

Land Market Liberalization and Firm Dynamics: Theory and Evidence from India

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Abstract

This paper examines the impact of land market liberalization on the productivity and growth of manufacturing firms in India, using the staggered repeal of India's Urban Land Ceiling and Regulation Act (ULCRA) as a natural experiment. The ULCRA imposed ceilings on landholdings and restricted land transfers, potentially leading to land misallocation and hindering creative destruction. We find that the repeal of the ULCRA reduced land misallocation by allowing previously more productive firms to increase their land use by 17%. As a result, treated firms expanded their production capacity and became more productive. The liberalization also influenced firm dynamics. Following the repeal, treated firms exhibited a 15% increase in product turnover, introducing more new products and phasing out old ones. Moreover, the liberalization improved firm selection by facilitating the exit of unprofitable firms and attracting more innovative entrants. Using a dynamic innovation model with land market frictions, we find a 2.7% increase in aggregate productivity due to reduced land misallocation and a 14-basis-point rise in the growth rate, resulting in a 5% improvement in consumption-equivalent welfare. These findings underscore the importance of considering both the static and dynamic impacts of land market regulations.

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“Often the most valuable asset of an unprofitable firm was land. Since the [Urban Land Ceiling and Regulation] Act prohibited the firm from selling it at the market price, the firm chose not to exit and held onto the precious piece of land.”

– Arvind Panagariya, *India: The Emerging Giant*, 2010

1 Introduction

Restrictions on land property rights are common in developing countries, often characterized by insecure tenure, limits on land ownership, and restrictions on the ability to freely exchange land (World Bank, 2003, 2007).¹ While the economic development literature has long emphasized the importance of land property rights in *agricultural* production (de Janvry, 1981; Lin, 1992; Banerjee et al., 2002; Goldstein and Udry, 2008), there are few attempts to examine their implications for both the level and growth of *manufacturing* productivity.²

In this paper, we address this gap by studying the micro- and macroeconomic consequences of India’s urban land market liberalization on manufacturing firms, both empirically and theoretically. Before the liberalization, India’s urban land markets were tightly controlled by the 1976 Urban Land Ceiling and Regulation Act (ULCRA), which restricted land property rights by capping the amount of land individuals and firms could own and imposing stringent regulations on land transfers. These constraints limited firms’ ability to expand, adjust their landholdings, and exit the market—an issue eloquently captured in the epigraph from Panagariya’s book on India’s economic reforms. It is, therefore, not surprising that the Indian manufacturing sector is predominantly made up of small plants characterized by slow life-cycle growth and low exit rates (Hsieh and Klenow, 2014; Akcigit et al., 2021; Chatterjee et al., 2023).

Considered a policy failure, the ULCRA was repealed by the central government in 1999. We hypothesize that the liberalization significantly reduced land misallocation and spurred productivity growth among manufacturing firms. By lifting landholding caps and lowering transaction costs, the liberalization could improve land allocative efficiency, allowing more productive firms to use more land in production.³ Beyond its *static* effects on misallocation,

¹Drawing on surveys from 140 countries, Prindex (2020) reports that approximately 20% of respondents believe they are at risk of losing the right to use their property against their will within 5 years. Figure C.1 shows significant variation in tenure insecurity across countries and reveals a strong negative correlation with GDP per capita.

²Three papers also examine the impacts of land market frictions on manufacturing firms in India (Kimura, 2011; Duranton et al., 2017; Sood, 2022). However, they all consider a static framework in which productivity is assumed to be exogenous. We further discuss how we differentiate from previous studies below.

³See Hopenhayn (2014) and Restuccia and Rogerson (2017) for comprehensive reviews of the growing

the liberalization could also influence *firm dynamics*, encouraging firms to engage in endogenous innovation in order to grow and facilitating the exit of unproductive firms. However, while the liberalization may foster the expansion of incumbent firms, its overall effect on firm growth remains *ex-ante* ambiguous due to general equilibrium effects on firm entry. This intensified competition from incumbent firms could discourage the entry of new firms, thereby mitigating the positive impact on growth rates.⁴

To examine the causal effects of the liberalization, we leverage hand-collected data on both the gradual repeal of the ULCRA across Indian states and the within-state variation in its implementation. We employ a Difference-in-Differences (DiD) design, comparing firms in 64 Urban Agglomerations (UAs)⁵—where the ULCRA was enforced—to firms located outside UAs (non-UAs), both before and after the repeal in specific states. This comparison with non-UA firms helps isolate the causal effects of the liberalization from other state-level shocks and concurrent policies. To further support our identification strategy, we demonstrate that firms in UAs and non-UAs exhibited no differential growth trends before the Repeal. Moreover, the Repeal’s effects on firms in non-UAs are negligible, suggesting minimal spillovers from UAs to non-UAs.

Our findings indicate that, after the Repeal, UA firms increased their landholdings by about 18% on average, which thickened the right tail of the plant size distribution. This was driven both by an expansion of landholdings within plants and a reduction in the total number of plants. Moreover, the reform improved land allocative efficiency: initially more productive plants experienced a 17% increase in their landholdings, while low-productivity plants didn’t. Consequently, the liberalization of the land market unleashed industrial growth. UA firms expanded production by acquiring 14% more fixed assets (excluding land) and hiring 7% more labor, leading to a 14% increase in sales and a 12% increase in physical productivity.

The land market liberalization also significantly influenced the dynamics of firm growth through product innovation. Following the Repeal, the rates at which plants introduced new products and deleted old ones both increased by approximately 15%, reflecting intensified

literature on resource misallocation in the manufacturing sector.

⁴This trade-off between incumbent innovation/productivity growth and firm entry is common in the literature. For instance, [Atkeson and Burstein \(2010\)](#) find that slower productivity growth of incumbents can encourage entry, as entrants enjoy higher discounted profits when facing less competition from efficient incumbents. Consequently, in response to higher trade barriers, the benefits of increased entry can largely offset the costs of lower average productivity among operating firms. In the context of India, [Bertrand et al. \(2021\)](#) demonstrate that the effects of contract labor on incumbent innovation and firm entry offset each other, resulting in a net zero effect on growth rate.

⁵An Urban Agglomeration (UA) encompasses the primary town and its adjacent suburban areas. It may include multiple statutory towns, such as adjacent municipalities, cantonments, and other urban entities like railway colonies or university campuses. Conceptually, a UA is similar to a metropolitan statistical area in the United States.

creative destruction.⁶ Furthermore, we find that the liberalization improved the selection of plants—unprofitable or dormant plants became more likely to exit the market, whereas the composition of new entrants shifted towards more innovative plants.

To quantify the macroeconomic consequences of the Repeal on the Indian manufacturing sector, we develop a general equilibrium model of endogenous growth disciplined by our causal microeconomic estimates. Our model builds on the framework of [Klette and Kortum \(2004\)](#), in which we introduce land market frictions. This model features two types of plants: “high-type” plants are innovative and grow by adding new products, whereas “low-type” plants are stagnant and remain small. Consistent with our empirical findings, plant types are endogenous as potential entrants can make a costly investment to increase their likelihood of entering as high-type. We model the ULCRA as a land wedge (tax) faced by high-type plants exclusively, which are larger and more likely to exceed landholding limits.⁷ Our model captures both the static and dynamic consequences of land market frictions. Larger plants use less land than optimal due to the tax, leading to static land misallocation. Moreover, since this tax lowers the profits generated by a product, it discourages incumbent plants from creating new products and deters potential entrants from investing to become high-type plants. As a result, low-type plants are more prevalent and face less competition from innovating high-type plants.

We quantitatively discipline the land market friction in our model to match our DiD estimates of the liberalization’s treatment effects on the marginal revenue product of land, product innovation, and the entry of innovative plants.⁸ Our baseline estimates indicate that innovative plants incur 24% higher land costs than low-type plants due to the ULCRA. Using the quantified model, we simulate a counterfactual economy without the land tax to assess the effects of the liberalization. We find that potential entrants reduce their innovation activities by 3.7% due to heightened competition from larger incumbent firms. However, this

⁶The detailed product information also enables us to explore the broader consequences of the Repeal. The liberalization likely reduced the marginal costs for affected firms, potentially allowing them to pass these gains on to consumers through lower prices. We find that treated firms reduced their product prices by 12% without increasing markups, indicating that the gains were fully passed on to consumers.

⁷This approach acts as a shorthand for modeling size-dependent frictions like the ULCRA. [Bertrand et al. \(2021\)](#) make similar assumptions in their model of labor regulations in India, which increase the costs for larger plants (with more than 100 employees) to fire workers. Specifically, they assume that these labor regulations create a wedge in labor costs, but only for the more innovative type.

⁸Our micro-to-macro approach may be subject to the “missing intercept” problem (see, e.g., [Wolf \(2023\)](#)). Specifically, the estimated relative change between treated (UA) and control (non-UA) firms could capture both the causal effects of the Repeal and any spillover effects from UAs to non-UAs. Simply aggregating micro-level estimates into macro counterfactuals could be misleading if such spillovers are present. However, the staggered repeal of the ULCRA across states allows us to estimate these spillover effects by comparing non-UAs in early-repeal states, which likely experienced spillovers, with non-UAs in later-repeal states that had not yet been exposed. Our estimated spillover effects are consistently negligible.

reduction in firm entry is more than compensated by the expansion of larger, more innovative firms, which increase their employment share by 11.7%, leading to a 4% overall increase in the rate of creative destruction. Through the lens of our model, the liberalization increased the level of manufacturing productivity by 2.7% and raised its growth rate by 14 basis points. With a discount rate of 5%, this corresponds to a 5% improvement in consumption-equivalent welfare, with roughly equal contributions from the higher level (static gain) and the increased growth rate (dynamic gain) of aggregate productivity.

Our study contributes to several strands of literature. First, it adds to the well-established literature on land market frictions and land reforms in developing countries (de Janvry, 1981; Lin, 1992; Besley and Burgess, 2000).⁹ In the agricultural sector, existing studies have highlighted the important role of property rights, particularly tenancy rights, in enhancing agricultural investment (Banerjee et al., 2002; Goldstein and Udry, 2008), as well as the importance of well-functioning land markets and clear land titles in resource and human capital allocation (de Janvry et al., 2015; Adamopoulos and Restuccia, 2020; Chari et al., 2021; Acampora et al., 2022; Adamopoulos et al., 2022; Liu et al., 2023). We extend this body of research by identifying the causal effects of land market frictions on the growth and productivity of manufacturing firms, leveraging novel landholding and land adjustment data in the Indian manufacturing census and the gradual repeal of the UCLRA as a natural experiment.

Second, we contribute to the expanding body of literature on resource misallocation and productivity growth among manufacturing firms in developing countries (Hsieh and Klenow, 2009; Hsieh and Olken, 2014; Hopenhayn, 2014; Restuccia and Rogerson, 2017; Verhoogen, 2023). In the Indian context, manufacturing firms tend to be inefficiently small and remain so throughout their lifecycle due to muted creative destruction (Akcigit et al., 2021; Peters and Zilibotti, 2021). Several recent studies have examined various forces that may hinder manufacturing growth, such as the role of contract enforcement (Boehm and Oberfield, 2018), delegation (Akcigit et al., 2021), industrial licensing (Chari, 2011; Alfaro and Chari, 2015), reservation laws (Martin et al., 2017), FDI restrictions (Bau and Matray, 2023), priority-sector lending (Banerjee and Duflo, 2014), and labor regulations (Amirapu and Gechter, 2019; Bertrand et al., 2021). We provide new evidence on the sources of misallocation and weak business dynamism in developing countries by exploring the role of land market frictions.

⁹India enacted the most extensive body of postcolonial land reforms compared to any other country, but empirical assessments are challenging due to state-specific variations in policies. Besley and Burgess (2000) categorize roughly 80 reforms into four broad categories and find mixed impacts of land reforms on economic growth. Using the same data, Ghatak and Roy (2007) find significant negative effects on agricultural productivity but emphasize the heterogeneity of effects across states and over time, cautioning against simplistic interpretations.

Three papers that explore the relationship between land market frictions and Indian firms merit further discussion. [Kimura \(2011\)](#) is the first to investigate the ULCRA’s impacts on firms, focusing on frictions in the land mortgage market and arguing that the Repeal improved firms’ credit access. [Duranton et al. \(2017\)](#) conduct a growth accounting exercise to show that the ULCRA has led to significant resource misallocation. [Sood \(2022\)](#) utilizes the ASI data to estimate the effect of land fragmentation on firm-level profits. While these studies offer valuable insights, they do not take into account that land market frictions may affect productivity growth by influencing firms’ innovation decisions. Our research differs by exploring such *dynamic* effects of these frictions, wherein firms endogenously invest in R&D to increase their profits over time. To the best of our knowledge, ours is the first study to empirically document and quantify the dynamic impacts of land market frictions.

Lastly, a burgeoning theoretical literature, built on the canonical product innovation model of [Klette and Kortum \(2004\)](#), has explored the dynamic consequences of distortionary regulations and market frictions on innovation ([Mukoyama and Osotimehin, 2019](#); [Bertrand et al., 2021](#); [König et al., 2022](#); [Aghion et al., 2023](#); [Akcigit et al., 2023](#)). Our paper contributes to this literature in two significant ways. First, we provide some of the earliest causal evidence on the impact of removing input market frictions on business dynamism by demonstrating that firms tend to add and delete more products following the Repeal. Second, by quantifying both the static and dynamic gains from a land market reform, our model provides new insights for policymakers in developing countries, suggesting that land regulations may lead to suboptimal outcomes through their consequences for business dynamism.

The remainder of the paper is organized as follows: Section 2 provides background information on the policy context and land market institutions in India. Section 3 describes our datasets and outlines the identification strategy. Section 4 presents our main empirical findings, highlighting the static and dynamic consequences of the Repeal. Section 5 outlines our model and discusses some of its implications. Section 6 details the estimation of the model’s parameters and quantifies both the equilibrium effects and welfare consequences of the Repeal.

2 Policy Background

In this section, we provide a brief overview of how the Urban Land (Ceiling and Regulation) Act (ULCRA) increased landholding and transaction costs by imposing ceilings on land ownership and restricting land transactions. We also present essential background information on the policy context and the eventual repeal of the Act.

The Urban Land (Ceiling and Regulation) Act (ULCRA). Since gaining independence, India struggled with a severe urban housing shortage, with a deficit of 3 million housing units in 1971 (Tiwari, 2016).¹⁰ This shortage became more pressing due to rapid urbanization; from 1951 to 1971, the urban population surged from 62 million to 109 million. Additionally, there were widespread concerns about speculative landholding practices, with landlords sitting on large areas of undeveloped land, exacerbating the housing “crisis”. Despite the enactment of numerous rural land legislation, reforms in urban areas significantly lagged, with no limits on land ownership or possession until the introduction of the ULCRA. This combination of rapid urban growth and “lax” regulation in urban land markets set the stage for the enactment of the ULCRA in 1976.

From its inception, the ULCRA was fundamentally aimed at socializing urban land, a goal that became feasible during the national emergency period from 1975 to 1977, when the democratic process was entirely suspended. It was enacted to address the “excessive” concentration of urban land, curb land speculation, and promote equitable land distribution. The ULCRA targeted urban agglomerations (UAs)—central cities and their adjacent suburban areas with populations exceeding 200,000 as per the 1971 Census. A list of 73 UAs was published under the ULCRA to guide state-level implementation. The Act was adopted by 17 states and 3 union territories, applying to 64 UAs in total.¹¹

Ceilings on Landholdings. The ULCRA established ceilings on vacant land in urban agglomerations to prevent excessive land concentration. Specifically, the ULCRA set limits on the amount of land that could be held by individuals, families, firms, companies, or associations, regardless of incorporation status. Those exceeding these limits were required to surrender excess land to the government for minimal compensation.¹² The limits were very restrictive, ranging from only 500 to 2,000 square meters.¹³ The ULCRA defined land-

¹⁰Housing shortage is estimated by counting the number of households living in non-serviceable katcha (non-durable) houses, obsolescent houses, congested houses, and those who are homeless.

¹¹Some states and union territories without UAs surpassing the 200,000 population mark also adopted the Act, including Haryana, Himachal Pradesh, Manipur, Meghalaya, and Tripura. Conversely, Jammu & Kashmir, Kerala, and Tamil Nadu, despite having qualifying UAs, did not adopt the Act. Tamil Nadu implemented its own version of a land ceiling act, which remains in effect.

¹²The compensation was calculated as follows: if the land generated income, the amount was eight and one-third times the net average annual income from the previous five years; for non-income-generating land, the compensation ranged from five to ten rupees per square meter, depending on the urban agglomeration category. In either case, total compensation was capped at two lakhs rupees, equivalent to approximately \$480 USD.

¹³Urban agglomerations were systematically categorized into four groups based on their population size from the 1971 Census: *Category A*: Metropolitan areas of Delhi, Mumbai, Kolkata, and Chennai with a ceiling limit of 500 sq. meters for vacant lands per person; *Category B*: Urban agglomerations with populations exceeding 1,000,000 had a ceiling limit of 1,000 sq. meters per person; *Category C*: Agglomerations with populations ranging between 300,000 to 1,000,000 were capped at 1,500 sq. meters per person; *Category*

holding not just as land owned, but also included land held under lease or mortgage. In essence, all forms of land possession—whether direct ownership, tenured lease, or mortgaged property—were encompassed within the Act’s scope. Moreover, the definition of “vacant” was somewhat ambiguous, often leading to any land not covered by buildings being classified as vacant (Ridhi, 2023). As a consequence, larger plots, particularly those exceeding the ceiling limits, often remained undeveloped or became entangled in litigation, effectively freezing them out of the market and leading to inefficient land use. Such ceilings could disproportionately impact larger firms, which typically require more extensive plots of land.

Transfer of Property. The Act also imposed stringent regulations on the transfer of land and buildings, applying to all transfers regardless of whether the land exceeded the established ceiling limits. Specifically, no person was allowed to transfer his or her land and buildings by way of sale, mortgage, gift, lease, or otherwise without prior government approval. Furthermore, the government could expropriate any land and buildings for which an application to transfer was submitted, at a price calculated according to the Act.¹⁴ These regulations acted as a deterrent to many potential transactions, as participants feared potential expropriation without receiving adequate compensation. In some cities, land transactions plummeted by 75%, and land prices rose by 30% to 50% during the post-ULCRA period (Srinivas, 1991).

These constraints likely restricted firms’ ability to expand, adjust their landholdings, or exit the market, as illustrated in the epigraph from Panagariya. Consequently, firms may have been deterred from making costly investments to grow or enter the market. Such land market constraints likely contributed to the well-documented pattern of Indian plants remaining inefficiently small and showing low life-cycle growth (Hsieh and Klenow, 2014; Hsieh and Olken, 2014; Akcigit et al., 2021).

Repeal and Aftermath. By the late 1990s, the limitations of the ULCRA became evident. Originally intended to prevent the monopolization of urban land and ensure its equitable distribution, the Act largely fell short of its objectives. As noted by the Ministry of Urban Affairs, only 20,654 hectares (about 80 square miles) of urban land had been expropriated, and about half of them had not been developed by the government by 1999. Empirical

D: Agglomerations with populations between 200,000 to 300,000 had a ceiling limit of 2,000 sq. meters per person.

¹⁴These limitations applied universally to both land and buildings in urban areas, irrespective of whether the buildings were constructed before or after the Act’s commencement. The ULCRA also introduced regulations on building construction. If a building housed any dwelling unit, the permissible built-up area was restricted to 300 sq. meters in *A*- and *B*-cities, and 500m sq. meters in *C*- and *D*-cities, aimed at managing urban population density. Furthermore, the state retained the authority to mandate the demolition of structures erected post-ULCRA if deemed in the public interest.

studies underscored the ULCRA’s failure to promote the construction of affordable housing, ultimately leading to its repeal by the central government in 1999 (Srinivas, 1991; Joshi and Little, 1996; Sridhar, 2010; Siddiqi, 2013; Dutta and Gandhi, 2023).

The repeal was both sudden and largely unexpected. In their 1998-1999 working report, the Ministry of Urban Affairs noted: “[T]he Government have not made any analysis with regard to impact of the repeal Act on the prices of land as also the trend of land prices after the Act was implemented in 1976.” However, under the Indian constitution, states retained the authority to legislate on urban land. Thus, the central government’s repeal only meant states were no longer obligated to maintain urban land ceilings. To abolish these ceilings, states had to individually repeal the ULCRA through their legislative assemblies.

The Repeal Act was adopted by a majority of states and union territories in 1999, as listed in Table C.1. Between 2000 and 2011, the ULCRA was repealed in Chhattisgarh and Madhya Pradesh (2000), Odisha (2002), Assam (2003), Bihar (2006), Andhra Pradesh, Maharashtra, and Telangana (2008), and Jharkhand (2011). Tamil Nadu and West Bengal have yet to adopt the Repeal Act.¹⁵ While the exact reasons for the staggered and delayed repeal of ULCRA in some states remain uncertain, case studies suggest that political factors predominated over economic ones. The act had led to widespread corruption, and state elites who benefited from it may have resisted repeal to protect their rent-seeking opportunities (Siddiqi, 2013). Moreover, divisions among political parties often prevented state governments from building the consensus necessary to repeal ULCRA (The Economic Times, 2007).

3 Data and Empirical Strategy

3.1 Data Sources

ASI Data. Our primary data source is the Annual Survey of Industries (ASI), which provides extensive information on manufacturing plants from 1993 to 2013 with district and plant identifiers.¹⁶ The ASI provides a representative sample of all registered manufacturing

¹⁵Tamil Nadu implemented its own version of a land ceiling act, which remains in effect. Meanwhile, West Bengal, ruled by the Left Front—an alliance of Marxist and Socialist political parties—since 1977, is noted for its achievements in land expropriation and redistribution (Raychaudhuri, 2004). These two states are likely outliers and thus excluded from our analysis.

¹⁶The reporting period for the ASI is the Indian fiscal year, which begins on April 1 and ends on March 31. Throughout the paper, when we refer to a survey year, we use the calendar year in which the fiscal year commences. While the official ASI data only provides plant identifiers after 1998, the dataset that was purchased separately contains plant identifiers starting from 1993, which is also used in, for example, Bertrand et al. (2021) and Bollard et al. (2013). The publicly available ASI dataset lacks district information, which is critical to our analysis. To address this, following Martin et al. (2017), we match the panel version of ASI with

plants in India, with large plants covered yearly and smaller ones surveyed on a sampling basis. Over 98% of surveyed plants are single-plant firms, so we use “plant” and “firm” interchangeably in the following text. Like other manufacturing surveys, the ASI provides detailed plant-level information, including fixed assets, wage bills, number of employees, consumption of raw materials, and sales revenue.¹⁷

Land Data. Unlike other surveys, the ASI provides a detailed breakdown of capital stock into land, buildings, machinery, and other fixed assets, allowing us to distinctly measure land value. We use the average of the book value at the start and end of the year to measure land use, which reflects the acquisition cost of the land rather than its current market value.¹⁸ This measure includes both owned and leased land used in production but excludes unused land.¹⁹ A limitation is that the ASI lacks data on land prices or physical land quantities, which we address in more detail in our empirical analysis.

Product Data. Another unique feature of the ASI dataset is that it provides information on both total product sales and total quantity sold at the product level, as mandated by the 1956 Companies Act. Products are defined based on 5-digit product codes, encompassing over 12,000 distinct products. Using the plant panel data, we can directly observe product innovation in the form of adding (deleting) products to (from) a plant’s existing product portfolio. These product-based measures of innovation are crucial for us to examine the effects of land constraints on innovation, especially because firms in developing countries rarely file patents or report their R&D expenditure.

an older cross-sectional version, which contains district identifiers until 2009, based on time-invariant factors and open/close variables. Since the ASI does not provide district identifiers after 2009, we use the panel structure of our data to infer the district information for a subset of firms (approximately 2/3) that appear in the data before 2010. Our analysis is robust to only using the pre-2009 sample. Since district boundaries are rather volatile in India, we built a crosswalk that maps the district information to time-invariant 1991 districts.

¹⁷All financial amounts are expressed in 2004 Rupees following the procedures outlined in [Allcott et al. \(2016\)](#). Revenue is adjusted for inflation using 3-digit industry-level commodity price deflators. The deflators for materials reflect the average price changes in outputs from a given industry’s suppliers, as determined by the 1993-1994 input-output table. For capital, we use an implied national deflator based on capital formation provided by the Reserve Bank of India.

¹⁸Land value may be adjusted for market changes, which is reported separately through land re-valuation, though it is very rare—less than 1% of firms report a positive re-valuation. Additionally, land does not depreciate.

¹⁹Rented land is reported in a separate block of other expenditures, where plants report the total amount of rent paid for land or royalties on mines, quarries, etc., but these amounts are not itemized. However, it is relatively rare—less than 10% of firms ever report a positive total rent expenditure.

ULCRA Data. We manually collected and compiled the ULCRA dataset, including the repeal time in each state and the geographic coverage of the 1976 Act.²⁰ The 1976 Act delineates numerous urban agglomerations (UAs) and their associated towns and villages. We systematically gathered coordinates for over six hundred listed locales through extensive online research. To ensure their accuracy, we used the Indian Village Directory to verify the existence and correct spellings of these places, especially when they were unavailable online. Historical name changes and alternate spellings presented additional challenges, which were addressed through targeted searches. All UAs were mapped onto the district boundaries as defined in the 1991 district map.

We use districts as our unit of treatment, meaning firms are considered treated if they reside in a district containing any UA locales.²¹ This decision is guided by several considerations. First, our primary data source, the ASI, only provides information up to the district level, lacking more precise geographic identifiers to pinpoint firms *within* UAs. Second, using districts as the treatment unit could mitigate potential biases due to firms relocating between cities and suburbs.²² Moreover, the influence of the ULCRA likely extended into nearby areas. For example, following the ULCRA’s introduction, developers began hoarding land in adjacent areas, causing land prices to soar by 30-50% as reported by Srinivas (1991). In practice, using districts as the treatment unit effectively approximates the actual coverage of the ULCRA, as population census data show that over 60% of non-agricultural employment within districts is concentrated in UAs.²³

3.2 Empirical Strategy

To estimate the causal effects of the ULCRA repeal, we utilize a difference-in-differences (DiD) approach, leveraging the gradual repeal across states and the within-state variation in the implementation of the ULCRA. Given that the ULCRA only applied to Urban Agglomerations (UAs), we can compare firms within UAs, where the ULCRA was binding, with

²⁰Collecting data on the timing of the repeal is challenging due to the lack of a centralized policy information platform in India, leading to discrepancies in previous studies regarding the timing of the repeal at the state level (Sridhar, 2010; Kimura, 2011; Duranton et al., 2017). We address this by consulting multiple legal databases and extracting repeal dates from public judicial records that explicitly mention these dates.

²¹Almost all UAs can be uniquely matched to a single district, meaning that all locales within a UA are situated in the same district. However, there are a few exceptions, such as the Calcutta UA and Madras UA, which span multiple districts.

²²Cross-district relocation is rare in our data as less than 3% of firms have ever changed districts. This low rate may even be inflated by entry errors in district information.

²³Figure C.2 plots village and town-level non-agricultural employment against their distance from the UAs’ centroids. Notably, employment decreases sharply to nearly zero outside a 5-kilometer radius from these centroids, suggesting that most non-agricultural activity within districts occurs within or very close to UAs.

firms not in UAs, before and after the repeal in specific states. To estimate the causal effects of the repeal, we present our main empirical specification as follows:

$$Y_{idst} = \alpha + \beta_1 PostRepeal_{st} + \beta_2 PostRepeal_{st} \times UA_d + \gamma X_{idst} + \delta_t + \delta_d + \epsilon_{idst} \quad (1)$$

where Y_{idst} represents the various outcome variables for firm i in district d of state s in year t . $PostRepeal_{st}$ is an indicator variable that equals 1 if the state s has adopted the repeal act by year t . UA_d is an indicator variable set to 1 if the firm resides in a district d that contains an UA. X_{it} is a set of firm-level and district-level control variables, including a firm ownership dummy, urban dummy, 2-digit industry fixed effects, and a district’s pre-reform land endowment-by-year fixed effects. δ_t and δ_d are year and district fixed effects, which account for any aggregate fluctuations and time-invariant cross-district heterogeneity. In certain specifications, when the focus is on within-plant growth, we include plant fixed effects δ_i . Standard errors are clustered at the state and year level, as the reform was adopted gradually by individual states and union territories.

Our primary coefficient of interest is β_2 , which measures the differential growth of firms in districts with UAs—where the ULCRA was binding—relative to those in non-UAs before and after the Repeal. β_1 , in contrast, captures the effects of the Repeal on non-UA firms. Since the ULCRA was not directly applicable in non-UAs, a non-zero β_1 might suggest that our DiD design is confounded by other concurrent state-level shocks or biases due to the staggered nature of the treatment. In addition, β_1 might capture the spillover effects of the Repeal from UAs to non-UAs, potentially violating the stable unit treatment value assumption (SUTVA). Therefore, in our baseline specification, we report both β_1 and β_2 . The results for β_2 remain consistent even when we include state-by-year fixed effects, which absorb β_1 and flexibly control for any state-level shocks and differential trends.

The identification of β_2 relies on the assumption that any differences between firms in UAs and non-UAs in states that have repealed the ULCRA would not evolve differently, in the absence of the Repeal, than those in states that have not yet repealed it. This assumption is less stringent than the typical “parallel trends” assumption, which suggests no differential growth between early and late repeal states. Instead, we only require that, for any differential growth that does exist, the relative growth between UAs and non-UAs do not systematically differ across states that repealed early versus those that repealed later. Essentially, any confounding factors that could potentially bias the estimation of β_2 would need to (1) differentially affect firms in UAs and non-UAs *and* (2) coincide with the timing of the state-level repeal.

To further illustrate our empirical design, we present the timeline of the ULCRA and the

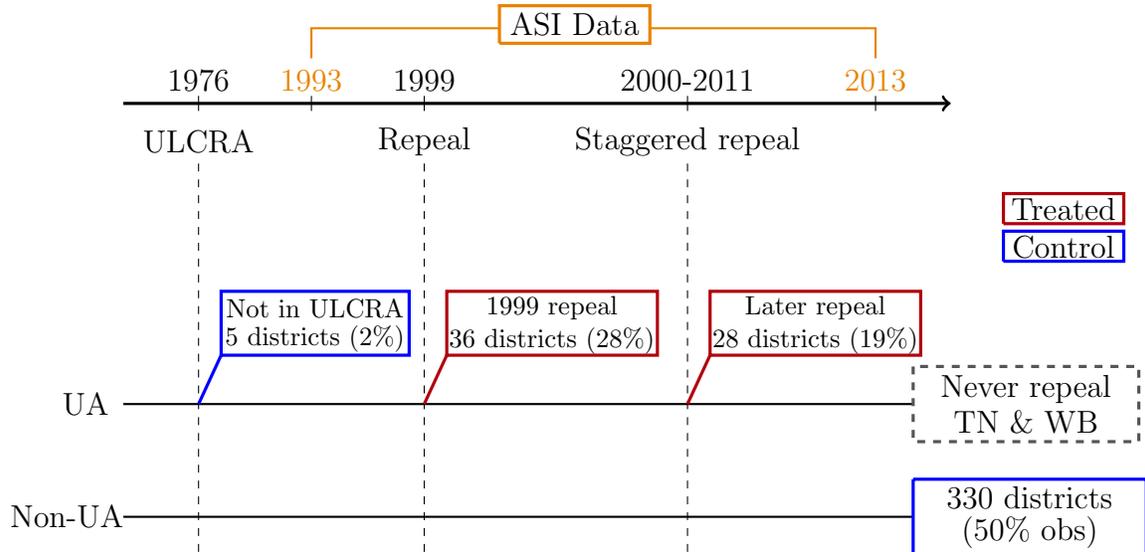


Figure 1: Timeline of the ULCRA and its Repeal

Repeal in Figure 1. The control group, non-UAs, consists of 330 districts, which constitutes approximately 50% of our ASI data. Jammu & Kashmir and Kerala, while having qualified UAs, never participated in the ULCRA, so we include UAs in these two states ($n = 5$) in the control group as well. However, they constitute merely 2% of the data, and our results are robust to dropping them. A majority of the states repealed the ULCRA in 1999, as listed in Table C.1, encompassing 36 UA districts, or 28% of the observations. From 2000 to 2011, those lagging states implemented the Repeal gradually, including 28 UA districts, or 19% of the data. Tamil Nadu and West Bengal never adopted the Repeal Act and were excluded from the sample as discussed earlier. Therefore, our design essentially compares UAs vs. non-UAs, before and after these two episodes of repeal.

3.3 Threats to Identification

In this section, we further elaborate on our identification strategy and address concerns about several potential sources of bias that could contaminate our results.

Non-Random Assignment of Repeal. One concern is that firms in states that adopted the Repeal earlier may differ from those in states that adopted it later. Similarly, firms in UA districts could significantly differ from those in non-UA districts. However, district fixed effects (δ_d) account for any pre-existing, time-invariant differences—whether observed or unobserved—between firms across UAs, non-UAs, early-repeal states, and late-repeal states. In fact, our identification strategy, by including the UA and non-UA comparison, does not

require the repeal timing to be random or uncorrelated with underlying state-level trends. Rather, the estimate of β_2 will be unbiased as long as any factors causing a state to repeal earlier do not lead to disproportionately faster growth in firms within UAs compared to non-UAs. This assumption could be violated if, for instance, states with limited urban land supply and rising land prices in UAs were more likely to repeal earlier. While our dataset lacks specific state- or district-level land price data, any pre-existing trends related to varying land supplies would be captured by our district-level land endowment-by-year fixed effects.

Validation of Identification Assumptions. While our identification assumptions are untestable, we offer several pieces of supporting evidence. First, our event study plots for β_1 show no pre-existing trends between non-UA firms in states that had repealed and those in states that had not, indicating that these states followed similar trajectories before the policy change. Moreover, the trend for β_1 remains flat even after the Repeal, lending further support to the validity of our design. Second, the event study graphs for β_2 demonstrate that firms in UAs did not experience differential growth compared to firms in non-UAs prior to the Repeal across states. Third, we conduct extensive robustness checks to demonstrate that our estimates remain stable when we include additional controls for differential trends at the district, industry, and state levels.

We further confirm that there were no differential trends between UAs and non-UAs before the Repeal. Using pre-1998 firm-level data, we analyze several outcomes: output, landholding, fixed assets, number of employees, and marginal revenue product of land (MRPLand).²⁴ We regress these variables on a UA dummy, a linear time trend, and their interaction, controlling for industry and state fixed effects. The results, presented in Table C.3, show that the interaction terms are consistently close to zero and not statistically significant, confirming the absence of differential growth trends between UAs and non-UAs before the Repeal.

We conduct additional checks to further address concerns about the endogenous timing of repeal adoption, particularly whether early repeal could be driven by land shortages or unequal land access. Specifically, we investigate whether the timing of the repeal correlates with the pre-Repeal distribution of land and the degree of variation in land productivity across firms. We regress an indicator variable (set to 1 in the year of repeal) on the lagged (up to three years) standard deviation of landholdings, as well as the average and standard deviation of MRPLand. These measures are constructed at the state-industry level from the ASI data. Results presented in Table C.7 show that the pre-Repeal distribution of land and

²⁴MRPLand is measured by the average revenue product of land. Assuming a Cobb-Douglas production function, a higher average revenue product suggests a correspondingly higher marginal revenue product of land within industries.

MRPLand does not predict the timing of the reform’s adoption. In addition, we demonstrate that our results are robust when using only the first episode of the repeal (states that adopted the Repeal Act in 1999). Since the central government’s repeal was beyond the control of individual states, this strategy effectively eliminates any potential endogeneity in the timing of repeal adoption.

Staggered DiD. Recent literature has highlighted potential biases in two-way fixed-effect (TWFE) DiD estimates, particularly in scenarios with staggered treatment adoption across units (Athey and Imbens, 2018; Borusyak et al., 2023; Callaway and Sant’Anna, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2021; de Chaisemartin and D’Haultfœuille, 2020). The bias in staggered DiD designs arises primarily due to heterogeneous treatment effects over time and across different groups, leading to the DiD estimator producing variance-weighted averages of these different treatment effects. Such averaging can lead to misleading results, as the already-treated units can act as controls, skewing the estimated effects away from the true effects.²⁵ To address these concerns, we demonstrate that our results are robust to using various DiD estimators introduced by Cengiz et al. (2019), Sun and Abraham (2021), de Chaisemartin and D’Haultfœuille (2020), and Borusyak and Jaravel (2023). Moreover, we show that our results remain consistent when using only the first episode of the Repeal—states that repealed in 1999—thus entirely eliminating the early-late comparison.

4 Land Constraints, Allocation, and Productivity Growth

4.1 Did the Repeal Act Reduce Land Market Constraints?

We begin by analyzing the impact of the liberalization on plants’ *average* land size. The ULCRA, by capping the amount of land plants could own, likely led to an overabundance of small plants using minimal land. This is consistent with fact that India’s manufacturing sector is dominated by numerous small, informal plants with limited growth potential (Hsieh and Klenow, 2014; Akcigit et al., 2021).

²⁵In the context of staggered DiD TWFE estimates, biases can arise in at least two different ways, even when the parallel trends assumption is satisfied. Firstly, the traditional TWFE estimator is a weighted average of each of the 2x2 ATTs (Goodman-Bacon, 2021). With time-varying treatment effects, this composition can lead to biases, particularly when early-treated groups serve as control groups, i.e., “forbidden comparisons”. As a result, treatment effects for some units and periods receive negative weights in the TWFE estimand, possibly leading to underestimated or even incorrectly signed TWFE estimates — e.g., the estimand could be negative even if all the treatment effects are positive. Second, the TWFE estimator disproportionately weights units treated in the middle of the panel, which is often not relevant to the policy we are studying. If these units’ treatment effects significantly differ from those in other periods, the estimator may be biased and hard to interpret.

We use the event study version of our empirical equation 1 to estimate the effects on plants' land size, measured by the stock of land used in production. Figure 2 below presents the estimated effects on firms in both non-UAs (β_1 —blue line) and UAs (β_2 —red line).²⁶ The event study graphs indicate that there is no effect of being in treated states prior to the Repeal, for firms either in UAs or non-UAs. It suggests two things. First, the lack of pre-trend in β_1 indicates that states that adopted the Repeal Act at different times did not have differential trends in landholdings. Second, the graph for β_2 shows that UA firms did not grow faster in terms of land use than non-UA firms before the Repeal, implying that our results are unlikely driven by pre-existing growth differences between UAs and non-UAs, consistent with the findings reported in Table C.3.

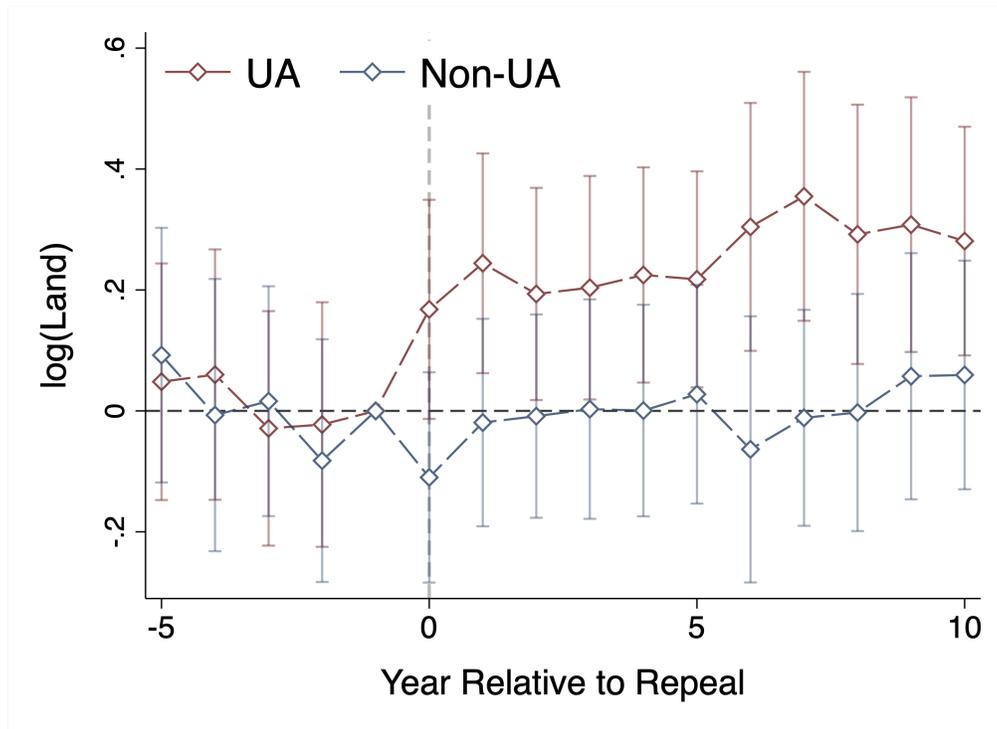


Figure 2: Event Study Plot for the Effect of the Repeal on Firm-level Land Use

Note. This figure reports the event study graph for the treatment effect of the Repeal Act on firms' landholdings. The dependent variable is the logarithm of the book value of land. Coefficients are normalized 1 year before the reform. The blue line indicates the effects on firms in non-UAs (β_1) and the red represents the differential effects on firms in UAs (β_2). The regression includes firm ownership dummies, an urban dummy, industry fixed effects, district-level land endowment-by-year fixed effects, district fixed effects, and year fixed effects. δ_t and δ_d are year and district fixed effects. Standard errors are clustered at the state-year level. The confidence interval is at the 95% level.

Consistent with the fact that the ULCRA only applied to UAs, the reform does not affect

²⁶The ASI dataset reports the book value of land at both the start and end of the year. We use their average to measure firms' land use, which reflects the amount of land used in production, not ownership.

plants’ land size in non-UAs. The flat β_1 line lends more confidence to the validity of our empirical strategy, indicating that our results are unlikely to be contaminated by other state-level time-varying shocks or spillovers from UAs to non-UAs.²⁷ In contrast, UA plants saw an increase in average land size by approximately 20% after the Repeal, equivalent to about 2.6 million Indian rupees.

How Did Average Land Use Increased? One might wonder why plants’ average land use increased post-Repeal, especially considering that land supply is often inelastic in the short run. It is important to note that the results in Figure 2 exclude plant fixed effects, meaning the increase in land use among UA plants reflects both plant-level expansion and shifts in plant composition. Table C.4 further illustrate this by reporting the effects of the Repeal on district level total land use and the number of plants. While the total land used in production did not increase, the number of plants declined by roughly 12% post-Repeal. This suggests that the Repeal, by removing land caps on larger firms and pushing out smaller ones, shifted the distribution of plant land size to the right.²⁸ Appendix D.1 presents further evidence that the Repeal enhanced flexibility in land use by reducing barriers to land transactions. Firms were able to adjust their landholdings more freely, particularly in response to profitability shocks, making land a more flexible input in production.

Staggered DiD. To address issues regarding the staggered nature of the Repeal, Figure C.3 presents the event study graphs using various robust DiD estimators. Panel (a) reports the average treatment effect on UA firms (β_2), by including state-by-year fixed effects into equation (1) using: de Chaisemartin and D’Haultfoeulle (2020), stacked DiD proposed by Cengiz et al. (2019), Sun and Abraham (2021), TWFE as a benchmark, and TWFE using only the 1999 repeal cohort. The estimates are similar across all recently developed robust

²⁷This lack of spillover effects is plausible, given that Indian districts are quite large, averaging around 5,000 sq km, and cross-district business relocation and migration can be quite costly (Kone et al., 2018).

²⁸One concern is that this increased land use might be driven by rising land prices rather than an actual increase in the physical amount of land held by a plant. While the ASI data does not provide information on land prices or quantities, we offer several pieces of evidence against the rising land prices explanation. First, Table C.4 shows that district-level total land use did not increase post-Repeal. If the rise in land use were primarily due to higher prices, we would expect an overall increase in total land use. Second, Table C.5 demonstrates that the Repeal led to a decline in the marginal revenue product of land (MRPLand), which should be proportional to land prices times land wedges. If land prices had increased and raised the marginal cost of production, cost-minimizing plants would use less land until the MRPLand rose to match land costs. Third, while we lack industrial land price data, residential rent expenditure data from the National Sample Surveys shows that median household rent expenditures did not rise post-Repeal, as reported in Table E.1. Given that residential and industrial land prices tend to move in tandem in urban areas, this provides further evidence that land prices likely did not drive the observed changes in land use. Finally, in the next section, we document the “real” expansion of plant production in terms of capital, labor, and sales. This makes it unlikely that the increase in land use is purely due to rising land prices.

DiD methods, showing no evidence of pre-trend and confirming our results. Notably, by only using the 1999 repeal cohort, we entirely shut down the early-late comparison and find consistent patterns. Panels (b) and (c) replicate Figure 2 by reporting both β_1 and β_2 using our baseline equation, employing the stacked DiD (Cengiz et al., 2019) and the imputation method (Borusyak et al., 2023).²⁹ Taken together, the consistency across all the methods suggests that our results are unlikely to be biased by the staggered adoption of the repeal.

Improved Allocative Efficiency of Land

We now test the effects on the allocative efficiency of land. Given that the landholding caps could disproportionately affect larger and more productive plants, we hypothesize that the Repeal reduced land misallocation by enabling more productive plants to expand. Following Chari et al. (2021), we examine the differential impacts of the Repeal on plants with high/low Total Factor Productivity (TFP) *before* the Repeal, while controlling for plant fixed effects to isolate within-plant land growth.³⁰ By including plant fixed effects, we control for any time-invariant plant specific factors and focus on the sample of plants that survived from pre- to post-Repeal periods. We will discuss more about the impacts on plant composition, including the effects on plant entry and exit in Section 4.3.

We employ both the conventional revenue-based TFP (TFPR) and quantity-based TFP (TFPQ) to account for the possibility that higher TFPR may reflect market power or product appeal rather than actual productivity. We estimate TFPR and TFPQ separately for each 2-digit industry using the methodology proposed by De Ridder et al. (2022).³¹

We then estimate the treatment effect of the Repeal on *within*-plant increases in land

²⁹These two approaches are chosen as they are flexible enough to accommodate heterogeneous treatment effects by UAs and non-UAs.

³⁰An alternative method is examining the heterogeneous treatment effects on firms with high/low marginal revenue product of land (MRPLand) before the Repeal, as suggested by Bau and Matray (2023). However, a concern with this approach is the slow adjustment of land, e.g., firms may need years to build up their land stock. Consequently, firms with higher MRPLand (i.e, those more constrained by land according to this approach) might be the firms that are actively increasing their land stock and would thus experience accelerated land growth even without the Repeal. We discuss more about this approach in Appendix D.1.3.

³¹Specifically, we employ a two-stage procedure. In the first stage, we correct observed output (deflated sales for TFPR and quantity sold for TFPQ) for measurement error by regressing it on time fixed effects and a third-order polynomial of input usage. We also incorporate controls for prices and market shares within 5-digit industries in our TFPQ estimation to account for imperfect competition, following the recommendations of De Ridder et al. (2022). In the second stage, this corrected output serves as the dependent variable in an IV-GMM estimation procedure to estimate the output elasticity for TFPQ and the revenue elasticity for TFPR. We construct physical output by subtracting firm-level prices from deflated sales. Following De Ridder et al. (2022), prices are aggregated from product-level unit prices for multi-product firms. More specifically, we first standardize product unit prices by dividing them by the average price across all similar products weighted by their corresponding sales. We then construct firm-level prices as the sales-weighted average of standardized prices across the products that each firm produces in a year.

Table 1: Within-Plant Land Growth by High/Low Pre-Repeal Productivity Plants

<i>Dep. Var. (log)</i>	Land Used in Production			
	High Productivity Plants		Low Productivity Plants	
<i>Productivity measured by...</i>	(1)	(2)	(3)	(4)
	TFPR	TFPQ	TFPR	TFPQ
$Repeal_{st}$	0.005 (0.029)	0.009 (0.029)	0.027 (0.027)	0.016 (0.031)
$Repeal_{st} \times I_d^{UA}$	0.164*** (0.035)	0.179*** (0.033)	0.030 (0.031)	0.012 (0.034)
Observations	61,561	59,648	57,588	57,684
R-squared	0.887	0.892	0.895	0.890
Plant FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes
Industry×Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is log land use. We estimate Total Factor Productivity (TFPQ and TFPR) for each 2-digit industry using the methodology proposed by De Ridder et al. (2022). The regression sample is segmented by whether firms' pre-Repeal average TFPR or TFPQ was above (Columns 1-2) or below (Columns 3-4) the district median. 'Land Size×Year' incorporates both district pre-Repeal land endowment size bins and firm-specific land size bins, interacted with year fixed effects. Standard errors are clustered two-way by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

use, segmenting the sample of plants based on whether their *pre-Repeal* average TFPR(Q) was above or below the district median. Table 1 presents our findings, with Columns (1)-(2) detailing the effects on firms with high TFPR(Q) and Columns (3)-(4) for less productive firms. Our results demonstrate that post-Repeal, UA plants with initially higher TFPR(Q) saw a 16-18% increase in their land use, while the effects on less productive firms are small and not statistically significant.

The precisely estimated null effect on non-UA plants also alleviates the concern that our results are driven by the slow movement of land—high-productivity plants might be accumulating land faster even in the absence of the Repeal. If that were the case, we would expect to see an increase for high-productivity firms in non-UAs as well. Table C.10 further confirms that our results are consistent across various alternative measures of TFP. Figure 3 presents the event study graphs, showing the effects on land use for high- versus low-productivity plants in UAs, confirming that our results are not driven by pre-existing trends. These findings support our hypothesis that the Repeal enhanced the allocative efficiency of land, enabling more productive firms to expand.³²

It may seem surprising that those less productive plants did not experience a decrease in their land use after the Repeal. This raises the question: where did these new plots of

³²Appendix D.1.3 provides further discussion on the implications of the Repeal for the dispersion of the marginal revenue product of land (MRPLand) and land misallocation.

land come from? It is important to clarify that our analysis here, by including plant fixed effects, focuses only on the group of plants that have survived from the pre-Repeal to the post-Repeal periods—typically larger plants included in ASI’s census scheme.³³ Therefore, these *less* productive plants were not the *least* productive ones. In Section 4.3.1, we explore how the Repeal released resources from dormant plants (i.e., plants that were no longer operational but that still held onto their land and buildings) by driving them out of the market.

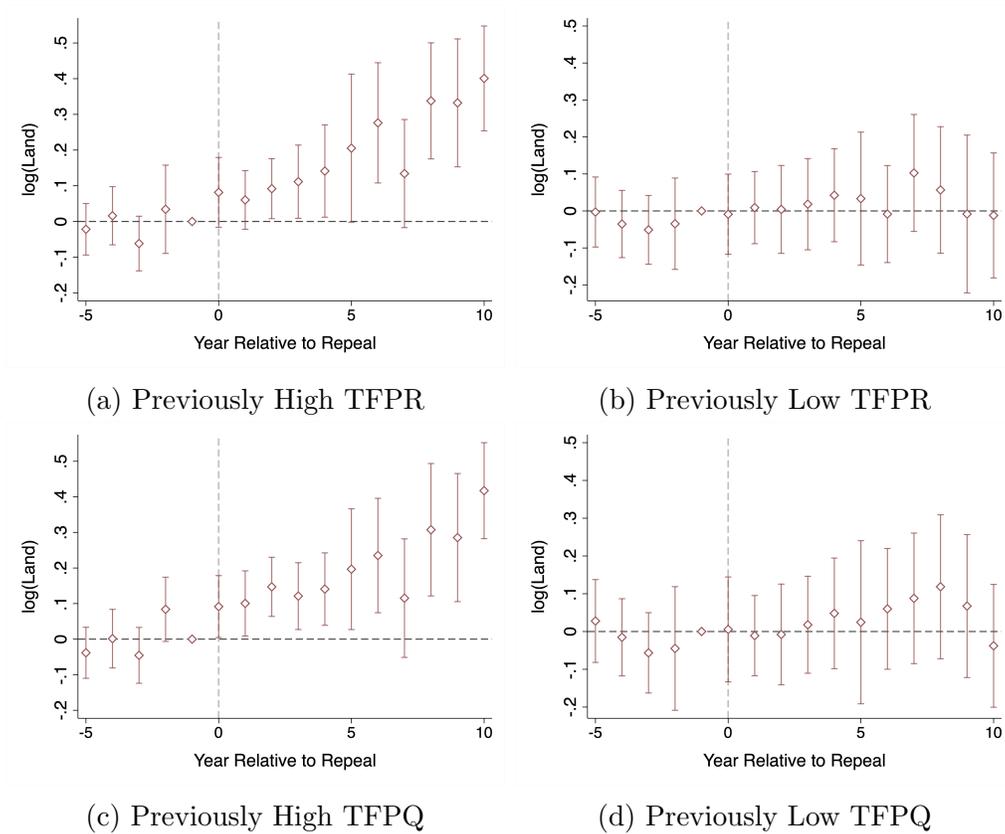


Figure 3: Event Study Plots for the Effect of the Repeal on Land Use for High/Low Productivity Plants in UAs

Note: The dependent variable is log-landholdings. We estimate Total Factor Productivity (TFPQ and TFPR) for each 2-digit industry using the methodology proposed by De Ridder et al. (2022). The regression sample is segmented by whether firms’ pre-Repeal average TFPQ (or TFPR) was above or below the district median. All regressions include plant fixed effects, year fixed effects, and controls incorporate both district pre-Repeal land endowment size bins and firm-specific land size bins, interacted with year fixed effects. Standard errors are clustered two-way by state and year. The confidence interval is at the 95% level.

³³The ‘census scheme’ in the ASI refers to plants with more than 100 employees that are surveyed every year, as opposed to a ‘sample scheme’ which may include smaller plants surveyed less frequently.

Table 2: Treatment Effect of the Repeal on Firm Production

<i>Dep. Var. (log)</i>	(1) Capital	(2) Employment	(3) Wage Bills	(4) Sales
$Repeal_{st}$	0.021 (0.045)	-0.005 (0.016)	0.017 (0.021)	0.001 (0.027)
$Repeal_{st} \times I_d^{UA}$	0.139*** (0.029)	0.066*** (0.013)	0.075*** (0.016)	0.143*** (0.022)
Observations	530,008	533,802	531,119	464,755
R-squared	0.253	0.148	0.214	0.243
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated. Capital excludes land value to avoid mechanical correlation. Land Size \times Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.2 Did the Removal of Land Constraints Unleash Industrial Growth?

4.2.1 Effects on Manufacturing Production

We now examine the effects of the liberalization on manufacturing production. This is not *ex-ante* clear, as it's uncertain whether land was truly a binding constraint on plant growth. If it was not, plants may not have produced more post-Repeal due to other market frictions, and the increase in land use might merely reflect speculative accumulation. To test if land was indeed a binding constraint, we assess the Repeal's impact on several key firm-level outcomes: fixed assets (excluding land to avoid mechanical correlation), wage bills, number of employees, and sales revenue, using the baseline empirical model in equation 1.

Table 2 documents that the Repeal had precisely null effects on all outcomes for plants in non-UAs, which is consistent with previous results. In contrast, the average plant in UAs saw a 14% increase in its stock of buildings and machinery following the Repeal. This increase in capital did not crowd out labor, as both wage bills and employee counts increased by approximately 7%. Consequently, plants in UAs experienced a 14% increase in revenues. Taken together, these results suggest that plants in UAs were indeed land-constrained prior to the reform.

Distributional Impacts. We further examine whether this expansion was predominantly driven by larger or smaller plants. Using the (re-centered) influence function approach pro-

posed by [Firpo et al. \(2009\)](#), we present quantile regression estimates of the Repeal’s effects across the entire plant size distribution for UA plants. [Figure C.5](#) shows that the Repeal had small and insignificant, albeit positive, effects on plants at the lower end of the size distribution. These effects gradually increase, peaking at the 60th to 70th percentiles. This pattern aligns with the provisions of the ULCRA, particularly the landholding ceilings, which may have disproportionately constrained larger plants due to their greater land requirements.

To further elaborate on this hypothesis, we perform an analysis similar to that of [Hsieh and Olken \(2014\)](#), examining the relationship between the average revenue product of land and plant size. [Figure C.6a](#) shows that larger plants, as measured by employee counts, exhibited a higher average revenue product of land within each 2-digit industry and year. Assuming a Cobb-Douglas production function, a higher *average* revenue product of land implies a correspondingly higher *marginal* revenue product of land. This suggests that larger plants may have faced higher land costs, as reflected by their higher marginal returns to land.³⁴

Event Study Graphs and Robustness Checks. [Figure C.4](#) presents the event study graphs for the treatment effects on firm production. Consistent with our DiD estimates, the Repeal did not affect plants in non-UAs, while plants in UAs ramped up production after the Repeal. Importantly, there is no sign of differential pre-Repeal trends in either UAs or non-UAs, supporting the causal interpretation of our findings. Additionally, [Table C.11](#) and [Table C.12](#) show that our results are robust to adding state-by-year or sector-by-year fixed effects to flexibly control for any state-level or 2-digit-sector-level policy changes or shocks. [Table C.16](#) and [Table C.15](#) further show that our results are robust to using the Stacked DiD and the imputation methods to account for potential biases in staggered DiD.

4.2.2 Effects on Productivity

Having established that the Repeal Act enabled land-constrained plants to expand production, we now examine its impact on aggregate productivity. We measure plant-level productivity as TFPQ using several methods. Our primary measure uses the methodology proposed by [De Ridder et al. \(2022\)](#) to estimate the quantity-based production function, controlling

³⁴One potential concern is that larger plants may charge higher markups rather than face higher land costs. To address this concern, panel (b) of [Figure C.6](#) shows that larger plants also tend to have higher input values per land. Additionally, one may worry that larger plants use higher-quality and imported inputs, as noted by [Kugler and Verhoogen \(2012\)](#). To mitigate this issue, panel (c) demonstrates that the positive correlation between input value per land and plant size persists even for domestic inputs. Moreover, panel (d) confirms this pattern using fuels, which should be homogeneous across plants.

for firm prices and market shares in the first stage. We demonstrate that our findings remain robust across various alternative measures of TFPQ.

Table 3: Treatment Effect of the Repeal on Productivity

<i>Dep. Var.</i>	TFPQ		
	(1)	(2)	(3)
$Repeal_{st}$	0.049 (0.047)	0.049 (0.047)	0.013 (0.032)
$Repeal_{st} \times I_d^{UA}$	0.129*** (0.040)	0.129*** (0.040)	0.126*** (0.028)
Observations	365,225	365,225	365,211
R-squared	0.489	0.489	0.532
District FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Land Size \times Year FE	No	Yes	Yes
Industry \times Year FE	No	No	Yes

Notes: The dependent variable, logged TFPQ, is measured following the methodology of [De Ridder et al. \(2022\)](#). ‘Land Size \times Year’ represents district-specific average pre-treatment land size bins, interacted with yearly fixed effects. ‘Industry \times Year’ are 2-digit industry-by-year fixed effects. Additional controls include an urban dummy, ownership fixed effects, and 2-digit industry fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 reports the TFPQ results and demonstrates that the Repeal had significantly positive effects on plants’ physical productivity. Specifically, plants in UAs experienced an approximate 13% increase in TFPQ compared to plants in non-UAs following the Repeal. The results are very stable across different specifications, and Table C.13 further confirms this consistency using three alternative TFPQ measures. Figure C.7 presents an event study graph for the regression, substantiating that our findings are not driven by pre-existing trends.

One might wonder why we observe such a substantial treatment effect on TFPQ, given that both sales revenue and input usage increased by roughly the same amount, as shown in Table 2. These results are intriguing, especially considering the findings of [Bollard et al. \(2013\)](#), who were unable to robustly link productivity growth in the Indian manufacturing sector to any other major reforms. One possible explanation is that more efficient producers may charge lower prices, which reduces sales revenue and revenue-based productivity (TFPR), as suggested by [Garcia-Marin and Voigtländer \(2019\)](#). If the Repeal reduced

marginal costs by decreasing plants’ land use costs and this reduction was fully passed on through lower prices, the effect on TFPR would be muted even when physical productivity increased. Table C.14 supports this hypothesis: Columns 1-3 show that while TFPR saw a modest and imprecise increase of 1-3% post-Repeal, average prices decreased by approximately 12%. This decline in product prices suggests that plants primarily innovated to improve production efficiency rather than quality, which would typically drive up prices. Furthermore, the impact on markups is minimal and not statistically significant, suggesting that the productivity gains were fully passed through to consumers.

4.3 How Did the Repeal Act Unleash Industrial Growth?

4.3.1 Weeding out Dormant Plants

As documented by Akcigit et al. (2021), India’s manufacturing sector suffers from a significant lack of selection, allowing stagnant plants with little growth potential to survive for extended periods. Consistent with this, Chatterjee et al. (2023) document that Indian manufacturing plants have much lower exit rates even compared to those in other developing countries. The ULCRA, by imposing restrictions on land transfers, could have further exacerbated the costs for plants to divest and exit the market, thereby locking productive resources in plants that were unprofitable or even dormant (Panagariya, 2010). In this section, we formally test Panagariya’s observation by analyzing the impact of the Repeal on plant exit.

A valuable aspect of the ASI data is that it has, since 1998, differentiated between plants that are currently non-operational but still exist (dormant)³⁵ and those that no longer exist and have thus been removed from the survey (exit).³⁶ We begin our analysis by describing the evolution of plant exit rates in states that implemented the repeal earlier vs. later.

Figure 4 panel (a) displays exit rates in states that had repealed the ULCRA in 1999 (red) versus those that repealed it in 2008 (blue), which is normalized to zero in the year

³⁵Before 1998, the *status of units* variable in the Annual Survey of Industries (ASI) was limited to two codes: (1) open and (2) closed. Since 1998, the ASI has expanded this categorization to provide specific reasons behind closures. We categorize plants as “dormant” if, during the survey, it is found that the unit was present at the specified location and had employed some staff during the reference period but either did not commence production or produced nothing (coded as 2 in the variable *status of units*). Alternatively, a plant is also considered dormant if it was present at the location but did not employ any staff or produce anything during the reference period (coded as 3 in the variable *status of units*).

³⁶Plants are labeled as exited if they meet any of the following criteria: status code 3 for three years or more, non-existence (absence of any fixed assets), deregistration, falling out of survey coverage (i.e., no longer operating as manufacturing plants), or any other reason deemed appropriate by the National Statistical Office for removal from the survey (coded as 4 in the variable *status of units*). Our definition of exit excludes cases where plants still exist but no response is received from the owners. However, it does include cases where plants remain under code 3 for more than three years.

1999. The two vertical dashed lines mark the years of the repeal. Following 1999, states that had already repealed saw higher exit rates compared to states that had not. This disparity in exit rates remained relatively stable until 2008, when the late adopters finally repealed. Subsequently, the blue line rose rapidly until it became indistinguishable from the red line. Panel (b) further confirms this trend by presenting the coefficients from a regression of plant exit dummy on the interactions between the early repeal dummy variable and bi-annual dummies, while controlling for industry-by-year, firm age, rural, and state fixed effects. This analysis demonstrates that the observed patterns are not attributable to differences in industry structures, plant age profiles, or other time-invariant state factors among early and late adopters. Consistent with this, Figure C.8 shows that states that had repealed earlier saw lower dormant rates than late adopters before 2008, supporting the hypothesis that the Repeal intensified business dynamism by weeding out dormant firms.

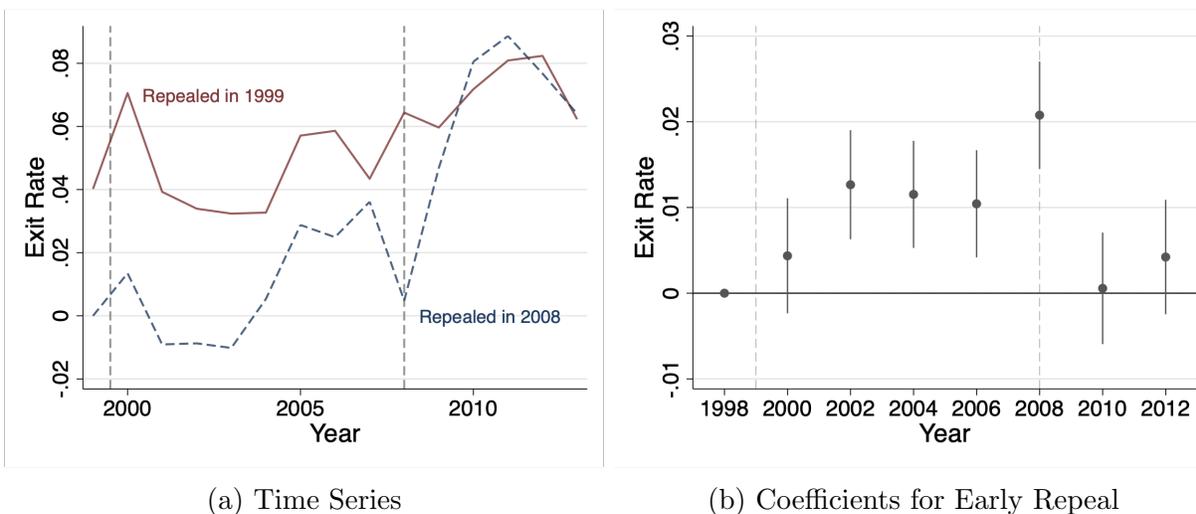


Figure 4: Exit Rates in States that Repealed in 1999 vs. Repealed in 2008

Note: Panel (a) displays the time series of exit rates for states that adopted the repeal in 1999 (red) versus those that did so in 2008 (blue). The exit rate for the states that repealed in 2008 is normalized to zero in the year 1999. ‘Exit’ is defined by code 4 in the variable ‘status of units,’ which encompasses several conditions: status code 3 (non-operational with no employees) for three years or more, non-existence (no fixed assets), deregistration, falling out of survey coverage (i.e., ceasing to operate as manufacturing plants), or any other reason approved by the National Statistical Office for survey removal. Panel (b) plots the regression coefficients of firm exit on an early repeal dummy variable, interacted with bi-annual dummies, controlling for industry-by-year, firm age, rural, and state fixed effects. The confidence intervals are set at the 95% level.

We now establish this result more rigorously. Figure 5 presents the treatment effects of the Repeal on plant exit, estimated using our baseline empirical equation. The red line shows the coefficients for UA plants (β_2), while the blue line shows the coefficients for non-UA plants (β_1). Column 1 shows that UA plants experienced a roughly 0.8 percentage point higher exit rate post-Repeal, representing a 22% increase relative to the sample mean of 3.6%. The effect is larger for plants that had ever been dormant (Column 3), with a 2.2 percentage

point increase in exit rates, equivalent to a 40% increase relative to the sample mean of 5.5%. The effect for non-dormant plants (Column 2) is similar to that of the full sample. We can also explore the heterogeneous effects on plant exit based on plants' pre-Repeal profitability. Figure C.9 shows that previously less profitable plants experienced significantly higher exit rates following the liberalization. Taken together, our results confirm that the Repeal intensified the process of creative destruction by facilitating the exit of unprofitable firms, consistent with Panagariya's observation.

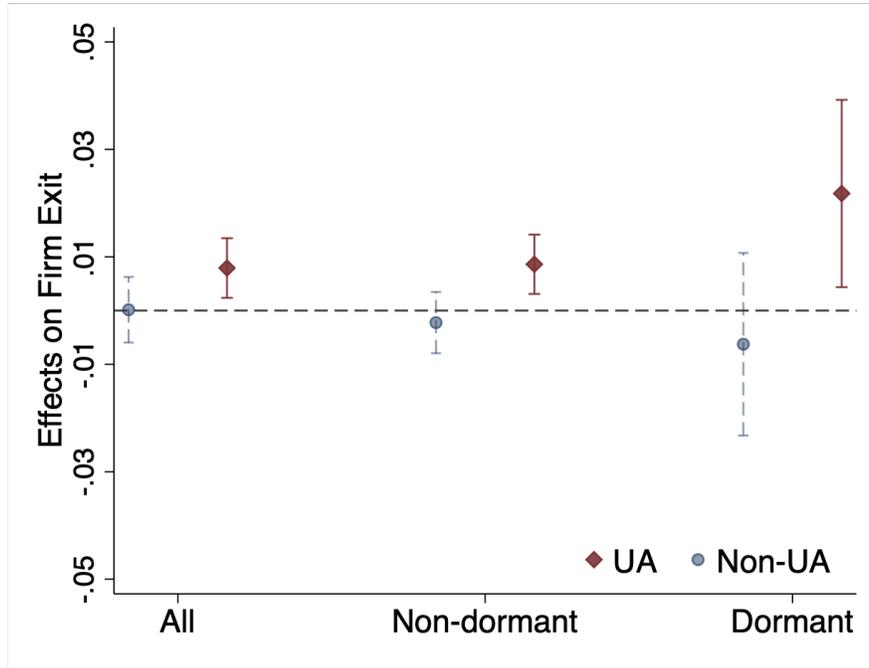


Figure 5: Treatment Effect of the Repeal on Plant Exit

Note: This figure displays the treatment effects of the Repeal on plant exit. The dependent variable is a plant exit dummy, coded as 4 in the 'status of units' (as previously described in Figure 4). 'Dormant' refers to plants that have even been indicated as dormant by codes 2 or 3 in 'status of units', while 'Non-dormant' includes all other plants. Controls include a rural dummy, 2-digit industry fixed effects, firm age fixed effects, and land size quartile-by-year fixed effects.

4.3.2 Intensified Creative Destruction of Products

We further demonstrate that the Repeal fostered business dynamism by encouraging plants to engage in endogenous innovation for growth. We measure innovation by tracking product innovation, using the ASI's detailed product data.³⁷ We construct two measures of product

³⁷The ASI dataset provides product-level sales and quantities, as mandated by the 1956 Companies Act. Products are categorized by 5-digit product codes, with over 12,000 distinct products in our sample, differentiating items like men's shirts (28232) from women's shirts (28234).

innovation at the plant-year level: 1) the number of new products a firm adds to its portfolio, and 2) the number of products it stops producing.³⁸ In our sample, over 50% of the plants introduced zero new products throughout their life cycle. This is consistent with estimates in [Akcigit et al. \(2021\)](#) and [Peters and Zilibotti \(2021\)](#), which suggest that the majority of Indian plants are subsistence plants with low growth potential.

Table 4: Treatment Effect of the Repeal on Creative Destruction

<i>Dep. Var.</i>	(1) #New Products	(2) #Del. Products
<i>Repeal_{st}</i>	-0.066 (0.042)	-0.057 (0.061)
<i>Repeal_{st} × I_d^{UA}</i>	0.142*** (0.041)	0.179*** (0.045)
Observations	264,437	272,669
Year FE	Yes	Yes
District FE	Yes	Yes
Land Size×Year FE	Yes	Yes

Notes. #New Products indicates the number of new 5-digit products added to a firm’s product portfolio. #Del. Products indicates the number of 5-digit product deleted from a firm’s portfolio. Columns (1) - (2) are obtained through Poisson Pseudo-Maximum Likelihood regression and are based on data from 1995 to 2009 due to the change in product code classifications after 2010. Land Size×Year are quartiles of districts’ pre-treatment average land value interacted with year fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4 reports the impact of the Repeal on product innovation within UAs and non-UAs, using our baseline specification. In line with our hypothesis, the Repeal led to a 14% increase in the addition of new products (Column 1) and an 18% increase in the deletion of old products (Column 2) among firms in UAs, indicating intensified creative destruction. Table C.18 confirms that our findings are robust to defining products using 4-digit product codes.³⁹ Table C.19 shows that the Repeal did not affect the number of products a firm produces, suggesting that it had no impact on product varieties. Figure C.10 presents event

³⁸Our measure of product innovation has several advantages over more conventional measures of innovation, such as patent counts and R&D spending, which are rarely pursued by firms in developing countries. For example, the ASI only began including questions about R&D activities in 2015, and merely 3% of plants reported having spent anything on R&D.

³⁹One concern is that our coding of product innovation might inadvertently capture measurement error and misreporting. For instance, a misreported change from men’s shirts (28232) to women’s shirts (28234) would be counted as product innovation under our current definition. Although there is no reason to suspect that such misreporting became more prevalent after the Repeal, we verify that our results are robust to using a more conservative coding of product innovation based on 4-digit product codes. Products in different 4-digits generally represent different subclasses and are produced using distinct techniques. For example,

study graphs showing the treatment effects on creative destruction. Although the estimates are noisier, there is no evidence of differential pre-Repeal trends in either UAs or non-UAs. This analysis illustrates how the Repeal enhanced market dynamism by prompting plants to update their product portfolios more frequently, introducing new products, and discontinuing old ones, thereby driving the cycle of creative destruction.

4.3.3 Entry of More Innovative Plants

We now turn to the effects of the Repeal on plant entry, which is *ex-ante* ambiguous due to two countervailing forces. On one hand, the Repeal reduced landholding and transaction costs, making it easier for entrepreneurs to start and expand their businesses, which could attract new entrants with higher growth potential. On the other hand, the intensified creative destruction resulting from the Repeal have increased the risks of market entry, which could discourage potential entrants from entering the market.

To analyze the impact on plant entry, we aggregate our data to the district-year level and measure three types of entry: the total number of new entrants, the number of subsistence entrants, and the number of innovative entrants. Entrants are classified as subsistence if they introduce no new products throughout their life cycle, once they enter the market. Over 60% of entrants in our sample are subsistence entrants. We then estimate our DiD specification at the district-year level for each entry measure using the Poisson Pseudo-Maximum Likelihood (PPML) method, given the frequent occurrence of zeros in our outcome variables.

Table 5 presents the treatment effects of the Repeal on three types of entry. Column (1) shows that the Repeal had a small and statistically insignificant effect on the total count of entrants in both UAs and non-UAs. However, Columns (2) and (3) reveal underlying heterogeneity in these effects across different types of plants. Specifically, while the entry of subsistence plants remained unaffected, districts that implemented the Repeal experienced a significant 32% increase in the number of innovative entrants. Figure C.11 presents the event study graphs for the Repeal's effect on the entry of innovative plants, confirming that our results are not influenced by pre-existing trends. These findings support our hypothesis that the Repeal, by easing land market constraints, facilitated firm expansion and preferentially attracted new firms with higher growth potential.

this includes distinctions between (2822) wearing apparel, knitted or crocheted, and (2823) wearing apparel, not knitted or crocheted. Hence, the creative destruction measures using 4-digit codes could be viewed as indicating more radical innovation.

Table 5: Treatment Effect of the Repeal on Firm Entry

<i>Dep. Var.</i>	# Entrants		
	Total Entrants (1)	Subsistence Entrants (2)	Innovative Entrants (3)
$Repeal_{st}$	-0.076 (0.099)	-0.155 (0.104)	-0.109 (0.110)
$Repeal_{st} \times I_d^{UA}$	0.091 (0.100)	0.043 (0.113)	0.320*** (0.109)
Observations	5,383	5,314	5,196
Year FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
District Control \times Year FE	Yes	Yes	Yes

Notes: The dependent variables are the count of total entrants (column 1), subsistence plant entries (column 2), and innovative plant entries (column 3) per district-year. An ‘entrant’ is defined as a firm whose age is less than or equal to one year. Data is aggregated to the district-year level from plant-year records using sampling weights. Observations in district-years with fewer than 30 cases are excluded. Regressions employ the Poisson Pseudo-Maximum Likelihood method. Subsistence plants are defined as those that do not introduce any new products throughout their lifecycle. District Control \times Year FE include quartiles of pre-Repeal district-level metrics: share of plants in urban areas, share of privately owned plants, and number of plants, each interacted with year fixed effects. Standard errors are clustered two-way by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Predicted Innovativeness. Concerns might arise about classifying entrants based on their *ex-post* innovativeness (as measured by the number of new products introduced throughout a plant’s life cycle), which could also be influenced by land market frictions. To address this, we applied the least absolute shrinkage and selection operator (LASSO), which is trained using pre-Repeal data to predict entrants’ innovativeness based on initial plant characteristics at the time of entry. These characteristics include ownership and organization structure, import behavior, computer usage, and product count, along with all two-way interactions and quadratic terms. Figure C.12 displays a strong correlation between the predicted and actual innovativeness, both before and after the Repeal, confirming the accuracy of the LASSO prediction. Entrants are then classified as innovative if their predicted innovativeness exceeds a cutoff value, which is chosen to match the proportion of entrants that have introduced some new products in the pre-Repeal period.

Table C.20 replicates the findings of Table 5 but classifies entrants based on LASSO-predicted innovativeness. The close alignment of estimates between the two tables alleviates concerns of bias from potentially endogenous classifications. Another concern might arise regarding the arbitrary cutoff used to categorize entrants as innovative or subsistence. To address this, Figure 6 illustrates the treatment effects of the Repeal (β_2) on the number of entrants within each quartile of innovativeness. The results show a notable decrease in entrants in the least innovative quartile following the Repeal. However, the effects become

more positive, albeit not statistically significant, for the two middle quartiles and significantly positive for the most innovative quartile. Overall, these results confirm that the Repeal shifted the composition of new entrants towards greater innovativeness.⁴⁰

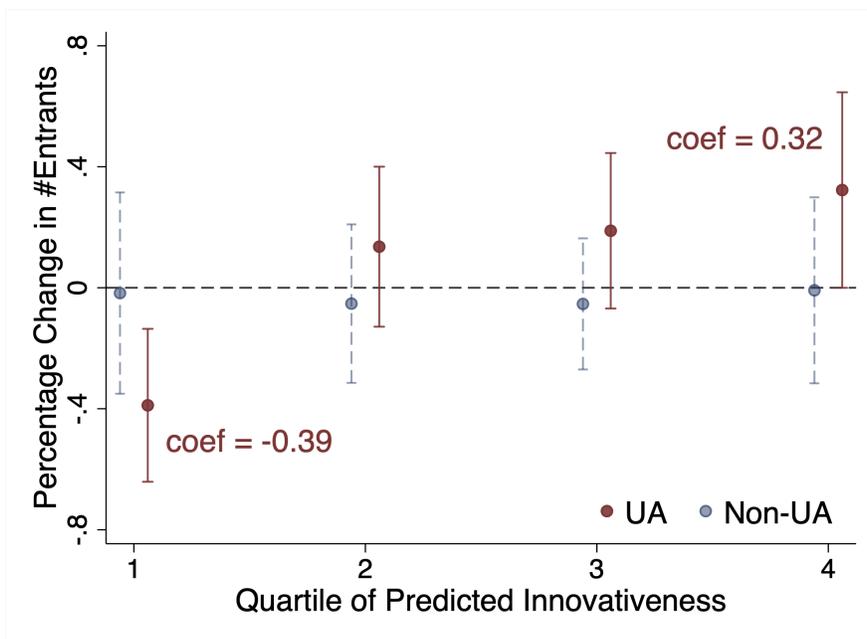


Figure 6: Treatment Effects of the Repeal on Firm Entry Across Innovativeness Quartiles

Note: This figure illustrates the treatment effects of the Repeal (β_2) on the number of entrants within each quartile of innovativeness. Quartile 1 represents the least innovative firms, while Quartile 4 represents the most innovative, as determined by the LASSO-predicted innovativeness measure. The LASSO model is trained by regressing the number of new products introduced by plants throughout their life cycle on various plant-level characteristics recorded at entry, using pre-Repeal data. These characteristics encompass a range of dummies for private ownership, urban location, sole proprietorship, census scheme participation, importing foreign intermediates, and using computers, in addition to the total number of products. The model also includes the quadratic and interaction terms of these variables.

4.4 Further Remarks on the Impacts of the Repeal

While our empirical analysis in this paper focuses on the impacts of the Repeal Act on manufacturing firms, the ramifications of this legislative change extended well beyond the manufacturing sector. The land ceiling regulation, a key element of the ULCRA, might influence aggregate productivity through both agglomeration and congestion forces, which

⁴⁰This pattern also explains why we observe a null effect of the Repeal on total firm entry. The ASI data contains only formally registered manufacturing plants; informal plants and household enterprises are, therefore, outside the scope of the analysis. In other words, the ASI sample is likely to be left-truncated, with many less innovative plants that experienced a decline in entry rate missing from our data. The absence of the left tail should not bias our estimate of the effect on innovative firm entry, as those informal plants are unlikely to have high growth potential.

have been extensively discussed in the urban literature. Furthermore, the expansion of urban manufacturing firms could potentially act as a catalyst for rural-to-urban migration and structural changes, thereby reshaping the spatial distribution of labor. Apart from these economic implications, the redevelopment of urban land holds significant relevance for the living conditions of urban inhabitants. For instance, [Gechter and Tsivanidis \(2023\)](#) provides a case study of the redevelopment of 60 textile mills in Mumbai. Their study highlights that while such urban redevelopment projects can benefit the city’s residents by increasing housing and floor space supply, they can concurrently impose substantial costs on slum dwellers who are forcibly relocated. These dimensions present interesting avenues for future research, yet they fall outside the scope of this study.

Socio-economic Impacts of the Repeal. For interested readers, we provide some evidence on the socioeconomic impacts of the Repeal in Appendix Section E, drawing on village-level employment and amenity data from three rounds of the Population Census, household wealth data from the 2012 Socio-Economic and Caste Census, and household expenditure data from the National Sample Surveys. We show that the Repeal Act facilitated the reallocation of agricultural laborers to non-agricultural sectors. Notably, villages even 25 kilometers away from UAs experienced significant structural changes after the Repeal. However, we do not observe short- to mid-term improvements in amenities such as roads, electricity, and schools around Urban Agglomerations. The null effects on amenities also mitigate concerns that our firm results are driven by infrastructure investments made after the Repeal. Additionally, there was no deterioration in housing conditions or increase in residential rents post-Repeal. We also present suggestive evidence of increased household income and reduced poverty rates.

JNNURM. One potential confounding policy is the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a nationwide urban development initiative launched by the federal government from December 2005 to March 2011. The JNNURM had two missions: Urban Infrastructure and Governance (UIG), which aimed to improve water supply and sanitation, solid waste management, road networks, urban transport, and the redevelopment of old city areas, and Basic Services to the Urban Poor (BSUP), which focused on slum development. One of the conditions for states to receive JNNURM funding was the repeal of ULCRA if it had not already been repealed. The JNNURM targeted 65 cities in total, which included cities with populations exceeding one million in 2001, as well as cities of religious, historic, and touristic significance. The list of JNNURM cities had a partial overlap with the Urban Agglomerations (UAs) affected by the ULCRA.

Given this overlap, there is a concern that our estimated Repeal’s effects might be influenced by JNNURM funding and infrastructure projects initiated after 2006. However, the impacts of the JNNURM likely had not materialized within our study timeframe, which ends in 2013. According to the government’s audit report, by 2011, only 17.8% of approved UIG projects and 1.5% of BSUP projects had been completed ([Comptroller and Auditor General of India, 2012](#)). Using detailed JNNURM implementation data, we demonstrate that it is unlikely to bias our results, as discussed in Appendix Section F.

5 A Model of Firm Dynamics and Land Constraints

In this section, we present a dynamic model of innovation with heterogeneous firms subject to land market constraints to quantify the aggregate consequences of the Repeal Act on both the *level* and *growth rate* of productivity. The core of our model is the Schumpeterian force of creative destruction, following the framework of [Klette and Kortum \(2004\)](#) and [Lentz and Mortensen \(2008\)](#). In this model, firms grow and enter the market by innovating to take over products from their current holders, while they shrink and exit when hit by a series of innovation shocks from competitors. The economy as a whole grows as these innovations enhance the process efficiency of a given set of products. Following [Acemoglu et al. \(2018\)](#) and [Akcigit et al. \(2021\)](#), firms in our model have heterogeneous types—high and low—determined upon entry, which dictate their “innovative capacity.” Additionally, potential entrants can make a costly investment to increase their likelihood of becoming a high-type firm upon successful entry.

Our model is designed to incorporate the following key findings from our empirical analysis: (1) the Repeal Act eased land constraints for manufacturing firms and reduced land misallocation; (2) it enhanced firm selection by driving unprofitable firms out of the market and attracting more innovative ones; and (3) post-Repeal, firms experienced accelerated creative destruction, simultaneously adding and deleting more products. The model thus captures both the *static* effect of the Repeal on the level of aggregate productivity, arising from changes in resource misallocation, as well as its *dynamic* effect on productivity growth through endogenous innovation.

5.1 Economic Environment

Preferences

Consider an economy in which time is continuous and indexed by $t \in \mathbb{R}_+$. This economy is populated by an infinitely-lived representative household of unit measure with the following preferences over a consumption bundle C_t :

$$U_t = \int_t^\infty e^{-\rho(T-t)} \ln(C_T) dT. \quad (2)$$

Here, $\rho > 0$ is the household's rate of time preference, and the consumption bundle is a CES aggregator of differentiated products (indexed by i):

$$C_t = \left(\int_0^1 c_{it}^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \quad (3)$$

where c_{it} is the quantity consumed of product i , and $\sigma > 1$ is the elasticity of substitution between products. The household supplies one unit of labor inelastically per period and owns one unit of land, which is also rented out inelastically.

Technology

Each product is manufactured by a single firm using both labor and land with Hicks-neutral productivity $z_{it} \in \mathbb{R}_+$ according to the following Cobb-Douglas production technology:

$$y_{it} = z_{it} h_{it}^\alpha l_{it}^{1-\alpha}. \quad (4)$$

Here, y_{it} is the quantity of product i supplied by the firm, h_{it} and l_{it} respectively denote the quantity of labor and land used in production, and $\alpha \in [0, 1]$.

A firm is indexed by f and consists of a portfolio of products collected in the set \mathcal{P}_{ft} with cardinality $n_{ft} = |\mathcal{P}_{ft}| \in \mathbb{N}$ and corresponding process efficiencies $\{z_{it}\}_{i \in \mathcal{P}_{ft}}$. Firms can grow over time by adding more products to their portfolio. Specifically, a firm holding n products must allocate $c_t^X(X, n, \theta)$ units of final goods towards R&D to achieve a Poisson expansion rate of X :

$$c_t^X(X, n, \theta) = \frac{X^{1+\zeta} Y_t}{\theta(1+\zeta)n^\zeta} \quad (5)$$

where Y_t denotes aggregate output, θ is the firm's expansion "capacity" and $\zeta > 0$ determines the convexity of the expansion cost function. If expansion is successful, a firm takes over one

of its competitors' products and improves on its process efficiency by a factor of $\lambda > 1$.

Following [Acemoglu et al. \(2018\)](#) and [Akcigit et al. \(2021\)](#), we assume that firms differ in their expansion capacity $\theta \in \{\theta_L, \theta_H\}$, corresponding to high (H) and low (L) types ($\theta_H > \theta_L \geq 0$). Therefore, high-type firms tend to grow faster, own more products, and be larger. For simplicity, we assume that low-type firms are subsistence firms and do not innovate, setting $\theta_L = 0$.⁴¹ Upon successful entry into the economy, each firm draws its type such that

$$P(\theta = \theta_H) = \delta \quad \text{and} \quad P(\theta = \theta_L) = 1 - \delta.$$

A unit measure of potential entrants can allocate final goods toward R&D to enter the market and invest to increase their chances of becoming high-type firms. Specifically, $c_t^E(e, \delta)$ units of final goods are required to achieve an entry rate of e and a probability δ of being high-type:

$$c_t^E(e, \delta) = \frac{e^{1+\zeta} Y_t}{\theta_E(1+\zeta)} + \frac{\delta Y_t}{\phi(1-\delta)} \quad (6)$$

where $\theta_E > 0$ determines the efficiency of the entry technology, and $\phi > 0$ governs the scale of the investment cost for becoming high-type.⁴²

Land Constraints. For tractability and to focus on firm dynamics, we make several simplifying assumptions regarding land constraints in the baseline model. We model the ULCRA as imposing a “wedge” $\tau > 0$ on the land cost and assume that only high-type firms are affected by land constraints. These assumptions serve as a shorthand for modeling size-dependent frictions, capturing the idea that high-type firms are larger, use more land, and are thus more likely to exceed landholding limits and face greater regulatory burdens. In contrast, low-type firms, often smaller and informal, can avoid such land constraints since it is more costly for the government to monitor their land transactions and holdings.⁴³

⁴¹Modeling low-type firms as subsistence is consistent with the Indian context, where most firms operate on a very small scale with limited growth potential. It also aligns with existing literature. For example, [Akcigit et al. \(2021\)](#) make a similar assumption in their model of the managerial environment in India, where low-type firms are assumed to be non-innovative. Additionally, [Bertrand et al. \(2021\)](#) estimate θ_L from data and find it to be nearly zero in their study of contract labor in Indian manufacturing firms.

⁴²The functional form of the entrant investment cost, $\frac{\delta Y_t}{\phi(1-\delta)}$, ensures the cost tends to infinity as δ approaches 1. This endogenous firm type at entry is important to matching our empirical evidence that the Repeal changed the composition of new entrants.

⁴³[Bertrand et al. \(2021\)](#) make similar assumptions in their model of labor regulations in India, which increase the costs for larger plants (with more than 100 employees) to fire workers. Specifically, they assume that these labor regulations create a wedge in labor costs, but only for the more innovative type. This is also consistent with our empirical findings reported in [Figure C.5](#) that the Repeal had minimal impacts on smaller plants, as they were less constrained by the ULCRA's landholding limits.

Resource Constraints

Final goods can either be allocated to consumption, expansion, or entry, which delivers the following resource constraint:

$$C_t + R_t^X + R_t^E \leq Y_t. \quad (7)$$

Here, R_t^X and R_t^E denote the aggregate allocations of final goods towards expansion and entry, respectively. The resource constraint for labor is given by:

$$\int_0^1 h_{it} di \leq 1 \quad (8)$$

The resource constraint for land is given by:

$$\int_0^1 l_{it} di \leq 1 \quad (9)$$

and the resource constraints for products are given by:

$$c_{it} \leq y_{it}, \quad \forall i \in [0, 1]. \quad (10)$$

5.2 Decision Problems

The Household's Problem

Taking prices as given, the household's problem is to choose its demand for each product to maximize lifetime utility:

$$\max_{\{c_{i\tau} \geq 0\}_i} \int_t^\infty e^{-\rho(\tau-t)} \ln(C_\tau) d\tau$$

subject to the flow budget constraint:

$$\dot{A}_t + \int_0^1 p_{it} c_{it} di \leq r_t A_t + w_t + m_t \quad \text{s.t.} \quad C_t = \left(\int_0^1 c_{it}^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}.$$

Here, w_t and m_t respectively denote the prices of labor and land, A_t is the value of corporate assets, and r_t is the rate of return on those assets:

$$A_t = \int_0^1 V_{it} di \quad \text{where} \quad \lim_{t \rightarrow \infty} e^{-\int_0^t r_\tau d\tau} A_t = 0$$

and where V_{it} denotes the value of product i . This problem delivers the usual Euler equation:

$$\dot{C}_t = (r_t - \rho)C_t,$$

and the following demand functions for each product:

$$c_{it} = C_t(P_t/p_{it})^\sigma, \quad \forall i \in [0, 1]$$

where P_t denotes the ideal price index and is defined as:

$$P_t \equiv \left(\int_0^1 p_{it}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}.$$

The final good is chosen as the numéraire such that $P_t = 1$ for all t .

The Firm's Problem

Static Maximization. Firms engage in monopolistic competition in the product market but perfect competition in the input markets, taking the prices of labor and land, and the demand for their products as given. A firm thus chooses the price at which to sell each of its products and its demand for labor, land, and final goods to maximize the expected present discounted value of its profits.

Denoting by π_{it}^T the flow profits from product i operated by a type- T firm, we have:

$$\pi_{it}^T = p_{it}y_{it} - w_t h_{it} - (1 + \tau_t^T)m_t l_{it} \quad \text{where} \quad \tau_t^T \equiv \tau \mathbb{1}_{T=H}.$$

As a consequence of monopolistic competition against its closest competitors, the firm sets the price of its product to a constant markup above its marginal cost of production:

$$p_{it}^T = \mu \cdot \frac{\varsigma_t}{z_{it}} (1 + \tau_t^T)^{1-\alpha} \quad \text{where} \quad \mu \equiv \frac{\sigma}{\sigma - 1} \quad \text{and} \quad \varsigma_t \equiv \left(\frac{w_t}{\alpha} \right)^\alpha \left[\frac{m_t}{1 - \alpha} \right]^{1-\alpha}. \quad (11)$$

Here, ς_t denotes the producer price index of inputs. Product-level profits net of land frictions are equal to:

$$\pi_t^T(z) = \frac{z^{\sigma-1} C_t}{\sigma (\mu \varsigma_t)^{\sigma-1}} (1 + \tau_t^T)^{(1-\sigma)(1-\alpha)}.$$

Hence, high-type firms tend to have lower product-level profits since $\sigma > 1$ and $\alpha < 1$.

Value Functions. The dynamic problem of a high type firm with a portfolio of n products with corresponding process efficiencies $\{z_i\}_i$ is summarized by the Hamilton-Jacobi-Bellman (HJB) equation:

$$\begin{aligned}
r_t V_t^H(n, \{z_i\}_i) &= \sum_{i=1}^n \pi_t^H(z_i) && \text{Flow profits} \\
- \sum_{j=1}^n \chi_t [V_t^H(n, \{z_i\}_i) - V_t^H(n-1, \{z_i\}_{i \neq j})] &&& \text{Creative destruction} \\
+ \max_X \{X \int V_t^H(n+1, \{z_i\}_i \cup \{\lambda z\}) dF_t(z) &&& \text{Expansion benefit} \\
- c_t^X(X, n, \theta_H)\} &&& \text{Expansion cost} \\
+ \dot{V}_t^H(n, \{z_i\}_i) &&& \text{Capital gains.}
\end{aligned}$$

The firm's value function is intuitive and can be interpreted as follows. Given the discount rate r_t , the left-hand side is the flow value of holding a portfolio of n products with process efficiencies $\{z_i\}_i$. The right-hand side includes the components that make up this flow value. The first term represents the flow of profits generated by each product. The second term captures changes in firm value if any of its products gets replaced by another firm through creative destruction at the rate χ_t . The third term represents the change in firm value when the firm successfully expands. The fourth term subtracts its R&D investments, and the last term captures capital gains. The value function takes an additive form

$$V_t^H(n, \{z_i\}_i) = \sum_{i=1}^n v_t^H(z_i) C_t$$

where $v_t^H(z_i)$ is the franchise value of a product line, normalized by the final product, of productivity z_i for a high-type firm. $v_t^H(z)$ is given by the following differential equation:

$$(\rho + \chi_t) v_t^H(z) = \dot{v}_t^H(z) + \frac{z^{\sigma-1} (1 + \tau)^{(1-\sigma)(1-\alpha)}}{\sigma (\mu \zeta_t)^{\sigma-1}} + \max_{x_t^H} \left\{ x_t^H \mathbb{E}[v_t^H(\lambda z)] - \frac{(x_t^H)^{\zeta+1} Y_t}{\theta^H (1 + \zeta) C_t} \right\} \quad (12)$$

where the last term captures the option value of innovating upon a new product, which equals the expected payoff of innovation minus the expansion costs. The optimal expansion rate is thus given by:

$$x_t^H = \left\{ \mathbb{E}[v_t^H(\lambda z)] \theta^H C_t / Y_t \right\}^{1/\zeta} \quad (13)$$

This expression makes it clear that the expansion rate is increasing with the innovation capacity θ_H and the expected value of a new product, $\mathbb{E}[v_t^H(\lambda z)]$. We can substitute Equation (13) into Equation (12) and solve the ODE for the expected product value of for high-type

firms:

$$\mathbb{E}[v_t^H(z)] = \frac{\mathbb{E}[z^{\sigma-1}](1+\tau)^{(1-\sigma)(1-\alpha)}}{[\rho + \chi_t + (\sigma-1)g_t]\sigma(\mu_{\zeta_t})^{\sigma-1}} + \frac{\mathbb{E}[v_t^H(\lambda z)]^{1+1/\zeta}(\theta_H C_t/Y_t)^{1/\zeta}}{[(1+1/\zeta)(\rho + \chi_t)]} \quad (14)$$

This equation is intuitive and illustrates how land market frictions (τ) result in dynamic losses. The first term represents the expected flow profits, adjusted for the land cost wedge, and the second term captures the net payoff of obtaining a new product line, or the option value. The expected product value for high-type firms decreases with τ since they must pay higher land costs and employ less land, resulting in lower flow profits. In response to this, high-type firms invest less in innovation, which further pushes down the option value.

Similarly, the expected value of a product for low type firms is given by:

$$\mathbb{E}[v_t^L(z)] = \frac{\mathbb{E}[z^{\sigma-1}]}{[\rho + \chi_t + (\sigma-1)g_t]\sigma(\mu_{\zeta_t})^{\sigma-1}}$$

Note that low-type firms do not innovate and thus receive no option value of innovating upon a new product, but they enjoy greater flow profits since they are not subject to land market frictions.

The Entrant's Problem

Entrants engage in perfect competition on the labor market and, therefore, choose a flow of entry to maximize future expected profits while taking prices as given:

$$V_t^E = \max_{e,\delta} \{e[\delta \int V_t^H(1, \{\lambda z\})dF_t(z) + (1-\delta) \int V_t^L(1, \{\lambda z\})dF_t(z)] - c_t^E(e, \delta)\}.$$

The first-order condition of the entrant's problem delivers the optimal entry rate:

$$e_t = \left\{ \left(\delta \mathbb{E}[v_t^H(\lambda z)] + (1-\delta) \mathbb{E}[v_t^L(\lambda z)] \right) \theta_E C_t/Y_t \right\}^{1/\zeta} \quad (15)$$

and the optimal high-type probability:

$$\delta = 1 - \left\{ \left(\mathbb{E}[v_t^H(\lambda z)] - \mathbb{E}[v_t^L(\lambda z)] \right) \phi e_t C_t/Y_t \right\}^{-1/2}. \quad (16)$$

Equation (16) illustrates how land market frictions (τ) distort the composition of entrants. A higher τ leads to a lower expected product value for high-type firms, $\mathbb{E}[v_t^H(\lambda z)]$, by reducing their flow profits and R&D values. Meanwhile, a higher τ increases the expected product

value for low-type firms, $\mathbb{E}[v_t^L(\lambda z)]$, by reducing the high-type expansion rate and thus the rate of creative destruction, allowing low-type firms to survive longer. These two forces both contribute to a decrease in the difference ($\mathbb{E}[v_t^H(\lambda z)] - \mathbb{E}[v_t^L(\lambda z)]$). In other words, it becomes more profitable for potential entrants to enter as low-type firms, resulting in less investment in δ . However, the effect of τ on ($\delta\mathbb{E}[v_t^H(\lambda z)] + (1 - \delta)\mathbb{E}[v_t^L(\lambda z)]$), and thus on the optimal entry rate e , is ambiguous.

Aggregate Growth

In the steady state, the share of products owned by high-type firms, N^H , and low-type firms, N^L , is given by:

$$N^L = \frac{e(1 - \delta)}{\chi} \quad \text{and} \quad N^H = 1 - N^L$$

where N^L decreases with χ , since low-type firms hold only one product and exit the market at the creative destruction rate χ . The creative destruction rate is determined by the expansion rate of high-type firms, their product share, and the entry rate of potential new entrants:

$$\chi = x^H \cdot N^H + e$$

The growth rate of aggregate output Y is then:

$$g = \chi \cdot \frac{\lambda^{\sigma-1} - 1}{\sigma - 1} \tag{17}$$

5.3 Equilibrium

A dynamic equilibrium of this economy is characterized by time paths:

$$\{y_t, l_t, h_t, p_t, \{V_t^H(n)\}_{n=1}^\infty, V_t^L, x_t^H, x_t^E, \delta_t, \{M_t^H(n)\}_{n=1}^\infty, N_t^L, m_t, w_t, g_t, r_t\}_{t=0}^\infty$$

such that: (i) $\{y_t, l_t, h_t, p_t\}$ satisfy the firm's maximization problem as outlined in (11); (ii) the value functions $V_t^H(n)$ and V_t^L ; (iii) the entry rate, innovation intensity, and the share of high-type upon entry $\{e_t, x_t^H, \delta_t\}$ are given by Equations (13), (15) and (16); (iv) the mass of firms of each size $\{M_t^H(n), N_t^L\}$ are consistent with the flow equations in Appendix B.4.1; (v) land rent and labor wage $\{m_t, w_t\}$ are pinned down by land and labor market clearing conditions; (vi) the aggregate growth rate g is given by Equation (17) and, together with the interest rate r_t , are consistent with the household's Euler equation.

Taking Stock. We have developed a dynamic model of innovation by firms subject to land constraints τ to quantify the *aggregate* effects of the Repeal Act on both the *level* and *growth rate* of productivity. The model makes several predictions that are consistent with our empirical results. First, the Repeal leads to an increase in firms’ landholdings and life-cycle growth, especially for high-type firms that were previously land-constrained. Secondly, firms experience accelerated productivity growth driven by creative destruction, resulting from intensified innovation by high-type firms. Finally, because firms are heterogeneous in their growth potential, a reduction in land market frictions is also accompanied by intensified firm selection. Since subsistence entrepreneurs are small in equilibrium, they do not benefit from the opportunity to grow post-Repeal. Consequently, they are less likely to enter the market and more likely to exit due to the higher rate of creative destruction. In the following section, we take our model to the data and analyze the equilibrium impacts of the Repeal and its welfare consequences.

6 Estimation

In this section, we discuss the quantification of our model. Section 6.1 presents the resulting values of its structural parameters and the corresponding targeted moments. We show that our model successfully match key estimated Repeal’s effects presented in Section 4. Section 6.2 demonstrates that our model also replicates a variety of non-targeted moments, capturing several key characteristics of the Indian economy. Section 6.3 discusses the equilibrium impacts of the Repeal through the lens of our model. In Section 6.4, we use the model to quantify the static and dynamic welfare gains from the Repeal. Finally, Section 6.5 discusses counterfactual policies.

6.1 Calibrated Parameters and Targeted Moments

Our model features eight *structural* parameters, $\{\rho, \sigma, \alpha, \phi, \lambda, \zeta, \theta_E, \theta_H\}$, and one *policy* parameter τ . Table 6 summarizes these parameters and their corresponding targeted moment.

We first assign conventional values to the following subset of structural parameters: $\{\rho, \sigma, \alpha, \zeta\} = \{0.05, 4, 0.8144, 1\}$. Here, α is chosen to match the average elasticity of output with respect to labor and land estimated by Sood (2022) for the Indian manufacturing sector.⁴⁴ We set the innovation cost convexity, $1 + \zeta$, to 2, aligning with the elasticity of

⁴⁴Using the same ASI data from 1999 to 2015, Sood (2022) estimate the share of land costs relative to labor costs as ranging from 0.19 in the non-metallic mineral sector to 0.21 in textiles and 0.42 in the vehicle manufacturing sector.

Table 6: Summary of Parameters

Parameter	Description	Value	Target
<i>Panel A. Externally calibrated</i>			
ρ	Discount rate	0.05	-
σ	CES elasticity	4.00	Gaulier and Méjean (2006)
$1 - \alpha$	Land share	0.19	Sood (2022)
$1 + \zeta$	Innovation cost convexity	2.00	Acemoglu, Akcigit, Alp, Bloom, Kerr (2018)
<i>Panel B. Internally calibrated</i>			
λ	Innovation step size	1.337	TFP growth rate 1980-1992
θ^H	High-type innovation efficiency	0.020	Average number of products
θ^E	Entrant innovation efficiency	0.013	Entry rate
ϕ	Entrant cost of being High-type	5.200	Share of old firms (40-45) relative to young (1-5)
τ	Land cost wedge	0.239	DiD moments

innovation relative to R&D resources as discussed in [Acemoglu et al. \(2018\)](#). The CES elasticity of substitution, σ , is set to 4, following the estimates from [Gaulier and Méjean \(2006\)](#) for India. Additionally, we use a time discount rate of 0.05.

The remaining structural and policy parameters are jointly estimated by minimizing the distance between several key empirical moments and their theoretical counterparts in the model. To calibrate these structural parameters, we use data from the period before 1999. While our parameters are calibrated jointly, we provide below a heuristic description of the relationship between the parameters and specific moments. We calibrate the innovation step size, λ , to match the growth rate of TFP observed among manufacturing firms from 1980 to 1992, as calculated by [Bollard et al. \(2013\)](#). The entry capacity parameter, θ^E , is calibrated to match the firm-level entry rate, whereas the expansion capacity, θ^H , is primarily identified by the average number of products held by a firm. Given that firms enter the market with a single product and expand by adding more, a higher θ^H results in a larger average firm size. The scale parameter, ϕ , of the targeted entry cost function, is identified by the prevalence of older firms relative to younger ones. Indeed, a higher ϕ raises the cost of achieving a higher likelihood of drawing a high expansion capacity, thus reducing δ . In turn, a lower level of δ , which implies that only a small fraction of entrants would be high-type firms, is consistent with fewer firms surviving to old age at any given rate of creative destruction.

We calibrate the policy parameter τ to match our DiD estimates.⁴⁵ Specifically, we maintain all structural parameters at their pre-Repeal values, except for τ , which is set to

⁴⁵A few previous studies in the firm dynamics literature also calibrate key parameters by targeting well-identified microeconomic estimates. For example, [Akcigit et al. \(2021\)](#) focus on the managerial environment in India and calibrate managerial output elasticity by targeting the treatment effects from a management consulting experiment in [Bloom et al. \(2013\)](#). Similarly, [Aghion et al. \(2023\)](#) estimate the regulation tax by targeting the decline in innovation rates around regulatory thresholds among French firms.

zero in the post-Repeal period. We then calibrate the pre-Repeal value of τ to ensure that the observed changes between the pre- and post-Repeal periods match our empirical DiD estimates. We choose three DiD estimates that reflect several salient effects of the policy change: the decline in the marginal revenue product of land (MRPLand), the increase in the average number of new products introduced by firms, and the rise in the entry of innovative firms. Intuitively, the reduction in MRPLand disciplines the magnitude of the wedge, as high-type firms exhibit higher MRPLand due to the land cost wedge. Post-Repeal, firms tend to introduce more products, driven by both an increased expansion rate and a larger proportion of high-type firms. Additionally, new entrants have stronger incentives to further invest towards improving their likelihood of drawing a high type after the Repeal.

Table 7: Targeted Moments: Data vs. Model

Moment	Data	Model
<i>Panel A. Firm Dynamics</i>		
TFP growth rate 1980-1992	0.035	0.035
Average number of products	1.748	1.625
Entry rate	0.052	0.057
Share of old firms (40-45) relative to young (1-5)	0.077	0.080
<i>Panel B. Diff-in-Diff Estimates</i>		
Marginal revenue product of land	-0.108	-0.109
Product Innovation	0.142	0.135
Entry of innovative plants	0.320	0.330

Tables 6 and 7 present the calibrated parameters and the targeted moments, respectively. At first glance, Table 7 demonstrates that our model closely replicates all targeted moments. Despite its parsimonious nature, our model can successfully explain the treatment effects of the Repeal on MRPLand, the number of new products introduced, and the entry of innovative firms. To match our DiD results, we need an estimate of the land cost wedge τ of approximately 0.24, which indicates that high-type firms had to pay 24% higher land costs compared to low-type firms due to the ULCRA.

This estimate is plausible in magnitude. In the data, we observe that firms with above-median employment have approximately 80-90% higher average value-added per land than firms with below-median employment, suggesting that the ULCRA accounts for roughly a third of the overall land market friction. In the model, we do not attempt to quantify overall land market frictions due to potential measurement errors and the existence of other market frictions that cannot be causally identified.

6.2 Non-targeted Moments

Our model also performs well in matching a variety of important non-targeted moments that capture several key characteristics of the Indian economy.

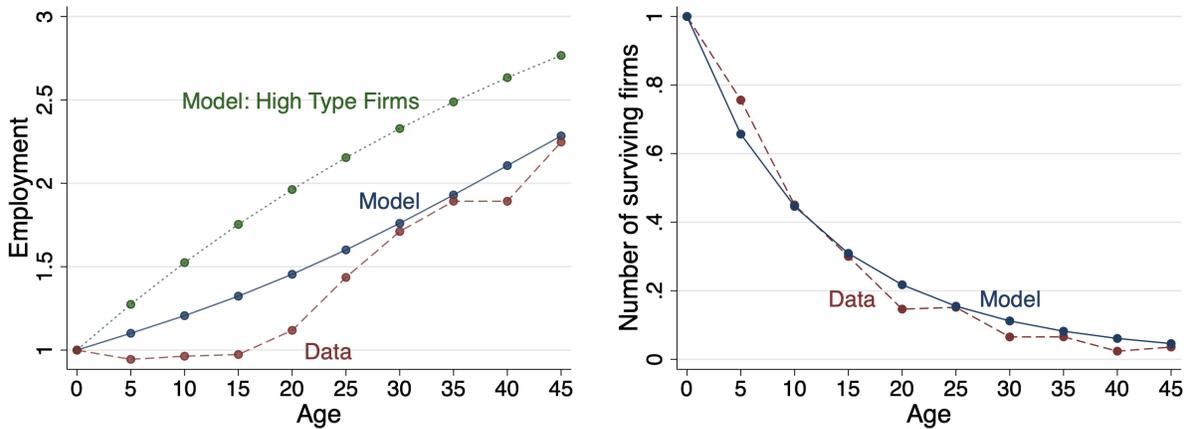
Life-Cycle Employment Growth. It is well documented that Indian plants exhibit nearly flat life-cycle growth. For instance, the average 40-year-old plant employs only about twice as many workers as plants that are less than 5 years old, in contrast to a factor of seven in the U.S. (Hsieh and Klenow, 2014). Although not specifically targeted in our calibration, our model successfully generates a firm size-age profile that closely mirrors this observed pattern.

Panel (a) of Figure 7 illustrates the relationship between employment growth and the age of a plant. The red line illustrates the minimal growth among Indian plants in our data, and the blue line represents its theoretical counterpart—expected firm size by age. The flat life-cycle profile in the model is attributed to both a low expansion rate and a low share of high-type firms. Note that these high-type firms, represented by the green dotted line, grow significantly faster than the average firm.

Firm Survival. Panel (b) of Figure 7 shows the survival rates of firms by cohort, defined as the proportion of firms from each cohort that remains active over time relative to the initial cohort size.⁴⁶ Our model’s predictions for survival rates align closely with what we see in the data. The relatively fast exit of older firms, combined with their low growth rates, leads to manufacturing employment in India being predominantly concentrated in young firms (Hsieh and Klenow, 2014).

Product Distribution. Indian firms are predominantly small, with approximately 90% employing at most four workers (Peters and Zilibotti, 2021). This suggests that, through the lens of our model, which conceptualizes a firm as a collection of products, most Indian firms likely only operate a single product. Panel (a) of Figure 8 plots the distribution of firm-level product counts alongside its theoretical counterpart. Our model slightly underestimates the share of single-product firms, predicting nearly 80%, whereas the actual share, according to the data, is 90%. Nonetheless, our model effectively captures the thin right tail of the product distribution.

⁴⁶Note that the ASI focuses on formal manufacturing plants, possibly leaving many small and young plants outside the sampling frame. Following Akcigit et al. (2021), we supplement the ASI data with the National Sample Survey of the unorganized manufacturing sector to capture the overall age distribution.



(a) Life-cycle employment growth

(b) Share of surviving firms

Figure 7: Employment Growth and Firm Survival: Model versus Data

Note: Panel (a) plots the average employment by cohort, normalized by the youngest cohort (age ≤ 5 years). ‘0’ denotes the age group 0-5 years, ‘5’ denotes 5-10 years, and so on. The red dashed line represents the empirical employment-age profile observed in the cross-section using the ASI data before 2000. The blue line illustrates the theoretical counterpart—the expected firm size by age, conditional on survival, using the estimated pre-Repeal creative destruction rate and high-type innovation intensity. The green dotted line displays the model-predicted life-cycle growth for high-type firms. Panel (b) depicts the share of firms by age relative to the share of firms in the youngest age group. The red line depicts the empirical share of firms by age as observed in the combined NSS-ASI data. The blue line illustrates the theoretical counterpart—the fraction of firms surviving to that age. We assume a constant entry rate across cohorts.

Employment Share by Age. Manufacturing employment in India tends to be concentrated in young firms due to their slow life-cycle growth. Hsieh and Klenow (2014) notes that the employment share of plants aged 40 years or older is less than 5 percent in India, compared to almost 30 percent in the United States. Although we do not explicitly target employment shares in our model, it replicates this pattern reasonably well, as shown in panel (b) of Figure 8.

6.3 The Equilibrium Effects of the Repeal

We have empirically demonstrated that the Repeal spurred business dynamism by weeding out dormant plants, intensifying product turnover, and encouraging the entry of more innovative plants. Quantitatively, how important are land market frictions, and through which channels do they contribute to the observed sluggish business dynamism in India? To address these questions, we conduct a policy experiment that mirrors our empirical exercise. That is, we eliminate the estimated ULCRA friction τ while maintaining other structural parameters at their calibrated values. Through this experiment, our model thus allows us to quantify the equilibrium effects of the Repeal on business dynamism, with a focus on both the innovation and selection margins.

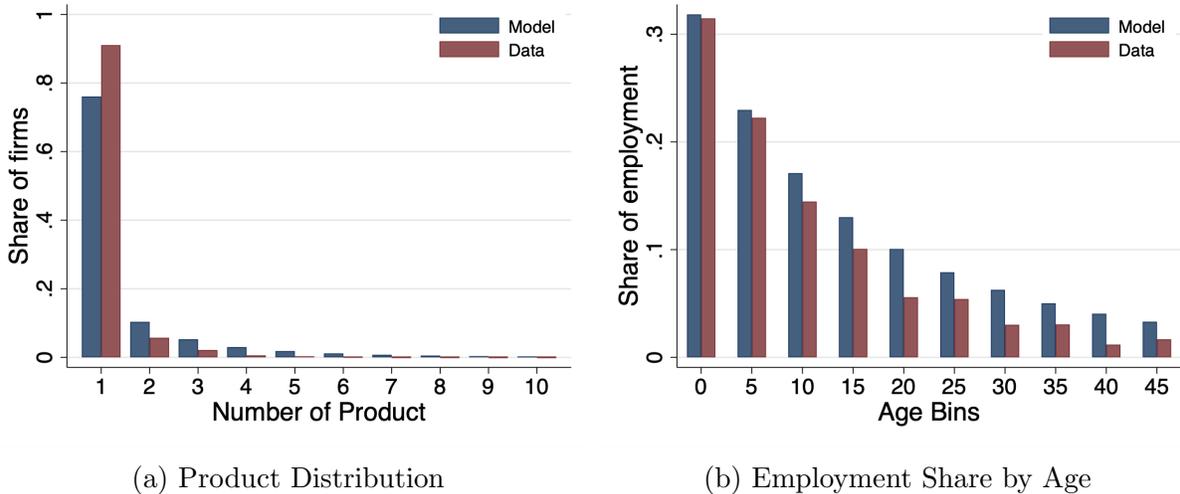


Figure 8: Product Distribution and Employment Share by Age

Note: Panel (a) displays the distribution of product counts per firm according to the combined NSS-ASI data (red) alongside the model’s predictions (blue). Panel (b) shows the cross-sectional employment share by age, comparing the empirical data (red) with the model’s predictions (blue). ‘0’ denotes the age group 0-5 years, ‘5’ denotes 5-10 years, and so on.

Innovation and Selection. Table 8 presents the results of our policy experiment. Panel A focuses on the effects of the Repeal on creative destruction (χ), the expansion rate of high-type firms (x^H), and the overall entry rate (e). After the Repeal, the creative destruction rate increases by 4%, which implies, according to Equation (17), that the economy’s growth rate must also rise by the same proportion. However, high-type firms experience a 0.77% decline in their expansion rate. This decline is somewhat surprising because, with lower land costs for high-type plants post-Repeal, we would expect them to achieve a higher return on product ownership and thus increase their rate of innovation. Moreover, the entry rate declines by 3.8%, driven by intensified creative destruction that makes market entry less profitable for potential entrepreneurs. This decline lowers the creative destruction rate by 1.7%, resulting in a 6 basis points decrease in the growth rate. It illustrates that by limiting the growth of larger and more innovative firms, the ULCRA could indeed foster firm entry.

Then why does χ increase despite both x^H and e decreasing? Panel B provides the answer. Recall that the rate of creative destruction is given by

$$\chi = x^H \times N^H + e$$

where N^H denotes the employment share of high-type firms. The significant increase in χ suggests that the employment share of high-type firms must have expanded considerably following the Repeal.

Table 8: Equilibrium Effects of the Repeal on Firm Dynamics

	Pre	Post	Change (%)
Panel A. Innovation			
Creative destruction (χ)	0.075	0.078	3.99
Expansion rate (x^H)	0.057	0.057	-0.77
Entry intensity (e)	0.035	0.034	-3.79
Panel B. Selection			
Employment share of high-type firms (N^H)	0.699	0.781	11.69
Share of low-type upon entry ($1 - \delta$)	0.642	0.505	-21.30
Share of low-type aged 45+	0.273	0.172	-36.88

Panel B reveals that it is indeed the case as the employment share of high-type firms increases by 11.7% following the Repeal. Consistent with our empirical evidence reported in Section 4.3, this increase is driven by both a higher entry rate for high-type firms and a more rapid weeding-out process for low-type firms. The second row of Panel B indicates that, while the overall entry rate (e) slightly declines, the share of low-type firms among entrants declines from 64.2% to 50.5%. This shift occurs because the reduction in the land cost wedge increases the value of high- relative to low-type firms. Consequently, potential entrepreneurs face stronger incentives to further invest to increase their chances of operating a high-type firm upon successful entry. Furthermore, low-type firms are more likely to exit the market due to the higher rate of creative destruction. Among firms older than 45 years, the proportion of low-type firms decreases from 27.3% to 17.2%.⁴⁷

This shift in the composition of firms also explains why we observe a decline in the expansion rate x^H . After the Repeal, the expansion rate spikes due to the removal of land market frictions. However, over time, the share of high-type firms increases, driven by both the increase in high-type entry and the fact that low-type firms are edged out of the market at a faster rate. As a result, even high-type firms face increasingly stiffer market competition and respond by curbing their investments in R&D. In the steady state, the selection margin becomes strong enough to offset the initial increase in the expansion rate. Figure 9 illustrates this dynamic by presenting the transition paths of the creative destruction rate, the expansion rate of high-type firms, the overall entry rate, and the employment share of high-type firms. We solve for the transition dynamics of the model by casting it as a differential-algebraic system of equations (DAE) in which we discretize the differential equations using an implicit

⁴⁷A simple back-of-the-envelope calculation shows that the exit channel accounts for 15% of the high-type expansion. The employment share of low-type firms is given by $N^L = (1 - \delta)e/\chi$. After the Repeal, N^L declines from 30% to 22%, a roughly 27% drop, while χ increases by 4%. Thus, the exit channel explains about $4/27 = 0.15$ of the overall change, with the remainder driven by the decline in $(1 - \delta)$ and e .

finite difference scheme. The resulting system is solved numerically using the IPOPT solver developed by [Wächter and Biegler \(2006\)](#).

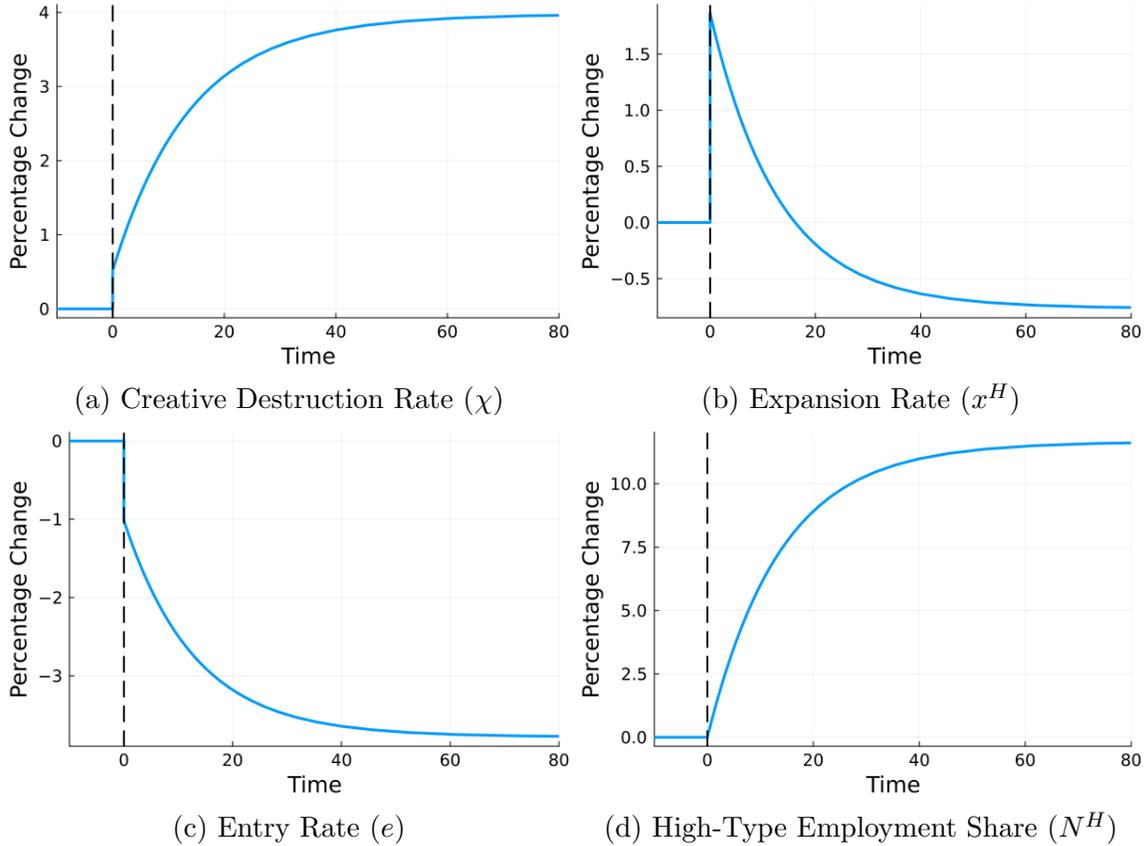


Figure 9: Transition Dynamics of the Repeal

Note: The figure presents the post-Repeal transition dynamics of the creative destruction rate (panel a), expansion rate (panel b), entry rate (panel c), and the employment share of high-type firms (panel d). The vertical dashed line indicates the timing of the Repeal (when τ changes to zero). Pre-Repeal values are normalized to zero.

6.4 Static vs. Dynamic Gains from the Repeal

We are now ready to examine the Repeal's effects on aggregate productivity and welfare. The land market wedge leads to two distortions: a static distortion from misallocation in the production sector and a dynamic inefficiency that distorts firms' R&D incentives and selection. We quantify both the static and dynamic welfare gains from the Repeal.

Static Gain. The static distortion is caused by misallocation in the land market, as high-type firms employ too little land, resulting in dispersion in the marginal revenue product of

land. Appendix B.3.1 shows that our model admits a very simple aggregation.

$$Y_t = \mathcal{M}_t Z_t H^\alpha L^{1-\alpha}, \quad \text{where} \quad \mathcal{M}_t = \left(N^H (1 + \tau)^{(\alpha-1)(\sigma-1)} + N^L \right)^{\frac{1}{\sigma-1}} \quad (18)$$

L and H denote the time-invariant land endowment and labor supply. Z_t is the aggregate productivity index defined by $Z_t \equiv \left(\int_0^1 z_{it}^{\sigma-1} di \right)^{1/(\sigma-1)}$. The term $\mathcal{M}_t \in (0, 1]$ summarizes the static loss due to land market frictions and Equation (18) highlights its macroeconomic consequences, showing that aggregate TFP is the product of the productivity measure Z and the term \mathcal{M} . Since $\alpha < 1$ and $\sigma > 1$, \mathcal{M} decreases with τ and equals one in the absence of a land market wedge ($\tau = 0$). Thus, land market frictions reduce allocative efficiency and, consequently, aggregate TFP.

We can measure the static gain from the Repeal as $\ln(1/\mathcal{M}_{pre})$. According to our model, the static gain in aggregate output from reallocating land towards high-type firms is 2.73%. This increase in TFP may appear small, especially when compared to the 40-60% TFP gains estimated by Hsieh and Klenow (2009) from improving the allocation of capital and labor to the U.S. levels. The reason is that our model considers land misallocation due to the UCLRA as the only source of inefficiency, and we focus on the efficiency gains from the Repeal, rather than eliminating the dispersion in the marginal revenue product of all inputs.

Dynamic Gain. Consider the life-time discounted utility at time 0

$$U_0 = \int_0^\infty e^{-\rho t} \ln(C_t) dt$$

In the stationary equilibrium, $C_t = C_0 e^{gt}$ and we can rewrite the above equation as

$$U_0(C_0, g) = \frac{1}{\rho} \left[\ln(Y_0) + \frac{g}{\rho} + \ln(C_0/Y_0) \right] \quad (19)$$

In comparing welfare in two scenarios—before and after the Repeal—we keep all other parameters constant and set $\tau = 0$ in the post-Repeal scenario. We calculate the respective growth rates, g^{pre} and g^{pos} , and initial consumption levels C_0^{pre} and C_0^{pos} . Here, ‘pre’ and ‘pos’ denote variables before and after the Repeal, respectively. Note that for now, we are comparing two stationary equilibria without evaluating the transitional dynamics between them. To compute the consumption-equivalent welfare changes, we find the multiplier of initial consumption (ξ) that equates the discounted utility under the new growth rate and the initial conditions. More formally, the overall welfare change from the Repeal, ξ , is given

by

$$U_0(\xi C_0^{pre}, g^{pre}) = U_0(C_0^{pos}, g^{pos})$$

Appendix B.3.2 shows that we can decompose the total welfare change into three distinct components:

$$\underbrace{\ln(\xi)}_{\text{Welfare Gain (5\%)}} = \underbrace{\frac{g^{\text{post}} - g^{\text{pre}}}{\rho}}_{\text{Dynamic (2.79\%)}} + \underbrace{\ln\left(\frac{1}{\mathcal{M}}\right)}_{\text{Static (2.73\%)}} + \underbrace{\ln\left(\frac{C^{\text{pos}}/Y^{\text{pos}}}{C^{\text{pre}}/Y^{\text{pre}}}\right)}_{\Delta \text{ Consumption (-0.5\%)}}$$

On the right-hand side, the first term captures the dynamic gain, quantifying the benefit of an increased growth rate post-Repeal. The second term represents the static gain from the reduction of misallocation. The third term accounts for changes in consumption due to the reallocation of final goods to the R&D sector. The dynamic gain from a faster growth rate, which increases from 3.5% to 3.64%, amounts to a 2.79% increase in consumption-equivalent welfare, assuming a relatively conservative discount rate of 0.05. This gain is of the same magnitude as the static gain from an improved allocative efficiency of land, which stands at 2.73%. The total welfare gain of 5% is smaller than the sum of these two because more final goods are allocated to R&D and less to consumption. The dynamic gain is sensitive to the discount rate ρ ; it increases as ρ approaches zero, reflecting greater emphasis on future consumption. When $\rho = 0.02$, the dynamic gain rises to 7%, more than doubling the static gain.

Transition Dynamics. To properly calculate the welfare gain of the Repeal, we need to consider the transition dynamics. The Repeal initiates a shift toward an undistorted stationary equilibrium, resulting in a permanently higher growth rate. However, this change is not instantaneous and the welfare gains are contingent on the speed at which the economy reaches this new equilibrium. If the growth rate increases gradually while households are required to invest more final products into R&D immediately, the welfare gain will be diminished. We characterize the welfare gain, accounting for transition dynamics, in Appendix B.3.3. Our calculation shows that the total welfare gain decline modestly from 5% to 4% when these transition dynamics are considered.

Alternative Models. One may wonder to what extent our welfare results hold across different model specifications. We consider several alternative models, with detailed discussion and solutions provided in Appendix B.4, B.5, and B.6. First, we assume that innovation costs are paid in labor rather than final goods. In addition, we allow for elastic labor supply to

reflect possible increases in labor supply in response to higher wages post-Repeal.⁴⁸ Second, instead of imposing a targeted entry cost function $\delta/(\phi(1-\delta))$, we assume a convex cost $\frac{\delta^{1+\gamma}}{\phi(1+\gamma)}$ and estimate the elasticity γ from the data. Third, we assume the innovation step size λ follows a Pareto distribution with unit scale and shape parameter ε , which is calibrated to match the TFP growth rate. In addition, we assume that high-type firms need to draw an improvement sufficiently large (such that $\lambda > 1+\tau$) to replace a low-type incumbent. Finally, we assume that high-type firms may “age” and lose their innovativeness at a rate ν , following [Acemoglu et al. \(2018\)](#).⁴⁹ Reassuringly, [Table 9](#) demonstrates that our welfare results remain robust across these alternative models, with dynamic gains consistently comparable in magnitude to the static gains.

Table 9: Welfare Decomposition: Alternative Models

Model	Total Gain (%)	Dynamic Gain (%)	Static Gain (%)
Baseline	5.00	2.79	2.73
R&D labor	4.93	2.82	2.78
Convex entry investment cost	5.14	2.72	3.06
Stochastic step size	4.18	2.24	2.23
Evolving firm types	5.50	3.33	2.70

Magnitudes. We can benchmark our welfare estimates against several previous studies that focus on other market frictions in the Indian economy. [Bertrand et al. \(2021\)](#) examine the rise of contract labor after 2001 and, using a similar model framework as ours, and uncover that contract labor leads to a 5.9% static gain in consumption and zero dynamic gain. [Akcigit et al. \(2021\)](#) model the managerial environment in India and demonstrate that by improving the delegation efficiency to the U.S. level, it will close approximately 11% of the UA-India income per capita gap, with half of this effect due to the static and the other half due to the dynamic gain. [Bau and Matray \(2023\)](#) analyze the liberalization of FDI and find a 3-17% static gain due to reducing capital misallocation, without discussing the dynamic gains. Outside India, [Aghion et al. \(2023\)](#) demonstrate that labor regulations in France lead

⁴⁸We model the disutility from supplying labor H with the function $-\beta H^{1+\eta}/(1+\eta)$, setting the elasticity $\eta = 1$ and calibrating the scale parameter β to match the average fraction of time spent working in India (35.46%).

⁴⁹Previously high-type firms remain subject to the land wedge τ , but results are similar if they are not. Low-type is an absorbing state, meaning low-type and aged high-type firms cannot regain innovativeness. We calibrate ν to match the observed share of single-product firms. A higher ν implies that more young high-type firms never grow, increasing the proportion of single-product firms. The estimated value of ν is just 0.01, much lower than the 0.21 estimated by [Acemoglu et al. \(2018\)](#). This difference arises because, in our model, 64% of new entrants are low-type firms, compared to only 7.4% in the U.S. A higher ν would lead to a counterfactually high share of low-type firms in the economy.

to a 10 basis points lower growth rate, which translates to approximately 2.3% dynamic loss, compared to a 1.3% static loss. Overall, our estimates of the welfare impacts of land market liberalization appear plausible in magnitude and align with the literature.

6.5 Counterfactual Policy

We have demonstrated that while the Repeal lowers the entry rate for potential entrepreneurs, it is more than compensated by the expansion of larger and more innovative firms, leading to a 5% total welfare gain. However, policymakers in developing countries might place greater weight on the entry of micro- and small-scale businesses for redistributive motives, and therefore push for regulations like the ULCRA despite its inefficiency. For instance, many industries in India were traditionally reserved for small enterprises, leading to slower employment and output growth (Martin et al., 2017).

We conduct a simple counterfactual exercise to explore alternative policies that can achieve the goal of promoting firm entry without incurring the static and dynamic losses associated with the ULCRA. Using our model, we consider a counterfactual industrial policy that subsidizes firm entry, which is introduced at the time of the Repeal, to equalize the post-Repeal entry rate to its pre-Repeal level. The model indicates that this policy would require a 4.83% subsidy on entry, costing roughly 0.22% of GDP. Under this counterfactual policy, the total welfare gain post-Repeal increases from 5% to 5.6%, with 3.7% attributed to the dynamic gain. The increased total welfare gain with the entry subsidy indicates that the post-Repeal entry rate (without subsidy) is inefficiently low and warrants government intervention. However, this can be achieved through a direct entry subsidy or by reducing other entry frictions, at a much lower cost than the ULCRA.

7 Conclusion

This paper examines both the static and dynamic impacts of land market liberalization on manufacturing firms by leveraging the staggered repeal of the Urban Land Ceiling and Regulation Act (ULCRA) in India as a natural experiment. Our Difference-in-Differences analysis shows that the Repeal significantly enhanced the efficiency of land markets by removing the restrictive regulations imposed by the ULCRA. Post-Repeal, firms with previously high productivity expanded their landholdings, suggesting reduced land misallocation. The liberalization of land markets effectively unleashed industrial growth, as treated firms increased their capital investments, employment, sales, and productivity. Importantly, we provide

the first causal evidence of the dynamic impacts of land market frictions on firms' product innovation and the selection of more innovative firms.

To quantify the aggregate consequences of the Repeal, we developed a dynamic innovation model incorporating land market frictions. Our model indicates that the Repeal increased aggregate productivity by 2.7% and raised the growth rate by 14 basis points, resulting in a 5% improvement in total welfare. This quantitative exercise highlights that the dynamic gain—faster growth rate post-Repeal—is at least as important as the static gain from reduced land misallocation, even with a relatively conservative time discount rate of 5%. This large dynamic gain from liberalizing land markets offers new insights for policymakers in developing countries seeking to regulate land markets, suggesting that such policies could be suboptimal without considering their effects on firm dynamics.

While our analysis focuses on the impacts of the Repeal Act on manufacturing firms, the ramifications of land market policies extend beyond the manufacturing sector. We provide some preliminary evidence on the socioeconomic consequences of the Repeal, including the effects on structural transformation, housing and other amenities, and poverty reduction. Additionally, we explore the short-run impacts of another prominent urban development policy in India, the Jawaharlal Nehru National Urban Renewal Mission, which focused on the redevelopment of slums and the improvement of urban infrastructure. However, many interesting questions remain for future research. First, examining the long-term impacts of the ULCRA and other land policies on urban and rural development, including their employment and distributional consequences, would be valuable. Second, investigating the interactions between land market reforms and other economic frictions, such as labor regulations and capital misallocation, could provide insights into the broader policy environment needed to stimulate industrial growth. Lastly, it is crucial to uncover the social implications of land market reforms, particularly their effects on displaced communities and urban inequality.

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A A Dynamic Model of Innovation with Adjustment Costs

In this section, we outline an alternative model of dynamic innovation with land adjustment costs. Firms accumulate landholdings over time, facing quadratic land adjustment costs, as in [Cooper and Haltiwanger \(2006\)](#). The model is currently under development and will be updated soon.

A.1 Economic Environment

Preferences

Consider a continuous-time economy where time is indexed by $t \in \mathbb{R}_+$, populated by an infinitely-lived representative household of unit measure with the following preferences over consumption C_t :

$$U_t = \int_t^\infty e^{-\rho(\tau-t)} \ln(C_\tau) d\tau. \quad (20)$$

Here, $\rho > 0$ is the household's rate of time preference. The household inelastically supplies one unit of labor per period.

Technology

The economy is composed of two distinct sectors: a final and intermediate sector. The former produces final goods using intermediate products according to a Cobb-Douglas technology:

$$\ln(Y_t) = \int_0^1 \ln(y_{jt}) dj. \quad (21)$$

where $Y_t \geq 0$ is the produced quantity of final goods and y_{jt} is the quantity of product $j \in [0, 1]$ used in production.

Each product is manufactured by a single firm from the intermediate sector using labor and land. We assume that the amount of land allocated to each product line determines the scale of production, and thus affects the efficiency of production workers. The production function is given by:

$$y_{jt}^s = z_{jt} h_{jt} \phi(l_{jt}) \quad (22)$$

where y_{jt}^s is the quantity of product j supplied by the firm, h_{jt} , and l_{jt} respectively, denote the quantity of labor and land used in production. In the spirit of [Akcigit et al. \(2021\)](#), $\phi(l_j) \geq 1$

is an increasing function that translates land into physical productivity. For simplicity, we assume that:

$$\phi(l_j) = \frac{1}{1 - l_j^\alpha}. \quad (23)$$

A firm is indexed by $f \in \mathcal{F}_t$ and consists of (1) a stock of land $l_{ft} \in \mathbb{R}_+$ and (2) a portfolio of products collected in the set \mathcal{P}_{ft} . Let us first describe the dynamics of a firm's landholdings. The firm can frictionally adjust its land stock at a cost. That is, to adjust its stock by $i \in \mathbb{R}$ units, a firm with current landholdings l must pay a flow cost of $a_t(i/l)$ units of final goods. In particular, we assume a symmetric adjustment cost function that takes the quadratic form proposed by [Cooper and Haltiwanger \(2006\)](#):

$$a_t(i/l) = \beta Y_t (i/l)^2 l \quad (24)$$

where $\beta > 0$ determines the scale of this quadratic adjustment cost.

We now describe the dynamics of a firm's product portfolio. The set \mathcal{P}_{ft} is of measure $n_{ft} = |\mathcal{P}_{ft}| \in \mathbb{R}_+$ and each product it contains is described by the process efficiency $z_{jt} \in \{z_{j't}\}_{j' \in \mathcal{P}_{ft}}$ at which it is currently manufactured. Firms can grow over time by adding more products to their portfolio. Specifically, a firm holding n products must allocate $c_t^X(X, n)$ units of final goods to R&D to achieve a Poisson expansion rate of X :

$$c_t^X(X, n) = \frac{X^{1+\zeta} Y_t}{\theta(1+\zeta)n^\zeta} \quad (25)$$

where $\theta > 0$ denotes the firm's expansion "capacity" and $\zeta > 0$ determines the convexity of the expansion cost function. If expansion is successful, a firm takes over one of its competitors' products and improves upon its process efficiency by a factor of $\lambda > 1$. However, some "subsistence" firms never expand and, therefore, hold a single-product portfolio throughout their entire life cycle.

In every period, a unit measure of potential entrants can allocate $c_t^E(e, \xi)$ units of final goods to entry to achieve an entry rate of e :

$$c_t^E(e, \xi) = \frac{e^{1+\zeta} Y_t}{\theta_E(1+\zeta)} - \frac{\ln(1-\xi) Y_t}{\eta} \quad (26)$$

where $\theta_E > 0$ determines the efficiency of the entry technology, $\eta > 0$ is a convexity parameter, and $\xi \in [0, 1]$ denotes the controlled probability of becoming an "expanding" firm. If entry is successful, a new entrant takes over the product of one of its competitors and improves on its process efficiency by the same factor $\lambda > 1$. We simplify the assumption about

the initial land endowment distribution by positing that the stock of land previously held by creatively destroyed single-product firms is evenly redistributed among all new entrants.

Resource Constraints

The resource constraint for labor is given by:

$$\int_0^1 h_{jt} dj \leq 1. \quad (27)$$

The resource constraint for final goods is given by:

$$Y_t = C_t + \int_{f \in \mathcal{F}_t} a_t(i_{ft}/l_{ft}) df + R_t^X + R_t^E \quad (28)$$

where R_t^X and R_t^E respectively denote the aggregate allocations of final goods towards expansion and entry:

$$R_t^X \equiv \int_{f \in \mathcal{F}_t} c_t^X(X_{ft}, n_{ft}) df \quad \text{and} \quad R_t^E \equiv c_t^E(e_t, \xi_t).$$

We assume that the aggregate land stock is equal to one such that the resource constraint for land is given by:

$$\int_{f \in \mathcal{F}_t} l_{ft} df \leq 1. \quad (29)$$

The resource constraints for products are given by:

$$y_{jt} \leq y_{jt}^s, \quad \forall j \in [0, 1]. \quad (30)$$

A.2 Decision Problems

We now define the decision problems of economic agents, which determine equilibrium prices and quantities on the final goods, products, labor, and land markets. Regarding market structure, we assume all markets are perfectly competitive except product markets, where firms engage in Bertrand competition and choose the prices at which to sell their different products.

The Household's Problem

Taking prices as given, the household's problem is to choose its demand for each product and hours worked to maximize lifetime utility:

$$\max_{\{C_\tau\}_{\tau \geq t} \geq 0} \int_t^\infty e^{-\rho(\tau-t)} \ln(C_\tau) d\tau \quad \text{s.t.} \quad \dot{A}_t + P_t C_t \leq r_t A_t + w_t$$

where P_t denotes the price of final goods, w_t the price of labor, A_t is the value of corporate assets, and r_t is the rate of return on those assets:

$$A_t = \int_{f \in \mathcal{F}_t} V_{ft} df \quad \text{where} \quad \lim_{t \rightarrow \infty} e^{-\int_0^t r_\tau d\tau} A_t = 0.$$

Here, V_{ft} denotes the value of firm f . This problem delivers the usual Euler equation:

$$\dot{C}_t = (r_t - \rho)C_t.$$

The Final Sector's Problem

Taking prices as given, the final sector's problem is to choose its demand for intermediate products to maximize profits:

$$\max_{\{y_{jt}\}_{j \in [0,1]}} \{P_t Y_t - \int_0^1 p_{jt} y_{jt} dj\} \quad \text{s.t.} \quad \ln(Y_t) = \int_0^1 \ln(y_{jt}) dj \quad (31)$$

where p_{jt} denotes the price of intermediate product j . This problem delivers the usual demand functions:

$$y_{jt} = \frac{P_t Y_t}{p_{jt}}$$

where the price of final goods is given by:

$$\ln(P_t) \equiv \int_0^1 \ln(p_{jt}) dj.$$

Final goods are chosen as the numéraire such that $P_t = 1$ for all t .

The Undistorted Firm's Problem

Firms engage in Bertrand competition in the product market but perfect competition in the markets for labor and land investments, taking the prices of labor and final goods, and the demand for their products as given. We assume that in each market j , the producing firm

competes against a fringe of potential producers who can produce variety j at a marginal cost w_t/z_{jt} , where w_t is the wage. Due to the Bertrand competition, the producing firm set the price equal to the marginal cost of the competing firm. The gross profit of firm f (before paying the land adjustment costs) is given by

$$\pi_{ft} = \int_{j \in \mathcal{P}_{ft}} l_{jt}^\alpha dj \cdot Y_t$$

Since the profit function is concave in l_{jt} , firms allocate land equally across products such that $l_{jt} = l_{ft}/n_{ft}$. And labor demand is given by $h_{jt} = Y_t/[w_t \cdot \phi(l_{ft}/n_{ft})]$. Hence, firm-level net profits are equal to:

$$\Pi_{ft} = (l_{ft}/n_{ft})^\alpha Y_t n_{ft} - q_t i_{ft} - a_t(i_{ft}/l_{ft})$$

where q_t denotes the price of land investments. The dynamic problem of a firm with landholdings l and a portfolio of n products is thus summarized by the Hamilton-Jacobi-Bellman (HJB) equation:

$$\begin{aligned} r_t V_t(l, n) &= (l/n)^\alpha Y_t n + \dot{V}_t(l, n) && \text{Profits and capital gains} \\ &+ \max_i \{i \partial_l V_t(l, n) - q_t i - a_t(i/l)\} && \text{Land investment} \\ &- \chi_t n [V_t(l, n) - V_t(l, n-1)] && \text{Creative destruction} \\ &+ \max_X \{X [V_t(l, n+1) - V_t(l, n)] - c_t^X(X, n)\} && \text{Product expansion} \end{aligned}$$

where χ_t denotes the endogenous rate of creative destruction. The firm's value function is intuitive and can be interpreted as follows. Given the discount rate r_t , the left-hand side is the flow value of a firm holding a portfolio of n products. The right-hand side includes the components that make up this flow value. The first term represents the flow of profits generated by each product and the capital gains. The second captures the change in firm value from land investments. The third term captures the change in firm value if competitors steal any of the firm's products through economy-wide creative destruction. Finally, the fourth term captures the change in firm value when the firm successfully expands. In contrast, the dynamic problem of a "subsistence" firm with landholdings l is summarized by the following HJB equation:

$$(r_t + \chi_t) V_t^S(l) = l^\alpha Y_t + \max_i \{i \partial_l V_t^S(l) - q_t i - a_t(i/l)\} + \dot{V}_t^S(l).$$

Defining the land investment rate by $s_t(l, n) \equiv i_t(l, n)/l$, the firm's problem delivers the following optimal land transaction policy functions:

$$s_t(l, n) = \frac{\partial_l V_t(l, n) - q_t}{2\beta Y_t} \quad \text{and} \quad s_t^S(l) = \frac{\partial_l V_t^S(l) - q_t}{2\beta Y_t}.$$

This problem also delivers the following optimal expansion intensity:

$$x_t(l, n) = \{[V_t(l, n+1) - V_t(l, n)]\theta/Y_t\}^{1/\zeta}.$$

Defining $\mathcal{V}_t(l, n) \equiv V_t(l, n)/(nC_t)$, we can rewrite the above HJB equation as:

$$\begin{aligned} \rho \mathcal{V}_t(l, n) &= (l/n)^\alpha Y_t/C_t + \dot{\mathcal{V}}_t(l, n) && \text{Profits and capital gains} \\ &+ \beta Y_t s_t(l, n)^2 l / (nC_t) && \text{Land investment} \\ &- \chi_t [n \mathcal{V}_t(l, n) - (n-1) \mathcal{V}_t(l, n-1)] && \text{Creative destruction} \\ &+ \zeta x_t(l, n)^{1+\zeta} Y_t / [\theta(1+\zeta)C_t] && \text{Product expansion.} \end{aligned}$$

Similarly, defining $\mathcal{V}_t^S(l) \equiv V_t^S(l)/C_t$ for the case of “subsistence” firms, we can rewrite:

$$(\rho + \chi_t) \mathcal{V}_t^S(l) = l^\alpha Y_t/C_t + \beta Y_t s_t^S(l)^2 l / C_t + \dot{\mathcal{V}}_t^S(l).$$

Finally, the Kolmogorov-Fokker-Planck (KFP) equation, which describes the evolution of the land and product distribution across expanding firms over time, is given by:

$$\begin{aligned} \dot{f}_t(l, n) &= -\partial_l [s_t(l, n) l f_t(l, n)] \\ &+ (n-1) x_t(l, n-1) f_t(l, n-1) \\ &+ (n+1) \chi_t f_t(l, n+1) \\ &- n [x_t(l, n) + \chi_t] f_t(l, n), \quad \forall n > 1. \end{aligned}$$

However, the share of single-product high-type firms evolves according to:

$$\dot{f}_t(l, 1) = -\partial_l [s_t(l, 1) l f_t(l, 1)] + e_t \xi_t \delta(l - l_t^E) + 2\chi_t f_t(l, 2) - [x_t(l, 1) + \chi_t] f_t(l, 1)$$

where δ is the Dirac delta function and l_t^E is defined as:

$$l_t^E \equiv (\chi_t/e_t) \int_0^\infty [N_t^S f_t^S(l) + (1 - N_t^S) f_t(l, 1)] l dl.$$

In contrast, the KFP equation describing the evolution of the land distribution across subsistence firms over time, is given by:

$$\dot{f}_t^S(l) = -\partial_l[s_t^S(l)lf_t^S(l)] - \chi_t f_t^S(l) + e_t(1 - \xi_t)\delta(l - l_t^E)$$

The Entrant's Problem

Entrants engage in perfect competition on the labor market and, therefore, choose a flow of entry to maximize future expected profits while taking prices as given:

$$V_t^E = \max_{e, \xi} \{e[\xi V_t(l_t^E, 1) + (1 - \xi)V_t^S(l_t^E)] - c_t^E(e, \xi)\}.$$

The first-order condition of the entrant's problem delivers the optimal entry rate:

$$e_t = \{[\xi_t V_t(l_t^E, 1) + (1 - \xi_t)V_t^S(l_t^E)]\theta_E/Y_t\}^{1/\zeta}$$

and the optimal high-type probability:

$$\xi_t = 1 - Y_t/\{[V_t(l_t^E, 1) - V_t^S(l_t^E)]e_t\eta\}.$$

A.3 The Undistorted Stationary Solution

The undistorted stationary solution of the model consists of the following system of integro-differential-algebraic equations (IDAEs):

1. $w = Y \int_0^\infty [\sum_{n=1}^\infty \phi(l/n)^{-1} f(n, l) + \phi(l)^{-1} f^S(l)] dl$
2. $Y = C + \beta Y \int_0^\infty [\sum_{n=1}^\infty s(l, n)^2 l f(l, n) + s^S(l)^2 l f^S(l)] dl + R^X + R^E$
3. $R^X = Y(1 - N^S) \sum_{n=1}^\infty \int_0^\infty x(l, n)^{1+\zeta} f(l, n) dl / [\theta(1 + \zeta)]$
4. $R^E = e^{1+\zeta} Y / [\theta_E(1 + \zeta)] - \ln(1 - \xi) Y / \eta$
5. $x(l, n) = \{[(n + 1)\mathcal{V}(l, n + 1) - n\mathcal{V}(l, n)]\theta C / Y\}^{1/\zeta}$
6. $s(l, n) = [\partial_l \mathcal{V}(l, n)nC - q] / (2\beta Y)$
7. $s^S(l) = [\partial_l \mathcal{V}^S(l)C - q] / (2\beta Y)$
8. $e = \{[\xi \mathcal{V}(l^E, 1) + (1 - \xi)\mathcal{V}^S(l^E)]\theta_E C / Y\}^{1/\zeta}$
9. $\xi = 1 - Y / \{[\mathcal{V}(l^E, 1) - \mathcal{V}^S(l^E)]e\eta C\}$

10. $N^S = (1 - \xi)e/\chi$
11. $\int_0^\infty [\sum_{n=1}^\infty (1 - N^S)f(l, n) + N^S f^S(l)]l dl = 1$
12. $g = \chi \log(\lambda)$
13. $\chi = (1 - N^S) \sum_{n=1}^\infty \int_0^\infty x(l, n)f(l, n)dl + e$
14. $l^E = (\chi/e) \int_0^\infty [N^S f^S(l) + (1 - N^S)f(l, 1)]l dl$
15. $(\rho + \chi)\mathcal{V}^S(l) = l^\alpha Y/C + \beta Y s^S(l)^2 l/C$
16. $-\partial_l [s^S(l)l f^S(l)] - \chi f^S(l) + e(1 - \xi)\delta(l - l^E) = 0$
17. $Z_t = w_t$

together with the stationary HJB equation for the value of expanding firms:

$$\begin{aligned} \rho \mathcal{V}(l, n) &= (l/n)^\alpha Y/C + \beta Y s(l, n)^2 l/(nC) \\ &\quad - \chi [n\mathcal{V}(l, n) - (n-1)\mathcal{V}(l, n-1)] \\ &\quad + \zeta x(l, n)^{1+\zeta} Y/[\theta(1+\zeta)C], \end{aligned}$$

the stationary KFP equation for expanding firms with more than one product:

$$\begin{aligned} 0 &= -\partial_l [s(l, n)l f(l, n)] + (n-1)x(l, n-1)f(l, n-1) \\ &\quad + (n+1)\chi f(l, n+1) - n[x(l, n) + \chi]f(l, n), \quad \forall n > 1, \end{aligned}$$

and the stationary KFP equation for single-product expanding firms:

$$0 = -\partial_l [s(l, 1)l f(l, 1)] + e\xi\delta(l - l^E) + 2\chi f(l, 2) - [x(l, 1) + \chi]f(l, 1).$$

A.4 The “Scale-Free” Undistorted Stationary Solution

The model’s equilibrium is characterized by an initial condition for Z_t . In that sense, the economy’s “scale” is not endogenously determined in the model. Therefore, to solve for a “scale-free” non-stationary equilibrium, we assume that $Z_0 = 1$ and define the following composite variables:

$$\mathcal{W} \equiv w/Y, \quad \mathcal{C} \equiv C/Y, \quad \mathcal{Q} \equiv q/Y, \quad \mathcal{R}^X \equiv R^X/Y \quad \text{and} \quad \mathcal{R}^E \equiv R^E/Y.$$

With these definitions, we can reduce the above system of IDAEs to:

1. $\mathcal{W} = \int_0^\infty [\sum_{n=1}^\infty \phi(l/n)^{-1} f(n, l) + \phi(l)^{-1} f^S(l)] dl$
2. $1 = \mathcal{C} + \beta \int_0^\infty [(1 - N^S) \sum_{n=1}^\infty s(l, n)^2 l f(l, n) + N^S s^S(l)^2 l f^S(l)] dl + \mathcal{R}^X + \mathcal{R}^E$
3. $\mathcal{R}^X = (1 - N^S) \sum_{n=1}^\infty \int_0^\infty x(l, n)^{1+\zeta} f(l, n) dl / [\theta(1 + \zeta)]$
4. $\mathcal{R}^E = e^{1+\zeta} / [\theta_E(1 + \zeta)] - \ln(1 - \xi) / \eta$
5. $x(l, n) = \{[(n + 1)\mathcal{V}(l, n + 1) - n\mathcal{V}(l, n)]\theta\mathcal{C}\}^{1/\zeta}$
6. $s(l, n) = [\partial_l \mathcal{V}(l, n)n\mathcal{C} - \mathcal{Q}] / (2\beta)$
7. $s^S(l) = [\partial_l \mathcal{V}^S(l)\mathcal{C} - \mathcal{Q}] / (2\beta)$
8. $e = \{[\xi\mathcal{V}(l^E, 1) + (1 - \xi)\mathcal{V}^S(l^E)]\theta_E\mathcal{C}\}^{1/\zeta}$
9. $\xi = 1 - 1 / \{[\mathcal{V}(l^E, 1) - \mathcal{V}^S(l^E)]e\eta\mathcal{C}\}$
10. $N^S = (1 - \xi)e / \chi$
11. $\int_0^\infty [\sum_{n=1}^\infty (1 - N^S) f(l, n) + N^S f^S(l)] l dl = 1$
12. $g = \chi \log(\lambda)$
13. $\chi = (1 - N^S) \sum_{n=1}^\infty \int_0^\infty x(l, n) f(l, n) dl + e$
14. $l^E = (\chi/e) \int_0^\infty [N^S f^S(l) + (1 - N^S) f(l, 1)] l dl$
15. $(\rho + \chi)\mathcal{V}^S(l) = l^\alpha / \mathcal{C} + \beta s^S(l)^2 l / \mathcal{C}$
16. $-\partial_l [s^S(l) l f^S(l)] - \chi f^S(l) + e(1 - \xi)\delta(l - l^E) = 0$

together with the stationary HJB equation for the value of expanding firms:

$$\begin{aligned} \rho \mathcal{V}(l, n) &= (l/n)^\alpha / \mathcal{C} + \beta s(l, n)^2 l / (n\mathcal{C}) \\ &\quad - \chi [n\mathcal{V}(l, n) - (n - 1)\mathcal{V}(l, n - 1)] \\ &\quad + \zeta x(l, n)^{1+\zeta} / [\theta(1 + \zeta)\mathcal{C}], \end{aligned}$$

the stationary KFP equation for expanding firms with more than one product:

$$\begin{aligned} 0 &= -\partial_l [s(l, n) l f(l, n)] + (n - 1)x(l, n - 1)f(l, n - 1) \\ &\quad + (n + 1)\chi f(l, n + 1) - n[x(l, n) + \chi]f(l, n), \quad \forall n > 1, \end{aligned}$$

and the stationary KFP equation for single-product expanding firms:

$$0 = -\partial_l[s(l, 1)lf(l, 1)] + e\xi\delta(l - l^E) + 2\chi f(l, 2) - [x(l, 1) + \chi]f(l, 1).$$

Change of Variable

To solve this system of IDAEs numerically, we proceed with the following change of variable:

$$\hat{l} \equiv \frac{\nu l}{\nu l + 1} \in [0, 1)$$

where $\nu > 0$ is a curvature parameter. With this change of variable, we can redefine:

$$\hat{\mathcal{V}}(\hat{l}, n) \equiv \mathcal{V}(l, n) \quad \text{and} \quad \hat{f}(\hat{l}, n) \equiv f(l, n),$$

and therefore, we have:

$$\partial_l \mathcal{V}(l, n) = \partial_{\hat{l}} \hat{\mathcal{V}}(\hat{l}, n) \cdot \frac{\partial \hat{l}}{\partial l} = \nu(1 - \hat{l})^2 \partial_{\hat{l}} \hat{\mathcal{V}}(\hat{l}, n)$$

B Model Appendix

B.1 Stationary Equilibrium: Baseline Model

B.1.1 Undistorted Non-Stationary Solution

The non-stationary solution of the model consists of the following system of differential-algebraic equations:

1. $\dot{a}_t^T = [\rho + \chi_t + (\sigma - 1)g_t]a_t^T - [Z_t/(\mu\varsigma_t)]^{\sigma-1}/\sigma, \quad \forall T \in \{L, H\}$
2. $\dot{b}_t^T = (\rho + \chi_t)b_t^T - (\theta_T C_t/Y_t)^{1/\zeta}(a_t^T \lambda^{\sigma-1} + b_t^T)^{1+1/\zeta}/(1 + 1/\zeta), \quad \forall T \in \{L, H\}$
3. $x_t^T = [(a_t^T \lambda^{\sigma-1} + b_t^T)\theta_T C_t/Y_t]^{1/\zeta}, \quad \forall T \in \{L, H\}$
4. $\varsigma_t = (w_t/\alpha)^\alpha [m_t/(1 - \alpha)]^{1-\alpha}$
6. $\dot{N}_t^L = (1 - \delta_t)e_t - \chi_t N_t^L$
7. $N_t^H = 1 - N_t^L$
8. $e_t = \{[\delta_t(a_t^H \lambda^{\sigma-1} + b_t^H) + (1 - \delta_t)(a_t^L \lambda^{\sigma-1} + b_t^L)]\theta_E C_t/Y_t\}^{1/\zeta}$
9. $\delta_t = 1 - \{[(a_t^H - a_t^L)\lambda^{\sigma-1} + b_t^H - b_t^L]\phi e_t C_t/Y_t\}^{-1/2}$
10. $g_t = \chi_t(\lambda^{\sigma-1} - 1)/(\sigma - 1)$
11. $\chi_t = \sum_{T \in \{L, H\}} N_t^T x_t^T + e_t$
12. $R_t^X = \sum_{T \in \{L, H\}} N_t^T x_t^{T^{1+\zeta}} Y_t / [\theta_T(1 + \zeta)]$
13. $R_t^E = e_t^{1+\zeta} Y_t / [\theta_E(1 + \zeta)] + \delta_t Y_t / [\phi(1 - \delta_t)]$
14. $Y_t = C_t + R_t^X + R_t^E$
15. $1 = \alpha C_t / (\mu w_t)$
16. $1 = (1 - \alpha) C_t / (\mu m_t)$
17. $Z_t = (\sum_{T \in \{L, H\}} N_t^T Z_t^{T^{\sigma-1}})^{\frac{1}{\sigma-1}}$
18. $\sum_{T \in \{L, H\}} N_t^T [Z_t^T / (\mu \varsigma_t)]^{\sigma-1} = 1$

with initial conditions $\{N_0^T, Z_0^T\}_{T \in \{L, H\}}$ such that $Z_0^L = Z_0^H$ and terminal conditions:

$$\lim_{t \rightarrow \infty} a_t^T = a_\infty^T \quad \text{and} \quad \lim_{t \rightarrow \infty} b_t^T = b_\infty^T, \quad \forall T \in \{L, H\}.$$

B.1.2 “Scale-Free” Undistorted Non-Stationary Solution

The model’s equilibrium is characterized by initial conditions for Z_t^L and Z_t^H . In that sense, the economy’s “scale” is not endogenously determined in the model. Therefore, to solve for a “scale-free” non-stationary equilibrium, we assume that $Z_0^L = Z_0^H$ and define the following composite variables:

$$\mathcal{Z}_t \equiv Z_t(\alpha/w_t)^\alpha[(1-\alpha)/m_t]^{1-\alpha}, \quad \mathcal{C}_t \equiv C_t/Y_t, \quad \mathcal{C}_t^w \equiv C_t/w_t \quad \text{and} \quad \mathcal{C}_t^m \equiv C_t/m_t.$$

With these definitions, we can reduce the above system of differential-algebraic equations to:

1. $\dot{a}_t^T = [\rho + \chi_t + (\sigma - 1)g_t]a_t^T - 1/\sigma, \quad \forall T \in \{L, H\}$
2. $\dot{b}_t^T = (\rho + \chi_t)b_t^T - (\theta_T \mathcal{C}_t)^{1/\zeta}(a_t^T \lambda^{\sigma-1} + b_t^T)^{1+1/\zeta}/(1 + 1/\zeta), \quad \forall T \in \{L, H\}$
3. $x_t^T = [(a_t^T \lambda^{\sigma-1} + b_t^T)\theta_T \mathcal{C}_t]^{1/\zeta}, \quad \forall T \in \{L, H\}$
5. $\dot{N}_t^L = (1 - \delta_t)e_t - \chi_t N_t^L$
6. $N_t^H = 1 - N_t^L$
7. $e_t = \{[\delta_t(a_t^H \lambda^{\sigma-1} + b_t^H) + (1 - \delta_t)(a_t^L \lambda^{\sigma-1} + b_t^L)]\theta_E \mathcal{C}_t\}^{1/\zeta}$
8. $\delta_t = 1 - \{[(a_t^H - a_t^L)\lambda^{\sigma-1} + b_t^H - b_t^L]\phi e_t \mathcal{C}_t\}^{-1/2}$
9. $g_t = \chi_t(\lambda^{\sigma-1} - 1)/(\sigma - 1)$
10. $\chi_t = \sum_{T \in \{L, H\}} N_t^T x_t^T + e_t$
11. $1 = \mathcal{C}_t + \sum_{T \in \{L, H\}} N_t^T x_t^{T^{1+\zeta}}/[\theta_T(1 + \zeta)] + e_t^{1+\zeta}/[\theta_E(1 + \zeta)] + \delta_t/[\phi(1 - \delta_t)]$
12. $1 = \alpha \mathcal{C}_t^w / \mu$
13. $1 = (1 - \alpha) \mathcal{C}_t^m / \mu$

B.1.3 Stationary Solution

The stationary solution of the model consists of the following nonlinear system of equations:

1. $a^T = [Z/(\mu \zeta^T)]^{\sigma-1}/\{\sigma[\rho + \chi + (\sigma - 1)g]\}, \quad \forall T \in \{L, H\}$
2. $b^T = (\theta_T C/Y)^{1/\zeta}(a^T \lambda^{\sigma-1} + b^T)^{1+1/\zeta}/[(1 + 1/\zeta)(\rho + \chi)], \quad \forall T \in \{L, H\}$
3. $x^T = [(a^T \lambda^{\sigma-1} + b^T)\theta_T C/Y]^{1/\zeta}, \quad \forall T \in \{L, H\}$

4. $\zeta^T = (w/\alpha)^\alpha [(1 + \tau^T)m/(1 - \alpha)]^{1-\alpha}, \quad \forall T \in \{L, H\}$
5. $Z^T = 1, \quad \forall T \in \{L, H\}$
6. $N^L = (1 - \delta)e/\chi$
7. $N^H = 1 - N^L$
8. $e = \{[\delta(a^H \lambda^{\sigma-1} + b^H) + (1 - \delta)(a^L \lambda^{\sigma-1} + b^L)]\theta_E C/Y\}^{1/\zeta}$
9. $\delta = 1 - \{[(a^H - a^L)\lambda^{\sigma-1} + b^H - b^L]\phi e C/Y\}^{-1/2}$
10. $g = \chi(\lambda^{\sigma-1} - 1)/(\sigma - 1)$
11. $\chi = \sum_{T \in \{L, H\}} N^T x^T + e$
12. $R^X = \sum_{T \in \{L, H\}} N^T x^{T^{1+\zeta}} Y / [\theta_T(1 + \zeta)]$
13. $R^E = e^{1+\zeta} Y / [\theta_E(1 + \zeta)] + \delta Y / [\phi(1 - \delta)]$
14. $Y = C + R^X + R^E$
15. $1 = \alpha C / (\mu w)$
16. $1 = (1 - \alpha) C / (\mu m)$
17. $Z = (\sum_{T \in \{L, H\}} N^T Z^{T^{\sigma-1}})^{\frac{1}{\sigma-1}}$
18. $\sum_{T \in \{L, H\}} N^T [Z^T / (\mu \zeta^T)]^{\sigma-1} = 1$

B.1.4 “Scale-Free” Stationary Solution

The model’s equilibrium is characterized by initial conditions for Z_t^L and Z_t^H . In that sense, the economy’s “scale” is not endogenously determined in the model. Therefore, to solve for a “scale-free” stationary equilibrium, we assume that $Z_0^L = Z_0^H$ and define the following composite variables:

$$\mathcal{Z} \equiv Z(\alpha/w)^\alpha [(1 - \alpha)/m]^{1-\alpha}, \quad \mathcal{C} \equiv C/Y, \quad \mathcal{C}^w \equiv C/w \quad \text{and} \quad \mathcal{C}^m \equiv C/m.$$

With these definitions, we can reduce the above system of equations to:

1. $a^T = \{\mathcal{Z}/[\mu(1 + \tau^T)^{1-\alpha}]\}^{\sigma-1} / \{\sigma[\rho + \chi + (\sigma - 1)g]\}, \quad \forall T \in \{L, H\}$
2. $b^T = (\theta_T \mathcal{C})^{1/\zeta} (a^T \lambda^{\sigma-1} + b^T)^{1+1/\zeta} / [(1 + 1/\zeta)(\rho + \chi)], \quad \forall T \in \{L, H\}$

3. $x^T = [(a^T \lambda^{\sigma-1} + b^T) \theta_T \mathcal{C}]^{1/\zeta}, \quad \forall T \in \{L, H\}$
4. $N^L = (1 - \delta)e/\chi$
5. $N^H = 1 - N^L$
6. $e = \{[\delta(a^H \lambda^{\sigma-1} + b^H) + (1 - \delta)(a^L \lambda^{\sigma-1} + b^L)] \theta_E \mathcal{C}\}^{1/\zeta}$
7. $\delta = 1 - \{[(a^H - a^L) \lambda^{\sigma-1} + b^H - b^L] \phi e \mathcal{C}\}^{-1/2}$
8. $g = \chi(\lambda^{\sigma-1} - 1)/(\sigma - 1)$
9. $\chi = \sum_{T \in \{L, H\}} N^T x^T + e$
10. $1 = \mathcal{C} + \sum_{T \in \{L, H\}} N^T x^{T^{1+\zeta}} / [\theta_T(1 + \zeta)] + e^{1+\zeta} / [\theta_E(1 + \zeta)] + \delta / [\phi(1 - \delta)]$
11. $1 = \alpha \mathcal{C}^w / \mu$
12. $1 = (1 - \alpha) \mathcal{C}^m / \mu$
13. $1 = (\mathcal{Z}/\mu)^{\sigma-1} \sum_{T \in \{L, H\}} N^T (1 + \tau^T)^{(\alpha-1)(\sigma-1)}$

Moreover, if ζ is calibrated to unity, the solution to the quadratic equation that characterizes b^T is given by:

$$b^T = \{\rho + \chi - a^T \lambda^{\sigma-1} \theta_T \mathcal{C} - [(\rho + \chi)^2 - 2(\rho + \chi) a^T \lambda^{\sigma-1} \theta_T \mathcal{C}]^{1/2}\} / (\theta_T \mathcal{C}).$$

B.2 Characterization of model moments: baseline model

B.2.1 Model moments to identify the structural parameters

We know from [Klette and Kortum \(2004\)](#) that the average age of high-type firms is given by:

$$\mathbb{E}[a_f | f \in H] = \ln[\chi / (\chi - x^H)] / x^H$$

whereas that of low-type firms is given by:

$$\mathbb{E}[a_f | f \in L] = 1/\chi.$$

Therefore, the average age of any given firm is:

$$\mathbb{E}[a_f] = \frac{\mathbb{E}[a^H] M^H + \mathbb{E}[a^L] N^L}{M^H + N^L}$$

where M^H denotes the measure of high-type firms, given by:

$$M^H \equiv \ln \left(\frac{\chi}{\chi - x^H} \right) \left(\frac{\delta e}{x^H} \right).$$

The share of single product firms is:

$$(\delta e/\chi + N^L)/(M^H + N^L).$$

B.2.2 Model moments to identify the policy parameters

The number of new products introduced by a high-type firm holding n products is equal to $x^H n$. We know from [Klette and Kortum \(2004\)](#) that the fraction of high-type firms holding n products is equal to:

$$\frac{(x^H/\chi)^n}{n \ln[\chi/(\chi - x^H)]}.$$

Therefore, the average number of new products introduced by high-type firms is equal to:

$$\frac{x^H}{\ln[\chi/(\chi - x^H)]} \sum_{n=1}^{\infty} (x^H/\chi)^n = \frac{x^{H^2}}{\ln[\chi/(\chi - x^H)](\chi - x^H)}.$$

The average number of new products introduced by all firms is equal to:

$$\frac{x^{H^2} M^H}{\ln[\chi/(\chi - x^H)](\chi - x^H)(M^H + N^L)}.$$

Similarly, the average number of deleted products by all firms is equal to:

$$\frac{\chi x^H M^H}{\ln[\chi/(\chi - x^H)](\chi - x^H)(M^H + N^L)} + \frac{\chi N^L}{M^H + N^L}.$$

Average log-employment across all firms is given by:

$$\begin{aligned} \frac{\mathbb{E}[\ln(h_f)|f \in H]M^H + \mathbb{E}[\ln(h_f)|f \in L]N^L}{M^H + N^L} &= \ln(\alpha \mathcal{C}^w/\mu) + \int \tilde{z} dF(\tilde{z}) + (\sigma - 1) \ln(\mathcal{Z}/\mu) \\ &+ \frac{(1 - \sigma)(1 - \alpha) \ln(1 + \tau^H) M^H}{M^H + N^L} \\ &+ \frac{M^H}{M^H + N^L} \cdot \sum_{n=1}^{\infty} \frac{\ln(n)(x^H/\chi)^n M^H}{n \ln[\chi/(\chi - x^H)]} \end{aligned}$$

whereas average landholdings across all products is:

$$\begin{aligned} \frac{\mathbb{E}[\ln(l_f)|f \in H]M^H + \mathbb{E}[\ln(l_f)|f \in L]N^L}{M^H + N^L} &= \ln((1 - \alpha)\mathcal{C}^m/\mu) + \int \tilde{z} dF(\tilde{z}) + (\sigma - 1) \ln(\mathcal{Z}/\mu) \\ &+ \frac{[(1 - \sigma)(1 - \alpha) - 1] \ln(1 + \tau^H)M^H}{M^H + N^L} \\ &+ \frac{M^H}{M^H + N^L} \cdot \sum_{n=1}^{\infty} \frac{\ln(n)(x^H/\chi)^n M^H}{n \ln[\chi/(\chi - x^H)]} \end{aligned}$$

where we have defined the following transformation of process efficiency:

$$\tilde{z}_t \equiv (\sigma - 1)[\ln(z_t) - \ln(Z_t)].$$

The stationary distribution of this transformed process efficiency $F(\tilde{z})$ satisfies the following ordinary differential equation:

$$(1 - \sigma)gF'(\tilde{z}) = \begin{cases} -\chi F(\tilde{z}) + \xi \chi \sum_{k=1}^{\infty} F(\tilde{z} - (\sigma - 1)k \ln(\lambda))p(k) & \text{if } \tilde{z} < (\sigma - 1) \ln(\lambda), \\ -\chi F(\tilde{z}) + \xi \chi \sum_{k=1}^{\infty} F(\tilde{z} - (\sigma - 1)k \ln(\lambda))p(k) + (1 - \xi)\chi \sum_{k=1}^{k^*} p(k) & \text{if } \tilde{z} = (\sigma - 1)k^* \ln(\lambda). \end{cases}$$

B.3 Aggregation: baseline model

B.3.1 Static

The optimal product price is given by $p^T(z) = \frac{\mu \varsigma^T}{z}$, where ς^T is the cost index of a type-T firm. Substitute into the aggregate price index, we have

$$\begin{aligned} 1 \equiv P &= \left(N^H \int p^H(z)^{1-\sigma} dF^H(z) + N^L \int p^L(z)^{1-\sigma} dF^L(z) \right)^{\frac{1}{1-\sigma}} \\ &= \underbrace{\mu \bar{\varsigma} \left(\sum_{T=H,L} N^T \int (1 + \tau^T)^{(1-\sigma)\alpha_L} z^{\sigma-1} dF^T(z) \right)^{\frac{1}{1-\sigma}}}_{\text{denoted by } 1/A} \end{aligned}$$

where $\bar{\varsigma} \equiv \left(\frac{w_t}{\alpha_H} \right)^{\alpha_H} \left(\frac{m_t}{\alpha_L} \right)^{\alpha_L}$ represents the undistorted cost index.

Firms' static maximization gives us:

$$\begin{aligned} h(z)^T &= \frac{\alpha_H \varsigma^T y^T(z)}{w z} \\ l(z)^T &= \frac{\alpha_L}{m(1 + \tau^T)} \frac{\varsigma^T y^T(z)}{z} \end{aligned}$$

Given the inverse demand function $y(z)^T = Y p^T(z)^{-\sigma}$, we can write the aggregate demand for labor as

$$\begin{aligned} H &= \sum_{T=H,L} N^T \int h^T(z) dF^T(z) \\ &= \frac{\alpha_H}{w} \mu^{-\sigma} \bar{\zeta}^{1-\sigma} A^{\sigma-1} Y \end{aligned}$$

Since we assume that the land cost wedge is paid in land, for the high-type, the amount of land used for each unit of production land is $(1 + \tau)l^H(z)$. So land market clearing gives

$$\begin{aligned} 1 = L &= \sum_{T=H,L} N^T \int (1 + \tau^T) l^T(z) dF^T(z) \\ &= \sum_{T=H,L} N^T \int \frac{\alpha_L \zeta^T y(z)^T}{m z} dF^T(z) \\ &= \frac{\alpha_L}{m} \mu^{-\sigma} \bar{\zeta}^{1-\sigma} A^{\sigma-1} Y \end{aligned}$$

We can therefore write the aggregate production function

$$H_p^{\alpha_H} L^{\alpha_L} = \mu^{-\sigma} \bar{\zeta}^{-\sigma} Y A^{\sigma-1} = Y/A$$

Since only the high-type firms face the land cost wedge, and the wedge is constant among them, we can explicitly characterize its efficiency loss:

$$\begin{aligned} A &= \left(\sum_{T=H,L} N^T \int (1 + \tau^T)^{(1-\sigma)\alpha_L} z^{\sigma-1} dF^T(z) \right)^{\frac{1}{\sigma-1}} \\ &= Z \left(N^H / (1 + \tau)^{\alpha_L(\sigma-1)} + N^L \right)^{\frac{1}{\sigma-1}} \\ &\equiv Z \mathcal{M} \end{aligned}$$

where $\mathcal{M} \in (0, 1]$ denotes the efficiency loss from the land wedge—holding Z fixed and not considering any dynamic effects that \mathcal{M} may have on Z . \mathcal{M} decreases with an increase in the high-type employment share N^H , the land cost wedge τ , and the output elasticity of land α_L .

Here \mathcal{M} accounts for both the direct cost of the land wedge—land diverted to pay the wedge rather than being used in production—and the loss due to misallocation, reflected in the dispersion of land productivity across firms. We can decompose \mathcal{M} to isolate the misallocation loss as shown below. First, we re-write the aggregate demand for production

land, excluding the land used to pay the wedge:

$$\begin{aligned} L_p &= \sum_{T=H,L} N^T \int l^T(z) dF^T(z) \\ &= \frac{\alpha_L}{m} \mu^{-\sigma} \xi^{1-\sigma} A^{\sigma-1} Y B \end{aligned}$$

where B is given by

$$B \equiv \frac{\sum_{T=H,L} N^T \int (1 + \tau^T)^{(1-\sigma)\alpha_L - 1} z^{\sigma-1} dF^T(z)}{\sum_{T=H,L} N^T \int (1 + \tau^T)^{(1-\sigma)\alpha_L} z^{\sigma-1} dF^T(z)}$$

We can then re-write the aggregate production function as below:

$$Y = AB^{-\alpha_L} L_p^{\alpha_L} H^{\alpha_H}$$

which simplifies to

$$Y = Z \mathcal{M}^{\text{Mis}} L_p^{\alpha_L} H^{\alpha_H}$$

where

$$\mathcal{M}^{\text{Mis}} \equiv \frac{\left(N^H (1 + \tau)^{\alpha_L(1-\sigma)} + N^L \right)^{\frac{1}{\sigma-1} + \alpha_L}}{\left(N^H (1 + \tau)^{\alpha_L(1-\sigma)-1} + N^L \right)^{\alpha_L}}$$

\mathcal{M}^{Mis} thus summarizes the loss due to land misallocation, and it is easy to verify that $\mathcal{M}^{\text{Mis}} = 1$ when the wedge τ is equalized across firms.

B.3.2 Dynamic

Have household life-time discounted utility

$$\begin{aligned} U_0(C_0, g) &= \frac{1}{\rho} \left[\ln(C_0) + \frac{g}{\rho} \right] \\ &= \frac{1}{\rho} \left[\ln(Y_0) + \frac{g}{\rho} + \ln(C_0/Y_0) \right] \end{aligned}$$

where pre-Repeal initial production is given by $Y_0^{\text{pre}} = \mathcal{M} Z_0^{\text{pre}}$

We normalize $Z_0 = 1$ for both ‘pre’ and ‘pos’, and in stationary equilibrium the mass of production worker is constant. We can then write the consumption-equivalent welfare change as

$$\xi = \exp \left(\frac{g^{\text{pos}} - g^{\text{pre}}}{\rho} \right) \frac{1}{\mathcal{M}} \left(\frac{C_0^{\text{pos}} / Y_0^{\text{pos}}}{C_0^{\text{pre}} / Y_0^{\text{pre}}} \right)$$

B.3.3 Welfare Calculation with Transition Dynamics.

Consider two scenarios: (1) the economy remains in its pre-repeal stationary equilibrium, or (2) the repeal launches the economy on a transition path toward its undistorted stationary equilibrium. To quantify the welfare gain from the repeal, we can ask the following question: by what factor $\xi > 0$ would we need to permanently multiply consumption per capita in scenario (1) to achieve the same utility as in scenario (2)? In scenario (1), consumption is given by $C_t = C_0 e^{gt}$. Therefore, discounted lifetime utility can be expressed as:

$$U_0 = \frac{1}{\rho} \left[\ln(\xi) + \ln(Y_0) + \frac{g}{\rho} + \ln(C_0/Y_0) \right]$$

In scenario (2), consumption is given by $C_t^* = C_0^* e^{\int_0^t g_\tau^* d\tau}$ such that discounted lifetime utility can be expressed as:

$$U_0^* = \frac{1}{\rho} \cdot \left[\ln(Y_0^*) + \frac{g_\infty^*}{\rho} + \ln(C_0^*/Y_0^*) \right] + \int_0^\infty e^{-\rho t} \int_0^t (g_\tau^* - g_\infty^*) d\tau dt + \int_0^\infty e^{-\rho t} [\ln(C_t^*/Y_t^*) - \ln(C_\infty^*/Y_\infty^*)] dt / (1 + \eta)$$

where we define $\ln(C_\infty^*/Y_\infty^*) \equiv \lim_{t \rightarrow \infty} \ln(C_t^*/Y_t^*)$ and $g_\infty^* \equiv \lim_{t \rightarrow \infty} g_t^*$ denotes the post-repeal stationary growth rate of consumption. Hence, the first term reflects discounted lifetime utility if the economy jumped instantaneously to its new stationary equilibrium, whereas the second term captures transition dynamics.

B.4 Alternative Model: R&D Cost in Labor & Elastic Labor Supply

B.4.1 Undistorted Non-Stationary Solution

The non-stationary solution of the model consists of the following system of ZZZ differential-algebraic equations:

1. $\dot{a}_t^T = [\rho + \chi_t + (\sigma - 1)g_t]a_t^T - [Z_t/(\mu\varsigma_t)]^{\sigma-1}/\sigma, \quad \forall T \in \{L, H\}$
2. $\dot{b}_t^T = (\rho + \chi_t)b_t^T - (\theta_T C_t/w_t)^{1/\zeta} (a_t^T \Lambda + b_t^T)^{1+1/\zeta} / (1 + 1/\zeta), \quad \forall T \in \{L, H\}$
3. $x_t^T = [(a_t^T \Lambda + b_t^T)\theta_T C_t/w_t]^{1/\zeta}, \quad \forall T \in \{L, H\}$
4. $\varsigma_t = (w_t/\alpha)^\alpha [m_t/(1 - \alpha)]^{1-\alpha}$

6. $\dot{N}_t^L = (1 - \delta_t)e_t - \chi_t N_t^L$
7. $N_t^H = 1 - N_t^L$
8. $e_t = \{[\delta_t(a_t^H \Lambda + b_t^H) + (1 - \delta_t)(a_t^L \Lambda + b_t^L)]\theta_E C_t/w_t\}^{1/\zeta}$
9. $\delta_t = 1 - \{[(a_t^H - a_t^L)\Lambda + b_t^H - b_t^L]\phi e_t C_t/w_t\}^{-1/2}$
10. $g_t = \chi_t(\Lambda - 1)/(\sigma - 1)$
11. $\chi_t = \sum_{T \in \{L, H\}} N_t^T x_t^T + e_t$
12. $R_t^X = \sum_{T \in \{L, H\}} N_t^T x_t^{T^{1+\zeta}}/[\theta_T(1 + \zeta)]$
13. $R_t^E = e_t^{1+\zeta}/[\theta_E(1 + \zeta)] + \delta_t/[\phi(1 - \delta_t)]$
14. $[w_t/(\beta C_t)]^{1/\eta} = \alpha C_t/(\mu w_t) + R_t^X + R_t^E$
15. $1 = (1 - \alpha)C_t/(\mu m_t)$
16. $Z_t = (\sum_{T \in \{L, H\}} N_t^T Z_t^{T^{\sigma-1}})^{\frac{1}{\sigma-1}}$
17. $\sum_{T \in \{L, H\}} N_t^T [Z_t^T/(\mu \zeta_t)]^{\sigma-1} = 1$

with initial conditions $\{N_0^T, Z_0^T\}_{T \in \{L, H\}}$ such that $Z_0^L = Z_0^H$ and terminal conditions:

$$\lim_{t \rightarrow \infty} a_t^T = a_\infty^T \quad \text{and} \quad \lim_{t \rightarrow \infty} b_t^T = b_\infty^T, \quad \forall T \in \{L, H\}.$$

B.4.2 “Scale-Free” Undistorted Non-Stationary Solution

The model’s equilibrium is characterized by initial conditions for Z_t^L and Z_t^H . In that sense, the economy’s “scale” is not endogenously determined in the model. Therefore, to solve for a “scale-free” non-stationary equilibrium, we assume that $Z_0^L = Z_0^H$ and define the following composite variables:

$$\mathcal{Z}_t \equiv Z_t(\alpha/w_t)^\alpha [(1 - \alpha)/m_t]^{1-\alpha}, \quad \mathcal{C}_t^w \equiv C_t/w_t \quad \text{and} \quad \mathcal{C}_t^m \equiv C_t/m_t.$$

With these definitions, we can reduce the above system of differential-algebraic equations to:

1. $\dot{a}_t = [\rho + \chi_t + (\sigma - 1)g_t]a_t - 1/\sigma$
2. $\dot{b}_t^T = (\rho + \chi_t)b_t^T - (\theta_T \mathcal{C}_t^w)^{1/\zeta} (a_t^T \Lambda + b_t^T)^{1+1/\zeta}/(1 + 1/\zeta), \quad \forall T \in \{L, H\}$
3. $x_t^T = [(a_t^T \Lambda + b_t^T)\theta_T \mathcal{C}_t^w]^{1/\zeta}, \quad \forall T \in \{L, H\}$

5. $\dot{N}_t^L = (1 - \delta_t)e_t - \chi_t N_t^L$
6. $N_t^H = 1 - N_t^L$
7. $e_t = \{[\delta_t(a_t^H \Lambda + b_t^H) + (1 - \delta_t)(a_t^L \Lambda + b_t^L)]\theta_E \mathcal{C}_t^w\}^{1/\zeta}$
8. $\delta_t = 1 - \{[(a_t^H - a_t^L)\Lambda + b_t^H - b_t^L]\phi e_t \mathcal{C}_t^w\}^{-1/2}$
9. $g_t = \chi_t(\Lambda - 1)/(\sigma - 1)$
10. $\chi_t = \sum_{T \in \{L, H\}} N_t^T x_t^T + e_t$
11. $R_t^X = \sum_{T \in \{L, H\}} N_t^T x_t^{T^{1+\zeta}} / [\theta_T(1 + \zeta)]$
12. $R_t^E = e_t^{1+\zeta} / [\theta_E(1 + \zeta)] + \delta_t / [\phi(1 - \delta_t)]$
13. $(\beta \mathcal{C}_t^w)^{-1/\eta} = \alpha \mathcal{C}_t^w / \mu + R_t^X + R_t^E$
14. $1 = (1 - \alpha) \mathcal{C}_t^m / \mu$

B.4.3 Stationary Solution

The stationary solution of the model consists of a system of 21 equations and unknowns. The unknowns are:

$$\{\chi, e, g, w, m, \delta, C, Z, R^X, R^E, \{a^T, b^T, x^T, \zeta^T, Z^T, N^T\}_{T \in \{L, H\}}\}$$

and the equations are:

1. $a^T = [Z / (\mu \zeta^T)]^{\sigma-1} / \{\sigma[\rho + \chi + (\sigma - 1)g]\}, \quad \forall T \in \{L, H\}$
2. $b^T = (\theta_T C / w)^{1/\zeta} (a^T \Lambda + b^T)^{1+1/\zeta} / [(1 + 1/\zeta)(\rho + \chi)], \quad \forall T \in \{L, H\}$
3. $x^T = [(a^T \Lambda + b^T) \theta_T C / w]^{1/\zeta}, \quad \forall T \in \{L, H\}$
4. $\zeta^T = (w/\alpha)^\alpha [(1 + \tau^T)m / (1 - \alpha)]^{1-\alpha}, \quad \forall T \in \{L, H\}$
5. $Z^T = 1, \quad \forall T \in \{L, H\}$
6. $N^H = \delta e / (\chi - x^H)$
7. $N^L = 1 - N^H$
8. $e = \{[\delta(a^H \Lambda + b^H) + (1 - \delta)(a^L \Lambda + b^L)]\theta_E C / w\}^{1/\zeta}$

9. $\delta = 1 - \{[(a^H - a^L)\Lambda + b^H - b^L]\phi eC/w\}^{-1/2}$
10. $g = \chi(\Lambda - 1)/(\sigma - 1)$
11. $\chi = \sum_{T \in \{L, H\}} N^T x^T + e$
12. $R^X = \sum_{T \in \{L, H\}} N^T x^{T^{1+\zeta}} / [\theta_T(1 + \zeta)]$
13. $R^E = e^{1+\zeta} / [\theta_E(1 + \zeta)] + \delta / [\phi(1 - \delta)]$
14. $[w/(\beta C)]^{1/\eta} = \alpha C / (\mu w) + R^X + R^E$
15. $1 = (1 - \alpha)C / (\mu m)$
16. $Z = (\sum_{T \in \{L, H\}} N^T Z^{T^{\sigma-1}})^{\frac{1}{\sigma-1}}$
17. $\sum_{T \in \{L, H\}} N^T [Z^T / (\mu \zeta^T)]^{\sigma-1} = 1$

B.4.4 “Scale-Free” Stationary Solution

The model’s equilibrium is characterized by initial conditions for Z_t^L and Z_t^H . In that sense, the economy’s “scale” is not endogenously determined in the model. Therefore, to solve for a “scale-free” stationary equilibrium, we assume that $Z_0^L = Z_0^H$ and define the following composite variables:

$$\mathcal{Z} \equiv Z(\alpha/w)^\alpha [(1 - \alpha)/m]^{1-\alpha}, \quad \mathcal{C}^w \equiv C/w \quad \text{and} \quad \mathcal{C}^m \equiv C/m.$$

With these definitions, we can reduce the above system of equations and unknowns to:

1. $a^T = \{\mathcal{Z} / [\mu(1 + \tau^T)^{1-\alpha}]\}^{\sigma-1} / \{\sigma[\rho + \chi + (\sigma - 1)g]\}, \quad \forall T \in \{L, H\}$
2. $b^T = (\theta_T \mathcal{C}^w)^{1/\zeta} (a^T \Lambda + b^T)^{1+1/\zeta} / [(1 + 1/\zeta)(\rho + \chi)], \quad \forall T \in \{L, H\}$
3. $x^T = [(a^T \Lambda + b^T) \theta_T \mathcal{C}^w]^{1/\zeta}, \quad \forall T \in \{L, H\}$
4. $N^H = \delta e / (\chi - x^H)$
5. $N^L = 1 - N^H$
6. $e = \{[\delta(a^H \Lambda + b^H) + (1 - \delta)(a^L \Lambda + b^L)] \theta_E \mathcal{C}^w\}^{1/\zeta}$
7. $\delta = 1 - \{[(a^H - a^L)\Lambda + b^H - b^L]\phi e \mathcal{C}^w\}^{-1/2}$
8. $g = \chi(\Lambda - 1)/(\sigma - 1)$

9. $\chi = \sum_{T \in \{L, H\}} N^T x^T + e$
10. $R^X = \sum_{T \in \{L, H\}} N^T x^{T^{1+\zeta}} / [\theta_T(1 + \zeta)]$
11. $R^E = e^{1+\zeta} / [\theta_E(1 + \zeta)] + \delta / [\phi(1 - \delta)]$
12. $(\beta C)^{-1/\eta} = \alpha C^w / \mu + R^X + R^E$
13. $1 = (1 - \alpha) C^m / \mu$
14. $1 = (\mathcal{Z} / \mu)^{\sigma-1} \sum_{T \in \{L, H\}} N^T (1 + \tau^T)^{(\alpha-1)(\sigma-1)}$

Moreover, if ζ is calibrated to unity, the solution to the quadratic equation that characterizes b^T is given by:

$$b^T = \{\rho + \chi - a^T \Lambda \theta_T C_w - [(\rho + \chi)^2 - 2(\rho + \chi) a^T \Lambda \theta_T C_w]^{1/2}\} / (\theta_T C_w).$$

B.5 Alternative Model: Stochastic Step Size

Assume step size λ has Pareto distribution with unity scale and shape parameter ϵ . We further assume that a High-type innovation has to be $\lambda > 1 + \tau$ to replace a Low-type firm, while an entrant can always replace incumbent. We make the following modifications to the equations outlined above.

First note that high and low type products now face different creative destruction rates.

1. $\chi^L = Pr(\lambda > 1 + \tau) N^H x^H + e = (1 + \tau)^{-\epsilon} N^H x^H + e$
2. $\chi^H = N^H x^H + e$

Second, high-type firms' value function now becomes

$$\begin{aligned}
r_t V_t^H(n, \{z_i\}_i) &= \sum_{i=1}^n \pi_t^H(z_i) && \text{Flow profits} \\
&- \sum_{j=1}^n \chi_t^H [V_t^H(n, \{z_i\}_i) - V_t^H(n-1, \{z_i\}_{i \neq j})] && \text{Creative destruction} \\
&+ \max_X \{X N^H [\xi \int_z \int_\lambda V_t^H(n+1, \{z_i\}_i \cup \{\lambda z\}) d\lambda dF_t(z) \\
&+ (1 - \xi) \int_\lambda V_t^H(n+1, \{z_i\}_i \cup \{\lambda Z_t\}) d\lambda - V_t^H(n, \{z_i\}_i)] && \text{Replace high-type} \\
&+ X N^L Pr(\lambda > 1 + \tau) [\xi \int_z \int_{\lambda > 1 + \tau} V_t^H(n+1, \{z_i\}_i \cup \{\lambda z\}) f(\lambda | \lambda > 1 + \tau) d\lambda dF_t(z) \\
&+ (1 - \xi) \int_{\lambda > 1 + \tau} V_t^H(n+1, \{z_i\}_i \cup \{\lambda Z_t\}) f(\lambda | \lambda > 1 + \tau) d\lambda - V_t^H(n, \{z_i\}_i)] && \text{Replace low type} \\
&- w_t c^H(X, n, \theta_T) \} && \text{Expansion cost} \\
&+ \dot{V}_t^H(n, \{z_i\}_i) && \text{Capital gains.}
\end{aligned}$$

We can write the high-type's product value, after normalization by C , as

$$(\rho + \chi^H)v^H(z) = \dot{v}^H(z) + \frac{(z/Z)^{\sigma-1}}{\sigma(\mu\varsigma_t^H/Z)^{\sigma-1}} + \Xi$$

where Ξ represents the R&D value defined as

$$\Xi \equiv \max_x \left\{ xN^H E[v^H(\lambda z)] + xN^L P(\lambda > 1 + \tau)E[v^H(\lambda z)|\lambda > 1 + \tau] - \frac{wx^{1+\zeta}}{C\theta(1 + \zeta)} \right\}$$

We can solve the ODE as $v^H(z) = a^H(z/Z)^{\sigma-1} + b^H$, where $a^H = \frac{(Z/\mu\varsigma_t^H)^{\sigma-1}}{\sigma(\rho + \chi^H + (\sigma-1)g)}$, and $b^H = \frac{\Xi}{\rho + \chi^H}$.

The optimal innovation rate is given by

$$\begin{aligned} \frac{w}{C\theta}x^\zeta &= N^H E[v^H(\lambda z)] + N^L P(\lambda > 1 + \tau)E[v^H(\lambda z)|\lambda > 1 + \tau] \\ &= N^H(a^H E[\lambda^{\sigma-1}] + b) + N^L P(\lambda > 1 + \tau)(a^H E[\lambda^{\sigma-1}|\lambda > 1 + \tau] + b) \\ &= a^H E[\lambda^{\sigma-1}] + b - N^L P(\lambda < 1 + \tau)(a^H E[\lambda^{\sigma-1}|\lambda < 1 + \tau] + b) \end{aligned}$$

This expression makes clear that compared to the undistorted case, the high-type has lower innovation incentive if there are more low-type firms and if the wedge is higher. We can then substitute x into b^H

$$\begin{aligned} b^H &= \frac{\Xi}{\rho + \chi^H} \\ &= \frac{(\theta C)^{1/\zeta}}{(\rho + \chi^H)(1 + 1/\zeta)} [a^H E[\lambda^{\sigma-1}] + b^H - N^L P(\lambda < 1 + \tau)(a^H E[\lambda^{\sigma-1}|\lambda < 1 + \tau] + b^H)]^{1+1/\zeta} \end{aligned}$$

where $E[\lambda^{\sigma-1}] = \frac{\epsilon}{\epsilon - (\sigma-1)}$ and $E[\lambda^{\sigma-1}|\lambda < 1 + \tau] = \frac{\epsilon}{\epsilon - (\sigma-1)} \frac{1 - (1+\tau)^{-\epsilon + \sigma - 1}}{1 - (1+\tau)^{-\epsilon}}$. We can explicitly solve b^H below. Write $A = (E[\lambda^{\sigma-1}] - N^L Pr(\lambda < 1 + \tau)E[\lambda^{\sigma-1}|\lambda < 1 + \tau]) / (1 - N^L Pr(\lambda < 1 + \tau))$, and $P = 1 - N^L Pr(\lambda < 1 + \tau)$ for simplicity. When $\zeta = 1$, we have

$$b^H = \frac{\theta C P^2}{2(\rho + \chi^H)} (a^H A + b^H)^2$$

Rearrange, we have

$$\begin{aligned}
\left(\frac{\rho + \chi^H}{P}\right)^2 + 2\theta C(\rho + \chi^H)b^H &= \left(\frac{\rho + \chi^H}{P}\right)^2 + (P\theta C)^2(a^H A + b^H)^2 \\
\left(\frac{\rho + \chi^H}{P}\right)^2 + 2\theta C(\rho + \chi^H)(a^H A + b^H) &= \left(\frac{\rho + \chi^H}{P}\right)^2 + (P\theta C)^2(a^H A + b^H)^2 + 2\theta C(\rho + \chi^H)a^H A \\
\left[P\theta C(a^H A + b^H) - \left(\frac{\rho + \chi^H}{P}\right)\right]^2 &= \left(\frac{\rho + \chi^H}{P}\right)^2 - 2\theta C(\rho + \chi^H)a^H A \\
\left[\left(\frac{\rho + \chi^H}{P}\right) - P\theta C(a^H A + b^H)\right] &= \sqrt{\left(\frac{\rho + \chi^H}{P}\right)^2 - 2\theta C(\rho + \chi^H)a^H A} \\
b^H &= \frac{\left(\frac{\rho + \chi^H}{P}\right) - P\theta C a^H A - \sqrt{\left(\frac{\rho + \chi^H}{P}\right)^2 - 2\theta C(\rho + \chi^H)a^H A}}{P\theta C}
\end{aligned}$$

The value of a low type product remains unchanged after accounting for the fact that they now face lower creative destruction rate χ^L . Since entrant always replace incumbent, the optimal entry and targeted entry conditions remain unchanged.

The share of high-type products becomes

$$N^H = \frac{e\delta}{\chi^L - x^H Pr(\lambda > 1 + \tau)}$$

Denote $\bar{x}^H = x^H N^H + x^H N^L Pr(\lambda > 1 + \tau)$, the mass of high-type firms is

$$M^H = -\log\left(1 - \frac{\bar{x}^H}{\chi^H}\right) \frac{e\delta}{\bar{x}^H}$$

The average number of new products introduced by high-type firms is equal to:

$$\frac{\bar{x}^H}{\ln[\chi^H/(\chi^H - \bar{x}^H)]} \sum_{n=1}^{\infty} (\bar{x}^H/\chi^H)^n = \frac{(\bar{x}^H)^2}{\ln[\chi^H/(\chi^H - \bar{x}^H)](\chi^H - \bar{x}^H)}.$$

The average number of deleted products by all firms is equal to:

$$\frac{\chi^H \bar{x}^H M^H}{\ln[\chi^H/(\chi^H - \bar{x}^H)](\chi^H - \bar{x}^H)(M^H + N^L)} + \frac{\chi^L N^L}{M^H + N^L}.$$

The average age of high-type firms is given by:

$$\mathbb{E}[a_f | f \in H] = \ln[\chi^H / (\chi^H - \bar{x}^H)] / \bar{x}^H$$

Finally, the growth rate is given by:

$$\begin{aligned} g &= N^H \chi^H \frac{E[\lambda^{\sigma-1}] - 1}{\sigma - 1} + N^L Pr(\lambda > 1 + \tau) (N^H x) \frac{E[\lambda^{\sigma-1} | \lambda > 1 + \tau] - 1}{\sigma - 1} + N^L e \frac{E[\lambda^{\sigma-1}] - 1}{\sigma - 1} \\ &= \chi^H \frac{E[\lambda^{\sigma-1}] - 1}{\sigma - 1} - x N^L (1 - N^L) Pr(\lambda < 1 + \tau) \frac{E[\lambda^{\sigma-1} | \lambda < 1 + \tau] - 1}{\sigma - 1} \end{aligned}$$

Life cycle growth. From [Klette and Kortum \(2004\)](#), we know that the expected number of product for a high-type at age a is

$$E^H[n|a] = \frac{1}{1 - \gamma(a)} \quad \text{where} \quad \gamma(a) = \frac{\bar{x}^H (1 - e^{-(\chi^H - \bar{x}^H)a})}{\chi^H - \bar{x}^H e^{-(\chi^H - \bar{x}^H)a}}$$

Since the low-type has exit rate χ^L , the probability that they survive until age a is $p^L(a) = e^{-\chi^L a}$. The probability that a high-type firm survives until age a is given by

$$p^H(a) = 1 - \frac{\chi^H}{\bar{x}^H} \gamma(a) = \frac{(\chi^H - \bar{x}^H) e^{-(\chi^H - \bar{x}^H)a}}{\chi^H - \bar{x}^H e^{-(\chi^H - \bar{x}^H)a}}$$

The share of low-type among cohort a is given by

$$s^L(a) = \frac{(1 - \delta)p^L(a)}{\delta p^H(a) + (1 - \delta)p^L(a)} = 1 / \left(1 + \frac{\delta}{1 - \delta} \frac{(\chi^H - \bar{x}^H) e^{x^H a Pr(\lambda > 1 + \tau)}}{\chi^H - \bar{x}^H e^{-(\chi^H - \bar{x}^H)a}} \right)$$

The expected number of product among all firms at age a is

$$E[n|a] = s^L(a) + (1 - s^L(a))E^H[n|a]$$

Also from [Klette and Kortum \(2004\)](#), the density of a high type at age a is given by

$$f^H(a) = -\dot{p}^H(a) = \chi^H [1 - \gamma(a)] p^H(a)$$

while the density of a low type is $f^L(a) = -\dot{p}^L(a) = \chi^L e^{-\chi^L a}$. We can then calculate the

ratio of 10-15 year old firms relative to 0-5 year old as

$$\frac{\delta \int_{10}^{15} f^H(a) da + (1 - \delta) \int_{10}^{15} f^L(a) da}{\delta \int_0^5 f^H(a) da + (1 - \delta) \int_0^5 f^L(a) da}$$

B.6 Alternative Model: Evolving Firm Types

Now we assume an exogenous flow rate $\nu > 0$ such that high type firms become not innovative, while the low type is the absorbing state. We assume that previously high-type firms remain subject to the land cost wedge τ .

The value function for the high type firms is therefore given by

$$\begin{aligned} r_t V_t^H(n, \{z_i\}_i) &= \sum_{i=1}^n \pi_t^H(z_i) && \text{Flow profits} \\ &- \sum_{j=1}^n \chi_t [V_t^H(n, \{z_i\}_i) - V_t^H(n-1, \{z_i\}_{i \neq j})] && \text{Creative destruction} \\ &+ \max_X \{X \int V_t^H(n+1, \{z_i\}_i \cup \{\lambda z\}) dF_t(z) \\ &- c_t^X(X, n, \theta_H)\} && \text{Expansion benefit} \\ &+ \nu [V_t^S(n, \{z_i\}_i) - V_t^H(n, \{z_i\}_i)] && \text{Expansion cost} \\ &+ \dot{V}_t^H(n, \{z_i\}_i) && \text{Lose innovativeness} \\ &&& \text{Capital gains.} \end{aligned}$$

where superscript S denote previous high-type firms that are now stagnant. And the franchise value of a product for high type firms is:

$$(\rho + \chi_t + \nu) v_t^H(z) = \dot{v}^H(z) + \nu \cdot v_t^S(z) + \frac{z^{\sigma-1} (1 + \tau)^{(1-\sigma)(1-\alpha)}}{\sigma (\mu \varsigma_t)^{\sigma-1}} + \max_{x_t^H} \left\{ x_t^H \mathbb{E}[v^H(\lambda z)] - \frac{(x_t^H)^{\zeta+1} Y_t}{\theta^H (1 + \zeta) C_t} \right\}$$

The value function for the low type is

$$\begin{aligned} r_t V_t^L(n, \{z_i\}_i) &= \sum_{i=1}^n \pi_t^L(z_i) && \text{Flow profits} \\ &- \sum_{j=1}^n \chi_t [V_t^L(n, \{z_i\}_i) - V_t^L(n-1, \{z_i\}_{i \neq j})] && \text{Creative destruction} \\ &+ \dot{V}_t^H(n, \{z_i\}_i) && \text{Capital gains.} \end{aligned}$$

We can write the scale-free stationary solution for the franchise value as:

1. $a^H = [\{\mathcal{Z}/[\mu(1 + \tau^T)^{1-\alpha}]\}^{\sigma-1} + \nu(a^S)] / \{\sigma[\rho + \chi + \nu + (\sigma - 1)g]\}$
2. $b^T = (\theta_T C)^{1/\zeta} (a^T \lambda^{\sigma-1} + b^T)^{1+1/\zeta} / [(1 + 1/\zeta)(\rho + \chi + \nu)], \quad \forall T \in \{L, H\}$
3. $a^L = \{\mathcal{Z}/[\mu]\}^{\sigma-1} / \{\sigma[\rho + \chi + (\sigma - 1)g]\}, \quad \forall T \in \{L, H\}$

4. $b^L = 0$

5. $a^H = [\{\mathcal{Z}/[\mu(1 + \tau^T)^{1-\alpha}]\}^{\sigma-1}]/\{\sigma[\rho + \chi + (\sigma - 1)g]\}$

To solve the stationary firm distribution, let $M^H(n)$ denotes the mass of high type firms with n products.

$$\begin{aligned} \chi M^H(1) &= e\delta - M^H\nu \\ 2\chi M^H(2) &= M^H(1)x^H + M^H(1)\nu - M^H\nu \\ &\dots \\ n\chi M^H(n) &= (n - 1)M^H(n - 1)x^H + \nu \sum_{j=1}^{n-1} M^H(j) - M^H\nu \\ \text{s.t. } \sum_{j=1}^{\infty} M^H(j) &= M^H \end{aligned}$$

Similarly, the distribution for low type firms is given by

$$\begin{aligned} \chi M^L(1) &= e(1 - \delta) + M^H\nu \\ 2\chi M^L(2) &= M^H\nu - M^H(1)\nu \\ 3\chi M^L(3) &= M^H\nu - M^H(1)\nu - M^H(2)\nu \\ &\dots \\ n\chi M^L(n) &= M^H\nu - \nu \sum_{j=1}^{n-1} M^H(j) \end{aligned}$$

And the share of product held by type- T firms is $N^T = \sum_{j=1}^{\infty} M^T(j)j$.

C Additional Figures and Tables

C.1 Additional Figures

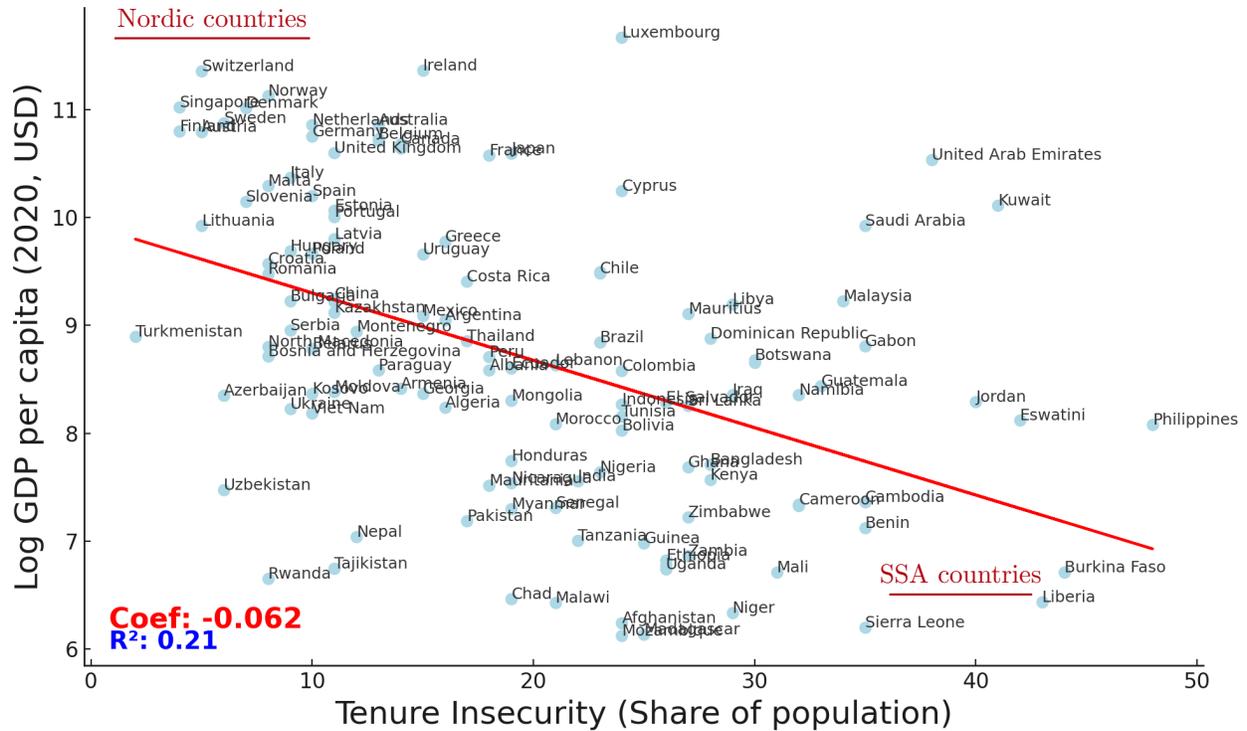


Figure C.1: Cross-Country Relationship between GDP per Capita and Tenure Insecurity

Note: This figure illustrates the cross-country relationship between log GDP per capita and tenure insecurity, defined as the percentage of the population expecting to lose property rights against their will within 5 years. Tenure insecurity data is sourced from [Prindex \(2020\)](#).

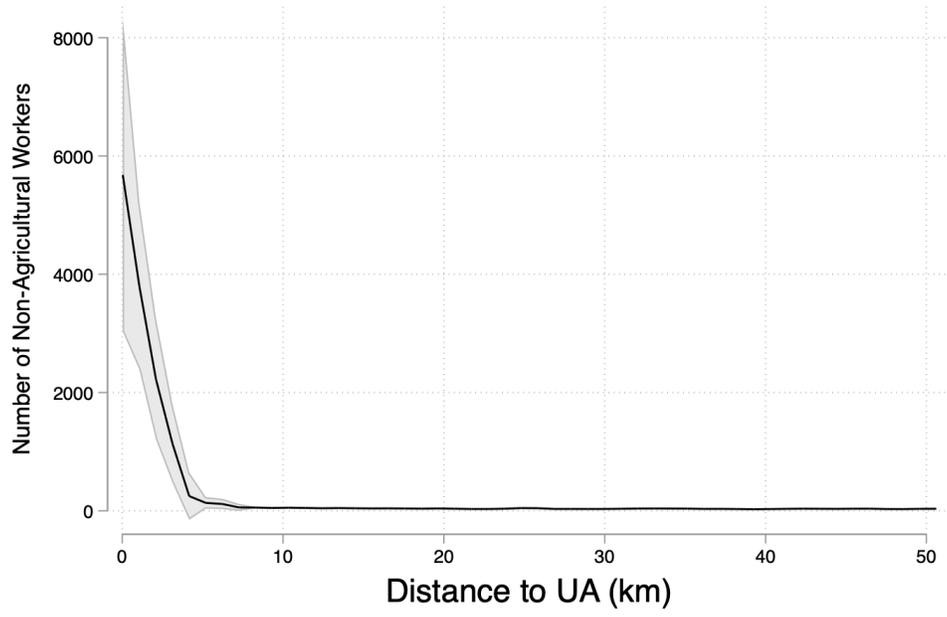
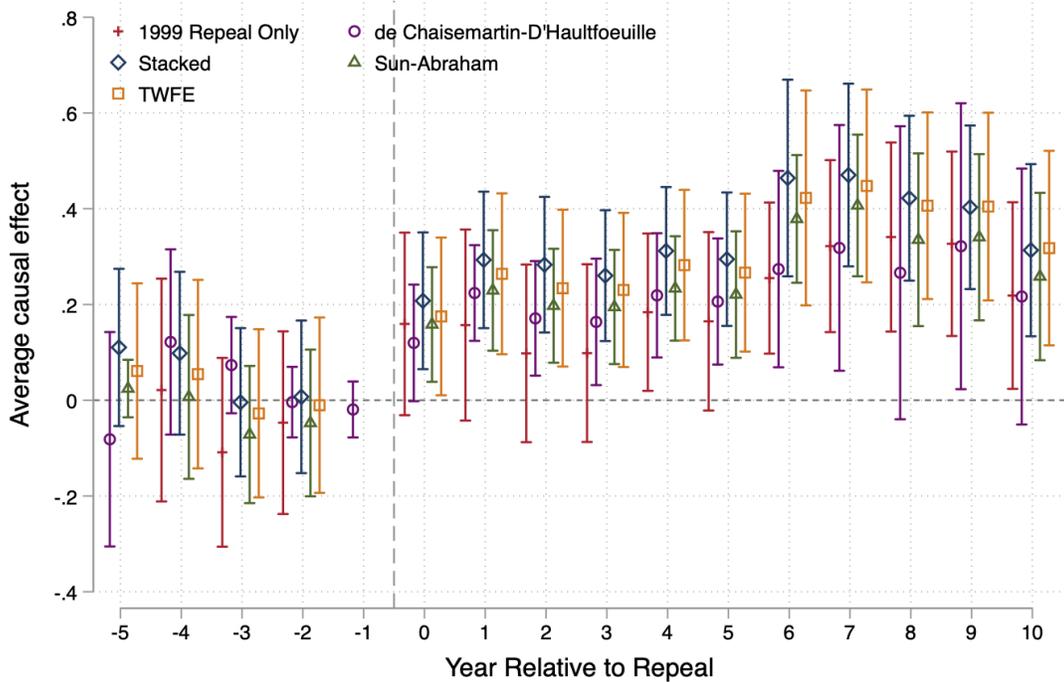
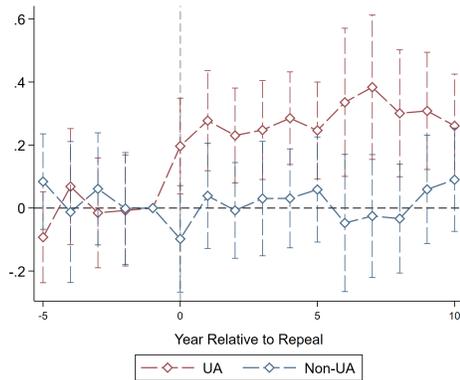


Figure C.2: Non-Agricultural Employment and Distance to UAs

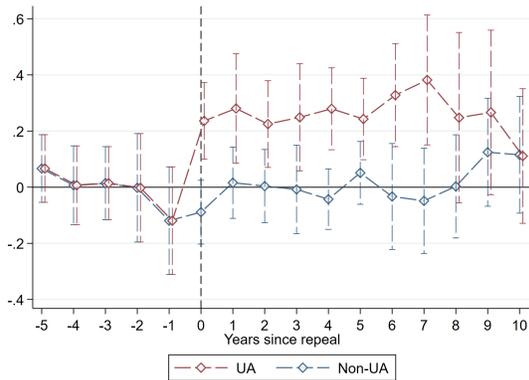
Note: This figure presents the distribution of non-agricultural employment at the village and town level against their distance from the centroids of Urban Agglomerations (UAs), using village-level population census data from 1991. The black line represents a local polynomial fitted line, and the shaded area indicates the 95% confidence interval.



(a) Causal Effect of the Repeal on Landholding (β_2)



(b) β_1 and β_2 (Cengiz et al., 2019)



(c) β_1 and β_2 (Borusyak et al., 2023)

Figure C.3: Event Study Graphs for the Treatment Effects of the Repeal on Landholding - Staggered DiD

Note: This figure reports the event study graphs for the treatment effect of the Repeal Act on landholding. Panel (a) reports the estimates for β_2 by including state-by-year fixed effects in equation (1), using various methods: de Chaisemartin and D'Haultfoeuille (2020) (purple circle), stacked DiD proposed by Cengiz et al. (2019) (blue diamond), Sun and Abraham (2021) (green triangle), TWFE (yellow square), and TWFE using only the 1999 repeal cohort (red cross). Panels (b) and (c) report both β_1 and β_2 using our baseline equation (1), using the stacked DiD approach in panel (a) (Cengiz et al., 2019) and the imputation-based method in panel (b) (Borusyak et al., 2023). All dependent variables are in logs. Coefficients are normalized to 1 year before the reform in panel (a), and 5 years before the reform in panel (b). The blue line indicates the effects on firms in non-UAs (β_1) and the red represents the differential effects on firms in UAs (β_2). Standard errors are clustered at the state-year level. The confidence interval is at the 95% level.

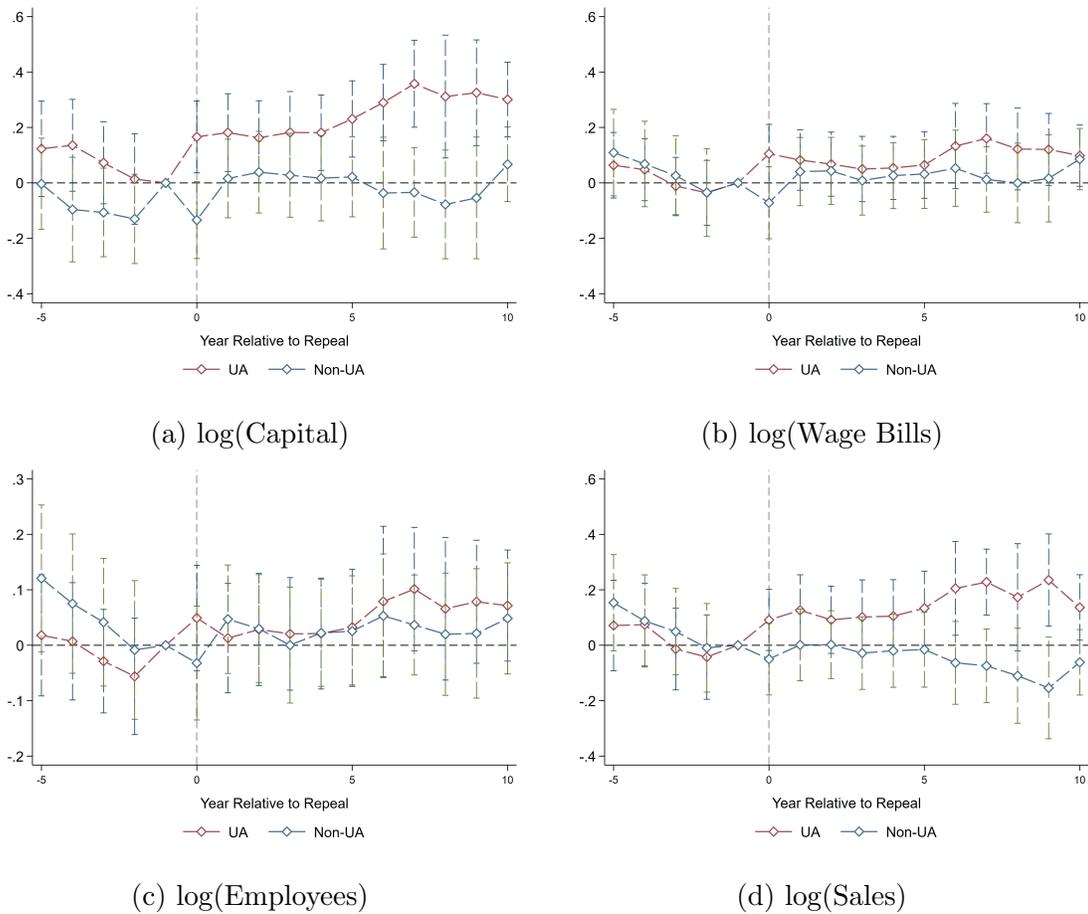


Figure C.4: Event Study Graphs for the Treatment Effects of the Repeal on Capital, Wage Bills, Employment, and Sales

Note: This figure reports the event study graphs for the treatment effect of the Repeal Act on firms' fixed asset (excluding land), wage bills, number of employees, and sales, using the baseline specification (1). All dependent variables are in logs. Coefficients are normalized in 1 year before the reform. The blue line indicates the effects on firms in non-UAs (β_1) and the red represents the differential effects on firms in UAs (β_2). The confidence interval is at the 95% level.

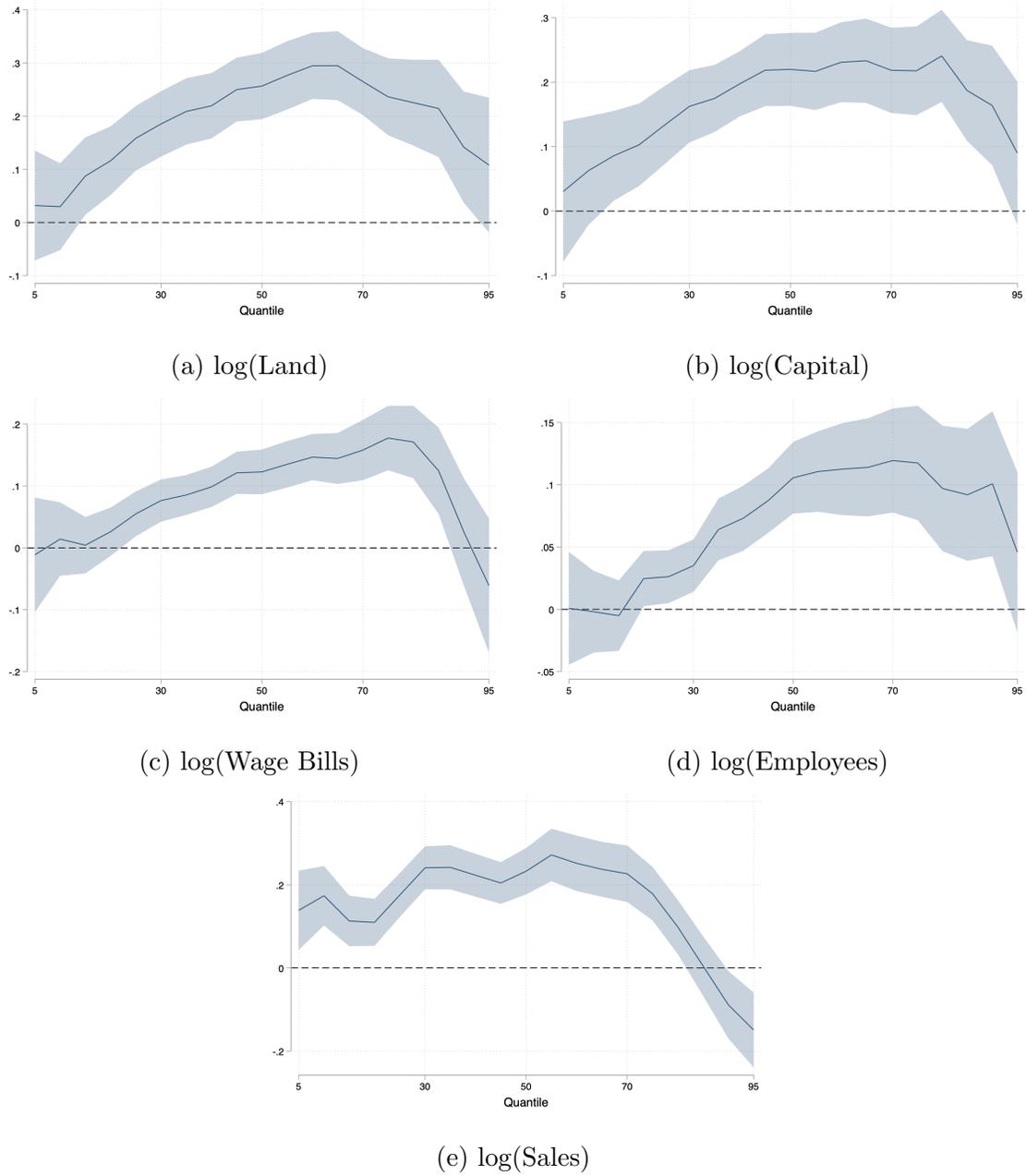
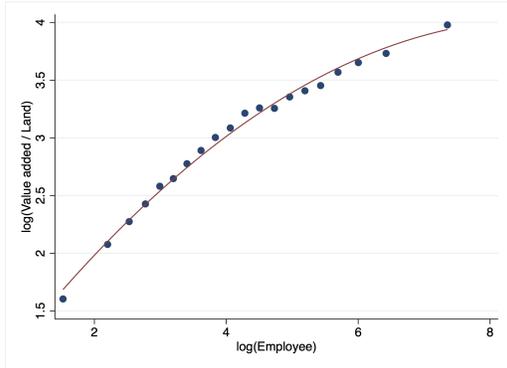
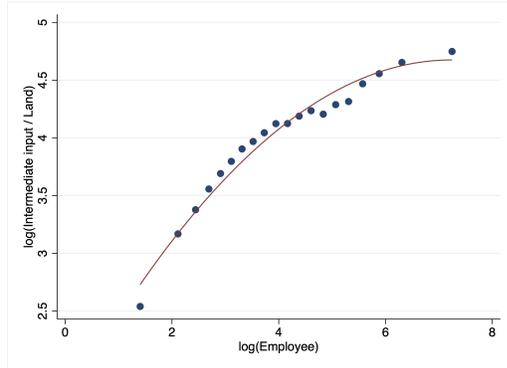


Figure C.5: Quantile Treatment Effects of the Repeal on Firms in UAs

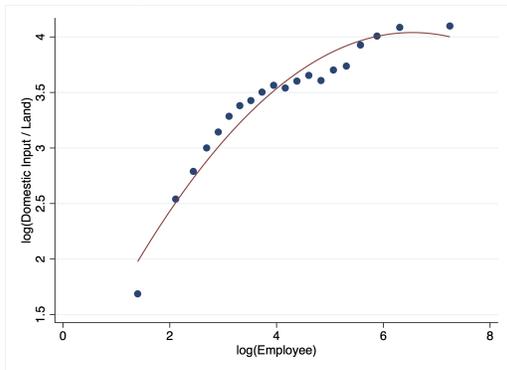
Note: This figure reports the quantile regression estimates for the treatment effect of the Repeal Act on firm-level outcomes, from 5th to 95th quantiles, using the re-centered influence function approach (Firpo et al., 2009). All dependent variables are in logs. The confidence interval is at the 95% level, calculated using standard errors clustered at the state-year level.



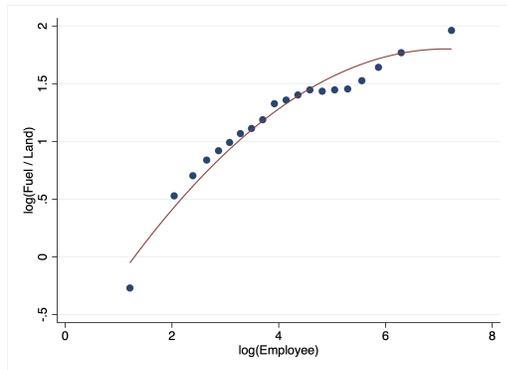
(a) Value Added / Land



(b) Input / Land



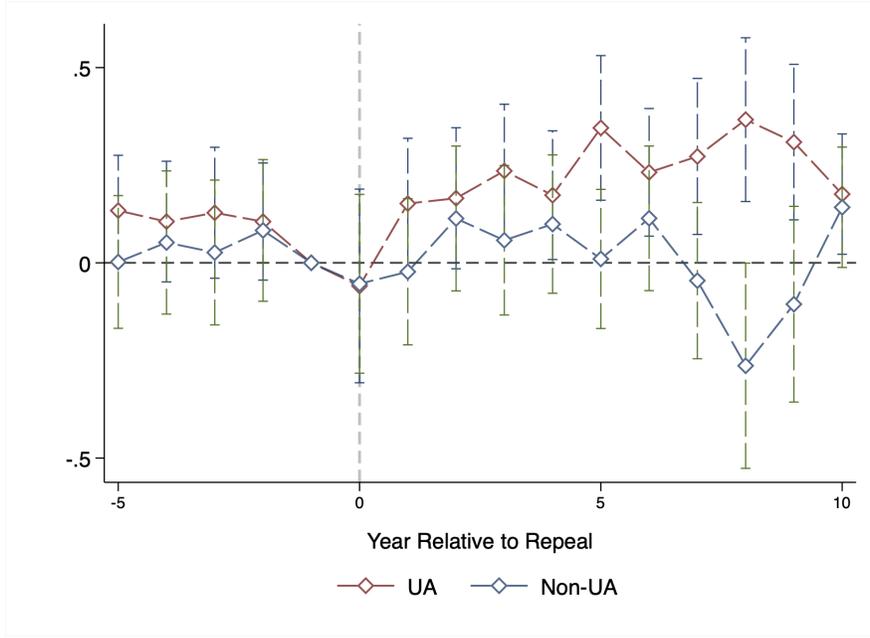
(c) Domestic input / Land



(d) Fuel / Land

Figure C.6: Average Value-Added per Land and firm Size

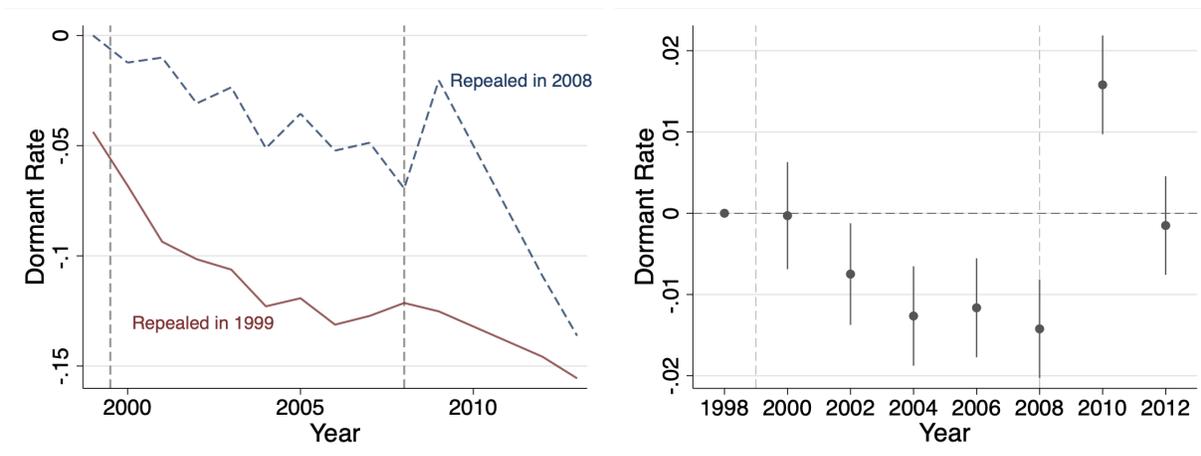
Note: This figure reports the binned scatter plot and quadratic fitted line of log value-added and inputs per land against log number of employees: value-added (panel a), all intermediate inputs (panel b), domestic inputs (panel c), and fuels (panel d). All regressions control for 2-digit industry fixed effects and year fixed effects.



(a) TFPQ

Figure C.7: Event Study Graphs for the Treatment Effects of the Repeal on TFPQ

Note: This figure presents the event study graph for the treatment effect of the Repeal Act on TFPQ, using the baseline empirical equation (1). The dependent variable, logged TFPQ, is measured following the methodology of De Ridder et al. (2022). We employ a two-stage procedure: first, we adjust the observed quantity sold for measurement errors by regressing it on time fixed effects and a third-order polynomial of input usage, including additional controls such as prices and market shares within 5-digit industries. In the second stage, this adjusted output is used as the dependent variable in an IV-GMM estimation to estimate output elasticity. TFPQ is estimated separately for each 2-digit industry. Coefficients are normalized to one year before the reform. The blue line shows the effects on firms in non-UAs (β_1), while the red line illustrates the differential effects on firms in UAs (β_2). The confidence interval is at the 95% level.



(a) Time Series

(b) Coefficients for Early Repeal

Figure C.8: Dormant Rates in States that Repealed in 1999 vs. Repealed in 2008

Note: Panel (a) displays the time series of dormant rates for states that adopted the Repeal in 1999 (red) versus those that did so in 2008 (blue). The dormant rate for the state that repealed in 2008 is normalized to zero in the year 1999. ‘Dormant’ is defined by code 2 and 3 in the variable ‘status of units,’ which include units found during the survey that were present at the location but did not initiate production and/or employ any staff during the reference period. Panel (b) plots the regression coefficients of firm dormant measure on an early repeal dummy variable, interacted with bi-annual dummies, controlling for industry-by-year, firm age, rural, and state fixed effects. The coefficient in 1998 is normalized to 0. The confidence intervals are set at the 95% level.

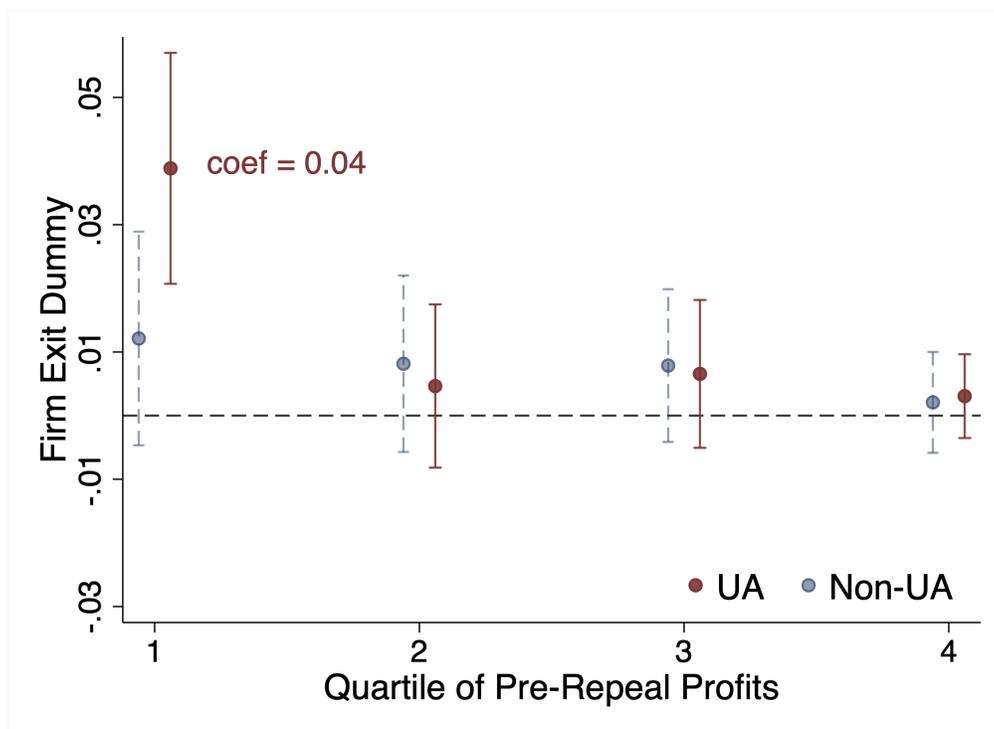
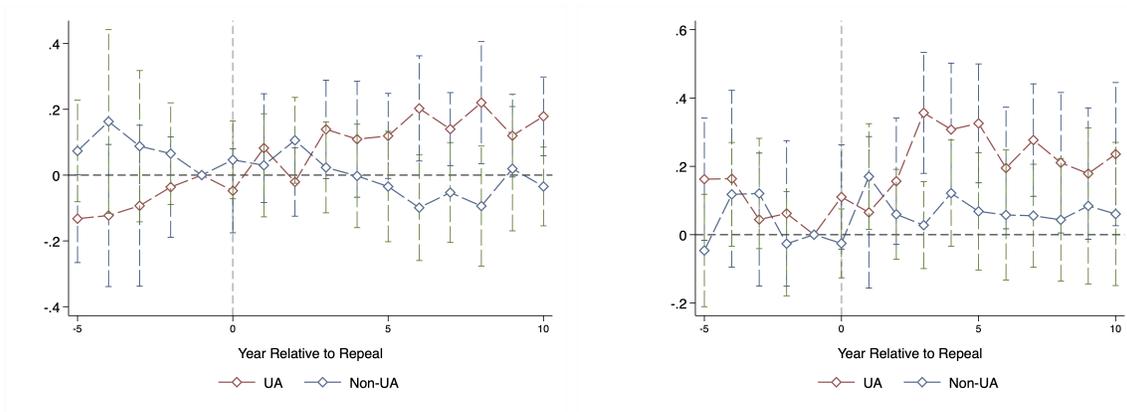


Figure C.9: Treatment Effect of the Repeal on Plant Exit by Pre-Repeal Profits

Note: This figure displays the treatment effects of the Repeal on plant exit. The dependent variable is a plant exit dummy, coded as 4 in the 'status of units' (as previously described in Figure 4). Quartile 1 represents the least profitable plants prior to the Repeal. Profit is measured as variable profits, calculated as sales revenue minus material and labor costs. Controls include a rural dummy, 2-digit industry fixed effects, firm age fixed effects, and land size quartile-by-year fixed effects.



(a) # New Products

(b) # Deleted Products

Figure C.10: Event Study Graphs for the Treatment Effects of the Repeal on Creative Destruction

Note: This figure reports the event study graphs for the treatment effect of the Repeal Act on firm adding and deleting products, using the empirical equation (1). The effects on adding/deleting products are estimated using the Poisson Pseudo-Maximum Likelihood regression. Coefficients are normalized in 1 year before the reform. The blue line indicates the effects on firms in non-UAs (β_1) and the red represents the differential effects on firms in UAs (β_2). # New Products is the number of new 5-digit products added to a firm's product portfolio in a given year, and # Deleted Products is the number of products deleted from the portfolio. The confidence interval is at the 95% level.

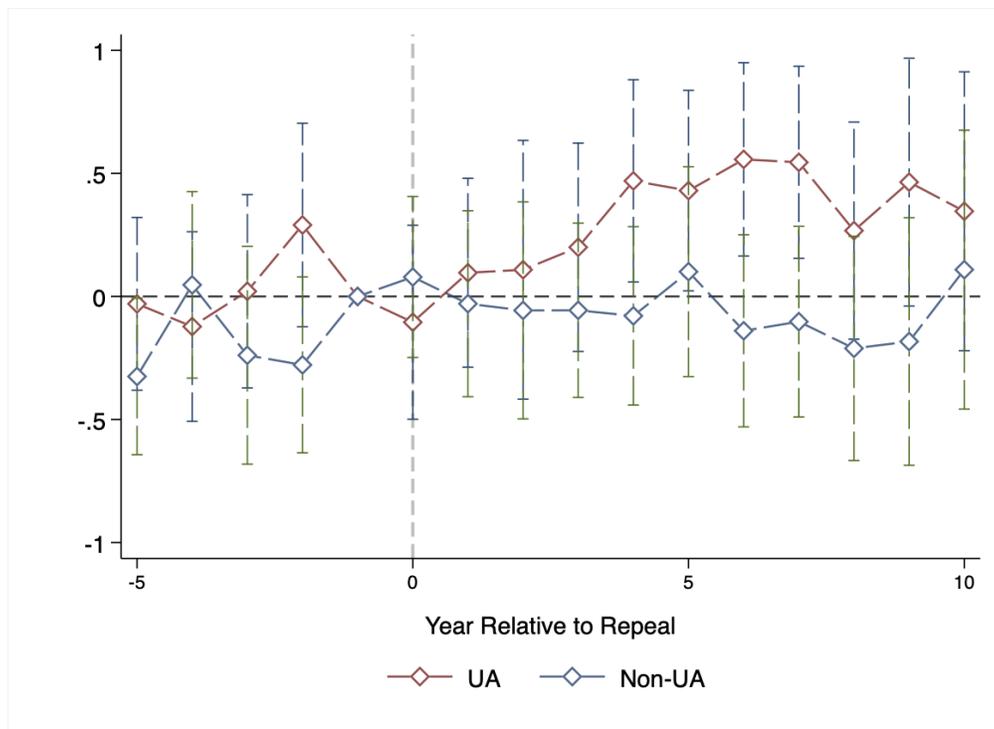


Figure C.11: Event Study Graphs for the Treatment Effects of the Repeal on the Entry of Innovative Plants

Note: This figure presents event study graphs for the treatment effect of the Repeal Act on the entry of innovative plants (plants that have introduced new products during their life cycle). The data is aggregated to the district-year level using sampling weights. District-years with fewer than 30 plants are excluded. The blue line indicates the effects in non-UAs (β_1) and the red represents the differential effects in UAs (β_2). The analysis employs the Poisson Pseudo-Maximum Likelihood method, controlling for district fixed effects, year fixed effects, and district control-by-year fixed effects. These district controls-by-year include quartiles of pre-Repeal metrics: share of plants in urban areas, share of privately owned plants, and number of plants, each interacted with year fixed effects. Confidence intervals are set at the 95% level.

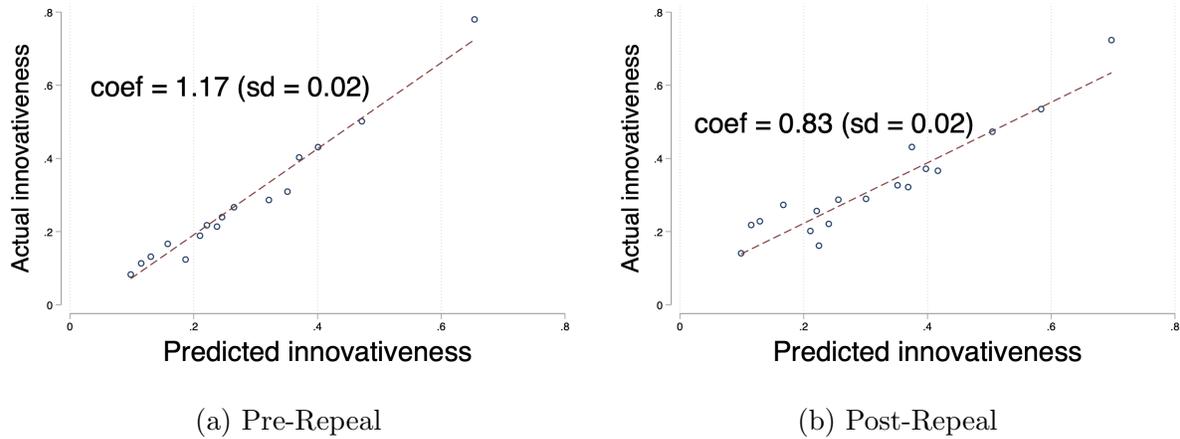


Figure C.12: Relationship between Actual and LASSO-Predicted Innovativeness

Note: This figure presents binned scatter plots comparing plants' average number of new products throughout their life cycle with our LASSO-predicted innovativeness. Panels (a) and (b) show these relationships using pre-Repeal and post-Repeal data, respectively. Since the LASSO model is trained with pre-Repeal data, the left panel provides in-sample predictions, while the right panel offers out-of-sample predictions. Both panels include the correlation coefficients. The LASSO model is trained by regressing the number of new products introduced by plants throughout their life cycle on various plant-level characteristics recorded at entry, using pre-Repeal data. These characteristics encompass a range of dummies for private ownership, urban location, sole proprietorship, census scheme participation, importing foreign intermediates, and using computers, in addition to the total number of products. The model also includes the quadratic and interaction terms of these variables.

C.2 Additional Tables

Table C.1: Timeline of the Repeal

Never participated	Jammu & Kashmir, Kerala
1999	Gujarat, Haryana, Himachal Pradesh, Karnataka, Manipur, Meghalaya,
-	Punjab, Rajasthan, Tripura, Uttar Pradesh, Uttarakhand, and all UTs
2000	Chhattisgarh, Madhya Pradesh
2002	Odisha
2003	Assam
2006	Bihar
2008	Andhra Pradesh, Maharashtra, Telangana
2011	Jharkhand
Still in effect	Tamil Nadu ^a , West Bengal

^aTamil Nadu has its own land ceiling law, which remains in effect.

Table C.2: Summary Statistics of the ASI Data

	Obs.	Mean.	P10	P50	P90
Fraction in Urban Agglomerations (%)	597,356	50.3	0.0	100.0	100.0
Land Stock Value (Million Rupee)	344,211	10.3	0.0	0.4	9.4
Fixed Assets (Million Rupee)	537,151	123.9	0.1	2.6	109.6
Wage Bills (Million Rupee)	537,918	14.6	0.2	1.1	26.3
Sales (Million Rupee)	468,778	413.2	1.4	21.0	561.2
Land Adjustment Flows - Addition (Thousand Rupee)	338,510	342.5	0.0	0.0	14.0
$\mathbf{1}\{Add > 0\}$	339,848	11.1	0.0	0.0	100.0
Land Adjustment Flows - Deduction (Thousand Rupee)	338,478	60.5	0.0	0.0	0.0
$\mathbf{1}\{Deduct > 0\}$	339,016	3.0	0.0	0.0	0.0

Table C.3: Pre-Repeal Differences in Time Trends between UAs and non-UAs

<i>Dep. Var.</i>	(1) Landholding	(2) Fixed Asset	(3) Employee	(4) Sales	(5) MRPLand
I_d^{UA}	-0.031 (0.034)	-0.300*** (0.030)	-0.124*** (0.016)	-0.141*** (0.026)	0.063* (0.035)
Time Trend	0.055*** (0.008)	0.177*** (0.007)	0.057*** (0.004)	0.108*** (0.006)	0.015* (0.009)
$I_d^{UA} \times$ Time Trend	-0.015 (0.012)	0.000 (0.009)	-0.004 (0.005)	-0.002 (0.008)	-0.003 (0.012)
Observations	92,557	160,436	163,847	138,821	78,769
R-squared	0.098	0.169	0.120	0.170	0.097
Industry FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes

Notes. All outcome variables are expressed in log. I_d^{UA} represents a dummy variable for districts containing UAs. The sample is restricted to the years prior to 1998. ‘Time Trend’ denotes a linear year trend, starting at 1 in 1993 and increasing by 1 each year, reaching 5 in 1997. Its interaction with I_d^{UA} allows for differential linear time trends across UAs vs. non-UAs. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.4: Treatment Effect of the Repeal on District-level Total Land and Number of Plants

<i>Dep. Var. (log)</i>	(1) Total land	(2) Number of plants
$Repeal_{st}$	0.055 (0.068)	-0.024 (0.049)
$Repeal_{st} \times I_d^{UA}$	0.014 (0.054)	-0.115*** (0.033)
Observations	6,118	6,503
R-squared	0.832	0.911
Year FE	Yes	Yes
District FE	Yes	Yes
Land Size \times Year FE	Yes	Yes

Notes: The dependent variables are the log of total land, summed across all firms (column 1), and the number of plants per district-year. Data is aggregated at the district-year level from plant-year records using sampling weights. Observations from district-years with fewer than 30 cases are excluded. District Controls \times Year fixed effects include quartiles of pre-Repeal district-level metrics: the share of plants in urban areas, the share of privately owned plants, and land endowment, each interacted with year fixed effects. Standard errors are two-way clustered by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.5: Treatment Effect of the Repeal on Marginal Revenue Product of Land

<i>Dep. Var. (log)</i>	MRPLand		
	(1)	(2)	(3)
$Repeal_{st}$	0.018 (0.034)	0.034 (0.031)	
$Repeal_{st} \times I_d^{UA}$	-0.081*** (0.026)	-0.097*** (0.026)	-0.156*** (0.025)
Observations	298,863	298,860	298,860
R-squared	0.124	0.135	0.140
District FE	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes
State×Year FE	No	No	Yes
Ind×Year FE	No	Yes	Yes

Notes. The dependent variable is the log of the marginal revenue product of land, measured as the ratio of sales revenue to land input use. Land Size×Year' represents district-specific average pre-treatment land size bins, interacted with yearly fixed effects. 'Ind×Year' are 2-digit industry-by-year fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.6: Treatment Effect of the Repeal on Land Adjustment: State * Year FE

<i>Dep. Var.</i>	Land Adjustment Flows			
	(1) Land Stock Value	(2) Addition	(3) Deduction	(4) Revaluation
$Repeal_{st} \times I_d^{UA}$	0.239*** (0.029)	0.293*** (0.102)	0.465** (0.199)	-0.038 (0.486)
Observations	338,685	332,132	326,502	247,327
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes
State×Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are deflated. Column (1) Land value is in log. Columns (2) - (4) are obtained through Poisson Pseudo-Maximum Likelihood regression. Land Size×Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.7: The Impact of Land Misallocation and Distribution on Repeal Timing

<i>Dep. Var.</i>	$1\{Repeal\}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Lag. MRPLand	-0.006 (0.004)	-0.004 (0.003)				
Lag2. MRPLand	0.001 (0.004)	0.002 (0.003)				
Lag2. MRPLand	-0.001 (0.004)	-0.001 (0.003)				
Lag. SD(MRPLand)			-0.001 (0.005)	-0.001 (0.004)		
Lag2. SD(MRPLand)			0.003 (0.005)	-0.001 (0.004)		
Lag3. SD(MRPLand)			0.001 (0.005)	-0.003 (0.004)		
Lag. SD(Land)					-0.003 (0.005)	-0.001 (0.004)
Lag2. SD(Land)					-0.005 (0.006)	-0.006 (0.005)
Lag3. SD(Land)					0.011* (0.006)	-0.001 (0.005)
Observations	3,979	3,979	3,319	3,319	3,533	3,533
R-squared	0.001	0.365	0.000	0.398	0.001	0.390
State FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Industry FE	No	Yes	No	Yes	No	Yes

Notes: Each observation corresponds to a state-2 digit industry-year. The dependent variable is set to one in the Repeal year. The analysis is restricted to pre-Repeal years and the year of Repeal adoption. ‘Lag1 MRPLand’, ‘Lag2 MRPLand’, and ‘Lag3 MRPLand’ represent the average marginal revenue product of land (MRPLand) lagged by one, two, and three years respectively, each calculated as the log ratio of sales revenue to land value. ‘Lag1 SD(MRPLand)’, ‘Lag2 SD(MRPLand)’, and ‘Lag3 SD(MRPLand)’ denote the standard deviation of MRPLand at the state-industry level, lagged by one, two, and three years respectively. ‘Lag1 SD(Land)’, ‘Lag2 SD(Land)’, and ‘Lag3 SD(Land)’ refer to the standard deviation of firm landholdings at the state-industry level, also lagged by one, two, and three years respectively. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.8: Treatment Effect of the Repeal on Land Adjustment: State * Year FE

<i>Dep. Var.</i>	Land Adjustment Flows			
	(1) Land Stock Value	(2) Addition	(3) Deduction	(4) Revaluation
$Repeal_{st} \times I_d^{UA}$	0.239*** (0.029)	0.293*** (0.102)	0.465** (0.199)	-0.038 (0.486)
Observations	338,685	332,132	326,502	247,327
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes
State×Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are deflated. Column (1) Land value is in log. Columns (2) - (4) are obtained through Poisson Pseudo-Maximum Likelihood regression. Land Size×Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.9: Treatment Effect of the Repeal on Land Adjustment: Sector * Year FE

<i>Dep. Var.</i>	Land Adjustment Flows			
	(1) Land Stock Value	(2) Addition	(3) Deduction	(4) Revaluation
$Repeal_{st}$	0.017 (0.030)	0.011 (0.082)	-0.089 (0.164)	-0.201 (0.359)
$Repeal_{st} \times I_d^{UA}$	0.138*** (0.028)	0.287*** (0.094)	0.468*** (0.177)	-0.023 (0.402)
Observations	338,681	332,629	324,174	205,215
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes
2-digit Industry \times Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are deflated. Column (1) Land value is in log. Columns (2) - (4) are obtained through Poisson Pseudo-Maximum Likelihood regression. Land Size \times Year are districts' average pre-treatment land size bin-by-year fixed effects. Industrial classifications across years are concorded to 2-digit levels. Standard errors are two-way clustered at the state and year level. Other control includes the urban dummy variable. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.10: Within-Plant Land Growth by High/Low Pre-Repeal Productivity Plants: Alternative Measures of TFP

<i>Dep. Var.</i>	Landholding					
	High Productivity Plants			Low Productivity Plants		
<i>Productivity measured by...</i>	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	LP	ACF	OLS	LP	ACF
$Repeal_{st}$	-0.002 (0.024)	0.021 (0.034)	-0.009 (0.033)	0.007 (0.032)	-0.039 (0.026)	0.008 (0.025)
$Repeal_{st} \times I_d^{UA}$	0.105*** (0.029)	0.107*** (0.040)	0.134*** (0.038)	0.036 (0.031)	0.056** (0.025)	0.025 (0.027)
Observations	55,490	53,216	52,116	52,112	54,310	55,476
R-squared	0.873	0.867	0.863	0.878	0.885	0.886
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry×Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged landholding. We estimate Total Factor Productivity (TFPR) for each 2-digit industry by: (1) OLS residuals (columns 1 & 4); (2) estimating revenue production functions following [Levinsohn and Petrin \(2003\)](#) (columns 2 & 5); and (3) using [Akerberg et al. \(2015\)](#) to correct for the functional dependence problems (columns 3 & 6). We include both landholdings and capital as the state variable. ‘Land Size×Year’ incorporates both district pre-Repeal land endowment size bins and firm-specific land size bins, interacted with year fixed effects. Standard errors are clustered two-way by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.11: Treatment Effect of the Repeal on Firm Production: State * Year FE

<i>Dep. Var.</i>	(1) Capital	(2) Employment	(3) Wage Bills	(4) Sales
$Repeal_{st} \times I_d^{UA}$	0.168*** (0.030)	0.073*** (0.015)	0.080*** (0.017)	0.138*** (0.023)
Observations	530,008	533,802	531,119	464,755
R-squared	0.257	0.151	0.217	0.246
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes
State×Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated. Capital excludes land value to avoid mechanical correlation. Land Size×Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.12: Treatment Effect of the Repeal on Firm Production: Sector * Year FE

<i>Dep. Var.</i>	(1) Capital	(2) Employment	(3) Wage Bills	(4) Sales
$Repeal_{st}$	0.029 (0.043)	0.009 (0.014)	0.025 (0.018)	0.027 (0.024)
$Repeal_{st} \times I_d^{UA}$	0.109*** (0.027)	0.031** (0.012)	0.042*** (0.015)	0.077*** (0.018)
Observations	530,005	533,799	531,116	464,752
R-squared	0.259	0.155	0.220	0.252
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes
2-digit Industry \times Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated. Capital excludes land value to avoid mechanical correlation. Land Size \times Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.13: Treatment Effect of the Repeal on TFPQ: Alternative Measures

<i>Dep. Var.</i>	TFPQ		
	(1) OLS	(2) LP	(3) ACF
$Repeal_{st}$	0.034 (0.048)	0.022 (0.052)	0.039 (0.048)
$Repeal_{st} \times I_d^{UA}$	0.148*** (0.045)	0.181*** (0.044)	0.126*** (0.044)
Observations	359,848	358,500	359,432
R-squared	0.092	0.081	0.080
District FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes

Notes: The dependent variable, logged TFPQ, is calculated by subtracting the logarithm of firm-level price from log TFPR. Firm-level price is derived from the sales-weighted average of standardized prices across products. TFPR is estimated using three methods: (1) OLS residuals (Column 1), (2) estimating revenue production functions as per [Levinsohn and Petrin \(2003\)](#) (Column 2), and (3) applying corrections for functional dependence using [Akerberg et al. \(2015\)](#) (Column 3). Each TFPR estimation is conducted separately for each 2-digit industry. ‘Land Size \times Year’ represents the fixed effects for districts’ average pre-treatment land size bins by year. Additional controls include an urban dummy variable, ownership fixed effects, and 2-digit industry fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.14: Treatment Effect of the Repeal on TFPR, Firm-Level Prices, and Markup

<i>Dep. Var.</i>	TFPR			Price	Markup
	(1) OLS	(2) LP	(3) ACF	(4) -	(5) -
<i>TFPR measured by...</i>					
<i>Repeal_{st}</i>	0.005 (0.006)	-0.005 (0.016)	0.012* (0.007)	-0.023 (0.048)	0.026* (0.013)
<i>Repeal_{st} × I_d^{UA}</i>	0.016*** (0.004)	0.043*** (0.013)	-0.003 (0.006)	-0.124*** (0.044)	-0.014 (0.010)
Observations	430,301	430,300	430,298	389,963	368,953
R-squared	0.034	0.156	0.101	0.090	0.111
District FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Land Size × Year FE	Yes	Yes	Yes	Yes	Yes

Notes: All dependent variables are logged. The dependent variable in Columns 1-3' is TFPR, measured using three methods: (1) OLS residuals (Column 1), (2) estimating revenue production functions following [Levinsohn and Petrin \(2003\)](#) (Column 2), and (3) applying [Ackerberg et al. \(2015\)](#)'s correction for functional dependence (Column 3). TFPR is estimated separately for each 2-digit industry. Firm-level price is calculated as the sales-weighted average of standardized prices across products. Markup is estimated using [De Ridder et al. \(2022\)](#)'s method in two stages. In the first stage, observed quantity sold is adjusted for measurement errors by regressing it on time fixed effects, a third-order polynomial of input usage, and additional controls including prices and market shares within 5-digit industries. In the second stage, this corrected output serves as the dependent variable in an IV-GMM estimation to estimate output elasticity. 'Land Size×Year' represents the fixed effects for districts' average pre-treatment land size bins by year. Additional controls include an urban dummy variable, ownership fixed effects, and 2-digit industry fixed effects. Standard errors are two-way clustered at the state and year level.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.15: Accounting for Potential Bias in Staggered Difference-in-Differences - Imputation Approach based on [Borusyak et al. \(2023\)](#)

<i>Dep. Var.</i>	(1) Land Stock Value	(2) Capital	(3) Wage Bills	(4) Employees	(5) Sales
$Repeal_{st}$	0.042 (0.042)	-0.069 (0.063)	0.055 (0.038)	0.032 (0.027)	-0.020 (0.042)
$Repeal_{st} \times I_d^{UA}$	0.255*** (0.033)	0.215*** (0.036)	0.103*** (0.024)	0.072*** (0.021)	0.144*** (0.031)
Observations	335,033	523,973	528,255	527,353	463,775
Year FE	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated (except for number of employees). Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table C.16: Accounting for Potential Bias in Staggered Difference-in-Differences - Stacked DiD based on Cengiz et al. (2019)

<i>Dep. Var.</i>	(1) Land Stock Value	(2) Capital	(3) Wage Bills	(4) Labor	(5) Sales
$Repeal_{st}$	0.007 (0.039)	0.057 (0.049)	0.007 (0.033)	-0.021 (0.024)	-0.053 (0.033)
$Repeal_{st} \times I_d^{UA}$	0.219*** (0.044)	0.185*** (0.036)	0.093*** (0.027)	0.084*** (0.023)	0.135*** (0.033)
Observations	412,874	627,525	629,991	628,540	546,141
R-squared	0.221	0.355	0.246	0.225	0.291
Stack*District FE	Yes	Yes	Yes	Yes	Yes
Stack*Year FE	Yes	Yes	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated. For each stack, we exclude data from five years preceding its event date. Robust standard errors are in parentheses. To control for potential biases introduced by the staggered design, we include Stack * District fixed effects and Stack * Year fixed effects to ensure that the treatment effect is estimated by comparing treated districts to never-treated districts during the study period. Other controls include Urban Dummy * Stack Fixed Effects and 2-Digit Industry * Stack Fixed Effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table C.17: Treatment Effect of the Repeal on Exit among Non-Dormant Plants

<i>Dep. Var.</i>	Exit		
	(1)	(2)	(3)
$Repeal_{st}$	-0.002 (0.003)	-0.001 (0.003)	-0.000 (0.003)
$Repeal_{st} \times I_d^{UA}$	0.009*** (0.003)	0.009*** (0.003)	0.007*** (0.002)
Observations	249,185	249,174	249,168
R-squared	0.037	0.045	0.049
Year FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
Size×Year FE	No	Yes	Yes
Industry×Year FE	No	No	Yes
Mean of dependent variable	0.0326	0.0326	0.0326

Notes: The dependent variable is the plant exit dummy, coded as 4 in the ‘status of units’. The analysis is limited to firms that have never been dormant. Firm controls include a rural dummy, 2-digit industry fixed effects, firm age fixed effects, and landholding quartile-by-year fixed effects. Size×Year FE represents firm’s labor quartile-by-year fixed effects. Standard errors are two-way clustered by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.18: Treatment Effect of the Repeal on Creative Destruction: 4-Digit Product

<i>Dep. Var.</i>	4-digit Product Code	
	(1) #New Products	(2) #Deleted Products
$Repeal_{st}$	-0.046 (0.044)	-0.088 (0.063)
$Repeal_{st} \times I_d^{UA}$	0.114** (0.046)	0.178*** (0.048)
Observations	264,423	272,645
Year FE	Yes	Yes
District FE	Yes	Yes
Land Size*Year FE	Yes	Yes

Notes. New Products and Deleted Products refer to the number of distinct products added to or deleted from a firm's portfolio, respectively. Products are defined based on 4-digit product codes, with data from 1995 to 2009. Products in different 4-digits generally represent different subclasses and are produced using distinct techniques. For example, this includes distinctions between (2822) wearing apparel, knitted or crocheted, and (2823) wearing apparel, not knitted or crocheted. Land Size \times Year are quartiles for districts' average pre-treatment land value interacted with year fixed effects. Other controls include the urban dummy variable and 2-digit industry fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.19: Treatment Effect of the Repeal on Product Scope

<i>Dep. Var.</i>	<i>log</i> (Number of Products)		
	(1)	(2)	(3)
<i>Repeal_{st}</i>	0.012 (0.009)		
<i>Repeal_{st} × I_d^{UA}</i>	0.000 (0.007)	0.011 (0.007)	0.005 (0.007)
Observations	422,453	422,453	422,445
R-squared	0.265	0.270	0.281
Year FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
State×Year FE	No	Yes	Yes
Ind×Year FE	No	No	Yes
Mean of dependent variable	1.787	1.787	1.787

Notes: The dependent variable is log number of products produced by a firm. Land Size×Year are districts' average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. 'Ind×Year FE' includes 2-digit industry-by-year fixed effects. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.20: Treatment Effect of the Repeal on Firm Entry: LASSO Predicted Innovativeness

<i>Dep. Var.</i>	Entry		
	Total Entrants (1)	Subsistence Entrants (2)	Innovative Entrants (3)
$Repeal_{st}$	-0.006 (0.095)	-0.006 (0.110)	-0.122 (0.133)
$Repeal_{st} \times I_d^{UA}$	-0.039 (0.094)	-0.121 (0.097)	0.338** (0.145)
Observations	5,383	5,314	5,196
Year FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
District Control \times Year FE	Yes	Yes	Yes

Notes: The dependent variables are the count of total entrants (column 1), subsistence plant entries (column 2), and innovative plant entries (column 3) per district-year. Plants are classified into ‘subsistence’ and ‘innovative’ based on a LASSO-predicted measure of innovativeness. We train the LASSO by regressing the number of new products introduced by plants throughout their life cycle on several plant-level characteristics at the time of entry, using pre-Repeal data. These characteristics include a dummy for privately owned, an urban dummy, a dummy for sole proprietorship, a dummy for census scheme plants, a dummy for importing foreign intermediates, a dummy for using computers, and the number of products, along with their quadratic and interaction terms. An ‘entrant’ is defined as a firm whose age is less than or equal to one year. Data is aggregated to the district-year level from plant-year records using sampling weights. Observations in district-years with fewer than 30 cases are excluded. Regressions employ the Poisson Pseudo-Maximum Likelihood method. District Control \times Year FE include quartiles of pre-Repeal district-level metrics: share of plants in urban areas, share of privately owned plants, and number of plants, each interacted with year fixed effects. Standard errors are clustered two-way by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D Additional Empirical Results

D.1 Land Adjustment

D.1.1 Enhanced Land Market Transactions Post-Repeal

We now demonstrate that the Repeal has facilitated land transactions and liberalized land markets that were previously restricted by the ULCRA. Although land transaction records are not available in India, the detailed land adjustment data from the ASI allow us to track the value of new land purchased (Column (2) Addition) and land sold (Column (3) Deduction) by firms within any given year.⁵⁰ Additionally, the dataset enables us to track changes in the market value of a firm’s existing landholdings, in Column (4) Revaluation.

Table D.1: Treatment Effect of the Repeal on Landholding and Adjustment

<i>Dep. Var.</i>	Land Adjustment			
	(1) Landholding	(2) Addition	(3) Deduction	(4) Revaluation
$Repeal_{st}$	-0.001 (0.030)	0.026 (0.082)	-0.086 (0.168)	-0.340 (0.349)
$Repeal_{st} \times I_d^{UA}$	0.176*** (0.030)	0.294*** (0.096)	0.500*** (0.174)	0.168 (0.408)
Observations	338,355	334,229	330,561	298,425
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes

Notes: All dependent variables are deflated. Column (1) Land value is in log. Columns (2) - (4) are obtained through Poisson Pseudo-Maximum Likelihood regression. Land Size×Year are districts’ average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Column (1) of Table D.1 reports our DiD estimates for land use in Figure 2. Consistent with the graphical evidence presented above, the Repeal has no effect on firms in non-UAs, while UA firms saw a 17.6% increase in their landholdings following the Repeal. We report the treatment effects on additions (purchase), deductions (selling), and revaluations in Columns (2)-(4).⁵¹ Results in Columns (2)-(3) indicate that the reform had minimal and

⁵⁰One advantage of using firm-level land data (as opposed to the non-existent administrative land transaction records) is that they are not biased by the possibility of unregistered transactions occurring in the black market, which were prevalent during the ULCRA period (Srinivas, 1991).

⁵¹Although all firms hold at least some land, adjustments in landholdings are infrequent. Chen and Roth

statistically insignificant effects on land additions and deductions for firms in non-UAs. By contrast, UA firms increased their land purchases by approximately 29.4%, or 0.1 million rupees, and increased their land sales by 50%, or 30,000 rupees, in a given year after the Repeal.⁵² The effects on land revaluations are much noisier and statistically insignificant for both UA and non-UA firms. The absence of a revaluation effect suggests that the Repeal did not increase landholdings by merely driving up land prices. If it had, we would expect to see a corresponding increase in land revaluations.

In Table D.2, we further decompose the effects on land transactions into extensive (likelihood of transactions) and intensive (scale of transactions) margins. Columns (1) and (2) employ a Probit model, indicating that the Repeal increased the probability of both buying and selling land by 1.1 and 0.4 percentage points, respectively, approximately 11% of the sample means. In columns (3) and (4), we adjust the data by setting all zero values to the smallest positive land adjustments before applying the logarithmic transformation, following [Chen and Roth \(2023\)](#). This method effectively isolates the intensive margin changes by shutting down the extensive margin changes between 0 and y_{min} . The results show that the repeal led to an 8.2% increase in land purchases and a 2.9% increase in land sales, conditional on positive adjustments.

(2023) show that using log-transformed outcomes could introduce bias when these outcomes feature many zeros; therefore, we estimate the same empirical equation using the Poisson Pseudo-Maximum Likelihood (PPML) method following their recommendation. The interpretation of the PPML coefficients is similar to that of log regression—they approximate the percentage change in the average outcome for the treated group during the post-treatment period, relative to the counterfactual treated group post-treatment mean, assuming that the percentage changes in the mean would have been the same for the treated and control group.

⁵²Note that these coefficients represent percentage changes relative to the control means. The larger percentage increase in land sales is mainly due to the initially smaller sales values, so even a modest absolute increase translates into a higher percentage change.

Table D.2: Treatment Effect of the Repeal on Land Adjustment: Extensive vs. Intensive

<i>Dep. Var.</i>	Extensive Margin		Intensive Margin $m(y) = \log(y + \mathbf{1}\{y = 0\} * y_{min})$	
	(1) $\mathbf{1}\{Add > 0\}$	(2) $\mathbf{1}\{Deduct > 0\}$	(3) $m(Add)$	(4) $m(Deduct)$
$Repeal_{st}$	-0.002 (0.022)	-0.032 (0.032)	-0.005 (0.022)	-0.013 (0.011)
$Repeal_{st} \times I_d^{UA}$	0.064*** (0.019)	0.065** (0.026)	0.082*** (0.021)	0.029*** (0.010)
Observations	332,860	330,323	333,638	333,973
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Land Size×Year FE	Yes	Yes	Yes	Yes
$dy/dx Repeal_{st} \times I_d^{UA}$	0.011	0.004	-	-
Sample mean	0.106	0.029	-	-

Notes: Probit model is used in columns (1)-(2). In columns (3)-(4), before log-transformation, we set all zeros to the smallest positive adjustments in the data, thus shutting off the extensive margin change between 0 and y_{min} , following [Chen and Roth \(2023\)](#). Land Size×Year are districts’ average pre-treatment land size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. Other controls include the urban dummy variable and 2-digit industry fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D.1.2 Increased Flexibility in Land Inputs

We further demonstrate that the Repeal reduced land adjustment costs, making it easier for firms to divest land in response to profitability shocks. Following [Guiso et al. \(2005\)](#), [Fagereng et al. \(2018\)](#), and [Chatterjee et al. \(2023\)](#), we measure plant-level profitability shocks by unanticipated changes in gross value added that cannot be explained by plant-specific characteristics and aggregate fluctuations. Specifically, we regress log value-added ($VA_{i,t}$) on plant (δ_i), industry-year ($\delta_{j,t}$), and state-year ($\delta_{s,t}$) fixed effects as shown below:

$$\log(VA_{i,t}) = \delta_i + \delta_{j,t} + \delta_{s,t} + \epsilon_{ijs,t}$$

The regression residuals, $\epsilon_{ijs,t}$, thus capture shocks to a plant’s “profitability”, including variation in both technical efficiency and product appeal.⁵³ We define a dummy variable

⁵³An alternative method for measuring productivity shocks involves estimating the residual of the revenue function, or Total Factor Productivity (TFP), by deducting the cost of inputs from sales revenue. However, as noted by [Decker et al. \(2020\)](#), this TFP measurement is susceptible to errors due to omitted variables. In contrast, the plant fixed effects in our approach effectively absorb any plant-specific factors that do not change over time.

$Shock_{i,t-1} = 1$ if the residual is negative in the previous year.⁵⁴ We then interact this measure of negative shocks with our baseline DiD regressors, while controlling for plant, industry-year, and state-year fixed effects, with standard errors clustered at the state-year level. Our identification leverages within-plant variation in responsiveness to negative shocks before and after the Repeal, compared to control firms in the same industry-year and state-year cells.

Table D.3 reports the regressions for landholdings (Column 1), number of employees (Column 2), and fixed assets (excluding land) in Column 3. Several patterns are noteworthy. First, land adjustments were considerably less flexible than adjustments in labor and other fixed assets such as machines and plants. Facing negative shocks, firms divest their landholdings by 10.2%, compared with a 16.2% and 17.8% decline in labor and capital, respectively, as indicated by the first row. Second, the second row of Column (1) suggests that firms in UAs were even less (4%) responsive to negative shocks, albeit not significantly so at the conventional level. Third, after the Repeal, land became approximately as flexible as other inputs for treated firms, as indicated by the sum of the effects in the first and last rows of Column (1).

Furthermore, the last row of Columns (2) and (3) indicates that the Repeal did not affect the flexibility of labor and capital, providing further evidence that the reform contributed to firm growth by alleviating land market constraints specifically, rather than other frictions in the labor and capital markets. We also document a notable 9.2% within-plant increase in landholdings for firms that did not experience a negative shock, suggesting that the Repeal may have reallocated land to more profitable firms.

D.1.3 Land Misallocation

An alternative approach to test the impacts on land misallocation is to examine the heterogeneous treatment effects on firms with high versus low marginal revenue product of land (MRPLand) prior to the Repeal, as in [Bau and Matray \(2023\)](#). Post-Repeal, we expect plants with higher pre-Repeal MRPLand to experience faster land growth and a subsequent decline in MRPLand. The Repeal reduced land misallocation if it compressed the MRPLand dispersion.

However, a concern with this approach is the slow adjustment of land, e.g., firms may need years to build up their land stock. Consequently, firms with higher MRPLand (i.e., those more constrained by land according to this approach) might be the firms that are

⁵⁴Note that all the estimates would be symmetric if we defined a positive shock as having positive residuals in the previous year.

Table D.3: Adjustments in Inputs Following Negative Shocks

<i>Dep. Var.</i>	(1) Landholding	(2) Employee	(3) Fixed Asset
<i>Negative Shock</i> _{<i>i,t-1</i>}	-0.102*** (0.021)	-0.162*** (0.012)	-0.178*** (0.015)
<i>Negative Shock</i> _{<i>i,t-1</i>} × <i>I</i> _{<i>d</i>} ^{UA}	0.039 (0.027)	-0.020 (0.015)	0.008 (0.019)
<i>Negative Shock</i> _{<i>i,t-1</i>} × <i>Repeal</i> _{<i>st</i>}	0.024 (0.024)	0.014 (0.015)	0.006 (0.018)
<i>Repeal</i> _{<i>st</i>} × <i>I</i> _{<i>d</i>} ^{UA}	0.092*** (0.035)	-0.019 (0.018)	0.054* (0.028)
<i>Negative Shock</i> _{<i>i,t-1</i>} × <i>Repeal</i> _{<i>st</i>} × <i>I</i> _{<i>d</i>} ^{UA}	-0.065** (0.033)	0.007 (0.018)	-0.003 (0.022)
Observations	79,470	106,935	107,046
R-squared	0.924	0.949	0.971
Firm FE	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes

Notes: All dependent variables are in logs and deflated. Capital excludes land value to avoid mechanical correlation. *Negative Shock*_{*i,t-1*} is set to 1 if the residuals from regressing firm-level gross value added on firm Fixed Effects, 2-digit Industry-by-Year Fixed Effects, and State-by-Year Fixed Effects are negative in the previous period. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

actively increasing their land stock and would thus experience accelerated land growth even without the Repeal. Moreover, previously high or low MRPLand firms may experience mean reversion, leading to a smaller MRPLand dispersion even without the Repeal.

Table D.4, Columns 1-2, present the Repeal's effects on within-plant land growth for previously high/low MRPLand plants. Consistent with our concern, high MRPLand firms saw an 11% land increase even in non-UAs, likely reflecting slow-moving land adjustments or strong mean reversion forces. However, high MRPLand firms in UAs experienced an additional 11% land increase relative to high MRPLand plants in non-UAs. Together with the null effects on low MRPLand firms, these results suggest that the Repeal improved land allocative efficiency by allowing previously land-constrained (high MRPLand) firms to expand. Figure D.1 presents the event study graphs for the different impacts on UA plants and confirms there is no pre-trend before the Repeal.

Columns 3-4 examine the impacts on MRPLand for previously high/low MRPLand plants. Two key patterns emerge. First, previously high (low) MRPLand plants experienced a decrease (increase) in MRPLand post-Repeal in non-UAs, indicating a mean reversion effect. Second, high MRPLand plants in UAs saw a 14% larger decline in MRPLand compared to their non-UA counterparts. Interestingly, low MRPLand plants in UAs experienced a

Table D.4: Treatment Effects of the Repeal on Land Growth and MRPLand by High/Low Pre-Repeal MRPLand Plants

<i>Dep. Var. (log)</i>	Land use		MRPLand	
	(1) High	(2) Low	(3) High	(4) Low
<i>Previously high/low MRPLand plants</i>				
<i>Repeal_{st}</i>	0.110*** (0.030)	-0.050 (0.030)	-0.098*** (0.030)	0.181*** (0.034)
<i>Repeal_{st} × I_d^{UA}</i>	0.111*** (0.033)	0.005 (0.030)	-0.137*** (0.033)	-0.070** (0.031)
Observations	71,874	63,787	68,960	58,405
R-squared	0.858	0.928	0.668	0.742
Plant FE	Yes	Yes	Yes	Yes
Land Size × Year FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variables are log land use in Columns 1-2 and log marginal revenue product of land (MRPLand) in Columns 3-4. MRPLand is calculated as the ratio of sales revenue to land use. The regression sample is segmented by whether plant's pre-Repeal average MRPLand was above (Columns 1, 3) or below (Columns 2,4) the district median. 'Land Size × Year' incorporates both district pre-Repeal land endowment size bins and firm-specific land size bins, interacted with year fixed effects. Standard errors are clustered two-way by state and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

smaller 7% increase in MRPLand than those in non-UAs, potentially due to the expansion of high MRPLand plants in UAs. Before the Repeal, high MRPLand plants had over 300% higher MRPLand than low MRPLand plants, suggesting that the liberalization reduced land misallocation by compressing the MRPLand dispersion.

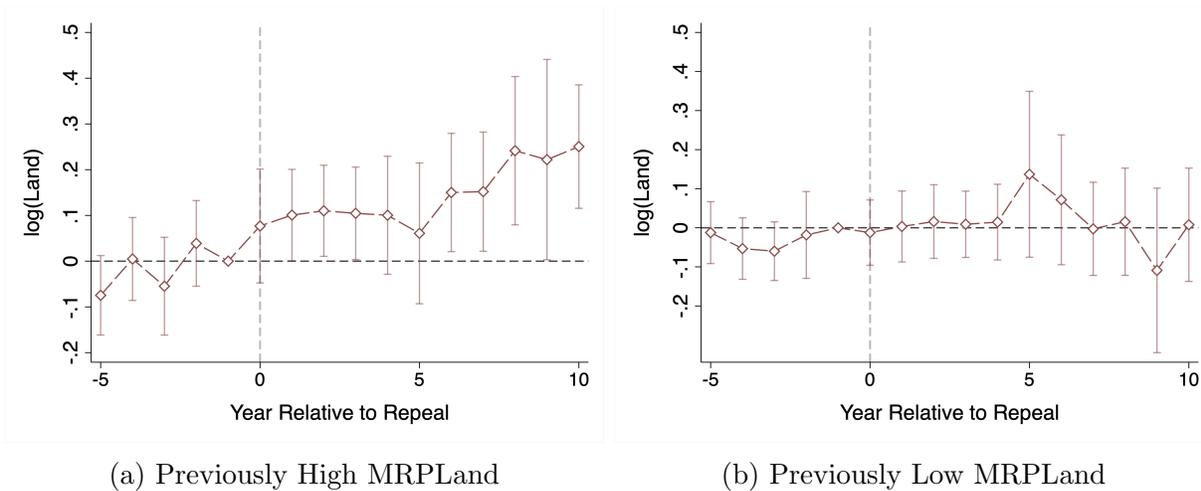


Figure D.1: Event Study Graphs for the Effects of the Repeal on Land Use for High/Low MRPLand Plants in UAs

Note: The dependent variable is log land used in production. MRPLand is calculated as the ratio of sales revenue to land use. All regressions include plant fixed effects, year fixed effects, and controls incorporate both district pre-Repeal land endowment size bins and firm-specific land size bins, interacted with year fixed effects. Standard errors are clustered two-way by state and year. The confidence interval is at the 95% level.

E Socioeconomic Impacts of the Liberalization

In the main text, we demonstrated that the Repeal of the Urban Land Ceiling and Regulation Act (ULCRA) unleashed manufacturing growth and improved the allocative efficiency of land. In this section, drawing on village-level data from three rounds of the Population Census and the 2012 Socio-Economic and Caste Census, we systematically investigate the socioeconomic impacts of the Repeal. Using detailed employment information from the Population Census, we explore how the Repeal Act facilitated the reallocation of agricultural laborers to non-agricultural sectors. The rich data on income, wealth, and housing in the Socio-Economic and Caste Census enables us to determine whether the industrial development facilitated by the Repeal came at the expense of the poor. Utilizing household expenditure data from the National Sample Survey, we also demonstrate that the Repeal had a negligible impact on residential rents in Urban Agglomerations. We conclude this section by noting the development effects of the Repeal on poverty reduction.

E.1 Data

Our labor market data are sourced from the Socioeconomic High-resolution Rural-Urban Geographic Dataset (SHRUG),⁵⁵ which integrates data from multiple rounds of the population and economic census. Specifically, we utilize the 1991, 2001, and 2011 village-level Population Census data from the Primary Census Abstract and Village Directory tables. This dataset offers comprehensive information on village infrastructure, demographics, employment, occupation, and population, which we use to construct variables related to labor supply in the agricultural, manufacturing, and service sectors, as well as self-employment. Additionally, we gather village-level income, wealth, and housing data from the Socioeconomic and Caste Census (SECC), a universal enumeration of household assets conducted in 2011. The SECC details household assets that are readily assessable, including roof and wall materials, number of rooms, and assets like agricultural equipment, vehicles, and mobile phones. By mapping data from the population census and the SECC to time-invariant municipalities—including both villages ($n=590,648$) and towns ($n=7,528$)—the SHRUG enables us to trace the evolution of these municipalities both before and after the Repeal. We discuss variable construction along with the results.

We supplement this municipality-level data with a manually collected ULCRA dataset, which includes the repeal time for each state and the geographic coverage of the 1976 Act.

⁵⁵Asher and Novosad (2020) provides details on the data construction, accessible at <https://www.devdatalab.org/shrug>.

The Act specifies numerous Urban Agglomerations (UAs) along with their associated towns and villages. We systematically gathered coordinates for over six hundred locales listed in these delineations through extensive online research. To ensure the accuracy of our data, we cross-referenced each locale with the Indian Village Directory to verify their existence and correct spellings, particularly for those not readily found online.

We overlay the map of UA locales with the map of municipalities to delineate groups of municipalities that were more or less exposed to the Repeal, determined by their proximity to UAs. Since the exact geographic boundaries of UAs are not known, we assume they are defined by the encompassing set of UA locales. We calculate the distance between each municipality and these UA locales. Figure E.1 illustrates this mapping for the Hyderabad UA. Red dots represent the UA locales under Hyderabad, while the colored polygons depict municipalities with available Population Census data. Darker colors indicate greater distances from the municipalities to the these locales—up to 50 km. Larger polygons at the center of the circle identify towns around the Hyderabad metro—areas likely within the boundaries of the Hyderabad UA.

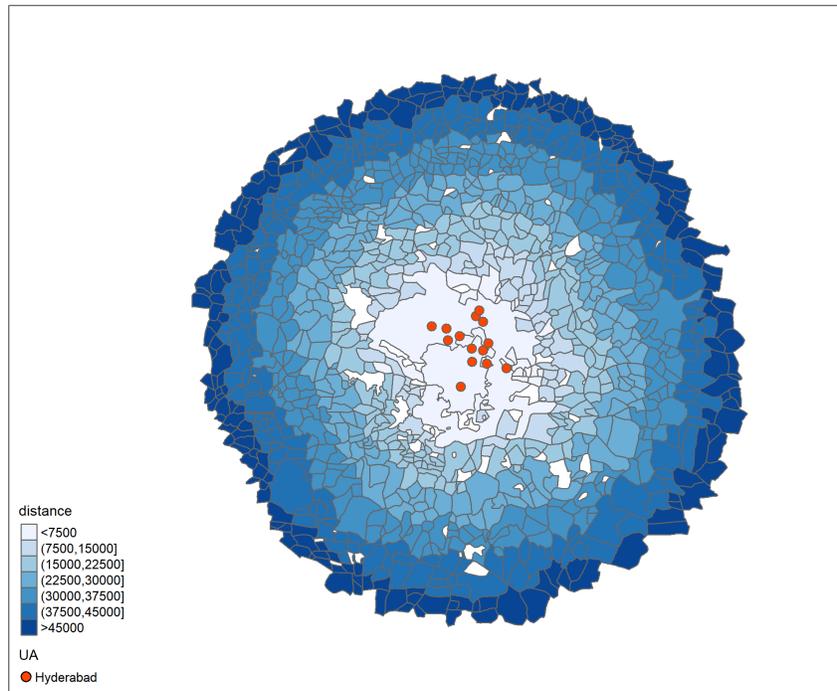


Figure E.1: UA Locales under Hyderabad UA and nearby Municipalities

E.2 Identification Strategy

To estimate the causal effects of the Repeal and to capture potential spatial spillover to nearby municipalities, we implement a Triple-Difference design following [Gechter and Tsivanidis \(2023\)](#). This design compares changes in outcome variables before and after the Repeal, between municipalities that are closer to UAs and those that are further away. Specifically, we group municipalities into 5km-distance rings around their closest UA, up to a distance of 50km. This non-parametric approach allows us to study the spatial effects of the policy. Municipalities outside the 50km radius around a UA are excluded from the analysis.

The main analysis relies on a spatial Triple-Difference model as described below:

$$y_{ijt} = \sum_{d=1}^{d=9} \beta_d (D[d_i = d] \times \text{POST}_{jt}) + X_i \times \text{Year}_t + \sigma_t + \sigma_i + \sigma_{jt} + \epsilon_{ijt}, \quad (32)$$

where y_{ijt} represents outcomes such as agricultural employment or the share of homeless people in municipality i , around UA j in year t . $D[d_i = d]$ indicates whether a municipality i is in distance bin d to the nearest UA, with $d = 1$ representing municipalities within a 5km distance to the UA—likely municipalities within the confines of the UA—and extending up to 50km. Distance bin $d = 10$ (45-50km) is omitted and serves as the reference category. Our final sample has approximately 120,000 municipalities in a given year. We interact the distance dummies with a post-Repeal dummy, POST_{jt} , which is set to 1 if UA_j is located in a state that had repealed the ULCRA by year t . The model includes municipality fixed-effects σ_i and year fixed effects σ_t . We also include UA-by-year fixed effects σ_{jt} to ensure that we are comparing relative growth among municipalities—those closer and further away—from the same Urban Agglomeration over time. Additional controls $X_i \times \text{Year}_t$ include various municipality-level baseline covariates interacted with year fixed effects. ϵ_{ijt} is the error term clustered at the UA level to account for spatial correlation. The β_d are the parameters of interest, capturing the triple-difference estimates. They capture the differential changes in outcome variables across municipalities in distance bin d that experienced the Repeal, relative to those in the reference category, and contrast these changes with municipalities in states that have not yet implemented the Repeal.

Our identification assumption is that the relative growth rates of municipalities near UAs compared to those farther away do not differ significantly between states that adopted the Repeal early and those that adopted it later. This assumption could be violated if, for example, municipalities closer to urban centers in early-adopter states grow differentially faster than those in late-adopter states, even in the absence of the Repeal. While this assumption is untestable, we address potential concerns in two ways. First, we control

for various baseline covariates—such as population size, distance to the nearest town, and proximity to roads—interacted with year fixed effects. These controls are intended to mitigate any pre-existing differential growth trends between closer and farther municipalities across early and late adopter states. Secondly, we perform a placebo test by substituting the distance-to-UA dummies with distance-to-town dummies. If the differential growth patterns were primarily driven by proximity to urban centers rather than the Repeal, we would expect to see similar patterns in the placebo test.

E.3 Results from Population Census

Effects on Structural Transformation. We begin our analysis by examining the effects of the Repeal on structural transformation, which could be facilitated through both labor supply and demand channels. On one hand, the expansion of manufacturing firms post-Repeal is likely to create more job opportunities in the industrial sector. On the other hand, by removing arbitrary building and construction regulations, the Repeal could decrease urban rent, thereby increasing the labor supply in non-agricultural sectors.

Using data from three rounds of the Population Census, we construct municipality-level shares of cultivators, agricultural hired laborers, other workers (include both manufacturing and service workers), and workers in household enterprises, among main workers. Main workers are those who work for more than six months in their jobs. Figure E.2 plots the coefficients β_d of our empirical equation (32) with each dot indicating the coefficient for a specific distance bin. Panels (b) and (c) show that municipalities closer to UAs experience an increase in the share of other workers and a decrease in the share of agricultural hired laborers. For more distant municipalities ($> 25\text{km}$), the estimates for β_d turn out to be small and statistically insignificant from the reference group (45-50km), suggesting that employment changes between municipalities in further distance do not differ systematically.

The spatial spillovers on structural change are substantial in magnitude. For example, municipalities that are 10-15 km away from UAs witness an increase in the share of other workers by about 10 percentage points, which corresponds to approximately 30% of the sample mean (31.5%). Similarly, these municipalities observe a decrease in agricultural hired laborers by 4 percentage points, amounting to about 17% of the sample mean (25%). By contrast, Panels (a) and (d) suggest that changes in the shares of cultivators and workers in household enterprises are smaller in magnitude and often insignificant. Moreover, Panels (e) and (f) demonstrate that the Repeal not only changes the employment shares but also accelerates the growth of the total population and the number of main workers in municipalities close to UAs.

Effects on Amenities. One might wonder how amenities—such as roads, schools, and electricity—respond endogenously to structural changes. These responses are particularly interesting as they could serve as potential mechanisms for the industrial growth results reported in our main text. For example, if the Repeal removed land constraints, it could allow developers in UAs to construct more roads, which in turn could boost manufacturing growth. To investigate this, we utilize municipality-level infrastructure data to construct various indicators of amenities, including the number of primary and high schools, the presence of paved and unpaved roads, and the availability of electricity for agricultural and general purposes. We then apply our spatial difference-in-differences (DiD) specification to assess the impact of the Repeal on these amenities. Note that, unlike our baseline specification, which controls for baseline amenities-by-year fixed effects, this analysis includes only baseline quartiles of population and distance to towns, interacted with year fixed effects. Interestingly, in Figure E.3 we do not observe accelerated growth of amenities in municipalities closer to UAs. In fact, municipalities near UAs experience somewhat slower growth in paved roads, although this effect is relatively modest in magnitude.

E.4 Results from the 2011 Socioeconomic and Caste Census

We now turn to the effects of the Repeal on household income, housing conditions, wealth, and poverty, using data from the 2011 Socio-Economic and Caste Census (SECC). Note that this is the only round of the SECC that contains household income and wealth information. Consequently, we are unable to estimate our baseline spatial DiD specification, as all UAs were treated by 2011. As an alternative, we examine the relative differences in the *levels* of outcomes between places closer to UAs and those further away. Our estimates should be interpreted with caution in light of this potential limitation.

Effects on Housing Conditions. We begin by examining the impacts on housing conditions. As noted by [Gechter and Tsivanidis \(2023\)](#), urban redevelopment could have adverse effects on the local population, particularly if local dwellers are forcibly relocated. In our context, if residential land near UAs is converted to industrial land following the Repeal, this might lead to a deterioration of housing conditions in nearby municipalities. To assess this, we consider several indicators of housing conditions, including the share of households that own or rent a house, the share of homeless individuals, the average number of rooms per house, and the proportion of houses with solid walls and roofs.

Figure E.4 demonstrates that municipalities closer to UAs tend to have a smaller share of households that own a house, but a higher share renting. The impacts on the share

of homeless individuals and the average number of rooms are negligible and statistically insignificant. Additionally, municipalities nearer to UAs are more likely to have houses with solid walls and roofs. Taken together, these findings suggest that there is no evidence of a deterioration in housing conditions attributable to the Repeal.

Income and Poverty. We then examine the effects on municipality-level income, poverty rate, and estimated consumption. Although consumption was not directly surveyed by the SECC, the SHRUG provides imputed consumption information, for each municipality, based on another household survey (IHDS-II, 2011-12), which includes similar asset, income, and land data as the SECC. SHRUG reports mean predicted consumption and the share of the population below the poverty line (27 Rupees/day) for each municipality. Figure E.5 shows that municipalities closer to UAs tend to have higher income, more likely to have salaried wage, consume more, and exhibit a lower poverty rate. We observe significant spatial spillovers in the effect on poverty rate—municipalities 25 km away from UAs show a reduction in poverty rate by approximately 0.02 percentage points compared to the reference group, which constitutes about 6.5% of the sample mean (31%). By contrast, the effects on income and salaried wage from the government tend to be more localized and diminish more rapidly with distance. In fact, the effects on earning more than 10,000 Rupees per month and the effects on having a government salaried wage are only significant within the 0-5 km distance bin, suggesting that these impacts are primarily driven by municipalities *inside* UAs. By contrast, the effects on private sector salaried wages exhibit stronger spatial spillover and are substantial in magnitude. For instance, municipalities that are 20-25 km away tend to have 1 percentage point more households earning a salaried wage from the private sector, which constitutes approximately 25% of the sample mean (3.9%).

We then examine the impacts of proximity to UAs on the main sources of household income. Consistent with our findings on structural transformation, Figure E.6 demonstrates that municipalities closer to UAs are less likely to report cultivation as the main source of income, and more likely to derive income from manual labor. Additionally, we do not observe any effects on the share of households who report begging or foraging as the main source of income, suggesting that the Repeal may not have displaced people.

E.5 Placebo Test

As previously noted, our identification assumption is that the relative growth rates of municipalities near Urban Agglomerations (UAs) compared to those farther away do not differ significantly between states that adopted the Repeal early and those that adopted it later.

This assumption could be violated if, for instance, municipalities closer to urban centers in early-adopter states exhibit differentially faster growth than those in late-adopter states, even in the absence of the Repeal. In our baseline regression, we always control for various baseline covariates—such as population size, distance to the nearest town, and proximity to roads—interacted with year fixed effects, to mitigate any pre-existing differential growth trends.

As an additional strategy, we perform a placebo test by substituting the distance-to-UA dummies with distance-to-town dummies. Should our previous results be driven primarily by proximity to urban centers rather than the Repeal itself, we would expect to observe similar patterns in the placebo test. Figures [E.7](#), [E.8](#), [E.9](#), [E.10](#), and [E.11](#) present the results of this placebo test, replicating our earlier analyses using the distance to the nearest town. Collectively, these results are significantly noisier, exhibit no systematic patterns, and tend to be considerably smaller in magnitude. This placebo test lends further support to our main findings, bolstering the causal interpretation of them.

E.6 Rent and Housing Prices

Another question left unaddressed in the main text concerns whether the increase in the value of firms' landholdings is driven by the increase in the amount of land or in land prices. Unfortunately, there is no systematic data on property prices across districts in India. To address this, we construct several measures of residential rent expenditure using household-level consumption data. The rationale behind this approach is that if urban land prices increased dramatically following the Repeal, we would expect a corresponding rise in rent expenditures. This examination is important in its own right. Suppose the Repeal facilitated the conversion of residential land to industrial land, thereby pushing up rents; this could potentially have negative effects on urban renters.

The consumption data are sourced from the Indian National Sample Survey (NSS), which provides pooled cross-sectional household consumer expenditure data. The full-scale quinquennial ('thick') rounds survey approximately 100,000 households every five years.⁵⁶ For our analysis, we utilize the data from the 50th (1993-94), 55th (1999-2000), and 61st (2004-05) rounds, corresponding to the fifth, sixth, and seventh quinquennial rounds.

The NSS dataset contains information on household consumption expenditure and quantity consumed across approximately 300 product categories. Rents are reported in four categories:

⁵⁶In addition to the quinquennial rounds, there are also annual NSS rounds that survey fewer households, ranging from 20,000 to 50,000 households.

- House and garage actual rent, which includes rent for residential buildings and garages for private vehicles.
- Hotel lodging charges, paid by any household member for staying in a hotel.
- Other consumer rent, which includes charges for consumer goods (like furniture) and decorations on ceremonial occasions.
- Imputed house and garage rent for urban households living in owned or otherwise occupied houses without paying rent, based on the prevailing rate of rent for similar accommodations in surrounding areas.

To capture the overall rent expenditure, we use the sum of the first three categories for the actual rent paid by the household over the last 30 days. However, for those urban households who already owned a house, they may not incur actual rents. Therefore, we supplement our rent expenditure measure with the imputed rent to construct a measure of combined rent whenever the actual expenditure information is missing.

Both rent expenditure and imputed rent are prorated to reflect monthly rent amounts. One limitation of our analysis is the lack of data on floor area, which is available only from the 62nd round of the NSS onward. Consequently, we are unable to calculate rent per square meter as in [Harari \(2020\)](#). This limitation may restrict our ability to standardize rent expenditures across household sizes and wealth. Therefore, we derive two outcome variables for each measure: the share of rent over the household’s total monthly expenditure over the last 30 days, and the rent expenditure per household member.

We construct a crosswalk to map districts in each NSS round to the time-invariant 1991 population census district boundaries, along with our policy and Repeal data. Subsequently, we aggregate household-level rent information to the district level by calculating the average rent expenditure using the sampling weights. Using the district-round level panel, we examine the treatment effects of the Repeal on our rent measures using the DiD design. This involves comparing rents in districts that had already adopted the Repeal to those that had not, and considering districts that contain any Urban Agglomerations versus those that do not. Our regressions include district fixed effects, year fixed effects, and baseline district population quartile bin-by-year fixed effects.

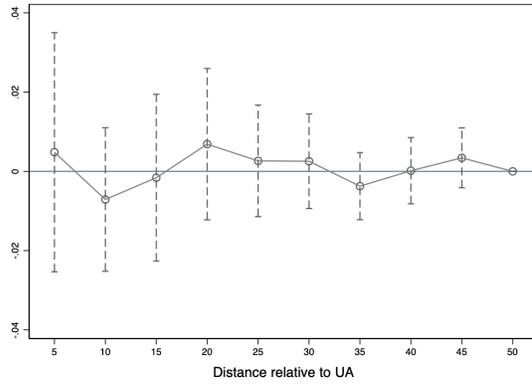
Table [E.1](#) reports the estimates of the treatment effects on four measures of rents. Columns (1) and (3) present the share of actual and combined rents over the household’s total monthly expenditure over the last 30 days, respectively. Columns (2) and (4) present the actual and combined rents per household member, respectively. Overall, our results indicate a very small and insignificant effect on rent across all four measures. Additionally,

the interaction term $Repeal_{st} * I_d^U$ is not significant in any specification, further confirming that the Repeal did not have a differential impact on households in districts that contain Urban Agglomerations. Taken together, we conclude that the Repeal had minimal impacts on residential rents in UAs. This provides suggestive evidence that our findings regarding firms' landholdings are unlikely to be driven solely by changes in land prices.

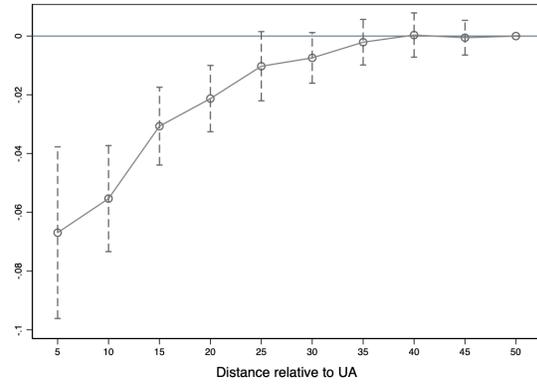
Table E.1: Treatment Effect of the Repeal on Rents

<i>Dep. Var.</i>	(1) Rent Share	(2) log(Rent p.c)	(3) Combined Rent Share	(4) log(Combined Rent p.c)
$Repeal_{st}$	-0.007 (0.006)	-0.032 (0.100)	-0.011 (0.008)	-0.004 (0.098)
$Repeal_{st} \times I_d^{UA}$	-0.007 (0.006)	-0.041 (0.113)	0.009 (0.009)	-0.016 (0.099)
Observations	2,034	2,034	2,065	2,065
R-squared	0.460	0.587	0.580	0.659
Year FE	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Population \times Year FE	Yes	Yes	Yes	Yes

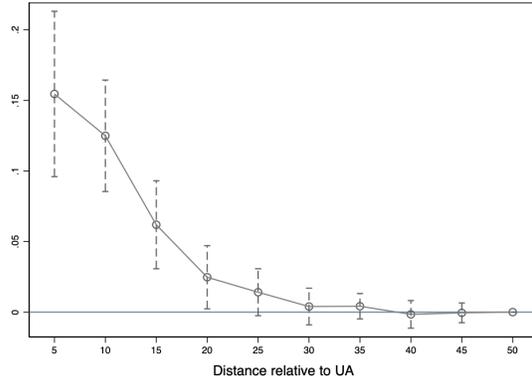
Notes: Columns (1) and (3) present the share of actual and combined rents over the household's total monthly expenditure over the last 30 days. Columns (2) and (4) present the actual and combined rents per household member, with values in logarithmic form. Population Size \times Year are districts' average pre-treatment population size bin-by-year fixed effects. Standard errors are two-way clustered at the state and year level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



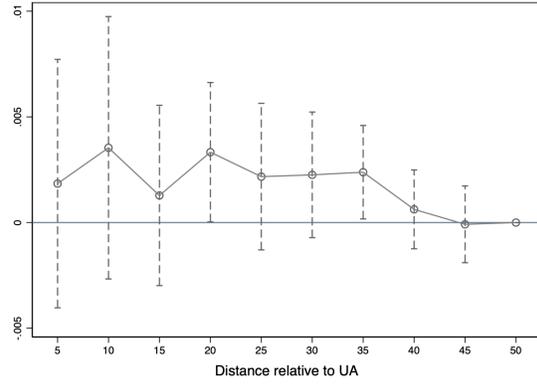
(a) Share of Cultivators



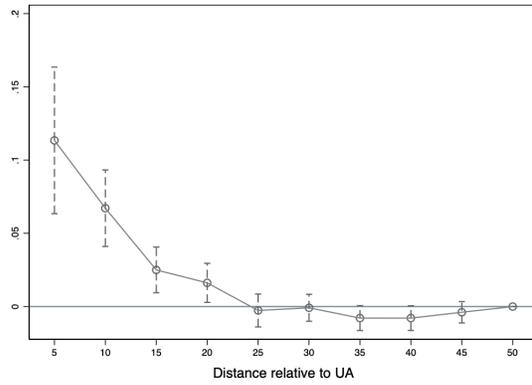
(b) Share of Agricultural Laborers



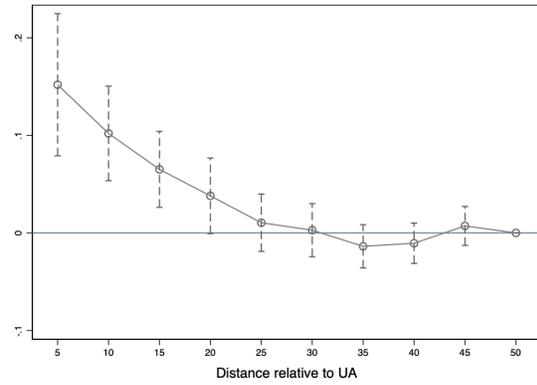
(c) Share of Other Workers



(d) Share of Workers in HH Enterprises



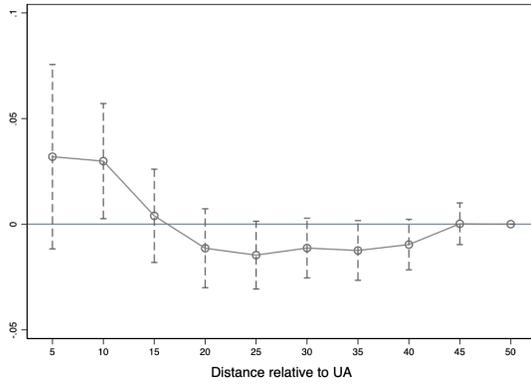
(e) $\log(\text{Population})$



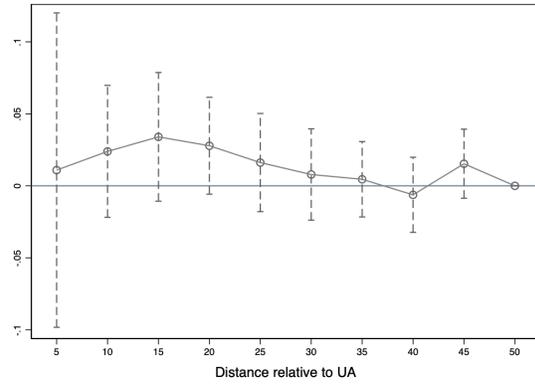
(f) $\log(\text{Main Workers})$

Figure E.2: Spatial DiD Effects on Employment Shares

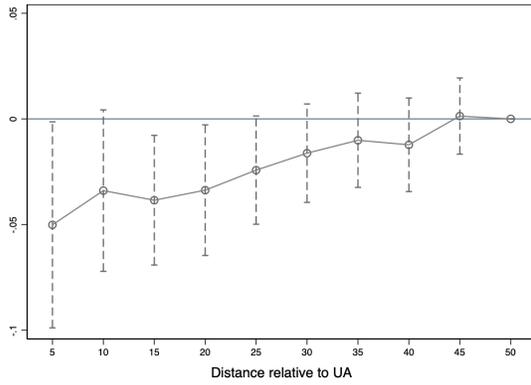
Note: This figure displays the spatial difference-in-differences (DiD) effects of the Repeal on the shares of cultivators, agricultural hired laborers, other workers, and workers in household enterprises among main workers (panels a-d), and logged population and main workers (panels e-f). The dots represent the estimated parameters β_d from our empirical equation (32), where each subscript d corresponds to a distance on the horizontal axis; for example, the coefficient at $d = 1$ indicates the municipality is within 5 km of a UA. The model accounts for municipality fixed effects, year fixed effects, and UA-by-year fixed effects. Controls include quartiles of baseline population, road presence, electrification, and distance to towns, each interacted with year fixed effects. Standard errors are two-way clustered at the UA-year level. Dashed lines represent 95% confidence intervals.



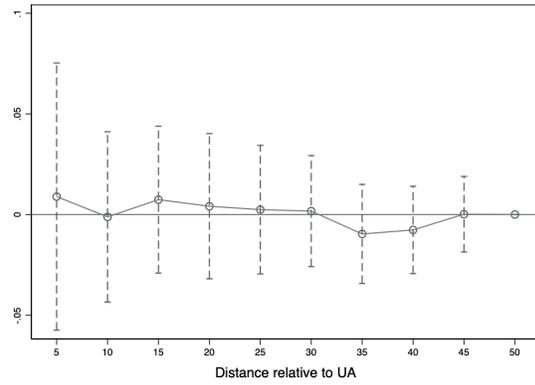
(a) $\log(\text{Primary Schools})$



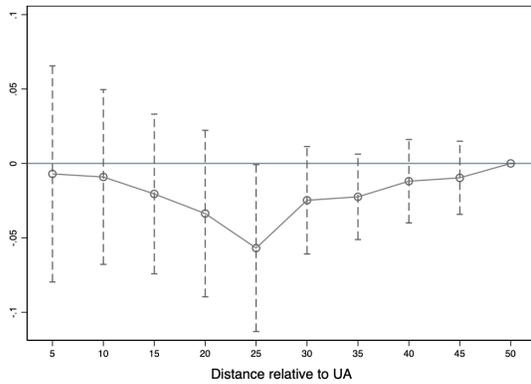
(b) $\log(\text{High Schools})$



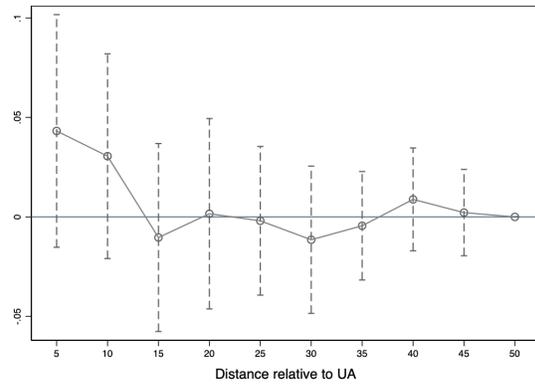
(c) Presence of Paved Roads



(d) Presence of Unpaved Roads



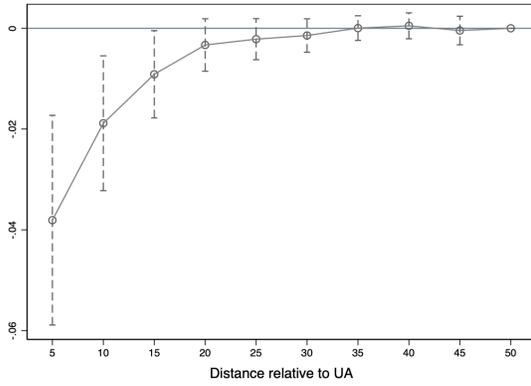
(e) Electricity for Agricultural Purposes



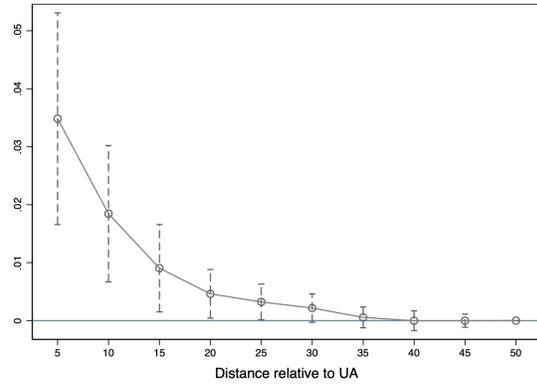
(f) Electricity for All Purposes

Figure E.3: Spatial DiD Effects on Amenities

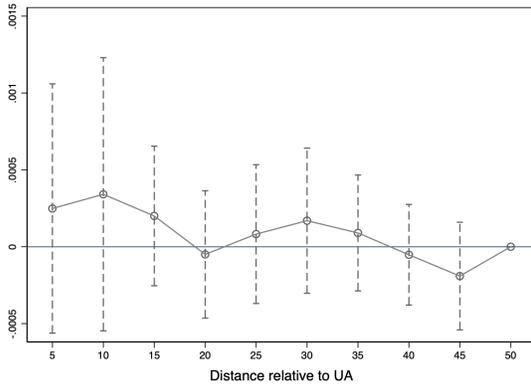
Note: This figure displays the spatial difference-in-differences (DiD) effects of the Repeal on logged number of primary and high schools, the presence of paved and unpaved roads, and the availability of electricity for agricultural and general purposes. The dots represent the estimated parameters β_d from our empirical equation (32), where each subscript d corresponds to a distance on the horizontal axis; for example, the coefficient at $d = 1$ indicates the municipality is within 5 km of a UA. The model accounts for municipality fixed effects, year fixed effects, and UA-by-year fixed effects. Controls include quartiles of baseline population and distance to towns, each interacted with year fixed effects. Standard errors are two-way clustered at the UA-year level. Dashed lines represent 95% confidence intervals.



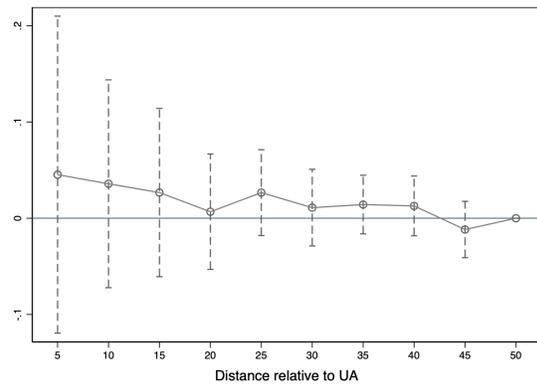
(a) Share of Owning a House



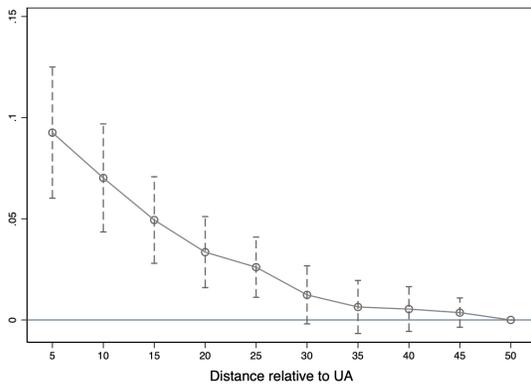
(b) Share of Renting a House



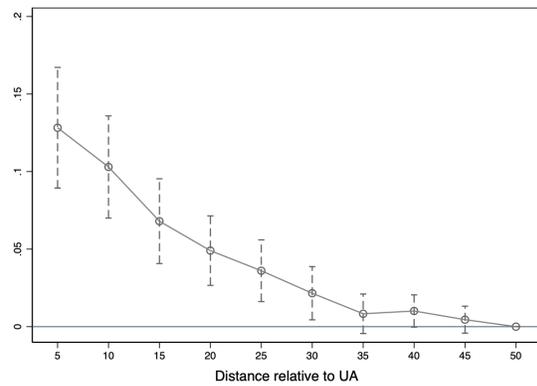
(c) Share of Homeless



(d) Number of Rooms



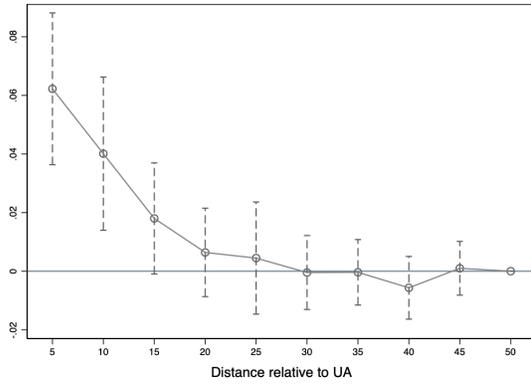
(e) Share of Solid Walls



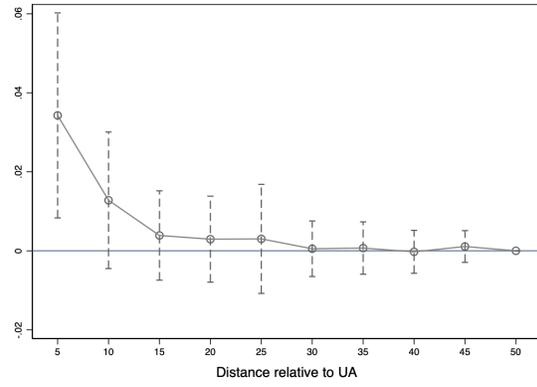
(f) Share of Solid Roofs

Figure E.4: Proximity to UAs and Housing Conditions

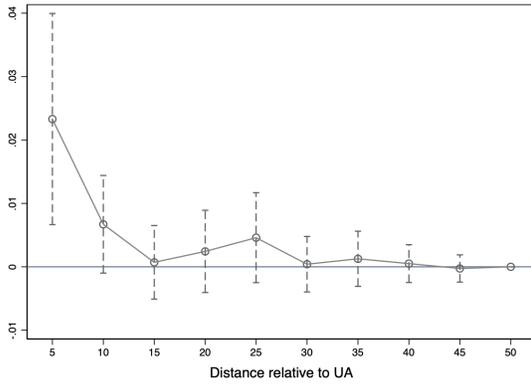
Note: This figure displays the effects of proximity to UAs on several housing indicators: the share of households that own or rent a house, the share of homeless individuals, the average number of rooms per household, and the proportion of houses with solid walls and roofs. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a UA. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.



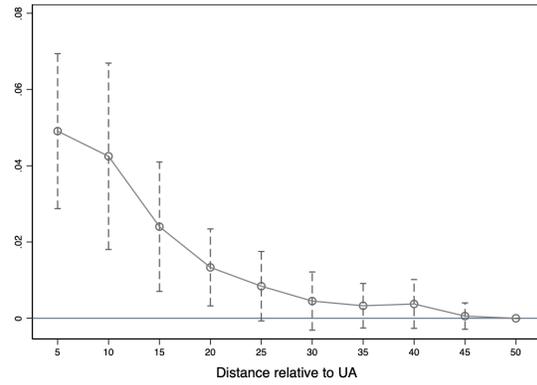
(a) Share Earning 5K+ per Month



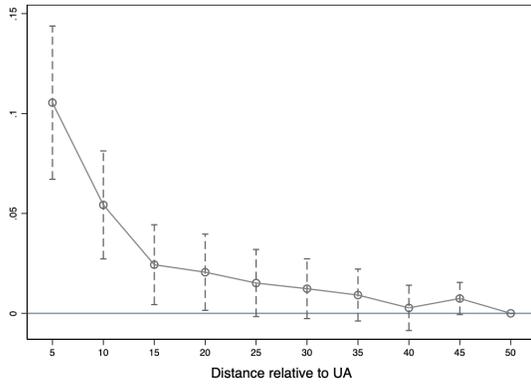
(b) Share of Earning 10K+ per Month



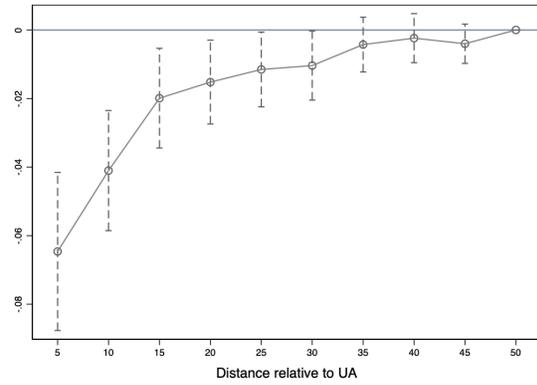
(c) Share of Government Salaried Wage



(d) Share of Private Sector Salaried Wage



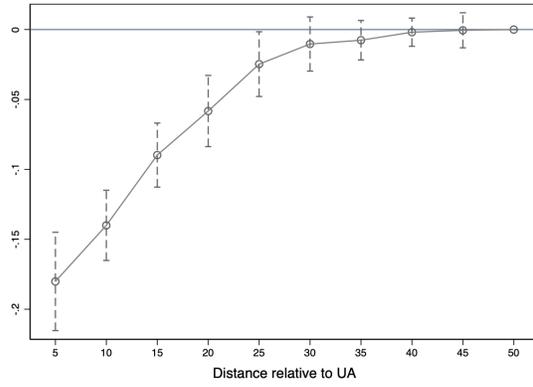
(e) $\log(\text{Consumption p.c.})$



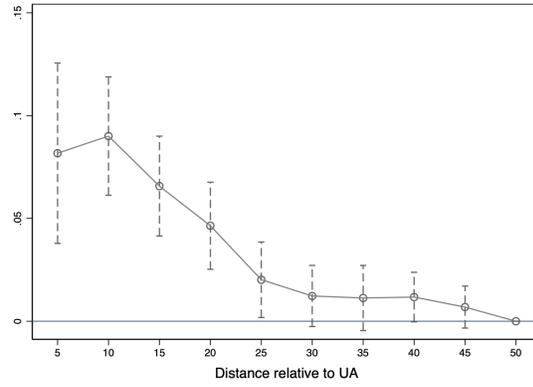
(f) Poverty Rate

Figure E.5: Proximity to UAs, Income, and Poverty

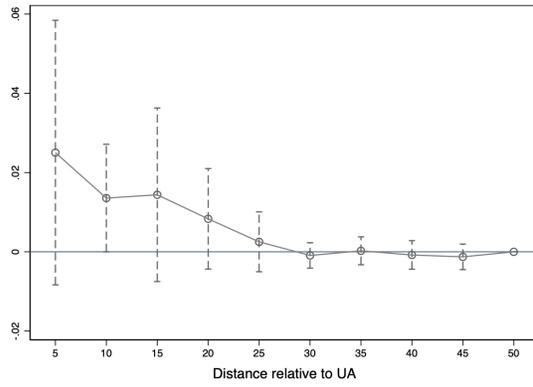
Note: This figure displays the effects of proximity to UAs on municipality-level income, poverty rate, and estimated consumption. Consumption information is imputed based on another household survey (IHDS-II, 2011-12). SHRUG reports mean predicted consumption and the share of the population below the poverty line (27 Rupees/day) for each municipality. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a UA. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.



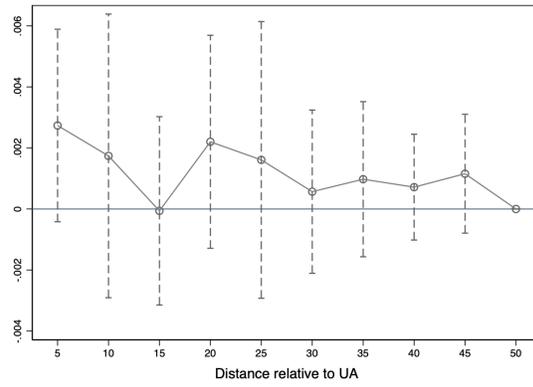
(a) Cultivation



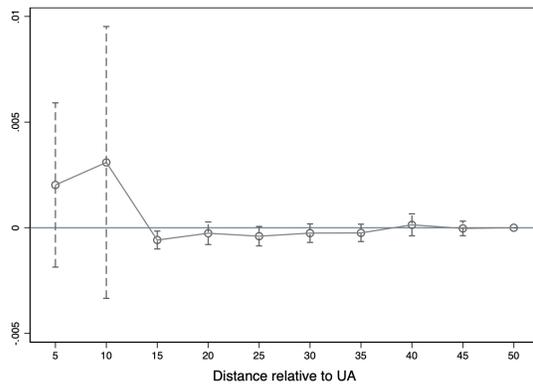
(b) Manual Labor



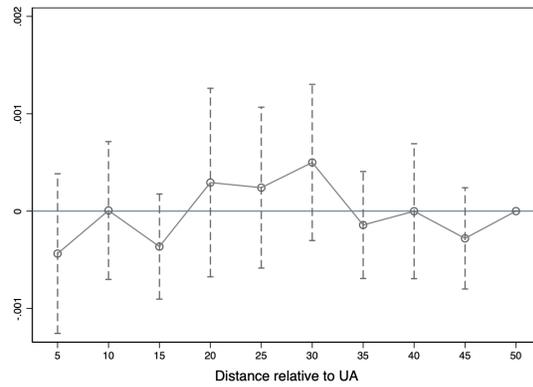
(c) Domestic Labor



(d) Household Enterprise



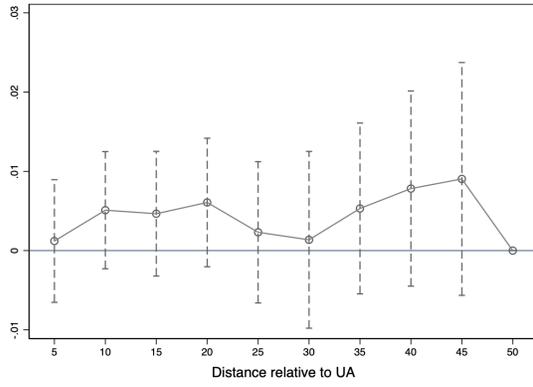
(e) Begging/Charity



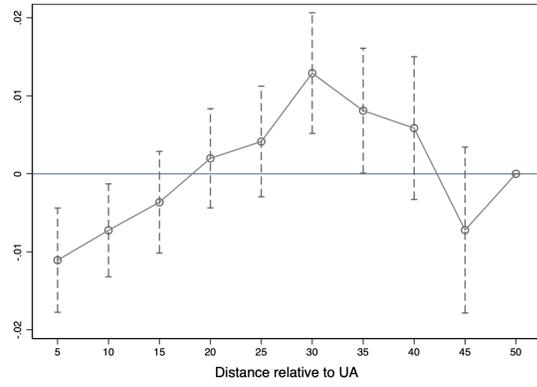
(f) Foraging/Rag Picking

Figure E.6: Proximity to UAs and Income Sources

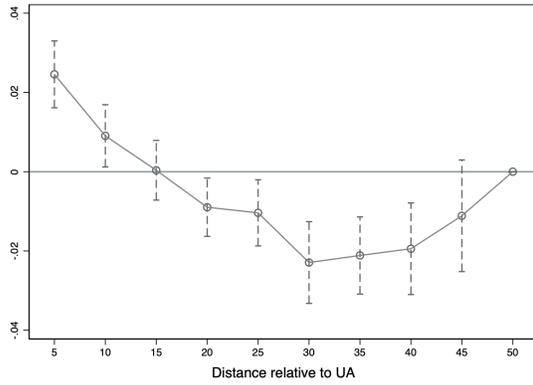
Note: This figure displays the effects of proximity to UAs on the main source of household income. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a UA. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.



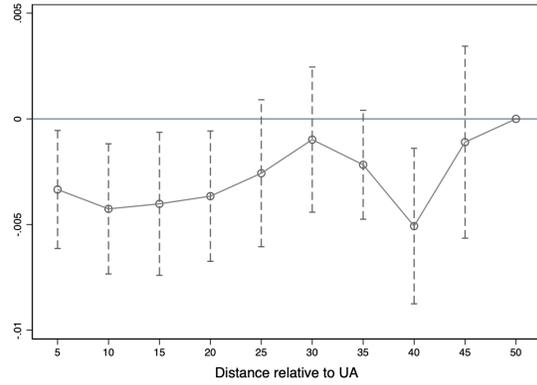
(a) Share of Cultivators



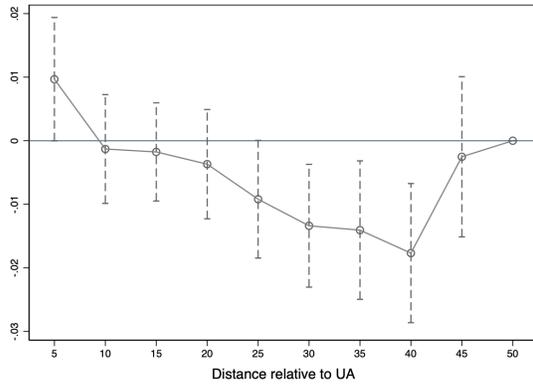
(b) Share of Agricultural Laborers



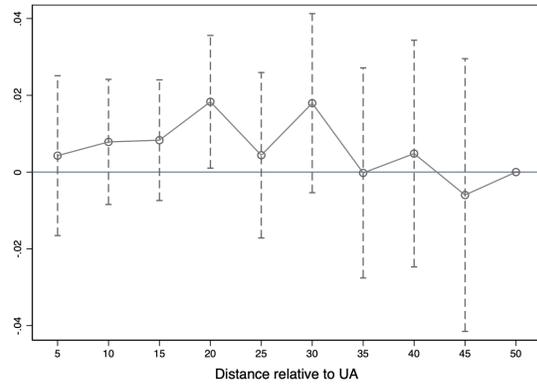
(c) Share of Other Workers



(d) Share of Workers in HH Enterprises



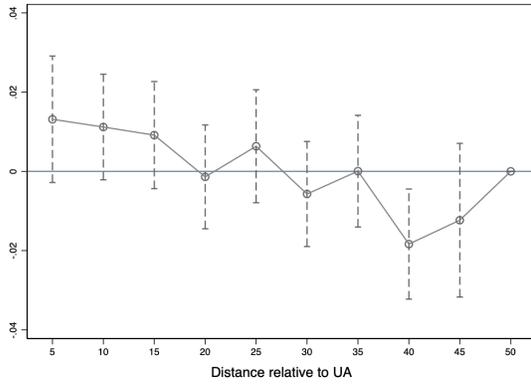
(e) $\log(\text{Population})$



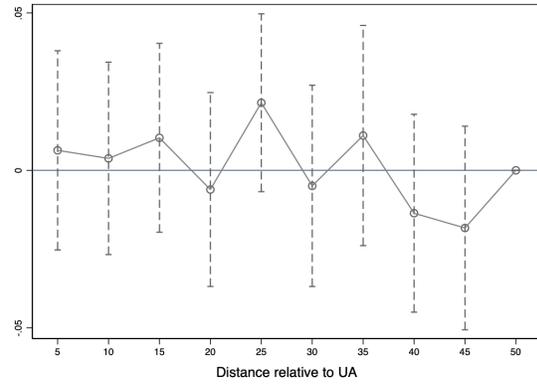
(f) $\log(\text{Main Workers})$

Figure E.7: Placebo: Spatial DiD Effects on Employment Shares

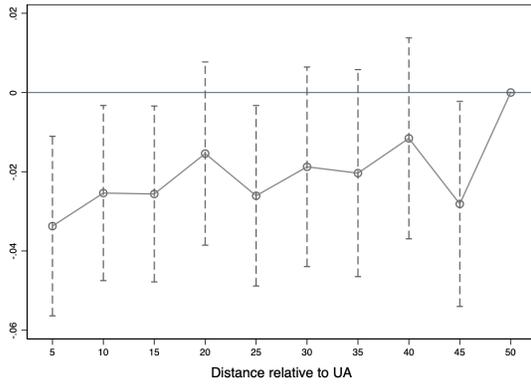
Note: This figure displays the spatial difference-in-differences (DiD) effects of the Repeal on the shares of cultivators, agricultural hired laborers, other workers, and workers in household enterprises among main workers (panels a-d), and logged population and main workers (panels e-f). The dots represent the estimated parameters β_d from our empirical equation (32), where each subscript d corresponds to a distance on the horizontal axis; for example, the coefficient at $d = 1$ indicates the municipality is within 5 km of a town. The model accounts for municipality fixed effects, year fixed effects, and UA-by-year fixed effects. Controls include quartiles of baseline population, road presence, electrification, and distance to towns, each interacted with year fixed effects. Standard errors are two-way clustered at the UA-year level. Dashed lines represent 95% confidence intervals.



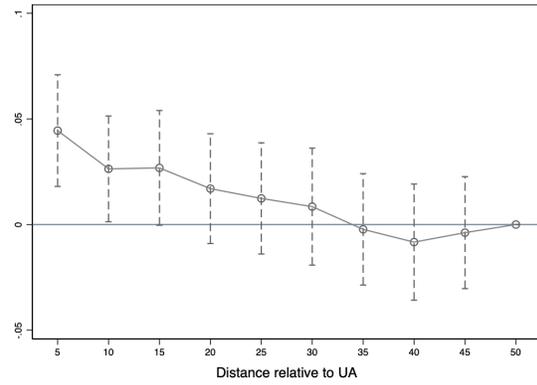
(a) log(Primary Schools)



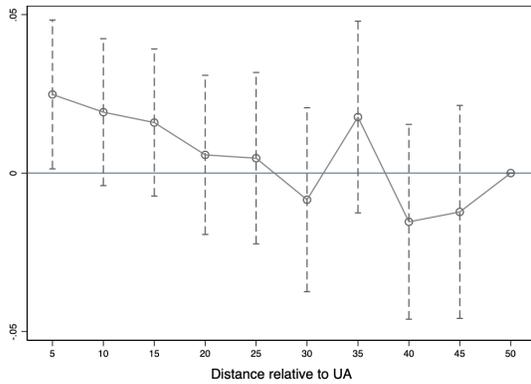
(b) log(High Schools)



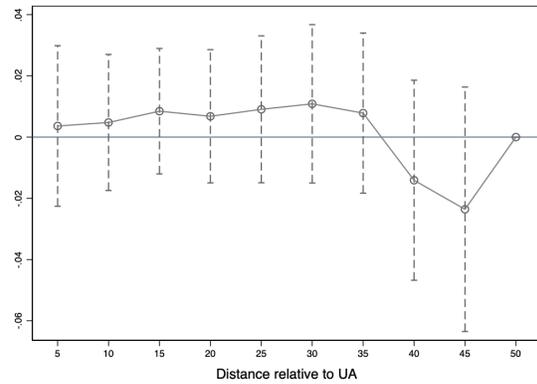
(c) Presence of Paved Roads



(d) Presence of Unpaved Roads



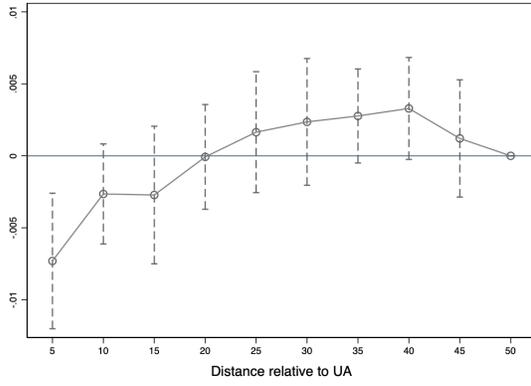
(e) Electricity for Agricultural Purposes



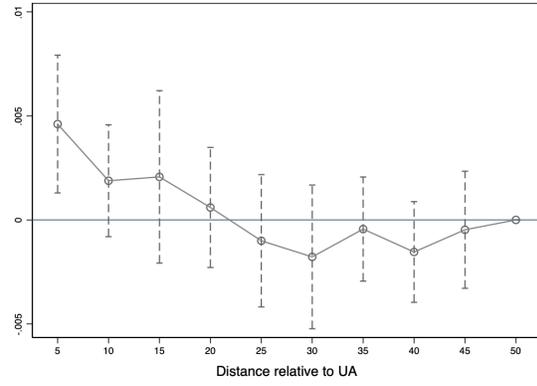
(f) Electricity for All Purposes

Figure E.8: Placebo: Spatial DiD Effects on Amenities

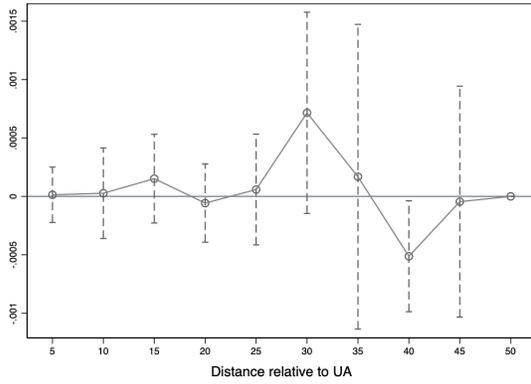
Note: This figure displays the spatial difference-in-differences (DiD) effects of the Repeal on logged number of primary and high schools, the presence of paved and unpaved roads, and the availability of electricity for agricultural and general purposes. The dots represent the estimated parameters β_d from our empirical equation (32), where each subscript d corresponds to a distance on the horizontal axis; for example, the coefficient at $d = 1$ indicates the municipality is within 5 km of a town. The model accounts for municipality fixed effects, year fixed effects, and UA-by-year fixed effects. Controls include quartiles of baseline population and distance to towns, each interacted with year fixed effects. Standard errors are two-way clustered at the UA-year level. Dashed lines represent 95% confidence intervals.



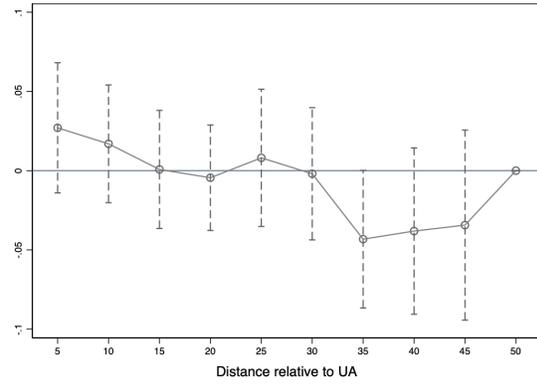
(a) Share of Owning a House



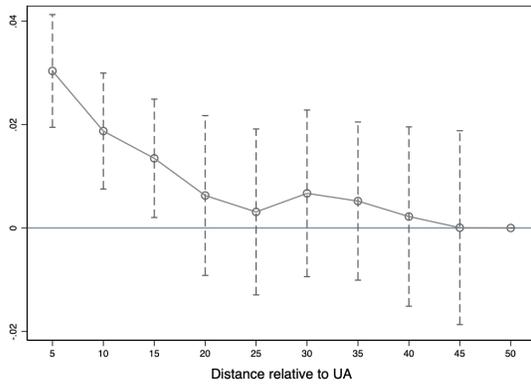
(b) Share of Renting a House



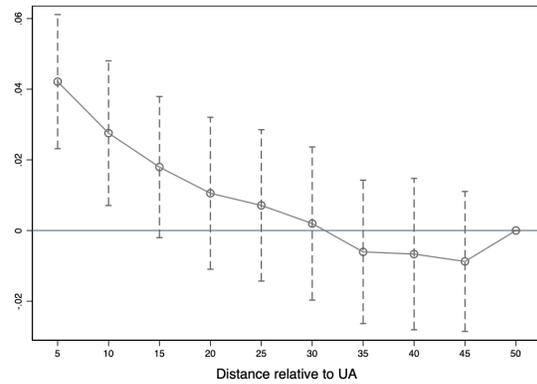
(c) Share of Homeless



(d) Number of Rooms



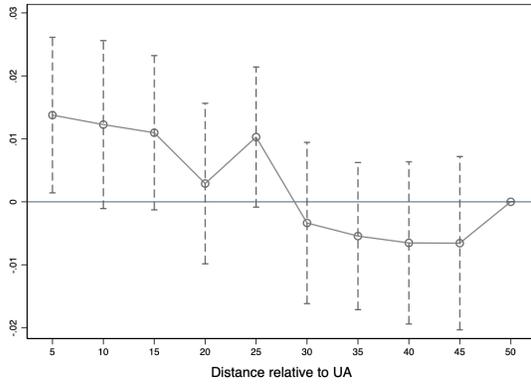
(e) Share of Solid Walls



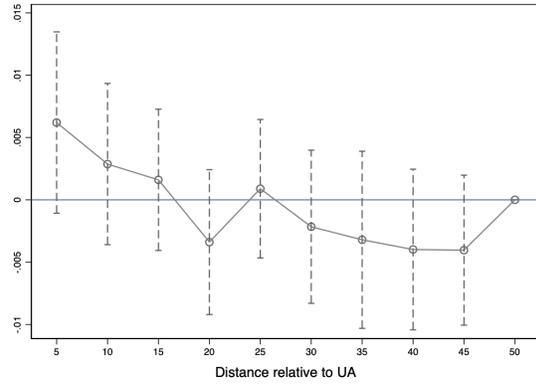
(f) Share of Solid Roofs

Figure E.9: Placebo: Proximity to UAs and Housing Conditions

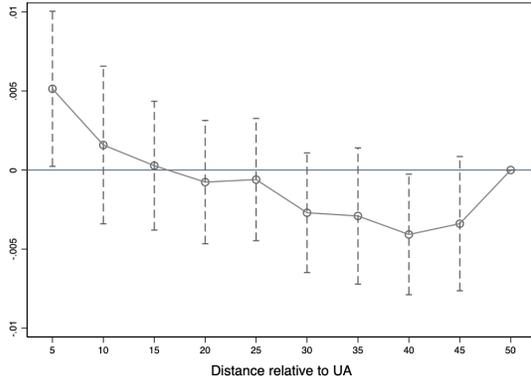
Note: This figure displays the effects of proximity to towns on several housing indicators: the share of households that own or rent a house, the share of homeless individuals, the average number of rooms per household, and the proportion of houses with solid walls and roofs. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a town. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.



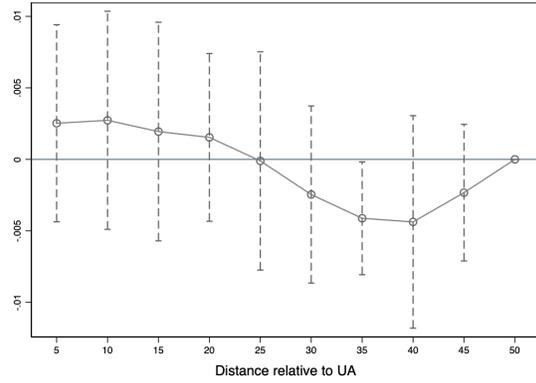
(a) Share Earning 5K+ per Month



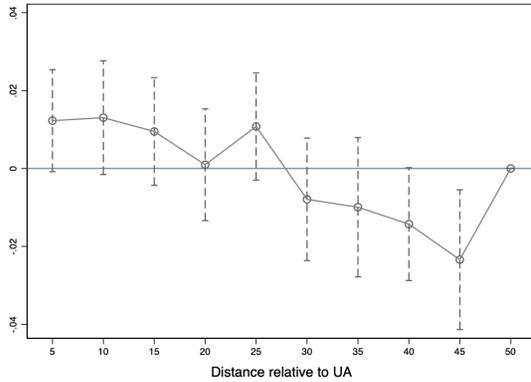
(b) Share of Earning 10K+ per Month



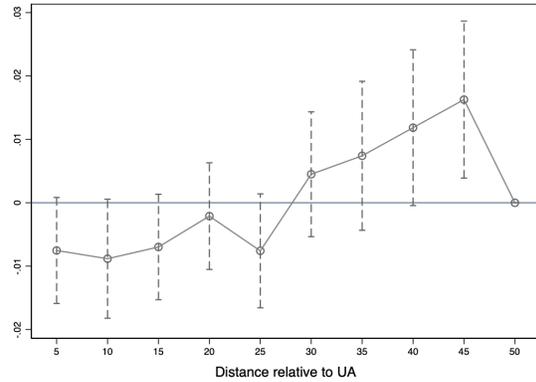
(c) Share of Government Salaried Wage



(d) Share of Private Sector Salaried Wage



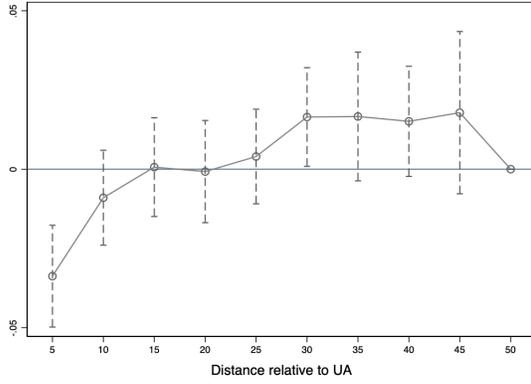
(e) $\log(\text{Consumption p.c.})$



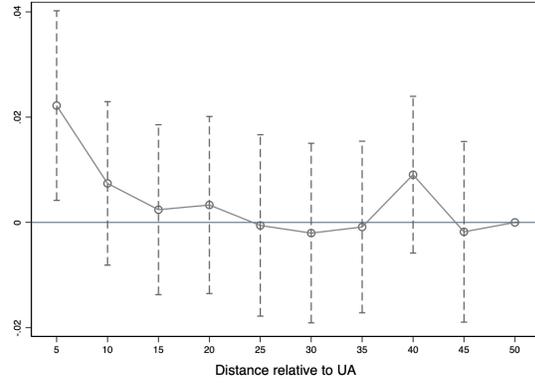
(f) Poverty Rate

Figure E.10: Placebo: Proximity to UAs, Income, and Poverty

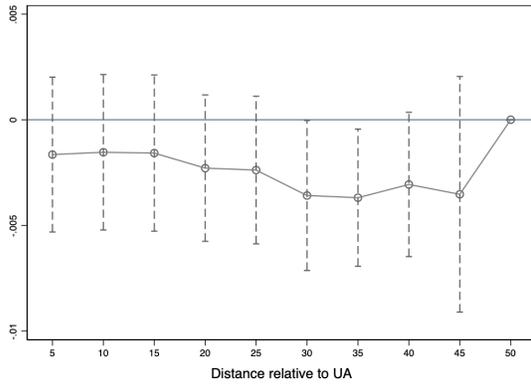
Note: This figure displays the effects of proximity to towns on municipality-level income, poverty rate, and estimated consumption. Consumption information is imputed based on another household survey (IHDS-II, 2011-12). SHRUG reports mean predicted consumption and the share of the population below the poverty line (27 Rupees/day) for each municipality. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a town. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.



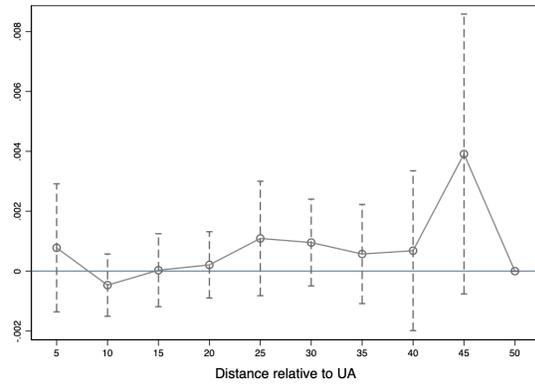
(a) Cultivation



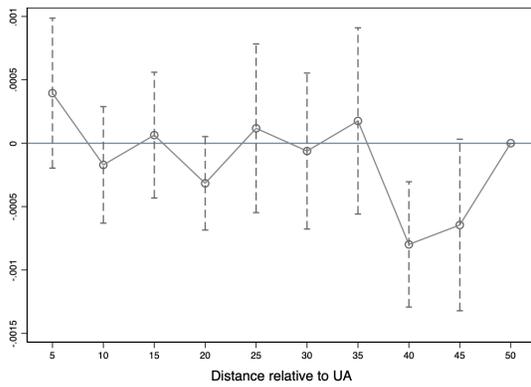
(b) Manual Labor



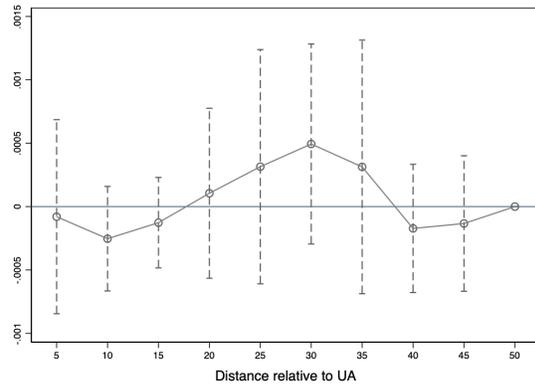
(c) Domestic Labor



(d) Household Enterprise



(e) Begging/Charity



(f) Foraging/Rag Picking

Figure E.11: Placebo: Proximity to UAs and Income Sources

Note: This figure displays the effects of proximity to towns on the main source of household income. Each dot represents the estimated parameter β_d , where each subscript d corresponds to a specific distance along the horizontal axis. For instance, a coefficient at $d = 1$ suggests that the municipality is within 5 km of a town. The model incorporates UA fixed effects, and controls include quartiles of baseline population, road presence, electrification, and distance to towns. Standard errors are clustered at the UA level. Dashed lines indicate 95% confidence intervals.

F JNNURM

In this section, we assess the impacts of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) on manufacturing firms, utilizing detailed data on the program’s implementation. Our primary data source is the audit report by [Grant Thornton \(2011\)](#), which served as the appraisal agency for the JNNURM. The report is based on information collected from a pre-approved sample of 41 mission cities, representing two-thirds of all JNNURM cities. The data includes city-level information on the number of projects approved and completed, as well as both approved and actual expenditures for the Urban Infrastructure and Governance (UIG) and Basic Services to the Urban Poor (BSUP) schemes, as of 2011.

To measure the implementation of the JNNURM, we construct four city-level metrics: logged per capita expenditure and the number of sanctioned projects in each scheme. It is important to note that using the number of sanctioned projects likely overestimates the true impacts of the JNNURM, as only 18% of UIG projects and 1.5% of BSUP projects were completed by 2011. To estimate the causal effects of the JNNURM, we interact these four measures of JNNURM implementation with a post-2006 dummy variable, employing a Difference-in-Difference framework. We assess whether our estimated effects of the Repeal, as reported in the main text, remain robust when controlling for JNNURM implementation. To the best of our knowledge, our study is the first to examine the short-run causal impacts of the JNNURM on manufacturing firms.

Tables [F.1](#), [F.2](#), [F.3](#), [F.4](#), and [F.5](#) report our results on firms’ landholdings, fixed assets, number of employees, sales revenue, and TFPQ. Column (1) reports the baseline estimates as a benchmark. Column (2) report the estimates of the Repeal’s effects by dropping firms in UAs that were covered by the JNNURM. In Columns (3)-(4), we use the full sample of data and directly control for the implementation of the JNNURM. Our estimates in Column (2) become smaller by approximately 20% (except for TFPQ) when dropping UAs covered the JNNURM, but remain highly significant. Importantly, the estimated Repeal’s effects in Columns (3)-(4) are very close to the baseline estimates reported in Column (1). Moreover, the effects of JNNURM implementation on almost all firm-level outcomes are small and insignificant. Collectively, the evidence indicates that the JNNURM is unlikely to bias our results.

Table F.1: Effects of the Repeal on Landholdings: Account for JNNURM

<i>Dep. Var.</i>	Landholdings			
	(1)	(2)	(3)	(4)
$Repeal_{st}$	0.003 (0.030)	0.021 (0.029)	0.012 (0.029)	0.010 (0.029)
$Repeal_{st} \times I_d^{UA}$	0.173*** (0.029)	0.149*** (0.038)	0.156*** (0.029)	0.165*** (0.029)
$Post2006_t \times JNNURM$ BSUP Projects _d			0.019** (0.008)	
$Post2006_t \times JNNURM$ UIG Projects _d			-0.002 (0.004)	
$Post2006_t \times JNNURM$ BSUP Expenditure _d				-0.041** (0.018)
$Post2006_t \times JNNURM$ UIG Expenditure _d				0.039*** (0.014)
Observations	338,686	235,346	338,686	338,686
R-squared	0.183	0.212	0.183	0.183
District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged landholdings. $Post2006_t \times JNNURM$ BSUP (UIG) Projects_d is the interaction of a post-2006 dummy with city-level sanctioned projects under the BSUP (UIG) scheme. $Post2006_t \times JNNURM$ BSUP Expenditure_d is the interaction of a post-2006 dummy with city-level logged per capita expenditure under the BSUP (UIG) scheme. Column (1) reports the estimates from the main text as a benchmark. Column (2) reports the estimates when all UAs covered by the JNNURM are dropped. Columns (3)-(4) use the full sample and include controls for the implementation of the JNNURM. Standard errors are two-way clustered at the state and year levels. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table F.2: Effects of the Repeal on Fixed Assets: Account for JNNURM

<i>Dep. Var.</i>	Fixed Assets			
	(1)	(2)	(3)	(4)
$Repeal_{st}$	0.034 (0.046)	0.100* (0.051)	0.040 (0.046)	0.044 (0.046)
$Repeal_{st} \times I_d^{UA}$	0.143*** (0.029)	0.114*** (0.041)	0.134*** (0.030)	0.126*** (0.030)
$Post2006_t \times JNNURM$ BSUP Projects _d			-0.000 (0.005)	
$Post2006_t \times JNNURM$ UIG Projects _d			0.002 (0.002)	
$Post2006_t \times JNNURM$ BSUP Expenditure _d				-0.001 (0.013)
$Post2006_t \times JNNURM$ UIG Expenditure _d				0.010 (0.010)
Observations	530,008	340,990	530,008	530,008
R-squared	0.253	0.310	0.253	0.253
District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged fixed assets (excluding landholdings). $Post2006_t \times JNNURM$ BSUP (UIG) Projects_d is the interaction of a post-2006 dummy with city-level sanctioned projects under the BSUP (UIG) scheme. $Post2006_t \times JNNURM$ BSUP Expenditure_d is the interaction of a post-2006 dummy with city-level logged per capita expenditure under the BSUP (UIG) scheme. Column (1) reports the estimates from the main text as a benchmark. Column (2) reports the estimates when all UAs covered by the JNNURM are dropped. Columns (3)-(4) use the full sample and include controls for the implementation of the JNNURM. Standard errors are two-way clustered at the state and year levels.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table F.3: Effects of the Repeal on Employees: Account for JNNURM

<i>Dep. Var.</i>	Employees			
	(1)	(2)	(3)	(4)
$Repeal_{st}$	-0.009 (0.016)	0.022 (0.017)	-0.010 (0.016)	-0.013 (0.016)
$Repeal_{st} \times I_d^{UA}$	0.064*** (0.013)	0.047** (0.020)	0.066*** (0.014)	0.069*** (0.014)
$Post2006_t \times JNNURM$ BSUP Projects _d			-0.003 (0.003)	
$Post2006_t \times JNNURM$ UIG Projects _d			0.001 (0.001)	
$Post2006_t \times JNNURM$ BSUP Expenditure _d				0.006 (0.009)
$Post2006_t \times JNNURM$ UIG Expenditure _d				-0.008 (0.007)
Observations	533,802	343,519	533,802	533,802
R-squared	0.148	0.172	0.148	0.148
District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged employees. $Post2006_t \times JNNURM$ BSUP (UIG) Projects_d is the interaction of a post-2006 dummy with city-level sanctioned projects under the BSUP (UIG) scheme. $Post2006_t \times JNNURM$ BSUP Expenditure_d is the interaction of a post-2006 dummy with city-level logged per capita expenditure under the BSUP (UIG) scheme. Column (1) reports the estimates from the main text as a benchmark. Column (2) reports the estimates when all UAs covered by the JNNURM are dropped. Columns (3)-(4) use the full sample and include controls for the implementation of the JNNURM. Standard errors are two-way clustered at the state and year levels. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table F.4: Effects of the Repeal on Sales: Account for JNNURM

<i>Dep. Var.</i>	Sales			
	(1)	(2)	(3)	(4)
$Repeal_{st}$	-0.009 (0.016)	0.022 (0.017)	-0.010 (0.016)	-0.013 (0.016)
$Repeal_{st} \times I_d^{UA}$	0.139*** (0.022)	0.085*** (0.027)	0.131*** (0.022)	0.135*** (0.022)
$Post2006_t \times JNNURM$ BSUP Projects _d			-0.003 (0.003)	
$Post2006_t \times JNNURM$ UIG Projects _d			0.003** (0.002)	
$Post2006_t \times JNNURM$ BSUP Expenditure _d				-0.011 (0.010)
$Post2006_t \times JNNURM$ UIG Expenditure _d				0.012 (0.008)
Observations	464,755	301,786	464,755	464,755
R-squared	0.243	0.287	0.243	0.243
District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged sales revenue. $Post2006_t \times JNNURM$ BSUP (UIG) Projects_d is the interaction of a post-2006 dummy with city-level sanctioned projects under the BSUP (UIG) scheme. $Post2006_t \times JNNURM$ BSUP Expenditure_d is the interaction of a post-2006 dummy with city-level logged per capita expenditure under the BSUP (UIG) scheme. Column (1) reports the estimates from the main text as a benchmark. Column (2) reports the estimates when all UAs covered by the JNNURM are dropped. Columns (3)-(4) use the full sample and include controls for the implementation of the JNNURM. Standard errors are two-way clustered at the state and year levels. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table F.5: Effects of the Repeal on TFPQ: Account for JNNURM

<i>Dep. Var.</i>	TFPQ			
	(1)	(2)	(3)	(4)
$Repeal_{st}$	0.046 (0.047)	0.042 (0.052)	0.045 (0.048)	0.043 (0.048)
$Repeal_{st} \times I_d^{UA}$	0.118*** (0.039)	0.175*** (0.048)	0.120*** (0.040)	0.122*** (0.041)
$Post2006_t \times JNNURM$ BSUP Projects _d			-0.002 (0.006)	
$Post2006_t \times JNNURM$ UIG Projects _d			0.000 (0.003)	
$Post2006_t \times JNNURM$ BSUP Expenditure _d				0.015 (0.020)
$Post2006_t \times JNNURM$ UIG Expenditure _d				-0.015 (0.017)
Observations	365,512	241,142	365,512	365,512
R-squared	0.489	0.514	0.489	0.489
District FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Land Size \times Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is logged TFPQ, measured with the methodology proposed by [De Ridder et al. \(2022\)](#). $Post2006_t \times JNNURM$ BSUP (UIG) Projects_d is the interaction of a post-2006 dummy with city-level sanctioned projects under the BSUP (UIG) scheme. $Post2006_t \times JNNURM$ BSUP Expenditure_d is the interaction of a post-2006 dummy with city-level logged per capita expenditure under the BSUP (UIG) scheme. Column (1) reports the estimates from the main text as a benchmark. Column (2) reports the estimates when all UAs covered by the JNNURM are dropped. Columns (3)-(4) use the full sample and include controls for the implementation of the JNNURM. Standard errors are two-way clustered at the state and year levels.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$