



The new economic geography of land use change: Supply chain configurations and land use in the Brazilian Amazon



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ABSTRACT

In this paper we present a framework for understanding regional land use processes by incorporating the concept of agglomeration economies into agricultural frontier theory. We show that agricultural firms can obtain positive externalities from locating in close proximity to other agricultural firms, leading to agglomeration economies. Agglomeration economies lead to high levels of competition and diversity within a local agricultural supply chain and influence local prices, information flows, and private enforcement of environmental institutions. We use the theory of agglomeration economies to understand the development of soybean production in two counties along the Santarém-Cuiaba (BR-163) highway in the Brazilian Amazon: Santarém, Pará and Sorriso, Mato Grosso. We conclude that differences in environmental and land tenure institutions influenced the occurrence of agglomeration economies in these two counties, which in turn affected the total factor productivity of soy in each region. In particular, the supply chain became extremely competitive and diverse in Sorriso where few environmental regulations existed, while environmental restrictions reduced the diversification of the supply chain in Santarém. The presence of a soy agglomeration economy in Sorriso spurred innovation, increased productivity, and led to extremely rapid soy expansion in that county, while the monopolistic supply chain in Santarém reduced producers' access to land and capital and impeded soy expansion.

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Introduction

Soybean production in Brazil has received considerable attention in the last decade for its contribution to economic growth and environmental degradation in the Cerrado and Amazon. Soybeans have been planted on 700,000 km² in the legal¹ Amazon, contributing both directly and indirectly to deforestation in the region (Arima et al., 2011; Macedo et al., 2012; Morton et al., 2006). It is estimated that another 700,000 km² in the region could be physically and economically suitable for production when the pavement of the Cuiaba–Santarém highway (BR-163) is completed, allowing soy from Mato Grosso to be transported north to the port in Santarém, rather than south to Santos and Paranaguá or west to Porto Velho

(Fig. 1) (Fearnside, 2007; Vera-Díaz et al., 2009). Predicting how soy production will develop in the legal Amazon requires a better understanding of regional variations in soybean profitability and the actors involved in soybean production.

While previous studies have examined the impact of soybean expansion on deforestation (Meuller, 2003; Jepson, 2006a,b; Morton et al., 2006; Barona et al., 2010; Arima et al., 2011; Macedo et al., 2012) few studies have examined the underlying economic and institutional causes of soybean area expansion in Brazil beyond temporal fluctuations in prices and exchange rates (Macedo et al., 2012; Richards et al., 2012). The existing land use literature on Brazil has focused primarily on small-holders and on the role of household demographics, government programs, roads, and institutional arrangements (Rindfuss et al., 2007). Intensive mechanized soy production demands a different set of skills than smallholder agriculture, entails a higher level of financial risk, and requires access to large amounts of capital. Annual profitability is dependent on access to volatile international markets for soy and fertilizers and local production technologies evolve rapidly.

The objective of this study is to understand the development of industrial agricultural frontiers in Brazil better using theory from

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¹ Includes portions of Mato Grosso, Tocantins, and Maranhão not considered part of the Amazon biome.

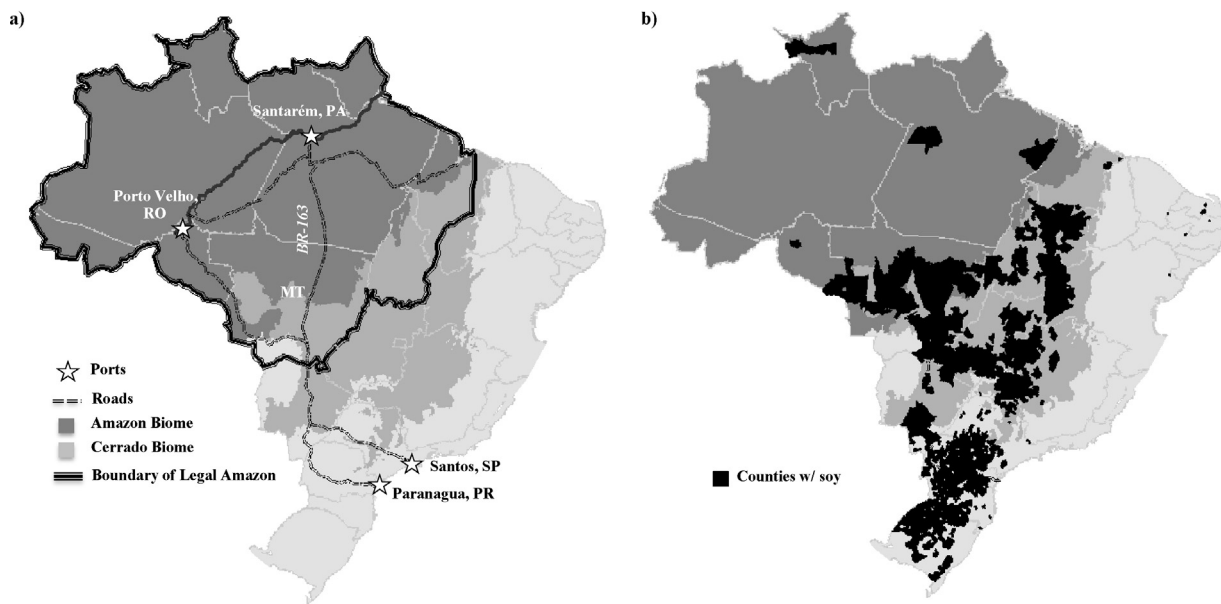


Fig. 1. (a) Key ports and transportation networks for Northern Mato Grosso, biome classifications, and the Legal Amazon boundary. (b) Counties in Brazil where soybeans are planted according to the 2010 IBGE Agricultural Production survey.

the field of “new economic geography” as defined by Krugman (1998).² In particular we propose a theoretical framework for understanding how supply chain configurations interact with local institutions, biophysical conditions, and transportation infrastructure to affect local agricultural prices, technology, and flows of information to farmers based on the literature regarding *agglomeration economies* and *clusters* (Hoover, 1948; Krugman, 1991, 1998; Marshall, 1920; Porter, 1990, 1998, 2000a). This framework characterizes local land use as a function of the concentration and diversity of various supply chain actors in the region, not just biophysical yield potential and transportation costs as predicted by Ricardian and Thunian theories of rent. It therefore represents an extension of these economic theories of land use.

We begin by briefly discussing Ricardian and Thunian theories of land use and describe why the recent extensions of these theories may be insufficient for understanding land use processes in the legal Amazon and in other rapidly developing agricultural regions. Next we explain the concepts of agglomeration economies and clusters in the agricultural sector and discuss how underlying biophysical conditions and transportation infrastructure can influence where agglomeration economies occur. We also examine how local supply chain configurations can influence agricultural profitability and local enforcement of environmental institutions by private companies. Finally, we introduce a comparative case study of two counties in the BR-163 corridor – Santarém, Pará and Sorriso, Mato Grosso – to illustrate how the concept of agglomeration economies helps explain different levels of soybean production in these two regions. We conclude by discussing how future changes in the supply chain configurations along the BR-163 corridor in the Amazon may influence soybean development in the region.

² We acknowledge that the field of “new economic geography” is no longer actually new (it is rather “middle aged” (Krugman, 2010), but the title still offers an important distinction from “old” economic geography (namely location theory) in that it incorporates general equilibrium dynamics, allowing for prices to be endogenous to the behaviors of producers. This distinction is critical because it acknowledges that competition can influence prices.

Theory

Existing theoretical framework of land use

Most economic land use models assume that land operators use their land in a way that will result in the largest expected profit after taking into account conversion costs between different uses. The profit of different land uses is in turn modeled as a function of the underlying value or “rent” of the land, rather than based on individual characteristics of the land operators (agents). Agents are assumed to buy their inputs and sell their goods at identical prices, have equal information, uniform production functions, and similar access to capital (Garrison and Marble, 1957). As a result of these assumptions it is possible to remove individual agents from these models and examine land use relationships at a broader scale.

For example, under the Ricardian framework, rents are determined exclusively by biophysical conditions (temperature, precipitation, and soil), which affect the maximum potential yield of agriculture, and by the relative scarcity of land with high quality biophysical characteristics (Ricardo, 1976). In contrast, Thunian theory states that, in an area of spatially uniform fertility, rent is determined by its distance to markets or transportation costs, which affect regional input and output prices for agriculture (Jones, 1978). Input and output prices influence rents directly by determining profits for a given level of production or indirectly by determining the economically optimal use of inputs (Kellerman, 1989).

A new economic geography of land use

Although Thunian theory has been adapted to incorporate the influence of government policy, speculation, and global market dynamics on expected land rents, few analyses, with the exception of Jepson (2006a,b), acknowledge the role of individual actors, informal networks, or formal organizations in determining local land rents in Brazil. For example, Walker et al. (2009) and Walker (2011) discuss how expectations of land rents can be influenced by government subsidies and global changes in demand, but they also assume that local prices and yields are not influenced by local processes

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