

LUMBER PRODUCTION AND ECONOMIC DEVELOPMENT IN THE BRAZILIAN AMAZON: REGIONAL TRENDS AND A CASE STUDY

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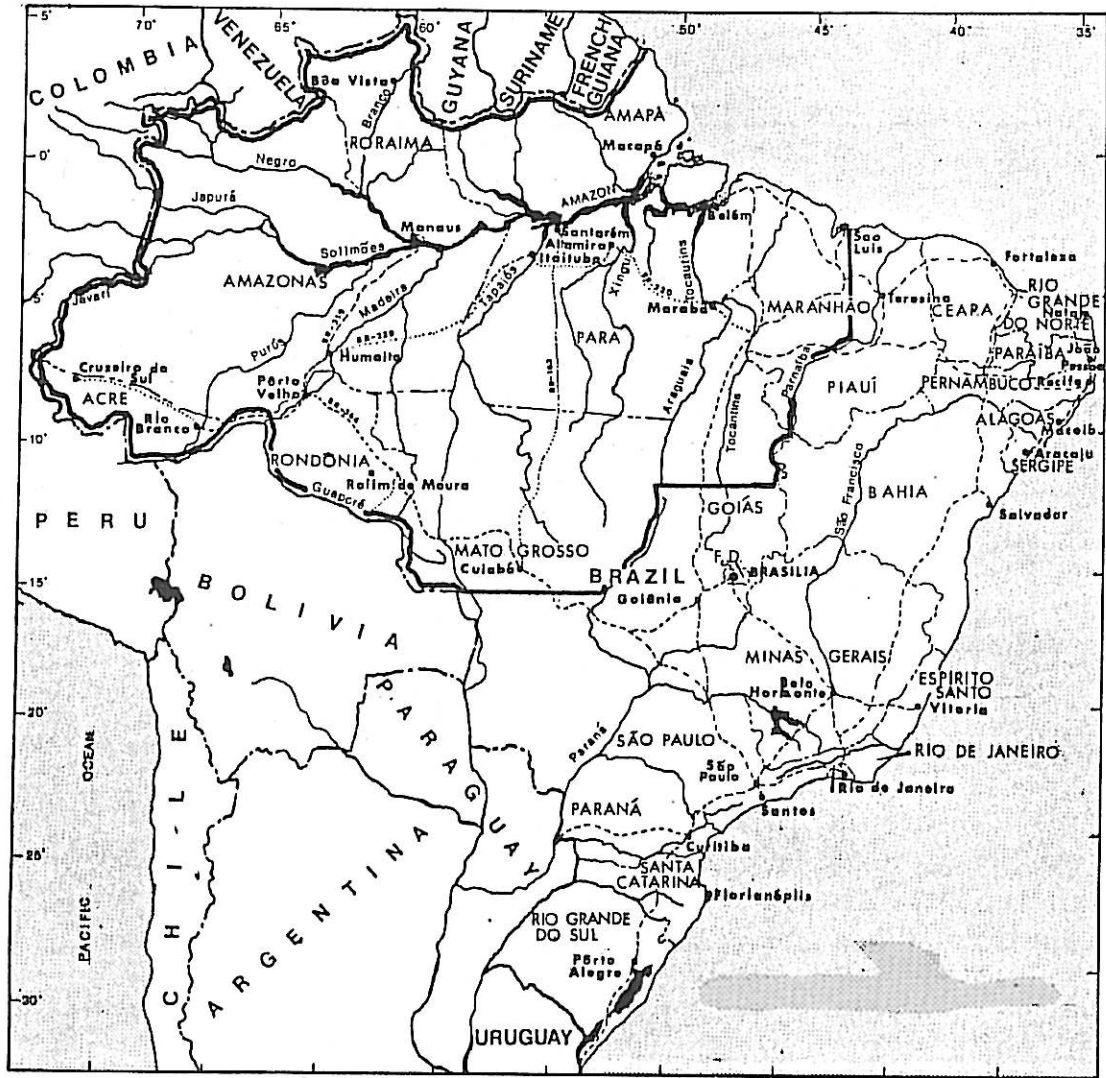
SUMMARY

Prevailing theories about the nature of economic expansion in the Brazilian Amazon have focused almost exclusively on production relations and land conflicts in the agrarian sector. This paper suggests that the region's growing urban sector is an important but little studied component of the process of capital expansion in Amazonia. The industrial wood sector is now a leading sector in the economy of the Amazon region and the economic foundation of many frontier urban settlements. It therefore provides a window onto the processes of urbanization, industrialization and capital accumulation in the Brazilian frontier. The recent growth of industrial wood production and processing in the Amazon is described, and a case study examines the forward linkages of the lumber industry and its impacts on employment, household income and value of production in several key sectors of the local economy of a frontier town, i.e transport, construction, furniture, and fuelwood.

INTRODUCTION

This paper examines the contribution of the lumber industry to the economic development of the Brazilian Amazon region. This region encompasses some 5.0 million square kilometers (sq. km.) of predominantly tropical evergreen forest (Fig. 1). Brazil is Latin America's largest producer of industrial roundwood, contributing about 58% of total 1980 sawlog and pulpwood output of 76.4 million cubic meters (m³) (McGaughey and Gregersen, 1983). Recently, the Amazon region has become Brazil's most important source of industrial roundwood. While the rapid growth of wood processing industries in the Amazon has closely accompanied the expansion of agriculture into tropical forestlands, the location of such industries in small urban settlements in the frontier has helped transform the Brazilian Amazon into one of the most rapidly urbanizing and industrializing regions of Latin America. The region's expanding lumber industry has influenced the structure of the frontier economy, providing off-farm employment in burgeoning boom towns. In one new settlement, Rolim de Moura, in the Amazon State of Rondonia, wood consuming and servicing sectors of the local urban economy in 1985 employed an estimated 47% of the local labor force and provided 67% of

total household income in the urban sector. In this case-study of Rolim de Moura, the far-reaching forward linkages of industrial wood production to other sectors of this emerging frontier economy are demonstrated.



- — — — — INTERNATIONAL BOUNDARIES
- - - - - STATE AND TERRITORY BOUNDARIES
- ~~~~~ RIVERS
- STATE AND TERRITORY CAPITALS
- LEGAL AMAZONIA
- - - - - PAVED ROADS
- UNPAVED ROADS

Fig. 1. The Brazilian Legal Amazon Region

AMAZON TIMBER IN THE BRAZILIAN NATIONAL ECONOMY: RECENT TRENDS

Since 1970, about 5,075 km of federal highways built into the Brazilian Amazon¹ have opened vast hitherto inaccessible areas of upland rain forest to exploitation by farmers, cattle ranchers, and loggers. Previously, most logging operations were confined to the narrow floodplain forests of the Amazon River and its tributaries. Today much of the Amazon's industrial roundwood originates from the expansive upland *terra firme* broadleaved forests.

The Amazon's contribution to Brazilian roundwood production nationwide has been steadily rising. In 1975, only 14.3% of Brazil's industrial roundwood production originated from the Amazon region. By 1984, the Amazon supplied 43.5% of Brazil's total industrial roundwood, becoming the nation's foremost source region for industrial sawlogs (Table 1).

TABLE 1

Roundwood production in Brazil: 1975-84 (millions of cubic meters)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Total	31.5	33.2	32.3	32.3	31.6	36.2	35.6	37.0	38.6	39.9
North (Amazonia)	4.5	5.9	6.7	7.7	8.4	11.5	13.1	14.6	16.1	17.4
(% of Total)	14.3	17.8	20.7	23.8	26.6	31.8	36.8	39.6	41.7	43.5
Northeast	5.2	5.5	5.3	5.4	5.6	6.6	6.8	6.9	7.2	7.7
(% of Total)	16.5	16.6	16.4	16.7	17.7	18.2	19.0	18.6	18.6	19.3
Southeast	2.2	2.0	2.0	1.5	1.2	1.2	1.6	1.3	1.7	2.2
(% of Total)	7.0	6.0	6.2	4.6	3.8	3.3	3.0	3.5	4.3	5.5
South	16.9	16.8	15.3	15.0	13.4	13.7	10.9	10.9	10.2	9.0
(% of Total)	53.6	50.6	47.4	46.1	42.4	37.8	30.6	29.5	26.4	22.5
Centre-West	2.6	2.8	2.9	2.7	3.0	3.2	3.3	3.3	3.4	3.5
(% of Total)	8.3	8.4	9.0	8.4	9.5	8.8	9.3	8.9	8.8	8.8

N.B. Percentage totals may not add up to 100, due to rounding

Source: IBGE (various years)

The rapid growth of Amazonian industrial roundwood production has been accompanied by a no less dramatic expansion of the region's lumber industry. During the thirty-year period from 1952 to 1982 the number of licensed lumber mills operating in Brazilian Amazonia increased over 17-fold from 89 to 1,639 mills respectively (Fig. 2).

In real terms, capital investment in the Amazon's lumber industry has climbed from about US\$4.7 million in 1973 (Muthoo, 1976) to about US\$307 million in 1984 (Browder, 1986). Average capital investment per

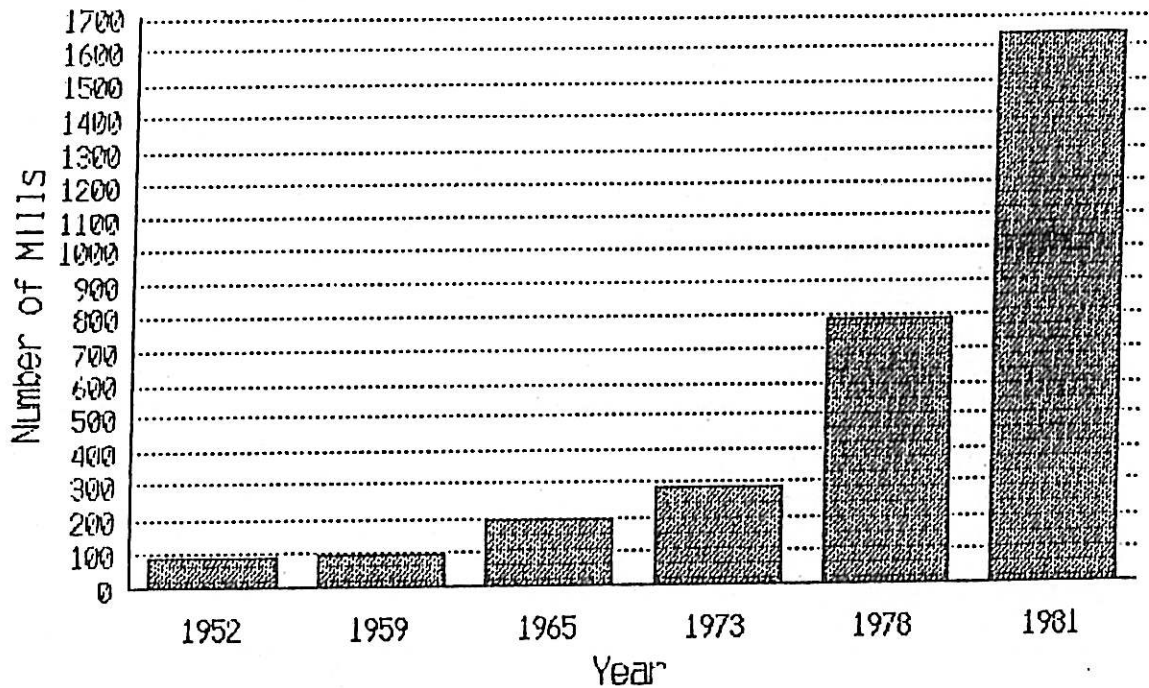


Fig. 2. Number of Amazon lumber mills: 1952-1981
Source: Browder (1986)

TABLE 2

Number of Amazon Sawmills by State and year

	1952	1959	1965	1973	1978	1981	1982
North	89	-	194	287	793	1,639	-
Rondonia	-	4	-	-	141	250	387
Acre	-	47	-	32 ^a	35	61	-
Amazonas	-	-	-	-	89	62	-
Roraima	-	-	-	-	18	17	-
Para	-	-	-	-	510	866	-
Amapa	-	-	-	-	-	60	-
Other ^b	-	-	-	-	-	323	-

NB (a) Includes Rondonia. (b) Includes Imperatriz, Maranhao (105 mills) and Mato Grosso (218 mills).

Sources: IBDF/PROMAEX (1982); Bruce (1976); Reis and Caneiro (1982); UFRRJ (1983).

mill increased from US\$ 16,500 to US\$ 187,000 during this period.

Not surprisingly, the industrial wood sector is the single largest employer of skilled and semi-skilled labour in 5 of the Amazon's 6 states and territories (in the state of Amazonas the sector is the second largest employer). Whereas nationwide employment in the industrial wood sector averaged about 5% of total industrial employment between 1975 and 1980, in the latter year the lumber industry provided the Amazonian

industrial labour force with 25.8% of its jobs (IBGE/AE, 1983). While the typical mill employs about 30 workers (IBGE/AE, 1983; Browder, 1986), and there is an estimated 49,000 mill workers region-wide, much of this employment is seasonal owing largely to the inability of mill owners to secure sufficient stocks of roundwood during the four to six month logging season to maintain operation during the rainy months. Accordingly, mill employment is largely occasional; workers frequently seek supplemental sources of income in other sectors of the economy (e.g. farming, gold mining, day work on road building crews, petty commerce etc.)

The westward migration of lumber producers and capital to the Brazilian Amazon is reflected by the growing contribution of industrial wood production to total regional industrial output. From 1970 to 1980 the value of lumber production in the Brazilian Amazon rose from US\$ 17 million to US\$ 454 million, growing from 8.1% and 12.9%, respectively, of the total value of industrial output in the region (Table 3). In many localities lumber production is virtually the only industrial activity. In four of the region's six states and territories, industrial wood production accounts for more than 25% of total value of industrial output and in two states (Rondonia and Roraima) industrial wood production represents about two-thirds of total state industrial product, excluding mineral extraction (IGBE/AE, various years).

In summation, since 1970 roundwood and sawnwood production have become the industrial backbone of the Amazon's rapidly expanding economy. In turn, the Amazon region has become Brazil's most important source of industrial wood products.

LUMBER PRODUCTION AND URBANIZATION IN THE AMAZON: THE CASE OF ROLIM DE MOURA

The recent emergence of the lumber industry as a leading sector in the economy of the Brazilian Amazon adds an important urban dimension to the process of capitalist expansion in this frontier region. Previous analyses of frontier expansion have largely adopted a theoretical framework emphasizing transitional agricultural and speculative land uses and the role of the State in transforming the agrarian sector (Cardoso and Muller, 1978; Foweraker, 1981; Pompermayer, 1979; Sawyer, 1985). The present analysis suggests that urban areas in the frontier are important "theatres of accumulation" and frontier urbanization, a process that accompanies the capitalist transformation of the agrarian sector. Urban location and growth in the Amazon may be influenced by the location decisions of lumber producers. The case of Rolim de Moura, a booming lumber town in southeastern Rondonia, illustrates this process of industrial capital penetration and urban growth in the interior.

Rolim de Moura was initially settled in July 1977 by a handful of pioneers from nearby Cacoal, an older town located on the interstate highway (BR 364) some 70 kilometers away. Shortly thereafter the state

TABLE 3

Industrial wood production in the North Region: 1970-1980 (US\$million and percentages)

	1970	1975	1980
North Region			
Total industrial output	206.0	1,009.0	3,522.0
Industrial wood sector production (IWS)	17.0	112.0	454.0
IWS as percent of Total industrial output	8.1	11.1	12.9
Rondonia			
Total industrial output	-	15.7	73.0
Industrial wood sector production	-	4.5	44.7
IWS as percent of Total industrial output in Rondonia	-	28.6	61.2
IWS as percent of Total industrial output in North Region	-	4.0	9.8
Acre			
Total industrial output	-	7.9	39.5
Industrial wood sector production	0.2	1.0	5.5
IWS as percent of Total industrial output in Acre	-	12.6	13.9
IWS as percent of Total industrial output in North Region	1.2	0.8	1.2
Amazonas			
Total industrial output	-	514.6	2,146.5
Industrial wood sector production	5.4	25.8	59.3
IWS as percent of Total industrial output in Amazonas	-	5.0	2.8
IWS as percent of Total industrial output in North Region	31.9	23.0	13.1
Roraima			
Total industrial output	-	1.5	7.9
Industrial wood sector production	-	0.6	5.4
IWS as percent of Total industrial output in Roraima	-	40.0	68.3
IWS as percent of Total industrial output in North Region	-	0.5	1.2
Para			
Total industrial output	-	415.7	1,108.2
Industrial wood sector production	10.5	68.7	313.2
IWS as percent of Total industrial output in Para	-	16.5	28.3
IWS as percent of Total industrial output in North Region	62.3	61.4	69.0
Amapa			
Total industrial output	-	39.2	76.7
Industrial wood sector production	0.6	11.5	25.9
IWS as percent of Total industrial output in Amapa	-	29.3	33.8
IWS as percent of Total industrial output in North Region	3.7	10.3	5.7

N.B. Total for North Region includes both extractive and transformation industries. Total for Rondonia excludes extractive industries (i.e. metallic mineral extraction).

Source: IBGE (various years). Monetary conversion rates from the World Bank (*World Tables*). U.S. dollars expressed in current values

government opened feeder roads from Cacoal and neighbouring Pimenta Bueno and the frontier settlement of Rolim de Moura burst into life. As word of the new town spread, more people poured in; a land-rush ensued. By 1980 Rolim de Moura's population had grown from an initial number of 12 to an estimated 5,000. Within two years the town's population had doubled, and then doubled again to about 20,000 in 1984-85.

This period of extraordinary population growth in Rolim de Moura corresponds with the increasing concentration of lumber mills in the town. Because of Rolim de Moura's location at the periphery of undisturbed forests relatively rich in native mahogany (*Swietenia macrophylla*), combined with an urban industrial growth policy that gave free land to factory owners, Rolim de Moura became an attractive location for lumber producers. In 1980 no more than 10 small saw mills (*picapaus*) operated in the town, producing in total about 12,000 m³ of rough lumber, squares and shorts for local building construction and veneer factories outside the region (Browder, 1986). In 1983 some 30 lumber mills were located in the town, producing 80,000 m³ of rough lumber, over 65% of which was high-grade export mahogany (Browder, 1986). In the brief span of three years, the lumber industry of Rolim de Moura tripled in size and shifted its orientation from local to export markets.

Although it remains largely conjectural, some evidence suggests that industrial location decisions by lumber producers were based on mahogany depletion from the natural forests. As mahogany became increasingly scarce around the older towns, the newer settlements further in the interior with extensive tracts of undisturbed forests became increasingly attractive as locations for industrial capital investment in the mahogany export trade. In a 1981 study of Rondonia's industrial wood sector undertaken by a research team from the Federal Rural University of Rio de Janeiro (UFRRJ), a total of 59 lumber mills were enumerated in the town of Pimenta Bueno, an older settlement of some 30,000 inhabitants situated on the BR 364 highway about 60 kilometers northeast of Rolim de Moura (UFRRJ, 1983). Although the UFRRJ team did not venture into Rolim de Moura, the author estimates that between 12 and 15 mills were operating there at the time of the UFRRJ survey. In 1984 another survey of Pimenta Bueno's lumber industry was undertaken by Professor Roberto Ticle of the Federal University of Mato Grosso who discovered that the number of lumber mills had dropped precipitously from 59 to 29 mills (a reduction of 50%) in three years (Ticle, personal communication). During this same period, the number of lumber mills operating in Rolim de Moura rose from 15 to 34 (a 126% increase).

Although the Brazilian federal government designated this incipient settlement as an urban service centre for a rapidly growing agricultural area, the increasing production of mahogany for export, fueled by government export subsidies more than foreign demand

(Browder, 1987), combined with the depletion of this resource from the forests surrounding the older towns, gave Rolim de Moura a new character as an industrial urban child prodigy of the mahogany export trade. By 1985, 40.6% of the urban labour force of Rolim de Moura (3,700 workers) was directly employed by the town's 36 industrial wood manufacturers (UFRRJ, 1985), a proportion more than twice as high as the manufacturing sector share of national employment in Brazil (17% in 1980) (IBGE/AE, 1985).

Since the first lumber mill started operation in 1978 the economic history of Rolim de Moura may be characterized by three stages associated with the shift in market orientation of the town's lumber industry. Initially, lumber production was oriented toward domestic (local and national) markets which consumed 82.5% of the town's sawnwood output in 1980. In the second stage, from 1981 to 1984, production shifted dramatically toward foreign markets, which consumed about one-half of the town's lumber product during this period. Suddenly, in 1985 the third stage began with the revision of federal export promotion policies prompting the collapse of the heavily subsidized Brazilian mahogany export trade (Browder, 1987). Export production dropped sharply to just 10% of Rolim de Moura's lumber output and production returned to its initial domestic market orientation (Table 4).

TABLE 4

Purchases and production by Rolim de Moura's Lumber Mills (1980-1985)

	1980	1981	1982	1983	1984	1985
Mills	10	20	22	27	34	36
Log purchases (m ³)	20,175	72,750	84,750	190,490	305,555	196,526
Primary output ^a (m ³)	12,860	30,900	30,680	81,650	98,964	104,300
Secondary output ^b (m ³)	-	-	-	-	20,778	31,051
Total recovery rate (%)	64	42	36	43	38.8	68.8
Foreign market consumption (% output)	17.5	52.1	41.2	65.3	36.1	9.9
National market consumption (% output)	57.5	30.3	50.9	26.3	42.8	64.1
Local market consumption (% output)	25.0	17.6	7.9	8.4	21.1	26.0
Est. residual ^c (m ³)	7,263	42,195	54,240	108,580	190,055	63,281

NB

(a) Board lumber rough or dressed.

(b) Lumber sub-products (e.g. shorts, rafters, beams, moulding, floor boards, etc.). Data not available for the years 1980-1983.

(c) Excess non-commercialized prime material and waste (e.g. bark, chips, sawdust, etc.).

Source: Browder (1986).

Two related trends, reflecting this shift in the market orientation of local production, emerge. First, as production became increasingly oriented toward foreign mahogany markets, log recovery rates for mahogany steadily declined (from 64% in 1980 to 39% in 1984). This decline reflects the depletion of mature mahogany from the town's surrounding timbershed. As mahogany became increasingly scarce in the forest, millgate prices for mahogany roundwood in the town soared to about US\$54/m³ (versus about US\$20/m³ for 15 other species) as loggers traveled nearly 100 km from the town to find standing mahogany (Browder, 1986). Second, as log recovery rates diminished industrial wood waste residues increased (from an estimated 7,300m³ in 1980 to 190,000m³ in 1984). Ironically, as lumber production expanded during this middle period, the local market languished for want of inexpensive construction materials (Dourojeanni, 1984). Lumbermen, having turned their attentions almost exclusively to export mahogany production, left local consumers sifting through the ever growing volume of mahogany wood waste for useful building materials. While much of this production residue was burned in open pit fires (creating a significant air quality problem in the town), a substantial amount found its way into the local market as production inputs for consumption by other forward-linked industrial and service sectors.

The author's survey findings, outlined below, point to the important forward linkages and economic impacts of lumber production on the local urban economy of this fledgling Amazonian lumber town.

THE LOCAL ECONOMIC IMPACTS OF ROLIM DE MOURA'S LUMBER INDUSTRY

There are both formal (market-mediated) and informal channels through which industrial wood products and by-products circulate through the local economy of Rolim de Moura. Five economic sectors directly consume or service wood products: lumber, transport, construction, furniture, and fuelwood sectors. The author's efforts to quantify the magnitude of the lumber industry's local economic impacts are based largely on casual interviews with various intermediate wood product consumers, and should be regarded as tentative. Unless otherwise stated, the main source of data for this section is Browder (1986), also summarised in UFRRJ (1985).

Lumber Sector

Based on the author's 1984 survey of 161 households in Rolim de Moura (UFRRJ, 1985), it is estimated that 40.6% of the town's labour force was

directly employed by the town's 34 lumber mills and one veneer slicing plant. The lumber sector's estimated total annual payroll was US\$935,500, representing 67% of total local household income (Browder, 1986). The gross value of lumber and lumber sub-product output was approximately US\$16.9 million, of which production costs represented US\$13.6 million in 1985. In that year mill-owners obtained an average return on investment of 24.2%.

Transport Sector

The long-haul motor carrier industry is the life-line for most settlements in Rondonia; conveying raw materials to the industrial Southeast and returning to the frontier with vital manufactures. The lumber industry is the main supplier of out-bound business for long-haul truckers. During the two-week period of July 25 to August 8, 1985, for example, 60% (191 truck-loads) of all freight shipments leaving Rolim de Moura contained lumber. Accounting for seasonal variations in the industrial wood freight traffic, average loads, transport rates, and principal destinations, in 1985 an estimated 511 truck drivers were fully employed in the inter-regional transport of industrialized wood products from Rolim de Moura. The income generated by the inter-regional transport of wood products was US\$1,011,000 and the estimated value of service rendered was US\$ 5,054,000 per year. Most of the substantial income benefits derived from the inter-regional transport of the town's industrial wood output are themselves transferred out of the local economy and should be treated cautiously in the appraisal of local impact.

Local freight delivery services also derive a significant business from the distribution of lumber products within the town. Lumber, lumber sub-products, and wood refuse generated by the sawmills are consumed by most households in the urban area of Rolim de Moura and by numerous intermediate and end users (e.g. furniture makers, commercial building contractors, and charcoal kilners). The circulation of these wood products to consumers in the local market area is provided by two types of freight delivery: horse-drawn carts (*carroceiros*) and pick-up trucks (*picuperiros*).

Based on informal interviews with both groups of local freight delivery operators, the lumber industry generates an estimated 32 full-time local transport jobs with a total income of about US\$51,000 per year.

Residential Construction Sector

With the urban population of Rolim de Moura growing at an annual rate of approximately 60% per year, inexpensive building materials are

always in high demand. The shortage of housing was a chronic problem in Rolim de Moura during the author's tenure in the town, due largely to the lack of locally produced building materials during this vigorous export period. Monthly rents for a rustic, one-room unfurnished dwelling place averaged about 40% of the minimum wage during this period (about US\$100 per month). In the urban residential construction sub-sector, rough sawnwood was used for wall construction in 95% of the 161 dwelling units visited and for flooring in 12% (most units had compacted soil or poured concrete floors). In 1985 there were 2,062 dwelling units in the town). Given a rough estimate of wood requirements (2.95 m³ per dwelling unit), the average local price of rough sawnwood (US\$126/m³), and the observed rate of new dwelling unit construction starts (18% per year), the estimated annual demand for wood construction materials would be 1,094 m³, worth US\$138,000 in 1985. No information was gathered on the labour impacts of residential construction. However, it may be inferred from the rudimentary type of dwelling units found in Rolim de Moura that the majority were built by their occupants and not by professional construction contractors.

On the 2,100 farms in the government colonization area surrounding Rolim de Moura it is estimated that annual sawnwood consumption for farm-related structures does not exceed 3,340 m³, representing a total annual sales value of US\$420,000. In many instances transactions between sawmills and farmers do not involve cash but rather the exchange of timber rights or roundwood for sawnwood in kind. Based on interviews of a representative sample of 72 farmers in the Rolim de Moura sector of the Gy Parana colonization project area, the author found that 54% of the colonists surveyed had marketed timber resources occurring on their lots at least once during their tenure, an average period of five years (UFRRJ, 1985). As in the case of urban home-building there is little evidence of any new permanent jobs created from farmhouse and related facility construction.

Civil Construction Sector

The urban civil construction sub-sector includes all non-residential structures in the urban area (i.e. commercial, service, and industrial). Within the town of Rolim de Moura there were 428 standing non-residential structures and another 55 building projects under construction in July, 1985, suggesting a possible 13% annual growth rate in non-residential building starts. Given this possible rate of growth, an estimated average wood requirement of 8.1 m³ of sawnwood per building (excluding exterior scaffolding), and the average local price of US\$126 m³, the urban civil construction subsector consumes about 450 m³ of sawnwood products per year worth US\$57,000. The author conservatively

estimates that 1984-85 non-residential building starts generated 220 full-time carpentry and construction jobs within the local economy (assuming 4 workers per project) with total wages of US\$341,000 (Browder, 1986).

Rural physical infrastructure potentially represents the single largest use of industrial wood products manufactured by the lumber mills of Rolim de Moura and purchased in the local market area. Three end-uses account for the largest share of these purchases: bridges, fencing and utility poles.

In the geographic market area served by Rolim de Moura's lumber industry during this period (5,000 to 8,000 sq. km., a total of 2,530 km. of local access roads have been opened crossing an estimated 2,302 streams and gulleys. Assuming that each crossing requires a simple unbuttressed platform bridge, each requiring about 1.25 m³ of thick lumber, then a total requirement of 2,880 m³ is obtained. Given the large volume of vehicular traffic observed on these roads, especially logging trucks, and the rapid deterioration to which these simple chemically untreated wooden structures are subjected, it is unlikely that the useful physical life of the typical bridge exceeds two years. Assuming an annual bridge replacement rate of 50%, total annual consumption would be 1,440 m³, worth approximately US\$181,000.

Two other semi-industrialized wood products are widely consumed in the rural sector of Rolim de Moura: fence materials and utility poles. With the increasing conversion of forest lands to crop lands, typically followed by their incorporation into pastures, the demand for fencing materials is always high and expected to increase. Approximately 77% of the farmers in the Rolim de Moura colonization sector surveyed by the author in 1985 reported having pasture, although the term *pastagem* is also used colloquially to refer to degraded unused fields. A roughly equal proportion (75%) of the farmers reported owning cattle. The average area in pasture given by the survey informants was 11.8 hectares (ha) per 100 ha farm in 1985. Information observations on all farms surveyed indicate that pasture rotation is only casually practiced, and that at most only one hectare of area per farm was enclosed and subdivided by wood corrals for cattle and horses or pens for other livestock. Given these observations, which are admittedly non-systematic, and assuming a wood requirement of 0.075 m³ per one linear metre of enclosed area, it is estimated that by 1985 a total of 63,000 m³ of semi-industrialized wood boards were used for livestock management in the colonization area, representing a total investment of nearly US\$4 million (given local 1985 price for such boards of US\$63/m³). Given a hypothetical rate of managed (i.e. fenced) pasture area expansion of 10% per year, the estimated annual demand for wood corral materials would approach 6,300 m³, worth US\$400,000 (in 1985 prices).

The rapidly expanding urban sector and increasing public efforts to install urban electrification and telephone communications systems in

the new towns on the frontier, have generated a demand for chemically treated wood utility poles. Most lumber mills did not carry an unordered inventory of such poles, but two mills in the author's survey sample periodically produced such poles on contract for the State's telephone utility (TELERON) and electrically utility (CERON). Regretably, official records of purchase orders were not made available to the author during his visits to Rondonia and so a reasonable estimate of production impacts could not be obtained.

Furniture Manufacturing Sector

There were 15 furniture manufacturers (*marcenarias*) operating in Rolim de Moura in July of 1985, 5 of which were surveyed by the author. These 5 small shops produced a total of 34 different furniture products each using wood materials produced by the town's lumber industry. From the author's survey findings, the furniture sector consumed an estimated 1,000m³ of board lumber and secondary wood products in 1985, representing only 1.0% of all lumber production and 6.9% of all output formally marketed in the local economy. Total annual sales of furniture products in the local market are approximately US\$388,000. The furniture sector employs an estimated 67 persons, a large number being minors, and accordingly spends a relatively low US\$35,950 on its total payroll.

Fuelwood Sector

Chronic energy deficiencies characterize virtually all urban settlements in Amazonia and retard the pace of industrialization. Although the Brazilian national government seems determined to pursue a regional electrification program based on Amazon's considerable hydroelectrical potential, numerous environmental concerns and questions about the cost-effectiveness of large hydroelectric projects have been raised (Caufield, 1983; Goodland, 1985; Junk and Mello, 1987; Mougeot, 1987; Sternberg, 1984). In the short-term, fuelwood could be an important transitional energy source for many small urban communities both for industrial and urban power. This opportunity is particularly promising in communities where substantial wood waste is produced by the local lumber industry.

In Rolim de Moura only the lumber industry itself uses wood residue as an industrial energy source. In addition a small cottage-level charcoal industry supplies local restaurants (*churrascurias*) and bakeries with cooking fuel and supports several itinerant vendors who regularly distribute fuelwood to these establishments. Finally, the vast majority of

urban households use industrial wood waste for cooking fuel, most of which is salvaged from the lumber mills and distributed locally by the *carroceiros*, while a small portion is scavenged directly from the scrap heaps of neighborhood furniture makers.

In 1985, only 20% of the lumber mills in Rolim de Moura employed wood-burning steam generators to produce electricity for mill operations, consuming about 7.5% of the local lumber industry's wood waste product (Browder, 1986). Substantial cost-savings were enjoyed by these energy self-sufficient producers who spent, on average only US\$0.79/m³ of lumber produced on energy inputs, compared to US\$8.91/m³ for the majority of producers burning imported diesel fuel. The major obstacles to widespread adoption of this cost-saving energy technology are the scarcity and relatively high purchase price of wood-to-steam generators.

Interestingly, in 1985 Rolim de Moura's 16 largest mills offered a proposal to the State's electrical utility company (CERON) to provide fuelwood sufficient to meet the town's entire demand for electrical power. According to this proposal the solid wood scrap generated by these 16 mills over a 190 day period would be enough to electrify the entire town of 2,062 dwelling units and 428 commercial and service establishments for 24 hours per day throughout the year. Additional surplus of firewood could be salvaged from the surrounding colonization project area during the forest cutting season (usually January to April). The proposal optimistically projects a total employment impact of 100 new permanent jobs and an estimated payroll of about US\$120,000 per year. Additional revenues would be widely distributed to farmers throughout the surrounding colonization project area, creating an important new source of farm income, should a major firewood salvage programme be inaugurated as the proposal anticipates.

Industrial wood scrap is also converted to charcoal for local restaurants and bakeries. Only one charcoal kilning operation was located in Rolim de Moura in 1985. Initiated by one of the town's largest sawmills, this rudimentary charcoal operation is managed by one of the mill's employees and his family for supplemental income and is located just outside the mill property to enable easy access to the mill's wood scrap piles. The operation involves two mud-brick ovens, each requiring an annual investment of about US\$315 and produces about 60 sacks (each containing 13 kg) of low grade charcoal per week. Mahogany wood was the favoured raw material in the charcoal production process, about 44 m³ of which are consumed annually. The producers charged about US\$0.79 per sack, generating a total estimated gross revenues of about US\$ 2,000 per year, one third of which the mill owners recovered as in-kind payment for the raw material. Net profits are about US\$700 per year. Industrial and service sector applications of high-temperature burning charcoal in auto repair, ceramics industries, and by blacksmiths and bakers are few. Where such activities occur, butane and other flammable

TABLE 5

The estimated economic impacts of the lumber industry: Rolim de Moura, Rondonia (1984-1985). (Multiplier coefficients in brackets)^a

Sector	Jobs Created	Annual Payroll US\$	Estimated Value of Production US\$
Lumber	674 (0.5)	935,500 (691.92)	16,889,200 ^b (12,474.56)
Transport (total)	543	1,061,750	5,105,000
Inter-regional	511 (0.38)	1,010,800 ^c (746.52)	5,054,100 (3,732.72)
Local	32 (0.02)	50,900 (37.59)	50,900 (37.59)
Construction	220 (0.16)	341,300 (252.07)	1,537,000 (1,135.16)
Urban Residential	-	-	138,000
Rural (Farms) ^d	-	-	820,000
Urban Civil ^e	220	341,000	398,000
Rural Civil ^f	-	-	181,000
Furniture	67 (0.049)	35,950 (10.16)	388,000 (286.56)
Fuelwood ^g	100 (0.074)	120,000 (88.62)	891,200 (658.20)
TOTAL	1,604 (1,185)	2,494,200 (1,842.10)	24,810,400 (18,323.78)

NB

- (a) Multiplier coefficients expressed as number of jobs, income, and value of production per 100 m³ of sawnwood produced by Rolim de Moura's industrial wood sector. Based on total 1985 production of 135,400 m³ of sawnwood.
- (b) Total estimated cost of production of 135,400 m³ of sawnwood (77% lumber, 23% secondary products), based on 1985 prices.
- (c) Wages estimated to 20% of the value of production (gross tariff revenues).
- (d) Value of sawnwood consumption for fencing materials (US\$400,000 per year) and farm structures (US\$420,000 per year) by the rural sector.
- (e) Value of production equal to market value of wood inputs (US\$57,000) plus payroll (US\$341,000).
- (f) Estimated annual bridge replacement costs in rural sector.
- (g) Assumes acceptance of proposal to develop fuel-wood project for public utility power generation in Rolim de Moura. Value of energy production derived from Browder (1986).
Source: Browder (1986).

liquids still provide the principal energy source.

The residential fuelwood subsector is one of the largest consumers of industrial wood waste. Each year town residents salvage about 8,900 m³ of sawnwood scrap. The weekly wood waste piles created by the town's furniture sector are the first sources of residential fuelwood to be

exhausted. Most households obtain their cooking fuelwood requirements directly from the mills, regularly engaging the services of local *carroceiros*. The household savings associated with the ubiquity of the fuelwood commodity in the town are impossible to estimate. The abundance of wood waste byproducts could make Rolim de Moura, and numerous other Amazonian lumber towns, completely self-sufficient in virtually all its energy needs.

Lumber mills are the industrial backbone of Rondonia's fledgling economy and an important generator of economic activity. In 1984-85 the lumber industry in Rolim de Moura generated approximately 1,600 jobs, 55% of which were in sectors other than lumber production (e.g. transport, construction, furniture). In total, wood consuming and servicing sectors of the local economy employed 47% of the local labour force and provided 67% of total household income in the town. The total value of sawnwood production and subsidiary manufacturing and service sector output in the local economy was nearly US\$25 million in 1985. The economic multipliers stemming from the lumber industry are substantial. For every 100 m³ of industrial sawnwood produced, the author estimates that nearly 1.2 jobs are created, generating an annual payroll of US\$1,842 and a total value of production of US\$18,324 in five different sectors of the urban economy (Table 5). These economic impacts of the lumber industry in Rolim de Moura suggest the significant degree to which economic expansion in Amazonia is taking place in rapidly industrializing urban centers.

CONCLUSIONS

The Amazon has been called the "world's last major resource frontier." Yet, for centuries the natural "riches" of the Amazon have eluded explorers, prospectors and speculators. During the last two decades, the Brazilian Amazon has been under unprecedented siege by corporate cattle ranchers, landless peasants, and lumbermen, many subsidized directly or indirectly by government economic development programs. In consequence the Amazon, a fragile tropical ecosystem, is becoming increasingly imperiled by destructive and often desultory land-uses. Unlike previous historical episodes of expeditionary settlement and resource exploitation, the current influx of people and capital to the Amazon bodes a more permanent occupation.

Among the great transformations occurring in Amazonia today is the expanding industrial wood sector, a leading sector in the regional economy. This paper draws three general conclusions concerning forest-based development and economic expansion in the Brazilian Amazon. First, the process of capital penetration into the Amazon is simultaneously taking place on two related fronts, the agricultural front and the

urban industrial front. Locational decisions by lumber producers may be an important determinant of the location and growth of numerous urban settlements in the interior of Amazonia.

Second, in the case of Rolim de Moura, Rondonia, the expansion of the urban industrial economy was closely associated with the shifting orientation of local lumber production toward foreign markets. Export subsidies underlying the Brazilian mahogany trade provided an important impetus to capital investment in the town's industrial wood sector. In turn, industrial wood production became an important generator of lateral activity.

Third, several important questions remain open to further research. Will the Amazon's industrial wood sector remain a permanent foundation of the regional economy, or will it evolve into a position of lesser importance as other sectors develop, as was the case with the 19th century North American lumber booms (Cox, 1974; Fries, 1951; Maxwell and Baker, 1983; Wynn, 1981)? How can industrial wood production sustain its expansive growth without forest management, as is presently the case? Can unmanaged forests of the Amazon be casually exploited for industrial roundwood without opening them up to more damaging land uses that might eventually undermine this important industrial base of the regional economy? What other industries might emerge from the invested surplus obtained from lumber production in the region?

The answers to these important questions may largely depend on how the lumbermen in towns like Rolim de Moura perceive their futures, where they invest their profits, and how effectively they compete with others for the Amazon's expansive but increasingly endangered woodland resources. The Amazon's lumber industry offers an appropriate point of departure for future research on the processes of capital expansion and economic transition in the world's largest remaining tropical frontier.

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FOOTNOTES

1. This estimate (5,075 km) represents federal road construction or improvements associated with two major regional development

programmes, the National Integration Programmes (1971-75), involving the construction of the Transamazon Highway, and the POLONOROESTE programme (1981-86) involving the improvement of the BR 364 between Cuiaba and Porto Velho (Browder, 1985; World Bank, 1981). Total state and federal road-building in the Brazilian Amazon is probably double this estimate.

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Résumé

Les théories courantes sur la nature de l'expansion économique dans la région de l'Amazonie brésilien se sont concentrées presque exclusivement sur les relations de production et les conflits de terrain dans le secteur agraire. Cet article suggère que le secteur urbain grandissant de la région est un élément important quoique peu étudié du processus d'expansion de capital dans l'Amazonie. Le secteur du bois industriel est maintenant un des principaux secteurs de l'économie de la région amazonienne, ainsi que la base économique de beaucoup de villes de frontière. Il permet donc d'examiner les processus d'urbanisation, d'industrialisation et d'accroissement de capital dans la région frontière brésilienne. L'on décrit la croissance récente de la production et du traitement du bois industriel dans la région de l'Amazonie, et une étude examine les liaisons à terme de l'industrie de scierie et ses effets sur l'emploi, les revenus de ménage et la valeur de production dans plusieurs secteurs clef de l'économie locale d'une ville frontière, c. à d. le transport, la construction, les meubles et le bois de chauffe.