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Move to innovation: place-based industrial relocation policy and firm innovation in China

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Abstract

Purpose – This study investigates whether and how place-based industrial relocation policy affects firm innovation.

Design/methodology/approach – By exploiting the establishment of China's National Industrial Relocation Demonstration Zones (NIRDZs) as a quasi-natural experiment in a difference-in-differences design, the authors examine the externalities of industrial policies that support sustainable development and growth from the perspectives of firms' patenting activities.

Findings – The study consistently finds that the NIRDZs policy significantly boosts local firm innovation, translating into a 60.46% increase in the patent applications of treated firms. The estimation results remain robust to a series of alternative specifications. Moreover, heterogeneity analysis suggests that the firms that benefited most were state-owned enterprises, firms with higher productivity, or firms in non-high-tech industries. Further, the authors find that the NIRDZs policy stimulates firm innovation mainly in the form of utility model patents, followed by designs and invention patents.

Research limitations/implications – The results provide suggestions and implications for policymakers to improve the efficiency of state-led industrial policies and avoid "government failure" in policy implementation.

Social implications – This study provides suggestions and implications for policymakers to improve the efficiency of state-led industrial policies and avoid "government failure" in the policy implementation.

Originality/value – This study fills the research gap by exploiting quasi-experiments to assess the effectiveness of state-led industrial policies for emerging economies. (2) The analysis sheds empirical light on how corporate innovation is motivated and financed by selective and functional industrial policies. (3) Theoretically, the results rationalize why state-led industrial relocation fuel innovation capabilities of localities from Marshall externalities and competition crowding-out effects.

Keywords China, Innovation, Place-based industrial relocation policy

Paper type Research paper

1. Introduction

Place-based policies have been widely implemented in many countries to reduce the remarkable regional disparities in economic development. Specifically, governments allocate public resources to underdeveloped regions to improve local economic activities, primarily through subsidies, tax exemptions, development of infrastructure and special beneficial rules. Despite the potentially significant policy implications, the empirical evidence on the effectiveness and welfare analysis of place-based policies at the micro level remains inconclusive, especially in developing countries with imperfectly competitive market structures (Koster *et al.*, 2019).

This paper exploits the establishment of National Industrial Relocation Demonstration Zones (NIRDZs) in China as a quasi-natural experiment to examine the effectiveness of state-

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led industrial relocation policies from the perspective of firm innovation. NIRDZs policy is a prominent place-based industrial relocation policy that aims to optimize the geographic layout of industries and fuel regional economic development through local spillovers (Okubo and Tomiura, 2012). NIRDZs were primarily established in the mid-west to accommodate industries, especially labor- and resource-intensive manufacturing, transferred from coastal areas with a reduced advantage since 2010.

Unlike the traditional place-based policies, state-led industry relocation also involves knowledge transfers, brain gains and inter-regional investments in destinations. There is a consensus that labor mobility and the movement of factors of production are crucial for developing local innovation. Given the additional benefits beyond government subsidies and preferential policies, NIRDZs provide an ideal opportunity to evaluate whether state-led industrial relocation policy stimulates innovation activities in disadvantaged regions through local spillovers. Besides, there are substantial temporal and cross-sectional variations in innovation capacity in China, with the total number of patent applications increasing from 293,066 in 2010 to 1,344,817 in 2020 [1]. Thus, understanding whether and how such policies affect is crucial because innovation is the key driving force for long-term growth.

A primary empirical concern is that simple ordinary least squares (OLS) approach that regresses firm innovation output on the city's NIRDZs treatment status and a set of control variables could produce biased estimates. First, targeted regions are underdeveloped and geographically disadvantaged relative to regions in control groups. OLS method might capture the inherent inter-regional differences in innovation capacities rather than the policy-induced differences. Second, there are time-varying unobservable confounders that simultaneously affect the establishment of NIRDZs and innovation output, leading to estimation bias arising from the omitted variable problem.

We address this concern by exploiting the difference-in-differences (DID) approach to compare innovation changes of firms [2] in cities with NIRDZs to their counterparts in other areas before and after the policy implementation. The DID framework has three advantages. First, it absorbs stable unobservable differences between treatment (i.e., cities with NIRDZs) and control cities. This requires the critical assumption that cities in treatment and control cities follow parallel trends. Second, it also disentangles the effects of NIRDZs from other confounding factors that correlate with both establishments of NIRDZs and firm innovation. Third, we also control for the time-invariant unobservable characteristics at the firm level and common shocks for all firm innovations.

We present several main findings. First, the NIRDZs policy significantly boosts local enterprise innovation, translating into a 60.46% increase in the patent applications of treated firms. These positive effects are economically significant and produce unexpected stimulative impacts on innovation output since NIRDZs do not directly target technological growth. Second, the surge in innovation activities has a long-lasting effect following the establishment of NIRZDs, as demonstrated by the dynamic DID analysis. Third, heterogeneity analysis shows that state-owned enterprises, *ex ante* highly productive firms, or firms in non-high-tech industries benefit more from NIRZDs policy. Four, the stimulus effect is more pronounced for utility model patents, followed by design and invention patents. Our findings remain robust to various validity checks and placebo tests on DID estimates, including checking parallel trend assumptions, anticipation effects, placebo tests, alternative measurement on dependent variables and different estimation approaches.

We contribute primarily to three strands of literature. Firstly, we contribute to a growing literature that exploits quasi-experiments to assess the effectiveness of place-based policies for both developed and emerging economies. While some studies prove the effectiveness in spurring productivity growth, employment and investments [3] (Brachert *et al.*, 2019; Busso *et al.*, 2013; Chaurey, 2017; Criscuolo *et al.*, 2019; Jia *et al.*, 2020; Lu *et al.*, 2019), some cast doubt on the efficiency (Glaeser *et al.*, 2010; Hanson and Rohlin, 2013). They argue that firms have incentives to arbitrage away the preferential benefits in target regions, ending up with little impact on local development. Besides, little is known about the effects of place-based policy on firm innovation, which serves as the primary impetus for regional economic growth (Hausman, 2022).

Our study provides empirical evidence on the effectiveness of place-based industrial policies, with a particular focus on firm-level innovation activities. In contrast with developed countries, we find supporting evidence that place-based policies in China have a beneficial impact on China's economic growth, as in Tian and Xu (2022). One possible explanation is that agglomeration economies could play an essential role in attracting investment, even with the presence of rent-seeking and corruption (Combes and Gobillon, 2015). Furthermore, we exploit the variations across firms and patent types to shed light on the potential mechanisms through which place-based policies affect firm innovation.

Second, we contribute to the literature on industrial policies by exploring the role of China's governments in stimulating long-term growth engine—firm innovation, which is relatively scarce in existing research. Industrial policies are designed to remedy the market failure and institutional deficiencies (Bertamino *et al.*, 2017), but simultaneously involve an increased risk of "government failure." From the perspective of innovation, government interventions are justified by two kinds of market failures: (1) positive externalities relating to technological advances; and (2) capital market imperfections and significant uncertainties relating to research and development (R&D). The former leads to a lower equilibrium level of R&D investment than the socially optimal level. The latter hinders firms' access to external financing in the R&D process. We scrutinize the treatment heterogeneity of the NIRDZs policy across industries to shed empirical light on which factors determine the success or failure of industrial policies.

The most closely related literature on industrial policies to our research is presented as follows. Liu and Li (2021) find that place-based IT-related industrial policy stimulates urban Innovation in China by providing innovation incentives and government support for R&D investment. Petti *et al.* (2019) argue that corporate innovation in China's automotive industry is highly motivated by a combination of industrial policies that facilitates globalization, R&D and market competition. Aghion *et al.* (2015) reveal that industrial policies in China significantly increase productivity growth. Similar supporting evidence can also be found for South Korea (Westphal, 1990). However, critics argue that industrial policies might distort resource allocation, crowd out private investments in Innovation (Becker, 2015; Zúñiga-Vicente *et al.*, 2014) and cause rent-seeking and corruption (Aghion *et al.*, 2015), which lead to unsustainable and inefficient innovation. We build on this strand of literature by investigating the underlying mechanisms through which place-based industrial policies affect firm innovation from the perspective of fiscal incentives.

Third, we build on research on how corporate innovation is motivated and financed. There is a consensus that avoiding competition and seeking political support are the two dominant incentives for firms to innovate (Aghion *et al.*, 2005). Besides, numerous factors have been proven to have a significant impact on enterprise innovation [4]. Recent research intensively studies the effects of R&D subsidies or tax incentives on firm innovation investments and outputs (Bai *et al.*, 2019; Bronzini and Piselli, 2016; Colombo *et al.*, 2011; Howell, 2017), but they have yielded somewhat mixed results. Our study addresses this controversy by estimating the impact of government-led industrial policies on firms' innovation incentives through the lens of market competition.

The remainder of the paper is organized as follows. Section 2 lays out the background of China's NIRDZs policy. Section 3 describes the conceptual framework. Section 4 introduces the identification strategies and data. Section 5 presents the empirical findings. Section 6 concludes the paper.

2. Institutional background

Regional inequality has long been a major concern of the Chinese government because it poses serious challenges to achieving high-quality economic development and maintaining social stability (Mirza *et al.*, 2021; van der Wouden, 2022; Wang *et al.*, 2017). With more than 40 years of rapid economic development, the comparative advantage in manufacturing in China's eastern regions gradually decays. Meanwhile, central and western regions, the economically backward areas, have rich resources (i.e., land, labor, energy), low factor prices and huge market potential. Governments' selective industrial policies have been widely implemented in emerging economies since the 2008 global financial crisis, among which China's five-year industrial plan is a typical example (Barbieri *et al.*, 2019; Di Tommaso *et al.*, 2021).

In 2010, the National State Council of China introduced the guiding principle of NIRDZs, intended to optimize the spatial distribution of industries in response to the shift in the overall industrial structure and to promote balanced regional development [5]. The government is encouraging the relocation of industries with low value added (i.e., labor- and resource-intensive manufacturing) from the eastern to the central and western regions, which makes it possible for eastern regions to accelerate industrial upgrading and economic transition. Furthermore, it brings the central and western regions new technologies, talents and employment opportunities, facilitating economic and industrial development and eradicating poverty.

Despite the overall expected benefits, regional industrial relocation is still mainly state-led rather than market-oriented. The underlying reasons are threefold. First, local authorities in the eastern regions have little incentive to transfer industries that could boost local GDP growth, which is encouraged by the existing cadre evaluation system (Tang *et al.*, 2018). Second, the lack of fiscal budgets and public incentives in the central and western regions leaves them unattractive to industries from the east. These regions with low value-added industries are locked in at the lower end of the industry chain because of the unavailability of financial resources and talents for R&D. To make matters worse, technology-biased growth and consumption upgrading further amplify the lock-in effect. Thus, firms in the east are still reluctant to relocate to the central and western regions with underdeveloped infrastructure (Aiginger and Rodrik, 2020). Third, cooperation mechanisms between the eastern and central-western regions must be strengthened simultaneously. As a result, an increasing number of industrial policies have been implemented to guide industrial relocation.

Among various political efforts, the NIRDZs policy, introduced by the National State Council in 2010, is regarded as one of the most important practices of regional industrial transfer. In contrast to other place-based policies in China, the ultimate policy goal of NIRDZs is to undertake industrial transfer and accelerate industrial upgrading. The NIRDZs are economic zones tailored to the relocated firms, established in the central and western regions with *ex ante* underdeveloped infrastructure but lower labor costs and abundant resources. Firms in NIRZDs can benefit from tax exemption, priority in land use, infrastructure, preferential lending and regulations and subsidies in factor prices. Local governments undertaking industrial transfer are required to take the following measures to improve infrastructure and business environment and to foster industrial clusters:

(1) Improve infrastructure, public services, investment/trade facilities, business environment and regulation.

(2) Implement tax exemption, prioritized land use and preferential lending from public/private financial institutions.

(3) Identify and prioritize the industries that could best leverage local comparative advantages, especially in terms of production factors.

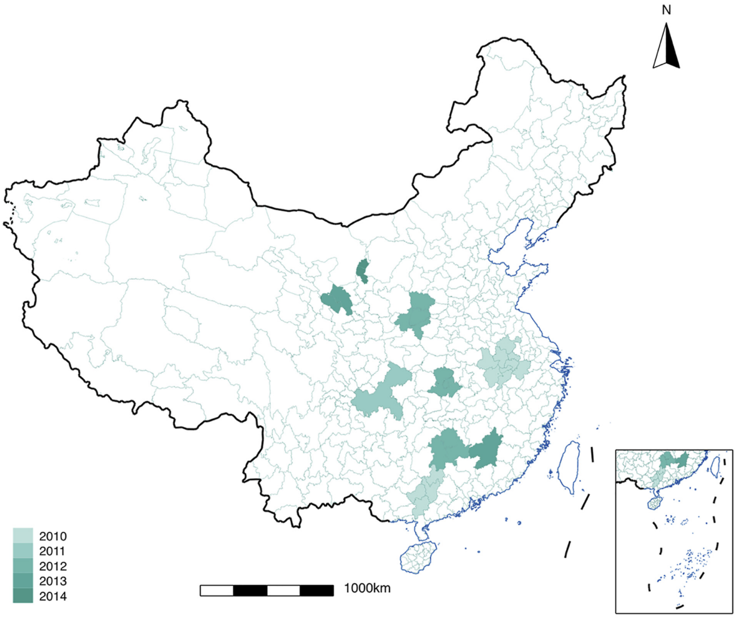
(4) Foster industrial clusters to achieve scale effects, improve the value chain and encourage vertical specialization and horizontal cooperation in the industry chain.

As shown in Figure 1, the central government approved the establishment of nine NIRDZs between 2010 and 2014 in 31 cities in the central and western regions. Figure 2 shows the time distribution in which each city established NIRDZ and thus changed from the control group to the treated group. The policy details NIRDZs in each affected city are listed in Table A1 in appendix.

3. Conceptual framework

There is conventional wisdom that the market is the most efficient way to allocate resources in neoclassical economics. Supporters believe that government intervention should only occur in the presence of market failures. Industrial policy, a set of political interventions in the industry's life cycle, including formation, development, maturity and decline, can be classified into *selective* and *functional* industrial policies.

Selective industrial policy refers to direct subsidies and preferential policies targeting specific regions, industries, or firms in an attempt to reshape structural changes and fuel economic development. In contrast, functional industrial policies aim to improve the business environment, maintain fair market competition, enhance human capital and develop secure public services and infrastructure. Hodler (2009) emphasizes that the effectiveness of selective industrial policy depends on how well-informed public agency is and whether it is



Note(s): This map depicts the geographic distribution of municipalities with NIRDZs. The colors indicate the year in which the NIRDZ was established. The Chongqing River-shore NIRDZs established in 2011 only include Fulin, Banan, Jiulongpo, Bishan, Yongchuan, Dazu, and Rongchang districts in Chongqing. Further details are provided in Table A1 in the appendix

Source(s): Figure by authors

Figure 1. Geographic distribution of cities with NIRDZs 2010–2014

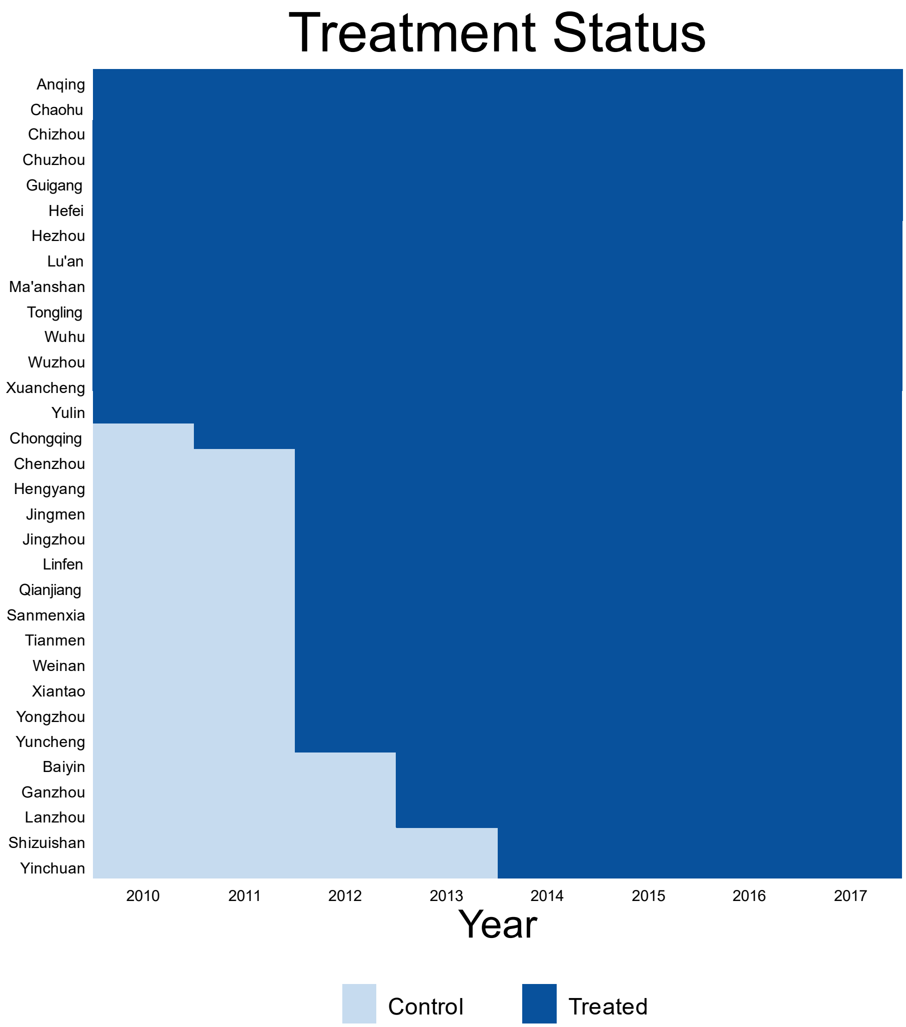


Figure 2. Staggered Adoption of NIRDZs policy for Treated Cities

Note(s): Darker colors indicate years in which cities in the treatment group have established NIRDZs, while lighter colors indicate cities in the treatment group that have not been treated in that particular year. Further details are provided in Table A1 in the Appendix
Source(s): Figure by authors

highly politically motivated, shedding light on the importance of the institutional setting in determining the success or failure of selective industrial policy. Thus, the government-oriented direct intervention might induce substantial distortions and "government failures."

In contrast, functional industrial policies aim to improve the business environment, maintain fair market competition, enhance human capital and develop secure public services and infrastructure. The theoretical framework legitimizing and guiding industrial policies emphasizes the government's role in conducting functional industrial policies. Bianchi and Labory (2011) argue that functional industrial policies are effective if these interventions facilitate a better role for market mechanisms in resource allocation. Grillitsch and Asheim (2018) believe that industrial development in disadvantaged areas depends on the extent to which government policies enhance the capacity and network embeddedness for local firms to access, transfer and internalize new knowledge and technology.

With an increasing emphasis on functional industrial policies, NIRDZs policy has the advantage of boosting local innovation. We present three reasons why NIRDZs are effective at spurring local firm innovation. First, NIRDZs are government-formed industrial clusters that benefit from preferential policies rather than spontaneous market-driven clusters. China's government has taken initiatives to remove barriers to industrial relocation and the formation of industrial clusters. The place-based industrial transfer policies facilitate the creation and growth of industrial clusters. Simmie and Sennett (1999) find that industrial agglomeration is an essential engine of regional innovation.

Second, local governments complement the market mechanism by improving the business environment and market efficiency. Such agglomeration could induce Marshall externality (Marshall, 2009), which raises productivity via the sharing of intermediate inputs, labor pools and knowledge spillovers (Agrawal *et al.*, 2014). Therefore, local firms can also indirectly benefit from relocated firms through learning spillovers, upstream demand for inputs and increased productivity resulting from agglomeration economies (Ahlfeldt and Feddersen, 2017; Glaeser and Gottlieb, 2008). Consequently, these policies contribute to the overall innovation capabilities of localities.

Third, NIRDZs policy specifies which industries should be undertaken by local government and provides guidance for preferential measures. Thus, NIRDZs enable local governments to have more discretion to overcome the principal-agent problems arising from information asymmetry (Di Tommaso *et al.*, 2020). This could significantly reduce the government failures arising from selective policies. In particular, it provides immediate financial motivation for local firms to innovate through subsidies, preferential loans and tax incentives. These financial and political forms of support help firms reduce deadweight loss and mitigate political uncertainty in the R&D process because such policies serve as positive market signals of private investment (Atanassov and Liu, 2020). This is especially helpful for early start-up firms facing an uncertain and turbulent internal and external environment, which makes innovation hard to succeed (Jiao *et al.*, 2021).

Consequently, these policies contribute to the overall innovation capabilities of localities. Thus, our first hypothesis is presented as follows:

H1. The NIRDZs policy significantly boosts firm innovation, ceteris paribus.

There is a consensus that state-owned enterprises (SOEs) are likely to benefit more from state-led industrial policies than non-state-owned enterprises (non-SOEs). We present two possible explanations. First, SOEs may have access to more favorable financial incentives due to their political connections with public funding authorities, while non-SOEs, on the other hand, are more likely to fail in overwhelming administrative procedures (Rodríguez-Pose *et al.*, 2021). This is particularly the case when the application process for fiscal incentives is not as straightforward and transparent as it could be. Thus, the selective policies of the NIRDZs may be more conducive to promoting Innovation in SOEs than in non-SOEs.

Second, the functional policy of the NIRDZs also plays an active role in motivating SOEs to innovate. As SOEs with political burdens are more reluctant to conduct risky innovation activities, the NIRDZs policy serves as a positive market signal, reshaping their incentives to innovate. This positive market signal also aligns the public interest with SOEs' motivations for innovation, which helps to mitigate information asymmetry and reduce managers' moral hazards that happen more in SOEs than in non-SOEs. Thus, as the positive effects of the NIRDZs policy may be more pronounced for SOEs, the second hypothesis is presented as follows:

H2. The effects of the NIRDZs policy on firm innovation are more significant for SOEs than for non-SOEs, ceteris paribus.

Marshall externalities induced by industrial clusters significantly increase productivity and innovation through the sharing of intermediate inputs, labor pools and knowledge spillovers. Moreover, the relocation of superior enterprises from eastern regions to the mid-west contributes to an increase in local market competition. This raises the question of how local competition affects innovation.

Aghion *et al.* (2005) reveal that within-industry competition could encourage innovation for highly productive firms under neck-and-neck competition because these firms are motivated to be more innovative to escape competition from their rivals. The prerequisites are a relatively effective market and largescale companies with great innovation potential and market power. However, in an unlevel playing field, the laggard has less incentive to innovate because of the potential limited returns from innovation (Raith, 2003). For existing companies without great innovation potential and market power, fierce competition discourages enterprise innovation; this is termed the competition crowd-out effect.

The Schumpeterian effect predicts that increased competition lowers the marginal returns from innovation activities, thus suppressing prior incentives to innovate (Ginzberg and Schumpeter, 1947). This is because strong players quickly enter the market and seize a higher market share, leaving a smaller profit margin for weak players. Therefore, the third hypothesis is presented as follows:

H3. The effects of the NIRDZs policy on firm innovation are more pronounced for high-productivity firms than for low-productivity firms, ceteris paribus.

4. Identification strategy

This study exploits the establishment of NIRDZs as a quasi-natural experiment to identify the causal effect on local enterprise innovation. Specifically, we compare the innovation changes between firms in NIRDZs (the treatment group) and firms in other cities (the control group) before and after the policy. Given the non-uniform nature of the NIRDZs policy, we exploit staggered difference-in-differences strategies. The baseline DID estimation is specified as follows:

$$y_{i,c,t} = \alpha_i + \beta NIRDZ_{i,c,t} + \boldsymbol{X}'_{i,c,t}\gamma + \lambda_t + \varepsilon_{i,c,t}\ , \tag{1}$$

where i, c, and t indicate firm, city and year, respectively. $y_{\mathrm{i,c,t}}$ is the dependent variable, measured as the log form of the number of patent filings; $NIRDZ_{i,c,t}$ is the regressor of primary interest. $NIRDZ_{it}$ is equivalent to the interaction term $treatment_i \times post_t$. $Treatment_i$ indicates whether a firm belongs to a city that adopts the NIRDZs policy. Specifically, if the firm i's registered office is located in a city that is approved to set up NIRDZs, it belongs to the treatment group. $treatment_i = 1$ for these firms, and 0 otherwise. $Post_t$ is a post-treatment effect indicator, taking a value of 1 if $t \geq t_0$, where t_0 is the year in which the city is authorized to establish the NIRDZs and 0 otherwise.

To isolate the impacts of NIRDZs, we control for a series of firm-level and city-level time-varying attributes ($\boldsymbol{X}_{i,c,t}$) that might affect innovation activities, including firm assets size, labor scale, age, leverage ratio, return on assets (ROA), cash, intangible assets, liquidity ratio and type of ownership. We also include city-level characteristics to mitigate the potential omitted variables bias, including population, government expenditure, regional GDP, number of general higher education institutions, total retail sales of consumer goods, science and technology expenditure and a dummy variable indicating whether the city has established a national high-tech zone (HTZ). α_i denotes firm fixed effects, accounting for all time-invariant unobservable factors across different firms, industries and regions, and λ_t

denotes year-fixed effects, capturing common shocks that are likely to affect innovation activities for all firms. ε_{it} is the error term.

4.1 Measurement of enterprise innovation

Current research mainly measures enterprise innovation in terms of R&D input and output, with the former reflecting a firm's desire and motivation to innovate and the latter reflecting a firm's capacity and efficiency to innovate. In this sense, innovation output seems to be a better proxy for innovation achievement. The most commonly used metrics for innovation output are the number of patent applications and granted patents. Many researchers argue that patent applications are a timely and valid measure of a firm's ability to innovate (Dorn *et al.*, 2020), given the time-consuming procedures for obtaining patents. Thus, a reliable proxy for the year an innovation takes place is the year a patent application is filed. Further, patent records provide us with detailed descriptions of the types of innovation activities undertaken. Therefore, this study uses the number of patent applications as the dependent variable in the baseline estimation and the number of patents granted for a robustness check.

Given that some firms have no patent filings, we use the following log transformation to proxy the innovation outputs:

$$y_{i,c,t} = \ln(1 + patent_{i,c,t}), \tag{2}$$

where $patent_{i,c,t}$ is the number of patent applications by firm i in city c in year t. Table 1 summarizes the specific definition of the above variables.

Variable	Definition
Outcome variables	
LnPatent	Ln (1 + total number of patent applications)
Inventions	Ln (1 + total number of inventions)
Utility model	Ln (1 + total number of utility models)
Designs	Ln (1 + total number of designs)
LnGranted	Ln (1 + total number of patents granted)
Regressor of interests	
NIRDZ	1 if firm i in year t belongs to a NIRDZ, and 0 otherwise
Firm-level control variables	
Size	Ln (total assets)
Scale	Ln (labor scale)
Age	Ln (firm age)
Leverage	Total liabilities divided by total assets
ROA	Net profit divided by total assets
Cash	Cash divided by total assets
Tangibility	Tangible assets divided by total assets
Liquidity	Current assets divided by current liabilities
SOE	1 if the firm is state-owned, and 0 otherwise
City-level control variables	
Population	Ln (number of residents with hukou registration)
Consumption	Ln (amount of total retail sales of consumer goods)
GovExp	Ln (amount of government expenditure)
GDP	Ln (regional gross domestic product)
School	Ln (1 + number of general higher education institutions)
Research	Ln (science and technology expenditure)
HTZ	1 if city c has set up a national high-tech zone in year t, and 0 otherwise

Source(s): Calculated by authors

Table 1. Variable definitions

4.2 Data

The primary data sources for this study are the China Stock Market and Accounting Research Database (CSMAR) and Wind, which provide a rich firm-level panel dataset for listed firms from 2003 to 2017. City-level data are obtained from China City Statistical Yearbooks. The NIRDZs policy involves relocations of firms, as well as the entry or exit of firms in policy-targeted areas. This might violate the stable unit treatment value assumption in the difference-in-differences framework. Therefore, we exclude firms that changed locations during the sample period to ensure stable composition in treatment and control groups. Further, we exclude firms registered in Beijing, Shanghai, Tianjin, Guangdong, Fujian and Zhejiang, which were not suitable control groups because some industries transfer out of these regions.

We also exclude companies labeled *ST or *PT [6], and those with missing or illogical indicators. Given that the objective and measures of NIRDZs policy predominantly focus on the manufacturing industry, we only retain manufacturing firms. To avoid estimation bias due to manipulation in patent applications or strategic innovation, we eliminate firms listed on the Science and Technology Innovation Board and those in the period of their initial public offering. Finally, we obtained a data set with 4,106 observations. All variables are winsorized at the top and bottom 1%. Table 2 presents descriptive statistics.

5. Empirical findings

5.1 Baseline estimation

The baseline estimation results for the DID specification are reported in Table 3. In column (1), we begin with a simple model that only accounts for firm, industry and year fixed effects. The

	Mean	S.D.	Min	Max
Outcome variables				
LnPatent	2.158	1.778	0.000	8.670
Inventions	1.434	1.503	0.000	8.539
Utility model	1.497	1.616	0.000	7.703
Designs	0.651	1.177	0.000	6.494
LnGranted	1.873	1.678	0.000	8.017
Firm-level control variables				
Size	22.012	1.180	19.831	25.119
Scale	8.181	1.042	3.584	11.286
Age	2.292	0.596	0.000	3.219
Leverage	0.487	0.182	0.028	1.567
ROA	0.042	0.283	−7.017	0.666
Cash	19.926	1.347	16.682	23.395
Tangibility	0.306	0.159	0.009	0.849
Liquidity	1.634	1.502	0.190	33.704
SOE	0.733	0.443	0.000	1.000
City-level control variables				
Population	5.055	0.783	2.795	7.804
Consumption	15.572	1.104	11.236	18.206
GovExp	0.126	0.059	0.028	1.879
GDP	6.694	1.187	2.688	9.724
School	2.515	1.079	0.000	4.443
Research	9.295	1.992	1.099	13.938
HTZ	0.613	0.487	0.000	1.000
Observations	4,106			

Note(s): This table shows descriptive statistics for the main variables
Source(s): Calculated by authors

Table 2.
Descriptive statistics of main variables

	Dependent variable: Ln (patent applications)			
	(1)	(2)	(3)	(4)
NIRDZ	0.3042*	0.3500**	0.3525**	0.4729***
	(0.165)	(0.139)	(0.142)	(0.131)
Firm controls	No	Yes	Yes	Yes
City controls	No	No	Yes	Yes
Treatment trends	No	No	No	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.73	0.76	0.76	0.76
Observations	4,106	4,106	4,106	4,106

Note(s): *This table reports coefficients in the baseline model of equation (1). Robust standard errors (in parentheses) are clustered at the firm level.* *, **, *and* *** *represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 3. Benchmark regression results

regressor of interest $NIRDZ_{i,c,t}$ is positive and statistically significant, implying that firms located in NIRDZs innovated more after the policy implementation than their counterparts in the control group. In column (2), we include a set of time-varying firm attributes that could simultaneously affect innovation output (i.e., the dependent variable) and our regressor of interests.

In column (3), we further include city-level characteristics to mitigate the non-random selection issue, including population, government expenditure, regional GDP, number of general higher education institutions, total retail sales of consumer goods and science and technology expenditure. To disentangle the impacts of the NIRDZs policy on firm innovation from other ongoing policy interventions, such as the high-tech industrial development zone (HTZ) policy, we also control for confounding effects by including a dummy variable indicating whether there have built-up HTZs in the specific year. Our results remain robust to the additional control variables.

An essential assumption to identify the causal effects of the NIRDZs policy on firm Innovation in DID estimators is the parallel trends assumption, namely that innovation in treatment and control groups evolves in a similar manner. We include treatment-specific linear time trends in column (4) to address the potential factors that may invalidate the assumption. The results consistently produce a positive and statistically significant coefficient on $NIRDZ_{i,c,t}$, translating to a 60.46 ($e^{0.4729}-1$) percent increase in patent applications by affected firms, which implies that this place-based industrial policy significantly boosts local firm innovation, *ceteris paribus*.

5.2 Event study

To further verify the validity of the parallel trends assumption, we conduct an event study to investigate the dynamic effects of the NIRDZs policy on firms' patent applications. Specifically, we include a series of leads and lags to trace out the year-by-year effects of the NIRDZs policy on the number of patent applications:

$$y_{it} = \alpha_i + \sum_{k=1}^{4} \beta_k^{pre} D_i^{-k} + \beta_0^{post} D_i^{0} + \beta_1^{post} D_i^{+1} + \beta_2^{post} D_i^{+2} + \beta_3^{post} D_i^{+3} + \beta_4^{post} D_i^{\geq 4} + \gamma_t + \varepsilon_{it}, \quad (3)$$

where $D_{i,0}$ denotes a dummy variable for the first year of establishing a NIRDZ in the city where firm i is located. $D_{i,t-k}$ equals one if k years before, firms in the treatment group are affected by the NIRDZs policy and 0 otherwise. Likewise, $D_{i,t+k}$ equals one if k years after the firms have been exposed to the NIRDZs policy and 0 otherwise. We take $D_i^{\leq -5}$ as the baseline group and drop it to avoid multicollinearity.

In column (1) of Table 4, we concentrate on the dynamic treatment effect of the NIRDZs policy and only include $D_{i,0}$, $D_i^{+1}, \ldots, D_i^{\geq 4}$ to decompose the policy effects into year-by-year dynamic effects. The results indicate the adoption of the NIRDZs policy has a persistent and increasing impact on firm innovation.

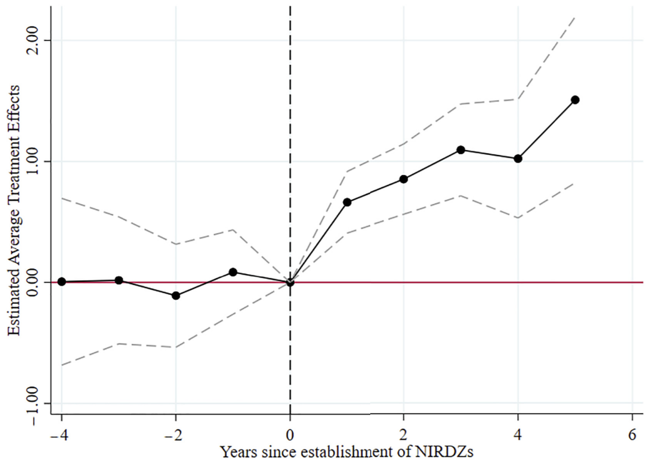
If local firms could anticipate the establishment of NIRDZs and correspondingly alter their behaviors even before the NIRDZs policy was implemented, the estimations in our baseline DID framework might be biased. To rule out the anticipation effects of the NIRZDs policy, we conduct an event study to check the validity of parallel trends. The results are presented in column (2) of Table 4 and Figure 3 for intuitive interpretation.

Figure 3 shows that none of the coefficients before the policy shock shows significant impacts on the patent application. This implies firms in NIRDZ-targeted cities and other cities did not differ considerably in innovation trends. The statistically significant positive effects of NIRDZs on firm innovation gradually strengthen after the policy interventions. The consistently increasing coefficients reveal that NIRDZ policies had salient lagged impacts. This result is reasonable because both industry relocation and firm Innovation take time. In sum, these results indicate that the NIRDZs policy has an increasing effect on local enterprise innovation, which supports the baseline estimation result.

	Dependent variable: Ln (patent applications)	
	(1)	(2)
post0	0.4251***	0.6574*
	(0.145)	(0.390)
post1	0.5729***	0.8474*
	(0.156)	(0.439)
post2	0.7781***	1.0890**
	(0.198)	(0.464)
post3	0.6706***	1.0167*
	(0.224)	(0.531)
post4	1.0804***	1.5027**
	(0.296)	(0.618)
pre4		0.0116
		(0.193)
pre3		−0.1155
		(0.243)
pre2		0.0802
		(0.278)
pre1		0.5133
		(0.352)
Firm controls	Yes	Yes
City controls	Yes	Yes
Treatment trends	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Adjusted R^2	0.76	0.76
Observations	4,106	4,106

Note(s): *This table reports coefficients in the baseline model of equation (2). Robust standard errors in parentheses are clustered at the firm level.* *, **, *** *represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 4.
Dynamic effects and parallel trends assumptions



Note(s): This figure plots the estimated coefficients from Eq. (2) and their 90% confidence intervals
Source(s): Figure by authors

Figure 3. Dynamic effects

To further account for the lagging impacts of NIRZDs on firm innovation, we use the innovation level of firm i one, two and three years later as outcome variables (i.e., y_{it+1}, y_{it+2} and y_{it+3}). The results, presented in Table 5, imply that the positive effects on firm innovation may last for at least two years after the establishment of a NIRZD.

5.3 Heterogeneity analysis

5.3.1 Types of patents. According to the China National Intellectual Property Administration, China's patent system recognizes three different patent types: inventions, utility models and designs. Applications for invention patents are subject to rigorous evaluation in the aspects of novelty, creativity and utility (Liu *et al.*, 2021). The innovation must have outstanding

	Dependent variable: Ln (patent applications)		
	(1) t+1	(2) t+2	(3) t+3
NIRDZ	0.4764***	0.3589**	0.2217
	(0.133)	(0.166)	(0.161)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Treatment trends	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adjusted R^2	0.77	0.76	0.76
Observations	3,745	3,441	3,157

Note(s): *t+1, t+2, and t+3 represent the innovation indicators for firm i after 1, 2, and 3 years, respectively. Robust standard errors in parentheses are clustered at the firm level. *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 5. Lagged effects of NIRDZs on firm innovation

substantive features and considerable enhancements relative to the existing technology. In contrast, the requirements for utility models and design patents are much more relaxed. The former highlight functional utility, and the latter focus on shape and appearance. Therefore, invention patents are commonly believed to represent a company's real ability to innovate.

This study explores the heterogeneity of the effect of the NIRDZs policy across different types of patents. The results in Table 6 indicate a positive and statistically significant effect on all types, with the most pronounced effect on the utility model, followed by design patents and then inventions. A possible explanation is as follows. The clustering of firms in the same industry generates Marshall externalities that reduce the cost of innovation by sharing inputs, services, expertise and talent, thus facilitating innovation processes. An immediate benefit is that local firms can learn new technologies and ways of running the business by direct observation and interaction (e.g., trade and investments) with relocated companies that are equipped with more advanced technologies and products. This process is manifested in the application of utility models and design patents. Therefore, our findings support the Marshall externalities of industrial agglomeration in the innovation process.

5.3.2 Type of ownership. To examine the heterogeneous effects of the NIRDZs policy, we divide the sample by firms' type of ownership. Table 7 presents the empirical results for SOEs and non-SOEs in columns (1) and (2), respectively. The results imply that the NIRDZs policy considerably boosts Innovation in SOEs relative to non-SOEs. This conclusion is consistent with previous research indicating that government policies stimulate Innovation in SOEs more than in non-SOEs due to the formers' political connections (Tsai *et al.*, 2019).

There are three reasons for these differential impacts on innovation. First, SOEs with political burdens are reluctant to conduct risky yet potentially profitable innovation activities. The NIRDZs policy helps reshape SOEs' innovation incentives in the form of explicit political goals. Second, SOEs suffer more than private firms from agency problems and management efficiency, so the NIRDZs policy helps improve their governance and reduces managers' moral hazard through signaling effects. Third, the NIRDZs policy induces competition between similar firms and tears down the monopoly barriers of SOEs, compelling SOEs to increase their efficiency and innovation. This is in line with the preference argument that managers in less productive firms have more incentives to innovate in order to survive in a competitive environment featuring rival firms (Raith, 2003). However, non-SOEs are more exposed to crowding-out effects from the competition, thus resulting in constrained positive effects of NIRDZs on Innovation. This finding echoes the Schumpeterian effect that predicts

	(1) Inventions	(2) Utility model	(3) Designs
NIRDZ	0.3071**	0.4060***	0.3276***
	(0.124)	(0.136)	(0.101)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Treatment trends	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adjusted R^2	0.74	0.75	0.68
Observations	4,106	4,106	4,106

Note(s): *Robust standard errors (in parentheses) are clustered at the firm level.* *, **, *and* *** *represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 6.
Patent type heterogeneity

	Dependent variable: Ln (patent applications)	
	(1) SOEs	(2) Private firms
NIRDZ	0.5271***	0.4893*
	(0.143)	(0.253)
Firm controls	Yes	Yes
City controls	Yes	Yes
Treatment trends	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Adjusted R^2	0.78	0.76
Observations	3,001	1,092

Note(s): *This table reports coefficients in the baseline model of equation (1). Robust standard errors (in parentheses) are clustered at the firm level. *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 7. Heterogeneity across type of ownership

that increased competition lowers the marginal returns from innovation activities in private firms and hence suppresses their prior incentives to innovate (Ginzberg and Schumpeter, 1947).

5.3.3 Productivity. We examine whether the impacts of the NIRDZs policy on firm innovation vary by firm productivity level. In detail, we follow the method proposed by Levinsohn and Petrin (2003) to estimate firm total factor productivity (TFP). Specifically, we classify firms into three quantiles according to their average total factor productivity before the NIRZDs policy. The results are presented in columns (1)–(3) of Table 8. Although the coefficients on the regressor of interests in all quantiles remain positive, the impact of NIRDZs on the lowest productivity firms is not statistically significant. This implies that there is no evidence that the NIRDZs policy promotes innovation for unproductive firms. Local market competition becomes intensified with the relocation of higher-productivity firms from eastern regions. Local highly productive firms are motivated to be more innovative to escape the

	Dependent variable: Ln (patent applications)		
	(1) Low productivity	(2) Medium productivity	(3) High productivity
NIRDZ	0.3215	0.5268*	0.4296*
	(0.225)	(0.266)	(0.242)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Treatment trends	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adjusted R^2	0.76	0.71	0.80
Observations	1,294	1,304	1,330

Note(s): *This table reports coefficients in the baseline model of equation (1). Robust standard errors (in parentheses) are clustered at the firm level. *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 8. Heterogeneity across firm productivity

neck-and-neck competition with relocated firms, whereas laggard firms have less incentive and ability to innovate due to the limited potential returns to Innovation (Aghion *et al.*, 2005).

5.3.4 High-tech industries. We also investigate whether the NIRDZs policy exerts differential impacts on firm innovation across different industries. Following Li and Zheng (2016), we categorize the following industries [7] as high-tech industries: general equipment manufacturing (C34); special-purpose equipment manufacturing (C35); automobile manufacturing (C36); railway, ship, aerospace, and other transport equipment manufacturing (C37); electrical machinery and equipment manufacturing (C38); computer communications and other electronic equipment manufacturing (C39); and instrument manufacturing (C40). All other firms are classified as non-high-tech firms. The results are reported in columns (1) and (2) of Table 9. The effects of the NIRZDs policy are positive but not statistically significant for firms in high-tech industries. Because the transferred industries are primarily labor- and resource-intensive, the impact on local firms in high-tech industries may be minimal.

Given that firms in different industries may manifest heterogeneous patterns in response to the common shocks from the place-based industrial policy on firm innovation, we follow Gobillon and Magnac (2016) to control for interacted fixed effects (IFE) at the industry level. Specifically, we additionally control for the $\lambda_n' F_t$ term based on the specification in equation (1), where F_t represents time-varying common shocks and λ_n denotes the $N \times 1$ vector of factor loadings. This allows us to account for the possibility that certain industries are more sensitive to common shocks than others due to unobservable time-varying characteristics, as the NIRDZs policy favors specific industries. We estimate the IFE model based on the method proposed by Bai (2009) and report the result in column (3) of Table 9. The coefficient on our regressor of interests remains stable compared with the main results in our baseline specifications.

5.4 Robustness checks

5.4.1 Placebo test. This study further conducts a placebo test to examine whether the baseline estimation results are driven by unobservable omitted variables bias. We employ the falsification specification by randomly assigning treated firms between 2010 and 2014. The

Table 9. Heterogeneity across industries

	Dependent variable: Ln (patent applications)		
	(1) High-tech firms	(2) Non-high-tech firms	(3) Interacted fixed effects model
NIRDZ	0.4049	0.4505***	0.4418***
	(0.278)	(0.132)	(0.131)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Treatment trends	Yes	Yes	Yes
Firm FE	Yes	Yes	No
Year FE	Yes	Yes	No
Industry FE	Yes	Yes	No
IFE	No	No	Yes
Adjusted R^2	0.83	0.70	
Observations	1,311	2,795	4,106

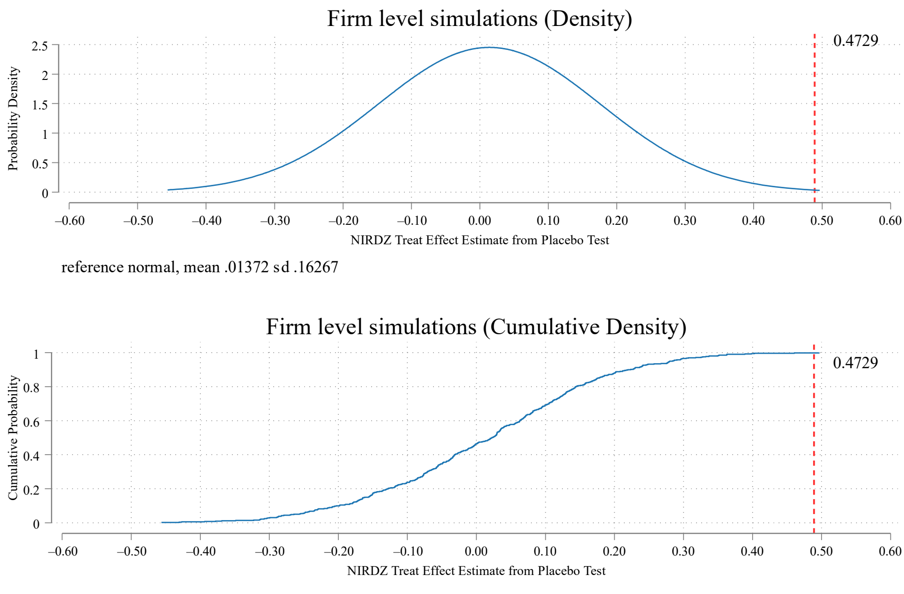
Note(s): *This table reports coefficients in the baseline model of equation (1). Robust standard errors (in parentheses) are clustered at the firm level.* *, **, *and* *** *represent significance levels of 10%, 5%, and 1%, respectively*

Source(s): Calculated by authors

number of designated companies coincides with the real sample [8]. Thus, a false regressor of interest $NIRDZ_{it}^{false}$ is generated, which should produce no statistically significant estimation with a magnitude close to zero; otherwise, this estimation would indicate that the baseline results are not robust. This procedure is repeated 500 times to ensure the validity of the placebo test.

Figure 4 shows the distribution of the estimated coefficients on $NIRDZ_{it}^{false}$ from 500 random assignments, as well as the baseline estimation result, 0.4548, from column (4) of Table 3. The distribution of the false $NIRDZ_{it}$ variable estimates is a normal distribution with a mean of 0.014, which is close to zero and a standard deviation of 0.163. The result suggests that there is no statistically significant effect of the false NIRDZs policy on local enterprise innovation. Further, the baseline estimation result is an outliner in this distribution. Therefore, the positive effect of the NIRDZs policy on local enterprise innovation is not driven by unobserved factors, and the baseline estimation result is robust.

5.4.2 DID approach with propensity score matching. The treatment and control group in baseline estimation is unbalanced as NIRDZs policy did not randomly assign treated cities. This would lead to sample selection bias as our results could be driven by group differences that existed prior to the implementation of the NIRDZs policy. To eliminate possible estimation bias, we match companies in the treatment and control groups using the year-by-year propensity score matching (PSM) strategies (Zhang *et al.*, 2022). First, we estimate a logit model with a dummy indicator for the treatment status in a certain event year as the dependent variable. Moreover, the included firm-level controls are as same as baseline estimation. Second, we perform a one-to-one nearest-neighbor propensity score matching without replacement using the propensity scores obtained from the logit regression. We



Note(s): This figure plots the cumulative distribution density of the estimated coefficients from 500 simulations using false treated cities and false time of establishment of NIRDZs. The vertical red line indicates the estimate of column (4) of Table 2
Source(s): Figure by authors

Figure 4. Distribution of the estimated coefficients of the falsification test

specifically select the control city as the one with the highest propensity score for each treatment city in a particular year.

Figure 5 shows the difference in propensity score density distribution before and after matching. Finally, we repeat the same regression in equation (1) based on the matched samples and present the result in Table 10. Columns (1) report the result of a simple model that only accounts for firm, industry and year-fixed effects, while Columns (2) includes all control variables the same as baseline regression. Both models report significantly positive coefficients of NIRDZs, indicating that the baseline estimation result is still reliable after accounting for possible bias of sample selection.

5.4.3 Alternative regression method and restricted sample. The outcome variable in our main specification is a count of patents filed by a specific firm in a certain year, so only non-negative and discrete figures are possible. To address this concern, we conduct a Poisson pseudo-likelihood regression with fixed effects to examine whether our main findings are sensitive to different estimation approaches. The results are presented in column (1) of Table 11.

In addition, we exclude firms with no patent applications and keep other specifications consistent with the baseline estimates. Column (2) of Table 11 reports the estimation results, which indicate a statistically significant positive impact of the NIRDZs policy on local enterprise innovation.

5.4.4 Alternative measure of enterprise innovation. To examine whether the positive effects of NIRDZs on firm innovation are sensitive to the measurement errors of innovation, we use the number of patents granted as an alternative measure of firm innovation, and the results are shown in column (3) of Table 11. It can be seen that the coefficient of interest is positive and statistically significant, which is consistent with the baseline estimation.

5.4.5 City-level outcomes. To further explore the validity of our findings, we estimate the impacts of NIRDZs policy on a series of city-level outcome variables. As shown in Table 12, we find no evidence that NIRDZs policy affects regional GDP per capita in column (1), but

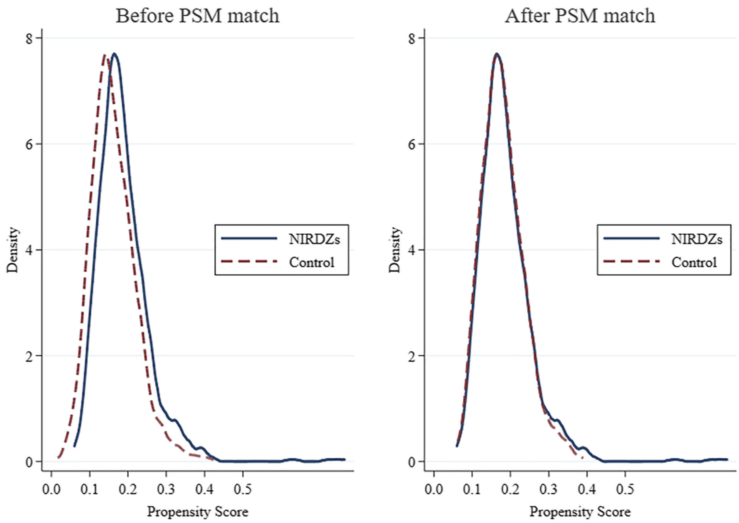


Figure 5.
Propensity score density before and after matching

Note(s): This figure compares the distribution of propensity score before and after PSM matching across treatment and control group
Source(s): Figure by authors

	Dependent variable: Ln (patent applications) (1)	(2)
NIRDZ	0.3158*	0.4291***
	(0.166)	(0.140)
Firm Control	No	Yes
City Control	No	Yes
Treatment trend	No	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Adjusted R^2	0.75	0.78
Observations	1,115	1,115

Note(s): Robust standard errors, clustered by the company level, are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10%, respectively
Source(s): Calculated by authors

Table 10. DID approach with propensity score matching

	Dependent variable: Ln (patent applications) (1) Poisson regression	(2) Restricted sample	(3) Ln (patent granted)
NIRDZ	0.1497**	0.2800**	0.5300***
	(0.067)	(0.129)	(0.156)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Treatment trends	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Pseudo R^2	0.29		
Adjusted R^2		0.75	0.75
Observations	4,016	3,064	4,106

Note(s): *Robust standard errors (in parentheses) are clustered at the firm level. *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 11. Robustness check

significantly alters the regional industrial structure, proxied by the share of secondary industry in GDP in column (2). In column (3), the dependent variable is the China Innovation and Entrepreneurship Index developed by (Zhang, 2019), a barometer of the innovation capacity of cities. In detail, we use an aggregate index normalized by area to represent city-level innovation capacity in column (3). Then we investigate the impacts of NIRDZs policy on the subcomponents of the aggregate innovation and entrepreneurship index, including numbers of new business registrations, inventions, utility models and designs in columns (4)–(7). The results consistently support our main findings and are aligned with the agglomerations economies of industrial clusters as predicted in the conceptual framework (Agrawal *et al.*, 2014; Ahlfeldt and Feddersen, 2017).

5.5 Fiscal incentives

Government financial support plays an important role in promoting firm innovation (Chen *et al.*, 2017; Hall, 2002; Li *et al.*, 2022; Mbanyele and Wang, 2022). Previous studies have

Table 12. Impacts of NIRDZs on city-level innovation dynamics

	(1) Regional GDP per capita	(2) Share of secondary industry in GDP	(3) Innovation and entrepreneurship index	(4) No. Of new business registrations	(5) Inventions	(6) Utility models	(7) Designs
NIRDZ	−0.0309	0.0220***	2.0334**	4.8882***	1.1248	6.6507**	7.7534**
	(0.024)	(0.008)	(0.843)	(1.847)	(2.278)	(2.704)	(3.884)
City Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Treatment trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.86	0.85	0.98	0.93	0.79	0.87	0.75
Observations	3,501	3,501	3,501	3,501	3,501	3,501	3,501

Note(s): *This table reports the impact of NIRDZs policies on city-level outcome variables. The specification is consistent with the baseline model of equation (1). China Innovation and Entrepreneurship Index constructed by Zhang (2019) serves as a barometer of the innovation capacity of cities. We use an aggregate index normalized by area to represent city-level innovation capacity in column (3). Then we investigate the impacts of NIRDZs policy on the subcomponents of the aggregate innovation and entrepreneurship index, including numbers of new business registrations, inventions, utility Models and designs in column (4)-(7). Robust standard errors in parentheses are clustered at the city level.* *, **, *** *represent significance levels of 10%, 5%, and 1%, respectively*

Source(s): Calculated by authors

explored how fiscal policies affect firm innovation, though the empirical result remains inconclusive (Tian and Xu, 2022). We present evidence demonstrating potential underlying fiscal mechanisms through which the establishment of NIRDZs significantly impacts local innovation: tax credit and access to government subsidies.

5.5.1 Tax credit. The tax credit has been widely proven to have a positive impact on firm innovation. For example, Labeaga *et al.* (2021) argue that persistent tax incentives contribute to firm innovation. Holt *et al.* (2021) provide empirical evidence that every dollar of R&D tax subsidy leads to an additional \$1.90 R&D expenditure of firms. Tian *et al.* (2022) suggest that tax credit encourages firms to invest in employees' on-the-job training, which promotes firms' overall innovation output level.

As tax credit might be a plausible channel underlying the firm innovation, we further examine whether establishing NIRDZs allows firms to enjoy favorable tax treatment. Specifically, we can observe a lower nominal tax rate if local firms benefit from tax credits. We conduct this regression using Equation (1) and the dependent variable is the nominal income tax rate at the firm level. Table 13 reports the empirical result. Column (1) presents the average treatment effect of the NIRDZs on the corporate income tax rate, which indicates that firms in NIRDZs indeed benefit from more favorable tax treatment. From columns (2) and (3) we find that the positive effect of NIRDZs on tax credits is common for both SOEs and non-SOEs. This also implies that tax credit is a relatively fair incentive to support firms.

5.5.2 Government subsidy. Numerous studies have demonstrated the effectiveness of government subsidies in fostering company innovation (Afcha and Lucena, 2022; Zhang, 2022; Wang, 2023). The NIRDZs policy, as stated in the guidelines, provides the midwestern region with necessary government subsidies to better accommodate relocated industries. As a result, we expect to observe a sharp increase in government subsidies for enterprises in NIRDZs, which might serve as a plausible underlying channel for firm innovation. In empirical studies, we identify NIRDZs-related government subsidies for local firms based on the keywords [9] in disclosure entries, including R&D and innovation subsidies, industrial policy subsidies and employment, education and training subsidies.

We estimate the effect of the NIRDZs on government subsidy based on the same specification as shown in equation (1). Table 14 reports the empirical result. Column (1) implies that firms in the NIRDZs do obtain more government subsidies than those not in the NIRDZs. We also find remarkable disparities between SOEs and non-SOEs, as only SOEs experience a significant increase (as in column (2)) in received government subsidies after the

	Dependent variable: Nominal income tax rate		
	(1)	(2) SOEs	(3) Non-SOEs
NIRDZ	−0.0326***	−0.0269**	−0.0355**
	(0.009)	(0.012)	(0.015)
Firm Control	Yes	Yes	Yes
City Control	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adjusted R^2	0.56	0.58	0.55
Observations	4,106	3,001	1,092

Note(s): *Robust standard errors in parentheses are clustered at the firm level.* *, **, *** *represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 13. Effects of NIRDZs on tax

	Dependent variable: Ln (innovation subsidy)		
	(1)	(2) SOEs	(3) Non-SOEs
NIRDZ	0.4382**	0.5959**	0.0294
	(0.193)	(0.247)	(0.353)
Firm Control	Yes	Yes	Yes
City Control	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adjusted R^2	0.46	0.48	0.41
Observations	1,989	1,384	599

Note(s): *Robust standard errors in parentheses are clustered at the firm level.* *, **, *** *represent significance levels of 10%, 5%, and 1%, respectively*
Source(s): Calculated by authors

Table 14. Effects of NIRDZs on government subsidy

establishment of NIRDZs. One possible explanation is that SOEs have more political connections with local public funding authorities and are more likely to gain access to innovation subsidies than non-SOEs, who are at a disadvantage in terms of "play the system" (Rodríguez-Pose *et al.*, 2021). This is particularly true for Chinese government subsidy applications due to their complexities and ambiguities (Branstetter *et al.*, 2022). Thus, non-SOEs are competed out of applications for innovation subsidies due to information asymmetries and overwhelming administrative costs, especially for small-and-median firms (SMEs). Moreover, local authorities that allocate subsidies tend to give priority to SOEs with political responsibilities.

6. Conclusions and policy implications

The effectiveness of the industrial policy on firm innovation has long been a controversial issue. In this paper, we examine whether and how the establishment of NIRDZs affects firm innovation, which is considered a major driving force behind long-term economic growth. To identify the causal impact of the place-based industrial relocation policy on innovation, we exploit the establishment of NIRDZs, a prominent place-based industrial policy in China used since 2010 to narrow down the country's remarkable regional disparities, as a quasi-natural experiment to evaluate its impact on enterprise innovation. We compare innovation changes of firms located in NIRDZs to their counterpart firms in other areas before and after the policy implementation.

The results of baseline estimation demonstrate that the NIRDZs policy can effectively encourage local enterprise innovation. Particularly, with the motivation of the NIRDZs policy, local companies have 60.46% more patent applications. Our findings remain robust to a range of validity checks and placebo tests on DID estimates, including checking the parallel trends assumption, anticipation effects and alternative measures of the dependent variable. Additionally, we conduct heterogeneity analyses by examining whether and how much the policy effects of NIRDZs vary with the type of patent application, type of firm ownership, firm productivity and industry. First, we find that the NIRDZs policy stimulates firm innovation mainly in form of utility models patents, followed by design patents and then invention patents. Second, we conclude that the NIRDZs policy has a stronger positive effect on innovation for SOEs than private firms. Third, we find the positive treatment effects of the NIRDZs policy are only significant for firms with medium or high productivity and for firms in non-high-tech industries. The differential effects of NIRDZs across firm productivity suggest the existence of competition crowding-out effects.

Our empirical results provide qualitative lessons that are worth emphasizing. In contrast to previous literature suggesting that place-based industrial policies have failed to achieve their intended objectives in many developed countries (Arundel *et al.*, 2015; Glaeser and Gottlieb, 2008), we provide empirical evidence that NIRDZs policy significantly motivates local firms in the mid-west to innovate, which helps to narrow the inter-regional technological gap in China. Our heterogeneity analysis implies that the NIRDZs policy stimulates innovation more in SOEs than in non-SOEs, which could be related to different abilities to capture government subsidies.

We propose three possible explanations for such disparities in findings. First, as NIRDZs policy attaches more importance to the *functional* industrial policies, in which the government's "managed hand" directly removes barriers to the creation and growth of industrial clusters, enabling a faster move towards innovation than market-driven clusters (Bosworth *et al.*, 2016; Powe *et al.*, 2022). However, governments' interventions are considered unnecessary in developed countries, potentially arising from the "Not In My Back Yard" opposition (Zheng *et al.*, 2017). Second, unlike place-based policies in developed countries targeting regions with lower income or employment rates, NIRDZs serve the goal of optimizing industrial layouts. Thus, such industrial clusters complement the market mechanism by triggering Marshall externalities, thus further benefiting the innovative activities of local firms through the agglomeration economies (Alder *et al.*, 2016). Third, the central government provides clear guidance to local governments on how to implement *selective* industrial policies, thereby mitigating government failures due to information asymmetries and agency problems. Thus, these lessons from China's NIRDZs program could be instructive, at least for other emerging countries with a more centralized government structure.

Our research carries several policy implications. Firstly, the government should play an active role in implementing place-based policies and efficient fiscal incentives that complement market competition mechanisms rather than forge distortions. Specifically, policymakers should highlight the industrial policies with a functional focus, which could facilitate the market to maximize Marshall externalities. This contributes to a competitive and innovation-friendly business environment. Secondly, local governments should reduce existing administrative burdens and political distortions in access to subsidies to ensure that more non-SOEs have available financial incentives to support their R&D process. Additionally, policymakers can explore about how to strengthen the ties between SOEs and non-SOEs and to encourage better agglomeration economies across ownership types. Thirdly, fiscal authorities still need to minimize the transaction cost and agency problem accompanied by direct government intervention, thereby mitigating the "government failure" and achieving the intended policy goals.

Notes

1. Date Source: World Intellectual Property Organization (WIPO), WIPO Patent Report (https://data.worldbank.org/indicator/IP.PAT.RESD?locations=CN).
2. The listing firms in our sample is those with the same location before and after the introduction of the NIRDZs policy.
3. For example, Lu *et al.* (2019) explore the effectiveness of China's special zone programs. Criscuolo *et al.* (2019) find that the UK's Regional Selective Assistance program exerts a positive influence on investment, local productivity, job creation, and firm entry. Chaurey (2017) investigate the impact of India's place-based tax incentive scheme on the entry and exit of enterprises and economic growth.
4. In the literature, numerous factors have been proven to have a significant impact on enterprise innovation, including internal and external financing (Amore *et al.*, 2013; Ayyagari *et al.*, 2011), political connections (Krammer and Jiménez, 2020; Tsai *et al.*, 2019), labor scarcity (Acemoglu, 2010),

the scale of capital, foreign trade and investment (Liu *et al.*, 2021) and board characteristics (Salehi *et al.*, 2018a, 2018b; Salehi and Zimon, 2021).

5. Data source: National State Council of China, Guiding Principles on Undertaking Industrial Transfer in the Central and Western Regions (http://www.gov.cn/gongbao/content/2010/content_1702211.htm)
6. ST and PT refer to Special Treatment and Particular Transfer respectively.
7. According to the Industry Classification Standard of the China's National Bureau of Statistics, manufacturing contains 27 secondary classifications, which are listed in Table A2 in appendix.
8. For instance, from the real sample, 25 companies are affected by the NIRDZs policy in the year 2010, and thus the placebo test also selects 25 firms at random for the first selected year of the post-treatment group.
9. All keywords are listed in Table A3 in appendix.

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Appendix

Table A1. The Timing of Implementation of the NIRDZs Policy and Treated Cities

No.	NIRDZs	Year	Target cities
1	Wanjiang City-clusters	2010	Hefei, Wuhu, Ma'anshan, Tongling, Anqing, Chizhou, Chaohu,[a] Chuzhou, Xuancheng, Lu'an
2	Guidong Guangxi	2010	Wuzhou, Guigang, Yulin, Hezhou
3	Chongqing River-shore	2011	Chongqing (only including Fulin, Banan, Jiulongpo, Bishan, Yongchuan, Dazu, and Rongchang districts)
4	Southern Hunan	2012	Hengyang, Chenzhou, Yongzhou
5	Yellow River Golden–delta	2012	Yuncheng, Linfen, Sanmenxia, Weinan
6	Jingzhou City-clusters	2012	Jingzhou, Jingmen, Qianjiang, Xiantao, Tianmen
7	Southern Jiangxi	2013	Ganzhou
8	Lanzhou-Baiyin of Gansu	2013	Lanzhou, Baiyin
9	Yinchuan-Shizui mountain of Ningxia	2014	Yinchuan, Shizuishan

Note(s): [a] Chaohu is a county-level city in Anhui Province, China, which is under the administration of the prefecture-level city of Hefei
Source(s): Summarized by authors

Code	Secondary classification	Code	Secondary classification
Non-high-tech industries of manufacturing			
C13	farm by-products processing industry	C25	oil, coal and other fuel processing industry
C14	food manufacturing	C26	chemical materials and chemical products manufacturing
C15	Wine, beverage and refined tea manufacturing	C27	pharmaceutical manufacturing
C16	tobacco product manufacturing	C28	chemical fiber manufacturing
C17	textile manufacturing	C29	rubber and plastic products manufacturing
C18	textile-clothing and garment manufacturing	C30	non-metallic mineral products manufacturing
C19	leather, fur, feathers and its products and footwear manufacturing	C31	ferrous metal smelting and calendaring industry
C20	Wood processing and wood, bamboo, rattan, brown, grass products manufacturing	C32	non-ferrous metal smelting and calendaring industry
C21	furniture manufacturing	C33	metal products manufacturing
C22	paper and paper products manufacturing	C41	other manufacturing industries
C23	Printing and recording media reproduction industry	C42	waste resources comprehensive utilization industries
C24	Culture and education, industry and art, sports and entertainment products manufacturing	C43	metal products, machinery and equipment repair industry
High-tech industries of manufacturing			
C34	general equipment manufacturing	C38	electrical machinery and equipment manufacturing
C35	special-purpose equipment manufacturing	C39	computer communications and other electronic equipment manufacturing
C36	automobile manufacturing	C40	instrument manufacturing
C37	railway, ship, aerospace, and other transport equipment manufacturing		

Note(s): This standard was implemented by the National Bureau of Statistics of China on June 30th, 2017, which is not equivalent to the International Standard Industrial Classification of all Economic Activities implemented by the United Nations Statistics Division in 2006
Source(s): Summarized by authors

Table A2. Industrial classification for national economic activities (GB / T4754)

Government subsidy	Keywords of disclosure entries
R&D and innovation subsidies	Patent (专利), invention (发明), utility model (新型), innovation and entrepreneurship (创新/创业/双创), R&D (研发/开发), science and technology (科学/技术/科技), progress (进步), intellectual property (知识产权), information (信息), digital (数字), Internet (互联网), machine (机器), SRDI (specialization-refinement-differential-innovation, 专精特新)
Industrial policy subsidies	industrial transformation (产业转型), industrial relocation (产业转移), industrial upgrade (产业升级), industrial reform (产业改造), industrial technology reform (工业技改), industry engineering prize (工程奖)
Employment, education and training subsidies	IUR (industry-university-research, 产学研), scientific research (科研), scientific education (科教), young- and middle-aged (中青年), university (大学), master (硕士), doctor (博士), talen t(人才/英才), talent program (百人计划/千人计划/万人计划), intelligence (智力), training (培养/培训)

Source(s): Summarized by authors

Table A3.
Types of Government Subsidies of the NIRDZs and Keywords of Disclosure Entries

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