

Household Demographics Mediating Livelihoods, Deforestation and Land Use in the Amazon

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Introduction. Household changes in size and composition over the lifecycle impact the many components of colonist's decision-making, individual aspirations of income and wellbeing, collective needs of familial groups in rural settings, and the context (community, region, nation) in which household decisions are made (Sherbinin et al., 2008). However, the literature has not adequately discussed how these changes may simultaneously connect to and shape distinct livelihood strategies according to specific stages of frontier development. This paper has two objectives. First, it reviews the extant literature to propose a synthetic theoretical framework that shows how demographic change and farm household lifecycle transitions mediate livelihoods strategies over distinct stages of frontier development. Finally, it tests the theoretical framework based on empirical evidences for the municipality of Machadinho, in the Southwestern Brazilian Amazon.

Microdemography of frontier areas. Household dynamics change the way the articulations with macro contextual factors at each frontier stage are made. Although some frontiers may experience boom-and-bust cycles of development – from intense deforestation to land abandonment – and recent evidences show that land cover and land use changes widely vary across the Amazon (Schielein and Börnera, 2018), there is a general trend of change in the economic environment from subsistence to an increasing articulation with markets (Marquette, 1998; Walker 2004; Barbieri et al., 2005; Caldas et al., 2007). This implies that the influence of household lifecycles on land use and livelihood strategies decrease as frontier integrates into markets over time (Barbieri et al., 2005). The more articulated the frontier with higher level economic forces (national and global markets) the less household dynamics explain changes in the local landscape (Barbieri et al., 2005). Although at a later frontier stage farmers may become market-oriented, they continue to derive livelihood from subsistence or market-oriented agriculture. This is the basic difference between smallholders and large capitalist farmers in post-frontier scenario (Ellis 1993; Browder & Godfrey 1997).

This paper reviews the literature and explore how the *household and land use life cycle*, the *livelihood and capabilities approach*, and the *revisited theory of multiphasic responses* have explained linkages between collective needs of rural households with different demographic composition, and decision-making regarding land use and labor allocation. Based on these theories and on the literature on frontier development, the paper proposes a synthetic theoretical framework on the co-evolution of farm household composition and lifecycles and livelihoods over three stages of frontier development in the Amazon: i) *Pioneer frontier*, corresponding to the first years of settlement, with high deforestation, annual crops to meet family needs, high Youth Dependency Ratio and some engagement in off-farm (mostly rural) employment and cooperative labor in a context of limited provision of infrastructure, public services and institutions (including urban labor markets). Livelihoods are highly dependent on farm household size (labor pool) and composition (age dependency); ii) *mature frontier*, when farm households take advantage of the smaller Dependency Ratio (children reaching young labor ages and entering the farm labor pool) to adopt on-farm strategies combining more profitable land uses such as perennials and cattle ranching; iii) *post-Frontier*, when farm households, usually with higher Old Dependency Ratios, diversify their livelihoods combining profitable on-farm and off-farm strategies in a context of urbanization, improved infrastructure, public services and institutions (including urban labor markets).

Household composition, aging and labor allocation mediate not only transitions over lifecycles, but also the ways farm households derive their livelihoods over stages of frontier development. Inspired on VanWey et al. (2013), the theoretical framework also discusses how farm households change their portfolio over time towards a combination of: i) *accumulated capitals*, characterized by increasing human (particularly education), physical (particularly land consolidation) and financial (particularly off-farm income) capitals; ii) *depleted natural capital*, corresponding to the use of wood, rubber trees, Brazilian nuts and other sources of natural capital that either loose financial returns or for which capital depletion rates exceed the capacity to recover initial levels; iii) *oscillating social capital*, corresponding to access to institutions and social conditions favoring settlement

(pioneer frontier) such as migration networks, cooperative work and access to governmental institutions promoting land access; it decreases in the mature stage due to the consolidation of land distribution programs (albeit informal land markets arise), weakening of migration networks and still incipient urban labor markets; and in the post-frontier, social capital is high given migration networks favoring off-farm mobility (rural-urban commuting, internal and international migration), access to public services and market institutions (urban labor, credit etc.).

Study Area. Machadinho (Figure 1) is a municipality located in the state of Rondônia, in the Southwestern Brazilian Amazon, with population estimated in 40,867 in 2020. A former federal Colonization Project, the occupation of plots began in 1984 (Sydenstricker, 1992). There are two reasons to choose Machadinho. First, it is within the most dynamic area of occupation by migrant colonists in the Amazon, leading to drastic land use changes linked to conversion of primary forest. Second, its occupation has been documented and surveyed over twenty three years (surveys with 808 farm households and 3,961 individuals in 1987; 1,069 farm households and 5,031 individuals in 1995; and 259 farm households and 914 individuals in 2010). This is the only study area in the Amazon with quality survey data (demographic, socioeconomic and land use) for the same plots since the very onset of occupation and tracked for so long, capturing all distinct stages of frontier settlement.

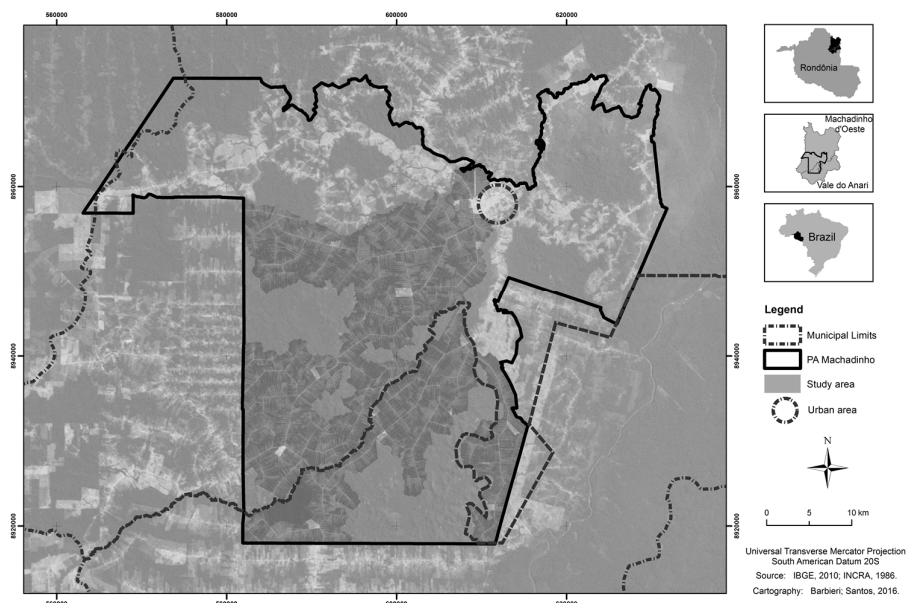


Figure 1 – Study Area: Machadinho D'Oeste, Brazilian Amazon

Methods: Descriptive and multivariate analysis. The paper will describe key variables representing farm household dynamics (lifecycles and composition) and livelihood strategies (capital portfolio) at each stage of frontier development. Then, it creates a typology of household composition over its lifecycles based on the theoretical framework through Principal Component Analysis (PCA). Finally, it builds correlation analysis between the principal components identified in the previous step and livelihood variables - human, physical, financial, natural and social capital.

Preliminary results and discussion. Table 1 presents the descriptive analysis (detailed discussion in the paper). The typology of household composition over its lifecycles (tables with results not shown) identified, for each frontier stage (pioneer, mature, post-frontier), two principal components that define two distinct subgroups at each frontier stage. While each of them will be described in detail in the paper, it is anticipated that the components for pioneer and mature stages have similar meanings. Demographic variables – (younger) household dependency ratio and size loaded in the first component for the pioneer and mature frontiers, when livelihoods are highly dependent on on-farm activities. This component is named *on-farm demographic subgroup (1)*. The second component was loaded by off-farm labor negatively associated with household lifecycle factors

(age of the head and time in the frontier, and was named *early off-farm specialization subgroup (2)*). In contrast, since older dependency ratio (rather than household size) and time exposure (of households and his/her head) load in the first component of the post-frontier, it was named *late on-farm demographic subgroup (3)*. In contrast to the predominance of demographic factors, household size and off-farm labor loaded on the second component. Given the importance of off-farm diversification strategies at this frontier stage, it was named it *off-farm diversification subgroup (4)*. Table 2 shows the correlation analysis between subgroups identified in the principal component analysis and livelihoods variables.

Overall, the discussion will show how farm households take advantage (or are constrained by) their demographic characteristics to define livelihood strategies based on the composition of five types of capitals, contingent on frontier and lifecycle stages. Demographic factors are significant to define livelihoods at earlier frontier stages, particularly due to the primacy of on-farm land use strategies dependent of farm household demographic and labor composition; and loose explanatory power at later stages, when farm households are more integrated to markets (particularly urban labor markets), and have access to institutions (such as government cash transfer programs), relaxing stricter dependence on livelihoods based on on-farm strategies. Rather than universalistic (applied to all frontiers and even the “within” internally heterogeneous frontiers) or ahistorical (decoupled of cultural, institutional and political experiences over time for each frontier), the theoretical framework aims to provide a synthetic description of the extant literature on the contemporary colonization of the Amazon and may have distinct levels of adherence to the experiences of other rural frontiers.

Table 1 - Descriptive statistics: sample, markers of household life cycle, household composition of capitals in Machadinho D'Oeste – 19 87, 1995 and 2010

Dimension of analysis	Variable	Frontier Stage		
		Pioneer 1987	Mature 1995	Post-frontier 2010
Sample characteristics	Number of farm households	808	1069	259
	Number of individuals in the plot	3961	5031	914
Farm households: composition and markers of life cycle	Dependency ratio ^a	0.40	0.38	0.35
	mean age of head of household (years)	40.0	42.3	52.2
	Time in Machadinho (years)	1.6	5.8	17.7
	Mean household size	4.9	4.7	3.5
	farm households hiring laborers (%)	31.4	-	44.0
	sex ratio	1.3	1.3	1.2
	out-migrants in the last 5 years (%)	-	-	60.0
	at least one international out-migrant (%) ^b	-	-	13.4
Human Capital	heads with more than 4 y. education (%)	7.0	11.3	8.3
	spouses with more than 4 y. education (%)	4.5	17.6	14.9
	% over 14 y.o. in off-farm employment	9.3	6.7	16.8
Physical Capital	farm households owning cattle (%)	13.6	62.6	85.3
	head own the plot in Machadinho (%)	88.1	76.0	89.2
	own other rural plots (%)	8.4	20.3	32.7
	ownership of land / house in the city (%)	16.3	13.1	16.2
Financial Capital	% income from on farm production	32.7	73.8	82.5
	households with cash transfers (%)	-	-	44.4
	households with credit or loans (%)	-	18.2	46.9
	land in pasture (%)	9.9	41.0	39.1
	land in annuals and perennials (%)	4.4	5.5	26.0
Natural capital	land in primary forest (%)	80.1	49.2	28.1
	farms with extractive production (%) ^c	1.2	18.4	9.6
Social capital	heads born in South/Southwest Brazil (%)	71.3	73.7	72.0
	nuclear family - parents and sons only (%)	83.9	88.0	76.9
	multigenerational household (%) ^d	2.8	2.0	15.4

Source: Machadinho Dataset (1987, 1995, 2010)

^a Sum of the population until 12 years old and the population 50 years old or more, in the numerator, divided by the population between 13 and 49 years old in the denominator

^b Living at the household or abroad at the survey date; 50 international out-migrants identified, in 35 households.

^c It refers, before 2010, to the existence of seringas (rubber tree); in 2010, to seringas, apiculture and fish ponds.

^d Farm households cohabited by at least grandsons and grandparents.

Table 2 – Correlation and significance statistics between each stage in the pioneer, mature and post-frontier and livelihood variables

Dimensions of analysis and variables	Pioneer (1987)		Mature (1995)		Post-frontier (2010)	
	on-farm	early on-farm	on-farm	early on-farm	late on-farm	off-farm
	demographic subgroup (1)	specialization subgroup (2)	demographic subgroup (1)	specialization subgroup (2)	demographic subgroup (3)	specialization subgroup (4)
<i>Human Capital</i>						
heads with more than 4 y. education (%)	-0.16**	-0.09*	-0.01	-0.12**	-0.16**	-0.04
spouses with more than 4 y. education (%)	-0.09*	-0.07*	-0.28**	0.01	-0.14*	0.03
% over 14 y.o. in off-farm employment	-0.01	-0.43*	-0.05	-0.62**	0.21**	0.77**
<i>Physical Capital</i>						
farm households owning cattle (%)	0.06+	-0.02	-0.01	0.20**	-0.07	-0.02
head own the plot in Machadinho (%)	0.09*	0.13**	0.10**	0.41**	0.19**	0.06
own other rural plots (%)	-0.03	-0.05	-0.06*	0.11**	0.01	0.03
ownership of land / house in the city (%)	-0.01	0.05	-0.12**	0.09**	0.14*	-0.04
<i>Financial Capital</i>						
% income from on farm production ^c	-0.01	0.10**	-0.05	0.31**	0.11+	-0.23**
land in pasture (%)	-0.02	0.08*	0.02	0.08*	-0.02	-0.01
land in annuals and perennials (%)	0.02	-0.02	0.01	-0.02	-0.02	-0.11+
<i>Natural capital</i>						
land in primary forest (%)	-0.03	-0.06*	-0.02	-0.08*	0.07	0.03
farms with extractive production (%) ^d	0.02	0.04	-0.05+	0.20**	0.01	-0.05
<i>Social capital</i>						
heads born in South/Southwest Brazil (%)	0.05	-0.12**	0.03	-0.09**	0.01	0.04
nuclear family - parents and sons only (%)	-0.09*	0.02	-0.09**	0.04	-0.13*	-0.31**
multigenerational household (%) ^e	0.06*	-0.03	0.10**	-0.03	0.22**	0.26**

Source: Machadinho Dataset (1987, 1995, 2010)

** p<0.01, * p<0.05, + p<0.1

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