currently so prevalent in the Amazon.

Note the profound effect of a change in interest rates. For example, taking a decay rate of 10-30 percent as a given, but interest rates of 5-10 percent, break-even points decrease markedly, to 14-50 percent of profits of unsustainable

activities. These are much more achievable ratios.

**Conclusion.** In spite of increasing calls for sustainable development, the mining of natural resources still appears to be the prevalent form of resource use in many tropical forest areas. Assuming a conservative rate of decay of the resource base (10-30 percent), we have found that prevailing interest rates can have a profound effect on whether resource users adopt sustainable technologies that yield moderate profits indefinitely, or unsustainable ones that initially render good profits but quickly deplete the resource. Given our assumptions about decay rates, high interest rates force farmers to seek quick--albeit unsustainable--profits, unless sustainable activities can offer initial profits that are 50-70 percent as high as initial unsustainable profits. Most known "sustainable" activities for tropical land use, under current technologies, simply do not offer such high annual incomes.

The implication is that governments wishing to promote sustainable use of the resource base have three basic options: (a) take steps to increase the profitability of sustainable activities, i.e. support applied research, foster markets, provide favorable credit; (b) decrease the profitability of unsustainable activities, i.e. increase taxes and remove subsidies, including favorable credit; or (c) adopt macroeconomic policies that will lower, or effectively lower, interest rates. In particular, governments should attack underlying fiscal problems that have forced them to rely on interest rates to attain macroeconomic stability. These measures will have the additional economic justification of minimizing environmental externalities and maximizing the preservation of future options and environmental goods, such as biodiversity, that are now difficult to quantify.

### ***The Sell-Out Effect***

So far we have reviewed two motives for farming unsustainable land in the Amazon. These were the "nutrient mining" motive, which relies on land being cheap relative to other

**Table 2.2: "Break-even" Ratio of *First-Year* Income of Sustainable Technique to Income from Unsustainable Technique**

Decay Rate	Interest Rates							
	5%	10%	15%	20%	25%	30%	35%	40%
0%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
5%	50.00	66.67	75.00	80.00	83.33	85.71	87.50	88.89
10%	33.33	50.00	60.00	66.67	71.43	75.00	77.78	80.00
15%	25.00	40.00	50.00	57.14	62.50	66.67	70.00	72.73
20%	20.00	33.33	42.86	50.00	55.56	60.00	63.64	66.67
25%	16.67	28.57	37.50	<b>44.44</b>	50.00	54.55	58.33	61.54
30%	14.29	25.00	33.33	40.00	45.45	50.00	53.85	57.14
35%	12.50	22.22	30.00	36.36	41.67	46.15	50.00	53.33
40%	11.11	20.00	27.27	33.33	38.46	42.86	46.67	50.00
50%	9.09	16.67	23.08	28.57	33.33	37.50	41.18	44.44
60%	7.69	14.29	20.00	25.00	29.41	33.33	36.84	40.00
70%	6.67	12.50	17.65	22.22	26.32	30.00	33.33	36.36
80%	5.88	11.11	15.79	20.00	23.81	27.27	30.43	33.33
90%	5.26	10.00	14.29	18.18	21.74	25.00	28.00	30.77

inputs, and the *immediatismo* argument, which holds that it is cheaper to draw down natural capital ("borrow from the land") than to borrow cash from alternative sources. Undoubtedly a significant amount of natural capital is being drawn down in the Amazon. But whether or not large areas are being left in the degraded state portrayed in the popular literature is an unanswered question. One obstacle to the answer is the lack of a clear meaning to the popular term "degraded lands." In many cases the term simply refers to any land that has previously been farmed but is not currently being farmed. For the most part, this kind of land is bush fallow. This section of the chapter argues that (a) much of what is currently labeled "degraded land" is, in fact, in transition between owners; and (b) this transition has more to do with

changing demographic patterns as the frontier matures and a subtle shift in the property rights regime than it does with loss of productive capacity.

The literature on farming and ranching reviewed in Chapter 1 portrays a picture of relative long-run economic success in the ranching and farming communities studied. Paradoxically, farm turnover was also high, and anecdotal evidence of farm abandonment is persistent. This section argues that the data on economic success and high farm turnover is not only consistent, but that in the absence of strong government policy initiatives to countervail them, fundamental demographic and economic forces prompt early settlers to sell out and move on as the frontier matures. For simplicity this influence will be labeled the "sell-out effect."

The sell-out effect results from three simple, observable facts:

- People migrating to the frontier self-select on the basis of human capital and opportunity cost. That is, people with lowest human capital, and therefore lowest opportunity cost, are most likely to be found furthest out on the frontier.
- Farthest out on the frontier property rights can only be retained by physical occupation of the land. As the frontier matures and homesteading is no longer necessary, speculation becomes possible.
- As the frontier matures, a later generation of urban-based capitalists find that ownership of land can cover *their* opportunity costs, and because of their access to capital markets (often due to collateralizable urban property), they can easily bid current owners off the land.

The remaining paragraphs elaborate the theoretical basis for these ideas and show how they can be used to explain observed behavior.

Figure 2.4 draws on the concept of a rent gradient most closely associated with the work of Von Thunen (1819). The basic idea is that as one moves away from urban areas (or markets), transportation costs increase. This movement has two effects. First, with increasing transportation costs, the profitability of economic activity falls. Second, the increase in transportation costs selects activities that have high value per unit of transportation costs. Thus, as one moves away from urban areas one tends to see a progression of land use with the following pattern: suburbs, vegetable and/or sod farming, dairy, field crops (corn, wheat, oats, etc.) and, finally, forest.<sup>6</sup> Each of these land uses tends to be associated with a range of land prices. For example, expanding suburbs pressure land prices and drive dairy farms out of Montgomery County (Maryland). Similarly rising land prices associated with encroaching soybean farming drive cattle from Mato Grosso (Brazil) to the Amazon.

Figure 2.4 has been drawn with a few peculiarities intended to facilitate analysis of land use change (and the role of government) at the frontier. First, rather than a *rent* gradient, the line represents the Net Present Value (excluding the cost of land) of (the highest value) economic activity at each distance from the urban center. Second, the figure has been drawn *as if property rights were perfectly (and costlessly) allocated*.

Consider the extreme right-hand side of the figure. Where NPV reaches zero, transport costs prohibit profitable production for market--even capitalizing expected income from future years. No person integrated into the economy to the left of the figure is tempted to claim land. This land is in forest because no alternative land use is profitable. At some point, as one walks toward the city, the potential for some people to make a living on the land begins to look as good as their alternatives in the fully integrated economy.<sup>7</sup>

At some point formal government arrives. Tenure protection, previously performed by voluntary associations, becomes the function of formal government. Police protect property at the cost of government. The role of voluntary associations dwindles. With government certification and protection of property ownership, land becomes collateral; titled owners of land now have two important advantages not available to early settlers. First, government now assumes the land-protection function; second, land ownership provides access to bank credit previously unavailable.

With the arrival of formal government, the early settlers become seriously disadvantaged. The human capital attributes that select for the early settlers are precisely those which limit their ability to take advantage of government--illiteracy now becomes a serious handicap. Perhaps more fundamentally, a general cultural distance from the urban-based functionaries who dispense government services puts early settlers at a tremendous disadvantage relative to urban-based competitors.

For convenience (not ideology), we will call those who arrive with government the capitalists.

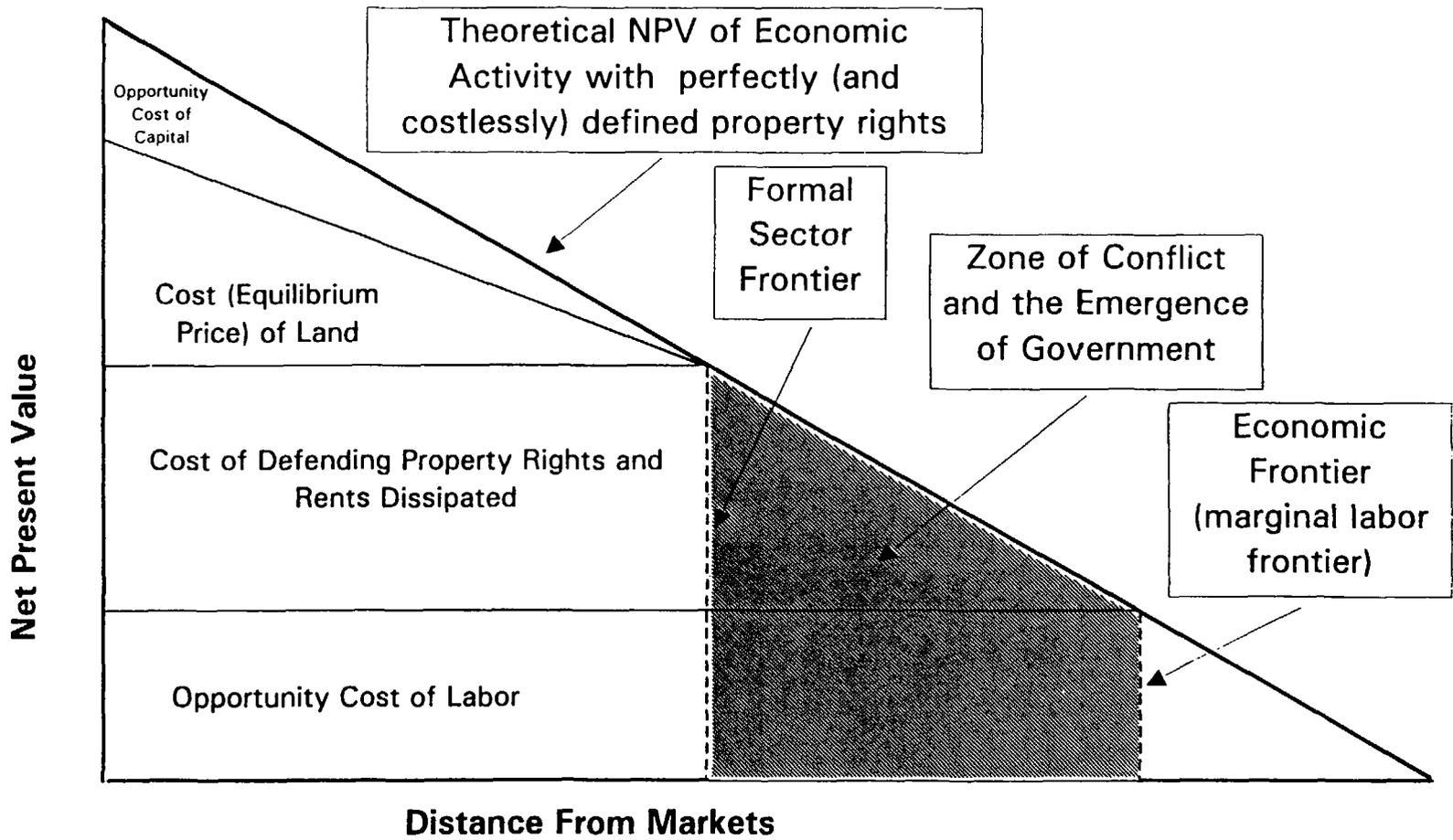
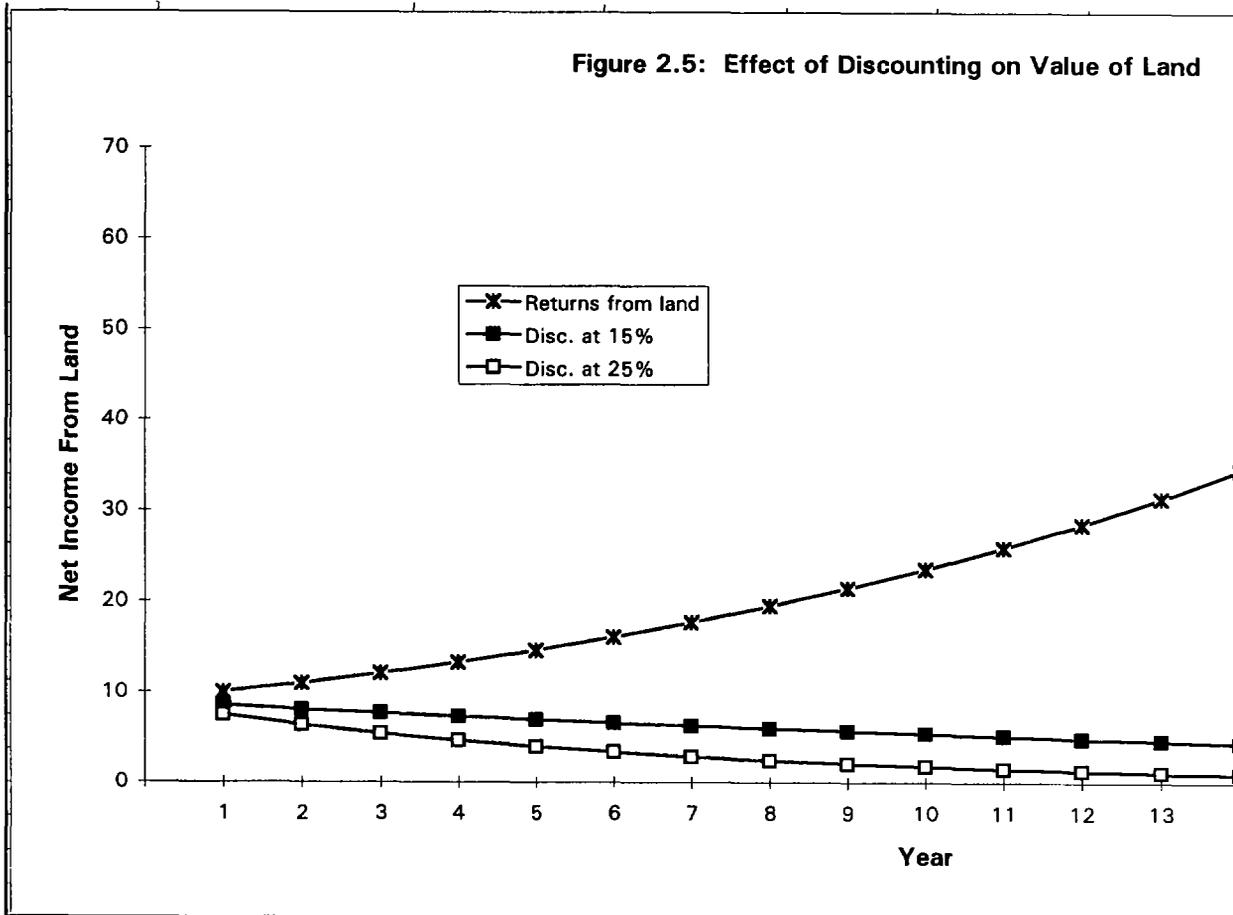


Figure 2.4: Economic Rent and the Emergence of Government

This tag emphasizes the fact that, from an analytical point of view, the single most important distinction between the early settlers and the later, urban-based groups is access to capital markets. Why is this so important? Consider Figure 2.5. For the sake of illustration, assume that both the capitalist and the settler recognize that with improved transportation, marketing, and technology the net value of agricultural income will grow from the current \$10 per hectare at a rate of 10 percent per year. Assume also that the capitalist, with access to bank credit, can borrow at 15 percent per year. The settler, who has neither access to bank credit nor his own capital, borrows from the moneylender at 25 percent.<sup>8</sup> The two downward-sloping curves in Figure 2.5 show the present value of the future income from the land

at discount rates of 15 percent and 25 percent. The value of the land to the capitalist is the area under the 15 percent curve, while the settler would be indifferent between the income stream from the land and the sum under the 25 percent curve.

In actual values, the total under the 15 percent curve is \$105. That under the 25 percent curve is \$23. Remember the *only* advantage we have given the capitalist in this case is the interest (discount) rate advantage. In actual fact, as Moran's evidence shows, the capitalist generally also has a management advantage and, through better access to government, an advantage with respect to land-protection services. At this difference in net present values of land, we should not be surprised to see capitalists buying out settlers.



The sequence of events described above is fully consistent with the literature reviewed in Chapter 1. Moran emphasized the characteristics of the settlers, in particular the rapid turnover and urban connection, in his "experimentation" stage. Ozorio de Almeida summarizes:

High turnover in some locations means that some people were willing to move in to lots that were left behind by others. ...these "newcomers" were younger and significantly wealthier than "survivors" in high turnover locations... Thus, as real estate appreciation pushed pioneer farmers out of older frontiers and into new ones, the deforested land accrued to a new constituency that was considerably better off than those who left. Many were probably not really farmers at all, but merchants, public servants, and other city dwellers.<sup>9</sup>

The site descriptions from the FAO/UNDP/MARA study carry a strikingly similar message. Three site descriptions for Pará give information concerning the purchasers of land. These findings are reported below:

#### Site PA1:

The (INCRA) technicians didn't know how many people have left the project, but it is known that there has been selling of lots, accelerating since 1987. One technician from INCRA confirmed that only 40 percent of the current colonists were part of the original project....It is calculated that 60 percent sell their lots to ranchers and new colonists...in CEDERE III (one of three areas considered in the PA1 settlement) there has been less selling because it is more distant and access is difficult....It's worth noting that the Prefeito of Parauabas bought 11 to 12 lots and that he maintains the laborers--ex colonists--that work on his land.

#### Site PA2:

Approximately 50 percent of the colonialists

have already sold their land. According to one local survey, the sales mostly occur due to a lack of infrastructure on the project.<sup>10</sup> People leave in search of a better life.

The buyer can be another colonist, a rancher, a politician, or a merchant. In general these types are the most frequent. Even if buyers don't come to occupy the land, in the end, they do occupy all of it.

#### Site PA3:

Today the major problem faced is the selling of lots. For this study a representative of the (colonists') association confirmed that a large part of the settlement is occupied by ranchers, who have been expelling the colonists from the area. It wasn't possible to find the ranchers mentioned, but to better understand the situation, we present below the profile of the beneficiaries of the project. This survey is based on data furnished by the Regional Secretary of INCRA/PA.

- 40 percent are original colonists.
- 59 percent are not original colonists and the lots were acquired from the originals or third parties.
- 39 percent of the lots belong to seven owners (one has 12 lots, another has 7 and the rest have 6 to 2).
- 4 percent of the owners exploit wood on more than one lot.
- 54 percent of the beneficiaries don't produce anything.
- 42 percent pursue some production of agriculture or cattle.
- of the 42 percent productive, 30 percent of the owners don't live on the lot.

Besides these types of colonists there exists a diversity of others. Following are a few cases:

- The owner of lot 93 is established on the lot, lives in the city (Paragominas, probably), and owns 4 holdings in the *garimpo* of Serra Pelada, but he works on the plot.

- The owner of lot 73 is a radio broadcaster in Paragominas.
- The owner of lot 64 is the manager of three ranches in the region.
- The owner of lot 77 is a *vereador* (town councilman).
- Four owners, owning six plots, gave their lots to a third person to cultivate.
- Nine owners, owning 19 lots, are businessmen in Paragominas (four own supermarkets; one owns 7 lots and owns an auto parts store; one has a construction materials supply store; one owns a warehouse; one owns the gas company; and another is a butcher).

**The Decision to "Abandon Land."** Does the evidence of abandoned land support the thesis of fertility decline and loss of agricultural productivity? It may; however, alternative explanations are more consistent with the evidence presented above. We can identify two kinds of abandonment that have nothing to do with fertility decline. Both are related to the role of government and the cost of defending property rights. The first is the abandonment of large schemes to squatters. This situation occurs when government encourages premature economic activity on the part of formal sector agents, such as the fiscal incentive schemes in Brazil.<sup>11</sup> The second type of abandonment is the reverse of the first. It takes place when formal government begins to effectively pick up the role of protecting and enforcing property rights.

The role of changing property rights leading to apparent abandonment of land is illustrated by Figure 2.6. The top graph of the figure shows annual incomes that could be earned from land on the frontier in different years. In year 1, the land is too far from market to yield any income. From years 1 to 10, potential incomes grow slowly. They rise sharply from years 10 to 20 as transportation and services create new potential income opportunities, and flatten out soon thereafter as the frontier becomes consolidated. For simplicity, assume that potential incomes for formal sector agents and for squatters are the same but have different

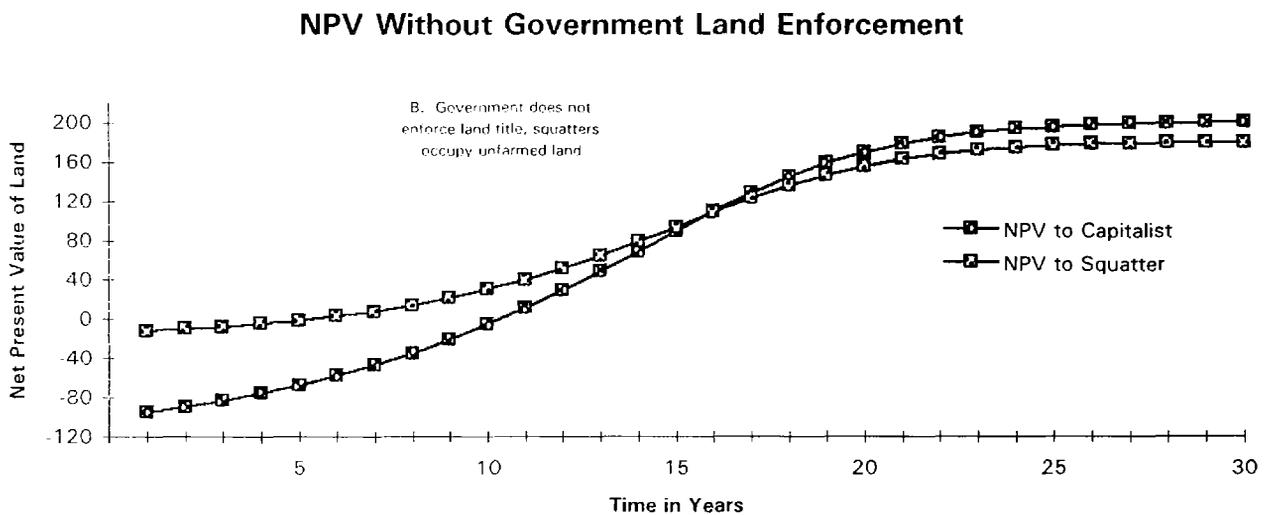
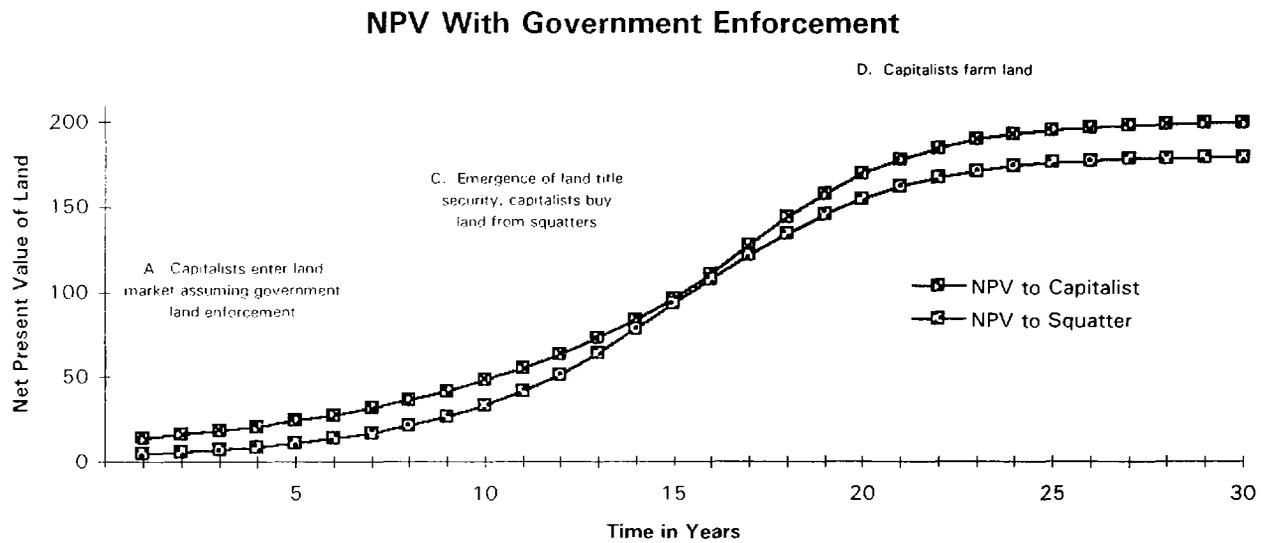
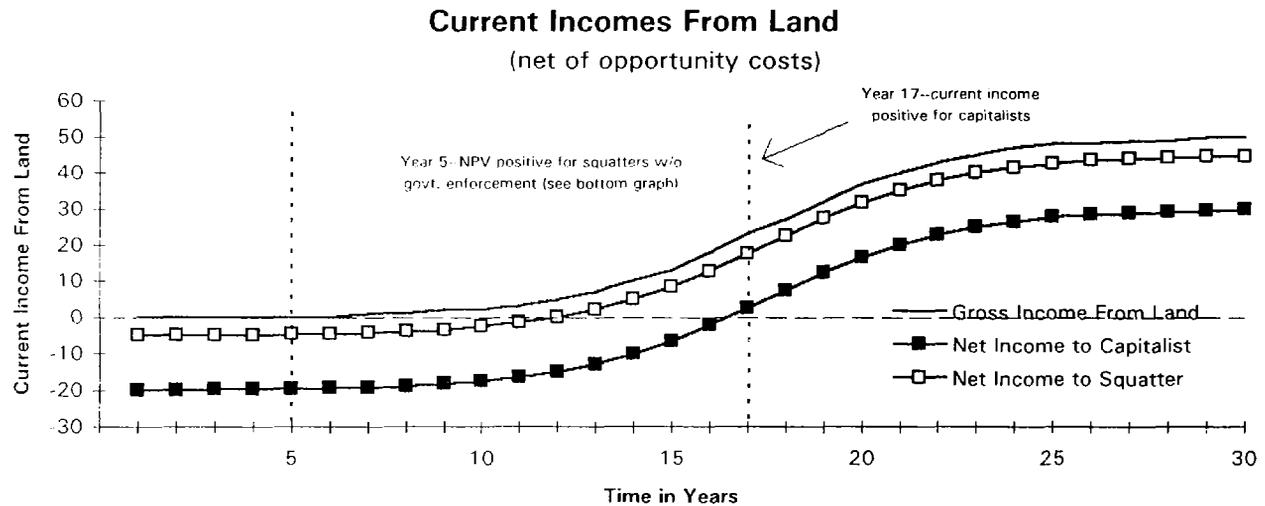
opportunity costs. Squatters must earn their opportunity cost of 5 units before they will move to the frontier, and capitalists must have 20 units. Subtracting the squatter's opportunity cost from the yield from the land generates the squatter's net income line. This line crosses the horizontal axis in year 12, indicating that in this year squatters would be as well off farming on the frontier as in their alternative activities. Repeating the exercise for the capitalists shows that capitalists will not cover their opportunity costs until year 17.

From the top graph, we can conclude that, everything being equal, squatters will not want to begin farming until year 12, and capitalists will want to wait until year 17. There is a clear risk to waiting however--to wait is to run the risk that somebody else makes a prior claim to the land. There is in fact a "race for property rights."<sup>12</sup> As we will see, the rules by which government organizes the race will determine the outcome and the amount of abandonment (see Figure 2.6 and the paragraphs below).

The middle and lower graphs of Figure 2.6 use data from the upper graph (see Annex D for data) to calculate the NPVs of land to squatters and capitalists. Following the discussion in paragraph 30, the calculations of NPV use a time preference of 15 percent for formal sector agents (capitalists) and 25 percent for squatters. The middle graph (government enforcement) reflects a property-rights regime where the government is responsible for ensuring the protection of private property. The lower graph (without government enforcement) assumes that it is necessary to actively farm the land to have property rights respected. The difference in the NPVs of the two graphs reflects the difference in the economic behavior that would be stimulated by the different regimes.

With government enforcement of property rights (middle graph) it is possible, by purchasing land and not occupying it (speculating), to buy the positive incomes of future years (top graph) without having to incur the losses of current years. Thus, to calculate the NPV under the enforcement regime, we ignore the negative values for current incomes

Figure 2.6: Effect of Property Rights on Economic Behavior



and discount the positive values to the present. This pattern is repeated each year to generate the NPV curves of the graph.

Without government enforcement (lower graph), land must be actively occupied to enforce claim to ownership, with or without a formal title to land. This requires *premature* activity on the land. The prospective owner must now accept incomes in the early years that are below his opportunity cost--that is, that correspond to the negative values in the current incomes graph (top). To calculate the NPVs under this regime, therefore, we perform the same exercise as before, with the difference that negative values for early years must be included.

The history of the large ranches established in the 1970s is consistent with activity that would be predicted under the enforcement regime. In an interview with Adrian Cowell (the producer of the film documentary "The Decade of Destruction"), Jose Garcia Gasques summarized the results of a government retrospective study<sup>13</sup> of large agricultural enterprises established under fiscal incentives supervised by the regional planning agency (SUDAM) as follows:

The tax incentives were primarily a means to guarantee the possession of land. The average size of the ranches we studied was over 21,000 hectares, and some were as large as 200,000 hectares. So a great part of the area was not occupied, and could easily be invaded by squatters. Registration for tax incentives, therefore, was a [legal] method to guarantee possession of the land.<sup>14</sup>

Ronaldo Barata, the head of the state land agency (ITERPA) is quoted by Cowell as follows:

Tax incentives were for a time very prejudicial to the region. When Pará was isolated from the rest of Brazil, our land had no value. The occupants of the land didn't even bother with title deeds. But with the opening of the Trans-Amazonica and Belém-Brasília highways, and with the military government's plan of national integration,

Pará began to have land feuds. First because the big businessmen of the south moved to Amazonia attracted by the incentives. Second, because the roads made access possible for the waves of migrants forced out by the land situation in the north-east and south. Third, because the Federal Government created an image that Amazonia was a huge, empty space that should be occupied to relieve the land crisis in other states. And since there was no government policy to help the waves of migrants, huge problems began to break out. The great companies found their areas already occupied by early squatters, some of whom had been there for centuries. The squatters were expelled. But after the areas were cleaned out, they were often reinvaded by people from other states who thought them unoccupied because no work was being done.<sup>15</sup>

How do these narratives translate into Figure 2.6? First, capitalists participate in government-sponsored schemes to buy land in the Amazon. Their actual activity on the land is token, and short lived. This is the behavior we should expect under a regime of government-enforced land rights where current incomes are still negative--that is, before year 17 for the capitalists. Second, capitalists face increasing pressure from squatters. This implies that the capitalists made a mistake: government was not prepared to enforce their ownership rights, after all. Instead of being on the middle graph, they are on the lower one, where, in fact, occupancy establishes ownership. The invasion of squatters implies recognition by squatters that, despite the fact that they will lower their current standard of living by invading the land, their future looks brighter on the new land than in alternative employment--the NPV to squatters reaches zero. Thus, starting in year 5, increasing numbers of squatters begin to invade the unoccupied or abandoned land of the capitalists. *This is the first abandonment--capitalists are perceived to abandon their ranches and agrobusiness schemes. In fact it was premature to initiate them as going concerns. The schemes were*

*primarily intended for speculation.*

By the mid-1980s most of the large capitalist schemes had been expropriated. Many became the INCRA-settlement schemes reviewed by FAO/UNDP/MARA and discussed above. By this time, government had established a substantial presence and, on the INCRA projects at least, ownership was relatively uncontested. Even if formal titles were not issued, both public and private agents recognized existing formal and informal documentation. This emergence of respect for property ownership, enforced by the police power of the state, moves us back to the middle graph. Here again, it pays for capitalists to buy land, but prior to year 17 they lose money if they actively farm it. Thus, as we saw in the descriptions of new owners in Moran, Ozorio de Almeida, and FAO/UNDP/MARA, many of the new owners are urban-based, formal sector representatives, with relatively good access to capital markets. Their purchases are investments. *This is the second abandonment--with improvement in tenure security; capitalists can safely buy out squatters and let the land stay unused until market conditions improve.* Note that in either enforcement regime, capitalists will begin to actively farm after year 16, when current incomes exceed their opportunity cost. The difference is that under a regime of government enforcement, they will buy out squatters as soon as government tenure enforcement is effective, but will not actively farm until year 17. Without government tenure enforcement, squatters will stay on the land until year 17, the period when capitalists will buy them out and continue farming.<sup>16</sup> In either case, farm consolidation will take place--a process readily observable in the maturing frontiers of the Amazon.

We can summarize the discussion above as follows. Changing or poorly defined property-rights regimes are critical in explaining the paradox of relatively high incomes to colonists and simultaneous abandonment of land. Occupation only pays for those members of society with the lowest opportunity cost. Efforts to sell *prematurely*, or give, large areas of land to select groups, inevitably falter; formal sector economic agents require their opportunity cost

on management and financial capital if they are to actively work the land. Holding the land until the frontier advances is feasible only if the cost of tenure security is low relative to expected productivity gains. Generally, large officially established ranches were abandoned and later expropriated by INCRA, creating the public settlements reviewed above. The reason was that the economic activity was premature and waiting was too costly, given the high cost of protecting property rights.

With the advance of the frontier, formal sector agents (the capitalists described in site PA3, para 32) can now own land without fear of invasion. Government has picked up responsibility for tenure protection. Like the premature ranchers, however, these agents require a higher return on their financial and management assets than the land can deliver. Although they fully expect the land to produce profit after further development of the frontier, active farming now would represent a loss if opportunity costs are considered--it would be "premature" economic activity.<sup>17</sup> For these formal sector owners, the net present value of the land is higher if they wait to initiate economic activity (or do what is theoretically the same thing, sell to others who do). While the previous abandonment is associated with the recognition by formal sector agents that government will not carry the costs of protecting ownership, this abandonment occurs when the opposite happens--formal sector agents recognize that they do not have to occupy land any longer in order to own it.

**Policy Implications.** The most important overall implication is that pressure for Amazon development will continue. Even though urbanization and an aging population have dramatically reduced migratory pressure on the Amazon, the relative economic success of settlers will not go unnoticed. Future policy will have to strike a balance between growth and environmental protection. Good policy outcomes will require accurate diagnosis, including the following strategies:

- Much more *field-based* work must be done to identify the determinants of success and failure in Amazonian agriculture, and to

evaluate overall economic performance. This analysis raises serious issues concerning the relative importance of socioeconomic and agronomic factors; these will require investigation through extensive field research.

- The role of government at the frontier needs to be seriously reevaluated, especially as regards allocation of property rights. From the point of view of equity, efficiency, and public order, the most serious policy mistake is to allocate indefensibly large holdings.
- Allocating initial property rights to first settlers has two important advantages: It promotes (a) equity because early arrivers are most disadvantaged, and (b) orderly evolution of property rights because, unlike formal sector agents, early settlers establish a presence on the land. By making this policy official, government presence required to enforce property rights is minimized.
- Providing formal title to early settlers provides improved access to credit, thereby reducing the probability that differential discount rates alone will lead to farm-size consolidation. As long as credit rationing exists, however, banks will continue to allocate credit preferentially where transaction costs and risks are minimized--to large, urban-based, formal sector customers.
- The two most direct ways to reduce the rate of forest conversion are to: (a) increase the opportunity cost of marginal workers; and (b) control the rate of expansion of the road network in the Amazon. Increasing the opportunity cost of marginal workers requires two fundamental changes in the Brazilian society. First, sufficient macroeconomic stability must be recovered for the private sector to make medium- and long-term investment. Second, primary and secondary education, long neglected in Brazil, must be vastly expanded and improved.

## Notes

1. As will be developed below, land abandonment in this context does not necessarily imply the relinquishment of ownership. It may represent the current cessation of agricultural activity with the intent to renew activity in the future.

2. Insufficient attention has been paid to secondary growth. A broad inventory of the nature of secondary growth in the Amazon and the conditions giving rise to it would be a key input in developing a more realistic assessment of both the economic and environmental futures of the Amazon.

3. For example, under economic pressure from labor shortage and low crop prices, farmers in Rondônia are uprooting tree crops, planted to provide a sustainable income, in order to establish unsustainable pasture.

4. We use the words "yield" and "income" interchangeably. In no-input or extremely low-input agricultural systems, yield can be taken as a reasonable proxy for income.

5. Rates of return at this level (on low-risk investments) are clearly not sustainable for long periods of time. Arbitrage will inevitably close the gap to levels approaching international norms. In the case of Brazil, rates reached this level as a result of extremely tight monetary policy intended to control inflation. Since fiscal policy was not brought under control, however, and many in the business community used the treasury bill rate as an indicator of future inflation, the policy has not been successful. The recent run-up of asset values in the Brazilian stock exchange is certainly consistent with the expected arbitrage behavior.

6. This sequencing of land use gives rise to the "Von Thunen Rings" for which we best remember Von Thunen.

7. We emphasize *in the economy* because we are interested here in those people who consider their alternatives in the developed economy, not tribal isolates.

8. This projection is probably a very low underestimate. A larger discount rate for the informal sector only strengthens the results derived below.

9. op cit., page 27.

10. Note that the technician in PA1 stated that there was *less, not more*, turnover where access was poorest. This behavior suggests that we should be very wary about accepting a technician's interpretation of events. As we have seen throughout, the demand for land by second generation settlers appears to be a stronger motive for turnover than low incomes.

11. Looking at the map of Brazil, one is struck by the correspondence between areas of concentrations of fiscal incentives and agrarian violence.

Essentially, the fiscal incentives system allocated indefensible property rights. Owners didn't want to occupy the land because occupation turned out not to cover opportunity costs of labor (management) and financial capital (see Gasques and Yokomizo, 1986), and government didn't have the will or the means to enforce property rights. The result was invasion of undetensible land holdings (ranches) by those with

lowest opportunity costs (squatters).

12. I owe this term to the paper by Anderson and Hill (1990).

13. Gasques and Yokomizo, *op cit.* For an English-language summary of the major findings of this report see Schneider (1992), pages 36 and 37.

14. Adrian Cowell (1990).

# PART III

## GOVERNMENT ARRIVES

### *Introduction*

The role of government in frontier areas deserves careful analysis. First, government is a critical determinant of the quality of frontier expansion. On the one hand, government policies can encourage environmentally destructive and economically wasteful mining of the natural resource; on the other hand, government could encourage stable communities based on sustainable activities. Second, the cost of frontier economies created or supported by externally financed government must be evaluated relative to the expected benefits. Transfers to support government in frontier states is an investment in the development of frontier economies. The eventual quality of that development, in terms of employment and quality of life in stable communities, ultimately determines the wisdom of the investment.

**The Role of Government and Efficient Settlement.** There are four major classes of efficiency losses at the frontier. These can be classified as (a) premature government, (b) premature settlement, (c) tenure insecurity inefficiency, and (d) environmental externalities.

*Premature government* occurs when government's investment in the economic activity of an area occurs too early relative to the underlying dynamics of frontier advancement.<sup>1</sup> In its fundamental activities as enforcer of contracts, protector of law and order, and provider of minimal social infrastructure, government provides an essential element in the production relations of an area. In some cases, however, the cost of government is far out of proportion to the current or expected value-added of the region. In these cases government expenditure can be considered premature from an investment point of view.

*Premature settlement* takes place when labor and capital occupy frontier land before the returns from the land can repay the factor's opportunity cost. This situation occurs when occupation is a condition of future ownership

(see Chapter 2). In this case farmers may farm at a loss (in opportunity cost terms) in order to win in the "race for property rights"<sup>2</sup>--that is, to be the first to lay claim to uninhabited land. For a farmer to accept a return on his resources below their opportunity cost represents a loss to society--this is "premature" settlement. Society would be better off if the farmer would remain in the more developed part of the country (earning full opportunity cost) and move only when he could be made more productive on the frontier. This can only happen if occupation is not necessary to maintain property rights. This in turn requires that the government enforce property rights for everyone--including those of "speculators" who purchase land and stay in the cities waiting for the frontier to advance.

Thus, one way to prevent premature settlement is for government to guarantee enforcement of property rights. In such a property-rights regime, entrepreneurs would buy land and hold it until it would repay economic use. Since the land would remain unused substantially after its present value turned positive, there would be competition for the land. Government would have to enforce the ownership rights of the legal owner. Since this condition requires government expenditure, the key question is whether the expenditure to enforce property rights is less than the efficiency losses from premature settlement. We will argue below that a well-conceived settlement policy can minimize both the size of frontier government and the efficiency losses from premature settlement.

*Land tenure insecurity* causes inefficiency whenever it leads a farmer to forgo a profitable investment he would otherwise have undertaken. Classic examples of such investments are farm roads, wells, permanent crops and high-quality pasture.

*Efficiency losses from externalities* come both from insecurity of tenure and from lack of a market in environmental values, principally biodiversity and carbon sequestration. With regard to tenure security, preliminary

econometric results from a study in Pará confirm that, all things being equal, titled farmers deforest less than those without title, although as would be expected those with more security put more land in pasture and permanent crops. This behavior suggests that at least some deforestation is undertaken to strengthen the claim to ownership rather than to put the land into economic use. This practice creates both a premature economic activity to the landowner and an environmental loss to the larger society.<sup>3</sup>

The more important environmental-externality related efficiency losses come through lack of markets for biodiversity and carbon sequestering.<sup>4</sup> Although the value of information embodied in genetic material is undoubtedly large, it is impossible at present to estimate it. Some basis exists for estimating the carbon sequestration value of moist humid forest, however, based on the relatively well-known carbon content of the forest and various measures of the value of sequestered carbon. This estimate is made in Annex E. The estimated carbon sequestration value of Amazon forest land is in the range of \$600 to \$7,000 per hectare. This value compares with its market value (presumably based on its value in agriculture) of \$2.50 to \$300 per hectare. For example (see Annex E for calculations), the inability of people in Sweden (who currently pay a carbon tax of \$45 per ton of carbon released) to transact with farmers preparing to clear land in Brazil represents a global welfare loss of more than \$4,500 per hectare of Amazon forest cleared for agriculture.<sup>5</sup>

The remainder of this chapter develops preliminary policy recommendations for improving settlement efficiency based on an appreciation of the economic and political setting of frontier governments. This analysis is preliminary, based on considerable theorizing and relatively little data. But the data that is currently available supports the theoretical conclusions drawn. Hopefully the 1990 census data, when available, will facilitate a wider analysis of these issues. In addition, a separate piece of sector work will be forthcoming from the World Bank in FY94. It will be based on a thorough analysis of the political constraints

acting on the making of environmental policy in the several levels of government.

**Characterizing Frontier Government.** The agricultural frontier is characterized by an abundance of land relative to people. It is also the area where market-oriented economic activity first becomes viable. These simple facts condition much of the behavior at the frontier: the choice of technology (land extensive, labor saving), the nature of early settlers (low opportunity cost, low human capital), the nature of property rights (weak, increasingly contested), and the quality and orientation of government.

In some settings frontier governments *emerge*. This formulation occurs when population growth in areas beyond reach of formal government creates conditions where people work together to achieve common objectives. In other settings governments are imposed, sold, or even transplanted. Imposed government is typically the result of military or security considerations. Government is sold when private colonization schemes provide both land and the functions of government (roads, schools, hospitals, tenure security, and law and order). Finally, in a number of notable cases government arrives at the frontier transplanted from elsewhere by ethnic and/or Utopian groups (Japanese in Brazil and Bolivia Lowlands, Hutterites and Mennonites in Bolivia Eastern Lowlands and Paraguayan Chaco).

In the context of determining the quality of frontier growth, the distinction between *emerging* government (at the economic frontier) and *imposed* government (beyond the economic frontier) is critical. While emerged government is a *product* of the frontier economy, imposed government *creates* an economy where one would not otherwise exist. What government is asked to do in the two cases differs considerably. What government *ought* to do differs also.

The following sections (a) explore the coevolution of economic rent, property rights and government; (b) contrast the stylized characterization of evolved government with the case of imposed or imported governments;

(c) summarize the major conclusions from the analysis; and (d) draw out the major policy conclusions.

### ***Emerges Government***

The relationship between the emergence of economic rent to land and the emergence of the demand for *some form of government* is nearly perfect. In early frontiers, clarifying and enforcing property rights is one of the earliest functions of emerging government. The need for collective action to enforce property rights increases with increasing value of land as the frontier moves forward. Understanding this evolution of local government, and its relationship to central government, can provide important insights into the strengths and weaknesses of policy initiatives.

**Rent Emerges.** Recall Figure 2.4. The point on the land rent gradient where the *marginal laborer* is as well off as he would be in his best alternative employment (covers his opportunity cost) can be considered the economic definition of the frontier. It is here that the marginal laborer begins to integrate the national economy into previously unexploited areas. Note, however, that since he only manages to cover his opportunity cost, he is relatively indifferent with respect to his ownership of the land. Since he has no competitors for land (remember *he* is the marginal laborer), he can farm unimpeded by concerns over land security. As roads improve, transportation costs fall, and markets grow, the potential value of this settler's land begins to increase. Its net present value (NPV) now exceeds both his opportunity cost *and that of other low-opportunity-cost settlers*. Competition for land begins to emerge. Since formal government is weak or non-existent, the rules to manage this competition are established locally. For example, as long as the potential income stream is perceived as being low relative to the opportunity costs of potential settlers, the initial settler may need only to mark his cleared area. To a newcomer the land isn't worth a fight--he can always settle on the plot next door. As transportation continues to improve, however, the difference between opportunity

costs and potential income streams grow--relative land scarcity and true economic rent emerge, and land becomes an item worth fighting over.

**Government Emerges.** With competition for land intensifying, settlers must strengthen their claims to land. Settlers might deforest: Cutting timber marks claims clearly, and increases the visibility of squatters should they attempt to invade.<sup>6</sup> It is expensive, however, and results in a dissipation of some portion of the economic value that was beginning to emerge. The more valuable the land becomes, the more competition arrives, and the more expensive it becomes for established settlers to protect ownership. In an effort to reduce these investments, and to increase the effectiveness of land security measures, early settlers coordinate efforts, forming into cooperatives, associations, and landowners societies--all designed to strengthen members claims to the land and discourage competition.<sup>7</sup> *These associations represent the emergence of government--a government whose costs are justified by the need to lower the costs of tenure security and thereby to allow the surplus (true economic rent) to accrue to the landowners.*

As formal government becomes increasingly effective the role of voluntary associations in the direct provision of services dwindles. These associations remain important vehicles for empowering local populations vis-a-vis formal government, however.

Table 3.1 summarizes this emergence of increasingly formalized government, with relatively informal collective actions gradually being replaced by formal ones. Government services can be roughly divided into tenure-related services and community services. Tenure services emerge first, induced by the need for early settlers to protect their land from other claimants.<sup>8</sup> As experience is gained with collective organization, the transactions costs of further collective pursuits are lowered and other (pre)government services emerge. As formal government approaches, with external support, direct protection increasingly evolves into collective representation in the relevant, yet still distant, government institution.

**Table 3.1: The Emergence of Government**

Function	Private Inputs (Pre-Government)	Associative Inputs (Emerging Government)	Government Inputs
<b>Tenure Services</b>			
Definition	Stake, Clear Boarders, Burn, Fence	Survey	Survey
Documentation	No formal mechanism	Landowners' associations, sindicatos, cooperatives, cattlemen's associations	Government Registry of deeds (Cartorio)
Adjudication	Conflict unlikely, land has no value	Above groups represent members' interest in (relatively) distant government institutions	Formal legal representation necessary, government represented locally
Enforcement	Not necessary, land not desired by others	Above groups, private police and/or vigilantes	Formal police power of government
<b>Community Services</b>			
Ag extension	Not performed--settlers use techniques from origin	Some groups develop excellent research and extension (Mennonites, Japanese)	Private sector may become primary vehicle
Marketing	Lack of marketing imposes subsistence strategies	Cooperative or Association builds and finances roads; cooperative marketing channels may emerge	Cooperatives commercialize; private sector moves into most profitable areas; governments become drawn into the losers
Education	Little education except within family	Cooperatives hire teachers, Communal groups (Mennonites, Japanese) develop teacher from within	Government provides education, quality depends much on in emerging urban areas
Health	No health care	Government provides some primary health care, only communal groups develop some secondary health care	Government provides primary health care, some secondary care available but quality is low
Transportation	Settler has no direct road access	Association maintains road; road usually constructed by loggers	Government has primary responsibility for construction and maintenance of roads.

### "Sustainability" and the Role of Government on the Frontier

Government has much to do with whether or not frontier settlements are "sustainable." For settlement to be stable, government must prevail against the economic forces which tend to promote transience. As discussed in Chapter 2, the effects promoting transience at the frontier are the "mining effect," *immediatismo*, and the "sell-out" effect. The mining effect results from cheap land due to abundance. *Immediatismo* results from high rates of time preference partially explained by credit rationing. The "sell-out" effect results from the fact that people with low opportunity costs are the most likely to be early settlers at the frontier; these people, in the absence of specific actions by government, will predictably sell out to those who arrive later.

There are several implications for the role of government in promoting stable settlement. First, any act by government that increases the supply of new land, or reduces its cost, will increase the mining effect and tend to undermine the stability of existing communities and economic activities. Also, unequal access to government services and credit markets (between early arrivers and the more highly educated, urban-based population that follows) will promote transience and continued expansion of the frontier through both the *immediatismo* and the "sell-out" effects.

**Policies to Reduce the Mining Effect.** If nutrient mining is caused by cheap land, then the most direct way to reduce it is to avoid government policies that lower the price of land. Three classes of government policies determine fundamentally the price of land on and near the frontier--roads, credit, and land tenure policies. A fourth policy, zoning policy, can combine elements of the other three. These policies are discussed below.

*Roads policy* can either raise or lower the price of land. Intensification of the road network increases the price of adjacent land through reducing transport costs and increasing farm

profitability. Extensive roads opening up new areas for exploitation, will, by putting more land on the market, reduce the price of currently accessible land.

*Credit policy* determines the supply of financial resources available to bid the price of new land to equilibrium.<sup>9</sup> Road building on the scale of the Transamazonia, Belém-Brasília, and Br 364 in Brazil, or the road building associated with the opening up of the Eastern Lowlands in Bolivia, put massive quantities of land on the market relative to the capacity of credit markets to permit the bidding of this land to a market equilibrium price (consistent with eliminating excess profits to all factors). The result is that land remains underpriced for long periods of time relative to what it should be at reasonable discount rates.

*Ineffective land tenure and collateral policy* typically represents the major market failure that prevents the rapid convergence of land prices to "economic" levels (where rent disappears). No bank is willing to accept rural land as collateral as long as rural land ownership is not legally documented and undisputed and systems to adjudicate land disputes are ineffective. Mortgage markets are essential to permit land prices to be bid to equilibrium, and to permit access by small farmers to capital for expansion.

The lack of mortgage markets has negative effects for both equity and the environment. It is inequitable because the relatively privileged people in society with their own capital or access to outside credit can purchase large quantities of underpriced land while successful small farmers cannot use their proven production record to access credit for expansion. Negative environmental effects occur because underpriced land (relative to its economic value) is used too extensively. In addition, since in areas with insecure land tenure ownership of land must be ensured through occupation (see Chapter 2), the combination of cheap land and the incentive to minimize costs of occupation tends to bias land use toward premature deforestation and ranching.

**Policies to Reduce *Imediatismo*.** *Imediatistas* (people with short time horizons) can be divided into two groups: those who, whether due to desperation or predisposition, have exhausted any possible source of credit and no longer have any hope of obtaining credit in the future; and those who borrow (and repay) and who make decisions based on the prevailing interest rates. The first group will be insensitive to government policies affecting the interest rate; they are likely to be found at the extreme limit of the economic frontier and are likely to rapidly become chronic nutrient miners. Credit policy has little or no influence on their activities. The second group, on the other hand, faces credit markets linked directly or indirectly to the formal credit system. For this group any policies effectively lowering interest rates (implying the attainment of an overall macroeconomic balance) would help. Other possible policies that would help include encouraging the mobilization of savings in rural areas through credit cooperatives or branch banking, combining the taking of deposits and short-term lending, and developing the capacity to judge the credit-worthiness of smallholders.

**Policies to Reduce the "Sell-Out" Effect.** The sell-out effect on an early settler will be reduced by all policies that reduce the relative attractiveness of selling out to a (typically urban-based) late arrival. Two classes of policies can influence this decision. The first class consists of policies that influence the economic value of the land to the current owner relative to the price offered by the prospective buyer. The second class consists of provision of "stabilizing services." Such services would provide nonmonetary benefits in the current region that would unlikely be available if the settler were to sell out and move farther out toward the economic frontier.

*Differential access to government services* is probably the major factor influencing the relative value of land to the early settler and the prospective buyer. As shown in Chapter 2, the relative rate of time preference is fundamental. If the prospective buyer can mortgage urban land at 10 percent while the early settler must

borrow from a moneylender at 100 percent, the effect on relative rates of time preference is overwhelming. In household surveys the need for money to deal with illness and family crises emerges repeatedly as a reason for selling out and moving forward. Other services also materially effect the relative valuation. For example, the urban entrepreneur may know that he can get secure title, while the settler is kept in doubt whether or not the land titling agency will ever deliver the promised title. Similarly, the extension service may be more comfortable dealing with well-educated entrepreneur farmers, and in fact, the techniques promoted by the extension service may be only accessible to the relatively well capitalized. More generally, all these factors combined make the land worth more to the relatively well-off, educated urban businessman than to the uneducated rural settler.

Other government "*stabilizing services*" reduce transience. Stabilizing services, such as health, education, and community services are important incentives for families to stay put. It is noteworthy that these services typically have to do with providing health and education to children.

*Zoning* is an attractive mechanism to direct government policies to address some of the policy issues addressed above. It can be particularly effective in ensuring that new road construction is designed to intensify the use of existing accessible land, rather than expanding the road network. Similarly zoning can concentrate stabilizing services in development areas. If effectively planned and executed, the policy should substantially reduce the mining effect of cheap land. Unless differential access to services between the advantaged and disadvantaged can be reduced, however, later arrivals will continue to buy out the early settlers. The latter, in turn, although with more cash in their pockets, will have fewer options for starting a new life.

**Summary.** In summary, government can promote stability by providing stabilizing services to early settlers--principally education, health care, and land tenure services, and by

ensuring that other services are *at least* as accessible to the relatively disadvantaged as they are to the advantaged. This policy is consistent with both an environmental and equity objective. The environmental objective is promoted because more services to the relatively disadvantaged early settlers makes them less likely to sell out. The equity objective is achieved because their current incomes are improved, and if they do sell out they demand a higher price than they would in the absence of a favorable provision of government services. Zoning can be effective in intensifying land use in developing areas. It cannot be expected to prevent buyouts and farm consolidation.

**Decentralization, Popular Participation, and Institutional Incentives.** Decentralization and local participation are increasingly popular themes among government and multilateral policymakers. The popularity of these themes risks creating a "some's good, more's better" mentality, where more decentralization and more popular participation is always considered to be preferred to less. Serious students of government and public finance know better; local groups predictably vote their own interest--even when it is not in the best interest of a larger public. The "not in my backyard" syndrome is well documented when it relates to citing waste facilities, prisons, half-way houses, etc. The syndrome can be generalized to all issues where local interests are likely to be at variance with the interest of the wider public.

It is possible to use the analysis developed above (and in Chapter 2) to predict the political interest in the provision of various government services. This approach, in turn, predicts the likelihood that these services will be conscientiously carried out by the various levels of government. For example, building local roads is an appropriate activity for local government (states and municipalities). There are no local interests likely to be opposed, the activity promotes the national interest by intensifying agricultural activity, and there are substantial advantages in having such activities planned and executed locally; it is a natural activity for the federal government to devolve to

states and local government. *Extending new roads* is a different issue, however: for the reasons discussed above, road extension into new unexploited lands is generally *not* in the national interest. Nevertheless it is likely to have widespread local political support.

Table 3.2 reviews briefly a number of other environmentally relevant services and policies. Environmental zoning, for example, is likely to be resisted by both the elite and the poor as limiting their economic options. Despite strong support at the national level the prospects for success on the local level would be low. One way to develop support is to create winners, through concentrating government services in current high population areas zoned as agriculture (preferably including both numbers and local political influence). The voice of the winners must clearly dominate the opposition of the losers, however. Although this winning majority may occur at the time of the initiation of the zoning project, losers are likely to find a political voice over the medium term.<sup>10</sup>

As described above, it is in the national interest to improve land tenure services in areas where the frontier is expanding. Local support is not guaranteed, however. As described in Chapter 2, in the absence of a smallholder settlement policy, improved tenure services can be expected to increase speculative holding by outsiders. This trend may be efficient (because it reduces premature economic activity) and environmentally preferable to current policies (which implicitly or explicitly encourage deforestation for purposes of establishing property claims), but it would not receive local support once outsiders began buying up substantial amounts of local land. A policy to preferentially allocate public land to smallholders (with full tenure services) may or may not be supported by local elites, depending, *inter alia*, on the amount and location of the land. The policy could be expected to be enthusiastically supported by the poor, however, and, as outlined in Chapter 2, would minimize the government expenditure required to establish an efficient and peaceful settlement policy.

Increased credit to urban elites is politically popular. Because it puts pressure on the local

land markets, it increases the options of the relatively poor, first-generation settlers (through increasing the probability that a bid will be made on their property, as well as influencing the bid price). Because it increases the high probability that the early settler will be bought out, move, and repeat the process, increased credit may not be in the national interest from an environmental standpoint.<sup>11</sup>

Environmental restrictions on logging and forest clearing (for agriculture) finds few supporters at the state and local level.<sup>12</sup> Possible future negative environmental effects are generally considered too far in the future and too uncertain to justify a loss of current incomes. Because politicians gear their agenda to the electoral cycle, they have every incentive to encourage current economic activity. For them more logging and agriculture means more tax revenue (through the ICM), and through population growth a greater share of the Federal Participation Fund revenue, and more political power.

The national interest in rationalizing the exploitation of forest and land resources suffers from an inability to argue its case persuasively. Although the economic activity stimulated by forestry and agriculture is evident in the Amazon, the possible long-run loss due to environmental degradation and/or externalities is much less concrete. In particular, there is a justifiable resentment that the largest benefits from restrained exploitation (greenhouse gas restrictions and biodiversity protection) are incurred long in the future and at the global level, while the costs are to be borne now by the local populations.

It is likely that government services improving human capital and quality of life (recreation, culture, health care, education) can do much to encourage stability and discourage migration. These services are in the interest of all levels of government. They create a more productive population, raise the reservation wage of potential migrants, and tend to promote a more intensive land use.

### *Imposed and Transplanted Government*

As suggested in the previous sections, frontier growth is often imposed from a relatively remote central government, rather than spontaneously emerging as a response to economic opportunity. In this section we argue that (a) imposed government is likely to be premature from an economic investment point of view, (b) unlike in frontier areas, settlement induced by imposed government will be relatively stable, and (c) decentralization of government in favor of imposed states (and subsequent induced municipalities), may not be in the national interest.

**Premature Government.** How long should it take to show a return on frontier government? Central government expenditure in frontier government can be seen as an investment in the future economy of the region.<sup>13</sup> One way to measure the effectiveness of government as an investment is to compare the state or region's net (of taxes sent back to the Federal Government) expenditure to its overall value-added (GDP). Where this ratio is large, government represents the main source of economic activity. Where the relative size of government is large initially, but falls rapidly, states are "growing up"--losing their dependency on transfers from outside the system. States where the share of government remains high, without sign of emerging independence, are probably premature from an economic point of view. In these states government expenditure has failed to create the preconditions for self-sustaining economic growth, either because their remoteness currently makes the states economically unviable, or because the mix of government expenditures has been wrong to promote independent, private sector, economic development.

Table 3.3 presents the share of government in the GDP of the Brazilian Amazon states and of comparators in other regions. While the intraregional pattern is one of the South and

**Table 3.2: Political Support For Various Government Policies and Services**

Government Service	Local Interest		National Interest
	Poor	Elite	
Intensify Existing Road Network	Yes	Yes	Yes
Extend Road Network	Yes	Yes	No
Environmental Zoning of Land	No	No	Yes
Zone and Concentrate Services	??	??	Yes
Improve Land Titling and Tenure Services	??	??	Yes
Allocate Public Land to Smallholders	Yes	??	Yes
Increase Credit to Urban-Based Entrepreneurs	Yes	Yes	No
Increase Credit and Extension Services to Small, First Generation Settlers	Yes	No	Yes
Impose Environmental Restrictions on Logging	No	No	Yes
Impose Environmental Restrictions on Farming	No	No	Yes
Improve Community Services (Recreation, etc.)	Yes	Yes	Yes
Improve Education Services	Yes	No (Uses Private)	Yes
Improve Health Care Services	Yes	No (Uses Private)	Yes

Southeast supporting the economies of the North, Northeast, and Centerwest, there is at the same time considerable evidence that the North and Centerwest are "growing up." The Northeast, on the other hand, appears not to have reduced its dependency on federal transfers.<sup>14</sup>

The Amazon states can be clearly divided into two groups. For states located beyond the frontier, dependency has grown over the 10-year period; for those currently on the frontier, dependency has decreased sharply.

Beyond the frontier are Roraima, Amapá, and Acre; undoubtedly Amazonas would also be

included were it not for the artificial support provided by the Manaus Free Trade Zone. As Table 3.3 shows, in these states government has grown faster than the economies, leading to an increase in the share of GDP represented by government expenditure. In Roraima, according to the official statistics, net transfers to state government exceeded the entire value-added of the state. In Acre also, the role of government grew much faster than that of the private sector, with government growing from 46 percent of GDP to 79 percent of GDP. In Amapá, the share of government was already high in 1975 (78 percent of GDP) and increased to 84 percent

**Table 3.3: Growing Up?**  
 Net Federal Transfers as a Percent of State/Regional GDP (1975 and 1985)

Region/State		1975	1985
States Beyond the Frontier--Imposed Government	Roraima	58	109
	Amapá	78	84
	Acre	46	79
States on the Frontier--Currently Emerging Government	Rondônia	21	6
	Pará	21	6
	Mato Grosso	21	5
Regions	North	24	10
	Northeast	11	12
	Centerwest	6	4
	South	-3	-2
	Southeast	-8	-10
Memorandum Item			
Amazonas		21	1

*Source: Government expenditures and revenues for 1975 and 1985 are from Fundacao Getulio Vargas (FGV); state and regional GDP are from IBGE.*

of state value-added by 1985.

The frontier states--Rondônia, Pará, and Mato Grosso--have made substantial progress towards self-sufficiency, both reducing their dependency on the Federation from 21 percentage points of their respective GDPs to 6 percentage points of GDP.<sup>15</sup> The largely Amazonian state of Mato Grosso has also dramatically reduced its dependency, from 21 percentage points of its GDP to 5 percent of GDP.

This progress in Rondônia, Pará, and Mato Grosso compares favorably in both direction and level with progress in the Northeast, which

increased its dependency from 11 percent of its GDP to 12 percent of GDP, despite progress in the (largely) Amazonian northeastern state of Maranhão. The question "how long should it take for states to grow up?" cannot be answered. Clearly a relatively long period of investment could be justified if the expected future return were sufficiently high. Such performance is unlikely for the remote states of the Amazon. For the other Amazonian states, however, the decrease in the rate of dependency has been rapid and substantial, although from a much lower dependency base. Further analysis should

explore the earlier dependency levels of previous frontier states and the rates at which they "grew up."<sup>16</sup>

**Farm Stability.** The poor economic performance of the imposed states (Roraima, Amapá, and Acre) has a corollary in farm turnover and agricultural stability. As discussed in Chapter 1, in consolidating frontiers early settlers tend to be *bid* off the land by recent, urban-based immigrants with better access to capital and government services. These recent formal-sector-based immigrants, in turn, become attracted to business activity on the frontier only when it reaches a critical level of consolidation. This description characterizes the consolidating frontiers of Rondônia, Pará, and Mato Grosso.<sup>17</sup> On the other hand, as Table 3.3 indicates, in Acre, Amapá, and Roraima, the level of economic activity is determined not by entrepreneurship but by the level of government expenditure. In this economic environment there will be few potential buyers anxious to bid settlers off the land, and existing farms are likely to be stable. Such an effect is a major explanation for the interest in extractive reserves in these states--it is premature for investment in activities that will later dominate as transport costs fall and labor/land ratios increase. In the FAO review of INCRA settlement schemes (FAO, 1992) for example, the *only* settlement scheme that had had no turnover was an extractive reserve in Acre. It also had the second lowest level of income and the lowest accumulation of assets (see Annex C).

**Decentralization, Expenditure Composition, and Institutional Incentives.** Who should make decisions about imposed government? Does decentralization of government functions and increased autonomy of state and *município* governments make sense in economically dependent states? Yes, some decentralization makes sense, but much less than it does in states with independent and sustainable development sources.

Government is imposed from without for strategic and/or military reasons--e.g., to establish sovereignty, control illegal activity, or

protect/exploit high-value natural resources. Because of remoteness, few if any activities are economically profitable if not based on either (a) directly or indirectly supporting government (providing food and services for government employees), or (b) mining (gold, cassiterite, trees). From the standpoint of economic growth, *investment* in these regions is premature--growth is limited to derived demand from government and mining. Government expenditure in these areas should be confined to (a) efficiently achieving the primary, strategic objectives, and to (b) efficiently maintaining and improving the quality of life of those who are consequently attracted to the area. The strategic objectives, which justify the creating of imposed government in the first place, are national. The incentives to carry them out efficiently and effectively are incentives that rise out of the national interest, and which may well be at variance with the perceived (short run) interests of the local population. The extremely lucrative illegal drug industry, timber mining, mercury-polluting placer mining, unrestrained deforestation--these are activities that the local population and its representation might be prone to tolerate, largely out of appreciation for the economic activity they stimulate. These activities are clearly not in the national interest, however, and any system that relegates control of such activities to local authority risks an overwhelming conflict of interest at the local level.

Quality of life and human capital expenditure, on the other hand, are better allocated at the local level. Decisions concerning the appropriate composition and nature of educational, health, recreational, and cultural services, are best made at the local level, by those who understand best their own needs and aspirations. It is appropriate that local political mechanisms determine the composition and nature of these services.

As has been noted repeatedly, investment in economic development in extra-frontier states is *a priori* a losing proposition.<sup>18</sup> National government that sustains the economic life of extra-frontier states must be ever wary not to forget this fact, or else it will be drawn into financing

local developmental schemes. These schemes will generate employment and wealth for the participants, but the chance of economic sustainability is minuscule.

In sum, the following considerations should determine the federal-state-*municipio* expenditure shares and composition: national interest dominates in extra-frontier states; quality of life and human capital expenditure is most efficiently allocated at the state and local level; and government investment in local/regional *economic development* (as opposed to human capital formation) is unwarranted (premature). These considerations should be embodied in any mechanism that determines the revenue sharing between the federal government and ex-frontier states.

#### Notes

1. Sometimes governments are imposed purely for national defense or other strategic reasons (interdicting drug trafficking, for example). This analysis does not concern itself with these cases. Military occupation would probably be found to be the least-cost option in an analysis of alternative means of meeting these objectives, rather than creating full-scale frontier governments. There is also a case for well-defined government intervention to protect the land rights of indigenous peoples. While the analysis is based on the assumption that there are no preexisting ownership rights, the sustainability of this assumption cannot be taken for granted, as evidenced by the belated and costly recognition of indigenous rights in places such as Maine, Canada, Australia, New Zealand and Indonesia.

2. This term comes from the title of a paper by Terry Anderson and P.J. Hill, "The Race for Property Rights," in the *Journal of Law and Economics* 33 (April 1990), which discusses the way land tenure policies influenced the efficiency of frontier settlement in the United States.

3. Arguably the environmental loss is small, however. Unless sustainable forestry is a competitive land use, lack of tenure security probably accelerates deforestation but does not increase it in the long run.

4. There are other environmental values not traded on the market, such as amenity and aesthetic values. These values are beyond the scope of this paper.

5. It may be that the Swedish tax of \$45 has revenue objectives as well as greenhouse gas reducing objectives. An alternative comparison would be to use the "medium" greenhouse damage estimate of Prof. Nordhaus. This calculation leads to a welfare loss of \$500-\$800 per hectare when Amazonian forest is converted to agricultural land.

6. This explains why deforestation is so widely accepted as strengthening claim to title. In general these laws have only codified locally established, commonsense practices.

7. The role of *syndicatos* and church groups in organizing squatters in Brazil is well known. Readers may need to be reminded of the U.S. history, however. An observer in 1830 described the following activity of a land claims association:

"The citizens occupying this land, together with a few others, have held a meeting or convention, and entered into written and solemn resolutions to prevent all, and every person, whatsoever, from viewing or exploring the land previous to the day of sale. They have pledged themselves to do this by force of arms, they have further resolved for one individual in each township to bid off the whole of the land that they or any of their body may wish to buy, and the balance of their company to be armed with their rifles and muskets before the land office door, and shoot, instantly, any man that may bid for any land that they want. . . . In consequence of the large body that is united, and their determined violence, they have, and will keep every individual from examining or buying the land. . . ."

One resident of Fort Dodge, Iowa, recalled that the local association advertised "that any one attempting to Settle on any Lands Claimed by any Member of the Club Would be dealt With by the Club and his life Would not be Safe in the Community." (From Anderson and Hill, quoting from Hibbard, 1939, and Gates, 1973.)

8. In the many cases of invasions of relatively idle landholdings (especially frequent in Para), the formation of a form of government *preceded* the actual settlement. In these cases the settlers organized to *claim* the land from the large landholder, not to *defend* it from other claimants.

9. Equilibrium price is the price where labor and financial capital just receive their opportunity cost or, equivalently, all economic rent is bid away.

10. For example, the agroecological zoning project of Rondônia appears to balance these forces. The similar project in Mato Grosso does not have the same concentration of clearly defined winners. It is harder to imagine local support for this project enduring.

11. It is not in the national interest if (a) the environmental externalities are large, or (b) the transaction of land is consummated only because of differences in the rate of time preference between the credit-starved settler and the elite entrepreneur--with no underlying productive advantage.

12. *Licensing*, which creates rents, finds some favor in the state and federal enforcement agencies. *Restricting* the activity, to a level that affects the local economic activity, finds virtually no support at the state and local levels, however.

13. As suggested in the introduction, the reasons for central government investment may be more strategic (militarily or geopolitically) than economic. Nevertheless, it is fair to evaluate the economic return.

14. It is important to note that it is unfair (and certainly not the purpose here) to focus only on the efficiency of government spending from the point of view of promoting self-sustaining growth.

Government also has important interregional equity objectives built into its revenue-sharing formula (see Shah and Larson, 1992). It is fair, however, to evaluate the growth performance of the region relative to the size of government transfers.

15. Amazonas cannot be included in these calculations because of the high amount of *implicit* transfers through preferential trade policies attached to the Manaus Free Zone. With recent steps toward liberalization of trade, the fundamental dependence of Manaus is becoming more evident.

16. Since 1985 the distribution of the Participation Funds has been altered by the new Constitution. As a result, the share of the states in the Legal Amazon has grown from 21 percent in 1985 to 24 percent in 1991. This increase took place at the expense of the Southeast and South, whose shares fell from 24 percent to 20 percent, and 6 percent to 5 percent, respectively.

17. This does not mean to imply that there are no new frontiers available in these states. In fact, each of them have considerable land not yet pressured by development.

18. This is not to say that private entrepreneurs should not invest in ex-frontier areas. It is the business of entrepreneurs to take informed risk.

## ANNEX A

### CALCULATION OF MAXIMUM NUMBER OF CATTLE ON FARMS BENEFITING FROM FINAM INCENTIVES AND OFFICIAL CREDIT, 1980 AND 1985

	Cumulative % Total													
	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Estab. <sup>a</sup>	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle
	1980													
No. of units, 1980	8,906	251,419	7,037	292,190	7,571	355,748	1,345	313,881	29,362	2,729,796	619	46,079	54,840	3,989,113
No. of units, 1985	24,639	768,411	9,036	333,457	9,534	420,940	2,058	303,501	44,175	3,485,468	757	46,901	90,199	5,358,678
Credit contracts, 1980	471	--	159	--	1,105	--	485	--	4,653	--	64	--	6,937	--
Credit contracts, 1985	1,044	--	488	--	971	--	327	--	2,619	--	11	--	5,460	--
Percent with contract, 1980	5.3	53.2	2.3	57.2	14.6	64.0	36	85.9	16	83.0	10	53.6	13	78.4
Percent with contract, 1985	4.2	46.0	5.4	66.1	10.2	61.9	16	68.7	16	80.9	1	23.7	6	63.3
FINAM projects approved, 1980 <sup>b</sup>	2	--	4	--	21	--	1	--	105	--	3	--	136	--
FINAM Projects approved, 1985 <sup>b</sup>	11	--	20	--	31	--	8	--	228	--	29	--	327	--
Percent with FINAM incent., 1980	0.0	3.2	0.1	4.4	0.3	9.8	0.1	0.8	0.4	20.6	0.5	21.3	0.2	16.5
Percent with FINAM incent., 1985	0.0	5.9	0.2	22.7	0.3	15.0	0.4	8.2	0.5	31.1	3.8	36.8	0.4	25.4

*Note:* The table above is the basis for the calculation for Table 1.4. The method is the following. The number of credit contracts and number of FINAM projects were obtained from Banco do Brasil and SUDAM, respectively. The number of farm establishments comes from the 1985 agricultural census. These data are used to calculate the percentage of farms receiving official credit and FINAM projects, respectively. Assuming that large farms receive official credit and FINAM projects before small farms do, a line can be drawn on the cumulative frequency distribution of farm sizes (from the agricultural census) to divide the farms that would receive transfers from those that would not. Since the census reports the cumulative frequency of cattle by farm establishments the percent of cattle receiving subsidies can be estimated from the percent of farms with subsidies. For the table above the percent of cattle on farms receiving subsidies is interpolated from the size categories in Table 1.4. On Table 1.4 the line separating those receiving subsidies from those not receiving them is drawn between the nearest farm size categories.

a. Number of establishments.

b. Cumulative number of projects approved to date.

*Source:* 1985 Preliminary Census, SUDAM (in Yokomizo, 1989), Banco do Brasil, and Ministry of Finance.

## ANNEX B

### REVIEW OF STUDIES OF COLONIZATION SUCCESS IN THE AMAZON

1. In Table B.1, Moran identifies four stages in the evolution of colonization projects.

**Table B.1: Moran's Stages of Colonization**

Stage	Settler/Government Activity	Observations
Evaluation, Planning, Construction and Recruitment	Spontaneous settlers generally visit and evaluate sites; settlers in government programs are more likely to rely on government's assessment. Moran emphasizes that when governments recruit settlers they ignore serious conflict between social and production objectives. Government promises to build infrastructure have been generally unfulfilled.	Moran emphasizes that settlers trust in government is generally misplaced--leading to lower success rates in government projects than in spontaneous projects where settlers have more complete responsibility.
Early Colonization (0-5 years)	Adaptational "testing of the past"--settlers attempt to reproduce the forms of agricultural production they bring from areas of origin. Moran argues that this adaptational period is inevitable and that governments fail to recognize settlers' priority of <i>survival</i> over yield and "efficiency."	Moran emphasizes the loss of social institutions in new settlements--in particular the importance of social institutions in risk-sharing, labor-sharing, and land tenure.
Experimentation (5-10 years)	Stage of considerable land turnover. Unsuccessful 25-75 percent of colonists abandon land; successful begin to experiment--expand operations, buy up land, invest in equipment and achieve increasing levels of productivity.	Successful diversify, including into urban enterprises and urban real estate. Stratification between managers and laborers increases.
Consolidation (10 years or more)	Government allows local populations to take over all the functions of their new communities.	Role of local taxation and fiscal independence becomes an issue.

**Table B.2: Ozorio de Almeida's Evidence on Viability of Settlements**

Settlement	Survivors		Rice Yield Kg/ha		Corn Yield Kg/ha		Value of Land (US\$/ha) <sup>a</sup>		Avg. Years on Farm
	No.	%	1981	1991	1981	1991	1981	1991	1991
PARÁ (Official)									
PACAL	72	74	1097	1765	859	1500	130	248	14
ANAPU- PACAJA	32	48	1068	1007	704	902	20	59	9.3
MONTE ALEGRE	35	81	1010	1369	941	1500	70	87	25
MATO GROSSO (Private)									
ALTA FLORESTA	48	63	1541	1390	1527	1573	460	258	10
PARA- NAITA	20	56	1244	1861	1230	2400	b	b	9.5
MUTUM	17	68	1244	1861	1092	1500	200	398	10
S.J. RIO CLARO	10	53	807	...	1092	1500	200	267	13
TOTAL or AVERAGE (% increase)	234	64	1166	1502	1005	1563	190	219	13
	---	---	---	29%	---	55%	---	15%	

a. Land values are weighted average of prices of each settlement.

b. Parnaíta land values are included in Alta Floresta's means.

Source: Ozorio de Almeida (1992)

2. Table B.2 presents critical findings of Ozorio de Almeida (1992) related to the viability of agriculture and permanence of settlement.

3. Table B.3 shows the geographical distribution of the settlements sampled in the FAO/UNDP/MARA study. The major results with regard to *economic* success of these projects are summarized in Table B.4.<sup>1</sup>

**Table B.3: FAO\UNDP\MARA Study: Geographical Distribution of Settlements Surveyed.**

Area	Number
Centerwest	<u>6</u>
Goiás	1
Mato Grosso Do Sul	2
Mato Grosso	3
Northeast	<u>16</u>
Bahia	4
Ceara	4
Maranhão	2
Paraíba	1
Pernambuco	2
Rio Grande Do Norte	2
Sergipe	1
North	<u>10</u>
Acre	1
Pará	5
Rondônia	2
Tocantins	2
Southeast	<u>4</u>
Espirito Santo	1
Minas Gerais	1
Rio De Janeiro	1
São Paulo	1
South	<u>10</u>
Paraná	5
Rio Grande Do Sul	1
Santa Catarina	4
Total	<u>46</u>

<sup>1</sup> The numbers of original settlers on the land in Table B.5 are not consistent with the verbal discussion of individual settlements given in the Annex. The latter states that 60 percent of the original settlers have sold out in Pa1, 50 percent in Pa2, 40 percent in Pa3, 25 percent in Ro1, 25 percent in Ro2, and 40 percent in To2.

**Table B.4: FAO\UNDP\MARA Review of Success of Settlement Projects**

**Average Family Income From All Sources (1990-1991)**  
(in minimum salaries)

Region	Crop Income	Animal Income	Imputed Subsistence Income	Off-Farm Income	Other Receipts	Total
North	0.94	0.73	1.63	0.32	0.56	4.18
Northeast	0.40	0.32	0.81	0.42	0.38	2.33
Centerwest	0.74	0.73	1.24	0.37	0.77	3.85
Southeast	0.89	0.39	1.77	0.70	0.38	4.13
South	1.72	0.58	2.03	0.53	0.76	5.62
Brazil	0.82	0.55	1.38	0.41	0.54	3.70

Source: FAO\UNDP\MARA (1992)

**Accumulation of Assets by Settlers**  
Average Values in IGP/FGV-DI<sup>a</sup>

Region	Endowments			Assets Acquired			Percent Accumulation Relative to Total Endowments	Percent Accumulation Relative to Own (initial) Capital
	Initial Capital	Gifts and Loans <sup>b</sup>	Total	Personal Goods	Productive Assets <sup>c</sup>	Total		
North	111	36	147	10	237	247	168	222
Northeast	59	28	87	2	54	56	69	95
Centerwest	211	43	254	5	224	229	90	108
Southeast	126	20	146	4	137	141	97	112
South	111	40	151	13	270	283	187	254
Brazil	109	37	146	7	176	183	125	168

a. Appropriate explanation.

b. Assumes loans are not continuing liabilities.

c. Includes all goods financed by gifts and loans.

Source: FAO\UNDP\MARA

**Summary: Incomes, Asset Accumulation and Time on Plot**

Region	Percent Original Settlers	Average Incomes (numbers of minimum wages)	Average Time on Plot (yrs)	Annual Average Rate of Growth of Own Capital (in %)
North	79	4.2	7	18
Northeast	99	2.3	15	3
Centerwest	98	3.8	5	15
Southeast	99	4.1	14	5
South	100	5.6	5	26

Source: Based on data in FAO\UNDP\MARA

**Table B.5: FAO\UNDP\MARA Data--Relationship Between Economic Performance and Turnover of Settlers**

Settlement	Percent Initial Settlers Still on Land (in sample)	Incomes (numbers of minimum wages)	Average Time on Plot (yrs)	Annual Average Rate of Growth of Initial Assets (%)
Pa5	47	5.51	6	25
Pa4	64	7.27	6	37
Pa1	67	5.79	6	22
To1	67	2.77	4	43
Ro2	78	3.08	3	10
To2	91	2.99	5	25
Ro1	92	4.03	4	47
Pa2	93	2.62	10	8
Ac	100	2.02	25	6
Pa3	100	1.68	8	46 <sup>a</sup>

- a. This high rate of growth reflects an extraordinarily low level of initial assets. Initial assets in this settlement were 4 percent of the mean level for the region as a whole, and 8 percent of the initial assets of the next lowest settlement. These numbers should be treated with reservation.

## ANNEX C

### MATHEMATICAL FORMULATION TO DERIVE THE "BREAK-EVEN POINTS"

The undiscounted income of the sustainable technique is,

$$\sum_{t=1}^n Y_s, \quad (\text{A})$$

where  $Y_s$  is the (fixed) annual yield.

Discounted, the series yields

$$V_s = \sum_{t=0}^{\infty} \frac{Y_s}{1+r} = \frac{Y_s(1+r)}{r}, \quad (\text{B})$$

where  $V_s$  is the discounted value of the sustainable technique.

For the unsustainable technique the undiscounted income stream is,

$$\sum_{t=0}^{\infty} Y_u (1-d)^t, \quad (\text{C})$$

where  $Y_u$  is the first year yield and  $d$  is the annual rate of yield loss.

Discounting, this becomes,

$$V_u = Y_u \sum_{t=0}^{\infty} \left[ \frac{(1-d)^t}{(1+r)^t} \right] = Y_u \left( \frac{1+r}{r+d} \right). \quad (\text{D})$$

Equating these discounted income streams we derive the ratio of incomes at which both activities are equally profitable ("break-even point").

$$\frac{Y_s(1+r)}{r} = Y_u \left( \frac{1+r}{r+d} \right) \Leftrightarrow \frac{Y_s}{Y_u} = \frac{r}{r+d} \quad (\text{E})$$

## ANNEX D

### CALCULATING THE NPV OF LAND FOR FIGURE 2.6

The following tables illustrate the calculations used to plot Figure 2.6. Tables D.1 and D.2 show the value of land with and without government enforcement of property rights, respectively. The difference in these tables is that where government enforces property rights the potential landholder need not incur the opportunity costs associated with "premature" occupation. Everything else is identical.

Both tables show the calculated NPVs for the first 10 years. For purposes of exposition, the tables are "frozen" in the values that would be used to calculate the 10th year's NPV. These are discussed below.

The yield data were generated by a logistic curve constructed to reach a maximum value of 50 in 35 years. The output from this curve is shown in the third column labeled "Yield." From this yield value the opportunity cost of the capitalist ("formal") and squatter are subtracted to yield the 6th and 7th columns labeled "Net Undiscounted." The 8th and 9th columns present the values from the 6th and 7th columns discounting at 15 percent and 25 percent respectively. Discounting takes place using the

first column (labeled "NPV Time") as will be explained below.

The objective of columns 8 and 9 is to calculate the net income stream for each year, *as seen in that year*. Therefore future discounted benefits must be calculated from each year discounted foreword *from that year*. Since we are illustrating the calculation of the NPV for year 10 the "NPV time" is set at 1 and all future years are discounted accordingly. Note that the NPV values for years 1 through 9 were calculated similarly, summing over all future net discounted values. These values have been converted to numerical values--they are no longer the sum of the net discounted values to their left since the discounting stance has moved foreword. The next step in filling out this table would be to convert the NPV values for year 10 into constants (they are currently formulas summing all "net discounted" values below them), and to move the "1" in "NPV Time" to year 11. This procedure was repeated, year-by-year to generate Figure 2.6.

Note that in the actual calculations the summation was run out to year 100.

## ANNEX E

# THE POTENTIAL FOR TRADE WITH THE AMAZON IN GREENHOUSE GAS REDUCTION

Growing worldwide interest in the problems of global warming and the emission of greenhouse gases has led to a search for innovative ways to reduce carbon emissions. One approach has been to use international trade based on comparative advantage to seek cost-effective strategies for carbon reduction. The costs of carbon reduction in the developed, industrialized countries of the North are large and are well known. However, there appears to be considerable scope to support carbon sequestration in developing countries in the South, especially in those that have large areas of tropical forests. This approach would serve several desirable goals: income transfers from the North to the South; income redistribution to poorer, frontier areas within southern countries; and provision of cost-effective carbon sequestration while also yielding biodiversity and ecosystem benefits.

This note explores the potential gains from trade between Amazonia and industrialized countries of the North. The first section shows that controlling emissions in the Amazon would be considerably cheaper than greenhouse-emission controls proposed, or in effect, in the industrialized North. The second section discusses potential institutional mechanisms to facilitate trade. It also identifies several problems that would have to be resolved.

### *Calculating the Potential Gains From Trade*

Indicative calculations suggest that the potential gains from trade in carbon emissions between industrial countries and the Amazon are very large. These gains can be calculated by comparing the value of a hectare of forest as a store of carbon to its value as agricultural land. To calculate the value of forest land as a store of carbon requires two numbers:

(a) amount of carbon sequestered in a hectare of forest, and (b) the per-ton value to society of reducing carbon emission. The product of these numbers is the social value of a hectare of forest in carbon sequestration. The value of forest land in agricultural use is best estimated by the selling price of forest land.<sup>1</sup> Comparing these numbers--the value of carbon sequestered on a hectare of forest relative to the land's selling price--yields the potential gains from trade between landowners and governments in the Amazon and the northern industrialized countries.

The value of forest land as a store of carbon can be estimated by: (a) estimating the global damages avoided by not releasing additional carbon to the atmosphere; (b) comparing the value society has been willing to tax itself to reduce further greenhouse emissions; or (c) comparing the costs of alternative sources of greenhouse reductions. Since proposals for carbon taxes are typically based on studies of the amount of carbon emissions that can be controlled at different levels of taxation, (b) and (c) are reduced to the same concept. Table E.1 illustrates the range of values obtained by various analysts interested in the amount of carbon sequestered per hectare of forest. Indicative values, based on a range of existing taxes and proposals, are shown in Table E.2.

Based on Tables E.1 and E.2, the potential value of Amazon land in carbon sequestration is between US\$245/ha and US\$28,300/ha. The low estimate is derived by multiplying Fearnside's value of 136 tons of carbon (for the average hectare of forest in the legal Amazon) by Nordhaus' "low" estimate of global warming damage costs. The upper bound is obtained by multiplying CBO's estimate of US\$100/t carbon, required to reduce emissions to their 1988 level by 2000, by the 283 tons of carbon per hectare estimated by the German Bundestag.

**Table E.1: Total Carbon Storage in Amazon Forest<sup>a</sup>**

Forest Type	tC/ha (assumes carbon is 50% of biomass)	Observations	Source
Average for Hilea Region	225	Estimates 112 t/ha above ground and 80-130 t/ha below ground	Sombroek (1992)
Dense Amazon Forest	160	Represents weighted average of dense forests comprising 49.3% of Brazil's legal Amazon	Fearnside (1992)
Average for Brazil's Legal Amazon	136	Area weighted average based on RADAMBRASIL's timber inventories	Fearnside (1992)
Average for Amazon	160	Above-ground carbon only	Houghton, et al. (1987)
Closed primary forest	283	Estimates 167 t/ha above ground and 116 t/ha below ground	German Bundestag (1990)

a. Carbon stored in above- and below-ground biomass.

**Table E.2: Indicative Values of Carbon Sequestered**

Basis of Valuation	Value US\$/Ton of Carbon	Observations	Source
Marginal damage estimate	1.8 "low" estimate 7.3 "medium" estimate 66.0 "high" estimate	Based on estimates of costs and damages to the world economy of global warming.	Nordhaus (1991)
Enacted taxes	6.1 45.0	Finland Netherlands and Sweden	Shah and Larson (1992)
Proposed taxes	5 phased to 25 in 1995 9 phased to 70 in 2000	Submitted to US Congress Debated in EC	Shah and Larson (1992)
Penny a gallon of gas	3.5		
Required to reduce US greenhouse emissions to 1988 levels by 2000	10 in 1991 increases 10 annually to 100 in 2000	Conclusions of a 1990 study by the Congressional Budget Office	CBO (1990)

Using values for carbon sequestration *that societies have actually demonstrated their willingness to pay* generates a narrower and more interesting range. Using Fearnside's average carbon content of dense Amazon forest (160 tC/ha), the US\$45/tC tax of the Netherlands and Sweden yields a carbon-storage value of US\$7,200 per hectare, the Finns' tax of US\$6.1/tC yields a value of US\$976 per hectare, and a tax of a penny per gallon of gas would yield US\$560 per hectare. This provides a relevant range of roughly US\$600-US\$7,000 per hectare.

Tables E.3 and E.4 compare the author's (unsystematic, 1992) observations on the market price of forest land in the Amazon with estimates of the value of carbon sequestering based on the information in Tables E.1 and E.2. The comparison shows that the value of the forest as a stock of carbon, even at the lowest estimates, is greater than its "present" value in agriculture. Even in Rondônia's more active agricultural areas, and using the most relevant range of implicit values of carbon (US\$600-US\$7,000 per hectare), the sequestration value of forest land is 4 to 50 times greater than its agricultural value. However, an accurate estimate of the global warming cost of deforestation must take account of the carbon content of crops established under subsequent land use. In the Amazon, economic and agronomic forces ultimately make pasture the most likely use. Even after subtracting the value of carbon in pasture (Table E.4), the net value of carbon loss would be 2 to 30 times the agricultural value of forest land in expanding frontier areas of the Brazilian Amazon.

### ***Impediments to Trade***

The numbers above demonstrate that very substantial potential exists for gains from North-South trade in greenhouse-gas reduction. Administrative difficulties are large, however, and despite these potential gains, a number of hurdles will have to be overcome to generate willing buyers and sellers. These are addressed below.

**Transaction Costs.** There are several difficulties which fall in the category of transaction costs. These costs reduce the potential gains calculated above--if they exceed them, no trade will occur.

However, the size of the potential gains suggests clearly that an effort to minimize these transaction costs, thereby creating a market, is justified. The most important transaction cost is *contract enforcement*. How can the buyer be assured that, having purchased carbon sequestration, the land will not be cleared anyway, if not by the contractee, then by someone else? Similarly, how can the seller be assured that payments will be made as promised? The second is *contract facilitation*. How can potential buyers and sellers be brought in contact? The third is *product grading*. How can the buyer get information necessary to make an informed choice concerning the value of his intended purchase of carbon sequestration? Important information would include forest density, the probability that it would be converted in the absence of intervention, and for many potential buyers, biodiversity value.

**Moral Hazard.** The major concern over using positive incentives to influence landowner behavior rather than negative incentives (taxes and/or command and control) is that of potential moral hazard.<sup>2</sup> In this case, moral hazard takes the form of landowners or governments taking, or threatening to take, environmentally adverse action *that they would not otherwise take*, in order to increase the value of their contracts. At the individual level moral hazard is minimal; once the land is burned or cleared, the landowner has forfeited any possibility to benefit from the program, which applies only to intact forest. An additional problem would have to be dealt with at the governmental level, however. Since building a road would increase the probability of land conversion, and therefore increase the value of a contract to not convert, a clear governmental commitment on road building would be necessary, as would other government policies.

**Tables E.3 and E.4: Comparison of the Market Value of Forested Land in Brazil to its Value in Carbon Sequestration**

<b>Table E.3: Expected Value of Amazon Forest Land in Agriculture<sup>a</sup></b>		<b>Table E.4: Value of Amazon Forest Land in Carbon Sequestration<sup>b</sup></b>		
<b>Location</b>	<b>Value US\$/ha</b>	<b>Value US\$/ha</b>	<b>Value Net Carbon in Pasture<sup>c</sup></b>	<b>Valuation Basis</b>
Pará, Paragominas area, near Belém Brazilia	300	7,200	4,950	Carbon tax in Sweden and Netherlands
Rondônia, BR364 South of Porto Velho	150	1,168	803	Nordhaus' "medium" estimate of marginal damage from global warming
Rondônia, Br364 West of Porto Velho	50	976	671	Carbon tax in Finland
Rondônia, Guajará Mirim area	15	560	385	Carbon equivalent of one cent a gallon gas tax
Pará, Transamazonia Altamira area	2.5	288	198	Nordaus' "low" estimate of marginal damage from global warming

- a. Current market price of the land.  
 b. Based on carbon content of 160 tons per hectare (see Table E.1).  
 c. Assumes 60 tons carbon per hectare (above and below ground).

**National Sovereignty.** Any program to allow global interest to influence activity in the Amazon would have to be effectively designed to minimize real or apparent impingement on national sovereignty.

### **Illustrative Mechanisms**

One mechanism to avoid most of the potential barriers discussed above would be for government, NGOs, and others

interested in preservation to enter into *short-term rental contracts* (of conversion rights, for example) that allow the landowner to carry out limited activity consistent with the environmental objective. These contracts would explicitly make the landowner responsible for enforcement of environmental restrictions. Ideally, an auction market for short-term rental contracts could be developed to generate rapid feedback to landowners. Contract values would fall rapidly in areas where violations occur, while good enforcement would be rewarded. Restricted and short-term rental contracts would not be seen as a threat to sovereignty, as would outright land purchases. NGOs, parties to "debt for nature" arrangements, and other bilateral and multilateral organizations (such as the Global Environmental Facility) could participate either through a concerted strategic program or independent action.

Another mechanism might be *franchising agreements*, entered into at, say, the municipio level. Municipios would contract with the international community to control the level and nature of development in their jurisdiction. Municipios, in turn, would be responsible for determining the nature of incentives and disincentives to be used to control activities at the municipio level. Competition among municipios would ensure efficiency in international resource allocation. Franchising appears to be a particularly promising way to deal with public lands.

### ***Other Issues***

A minimum critical size of contiguous protected area is essential for protecting biodiversity. This suggests that any mechanism to facilitate trade between the North and the South should contain a mechanism allowing contiguous land-use rights to receive a higher value than those that are isolated.

If successful, the program would probably lead to pressure to clarify land titles and, perhaps in

some areas, to an increase in land concentration. This process may reduce the prospects for squatters and small farmers. Extractivists, and others interested in sustainable economic activity in the intact forest should benefit, however. In the past extractivists' meager income has not made it possible to compete with farmers and ranchers for land. These low-impact land uses could now operate under the cover of the landowner's contract, or a franchise with the municipio.

### **Notes**

1. It is often argued that land speculation overvalues land relative to its value in agricultural use. In *general* however, one finds that speculators' prices are based on potential future agricultural potential of the land, not when any large land ownership confers special benefits. More generally, land values *often exceed* the capitalized value of farming profits. In any case, we will see that *whatever* is driving the current price of land in the Amazon, its value in carbon sequestration exceeds its value in alternative market use.

2. The reason for using positive incentives in this case is that negative incentives are probably unenforceable (see Schneider, 1992). Briefly, (a) in a frontier setting government has little potential to act in a manner that is contrary to local interests and local incentives--thus getting local incentives consistent with desired international outcomes is critical; and (b) clear property rights are essential to establish responsibility for land use. Property rights only emerge where justified by economic rent relative to transaction costs. Thus, in a frontier setting taxing carbon emissions has two fatal problems. First, practically, because it is against the interests of nearly everyone on the frontier, it is probably administratively impossible; and second, theoretically, since it would eliminate what little economic rent now exists at the frontier land, it would have no owners to assert responsibility for land use. Squatting and natural resource "mining" would become the norm.

# ANNEX F

## EXPENDITURE ISSUES

This Annex combines the insights from four sources to develop operational guidelines concerning good expenditure policy on the frontier. These sources are (a) the discussion of the determinants of frontier instability from Chapter 2, (b) the public finance theory of "assignment," (c) the findings from an OED review of rural development in Northeast Brazil (OED, 1991), and (d) the findings from Michael Nelson's classic study of 24 rural settlement projects on tropical lands in Latin America (Nelson, 1973). The major conclusion from each source is reviewed. This is followed by an attempt to draw out the relevant operational guidelines.

**Summary of Factors Contributing to Transience.** From Chapter 2 we conclude that the major factors leading to transient behavior at the economic frontier are (a) the *mining effect*, resulting from cheap, abundant land and forest, (b) the *immediatismo effect*, resulting from high interest rates and poorly developed credit markets, and (c) the *sell-out effect*, caused by differences between early migrants and subsequent migrants in human capital and access to government services, as well as changes in the rules regulating property rights.

**Summary of Factors Affecting Success in Development of Tropical Lands from Nelson.** In his classic study of 24 rural development projects on tropical lands in Latin America, Richard Nelson (1973) identified the factors affecting performance. These are reproduced as Table F.1 below. As shown, government planning was consistently either neutral (national plans, resource inventories, feasibility studies) or negatively related to success (directed settlement, colonist recruitment, cooperative promotion, formulation of development "packages"). The factors positively affecting performance are those relating to location on the frontier: roads, proximity to urban concentrations, and association with commercial enterprises and agro-industry. The availability of a forest industry was also important to success, allowing colonists to "cash in" the natural resources in the early stages of establishment. In terms of the role of government, only research, extension,

credit, and marketing services were positively related to project success, and these only became significant in the growth phase of the projects.

**Summary of Conclusions from OED Review of Rural Development Projects in Northeast Brazil.** An OED review of rural development in Northeast Brazil (1991) confirms the importance of the guidelines from the public finance literature, while at the same time emphasizing the local political dimension. The study found that successful projects were projects that were:

- (a) *relatively uncomplicated* (e.g., water supply rather than irrigation, because of the more complex decisions required of irrigation users);
- (b) under the *full control* of the executing agency;
- (c) under the scrutiny of *outside pressures*, especially for tasks that were not politically popular, such as redirecting services toward the poor, using less rather than more capital-intensive technologies for infrastructure, or reducing unit costs and reaching larger numbers of people (pressures came from beneficiaries, governors, other state agencies, development banks, municipal governments, nongovernment organizations, and the World Bank--it is noteworthy that withdrawal of pressure was clearly identified with deterioration of performance); and
- (d) *keenly involved with local government*. (The local involvement helped reduce costs and delays, made state agencies more accountable, and encouraged use of local materials and labor. This role of local politics is key:

"Many of the successful experiences owed much to the support by energetic governors or state secretaries. Governors tended to see Bank-supported projects as offering a menu of components for their support. They

identified more readily with simple activities that could be planned and executed within the four-year election cycle. Whole projects that had many components and long execution periods did not seem good vehicles for making a political mark; the resources they provided risked being used to meet short-term budget needs or pay off political debts.")

**Summary of Expenditure Guidelines from Assignment Theory.** The public finance theory of assignment provides several factors important to determine the appropriate allocation of expenditure authority among levels of government. First is *national interest*: Where it is in the national interest to have a function performed (for reasons of national security, national standards of performance, or other national policy) and the interest is not shared by the local population (or the local population can

benefit without paying, e.g., national defense), the national government must take responsibility for the action. Examples are national defense, national educational policy, national pollution standards, and various "homogenizing" and or nation-building actions at the national level (e.g., affirmative action in the USA). Second is *demand-matching*: Everything else being equal, services provided locally will be produced more efficiently than services provided from more distant levels of government because local people know best what they need, and they know best how to provide it cheaply (under local conditions). Third, and somewhat offsetting the demand-matching effect, is *economies-of-scale*: Where economies of scale of provision of a service at a state or national level are so great as to more than offset inefficiencies due to less-than-optimal expenditure composition, it is advisable to move expenditure authority to that higher level.

Table F.1: Factors Affecting Performance in Tropical Land Development

Elements influencing project performance	Stage of development and nature of the performance impact								
	Pioneer			Consolidation			Growth		
	Suc- cess	Neu- tral	Fail- ure	Suc- cess	Neu- tral	Fail- ure	Suc- cess	Neu- tral	Fail- ure
Settlement organization									
Directed			X*	not applicable			not applicable		
Semidirected	not applicable			X			not applicable		
Spontaneous	X*			X*			X*		
Highways									
Access	X*			X*			X		
Feeder	X*			X*			X*		
Maintenance	X*			X			X		
Planning									
Existence of a national plan		X			X			X	
Existence of resource inventory		X			X			X	
Existence of project feasibility study		X			X			X	
Application of colonist recruitment procedures			X			X	not applicable		
Forest industry	X*			X*			X		
Rural development activities									
Research		X			X		X		
Extension		X			X		X		
Credit				X			X		
Marketing services		X					X		
Cooperative promotion			X		X			X	
Titling		X			X			X	
Housing		X			X			X	
Water supply		X			X			X	
Community development		X			X			X	
Mechanization									
-large scale commercial enterprises	X			X			X		
-small holdings			X			X			X
Promotion of urban centers (infrastructure and concentration of services, industry, and population)	X*			X*			X*		
Farm size									
Establishment of standard minimum unit (10-15 ha)		X			X			X	
Subdivision in variable sizes	X			X			X		X
Reorganization and consolidation of <i>minifundia</i>	not applicable					X			
Balanced development "Package" projects			X*	not applicable			not applicable		
Simultaneous rural-urban development	X*			X*			X*		
Association of agro-industry and rural development	not applicable			X*			X*		
Association of commercial enterprises and small holdings	X			X			X		

\* High impact on success or failure.

**Table F.2: Transience and Premature Settlement on the Frontier  
Lessons from other Sources**

Problem	Causes	Lessons Learned From:		
		Nelson (1973)	OED (1991)	Assignment Theory
Transience: Nutrient mining	Cheap land relative to labor and purchased inputs. Caused by abundance of land and forest and building of extensive (rather than intensive) road systems.	Roads and proximity to urban populations and services are the most critical factors in project success. A local forest industry is very important to project success in both the initial and consolidation stages, however, suggesting that mining the forest substitutes somewhat for formal sector borrowing.	Roads have the right characteristics to receive support from local and regional politicians: they can fit nicely into the electoral cycle, they are relatively simple to execute, and can be built or withheld to influence various constituencies.	There is a <i>national</i> interest in preventing nutrient mining; that is, to ensuring that the road network is not excessively extensive. There is both a local and national interest in improving the local road network. There is also a local and regional interest in extending the road network.
Transience: <i>Imediatismo</i>	High interest rates, lack of credit availability, high personal rates of time preference.	Government credit programs are neutral with regard to initial project success and long term project growth. They do improve probability of success during the consolidation stage, however. As mentioned above, drawdown of natural (forest) capital may substitute.	—	It is in the national interest to (a) control overall credit expansion consistent with macroeconomic stability, (b) ensure that credit be allocated efficiently to generate economic growth, (c) reduce inequities in incomes and opportunities, and (d) reduce transience in frontier settlements. Tradeoffs are inevitable. Local authorities probably only share objective (b)
Transience: Incentives for farm sellout	Different human capital attributes between early settlers and later arrivals who buy them out.	—	—	—
	Preferential access to government services by <i>late</i> arrivals.	Research, extension, credit, and marketing services were found to contribute significantly to project success in the <i>growth</i> phase. All other government services are neutral or negative in effect.	Complicated services, requiring a sustained effort, are not well suited to the needs of state-level politicians.	Although there is a local interest in these services, in the initial phase there is not the resource base to finance them. There is a national interest in sustainable agricultural development.
	Lack of health care, education, and community services to "stabilize" early settlers.	These services are not found to be significant in project success at any stage. However project success is defined as economic productivity, not stability of settlement.	Field observation suggests that activities such as building schoolhouses, health posts and putting in electricity poles fits well in the electoral cycle. Recurrent costs of staff and materials often goes unmet, however.	There is a local interest in these services, although given initial incomes there is not the resource base to finance them. There is a national interest in both stabilizing frontier development and improving human capital, however.
Efficiency loss due to premature government	Imposition of government beyond the economic frontier.	Factors related to remoteness are most clearly correlated with project failure. Directed settlement is also consistently related to failure, while spontaneous settlement is related to success.	—	National interest creates the settlement (capital city). Subsequent local interest in (subsidized) development is not in national interest.

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