
The Economics of Deforestation in the Amazon

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Dispelling the Myths

João S. Campari

*Holds a Ph.D. in Economics and is Program Director at
The Nature Conservancy*

Edward Elgar

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In memory of
my friend and colleague Anna Luiza Ozório de Almeida

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Preface

This book is the outcome of several years of research, field work, and policy advice concerned with the rapidly growing subject of deforestation in the Amazon. My initial intention was to test a leading hypothesis of deforestation, the ‘turnover hypothesis’, which holds that the migration of small farmers in the Amazon is one of the main causes of deforestation. Many authors, including myself, have assumed for a long time that this hypothesis provided a good theoretical framework to explain the relationships between migrations and deforestation in the Amazon. When I began working on this book, I expected that my main contribution to the deforestation debate would be to test and hopefully prove the validity of the turnover hypothesis. I never reached my initial goal because, in the course of my work, I found that the motives that cause migrations and deforestation proved not to be as simple as stated under that hypothesis. Most of the results of this study are unexpected and, therefore, require novel interpretation. I would hope that in challenging the turnover hypothesis using field evidence, I have been able to make a greater contribution to the current debate on deforestation than I intended originally. On a broad level, my findings are inconsistent with many other recent studies on the Amazon that regard deforestation as an artifact of distortionary government policies. I have found that although government policies have contributed to deforestation in the past, today it is the outcome of rational profit-maximizing local agents. This finding is as new to me as it must be for most authors who believe they have nailed the causes of deforestation. My findings show that deforestation continues today because current policies are based on old assumptions of regional development.

One of the main lessons I learned in writing this book is that a defining characteristic of a frontier settlement area – and the one feature analysts find most perplexing to contend with – is rapid change. Because history moves at high speed in such places, it has a persistent habit of leaping ahead of our analytical grasp, rendering obsolete hard-won conclusions that now seem to apply only to a previous period. It is no exaggeration to say that much of what we think we know about the Brazilian Amazon today is probably out of date, including the process of deforestation.

The empirical evidence presented in this study permits the observation of the changing character of human settlement and its association with deforestation in the region at the plot level. The data presented here provide the most current source of information on small farmer behavior in selected areas of the states of Pará and Mato Grosso. The first round of surveys was begun in 1981, and the second round of surveys was undertaken ten years later, in 1991. In this study, much new experience and information have been added since the last survey. The three-stage research design makes this one of the few studies that can lay legitimate claim to document the ways things have changed in newly settled areas of the Brazilian Amazon.

The ten-year frame that separates the first (1981) and second surveys (1991) encompasses a period of structural changes in the Brazilian economy that altered the impact of government policies on the Amazon region. This period marked a fundamental transformation in the character of migrations in the Amazon, and altered the structure of the local rural economies. The ability to track such changes at the level of the individual farm plots is therefore one of the things that makes this a truly unique study.

The argument presented here is a needed corrective to current thinking and policies that ignore small colonists or, worse, treat them as environmental pariahs. In the 1970s, small farmers were disregarded, as traditional policies favored cattle ranchers. Now that the emphasis has shifted towards conservation, small farmers still are considered hopeless deforesters, and the emphasis is on protected areas or, at best, indigenous groups presumed to be superior resource stewards. This study hopes to shift the focus to determinants of successful farming and to make convincing and compelling arguments for why this must be a key objective of current and future policies for containing deforestation in the Amazon.

The additional strength of this study is its methodological pluralism and its broad conceptual approach. Disregarding conventional classifications, it draws insights from macro and microeconomics, natural resource management and environmental economics, public finance, institutional analyses, political economy, demography and economic geography. The findings of the various methods are woven together using an interpretive framework that is sensitive to linkages between the transformations at the national level, and the effects such economic and political changes have had on the region and, ultimately, on the microeconomic factors that motivate land management and deforestation by colonists.

This study hopes to live up to its commitment to deliver specific policy recommendations regarding a subject that is ridden with contradictions. For example, the results of the analysis point to the rather daunting conclusion that deforestation is, ironically, the outcome (albeit for very different reasons) of both low productivity farming (and the itinerancy that results

in deforestation of new areas) as well as high productivity farming (and the tendency to deforest where farmers are). On the basis of these, and similar results, this study goes beyond conventional income and pricing tools by proposing a set of policy recommendations uniquely tuned to local realities.

Most of the results presented in this study are quite definitive and lead to the rejection of much of what has been conjectured in the literature on the causes of deforestation in the Amazon. Many times, however, the connections made between multiple analytical levels are inevitably suggestive rather than definitive, in which case the interpretation of findings is open to criticism. At one end of the spectrum, a political economist might wish to see more attention given to, say, the restructuring that has taken place in Brazilian society since the early 1980s, and the way in which changes of this kind may have altered the course of deforestation in the Brazilian Amazon. At the opposite extreme, a microeconomist might wish to invoke more elaborate models of the decisions farmers make regarding land and resource use. But to heed either of these admonitions – legitimate though each may be in its respective domain – would undermine rather than enhance the study's main contribution: its willingness to offer an interpretation of frontier changes that culminate in deforestation, by plausibly integrating observations and data sources from multiple levels of economic and political organization. In contrast to a narrower approach, such a multileveled conceptualization is the only realistic way to come to grips with the complexities involved in the process of deforestation.

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Many of the ideas contained in this work were developed several years ago at the World Bank's Poverty and Social Policy Department (PSP). At PSP, Oey Astra-Meesook provided encouragement and institutional support for the development of important working papers which culminated in the publication of 'Sustainable settlement in the Brazilian Amazon' (Ozório de Almeida and Campari, 1996). 'Sustainable settlement' is an important precursor to this book. I am especially grateful to the contributions made by the Poverty Group.

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Although Anna Luiza Ozório de Almeida – who was my mentor, co-author and good friend – is no longer among us, I dedicate this study to her, with all my respect and grateful thoughts.

1. Deforestation and its myths

1.1. INTRODUCTION

The Amazon Basin, most of which lies within Brazil, is one of the last large areas of the world currently undergoing frontier settlement. The expansion of demographic and economic frontiers into the Amazon is often seen as the movement of people and of new activities into unoccupied, empty spaces. In fact, these regions are rarely as clear of human inhabitants as is generally supposed. Rather, the existence of occupants who predate the expanding frontier is increasingly recognized.

The Amazon population today numbers more than 22 million people, of whom more than 8 million are farming the rain forest. The current migration of small farmers from old to new frontiers within the Amazon poses an important threat to the forest. These migrations are thought to be associated with the failure of agriculture in rain forest soils that are considered too poor to sustain production. In view of such failure, small farmers are prompted to sell their plots to other farmers who can invest in large-scale agriculture or cattle ranching. Although this is thought to be a widespread regional phenomenon, it is conjectured to be happening mostly in colonization projects established by the federal government during the 1970s, but also in projects sponsored by private colonization companies during the 1980s.

The movement of colonists from plot to plot, opening new frontiers and selling out to newcomers after a few years on the land, is called *turnover*. In the Amazon, high turnover on farming plots is thought to have strong implications for land re-concentration and deforestation. The literature on deforestation conjectures that since colonists do not have the means to sustain production without the heavy use of fertilizers and other soil correctives, they sell their small plots to newcomers, who are large entrepreneurs in agribusiness. Furthermore, individual plots are only as large as 100 hectares and, therefore, considered too small to undertake commercial agricultural activities. For this reason, deforestation analysts believe that, as frontiers mature, newcomers start buying small neighboring plots and transforming the areas which were originally destined for family farming into large agricultural holdings. The practice of extensive agriculture in the Amazon

provokes an increase in the amount of land used for ranching and other large agricultural initiatives. This practice leads to an increase in the scale of deforestation since more land must be cleared for production.

The process described above is widely accepted in the literature on Amazon deforestation. This study formalizes this process and calls it the *Turnover Hypothesis of Amazon Deforestation*. The purpose here is to examine the claims that the literature has made for decades in favor of this hypothesis as a good theoretical framework to explain the process of demographic instability among the rural population (turnover), which is thought to have important implications for land re-concentration and deforestation in the region.

The current conjecture in the literature – one that has become the basis for the current views that attempt to inhibit the expansion of agriculture in the region – is that Amazonian agriculture leads to private as well as social losses, i.e., a *lose-lose* situation. From the point of view of public policies, the solid knowledge of the economics of deforestation seems fundamental to break with the mistaken premise that the ‘by-product’ of regional agriculture is an environmental disservice in terms of deforestation (externality) as well as a (private) economic ‘bad’. If a *lose-lose* situation prevailed, the enforcement of stringent conservation policies would not yield high private economic losses. However, current policies are based on overly strict regulation that would lead to high private losses if they were enforced.

The analysis carried out in the forthcoming chapters provides field evidence to challenge the arguments of this hypothesis. It also provides evidence that supports an alternative explanation that dispels the myth of turnover being associated with deforestation and land re-concentration in the Amazon.

1.2. DISPELLING OTHER MYTHS OF AMAZON DEFORESTATION

Contrary to what is usually conjectured, this study provides evidence that deforestation in the Amazon is a source of private economic gains, frequently substantial, at the same time as it imposes negative externalities, or social (environmental) costs associated with deforestation. This implies that deforestation leads to a *win-lose* scenario. The gains are generally associated with either relatively successful agriculture or speculation in land markets, in which case land is held as a hedge against inflation and later transacted so that its owner can reap capital gains. The first argument (successful agriculture) runs counter to the widespread belief that Amazonian soils

are unsuitable for agriculture, even for small-scale farming. The second argument (speculation in Amazonian land markets) is much less considered in the deforestation literature.

By discussing this issue using empirical evidence, this book brings a new perspective to the literature on Amazonian deforestation. It shows that small itinerant farmers do not cause most deforestation, contrary to the conjectures of the turnover hypothesis; those successful ones who have stayed on their plots are the ones responsible for most of the land cleared in the Amazon. This is a historic trend that has been happening since the early days of colonization.

1.3. ORGANIZATION OF THE WORK

A common tendency in the literature on Amazon deforestation is to distinguish between the demographic and the economic frontiers. The literature treats the impact of the population and economic policies on deforestation as separate issues. This work does not follow that precedent. On the one hand, the demographic occupation of an inhospitable place – such as the Amazon in the 1970s – would have been impossible without some form of incentive for the development of economic activity. To ignore the former, or treat it separately, thus runs counter to the main goal of this work: to establish the relationships between the economic factors associated with the mobility of the rural population (turnover), land re-concentration, and deforestation.

This study is organized in ten chapters. Chapters 2 and 3 are background chapters. These chapters discuss policies and macro variables associated with regional occupation and deforestation. These variables can be thought of as the underlying causes of deforestation: policies that stimulated migrations to the region, government regimes, sectoral policies, domestic and international markets, tax and credit systems, and the rules of land allocation. Chapter 2 uses census data to reflect upon the environmental consequences of early occupation and changing migration patterns that have affected the Amazon for the past 30 years. Chapter 3 discusses the motives behind the federal government's initiatives to expand the agricultural frontier to the Amazon and induce regional occupation through large development programs during the 1960s and 1970s. It also explains why the government, after 20 years of promoting occupation, came to a complete halt in its support of Amazonian development during the 1980s. The impact that such incentives and omissions had on deforestation permeates the arguments of this chapter. These two chapters provide the foundations upon which the turnover hypothesis is conceptualized.

Chapters 4 through 8 are related to the turnover hypothesis itself. These chapters examine how turnover and land re-concentration are associated with deforestation. Chapter 4 discusses the inadequacy of standard models of land clearing and proposes an analytical framework to explain the behavior of Amazonian farmers. Chapter 5 develops a theoretical framework of the turnover hypothesis. Chapter 6 discusses the field work undertaken in colonization projects in the Amazon and the data (obtained from the surveys) used to assess the extent to which the turnover hypothesis holds. Chapter 7 discusses the magnitude of turnover in the surveyed projects and the impact it has had on deforestation. Finally, Chapter 8 transforms the theoretical framework developed in Chapter 5 into an empirical economic model that sets the conditions under which the turnover hypothesis can be assessed.

Chapter 9 presents empirical evidence that dispels the myth that poor regional agricultural performance is the main force that triggers turnover and deforestation in the Amazon. Here, the economic returns to farming are compared with its opportunity costs to assess whether colonists are faring well or poorly in frontier agriculture and, further, how performance in frontier agriculture is associated with turnover and deforestation.

Chapter 10 summarizes the findings of this study and, based on them, discusses policies that could be implemented to contain the causes of deforestation in the Brazilian Amazon.

1.4. DIMENSIONS AND LIMITATIONS OF THE STUDY

The objective of this study is to assess the appropriateness of the turnover hypothesis to explain the causes of deforestation in the Amazon, as far as colonization projects are concerned. For many years (actually decades), the government of Brazil and the international community have considered this hypothesis a 'mantra' upon which policies for the region are conceived and implemented with substantial foreign aid. This study challenges this hypothesis and finds that it is out-dated for dealing with the complexity of current Amazonian issues. This study also analyzes the extent to which economic policy can be used to reduce the share of deforestation caused by local farmers in colonization areas.

The empirical sections of the study analyze turnover and deforestation and assess how well, or how badly, small farmers are covering their opportunity costs of frontier farming. The conceptualization of these opportunity costs are rather limited, as they only represent rates of remuneration of factors of production in the economy as a whole. Broader alternatives, such as gold prospecting, drug trafficking, and extractivism are not dealt with explicitly.

Some terms are used interchangeably in this study, glossing over important differences that are relevant for other disciplines of the social sciences. Farming households are interchangeably called 'frontier farmers' (who represent the universe of the rural population in the Amazon), 'settlers' (farmers who may or may not have title to the land), 'colonists' (farmers who are owners of a colonization plot) and 'pioneers' (farmers who first arrived on colonization plots, either sponsored by the government or by private colonization companies). The terms 'family farming' (farmers whose only source of labor is family labor), 'small farming' (whose farming plots are small) and 'subsistence farming' (farmers who do not generate surplus output or savings) are often substituted for one another, as are the terms 'the Amazon' (the basin itself, which transcends the borders of Brazil), 'Legal Amazonia' (the nine states in Brazil that contain the rain forest; an administrative definition for the implementation of regional policy) and 'the North region' (one of the five geographic regions of Brazil, a region that includes six out of the nine states of Legal Amazonia). In the context of this study, the interchangeable use of these terms should not sacrifice interpretation.

The terms 'new (recent) frontiers' and 'consolidated (old) frontiers' are used throughout the text and have important specific meanings. A *new frontier* can be thought of as marginal lands in the initial stages of occupation, with low population densities, and where markets are nonexistent or very incipient. New frontiers can also be considered places that select for individuals with low opportunity costs, relative to more developed areas, given the thankless reality they have before them. New frontiers can be understood as places where land is an abundant resource that is often unclaimed or, if claimed, is unoccupied. Further, the total area already deforested in these places is low relative to more developed regions.

The term *consolidated frontiers* can be defined as places with increasing population pressure, where disputes over land are common and often violent. In consolidated frontiers, input, output and factor markets are still incipient and thin relative to developed areas, but are certainly more evolved than they are in new frontiers. Consolidated frontiers can count on basic infrastructure and on the provision of government services, although both can be very rudimentary and inadequate given the size of the population. Land resources that were abundant in new frontiers become scarce as frontiers consolidate. Deforestation is higher in consolidated frontiers than in new frontiers. Consolidated frontiers generally select for individuals with relatively higher opportunity costs.

The difference between these two types of frontier is crucial for understanding some of the points that are discussed in this study. For example, while the rate at which a small farmer deforests in *new frontiers*

may be very high (because he expects the government to grant him a title over a multiple of the area that he has cleared), the rate of deforestation by the same farmer in *consolidated frontiers* may fall drastically (his marginal rate of deforestation is only that necessary to support family consumption rather than also to secure title). Therefore, the factors that influence farmers' decisions with regard to deforestation are different in new and consolidated frontiers. A clear space-time divide separates the two types of frontiers: new frontiers are located in *distant* places relative to the established economy and can be found in a very *early* stage of occupation; consolidated frontiers are places *near* the established economy at *later* stages of occupation.

There are several issues that this study does not attempt to treat. It does not analyze data on Amazonian deforestation beyond that caused by colonists. It does not discuss some of the broader consequences of Amazonian deforestation, such as its global environmental impact (e.g., climate change, carbon emissions) or the anthropological dimensions of deforestation (e.g., the deforestation by indigenous and native groups).

The issue of illegal logging is also ignored in this study. Small farmers may obtain additional income from illegally extracted wood, as they are thought to commercialize it in the informal market. Depending on the volume of the additional income, farmers may alter their choices with regard to deforestation and conservation. Studies on this issue are incipient, reliable data are scarce and the only source of evidence available is anecdotal.

Although this book does not attempt to offer an in-depth analysis of human capital, the data set used in this study does contain information that pertains to this issue. Ozório de Almeida (1992) and Ozório de Almeida and Campari (1996), using the same data set, offer more extensive research on human capital. Likewise, health conditions are not explicitly examined in the text even though they are known to correlate to economic performance. Finally, it was not possible to undertake an empirical qualitative analysis of the soils of sampled locations. There is no evidence, however, that government considered soil quality prior to settling farmers on the projects. The sample, therefore, is not biased in regard to soil type. All of these issues are beyond the scope of this study.

The new information and novel interpretations offered here are based on an analysis of the largest and most complete data set ever produced on the economic variables that influence small farmers in the Amazon. The empirical observation of the economic behavior of a panel of small farmers over a span of 20 years is unprecedented, from the major thrust toward Amazonian colonization in the early 1970s until the chaotic aftermath of the early 1990s.

One of the main lessons learned from this study is that Amazonian development and deforestation are an intra-Amazonian matter; interregional migrations no longer pose the threat to the forest they once did. If frontier farmers are not induced to settle where they are now, they will continue to move to areas meant to be reserved. Conservation of these areas, therefore, will not be possible unless intraregional migrations are contained.

By revealing the economic mechanisms at work in deforesting the Amazon today, this study hopes to contribute to the design of appropriate policies for use by the federal and state governments, multilateral institutions, lending agencies, international organizations, and to inform the academic debate on the causes of Amazonian deforestation.

2. Occupation, changing migration dynamics, and deforestation in the Brazilian Amazon

2.1. INTRODUCTION

Despite the front-page publicity given to deforestation, the Amazon embraces still the world's largest area of intact tropical rain forest. It has a relatively unexplored resource potential and is regarded as one of the last agricultural frontiers. Figure 2.1 shows that the Brazilian Amazon comprises the states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins, totaling an area of over 5 million square kilometers, equivalent to 60 percent of Brazil, and sufficiently large to accommodate the entire Western Europe. Of this, approximately 4 million square kilometers is covered by forest formations.

In the 1970s, the Brazilian government and people were blithely optimistic regarding the future of the Amazon region. The military regime (which had taken power in the previous decade) set out to colonize the region and tap its natural resources through a series of high-profile development projects. The federal government launched credit and tax incentive schemes to attract private capital to the region, and it financed the construction of the Transamazon Highway – an unpaved road extending some 5000 kilometers from the state of Maranhão in the east through Pará and Amazonas to the unpopulated Amazon basin to the westernmost state of Acre on the border of Bolivia.

The modernization of Amazonia was to be achieved through the National Integration Program, which envisioned colonization by smallholders on 100 hectare plots along both sides of the Transamazon Highway. Similar to the Homestead Act in the United States 100 years earlier, the government's attempts to colonize the Amazon were to create a prosperous small-farmer class by freely distributing agricultural land in sparsely populated territories. Colonists came from amongst poor farmers and rural landless in the overpopulated and poverty-stricken Northeast region of Brazil.



Figure 2.1. *The Brazilian Amazon*

Initial enthusiasm, however, soon gave way to the somber reality of the difficulties linked to agriculture in lowland tropical areas. The colonists settled by the federal government's Institute of Colonization and Agrarian Reform (INCRA) in Marabá, Altamira and Itaituba (the first projects in Pará) faced a myriad of difficulties, particularly in transporting produce to market. Nonetheless, the large flows of spontaneous migrants quickly swamped INCRA's capacity to provide services and to absorb them in the planned communities. As alternatives became scarcer, small farmers staked out land wherever accessible, falsely believing that any and all government lands not being cultivated could be claimed as a homestead.

One of the main initiatives of the federal government was the additional construction of roads off the Transamazon Highway, the main one being the Belém-Brasília Highway, which provided a corridor through which settlers occupied – either directed by the government in official colonization projects, or spontaneously – small plots of land in Pará (Figure 2.2). Furthermore, the 1970s were marked by highly profitable tax treatments and credit programs made available through SUDAM (the Superintendence for the Development of the Amazon, which was closed down in 2001 because of widespread corruption) to well-financed investors from southern Brazil. Some of these investors converted huge tracts of forest land to pasture, but most bought land to hold in investment portfolios as a hedge against

inflation. In occupied areas, land conflicts became quite common when cattle ranchers, land grabbers, and peasant farmers competed for control of the newly accessible territories. The violence that ensued claimed the lives of thousands of people and bestowed on Pará its unfortunate notoriety as the 'Wild West' of Amazonia (Schmink 1982; Schmink and Wood 1992; Alston et al. 1999).

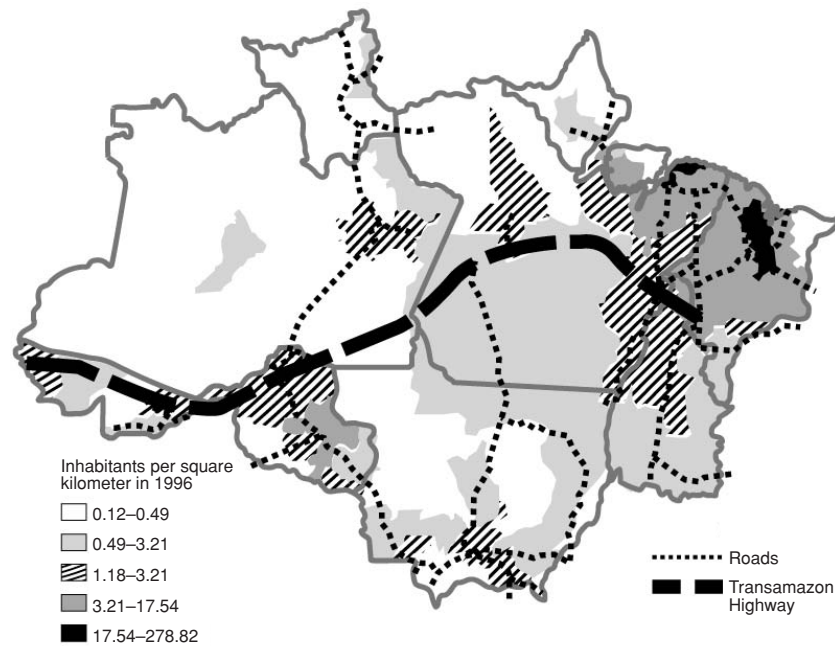


Figure 2.2. Dispersion of the population along the highway system

By the middle of the 1970s, many of the small farmers who informally claimed untitled land had been driven off the plots they had cleared. The dispossessed faced a difficult and uncertain future. Many moved down the road. Others ventured further into the forest, only to fall victim again to eviction. A large number of families drifted from one site to another, temporarily employed by labor recruiters who had been contracted by ranchers to clear land for pasture during the dry season. Those with enough resources to do so returned to their states of origin. Many more lost their land but were too poor to return, seeking refuge in the new villages that sprang up along the roads or in the shantytowns on the outskirts of established cities. A few places that once had held a modest number of

people exploded into makeshift towns of 15,000 to 20,000 (Schmink and Wood 1992). Most urban centers lacked sanitation, medical facilities, and educational services and offered displaced peasants and new migrants neither regular employment nor the means to support themselves. Most colonists whose stories are not generally told, however, stayed on their plots and were relatively successful in agriculture. These were the very fortunate, and their plots displayed increasing productivity, growth and deforestation.

The heavy influx of emigrants and the publicity given to the violent confrontations between ranchers and peasants, as well as the international outcry over deforestation and the threat to indigenous communities, served to undermine support for INCRA's colonization program at the time when frontier settlement came under growing criticism for being expensive and failing to live up to its original objectives. In the tradition of blaming the victim, the colonists themselves were faulted for their presumed lack of managerial skills, even though many of the problems they confronted were hardly of their own making (Wood and Schmink 1979). Business interests took the opportunity to wage a campaign arguing that a more 'rational' and less 'predatory' occupation of the region could be achieved by the private sector. By the late 1970s, pressure from the business lobby had succeeded, mainly in Mato Grosso, and public colonization, the only safe haven for the small farmer, was virtually abandoned in favor of privately owned and operated colonization schemes (Ozório de Almeida 1992; Ozório de Almeida and Campari 1996). Private colonization gained impetus in the early 1980s, as federal budgets for public colonization dwindled due to Brazil's economic crisis. When easy credit ceased to flow by the late 1980s, private companies lost interest in this type of colonization. Furthermore, issues concerning land occupation for agricultural development in the Amazon became increasingly complex as environmental concerns heightened.

The criticism of Amazonian development that began in Brazil in the late 1970s soon connected with the international concern about deforestation.¹ Conservation and environmental awareness lent both publicity and legitimacy to new priorities in the development of the region. By the early 1990s, the terms of the Amazonian debate had completely shifted. The environmental consequences of the development policy became the target of headline stories in Brazil and across the world. The expansion of cattle ranching in the Amazon, once the mainstay of the modernization program, was condemned in favor of environmentally and socially responsible development. The small farmers who had migrated to the frontier in the 1970s and 1980s shared a similar fate, and were either despised or labeled 'villains' in the deforestation process, when in fact they were lured to the Amazon as a new 'Eldorado' by federal programs and private colonization companies. The demise of colonization programs, without the appropriate

social safety nets to reduce the short-term impact of the structural changes brought about by the economic crisis of the 1980s on small farmers, impelled prospective colonists to settle and farm whatever land they could possibly find. Given the lack of support, many of those already settled also gave up their plots and moved: some did not have another choice but to sell out, as land was bad and agricultural production could not be sustained without external financial assistance; others whose land exhibited high productivity chose to sell out to earn capital gains and also moved on to other plots further inland. A process of intense in- and out-migrations among the rural population was under way.

The purpose of this chapter is to explore the differences in the past and the current migration dynamics that are likely to have determined the outcomes that this study sets out to analyze: turnover on farming plots and its relationship to deforestation and land re-concentration in the Amazon. The environmental significance of turnover depends on whether an itinerant population of small rural households open new frontiers, grow crops and stay on the land for a few years before they sell out to newcomers, only to start the process again further into the forest. Those who come in later are thought to arrive with a different agenda, demanding larger land holdings and larger deforested areas than did initial settlers. The turnover hypothesis is based on the premise that a critical mass of farmers does make a difference in deforestation and land re-concentration. A good way to begin to examine this issue is by analyzing migration dynamics.

Section 2.2 discusses the differences in the patterns of migration in two periods, from the mid-1960s to the mid-1980s, when farmers responded to government incentives to migrate, and from then until 2000, when migrations became a response to local stimuli. Since the population dynamics of the agricultural frontier is assumed to be strongly associated with land use and forest clearing, Section 2.3 discusses the dynamics of deforestation from the early 1970s until the late 1990s. Section 2.4 discusses the effects that occupation and changing population dynamics had on the forest resource base.

2.2. THE CHANGING PATTERN OF MIGRATION DYNAMICS

Although the efforts on the part of the federal government to induce occupation of the Amazon began in 1964, it was not until 1970 that a significant number of migrants started to make a difference in the demographic landscape of the region (Alston et al. 1999). Table 2.1 shows the percentage of land in each region of Brazil that was in private farms

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