6 Public policy and deforestation in the Brazilian Amazon

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The Brazilian Amazon's forest resource

Spanning an area of 5.5 million square kilometers, the Amazon (Figure 6.1) is the world's largest contiguous tropical moist forest. Tropical forests extend into nine South American countries, but in the Amazon the Brazilian portion (3.8 million square kilometers, or 69 percent) is the largest. The Amazon has four main types of vegetation. The dense tropical forest, *floresta densa* or "hylea" found mainly in the northern Amazon States (Amazonas, Amapá, Roraima, Pará, and Maranhão), covers 48.8 percent of the region. The less exuberant, shorter, but still continuous "transition forest," *floresta aberta* or *fina*, in the central Amazon (Acre, Rondônia, northern Mato Grosso and Goiás, and western Maranhão), covers 27 percent of the region. Farther south, mainly in Goiás and southern Mato Grosso, are savannah shrublands, *campo cerrado*, that cover 17.2 percent of the region. The fourth type, savannah grasslands, *campos naturais*, occurs mainly in the *várzea* floodplains, along the Atlantic coast in Amapá and Marajó Islands, and in northern Roraima, and covers only 6.9 percent of the "Legal Amazon" region. The tropical zone embraces about 76 percent of the Brazilian Legal Amazon region (3.8 million square kilometers).

The Brazilian Amazon region[1] alone is believed to contain some 6,000 different tree species (Correa de Lima and Mercado 1985: 152), many endemic to specific areas. The growing stock varies widely in density, from 100 to 270 cubic meters per hectare, but the natural distribution of individual tree species is sparse; an average of 84 to 90 percent of the species are represented by fewer than one individual (more than 15 cm. diameter at breast height – d.b.h.) per hectare (EMBRAPA 1981).[2] The Amazon contains 48 to 78 billion cubic meters of living timber, enough, according to one journalist, "to build every person in the world a house." In strictly monetary terms, this potential industrial roundwood, as a capital asset, would have a current (1984) market value of $1.7 trillion, making

Figure 6.1. The Brazilian Amazon

Brazil one of the wealthiest natural resource owners of the net oil-importing countries.[3]

Despite the size of this timber resource, the industrial wood sector[4] plays a small but rapidly growing role in the Brazilian economy. In 1980, the most recent year for which relevant census information is available, Amazonian timber accounted for only 12.9 percent of the region's industrial output (up from 6.1 percent in 1960). Nationwide, forest products accounted for only 4.9 percent of Brazil's 1980 foreign exchange earnings (IBGE, *Anuário Estatístico* and *Censo Industrial* various years). Brazil, with 31.7 percent of the world's estimated volume of living broadleafed timber (Erfurth 1974: 86), supplies less than 10 percent of the world's consumption of tropical wood products (UNIDO 1983: 35), which is expected to

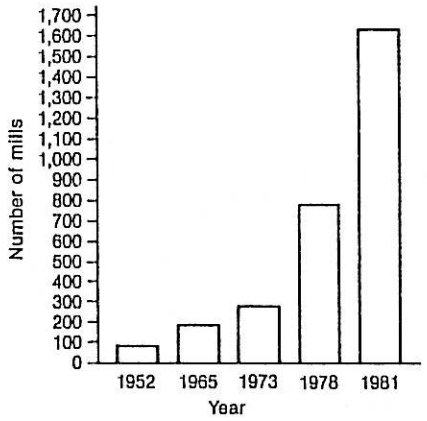

Figure 6.2. Growth in number of Amazon sawmills, 1952–81 (Browder 1986)

increase steadily in the future (Pringle 1976; FAO 1978; Myers 1981; UNIDO 1983).

In the Amazon, forestry is a leading industrial sector. Four of the region's six states and federal territories depend on wood products for more than 25 percent of their industrial output (IBGE, *Anuário Estatístico*, various years, cited in Browder 1986: 65). In Rondônia and Roraima, wood products account for more than 60 percent of industrial output. Many new urban Amazon settlements depend on local lumber industries for their only links to the national economy.

Industrial wood production in the Brazilian Amazon has expanded vigorously. The number of government-licensed mills increased more than eightfold since 1965, from 194 plants in that year to 1,639 plants in 1981 (Figure 6.2). Average annual output per mill increased from about 2,000 cubic meters of sawnwood in 1962 to 4,500 cubic meters in 1984. This rapid growth in capacity is reflected by the Amazon's increasing contribution to national roundwood production, from 14.3 percent (4.5 million cubic meters) in 1975 to 43.6 percent (17.4 million cubic meters) in 1984 (Table 6.1).

The biggest obstacle to better use of forest resources in the Brazilian Amazon is ignorance of the region's tropical hardwood resources. In 1972, only 23 of the region's estimated 1,500 different tree species accounted for 90 percent of total roundwood production (Bruce 1976: 14). In 1983, only 250 different tree species were harvested in volumes that would indicate industrial use in the Brazilian economy (IPT 1985: 6). Foreign markets for Brazilian tropical hardwoods are even narrower.

Table 6.1. *Roundwood production in Brazil, 1975–84 (million cubic meters)*

	1975	1977	1979	1981	1983	1984
Total	31.5	32.3	31.6	35.6	38.6	39.9
North (Amazônia)	4.5	6.7	8.4	13.1	16.1	17.4
Percent of total	14.3	20.7	26.6	36.8	41.7	43.6
Northeast	5.2	5.3	5.6	6.8	7.2	7.7
Percent of total	16.5	16.4	17.7	19.1	18.7	19.3
Southeast	2.2	2.0	1.2	1.6	1.7	2.2
Percent of total	7.0	6.2	3.8	4.5	4.4	5.5
South	16.9	15.3	13.4	10.9	10.2	9.0
Percent of total	53.6	47.4	42.4	30.6	26.4	22.6
Center-west	2.6	2.9	3.0	3.3	3.4	3.5
Percent of total	8.3	9.0	9.5	9.3	8.8	8.8

Note: Percentage totals may not add to 100 due to rounding.
Source: IBGE, *Anuário Estatístico* (various years).

Mercado (1980) found that of 34 species exported in 1978, five species represented 90 percent of the total (Mercado 1980: 55). Browder (1984) found that of the seven principal woods exported to the United States in 1982, mahogany accounted for 84 percent of the total. Thus, increasing production reflects not the introduction of new species, but rather more intensive cropping of traditional varieties. An important item on Brazil's agenda to enhance the market value of its forest resources, and a key to forest conservation in the Amazon, is a systematic, coordinated program of botanical identification and end-use evaluation of underutilized hardwoods.

The problem of underutilized species begins in the forest, where new woods are often given highly localized names, such as "*pau anta*," because one logger cut an unknown tree near the banks of the river Anta Atirada in Rondônia, a geographic reference point with no national recognition. Unless the commendable identification efforts of the numerous highly qualified research institutions, such as the Instituto de Pesquisa Tecnológica de São Paulo (IPT), Instituto Nacional de Pesquisa Amazônica (INPA), Instituto Brasileiro de Desenvolvimento Florestál (IBDF), Superintendência do Desenvolvimento da Amazônia (SUDAM), and others, are coordinated and applied in the field, there is little chance that the myriad of "*pau antas*" will become the *mognos* (mahoganies) that have come to be among the Amazon's most precious forest commodities.

Notwithstanding this tremendous industrial growth potential and the equally important and fragile ecological niche of the Amazon's rain forests, the rate of deforestation in Brazil appears to be increasing exponentially with time (Fearnside 1984). Brazil's stewardship of its tropical forest patrimony has allowed, in fact promoted, its destruction.

Deforestation of the Brazilian Amazon

Considerable attention has focused on the rate of forest destruction in the Amazon, but efforts to define and measure this rate have been much criticized. The Brazilian government's Forest Cover Monitoring Program (*Programa de Monitoriamento da Cobertura Florestál do Brasil*), based on Landsat reconnaissance, is the most widely accepted source of information. As of 1983, the program estimated that 14.8 million hectares of Amazon forests of all types had been altered, or slightly less than 3 percent of the Legal Amazon region (Table 6.2). Many scientists have argued that the actual damage has been more extensive, between 5 percent and 15 percent of the Amazon.[5]

More alarming than the actual area already altered is the apparent rate at which new areas are being cleared, a rate that appears to have been growing exponentially in some parts of the region (Figure 6.3). It has been suggested that if the deforestation rates observed in the 1970s continued unabated, then most of the Legal Amazon region would be deforested or altered by the year 2000. However, given the complexity of the social and economic causes of deforestation in the region, this extrapolation cannot be regarded as a reliable prediction.[6]

Cattle ranching has been the most important contributor to forest conversion. Deforestation due to pasture formation in the region may be roughly approximated from the region's estimated herd size of 8,937,000 head of cattle in 1980 and a widely used assumed average stocking rate of one head per hectare. Given the Landsat monitoring program's 1980 estimate of vegetation cover alteration (12,364,681 hectares), pasture formation would account for more than 72 percent of the total deforested area.

Settlement by small farmers has been the second most important cause of tropical forest destruction since 1970. Unequal land tenure regimes, the increasing mechanization of agriculture, and recurrent droughts have pushed landless farmers into the region, while government colonization and land settlement programs (e.g., the National Integration Plan and the POLONOROESTE Regional Development Program) have pulled small-scale farmers from other regions of Brazil. Massive government investments in social overhead (especially road-building), expected to exceed $6.2 billion by 1990 (Hecht 1986), have contributed to the influx. Brazil's population grew at 2.8 percent per year in the 1970s; the

Table 6.2. *Natural vegetation cover alteration in the Brazilian Amazon*

State or territory	Area (thousand hectares)	Area altered [thousand hectares (percent)] By 1975	By 1978	By 1983
Amapá	14,028	15.2 (0.11)	17.1 (0.12)	17.1 (0.12)
Pará	124,804	865.4 (0.69)	2,244.5 (1.80)	4,291.4 (3.44)[b]
Roraima	23,010	5.5 (0.02)	14.4 (0.06)	14.4[c]
Maranhão[a]	25,745	294.1 (1.14)	733.4 (2.85)	1,067.1 (4.15)
Goiás[a]	28,579	350.7 (1.23)	1,028.9 (3.60)	912.0 (3.20)
Acre	15,259	116.6 (0.76)	246.5 (1.62)	462.7 (3.03)
Rondônia	24,304	121.7 (0.50)	418.5 (1.72)	1,395.5 (5.74)
Mato Grosso	88,100	1,012.4 (1.15)	2,835.5 (3.22)	6,498.0 (7.38)[d]
Amazonas	156,713	78.0 (0.05)	178.6 (0.11)	179.1[c]
Total, Legal Amazônia	500,543	2,859.5 (0.57)	7,717.2 (1.54)	14,837.3 (2.97)

[a]These states are not totally inside the area of the Legal Amazon.
[b]Updated 1983 data refer only to southern Pará.
[c]Complete data not available.
[d]Updated 1983 data refer only to the area within POLONOROESTE.
Source: Programa de Monitoriamento da Cobertura Florestál do Brasíl, IBDF, November 1985.

Amazon's corresponding rate was 6.3 percent during this period (IBGE, *Anuário Estatístico* 1983: 76). In Rondônia, the target state of the POLONOROESTE program, population increased by a staggering 34.2 percent per year, doubling every 2.5 years (IGBE, *Anuário Estatístico* 1983: 76). Since shifting cultivation is the main agricultural production mode among peasant migrants, rapid population increase has been an important contributing factor, responsible for an estimated 9.6 percent of total regionwide deforestation by 1980.

Other government infrastructure investments have brought additional destruction. The Tucurui hydroelectric project on the Tocantins River cost about $4 billion and alone has flooded 2,160 square kilometers of forest land (Goodland 1985: 6). Other expensive hydroelectric projects, with similar land use impacts, are under construction near Manaus (Balbina) and Porto Velho (Samuel).

Population growth

Migration to the Amazon region has been the main determinant of the region's phenomenal 6.3 percent per year population growth rate between 1970 and 1980, which was more than twice the national average.

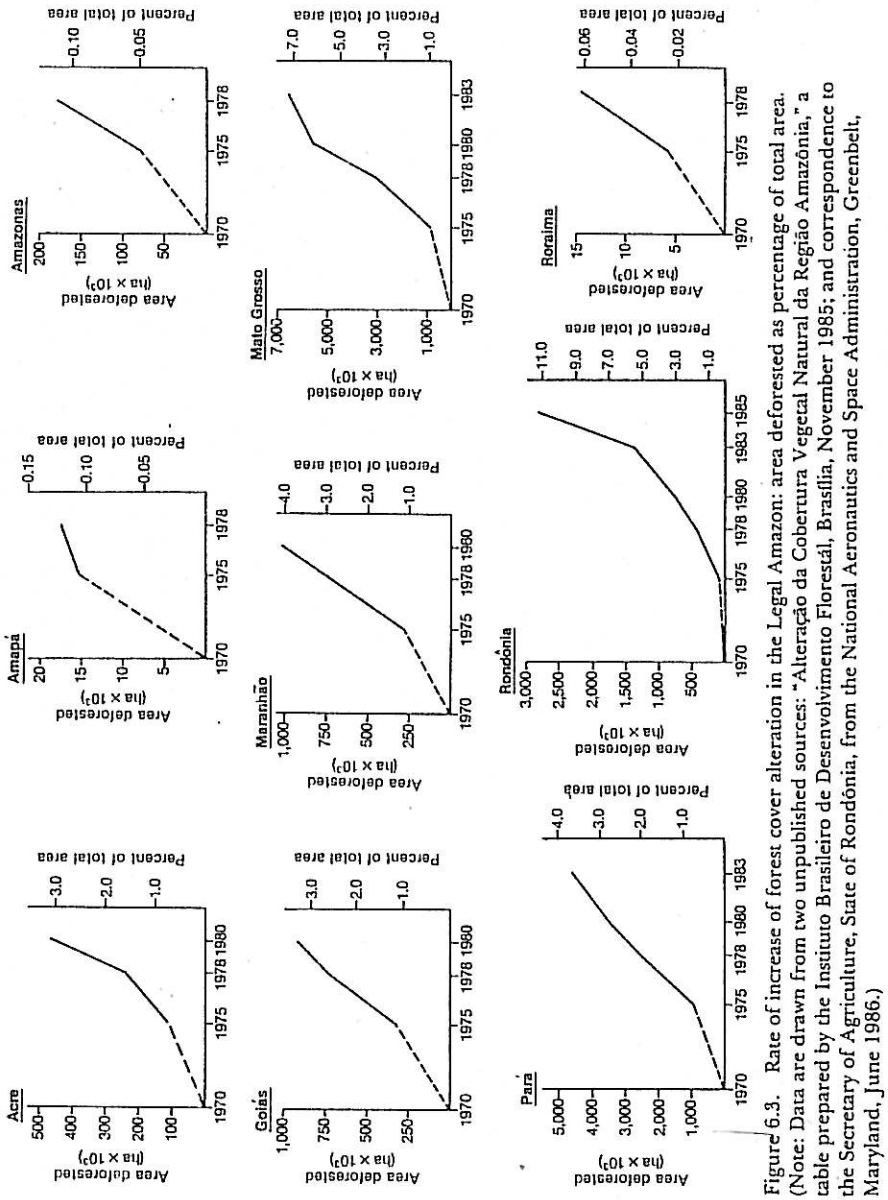

Figure 6.3. Rate of increase of forest cover alteration in the Legal Amazon: area deforested as percentage of total area. (Note: Data are drawn from two unpublished sources: "Alteração da Cobertura Vegetal Natural da Região Amazônia," a table prepared by the Instituto Brasileiro de Desenvolvimento Florestál, Brasília, November 1985; and correspondence to the Secretary of Agriculture, State of Rondônia, from the National Aeronautics and Space Administration, Greenbelt, Maryland, June 1986.)

Population growth has had three important implications for the region's forests (Fearnside 1985a):

1. It has increased the demand for subsistence products, such as food crops, and therefore the demand for farmland.
2. It has increased the size of the agricultural labor force, and therefore the capacity to clear forests, simply through the sheer numbers of new farmers in the region.
3. It has increased political pressure for road-building and other social overhead investments that not only damage forests directly, but also facilitate further migration and population growth.

Inflation

Forest land in the Amazon is cheap to acquire, and with government subsidies has tended to appreciate in market value at a higher rate than inflation (until recently 200 to 300 percent per year). Amazon land cleared of forest generally has higher market value than land with forest intact. Forest removal hedges investors' profits from the devastating effects of inflation. Therefore, the rate of forest conversion is believed to be positively associated with the general rate of inflation in the Brazilian economy.[7]

The attraction of frontier land as an inflation hedge is reinforced by highly favorable tax treatment of agricultural income. Due to liberal exemptions the effective tax rate on agriculture is even less than the nominal rate of 6 percent, while non-agricultural business profits are taxed at 35 to 45 percent. The low tax adds to the demand for pasture land in the Amazon, contributing to the rise in its value (Binswanger 1987).

Displacement of small farmers

The same tax incentive makes agricultural land in settled areas more valuable to corporations and high-tax-bracket individual investors, enabling them to outbid small farmers in settled farm areas.

The consolidation of small family farms into large corporate cattle ranches or coffee and soybean plantations in southern Brazil over the last 20 to 30 years has had an important "push" effect on population movements. ("*Quando chega o boi, o homen sai*" – "when the cattle arrive, the men leave.") With the opening of the Amazon region during the last 20 years, displaced small farmers from the south have moved to the Amazon, exacerbating the population effects already mentioned.

The intraregional corollary to this pattern has been the trend toward consolidation of small family farms in the Amazon region, which also displaces small farmers who move on to clear new forest areas.

Government social overhead investments

By the end of the 1980s, the Brazilian federal government will have invested about $6.2 billion in infrastructure development in the Amazon, mostly in road-building. The notorious National Integration Program (1970–74), intended to "bring men without land to land without men" and thereby alleviate chronic poverty in the drought-stricken Brazilian Northeast, was predicated on the construction and settlement of the 2,300-km Transamazon Highway. The equally long but absurdly conceived Northern Perimeter Highway was chastised as "linking misery to nothing." And the Cuiabá-Pôrto Velho Highway, now paved, thanks, in part, to the World Bank, has opened the floodgates for many thousands of small farmers and cattle ranchers to flow into the Amazon.

Cultural attitudes

In Brazil, and elsewhere, one finds a primordial psychological aversion to dense forests, especially among recent migrants from other regions. This "fear of the forest" impedes adoption of sustainable forest land uses and pyschologically justifies forest destruction. Longstanding Portuguese tradition accords higher status to ranchers than to farmers, leading to a preference for converting forest to pasture quite apart from the expected profit (Fearnside 1985a).

International economics

Brazil finds itself in a precarious position in the international economic community. The magnitude of Brazil's foreign debt, some $105 billion, has prompted Brazilian development planners to think big in terms of remedies. Big development projects in the Amazon region, such as the $4 billion Tucurui hydroelectric project and the $4 billion Carajás mineral and timber extraction project, have had major consequences for Amazonian forests (Goodland 1985; Fearnside 1986).

Political legitimization of the former military regime

Brazil shares undefended borders with 10 other countries. All but three of these have geographic tangents in the Amazon region. The fear of foreign encroachment has provided a territorial imperative to occupy the region. It is not coincidental that most of the forest destruction visited upon the Brazilian Amazon occurred while an unpopular authoritarian government ruled, between 1964 and 1985. Anxious to legitimize its tenuous authority by placating both the urban middle class and powerful socioeconomic elites, the military government subsidized agriculture heavily to maintain low food prices while offering lucrative investment

incentives to expand production. Moreover, as the spearhead of economic expansion in the Amazon, the livestock sector appeared to offer several logistic advantages over other sectors. As noted by Hecht (1985), infrastructural investments would be minimal, it was thought. A ready pool of underemployed cowboys already existed. And cattle could always walk to market if roads and bridges became impassable. Corporate entities would be preferentially treated since, it was presumed, they would have the entrepreneurial know-how and capital resources to sustain production. Moreover, North American beef producers, having widely adopted the more expensive grain feedlot system of cattle fattening by the beginning of the 1960s, were confronted with a rapidly rising demand for cheap cutter beef, for fast foods and sausages (Hecht 1985). Latin American pasture-fed cattle were viewed as an economical alternative.[8] All that was needed for Brazil to compete in foreign markets was a program to entice corporate investment to the Amazon region's land-intensive livestock sector.

Amazon regional development policies and the forestry sector

Brazil's vast Amazon region remained largely outside national political consciousness until 1946, when a new constitution was ratified, calling for a comprehensive long-term plan for the integration and development of the region. Acting on this mandate, the national Congress in 1953 established a regional planning agency, the *Superintendência do Plano de Valorização Económica da Amazônia* (SPVEA). The SPVEA was beleaguered by political problems from the start, and although a first five-year plan (1955–1960) was formulated, less than two-thirds of the resources guaranteed to the effort were forthcoming (Mahar 1979: 8–9).

By 1966, with the military regime in power, the government articulated a more assertive strategy toward the Amazon. The SPVEA was replaced by the Superintendency for the Development of the Amazon (SUDAM), which was to formulate five-year development plans to attract private investment to specific growth sectors in the region. The first of such plans included "Operation Amazônia," which had three basic objectives:

1. "The concentration of resources in areas selected in relation to their potential and existing populations . . . ."
2. "The adoption of a migration policy . . . [and] the formation of stable and self-sufficient regional population groups in the frontier zone . . . ."
3. "The [rationalization] of the exploitation of natural resources [especially forest resources]" (Lei 5.374/1967).

To attract the necessary private investment the law authorized various incentive programs, financed by an investment fund, *Fundo para Investimento Privado no Desenvolvimento da Amazônia* (FIDAM), administered by the region's development bank, the *Banco da Amazônia S.A.* (BASA). The fund was to be financed from three sources: (1) treasury transfers of 3 percent of all personal and corporate tax revenues collected by the federal government and lesser jurisdictions in the region, (2) revenues raised from the issuance of BASA stock obligations called "*Obrigações da Amazônia*," and (3) income-tax deductible deposits made by investors in support of specific SUDAM-approved development projects. With this fund, restructured as a mutual fund and renamed the *Fundo de Investimento da Amazônia* (FINAM) in 1975, three tax-based subsidy mechanisms, together referred to as the "fiscal incentive program," were made available to private investors: investment tax credit subsidies (*colaboração financeira*), personal and corporate income tax exemptions, and import duty exemptions (not addressed here).

Investment tax credit subsidies

Under present legislation private corporations in Brazil can exempt up to 50 percent of their federal income tax liabilities for investments in specific development projects in the Legal Amazon. In exchange, the corporation receives common shares of FINAM stock. The corporation may hold or sell its FINAM stock or trade it for shares of corporate stock in specific projects. Corporate stock acquired from FINAM is nontransferable for a period of four years to prevent rapid disinvestment. These tax credits may represent up to 75 percent of the total investment cost of a project. To secure the subsidy, corporations must commit their own money in an amount no less than 25 percent of the estimated total investment cost.

From January 1965 to September 1983, SUDAM disbursed $1.4 billion in tax credit subsidies to start, expand, or modify 808 existing and new private investment projects approved by its governing council (Table 6.3). Although private investment was to be the cornerstone of the incentive program and a prominent criterion in project evaluation, the projects SUDAM approved involved less private investment and reinvestment than had been anticipated. For the 808 projects approved by September 1983, only 21.6 percent of the total estimated investment had been funded by private corporations, and less than 1 percent originated in reinvested profits. In many cases the "private capital" share included land on which projects were to be located, valued at inflated appraisals. Legally, although SUDAM was permitted to finance only up to 75 percent of

Table 6.3. *Distribution of SUDAM tax credit financing by sector and year (thousand U.S. dollars)*[a]

Year	Livestock	Industry	Basic services	Agro-industry	Other	Total	Exchange rate[b] (cruzieros per U.S. dollar)
1965		458				458	1.896
1966	527	3,168				3,695	2.222
1967	4,057	5,960				10,017	2.669
1968	8,485	8,219	3,857	24		20,585	3.382
1969	18,001	13,094	1,555	177	179	33,005	4.076
1970	33,631	23,853	8,050	636	1,168	67,339	4.594
1971	28,337	23,390	6,345	1,312	438	59,822	5.288
1972	28,226	17,350	3,929	437	528	50,470	5.934
1973	25,789	22,279	1,639	833	1,419	51,959	6.125
1974	31,182	27,284	320	1,947	2,272	63,004	6.790
1975	52,247	55,617	390	5,034	4,557	117,850	8.127
1976	48,974	41,043	3,943	4,448	6,972	105,380	10.673
1977	53,031	33,211	5,622	1,709	4,785	98,357	14.144
1978	52,690	44,811	11,178	2,871	4,513	116,060	18.070
1979	40,594	46,806	5,813	8,382	8,747	110,340	26.945
1980	40,447	55,310	2,836	2,905	1,651	103,150	52.714
1981	37,975	65,083	3,070	8,674	3,420	118,220	93.125
1982	49,319	77,991	8,957	12,176	4,578	153,020	169.760
1983	44,202	54,160	4,151	12,632	2,418	117,560	434.020
Total	597,710	619,090	71,655	64,197	47,644	1,400,295	
Projects	469	252	31	36	20	808	

[a]Tax credit financing refers to direct tax credit subsidies as authorized by Law 5,174 of October 27, 1966.
[b]Exchange rates from *World Tables* (World Bank).
Source: SUDAM (1983a).

the investment costs of new projects with direct tax credit subsidies, numerous supplemental financing provisions in the law, intended to allow for such exigencies as inflation, project expansion, or diversification, reduced the real financial participation of private capital.

Industrial projects, ranging from matchstick factories to palm oil refineries, have received the largest share of tax credit financing from SUDAM: 44.2 percent of the total during this 18-year period. Fifty-nine industrial wood producers (mainly sawmills) constituted the single largest industrial beneficiary group, receiving about 35 percent of all tax credits approved by SUDAM by September 1983. Livestock projects were the second most important funding priority, representing 42.7 percent of SUDAM tax credits. Virtually all 469 livestock projects, 58 percent of all projects approved by SUDAM during this period, have been for beef cattle production (calving and fattening), with emphasis on calving.

Income tax exemptions and deductions

The second tax-based subsidy has two major elements: a total tax exemption on income from approved projects, and personal and corporate income tax deductions for the purchase of FINAM stock.

Income tax exemptions. As specified in Decreto Lei 5.174 (October 27, 1966) and revised by Decreto Lei 1.564 (July 29, 1977), companies could obtain up to 100 percent tax exemptions for up to 15 years on income derived from projects undergoing modernization, diversification, or expansion approved by the superintendent of SUDAM. Currently, this policy permits corporate income tax holidays of 10 years for projects approved before the end of fiscal 1985 (Decreto Lei 1.891, December 21, 1981). By September 1983 SUDAM had approved corporate income tax holidays for 843 projects, 39 percent of them cattle projects and 31 percent industrial wood projects.[9] Since the effective tax rate on agriculture income is very low anyway, less than the nominal rate of 6 percent, and liberal rules governing deductions of costs reduce taxable income substantially, the tax holiday has little impact. Equally important has been the ability of corporations to write off operating losses in approved Amazonian projects against other taxable income, including income earned outside the Amazon.[10]

Personal and corporate income tax deductions. As specified by Article 7 of Lei 5.174, any corporation may deduct from its taxable income up to 75 percent of the value of FINAM obligations, *Obrigações da Amazônia*, acquired from the Banco da Amazônia through an authorized

Table 6.4. *Flow of FINAM funds*

Year	Shareholders[a]	Deposits[b] (million U.S. dollars)	Disbursements[c] (million U.S. dollars)
1968	41,098	48.7	20.6
1969	67,116	63.8	33.0
1970	81,839	83.5	67.3
1971	94,906	89.8	59.8
1972	88,137	50.2	50.5
1973	72,749	62.1	52.0
1974	71,562	97.8	63.0
1975	66,836	102.5	117.8
1976	63,095	82.1	105.4
1977	48,512	153.3	98.4
1978	33,148	174.8	116.1
1979	30,925	218.7	110.4
1980	24,044	249.4	103.1
1981	n.a.	n.a.	118.2
1982	n.a.	n.a.	153.0
1983	n.a.	n.a.	117.6

[a]The number of persons and corporations declaring tax credits or tax deductions of FINAM stock.
[b]Total tax-credit deposits and FINAM stock purchases.
[c]Funds disbursed to projects.
Source: IBGE, *Anuário Estatístico* (various years).

brokerage institution. Individual taxpayers may deduct amounts equivalent to full purchase value of FINAM stocks in a given tax year, according to Article 2 of Decreto Lei 1.338 (July 23, 1974). FINAM obligations are regularly traded on the three major stock exchanges located in São Paulo, Rio de Janeiro, and Belo Horizonte, and may be exchanged for corporate stock in specific SUDAM projects that BASA offers at periodic stock sales. Corporate use of tax credit and deductions has been significant (Table 6.4). In 1980, 24,000 companies and individuals declared tax deductions as credits toward specific projects and for the acquisition of FINAM stocks worth about US$250 million. Two noteworthy patterns are evident from the flow of FINAM funds. First, in all but three years (1972, 1975, 1976), deposits have exceeded disbursements. While it may appear that FINAM shareholders oversubscribe to the Fund, Mahar (1979: 96) has shown that after 1970 "annual commitments persistently exceeded annual deposits . . . [indicating] SUDAM's failure to reduce project approvals at a rate commensurate with declining trends on supply side." Second, since 1972 the average stockholder investment in FINAM increased from US$569 to a 1980 high of US$10,375. This trend suggests

the increasing concentration of corporate stock acquisition by corporations seeking to consolidate their equity interest in SUDAM-supported projects.

Rural credit and the forest sector

A second policy that has directly financed forest destruction has been Brazil's rural credit system. In 1965, the national Congress gave the National Monetary Council, the governing board of Brazil's Central Bank, wide powers to develop the institutional infrastructure to distribute subsidized rural financing to the agricultural sector. The first tier of the resulting National Rural Credit System encompasses four government banks that control various credit funds: the Banco do Brasil, the Banco da Amazônia, the Banco do Nordeste do Brasil, and the Banco Nacional de Crédito Cooperativo. Funding for the National Rural Credit System was to come mainly from the several existing funds in these government lending institutions, from compulsory deposits by private banks participating in rural credit programs, and from selected foreign sources. The General Fund for Agriculture and Industry (FUNAGRI) has become one of the principal sources of funds channeled by the Central Bank to rural credit programs.

The second tier of the system includes government agencies involved in planning and financing rural development activities: the former Brazilian Agrarian Reform Institute, the National Institute of Agrarian Development, and the National Economic Development Bank. The third tier includes private banks, savings and loan institutions, state banks, and cooperatives that have direct contact with rural producers.

The National Rural Credit System disburses two basic kinds of loans: credits for agriculture and for livestock. In each category are three types of financing: capital investment (*investimento*), involving fixed and semi-fixed capital investments; annual production operations (*custeio*) that are often oriented to specific crops and animals; and marketing (*comercialização*) that covers transport, storage, insurance, and tax costs of marketing farm output, and the costs of operating the guaranteed minimum price program. More than 100 specific lines of credit are included in these categories of the National Rural Credit System, including 30 different crop and animal production credit lines, and loans for electrification, grain storage, irrigation, reforestation, soil protection, fertilizer and pesticides, pasture formation, and capital equipment.

From 1973 to 1983, US$147.1 billion (in current dollars) were disbursed in rural credits, an average of US$13.4 billion per year. Benefici-

Table 6.5. *Rural credit disbursements to producers and cooperatives in the North Region, 1969–82*[a]

Year	Total disbursements (million U.S. dollars)	Disbursements by category [million U.S. dollars (percent of total)][b]		
		Investment	Production	Commercialization
1969	21.3	5.8 (27.2)	9.2 (43.2)	6.3 (29.6)
1970	20.2	6.9 (34.2)	5.7 (28.2)	7.6 (37.6)
1971	26.5	8.6 (32.4)	10.0 (37.7)	7.9 (29.8)
1972	51.1	27.5 (53.8)	14.8 (29.0)	8.8 (17.2)
1973	66.2	35.5 (53.6)	20.7 (31.3)	10.0 (15.1)
1974	72.0	30.0 (41.7)	33.2 (46.1)	8.8 (12.2)
1975	143.9	67.4 (46.8)	60.4 (42.0)	16.1 (11.2)
1976	210.3	137.3 (65.3)	54.8 (26.1)	18.2 (8.7)
1977	221.5	117.3 (53.0)	66.5 (30.0)	37.7 (17.0)
1978	297.5	173.2 (58.2)	96.5 (32.4)	27.8 (9.3)
1979	437.3	188.8 (43.2)	213.7 (48.9)	34.8 (8.0)
1980	494.8	187.4 (37.9)	267.6 (54.1)	39.8 (8.0)
1981	410.7	152.9 (37.2)	223.0 (54.3)	34.8 (8.5)
1982	350.9	114.9 (32.7)	205.4 (58.5)	30.6 (8.7)

[a]National System of Rural Credit (Banco Central).

[b]Current monetary exchange rates from *World Tables* (World Bank).

Source: Banco Central do Brasil, *Dados Estatísticos*, "Financiamento Concedidos a Produtores e Cooperativas—Numero e Valor dos Contratos," various years.

aries in the North Region (Legal Amazônia less Mato Grosso, Goiás, and Maranhão) received 2.4 percent of these loans between 1977 and 1983. Nationwide, agricultural borrowers received an average of 80.4 percent, and livestock borrowers 19.6 percent. In the North Region, borrowing for investment purposes accounted for 44 percent of the value of credits disbursed in that region between 1969 and 1982. However, in several years, production subsidies (averaging 40 percent of total credits over the period) have exceeded investment loans (Table 6.5). In general, production credits have been available for eight-year terms with four-year grace periods. To stimulate activity in the priority regions, annual interest charges have been lower for producers in the Legal Amazon and the Northeast (12 percent) than elsewhere in the country (45 percent). Current interest charges are 3 percent per year, and after a credit reform, borrowers are now expected to pay between 70 percent and 100 percent of inflation correction costs, which were 259 percent for the 1983 calendar year as indicated by the official inflation index (Banco Central do Brasil 1985).

Low interest rates and a six-year grace period have conferred substantial subsidies on borrowers for forest clearance. Alternative commercial

Table 6.6. *Rural credit subsidy rates, 1975–81*

	1975	1976	1977	1978	1979	1980	1981
Commercial interest rate[a]	34.6	34.4	41.1	36.4	44.8	59.4	77.6
Rural credit interest rate[b]	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Effective rural interest rate[c]	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Percentage of interest rate subsidized[d]	86	86	88	86	89	92	94
Interest rate subsidy relative to credit amount[e]	49	49	56	51	59	69	76

[a]Rate of return on Brazilian treasury bonds, corrected for changes in CPI and monetary correction.

[b]Interest rate of PROTERRA loans to borrowers in Legal Amazônia. See Table 6.7 for more details.

[c]Equals the internal rate of return equivalent to a credit on PROTERRA terms.

[d]Equals the difference between the commercial and effective rural interest rates, expressed as a percentage of the commercial interest rate.

[e]Defined as the present value of debt service payments on PROTERRA loans, calculated at the commercial interest rate as discount factor, expressed as a percentage of initial loan value.

Source: Commercial interest rates: International Monetary Fund (1983).

capital borrowing has become more and more costly in recent years. For instance, in 1975 the rate of return on Brazilian treasury bills was 34.6 percent while the interest on rural investment loans was 12 percent with a six-year grace period. An equivalent rate of interest on a loan with no grace period would be 4.96 percent, implying an interest subsidy of 86 percent of the commercial rate. As commercial rates rose, the implicit interest subsidy rose over this period from 49 percent to over 75 percent of the face value of the credits (Table 6.6). The availability of virtually free money from the federal government encouraged businessmen to acquire and clear more forest land than they could immediately use in pasture. Such speculative land clearance by large ranchers, using highly subsidized credit, helped to forestall squatters – who normally do not invade cleared land – and strengthened land claims (Binswanger 1987).

As part of the National Rural Credit System, the Central Bank also sponsored "special programs" offering lines of subsidized credit in support of rural development objectives. Some of the programs have been aimed at promoting production of specific commodities, such as rubber (PROBOR), sugar cane and manioc (PROALCOOL), or coffee and cacao.

Table 6.7. *Special credit programs affecting Amazon forest resources (effective 1982)*

Program	Objectives	Amortization term/grace period (years)	Annual interest charges (percent)
POLOBRASILIA	Livestock development of savannah shrublands:		Amazon: 12
	• Production	3/0	Other: 45
	• Investment		
	Fixed (e.g., pastures)	12/6	
	Semi-fixed (e.g., cattle)	8/4	
POLOCENTRO	Same as above		
POLOAMAZONIA	Land acquisition, livestock, forest, agro-industrial and mineral development in most of Amazônia:		12
	• Land acquisition	20/6	
	• Agro-industry and industry	12/3	
	• Production	1–2/0	
	• Investment		
	Fixed	12/6	
	Semi-fixed	8/4	
PROTERRA	Legal Amazônia/Northeast		12
	• Land acquisition	20/6	
	• Capital equipment	12/3	
	• Investment		
	Fixed	12/6	
	Semi-fixed	8/4	
PROASE	Increase production area for annual food crops by small producers:		Amazon: 12 Other: 45
	• Production	2/0	
	• Investment		
	Fixed	12/?	
	Semi-fixed	5/?	
PROEXPAN	Expand area in agricultural production	8/4	Amazon: 2 Other: 45
PROPEC	Land acquisition and development for livestock:		Amazon: 12
	• Production	2–3/0	Other: 45
	• Investment	12/4	
PROALCOOL	Expand area in sugar cane production	3–8/	Amazon: 35

Source: Banco Central do Brasil, *Manual de Normas e Instruções* (various years).

Others have been targeted to various development activities in specific regions (e.g., POLOAMAZONIA, POLOCENTRO, POLONOROESTE, POLOBRASILIA, etc.). Several of the programs are described in Table 6.7.

Forest impacts of the livestock sector

Total investment tax credits to the livestock sector and subsidized rural credit loan disbursements for pasture formation in the Amazon reached more than $730.5 million from 1966 to 1983.[11] The livestock sector clearly has been a major beneficiary of Brazilian government policies promoting Amazon development. SUDAM funding of livestock projects has contributed more to deforestation in the Amazon than any other government subsidy program. New pasture formation by SUDAM-approved cattle projects was responsible for 30 percent of the forest cover alteration detected by Landsat in Legal Amazônia between 1973 and 1983,[12] according to estimates derived from an 8.5 percent sample of such projects. Total pasture formation in the Brazilian Amazon may be roughly calculated from the region's estimated 1980 cattle herd of 8,937,000 animal units and an assumed average stocking rate of one head per hectare. Given the 1980 alteration estimate of 12,364,681 hectares, reported by the Landsat monitoring program, total pasture formation, including that resulting from SUDAM subsidies, accounted for 72.28 percent of the region's deforested area detected by satellite.

These estimates imply that nearly two-thirds of the deforestation attributable to cattle ranching has occurred without SUDAM incentives. Nevertheless, incentives give SUDAM cattle projects a staying power not enjoyed by strictly private ranches. In a survey of 40 Amazon cattle ranches that received no SUDAM incentives, the author found that only 9.2 percent of the pasture formation by such ranches occurred after 1980 (Browder 1985), while 32.8 percent of that attributed to SUDAM-subsidized ranches occurred after 1980. When funding for other lines of subsidized rural credit (especially PROTERRA) was reduced in 1980, many smaller non-SUDAM ranches lost important financial support for forest clearance and pasture formation. SUDAM-supported ranches, on the other hand, have enjoyed long-term financing from investment credits, 15-year tax holidays, and multiple investment tax credits for the same project.

Another important difference is the larger average size of the SUDAM livestock projects, and the correspondingly greater area available for fu-

ture pasture expansion. The average area of the typical SUDAM-supported ranch is 23,600 hectares; non-SUDAM properties average 9,300 hectares.[13] Brazilian forestry law requires that 50 percent of the area of privately owned rural properties be left in original vegetation. By 1985, only 23.4 percent (5,500 hectares) of the area of the average SUDAM livestock project had been cleared for pasture, while 24.6 percent (2,288 hectares) of the area of the average non-SUDAM livestock property had been cleared. SUDAM projects not only have enjoyed greater financial capacity to clear forest, but also include larger forest areas still available for pasture expansion. A 1980 study of 123 beef products in the Araguaia region (southern Pará, northern Mato Grosso, and Goiás) showed that 74 percent planned to increase the pasture area on their ranches during the next two years.[14] Given these important differences in capacity, most future pasture expansion and concomitant deforestation can be expected to occur on the SUDAM-supported ranches.

The separate impacts of the National Rural Credit System and the special programs on the forest sector in the Amazon are difficult to estimate. Many borrowers also benefit from tax incentives, and it is the combined effect of tax and credit subsidies on private returns to investment that has stimulated large-scale conversions of forest to livestock operations.

In terms of forest conversion, "investment" credits have had the most important direct effect. While producers are often granted subsidized loans to bring new areas into production, usually implying forest conversion, the amount of area subsidized in this fashion is not indicated in the Central Bank's annual reports, though such data are given the Central Bank by participating local banks. In the "agriculture" credit category, estimating forest impacts is also confounded by the fact that many subsidized crops are planted together, so that estimates of forest area cleared, based on individual crop subsidies, are subject to multiple counting. In addition, many programs are vaguely defined, and the lending practices of participating local banks are not consistent nationwide. Finally, while the use of credits has been subjected to some review (*fiscalizacão*), most borrowers have been free to use their subsidies without regard for program objectives and requirements. In addition, short-term "production" loans have been designated for use in pasture maintenance. However, the way Central Bank data are assembled provides little foundation for reasonable estimates of actual credit applications to these activities.

Loans have also been furnished for reforestation. Credit lines for this activity have been mainly for industrial fuelwood and pulp (eucalyptus and pine) plantings, most of which have benefited regions other than the Amazon. In 1984 approximately US$131 million of tax-credit incentives were approved for reforesting of 300,000 hectares (US$437/hectare), but only 3.0 percent of this, equivalent to 9,000 hectares, was in the North Region (IBDF 1985: 13–15). Thus, while rural credit programs have been important financial catalysts to new forest conversion in the Amazon, they have not succeeded in aiding reforestation or the economic utilization of degraded clearings.

Financial performance of subsidized Amazon cattle ranches

The government's support for livestock development in the Brazilian Amazon, through infrastructure spendings, tax credits, and subsidized rural credit, has been predicated on the prospect of profitable economic development. Only this long-term economic potential, it has been asserted,[15] could justify government policies resulting in massive forest destruction and its widely documented environmental consequences.[16]

However, financial and economic analyses of the typical SUDAM-supported ranch, based on rancher surveys administered by the author in 1984–85, demonstrate that such operations have been intrinsically uneconomic. The typical cattle ranch, without subsidies, fails to generate a positive return from livestock production. The long-term financial performance analysis demonstrates that livestock investors reap their profits only from government tax and credit subsidies, which allow a generous return to the entrepreneur's own limited financial input, despite the project's overall unprofitability. It follows that the fiscal costs to the government have been heavy, since the government has not only absorbed project losses but also provided the substantial profits reaped by private investors.

Cost-benefit structure

Five-year prospectus. The cost structure of Amazon cattle ranches comprises capital investment and operating costs. Table 6.8 presents five-year capital investment and operating cost estimates based on Browder's 1984 survey data. The typical ranch is characterized as a new undertaking, involving initial land acquisition, forest clearance, pasture formation, construction of infrastructure (fencing, roads, and mis-

Table 6.8. *Cost structure and returns on typical SUDAM beef cattle ranch (U.S. dollars per hectare during five-year development period)*

	1984
Capital investment	
1. Land cost	31.70
2. Forest clearance	
a. Manual	65.95
3. Pasture planting	26.36
4. Fencing	19.38
5. Road-building[a]	6.31
6. Miscellaneous constructions	1.25
7. Cattle acquisition[b]	90.87
Subtotal	241.82
Five-year operating costs	
1. Labor costs[c]	26.16
2. Herd maintenance[d]	21.00
3. Pasture maintenance[e]	47.34
4. Facility maintenance[f]	74.35
5. Administration[g]	4.11
Subtotal	173.00
Total costs	414.78
Total revenues[h]	112.50

[a]Road-building: Based on US$676.20/km as given by seven rancher respondents and average of 108 km/ranch divided by average pasture area (11,600 ha). The average size of the ranches in the sample was 49,500 ha.

[b]Cattle acquisition: Based on total initial herd of 4,000 animals costing US$1,054,300 on 11,600 ha of pasture.

[c]Labor costs: Based on 52 permanent employees per ranch, an average annual payroll of US $60,500, and 11,600 ha of pasture, as provided by 24 rancher respondents.

[d]Herd maintenance: Based on annual animal vaccination costing US$2.50/ha and mineral salts costing US$1.70/ha, totaling US$4.20/year.

[e]Pasture maintenance: Based on two pasture cleanings (US$10.49/ha) and one replanting (US$26.36/ha), totaling US$47.34 during the five-year period.

[f]Facility maintenance (roads, fences, corrals, buildings, etc.): Based on US$14.87/ha/year as given by 10 rancher respondents.

[g]Administration: Based on 10 percent of capital investment and five-year operating costs.

[h]Revenues: Based on observed take-off rate of 17.1 percent in 1984 (1,026 fattened steers/year), and an average 1984 price of US$254.37 per head as given by 12 rancher respondents, or a total of US$260,983 (US$112.50/ha) per five-year period, and pasture of 11,600 ha.

Source: Browder (1985).

cellaneous constructions), and cattle acquisition. Annual operating costs (labor; the maintenance of herds, pastures, and facilities; and administration) are accumulated to a total five-year cost per hectare.

The wide variation in pasture formation practices among Amazon cattle ranchers, as well as the variations in soil and vegetation types, influences forest clearance and pasture formation and maintenance costs. Based on the sample of 21 SUDAM-supported cattle ranches surveyed by the author, total investment and operating costs in the typical SUDAM-subsidized ranch over the five-year period was about $6 million (current), or $414.82 per hectare of pasture.[17] Capital investment costs were $241.82 (58.3 percent of total costs) per hectare of pasture, and five-year operating costs were $173.00 (41.7 percent) per hectare of pasture. Forest clearance, indicated by 83 percent of the sample as the single most expensive item in the ranch development program, is, in fact, the second largest investment cost ($65.95/hectare), following cattle acquisition ($90.87/hectare).

The average return on production was $22.50 per hectare per year, or a total ranch income of $1.3 million during a typical five-year period based on the average 1984 price of $254.37 per fattened steer ($0.60/kg liveweight). Thus, cattle sales fail to cover even total operating costs in the absence of any subsidy, leaving no operating profit to justify the capital investment. However, as subsequent analysis will demonstrate, SUDAM subsidies have been generous enough to ensure ample profits on private financial investments.

Financial and economic analysis

Based on the author's survey data, the financial and economic performance of a typical SUDAM ranch was analyzed from the perspectives of the national economy and the private entrepreneur. The analysis contrasts the net benefits of Amazonian livestock investments to the national economy with the financial returns on the private investor's own equity participation, assuming the investor takes advantage of all available government incentives and subsidies. In effect, the analysis contrasts public loss and private gain.

The analysis extends over a 15-year horizon, including an initial investment and start-up period, and assumes that after 15 years all ranch assets – land, livestock, and depreciated ranch equipment – are sold at market values. Because inflation, land speculation, and credit subsidies have been central to private gains in Amazonian livestock investment, all values are recorded in nominal, rather than inflation-adjusted, terms. The general inflation rate for all prices except land values is assumed to be 25 percent

per annum over the entire period, close to the average Brazilian rate during the 1970s. Land values are assumed to rise more rapidly than the inflation rate – by 2 percent annually in the base case and 5 percent in sensitivity analyses – reflecting the actual appreciation of Amazonian land in real terms during this inflationary period. Interest and amortization charges are recorded in nominal terms as well, according to the terms of various official credit programs available to SUDAM ranches. To derive net present values for economic analysis, all cost and revenue streams are discounted at a rate 6 percent above the general inflation rate.

The analysis models typical calving beef cattle operations. Initial herd size is 4,000 head, which increases to an equilibrium size of 8,750 in the fifth year of operations, at which the annual offtake of 17 percent equals the herd's natural increase. Pasture formation in the model is driven initially by the increasing herd size, but continues throughout the period because existing pasturage in use is assumed to decline in productivity over time to require replacement by the fifth year. Carrying capacity of new pasture is assumed to decline from 1.05 head per hectare to 0.65 in the fifth year of use, and to go into fallow thereafter. Thus, although total operating pasture in the model ranch stabilizes at 10,500 hectares, the total area cleared for pasture increases over the life of the operation to 27,500 hectares, some of which may represent rehabilitated fallow put back into production.

The resulting pattern of pasture formation and herd increase determines the pace of investment spending (other than initial acquisition costs for land and cattle) and operating costs, which are linked to pasture formation and herd size, respectively. Thus, for example, investments in fencing and road construction continue throughout the life of the project, as do operating outlays for herd and pasture maintenance. Revenues come from annual cattle sales that start in year two and continue throughout the project period, and from capital gains from the final sale of ranch assets, including land at appreciated prices.

Economic evaluation. The details of the base case economic and financial analyses are presented in Tables 6.9 and 6.10. Because the purpose is to compare costs and benefits to the national economy, costs and revenues are charged to the project as they are incurred. Brazilian credit and tax provisions are ignored. Comparison of operating revenues and total operating costs shows that the project generates a small operating surplus after five years. However, this surplus is too small to cover investment expenses, so that net benefits from the operation are negative in each year. The final gain from the sale of ranch assets in year 15 is far too

little to offset these losses. Therefore, at a positive real interest rate of approximately 5 percent, the net present value of the project is negative $2.8 million. In other words, as the first row of Table 6.11 indicates, since the present value of total investment in the project is $5.1 million, the total loss is 55 percent of national resources invested.

Sensitivity analyses tested these conclusions under different assumptions about possible project benefits. A higher rate of appreciation in land values, at 5 percentage points above the general inflation rate annually, led to the results in the third row of Table 6.11. Even with a larger ultimate capital gain, the net present value of the project in economic terms is still negative $2.3 million, representing a loss of 45 percent of invested resources. A second departure from base case assumptions, presented in the second row, led to more favorable results. Were cattle prices assumed double those reported in the underlying survey data, implying a doubling of operating revenues in each year, the project would earn a small economic surplus, a present value of $0.5 million, which is 10 percent of invested funds. In other words, it would take a drastic improvement in project revenues to make the typical project even marginally economic at a real interest rate of 5 percent.

Financial analysis. From the private investor's perspective, the typical livestock project's profitability depends critically on the extent to which he can avoid or defer commitment of his own resources by taking advantage of government tax credits and loans, and on the extent to which he can write off costs against other tax liabilities. To show the potential impact of government incentives on private investment decisions in the Amazon, the financial analysis assumed that the private entrepreneur was able to use all available incentives: investment tax credits, tax deductions and holidays, accelerated depreciation provisions, and subsidized lending programs.

Since SUDAM-sponsored investments have been eligible for tax credits against other tax liabilities for up to 75 percent of approved investment costs, private parties have been able to finance most of the investment costs with money already due the government in taxes. Following survey findings, the analysis assumes that 54 percent of actual investment costs are met through tax credits in each year after the first. In the first year, land values are doubled in calculating the investment eligible for tax credits. This reflects the former SUDAM practice of overappraising the value of Amazon land owned by the corporate investor to ease the burden of the private investor's share in total project costs.[18]

The analysis also includes the contribution of subsidized rural invest-

Table 6.9. *Economic analysis of typical SUDAM-supported ranch (U.S. dollars)*

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Capital investment						
Land cost	1,578,660					
Forest clearance	251,270	123,162	168,585	230,825	315,903	606,608
Pasture planting	100,432	49,227	67,383	92,260	126,265	242,459
Fencing	73,838	36,192	49,540	67,830	92,831	178,257
Road-building	24,041	11,784	16,130	22,085	30,225	58,039
Miscellaneous construction	4,763	2,334	3,195	4,375	5,988	11,497
Cattle acquisition	1,016,000	0	0	0	0	0
Total	3,049,003	222,699	304,833	417,375	571,212	1,096,861
Operating Costs						
Labor costs	24,640	39,948	61,359	90,992	131,592	164,490
Herd maintenance	19,760	32,036	49,207	72,971	105,530	131,912
Pasture maintenance	44,560	72,243	110,965	164,554	237,976	297,470
Facility maintenance	70,000	113,488	174,316	258,501	373,840	467,300
Administration	3,840	6,226	9,563	14,181	20,508	25,635
Total	162,800	263,940	405,410	601,199	869,446	1,086,807
Total costs						
Capital costs	3,049,003	222,699	304,833	417,375	571,212	1,096,861
Operating costs	162,800	263,940	405,410	601,199	869,446	1,086,807
Loan payments	0	0	0	0	0	0
Subtotal	3,211,803	486,639	710,243	1,018,574	1,440,658	2,183,669
Tax credits	0	0	0	0	0	0
Subtotal	3,211,803	486,639	710,243	1,018,574	1,440,658	2,183,669
Tax loss or tax payment	0	0	0	0	0	0
Total	3,211,803	486,639	710,243	1,018,574	1,440,658	2,183,669
Total revenues						
Revenue from cattle sales	0	217,170	352,087	540,804	801,981	1,159,813
Revenue from land sales						
Investment loans	0	0	0	0	0	0
Operating loans	0	0	0	0	0	0
Total	0	217,170	352,087	540,804	801,981	1,159,813
Balance						
Total revenue	0	217,170	352,087	540,804	801,981	1,159,813
Total costs	(3,211,803)	(486,639)	(710,243)	(1,018,574)	(1,440,658)	(2,183,669)
Profit	(3,211,803)	(269,469)	(358,156)	(477,770)	(638,677)	(1,023,856)
Discount rate: 0						
Net present value: (2,824,132)						

ment (PROTERRA) credits to investment financing. Of the remaining 46 percent of project investment costs, the investor is assumed to finance half with his own funds and borrow the rest – 23 percent of total project investment costs – equally from two PROTERRA funds, the fixed investment fund and that for semi-fixed investment. The fixed investment

Table 6.9. (*continued*)

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
433,974	572,657	755,131	993,542	1,584,040	1,430,335	1,848,380	
173,458	228,889	301,823	397,115	633,136	571,700	738,791	
127,527	168,281	221,902	291,961	465,485	420,317	543,163	
41,522	54,791	72,250	95,061	151,559	136,852	176,850	
8,225	10,854	14,313	18,831	30,024	27,110	35,034	
0	0	0	0	0	0	0	
784,707	1,035,472	1,365,419	1,796,510	2,864,243	2,586,315	3,342,218	0
205,612	257,015	321,269	401,586	501,983	627,479	784,348	
164,890	206,113	257,641	322,051	402,564	503,205	629,007	
371,838	464,797	580,996	726,245	907,807	1,134,758	1,418,448	
584,126	730,157	912,696	1,140,870	1,426,088	1,782,610	2,228,262	
32,043	40,054	50,068	62,585	78,231	97,789	122,236	
1,358,509	1,698,136	2,122,670	2,653,338	3,316,673	4,145,841	5,182,301	0
784,707	1,035,472	1,365,419	1,796,510	2,864,243	2,586,315	3,342,218	0
1,358,509	1,698,136	2,122,670	2,653,338	3,316,673	4,145,841	5,182,301	0
0	0	0	0	0	0	0	0
2,143,216	2,733,608	3,488,089	4,449,848	6,180,916	6,732,155	8,524,519	
0	0	0	0	0	0	0	0
2,143,216	2,733,608	3,488,089	4,449,848	6,180,916	6,732,155	8,524,519	
0	0	0	0	0	0	0	0
2,143,216	2,733,608	3,488,089	4,449,848	6,180,916	6,732,155	8,524,519	
1,449,766	1,812,208	2,265,260	2,831,575	3,539,468	4,424,335	5,530,419	47,340,063
							35,296,934
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1,449,766	1,812,208	2,265,260	2,831,575	3,539,468	4,424,335	5,530,419	82,636,997
1,449,766	1,812,208	2,265,260	283,157	3,539,468	4,424,335	5,530,419	82,636,997
(2,143,216)	(2,733,608)	(3,488,089)	(449,848)	(6,180,916)	(6,732,155)	(8,524,519)	
(693,450)	(9,217,401)	(1,222,830)	(1,618,274)	(2,641,447)	(2,307,820)	(2,994,100)	82,636,997

credit carries a 12 percent nominal interest charge and is repayable in 20 annual installments after an initial six-year grace period during which no interest or amortization charges are imposed. The semi-fixed investment credit also has an interest rate of 12 percent, but is repayable over eight years after a four-year grace period. In the analysis, it is assumed that both

Table 6.10. *Financial analysis of typical SUDAM-supported ranch (U.S. dollars)*

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Capital Investment						
Land cost	1,578,660					
Forest clearance	251,270	123,162	168,585	230,825	315,903	606,608
Pasture planting	100,432	49,227	67,383	92,260	126,265	242,459
Fencing	73,838	36,192	49,540	67,830	92,831	178,257
Road-building	24,041	11,784	16,130	22,085	30,225	58,039
Miscellaneous construction	4,763	2,334	3,195	4,375	5,988	11,497
Cattle acquisition	1,016,000	0	0	0	0	0
Total	3,049,003	222,699	304,833	417,375	571,212	1,096,861
Operating Costs						
Labor costs	24,640	39,948	61,359	90,992	131,592	164,490
Herd maintenance	19,760	32,036	49,207	72,971	105,530	131,912
Pasture maintenance	44,560	72,243	110,965	164,554	237,976	297,470
Facility maintenance	70,000	113,488	174,316	258,501	373,840	467,300
Administration	3,840	6,226	9,563	14,181	20,508	25,635
Total	162,800	263,940	405,410	601,199	869,446	1,086,807
Total costs						
Capital costs	3,049,003	222,699	304,833	417,375	571,212	1,096,861
Operating costs	162,800	263,940	405,410	601,199	869,446	1,086,807
Loan payments	(44,750)	(32,350)	(15,377)	0	111,149	111,149
Subtotal	3,167,052	454,289	694,866	1,018,574	1,551,807	2,294,817
Tax credits	(2,480,427)	(119,367)	(163,390)	(223,713)	(306,170)	(587,918)
Subtotal	686,625	334,922	531,475	794,861	1,245,637	1,706,900
Tax loss or tax payment	(163,143)	(131,577)	(154,521)	(185,175)	(252,586)	(267,368)
Total	523,482	203,344	376,954	609,687	993,050	1,439,532
Total revenues						
Revenue from cattle sales	0	217,170	352,087	540,804	801,981	1,159,813
Revenue from land sales						
Investment loans	568,575	103,333	141,442	128,143	0	0
Operating loans	81,400	0	202,705	0	434,723	0
Total	649,975	320,503	696,234	668,947	1,236,704	1,159,813
Balance						
Total revenue	649,975	320,503	696,234	668,947	1,236,704	1,159,813
Total costs	(523,482)	(203,344)	(376,954)	(609,687)	(993,050)	(1,439,532)
Profit	126,493	117,158	319,280	59,261	243,653	(279,719)
Discount rate: 0						
Net present value: 1,875,436						

credits were drawn in the first project year, and temporarily unused proceeds were invested by the corporation in short-term money market instruments. The private investor's own resources provide residual financing and are committed to the project only when other financial sources are used up. At the end of the project life, at the sale of the ranch, all debts are assumed paid off at their remaining net present value.

Table 6.10. (*continued*)

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
433,974	572,657	755,131	993,542	1,584,040	1,430,335	1,848,380	
173,458	228,889	301,823	397,115	633,136	571,700	738,791	
127,527	168,281	221,902	291,961	465,485	420,317	543,163	
41,522	54,791	72,250	95,061	151,559	136,852	176,850	
8,225	10,854	14,313	18,831	30,024	27,110	35,034	
0	0	0	0	0	0	0	
784,707	1,035,472	1,365,419	1,796,510	2,864,243	2,586,315	3,342,218	0
205,612	257,015	321,269	401,586	501,983	627,479	784,348	
164,890	206,113	257,641	322,051	402,564	503,205	629,007	
371,838	464,797	580,996	726,245	907,807	1,134,758	1,418,448	
584,126	730,157	912,696	1,140,870	1,426,088	1,782,610	2,228,262	
32,043	40,054	50,068	62,585	78,231	97,789	122,236	
1,358,509	1,698,136	2,122,670	2,653,338	3,316,673	4,145,841	5,182,301	0
784,707	1,035,472	1,365,419	1,796,510	2,864,243	2,586,315	3,342,218	0
1,358,509	1,698,136	2,122,670	2,653,338	3,316,673	4,145,841	5,182,301	0
214,977	214,977	302,488	302,488	439,224	439,224	541,725	6,368,885
2,358,193	2,948,585	3,790,577	4,752,336	6,620,139	7,171,379	9,066,244	6,368,885
(420,603)	(555,013)	(731,864)	(962,929)	(1,535,234)	(1,386,265)	(1,791,429)	0
1,937,590	2,393,572	3,058,712	3,789,406	5,084,905	5,785,114	7,274,815	6,368,885
(244,270)	(285,522)	(361,423)	(432,633)	(593,033)	(659,280)	(840,813)	33,054,799
1,693,320	2,108,050	2,697,290	3,356,773	4,491,872	5,125,834	6,434,002	39,423,684
1,449,766	1,812,208	2,265,260	2,831,575	3,539,468	4,424,335	5,530,419	47,340,063
							35,296,934
0	0	0	0	0	0	0	0
679,255	0	1,061,335	0	1,658,336	0	2,591,150	0
2,129,021	1,812,208	3,326,595	2,831,575	5,197,804	4,424,335	8,121,569	82,636,997
2,129,021	1,812,208	3,326,595	2,831,575	5,197,804	4,424,335	8,121,569	82,636,997
(1,693,320)	(2,108,050)	(2,697,290)	(3,356,773)	(4,491,872)	(5,125,834)	(6,434,002)	(39,423,684)
435,701	(295,842)	629,305	(525,198)	705,932	(701,499)	1,687,567	43,213,313

In addition to these investment incentives, the private investor is assumed able to use several operating subsidies, including tax holidays and deductibility of tax losses against nonproject income, accelerated depreciation, and subsidized intermediate-term (POLOAMAZONIA) production credits. Production credits have the same terms as semi-fixed investment credits, and are available to finance up to 50 percent of operat-