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The effects of industrial land market reform on the local governments' land supply decision in China

By

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Abstract

This study examines the effect of industrial land market reform on the local governments' land supply decision in China. Since 2007, the central government has required that each land parcel for sale must be sold to a proposed industry through public auction. The unit transaction price of these sales (yuan per square meter) must be higher than the county-level minimum price, unless permitted by the central government. Therefore, the local governments are no longer able to sell industrial land parcels at low prices to attract firms and are forced to consider the comparative advantages of their land for particular industries. In order to analyze the local governments' land supply decision after the reform, I develop a theoretical model in which I treat the local governments as monopolist land suppliers subject to the central government's auction and minimum price restrictions. The model predicts that the local governments are responsive to the comparative advantages. In addition, when the relationship between the transaction price and the minimum price changes, the local governments can be more or less responsive to their comparative advantages, depending on the revenue from land sale, the positive externalities from the firms, and the preference of the central government. I employ detailed parcel-, county-, and industry- level data to test the model predictions. My empirical findings suggest that a one percentage point increase in the employment share of an industry leads to a 1.3% – 1.6% increase in the land supplied to that industry *ceteris paribus*. Moreover, the local governments become more responsive to the comparative advantages when the transaction price is lower than the minimum price. These findings verify the implications of the theoretical model. Furthermore, the effects are heterogeneous among counties; the local governments of more developed counties are more responsive to the comparative advantages.

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1 Introduction

In the past two decades, China has experienced rapid industrialization, with its manufacturing sector becoming the largest in the world[1]. Land allocation is crucial to industrialization because land is essential to firm production and manufacturing firms are the primary purchasers of land. From 2005 to 2010, industrial use, which accounted for around 56% of land supply[2], dominated other types of land use. Land supply is solely determined by local governments, so they can achieve their political goals through the decision they make about land supply. Revenue from land sales constitutes a large proportion of the local government revenue under current tax-sharing system (Sun and Zhou, 2014), so the local governments tend to supply more land than desired to raise enough government revenue. Moreover, the local government officials are placed in the promotion tournament, where the central government picks officials for promotion based on the economic performance of their administrative units (Li and Zhou, 2005; Xu, 2011). The firms can create jobs, increase tax bases, and support economic growth, all of which bring positive externalities to local economies. Therefore, the local governments compete to attract firms through supplying more land and lowering transaction prices.

Before 2007, land was in oversupply due to these two forces. What is worse, the land parcels were sold through negotiations without taking into account market conditions. During negotiations, the local governments deliberately lowered transaction prices to ensure the land sold. As a result of the lowered prices, distortions and efficiency losses posed a threat

[1] According to National Bureau of Statistics of China, China has the largest manufacturing sector since 2010.

[2] Data comes from 2006 – 2011 Yearbooks of Land and Resources. Appendix Table A1 provides the area of land supplied to each category from 2005 to 2010.

to long-term economic growth. In an effort to curb wasteful land use, the central government initiated industrial land market reform in 2007. The reform is divided into two parts. Firstly, all industrial land parcels must be sold through public auctions, which is known as auction reform. Secondly, the unit transaction price of each parcel must be higher than the county-level minimum price unless permitted by the central government, which is known as minimum price reform.

This paper investigates the effect of industrial land market reform on the land supply decision of the local governments. Since counties have different production environments, the comparative advantages of counties lie in different industries. This paper seeks to understand how the local governments allocate the land to different industries and whether they care about the comparative advantages in the process.

I formulate a theoretical model where the local governments are treated as monopolist land suppliers. The local governments care about the revenue from land sales and the externalities generated by providing the land to firms, but they are subject to the auction and minimum price restrictions. The model predicts that the local governments are responsive to the comparative advantages under market conditions. In addition, when the relationship between the transaction price and the minimum price changes, the local governments may become more or less responsive to their comparative advantages. This reflects that the local governments value the externalities and that the preference of the central government affects the local governments' decision.

To test the model predictions, I construct a dataset from the official website of the Ministry of National Land and Resources of China (www.landchina.com). The dataset contains

detailed information of the land transactions from 2001 to 2019, including parcel area, proposed industry, address, buyer, contract date, and auction mode. It is important to note that the data before 2007 are less reliable because reporting transactions was voluntary at that time. I merge the data with county economic conditions[3] from 2007 to 2010. In addition, I employ the 2004 and 2008 Economic Census data to calculate the employment share of each industry in every county and merge it to the dataset. The employment share can be used as an indicator of comparative advantages, as a higher employment share could reflect a better production environment (for instance, knowledge spillovers) for the firms in the industry (Henderson, Kuncoro and Turner, 1995).

In the sample for empirical analysis, approximately 20% of the transaction prices are less than the minimum price. This suggests that the central government occasionally permits lower transaction prices. Meanwhile, around 40% of the transaction prices are equal to the minimum price, so the minimum price restriction is enforced effectively.

According to my empirical analysis, the local governments supply the land parcels based on their comparative advantages. In terms of magnitude, the area of land supplied to an industry increases by roughly 1.3% – 1.6% for every percentage point increase in employment share in that industry, *ceteris paribus*. Meanwhile, when the transaction price is lower than the minimum price, the local governments are twice as responsive to the comparative advantage as when the price is higher than the minimum price. Given that a lower transaction price requires permission from the central government, this indicates that the preference of the central government plays a role in the local governments' land supply decision. In

[3]The data comes from the *China Statistical Yearbook for Regional Economy* and the *China County Statistical Yearbook*. See Section 4.1 for details.

contrast, when the transaction price equals the minimum price, the local governments are not more responsive to the comparative advantages. Hence, even though the fixed price increases the marginal revenue from land sales, the absence of the marginal benefit from externalities prevents the local governments from supplying more land.

The effects are not homogeneous across counties. By using GDP per capita to evaluate the economic development of each county, I find that the local governments in more developed counties are more responsive to the comparative advantages. However, the relationship between transaction price and minimum price does not affect more developed and less developed counties differently. Due to the importance of the market in the local governments' decision about land supply, heterogeneous effects can be a result of variation in the development of industrial land market in different counties.

Additionally, I employ the China Industrial Enterprises Database (CIED) to conduct a robustness check. The results suggest that the firms are more likely to be created in the industry where the county has comparative advantages. Given that the firms need to purchase land from the local governments, the emergence of the firms also reflects that the local governments care about the comparative advantages.

My work relates to literature examining the structure of China's land market. There is a branch of literature that looks at the effect of auction structure on the market welfare in the residential land market under corruption. For instance, Cai, Henderson and Zhang (2013) build a theoretical model based on Goeree and Offerman (2003) and Daniel and Hirshleifer (1998) to characterize China's residential land market from 2003 to 2007. They find that two-stage auctions are prone to corruption compared to English auctions, because the first stage

could be used as a signal. This leads to a positive selection into two-stage auctions. Li (2019) studies the auctions in the same market from 2007 to 2017. She also finds that two-stage auctions are prone to corruption, but land parcels of low quality are selected to two-stage auctions because of the asymmetric information in common value of the land parcels. My study changes the focus to the industrial land market and derives the equilibrium price and quantity. Moreover, my work enriches the literature by describing the land supply decision of the local governments under the auction and minimum price restrictions.

In addition, the county-level minimum price restriction affects the decisions of the local governments and the firms, so it serves as a place-based industrial policy in China. A branch of literature interrogates the consequences and efficiencies of different place-based industrial policies, including taxation (Duranton, Gobillon and Overman, 2011), grants (Becker, Egger and von Ehrlich, 2018; Criscuolo et al., 2019), and industrial parks (Lu, Wang and Zhu, 2019; Busso, Gregory and Kline, 2013). Despite the importance of land in the growth of firms, literature on place-based land policies is rare. This paper fills the gap by investigating a unique industrial land policy package and understanding the local governments' subsequent decision-making.

Finally, my study relates to the literature that investigates the impact of land use regulations. Extensive literature has explored the regulations in residential land markets. Turner, Haughwout and Klaauw (2014) ask how land use regulation affects the value of land and the welfare implications. By building a theoretical model and estimating it with regression discontinuity, they find that regulation has a negative impact on both the value of land and the welfare. Other studies have explored various land use regulations such as building height

restrictions (Bertaud and Brueckner, 2005; Brueckner and Sridhar, 2012), floor-to-area ratio (Cai, Wang and Zhang, 2017), and minimum lot size (Glaeser and Ward, 2009). However, the industrial land market is largely under-studied, so my work fills the gap and contributes to the literature by exploring the industrial land market reform in China.

The remainder of the paper proceeds as follows: Section 2 provides the policy background of the industrial land market reform; Section 3 presents the theoretical model characterizing the land supply decision of the local governments; Section 4 discusses the construction of the data and the empirical strategy; Section 5 presents the empirical findings; and Section 6 concludes.

2 Policy Background

In China, the local governments play an important role in determining the development of industrial land, according to the Law of Land Management. The local governments are the sole suppliers of industrial land parcels. Under current tax-sharing system, land sales make up of a large proportion of local government revenue (Sun and Zhou, 2014). Additionally, the local government officials are placed in the promotion tournaments, where the central government evaluates the officials and determines future promotions based on local economic performance (Li and Zhou, 2005; Xu, 2011). Before 2007, the local governments had strong incentives to lower the price of land to attract firms. Not only did the firms contribute to the overall land sale revenue, they also brought positive externalities to the local economies, such as creating new jobs, increasing tax bases, and supporting economic growth. The exter-

nalities enhanced the economic performance of the counties, which increased the possibility of promotion for the officials. However, lowered land prices also enabled unproductive firms to purchase the parcels and begin production. Even though these firms boosted investments and contributed to the local tax revenues temporarily, the use of land was wasteful in the long run (Xu, Huang and Jiang, 2017; Wu et al., 2014). Moreover, serious side effects of land oversupply such as loss of arable lands and under-compensation of farmers hindered the economic development of the whole country.

The rapid development and underpricing of industrial land led to significant efficiency losses, which caught the attention of the government; as a result, the central government enacted two policies to regulate industrial land use, both of which became effective in 2007. Firstly, all the land parcels must be sold via public auctions, known as auction reform. The form of the auction could be an English auction, a two-stage auction, or a sealed bid[4]. Before any auction, the local governments must declare the industry for which the land parcel will be used. Secondly, the resulting unit transaction price of any parcel must be higher than the minimum price unless the central government permits an exception, known as minimum price reform. The minimum price was set by the central government at the county level based on the economic condition of each county in 2006, and all the land parcels in a county share the same minimum price. Each county is assigned a grade ranging from 1 to 15, where a lower number indicates better economic conditions and a higher minimum price. Table 1 presents the 15 grades and the corresponding minimum prices. Figure 1 shows the

[4]Among the three types of auctions, sealed bids are only used in Beijing and Shanghai, and the winner is not solely determined by her bid (Cai, Henderson and Zhang, 2013). This threatens the assumption that the minimum price restriction affects the decisions of the local governments. Therefore, I exclude sealed bids in the following analysis

distribution of the minimum prices across China. Counties with a grade less than 3 are all located in Beijing, Shanghai, Guangzhou, and Shenzhen, which are the most developed cities in China. In contrast, most grade-15 counties are in the western provinces of China, whose economic development lags behind the national average.

Table 1: Land grade and minimum price

Grade	Number of Counties	Min. Price (yuan per sq. m.)	Grade	Number of Counties	Min. Price (yuan per sq. m.)
1	9	840	9	120	204
2	9	720	10	179	168
3	10	600	11	202	144
4	95	480	12	331	120
5	63	384	13	451	96
6	105	336	14	526	72
7	120	288	15	522	60
8	121	252			

Notes: This table presents the number of counties and the corresponding minimum price for each grade. Data come from No. 307 [2006], Ministry of Land and Resources of China.

Under the permission of the central government, the unit transaction price can be lower than the minimum price; however, the local governments need to negotiate with the central government to obtain this permission[5], which incurs an adjustment cost. A large gap between the transaction price and the minimum price makes negotiations difficult because the central government aims to prevent undervalued land sales. However, when deciding whether to permit a land sale lower than the minimum price, the central government also evaluates county-industry specific characteristics, because the minimum price was set only based on county economic conditions, not industry-specific conditions. This gives some negotiation

[5]The central government sometimes allows lower transaction prices if: (1) the land parcel is to be used for priority industries with an intense use of land; (2) the land parcel is to be used for seven two-digit industries directly using raw materials; (3) the land parcel is converted from state-owned undeveloped land; (4) the land parcel is located in a western county. (Extracted from No. 56 [2009], Ministry of Land and Resources of China.)

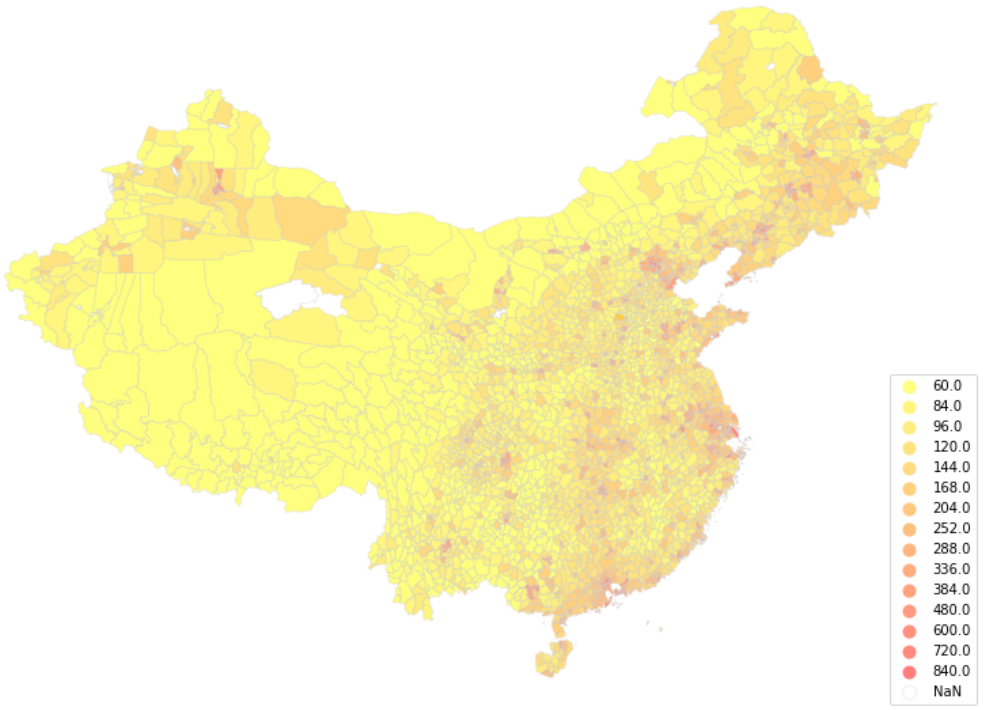


Figure 1: Minimum price of counties in China

Notes: This figure plots the counties with the corresponding minimum price in China.

power to the local governments.

Declaring the industry for which the land parcel will be used before the land is sold forces the local governments to consider the comparative advantages for certain industries. Additionally, the auction and minimum price restrictions incur an additional cost when lowering the transaction price. Therefore, the policies largely alleviate the wasteful use of land. Section 3 provides a theoretical model to depict the local governments' decision about land supply.

3 Theoretical Model

In this section, I present a simple theoretical model to characterize the local governments' land supply decision. I treat the local governments as monopolist land suppliers subject to the auction and minimum price restrictions. The model pins down the equilibrium price and quantity of land parcels and demonstrates how the central government's policies affect the equilibrium. More importantly, it describes the response of the local governments to their comparative advantages.

Consider the land supply decision of a county-level local government. It allocates land parcels across J industries, with n_j parcels allocated to industry j. For simplicity, suppose that the land parcels are identical, each of which incurs a marginal cost c to the local government. Suppose the parcels are sold simultaneously and each parcel is purchased by one firm.

Let t denote the general economic condition of the county and let t_j denote the industry j specific characteristics. t_j reflects the comparative advantages in industry j since a better production environment for an industry will attract more firms of that industry to that county. Define r_j as the local production potential for industry j. Then r_j is a function of t and t_j, and it increases in both t and t_j ($\partial r_j/\partial t > 0$, $\partial r_j/\partial t_j > 0$). Suppose there are N_j firms in industry j who would like to purchase the land parcels and do business, then N_j should increase with r_j as firms prefer a higher production potential when selecting a place for production. Suppose the firms in industry j are identical and let $V_j \in [\underline{v}, \bar{v}]$ be the private value of the firms towards the land parcels in industry j. Furthermore, let $F_j(\cdot)$ be the distribution of V_j, then the support of $F_j(\cdot)$ increases in r_j.

With n_j land parcels and N_j firms, the expected equilibrium price $\mathbb{E}(p_j)$ should correlate with n_j, N_j, and $F_j(V_j)$. An increase in n_j (an increase in supply) is associated with a decrease in $\mathbb{E}(p_j)$, while an increase in N_j or $F_j(V_j)$ (an increase in demand) is associated with an increase in $\mathbb{E}(p_j)$. Notice that both N_j and $F_j(V_j)$ are positively correlated with r_j, so I reduce $\mathbb{E}(p_j)$ to a function of n_j and r_j and it decreases in n_j and increases in r_j. To simplify the notation, I denote $p_j(n_j, r_j)$ as the expectation of transaction price, with $\partial p_j/\partial n_j < 0$ and $\partial p_j/\partial r_j > 0$. Inversely, $n_j = n_j(p_j, r_j)$ where $\partial n_j/\partial p_j < 0$ and $\partial n_j/\partial r_j > 0$. If a firm wins a land parcel, it pays the price to the local government and begins production in the county.

According to Section 2, the local government needs to obtain permission from the central government if the transaction price is lower than the minimum price, which incurs an adjustment cost for the local governments. Suppose the adjustment cost takes the form $\psi_0 + n_j\psi_j$, where ψ_0 is the fixed cost and ψ_j is the per parcel cost[6]. In the negotiation process, the central government cares about the following two factors. Firstly, it considers the difference between minimum price (denoted as MP) and transaction price. This is because the central government aims to avoid undervalued land sales. If the difference between the transaction price p_j and the minimum price (MP) is higher, the negotiation becomes more difficult for the local governments. Secondly, the central government considers county-industry specific characteristics t_j. This is because the minimum price is determined only by the county economic conditions t and the marginal cost c, but the central government considers county-industry specific characteristics in negotiations with local governments.

[6]In reality, the fixed cost can be viewed as the cost involved in the application process (including preparing related documents and sending the documents to the central government), while the per parcel cost can be viewed as the cost involved in the negotiation for each land parcel.

With a higher t_j, the negotiation becomes easier for local governments. Therefore, the per parcel cost ψ_j should be affected by the above two factors. I denote $\psi_j = \psi_j(MP - p_j, t_j)$, with $\partial\psi_j/\partial(MP - p_j) > 0$ and $\partial\psi_j/\partial t_j < 0$.

According to Sun and Zhou (2014), local government revenue comes primarily from land sales, so the local government cares about the land sale revenue. Additionally, firms introduce positive externalities to the local economy that enhance local economic performance. For instance, the firms could create jobs, increase tax bases, and support economic growth. Hence, the local government accounts for those externalities under promotion tournaments (Li and Zhou, 2005; Xu, 2011). The externalities from the firms depend on both county economic conditions and industry-specific characteristics. Better economic conditions and industry specific characteristics, for example, can strengthen the linkages between different firms, which benefit economic development. Explicitly, let $e_j(t, t_j)$ denote the externalities from each new firm in industry j, with $\partial e_j/\partial t > 0$ and $\partial e_j/\partial t_j > 0$. Then the local government solves the following problem:

$$\max_{p_1,\ldots,p_J} \sum_{j=1}^{J} n_j p_j - n_j c - \mathbf{1}(MP > p_j)(\psi_0 + n_j\psi_j) + n_j e_j$$

where $n_j p_j - n_j c - \mathbf{1}(MP > p_j)(\psi_0 + n_j\psi_j)$ is the revenue from land transactions and $n_j e_j$ is the externalities. The first order conditions for p_j are given by

$$\begin{cases} \dfrac{\partial n_j}{\partial p_j}(p_j - c + e_j) + n_j = 0 & MP > p_j \\ \dfrac{\partial n_j}{\partial p_j}(p_j - c + e_j) + n_j - \dfrac{\partial n_j}{\partial p_j}\psi_j + \dfrac{\partial \psi_j}{\partial(MP - p_j)}n_j = 0 & MP < p_j \end{cases}$$

To make it more tractable, suppose p_j takes a linear form $p_j(n_j, r_j) = \frac{\alpha r_j - n_j}{\beta}$, and suppose ψ_j can be separated as $\psi_j(MP - p_j, t_j) = MP - p_j - \phi_j(t_j)$ with $\phi_j'(t_j) > 0$. Under these function forms, the equilibrium price is given by

$$p_j^* = \begin{cases} p_{1j} = \dfrac{\alpha r_j}{2\beta} + \dfrac{c}{2} - \dfrac{e_j}{2} & p_{1j} > MP \\ MP & p_{0j} \le MP \le p_{1j} \\ p_{0j} = \dfrac{\alpha r_j}{2\beta} + \dfrac{c + MP}{4} - \dfrac{\phi_j + e_j}{4} & p_{0j} < MP \end{cases}$$

Therefore, the equilibrium quantity is given by

$$n_j^* = \begin{cases} \dfrac{\alpha r_j}{2} - \dfrac{\beta c}{2} + \dfrac{\beta e_j}{2} & p_{1j} > MP \\ \alpha r_j - \beta MP & p_{0j} \le MP \le p_{1j} \\ \dfrac{\alpha r_j}{2} - \dfrac{\beta(c + MP)}{4} + \dfrac{\beta(e_j + \phi_j)}{4} & p_{0j} < MP \end{cases}$$

The model states that $\partial n_j^* / \partial t_j > 0$, so the local government tends to supply more land parcels to the industry in which the county has comparative advantages. In addition,

$$\frac{\partial n_j^*}{\partial t_j} = \begin{cases} \dfrac{\alpha}{2}\dfrac{\partial r_j}{\partial t_j} + \dfrac{\beta}{2}\dfrac{\partial e_j}{\partial t_j} & p_{1j} > MP \\ \alpha \dfrac{\partial r_j}{\partial t_j} & p_{0j} < MP < p_{1j} \\ \dfrac{\alpha}{2}\dfrac{\partial r_j}{\partial t_j} + \dfrac{\beta}{4}\left(\dfrac{\partial e_j}{\partial t_j} + \phi_j'\right) & p_{0j} < MP \end{cases} \tag{1}$$

Formula (1) suggests that the response of the local government to its comparative advantages varies as the relationship between transaction price and minimum price changes. As opposed to the case where the transaction price is higher than the minimum price, the local govern-

ment is more sensitive to the industry-specific characteristics when the minimum price is binding, but it also ignores the externalities. This is because the price is fixed, so it does not contain any information about supply or demand. Hence, the marginal revenue from supplying more land parcels becomes higher if the comparative advantages are stronger, while the marginal benefit from the externalities disappears. Moreover, when the transaction price is lower than the minimum price, the local government incorporates the preference of the central government, so the local government is less responsive to externalities as compared to situations where the price is higher.

The above theoretical framework suggests that the local government takes into account supply and demand in their land supply decision. Therefore, industrial land market reform forces the local governments to consider market conditions. In the following sections, I will test the model implications via empirical analysis.

4 Data and Empirical Strategy

4.1 Data

The data for the empirical analysis are compiled from multiple sources. In this section, I will provide the data sources and describe the manipulations I made to the raw data.

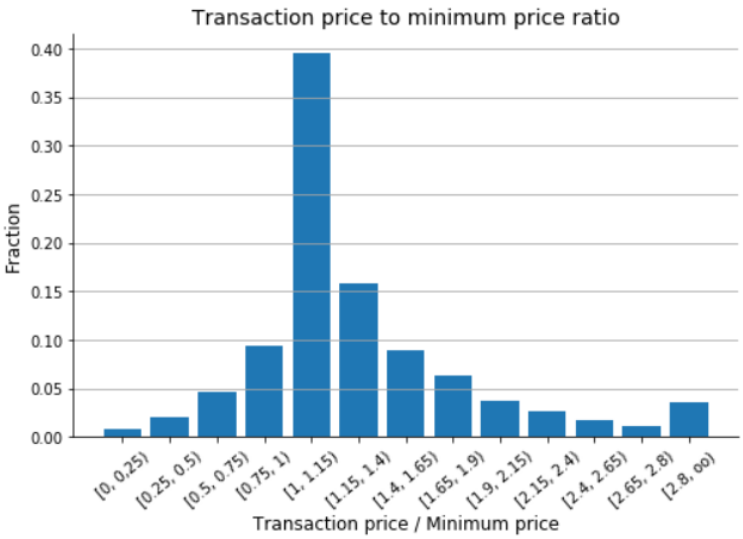
Land transaction data: The data for land transactions are taken from the official website of the Ministry of National Land and Resources of China (www.landchina.com). It contains the transactions of land parcels since 2000, but the data before 2007 are less comprehensive because it was voluntary to report the transactions at that time. For each transaction, the

website provides transaction price, contract date, size, address, proposed industry, auction mode, and buyers. Unfortunately, the data are sometimes reported incorrectly. In order to alleviate errors, I follow Li (2019) and delete land parcels that are larger than 100 hectares or smaller than 0.1 hectares. In addition, I calculate the unit transaction price (yuan per square meter) and then the ratio of the unit transaction price to the county-level minimum price. Although it is common for land parcels to be sold at higher or lower unit prices in practice, the above price ratio should lie in a reasonable range. As a result, I keep transactions that have a price ratio above 1% quantile and below 99% quantile. This leaves me with 44,693 parcels sold from 2007 to 2010 in the manufacturing or utility industry.

Based on the theoretical model, the local governments react differently to their comparative advantages when the relationship between transaction price and minimum price changes. Consequently, I examine the empirical relationship by plotting the price ratio from 2007 to 2010 at transaction level in Figure 2. To accommodate the small discrepancies in the data, I treat the transaction price as equal to the minimum price if the price ratio is greater than 1 but less than 1.15. According to Figure 2, the price ratio of around 20% transactions is less than 1, so the central government does permit exceptions occasionally. Moreover, nearly 40% transactions have a price ratio of 1 to 1.15, demonstrating the effectiveness of the minimum price policy. Furthermore, there are around 40% transactions with a price ratio that is greater than 1.15. Overall, Figure 2 indicates the validity of the implicit assumptions made in the theoretical model.

Next, I identify the industry of the land parcels by the two-digit industry code and aggregate the land transactions to county by industry by year level. For a given year, I

Figure 2: Relationship between transaction price and minimum price



Notes: This figure plots the distribution of the ratio of unit transaction price to minimum price from 2007 to 2013. The x-axis presents eight intervals of the ratio, while the y-axis shows the fraction of transactions that fall in each interval.

calculate the total area of land supplied to each industry in every county and the average transaction price for each industry in every county. Linked with the theoretical model, the former is used as a measure of quantity, while the latter is used as a measure of price.

County economic conditions: The county economic condition data come from two sources, the *China Statistical Yearbook for Regional Economy* and the *China County Statistical Yearbook*. From the *China Statistical Yearbook for Regional Economy*, I extract GDP per capita and the sectoral decomposition of GDP in primary, secondary, and tertiary industries. From the *China County Statistical Yearbook*, I extract rural and urban population, government revenues and expenditures, residential savings and debts, as well as grain yields. All monetary variables are deflated into the 2007 CNY. Since the GDP data are not available after the year 2010, the time span of the county-level economic data is restricted to 2007 – 2010. I use GDP per capita, the sectoral decomposition of GDP, rural and urban popula-

tion, government revenues and expenditures, and residential savings and debts to measure the county-level economic conditions, while I use grain yields to measure the marginal cost of land supply. I take the logarithm of all control variables, except for the sectoral decomposition of GDP, which I directly include the share of primary and secondary industries in the regressions.

Nevertheless, the county-level economic condition data are imperfect in two ways. Firstly, the local economic condition is reflected by a set of available variables; however, this does not represent the full set of socioeconomic factors that could affect the decision of local governments and firms. As a way to counteract this drawback, I include county and industry fixed effects in the regressions. Secondly, the county-level data from the two yearbooks do not include all of the county-level administrative units. Instead, they include all counties and county cities, but omit most urban districts, which could lead to an unintended selection. Two explanations could justify the selection: (1) urban districts are systematically different from the counties and county cities (Jia, Guo and Zhang, 2014; Zhang, 2006); (2) most transactions take place in counties and county cities. Due to the data limitation, endogeneity issues might arise, so one should exercise caution when interpreting the following empirical results.

County-industry specific characteristics: The county-industry level data come from the 2004 and 2008 China Economic Census, each of which contains a representative sample of Chinese firms. For each firm, the censuses provide the address, major industry, balance sheet, and employment data. I identify the industry of the firms by the two-digit code and aggregate the data from firm level to county-industry level. Then I calculate the employment

share of each industry in every county. It serves as the county-industry level feature in the empirical analysis, since employment share in an industry reflects the attractiveness of that industry in the county.

Summary statistics: Table 2 provides the summary statistics of the variables used in the empirical analysis at county level.

Table 2: Summary Statistics

	Mean	S.D.	p25	Median	p75	N
Parcel area (hectare)	8.02	15.26	1.34	3.33	8.32	15,437
Unit transaction price (yuan/sq.m.)	149.90	86.87	96.00	125.81	180.31	15,437
Minimum price (yuan/sq.m.)	115.09	42.20	84.00	96.00	144.00	15,437
Employment share	0.05	0.10	0.00	0.02	0.06	15,437
GDP per capita (yuan)	27139.53	21720.27	13213.47	20423.83	34044.51	15,437
GDP share of primary industry	0.19	0.11	0.10	0.18	0.26	15,437
GDP share of secondary industry	0.49	0.13	0.41	0.50	0.58	15,437
Total population (million people)	0.64	1.36	0.37	0.57	0.82	15,437
Rural population (million people)	0.52	0.56	0.30	0.46	0.69	15,437
Gov't revenue (million yuan)	888.22	1,397.56	224.06	430.78	1,024.91	15,437
Gov't expenditure (million yuan)	1,631.49	1,296.63	891.26	1,311.48	1,970.09	15,437
Residential saving (million yuan)	8,935.67	10596.45	3,403.04	5,725.31	10046.95	15,437
Residential debt (million yuan)	9,745.83	17101.12	2,215.85	4,143.01	9,257.58	15,437
Grain yield (thousand ton)	350.43	323.66	134.87	254.04	477.85	15,437

Notes: This table presents the summary statistics of the variables used in the empirical analysis at county level.

4.2 Empirical Strategy

Inspired by the model in Section 3, the main specification is given by

$$\begin{aligned}\log(\text{area}_{ijt}) = \beta_1 \text{Employ}_{ijt} + \beta_2 \text{Employ}_{ijt} \times \mathbf{1}_{ijt}(\text{Price} = \text{Min. Price}) \\ + \beta_3 \text{Employ}_{ijt} \times \mathbf{1}_{ijt}(\text{Price} < \text{Min. Price}) + X_{it}\gamma + \alpha_i + \mu_j + \lambda_t + \varepsilon_{ijt}\end{aligned} \tag{2}$$

$\log(\text{area}_{ijt})$ is the log of total land sale area in county i industry j during year t. It reflects the land supply decision of the local governments. Employ_{ijt} is the employment share of industry j in county i during year t, which is a measure of county-industry specific characteristics and represents the comparative advantages. $\mathbf{1}_{ijt}(\text{Price} = \text{Min. Price})$ and $\mathbf{1}_{ijt}(\text{Price} < \text{Min. Price})$ are two indicators which equal one when the average transaction price of land parcels in county i industry j during year t is equal to or lower than the minimum price in county i. I define $\mathbf{1}_{ijt}(\text{Price} = \text{Min. Price}) = 1$ when the ratio of average unit transaction price to the minimum price is greater than 1 but less than 1.15, and define $\mathbf{1}_{ijt}(\text{Price} < \text{Min. Price}) = 1$ when the ratio is less than 1. X_{it} is a set of county-level controls, including the log of GDP per capita, the sectoral decomposition of GDP in primary, secondary, and tertiary industries, the log of population and rural population, the log of government revenues and expenditures, the log of residential savings and debts, and the log of grain yields. α_i, μ_j, and λ_t are county, industry, and year fixed effects. In empirical analysis, the interactions between employment share and the indicators are sometimes excluded from the regression to examine the general response of the local governments to the comparative advantages of their land for certain industries.

5 Empirical Results

5.1 Main Results

Table 3 presents the regression result from Equation (2). The dependent variable is the log of the total land area supplied to an industry in a county for a specific year. In all regressions,

the county economic condition controls and the year fixed effect are included. Column (1) and (2) exclude the interactions with the indicator variables, while Column (3) and (4) include the interactions. Column (1) and (3) exclude the county and industry fixed effects, while Column (2) and (4) include the fixed effects. The standard errors are twoway clustered at the county by industry level. Column (1) and (2) indicate that the local governments are responsive to the comparative advantages, as the coefficients of employment share are all significantly positive. Holding all other variables constant, a one percentage point increase in the employment share of an industry corresponds to a 1.3 – 1.6% increase in the area of land supplied to the industry in a county. Column (3) and (4) suggest that the local governments react differently when the relationship between the transaction price and minimum price changes. The coefficients of the employment share are significantly positive, so the local governments are responsive to the comparative advantages when the transaction price is higher than the minimum price. Meanwhile, the coefficients of the interaction between employment share and the indicator of transaction price lower than the minimum price are significantly positive, so the local governments become more sensitive to the comparative advantages when the transaction price is lower than the minimum price. Numerically, they are about twice as responsive to the comparative advantages as when the transaction price is lower. Nevertheless, the coefficients of the interaction between employment share and the indicator of the price equal to the minimum price are positive but only marginally significant, so the local governments do not react in a significantly different way when the transaction price equals the minimum price than when the transaction price is higher.

The above results echo the theoretical model in Section 3 in several ways. Firstly, the

Table 3: Land sale area and employment share

	(1)	(2)	(3)	(4)
Employment Share	1.310***	1.608***	1.007***	1.430***
	(0.279)	(0.221)	(0.317)	(0.274)
Employment Share * **1**(Price = Min. Price)			0.402*	0.0465
			(0.226)	(0.232)
Employment Share * **1**(Price < Min. Price)			1.299***	1.290***
			(0.348)	(0.376)
County Economic Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	No	Yes	No	Yes
Industry Fixed Effect	No	Yes	No	Yes
Observations	15437	15228	15437	15228

Notes: This table presents the regression results from Equation (2). The dependent variable is the log of total land area supplied to an industry in a county for a specific year. In all regressions, the county economic condition controls and the year fixed effect are included. Column (1) and (2) do not include the interaction of two indicators with employment share. Column (3) and (4) include the interactions. Column (1) and (3) do not include any fixed effects. Column (2) and (4) include the county and industry fixed effects. Standard errors twoway clustered at the county by industry level are in the parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

empirical analysis shows that local governments care about the comparative advantages of their land for particular industries. They are willing to supply more land to industries with a higher employment share. Secondly, the preference of the central government has a significant impact on the land supply decision of the local governments, since the local governments become more responsive to their comparative advantages when the transaction price is lower than the minimum price. In addition, the response of the local governments matches the interest of the central government, so the central government is willing to permit downward adjustments under certain circumstances. In addition, the local governments value the externalities from the firms, so the increased marginal revenue when prices are fixed does not translate into more land supply to the corresponding industries. Therefore, the local governments are not more responsive to their comparative advantages when the

minimum price is binding. In summary, under market conditions, the local governments take into account the comparative advantages after the industrial land market reform, which coincides with the central government's intentions.

5.2 Heterogeneous Effects

Section 3 suggests that the market is an important factor for industrial land market reform. Nevertheless, the development of the land market can differ among counties, which affects the responsiveness of local governments. Since the development of the land market is correlated with the economic conditions of the counties, I use GDP per capita to evaluate counties' economic development and investigate the heterogeneous effects. The cutoff is chosen as the 1/3 quantile of GDP per capita at the county level each year (15,300 yuan in 2007, 18,756 yuan in 2008, 20,640 yuan in 2009, 24,900 yuan in 2010). The counties with higher GDP per capita are mainly from the eastern provinces such as Hebei, Zhejiang, Jiangsu, Fujian, Shandong, and Guangdong. Additionally, counties in the provincial capitals of the western provinces also have higher GDP per capita, such as counties in Yinchuan (capital of Ningxia Province), Urumqi (capital of Xinjiang Province), and Chengdu (capital of Sichuan Province). Therefore, the 1/3 quantile cutoff coincides reasonably with the regional economic development of China.

Next, I perform the regression in Equation (2) separately for more developed and less developed counties. To begin with, I exclude the interactions in Equation (2) to explore the heterogeneous responses to the comparative advantages of the local governments. Table 4 summarizes the results. The dependent variable is the log of total land area supplied

to an industry in a county for a specific year. In all regressions, the county economic condition controls and the year fixed effect are included. Column (1) and (2) exclude the county and industry fixed effects. Column (3) and (4) include the fixed effects. Column (1) and (3) present the results for more developed counties. Column (2) and (4) present the results for less developed counties. The difference of the coefficients from two subsamples are presented following the regression result. Standard errors are twoway clustered at the county by industry level. The coefficients of employment share are always significantly positive, so the local governments of both more and less developed counties are responsive to the comparative advantages. In addition, the local governments of more developed counties respond almost twice as strongly to the comparative advantages as those of less developed counties, and the difference is also statistically significant. Hence, the market plays a more crucial role in more developed counties, which shapes the land supply decision of the local governments accordingly.

As a follow-up to Table 4, I include the interactions with the indicators of the relationship between the transaction price and the minimum price in the regressions to examine the heterogeneous effects of the relationship between the transaction price and the minimum price. Table 5 summarizes the results. It mimics the specifications in Table 4 and further includes the interactions with the indicators. The results continue to show that the local governments of more developed counties are more responsive to their comparative advantages, since the difference of the coefficient for employment share between more developed and less developed counties is positive. Nevertheless, none of the differences in the coefficients for the interactions between the more developed and less developed counties are significant.

Table 4: Heterogeneous effects among counties: No interactions

	(1) More developed	(2) Less developed	(3) More developed	(4) Less developed
Employment Share	1.745***	0.982***	2.235***	1.182***
	(0.403)	(0.260)	(0.389)	(0.269)
More developed - Less developed:				
Employment Share	0.763**		1.053**	
	(0.320)		(0.462)	
County Economic Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	No	No	Yes	Yes
Industry Fixed Effect	No	No	Yes	Yes
Observations	6945	8492	6903	8302

Notes: This table presents the regression results from Equation (2) separately for more developed and less developed counties. The dependent variable is the log of total land area supplied to an industry in a county for a specific year. In all regressions, the interactions with the indicators are excluded, while the county economic condition controls and the year fixed effect are included. Column (1) and (2) do not include the county and industry fixed effects. Column (3) and (4) include the fixed effects. Column (1) and (3) use more developed counties subsample. Column (2) and (4) use less developed counties subsample. The difference of the coefficients from two subsamples are presented following the regression results. Standard errors twoway clustered at the county by industry level are in the parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Therefore, the local governments of more developed counties are no more sensitive to the comparative advantages than those of less developed counties when the transaction price equals or falls below the minimum price, compared to when the transaction price is higher than the minimum price. This suggests that the relationship between the transaction price and the minimum price does not affect the local governments' responsiveness to the comparative advantages differently in more or less developed counties. Moreover, with all the fixed effects included, the coefficient of the interaction between the employment share and the indicator of transaction price lower than minimum price becomes insignificant for more developed counties. Recalling the Formula (1) from the theoretical model, the result suggests that the externalities associated with land supply in more developed counties are highly beneficial to the local governments, which offsets the reduction in the adjustment costs when the transaction price is lower.

In conclusion, the above analysis verifies that the local governments in more and less developed counties are not equally responsive to the comparative advantages of the land for certain industries. The local governments in more developed counties care more about the comparative advantages under market conditions. In contrast, the relationship between the transaction price and the minimum price does not seem to play a heterogeneous role in the local governments' land supply decision.

5.3 Robustness Check

In the previous sections, I showed that the local governments are responsive to county-industry level characteristics using land area as the dependent variable. Alternatively, the

Table 5: Heterogeneous effects among counties: With interactions

	(1) More developed	(2) Less developed	(3) More developed	(4) Less developed
Employment Share	1.397***	0.625	1.945***	0.937**
	(0.356)	(0.384)	(0.377)	(0.361)
Employment Share	0.418	0.423	0.273	0.175
* **1**(Price = Min. Price)	(0.448)	(0.375)	(0.444)	(0.350)
Employment Share	1.342**	1.364**	1.308	1.421**
* **1**(Price < Min. Price)	(0.535)	(0.544)	(0.879)	(0.599)
More developed - Less developed:				
Employment Share	0.772***		1.009*	
	(0.365)		(0.547)	
Employment Share	-0.00558		0.0982	
* **1**(Price = Min. Price)	(0.568)		(0.595)	
Employment Share	-0.0221		-0.113	
* **1**(Price < Min. Price)	(0.740)		(1.228)	
County Economic Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	No	No	Yes	Yes
Industry Fixed Effect	No	No	Yes	Yes
Observations	6945	8492	6903	8302

Notes: This table presents the regression results from Equation (2) separately for more developed and less developed counties. The dependent variable is the log of total land area supplied to an industry in a county for a specific year. In all regressions, the interactions with the indicators, the county economic condition controls, and the year fixed effect are included. Column (1) and (2) do not include the county and industry fixed effects. Column (3) and (4) include the fixed effects. Column (1) and (3) use more developed counties subsample. Column (2) and (4) use less developed counties subsample. The difference of the coefficients from two subsamples are presented following the regression results. Standard errors twoway clustered at the county by industry level are in the parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

emergence of firms in each county may help explain the local governments' land supply decision, since the firms need to purchase land from the local governments to begin production. In this section, I present evidence from the development of new firms as a robustness check.

The data of the newly-formed firms come from Chinese Industrial Enterprises Database (CIED), which is constructed by National Bureau of Statistics of China. It contains all state-owned manufacturing and utility firms and all private-owned manufacturing and utility firms with a revenue over 5 million yuan. For each firm, the database provides the firm ID, name, address, founding year, major industry, phone number, balance sheet, and employment data from 1995 to 2013. This allows me to identify the formation of new firms in each industry in each county. Keeping in mind the caveats in Nie, Jiang and Yang (2012), I aggregate the CIED data to county-industry level and generate a binary variable newfirm_{ijt} which equals one if there is at least one new firm in industry j in county i for year t.

To accommodate the CIED data, I employ a regression specification that is similar to Equation (2) but change the dependent variable to the binary variable newfirm_{ijt}. As the dependent variable becomes a binary variable, I perform both linear probability regressions and logit regressions. For the sake of brevity, I present the results from the linear probability model in Table 6 and post the results from the logit model in Appendix Table A2. In all regressions, the county economic condition controls and year fixed effect are included. Column (1) and (2) do not include the interactions of two indicators with employment share. Column (3) and (4) include the interactions. Column (1) and (3) exclude the county and industry fixed effects. Column (2) and (4) include the county and industry fixed effects. Standard errors are twoway clustered at the county by industry level. The coefficients of employment

share are significantly positive, suggesting that new firms are more likely to be developed in industries where the employment share is higher. As the firms must purchase land from the local governments, the development of the firms demonstrate that the local governments value the comparative advantages. In addition, the coefficients of the interaction between employment share and the indicator of transaction price lower than minimum price are significantly positive, indicating that newly-formed firms in counties where the transaction price is lower than the minimum price are more likely to engage in industries where the county has a higher employment share. In other words, the preference of the central government is reflected in the newly-developed firms as the local governments become more interested in the comparative advantages.

Table 6: Robustness check: CIED data

	(1)	(2)	(3)	(4)
Employment Share	1.757***	1.591***	1.619***	1.512***
	(0.202)	(0.136)	(0.189)	(0.143)
Employment Share * **1**(Price = Min. Price)			0.191**	0.106
			(0.0897)	(0.0771)
Employment Share * **1**(Price < Min. Price)			0.407***	0.239*
			(0.132)	(0.123)
County Economic Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	No	Yes	No	Yes
Industry Fixed Effect	No	Yes	No	Yes
Observations	15078	14877	15078	14877

Notes: This table presents the regression results from Equation (2) but changes the dependent variable as the binary variable which equals one if there is at least one new firm in an industry in a county for a specific year and zero otherwise. Linear probability models are fitted. In all regressions, the county economic condition controls and the year fixed effect are included. Column (1) and (2) do not include the interactions of two indicators with employment share. Column (3) and (4) include the interactions. Column (1) and (3) do not include any fixed effects. Column (2) and (4) include the county and industry fixed effects. Standard errors twoway clustered at the county by industry level are in the parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6 Conclusion

This study investigates whether the local governments care about their comparative advantages of the land for particular industries in the land supply decision after the industrial land market reform in China.

I begin with modeling the local governments as monopolist land suppliers who care about the revenue and externalities from the land sales, subject to the central government's auction and minimum price restrictions. The theoretical model predicts that the local governments value the comparative advantages under market conditions. Additionally, the relationship between the transaction price and the minimum price affects the local governments' responsiveness to the comparative advantages.

The empirical analysis verifies the model prediction. In terms of magnitude, a one percentage point increase in employment share of an industry in a county leads to a 1.3% – 1.6% increase in the area of land supplied to that industry in the county *ceteris paribus*. Moreover, when the transaction price is lower than the minimum price, the local governments are twice as responsive to the comparative advantages as when the transaction price is higher than the minimum price. Therefore, the preference of the central government shapes the decision of the local governments effectively. Furthermore, the effects are heterogeneous among more developed and less developed counties. The local governments of the more developed counties are twice as more responsive to the comparative advantages comparatively. This suggests that the development of the market might be a crucial factor shaping the land supply decision of the local governments.

The results of the paper suggest that the industrial land market reform has boosted the development of the industrial land market in China, which encourages the local governments to take into account market factors when making land supply decisions. However, this study does not discuss the welfare implications of the reform, which opens an avenue for future research.

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A Appendix

Table A1: Land allocation by type of land use

Year	Area of land supply (hectare)		
	Commercial land	Industrial land	Residential land
2005	23268	90512	43675
2006	25394	144452	55016
2007	26975	135629	66575
2008	21802	86414	51507
2009	27571	141487	81548
2010	38905	153978	115273

Notes: This table summarizes the area of land supplied to different categories from 2005 to 2010.

Table A2: Robustness check: CIED data and Logit regression

	(1)	(2)	(3)	(4)
Employment Share	15.86***	16.17***	15.37***	16.82***
	(0.765)	(1.016)	(1.149)	(1.554)
Employment Share * **1**(Price = Min. Price)			0.961	-0.665
			(1.271)	(1.603)
Employment Share * **1**(Price < Min. Price)			0.170	-1.704
			(1.505)	(1.792)
County Economic Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	No	Yes	No	Yes
Industry Fixed Effect	No	Yes	No	Yes
Observations	15078	13889	15078	13889

Notes: This table presents the regression results from Equation (2) but changes the dependent variable as the binary variable which equals one if there is at least one new firm in an industry in a county for a specific year and zero otherwise. Logit models are fitted. In all regressions, the county-level economic condition controls and the year fixed effect are included. Column (1) and (2) do not include the interactions of two indicators with employment share. Column (3) and (4) include the interactions. Column (1) and (3) do not include any fixed effects. Column (2) and (4) include the county and industry fixed effects. Standard errors twoway clustered at the county by industry level are in the parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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