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Demand for beef is unrelated to pasture expansion in northwestern Amazonia

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ABSTRACT

For decades, pastures have replaced Amazon forests, threatening biodiversity. Two dominant hypotheses explain this process. First, according to the hamburger connection beef markets promote conversion of forests into cattle ranches resulting in deforestation. Second, the land-as-wealth hypothesis explains deforestation as the result of land appreciation in forest frontiers. We tested these hypotheses using land use and socioeconomic data from northwestern Amazonia from 2000 to 2009. We also investigated two key control variables: coca cultivation and eradication, both of which have been proposed as important drivers of forest loss. We found high rate of conversion from forest to pasture, and unimpeded forest fragmentation. As predicted by the hamburger connection, pastures expanded as the cattle inventory grew. Beef demand did not drive pasture expansion, as ranching revenues declined and beef prices were roughly stable. Coca cultivation did not respond to the eradication campaign, and declined as the population became increasingly urbanized. We propose that investment on roads has enhanced the anticipated value of land. Cattle bolster land claims and can be used as financial collateral, so they have inherent value even without market exchange. Cattle can then increase despite stable beef prices and declining ranching revenues. To protect biodiversity, policy interventions that enhance the value of standing forests are needed to slow deforestation and fragmentation in these rapidly changing landscapes.

1. Introduction

Amazon forests encompass the largest continuous blocks of low-latitude forest ecosystems in the world, harbor 10% of all known species, and hold an estimated 15-years worth of global CO_2 emissions (Houghton et al., 2001). Conversion of forests to pasture, however, has accelerated over the last four decades (Nepstad et al., 2006). Rapid degradation has eroded ecosystem functions, and habitat loss and fragmentation have increased vulnerability to edge effects and biodiversity loss (Barlow et al., 2012; Fearnside, 2005; Laurance et al., 2006).

Two contrasting hypotheses have emerged to explain conversion from forest to pasture in Amazonia. The hamburger connection proposed low-cost beef production for fast food drove the decline of Central American forests (Myers, 1981). Demand for beef promotes forest loss by making cattle ranching profitable. Relatively low start-up costs and institutional support for cattle ranching make cattle ranching attractive (Gomes et al., 2012; Murphy et al., 1997; Van Ausdal, 2009), and the perennial demand for beef promotes cattle ranching and ultimately causes deforestation (Kaimowitz et al., 2004; McAlpine et al., 2009).

The land-as-wealth hypothesis highlights legal and fiscal policies that enhance the value of cattle without growing demand for beef, and proposes land speculation is the ultimate incentive for clearing. Clearing the forest to establish a herd of cattle strengthens land claims in Amazonia, even if clearing and ranching are not economically productive (Hecht, 1985, 1993). Legal requirements for granting titles, improving means of access, and nearly non-existent rural property taxes encourage land speculation (Bowman et al., 2012; Parry et al., 2010). Land speculation can be further exacerbated by local urbanization and the closing of the forest frontier, as land quickly accrues value in regions newly interconnected to larger markets (Parry et al., 2010).

We analyze the dynamics of land use change and forest fragmentation in the northwestern Amazon (Guaviare, Colombia) between 2000 and 2009 to investigate the contemporary forces

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driving forest fragmentation and conversion to pasture. We focused on total area change as well as the number, size, and isolation of fragments. In particular, we analyze demand for beef and land appreciation as potential drivers of land use change and forest fragmentation in the region.

2. Theory

2.1. The hamburger connection

Global demand for beef has been identified as an ultimate driver of neotropical forest loss since the 1980s (Myers, 1981). In Brazilian Amazonia, for example, deforestation rates increased as the decline of hoof-and-mouth disease and devaluation of the *reais* made beef exports feasible and globally competitive (Kaimowitz et al., 2004). Local demand for beef from a growing, or increasingly affluent population can also drive deforestation, as it has in Australia since the 1980s (McAlpine et al., 2009). In both examples ranching revenues increased, as higher prices and expanding herds resulted in a growing ranching sector.

In Colombia, the domestic market is more important than exports because there are important obstacles to exports. Two sanitary barriers have confined beef to the domestic market: hoof-and-mouth disease and lack of refrigeration. Before 2009 exports to global markets were impossible because vaccination against hoof-and-mouth disease had not reached the targeted 99.9% of the total cattle inventory (Anonymous, 2010). More than 72% of beef production during the study period was unrefrigerated and hence could not be commercialized internationally (Anonymous, 2010). For these reasons, domestic beef prices were used to test the hamburger connection.

2.2. Land-as-wealth

The land-as-wealth hypothesis was proposed as an alternative to the hamburger connection, which it critiques on three points (Hecht, 1985, 1993). First, pastures must be connected to markets for beef demand to drive conversion to pasture, and many Amazonian forest frontiers were too remote to reach global or even urban markets. Second, local population growth cannot explain conversion to pasture, as people in the frontier often rely on food imports from more developed regions (Hecht, 1993). Finally, the focus on beef production is misguided if land tenure, taxation, and ownership laws and policies reward unproductive accumulation of cleared land (Fearnside, 2005; Hecht, 1985). The latter is the most important point of the land-as-wealth hypothesis, as there are strong incentives for converting to pasture to acquire land and eventually obtain legal titles to it (Hecht, 1985, 1993).

For land-as-wealth to explain conversion to pasture, there should be policies in place that facilitate legal claims for cleared (but not forested) lands, and land value should increase over time. Throughout Amazonia, clearing the forest for pasture results in a stronger claim to a land title than other land uses (Fearnside, 2005). Rural property taxes are too low and too often unenforced to deter land grabbing, and all that is needed to promote speculation in the forest frontier are increasing land values (Bowman et al., 2012; Parry et al., 2010). Urban growth (Lambin et al., 2001), road construction and improvement (Simmons, 2004), and the expectation of future titles (Hecht, 1993), all increase the value of the land. Since cattle enhance claims to the land (Hecht, 1993), the land-as-wealth hypothesis is also consistent with expansion of the cattle herd, as long as it is the land that increases in market value.

2.3. The role of coca

Since the 1980s, illegal coca cultivation for the global cocaine market has attracted smallholders to lowland Amazonian forests (Hecht, 1993; Kaimowitz, 1997; Young, 1996). As a high-value globalized crop, coca was initially thought to leave a small footprint on the forest (Dávalos et al., 2009). Since then, large-scale land cover analyses revealed signatures of deforestation associated with coca cultivation, a large indirect impact that dwarfs the direct footprint of coca (Dávalos et al., 2011). Consistent with those large-scale analyses, detailed time series from Guaviare found that coca was the first land use to fragment the forest, losing importance over time as pastures replaced coca (Armenteras et al., 2013).

During the study period, Guaviare was at the center of coca forced eradication policy (UNODC and Gobierno de Colombia, 2012). It is possible that the local decline in coca cultivation was a response to the eradication campaign, but this is unknown (Rincón-Ruiz and Kallis, 2013; Rincón-Ruiz et al., 2013). In contrast, Dávalos et al. (2011) argued that coca cultivation was an indicator of poor access to markets and underdevelopment. If this were the case, coca cultivation would decline in response to connections to markets and (legal) economic development, instead of eradication (Dávalos et al., 2009).

3. Materials and methods

3.1. Study area

The region corresponded to an area of ~4500 km^2 in the San José-Calamar axis in Guaviare, Colombia, northwestern Amazonia (Fig. 1). To reduce spatial autocorrelation and capture variation along the axis, 44 windows of 3 × 3 km were randomly selected, representing a subsample of 396-km^2. Aside from 1 window

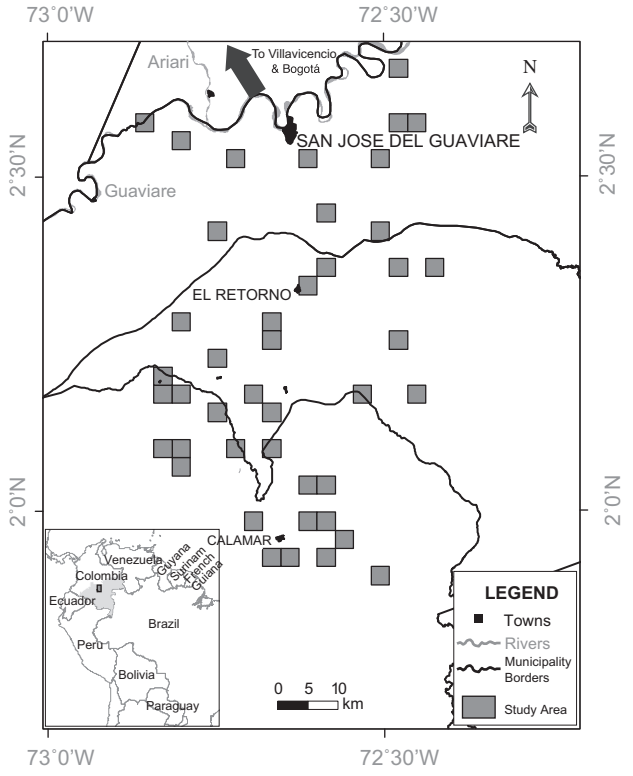

Fig. 1. Location of samples in Guaviare, Colombia northwestern Amazonia. Inset shows study area in South America. Samples were selected at random and cover the north–south axis from San José to Calamar.