

SOYBEAN EXPANSION AND LOCAL DEVELOPMENT IN BRAZIL

1. Introduction and Motivation

This study examines the socioeconomic impacts of Brazil's soybean production chain, asking whether its expansion has generated net positive or negative effects on local economic development. The paper also addresses the heterogeneity of these impacts, examining how they vary across space and local productive structures. In particular, we investigate whether effects differ according to municipal size, pre-existing economic structure, and the presence of downstream agro-industrial activities. By emphasizing heterogeneous effects, the analysis also provides insights that may inform interpretations for other agricultural value chains and other countries undergoing commodity-led transformations.

Soybean cultivation has been the fastest-growing agricultural activity in Brazil in recent decades. Between 1988 and 2024, total agricultural area expanded by 72% (40.6 million hectares), while soybean area alone increased by 336% (35.6 million hectares), according to Brazil's Municipal Agricultural Production survey (IBGE). Soybean production was responsible for approximately 30% of the real increase in Brazil's gross agricultural output between 2000 and 2023 (Gilio & Castro, 2024). This scale and persistence of expansion place soybean at the center of debates on agricultural-led development in Brazil. Soybean growth has combined intensification in consolidated agricultural regions with the spatial diffusion of technologically advanced production systems into new frontier areas – initially across the Center-West and more recently toward the northern Cerrado savanna regions (Alves, Osaki & Barros, 2025; Navarro et al., 2025). Buainain et al. (2014) characterize this process as an “intensification of extensive growth,” referring to the territorial expansion of high-productivity systems into previously less integrated regions.

This study is situated within a contemporary development paradigm that repositions agriculture as a central component of economic transformation. In contrast to earlier views that framed agriculture primarily as a supplier of food, labor, or surplus for industrialization, recent contributions emphasize its potential role in driving growth, poverty reduction, and structural change (De Janvry, 2010). However, the mechanisms through which agriculture contributes to development remain contested and context-dependent.

The literature generally distinguishes between two complementary channels. The first involves direct sectoral effects, operating through farm-level employment and income generation, export revenues, and tax contributions. Yet, for capital-intensive agricultural systems such as soybeans, direct employment effects are usually limited, and the literature suggests that the most relevant development channels operate through indirect and spatial spillovers.

Indirect effects may arise through backward and forward linkages within the value chain. Reardon et al. (1998) argue that dynamic agricultural production can stimulate rural non-farm employment by deepening integration with upstream and downstream segments, including input industries, agro-processing, and agri-services. Particularly, the food processing sectors can absorb labor leaving agriculture, often requiring relatively low levels of human capital and tending to locate near rural production areas (Christiaensen et al., 2020; Cazzuffi et al., 2017). In addition to value-chain linkages, the growth of agriculture and its related backward and forward linkages can induce endogenous demand for other local services and processing activities. Also, agricultural expansion may produce territorial effects, because infrastructure investments reduce transport costs and integrate previously isolated regions into national and global markets.

Consistent with this perspective, Richards et al. (2015) examine the impact of soybean production on non-agricultural employment and economic activity in the state of Mato Grosso, Brazil, showing that agricultural expansion can generate positive spillovers beyond the farm sector. Their contribution is particularly relevant for adopting a value-chain perspective. However, their analysis is geographically restricted to a single state and does not explicitly explore heterogeneous effects across municipalities.

This paper builds on and extends that literature, first by examining the entire Brazilian territory, allowing for substantial spatial heterogeneity. Second, it explicitly models heterogeneous effects. Third, like Richards et al. (2015), the analysis centers on the soybean production chain, recognizing that development impacts may depend critically on the presence of upstream and downstream segments.

2. Conceptual Framework

The empirical analysis is guided by a framework that distinguishes three interrelated channels through which soybean expansion may affect local economic development: direct effects, indirect effects, and spatial effects, which may interact and reinforce each other.

Direct effects operate within the soybean production sector and include employment and wages in primary production, productivity gains per worker, and fiscal revenues associated with agricultural activity. In soybean-producing municipalities, these effects may lead to better local development, even though, due to the capital-intensive nature of modern soybean systems, these effects alone are unlikely to generate broad-based local development outcomes.

Indirect effects arise from the integration of soybean production into a broader value chain, encompassing backward and forward linkages as well as income-induced local multipliers – see Richards et al. (2015). Backward linkages refer to the demand generated by soybean production for upstream inputs and

services, including seeds, fertilizers, agrochemicals, machinery, technical assistance, credit, and other support activities. In the Brazilian soybean context, local industrial multipliers from backward linkages may be relatively limited, since fertilizer and agrochemical supply chains are strongly dependent on imports and agricultural machinery manufacturing is regionally concentrated rather than widely dispersed across soybean-producing municipalities (Cepea/Abiove, 2023; Alves et al., 2022). Forward linkages refer to downstream activities that process, transform, or distribute soybeans and soybean-based processed products. These include crushing plants, biodiesel facilities, feed manufacturing, storage operations, and logistics services (Cepea/Abiove, 2023). Such segments may generate non-agricultural employment, wage premiums, and additional value added within municipalities. In Brazil, downstream soybean-related industries have undergone a marked process of territorial interiorization, expanding toward new production frontiers and increasingly operating at industrial scale (Cepea/Abiove, 2023; Alves et al., 2022). In addition to production linkages, soybean expansion may generate induced demand effects: income earned within the soybean production chain – whether in farming or upstream or downstream segments – may increase household consumption of retail goods, personal services, housing, construction, and other non-tradable local activities.

Spatial effects reflect broader territorial transformations associated with soybean expansion. The growth of production and related upstream and downstream activities often coincides with investments in transportation networks, storage infrastructure, energy systems, and telecommunications. These improvements may reduce transaction costs for other economic sectors, facilitating diversification and integration into national and global markets. Soybean expansion may also influence urbanization dynamics, contributing to the growth of intermediate cities and to the spatial reorganization of economic activity beyond the soybean chain itself, including the expansion of non-agricultural activities at the regional level.

This framework implies that soybean expansion may generate heterogeneous development effects across municipalities. In areas with diversified economic structures and established agro-industrial segments, direct, indirect, and spatial effects may reinforce each other, leading to stronger and more persistent development outcomes. In contrast, municipalities specialized in primary production without downstream integration, or regions characterized by weak infrastructure and institutional capacity, may experience more limited and localized impacts.

3 Empirical Strategy

The empirical strategy is designed to estimate the overall local development effects of soybean expansion while simultaneously examining the mechanisms and structural conditions through which these effects operate.

3.1 Estimating Local Development Effects

We estimate the relationship between soybean expansion and local development using a municipality-year panel covering Brazil. The baseline empirical strategy exploits within-municipality variation over time:

$$Y_{it} = \beta_0 S_{it} + \beta_1 WS_{it} + \mu_i + \lambda_t + \tau_{s(i),t} + \varepsilon_{it},$$

where Y_{it} denotes local development outcomes in municipality i and year t ; $S_{it} = \ln(1 + SoyArea_{it})$, $SoyArea_{it}$ is the harvested soybean area (in hectares) and $W\ln(1 + SoyArea_{it})$ is a spatially weighted average of soybean expansion in neighboring municipalities. β_0 captures the association between soybean expansion within the municipality and local development outcomes, while β_1 measures spillover effects arising from soybean expansion in the surrounding area – because agricultural production systems and related value-chain activities frequently operate beyond municipal administrative borders. μ_i are municipality fixed effects, λ_t are year fixed effects and $\tau_{s(i),t}$ are state-by-year fixed effects (to control for time-varying state-level policies, infrastructure investments, and regional economic trends).

The outcome variables in Y_{it} are selected to capture development effects beyond primary agricultural production: non-agricultural employment and wages, non-agricultural GDP and urban population. To examine heterogeneity, we interact soybean areas with predetermined municipal characteristics capturing initial size, baseline productive structure, and pre-existing value-chain capacity.

Our identification relies on the assumption that changes in soybean area are not systematically driven by unobserved municipal-level shocks that independently affect development outcomes, conditional on municipality fixed effects, year fixed effects, and state-by-year fixed effects.

3.2 Mechanism Analysis

The next step examines whether the effects of soybean expansion on local development outcomes are consistent with the mechanisms outlined in the conceptual framework. To evaluate value-chain deepening, we estimate whether soybean expansion leads to greater employment in soybean-related segments. The specification is similar to the baseline model:

$$CE_{it} = \delta_0 S_{it} + \delta_1 WS_{it} + \mu_i + \lambda_t + \tau_{s(i),t} + v_{it},$$

where the chain employment (CE_{it}) captures employment in primary soybean production, oilseed crushing, biodiesel production, animal feed manufacturing, and selected logistics activities directly linked to soybean flows. The coefficients δ_0 and δ_1 capture whether soybean expansion within the municipality and in neighboring areas is associated with deeper local integration into the soybean value chain.

To evaluate income-induced multipliers beyond directly soybean-linked sectors, we estimate the effects of soybean expansion on non-agricultural employment excluding soybean-related industries. If soybean expansion remains associated with employment growth, this would be consistent with induced local demand effects operating through regional income multipliers.

And to evaluate the territorial channels, we augment the baseline development equation by including soybean-chain employment:

$$Y_{it} = \beta_0 S_{it} + \beta_1 WS_{it} + \phi ChainEmployment_{it} + \mu_i + \lambda_t + \tau_{s(i),t} + \varepsilon_{it}.$$

We expect that a reduction in the magnitude of β_0 and/or β_1 relative to the baseline specification would indicate that part of the association between soybean expansion and local development operates through production linkages within the value chain. If there isn't a reduction in the magnitude, this may suggest the presence of broader territorial spillovers not fully captured by narrowly defined production linkages.

Finally, we examine whether these mechanisms differ across municipalities, by interacting soybean exposure and chain employment with predetermined municipal characteristics.

4. Expected Contributions and Tentative Conclusions

At the time of submission of this extended abstract, the empirical analysis was still ongoing. The study is expected to contribute to the literature by providing nationwide evidence on the local development effects of soybean expansion in Brazil, explicitly distinguishing between local and spatial spillovers and identifying the structural conditions under which these effects are stronger or weaker. By integrating a value-chain perspective with spatial modeling and heterogeneous treatment effects, the paper aims to clarify whether and when modern agricultural expansion translates into broader local economic transformation.

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