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Development Zones and Firm Innovation: Evidence from Shanghai

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A majority of Chinese high-tech firms were founded in development zones established by the Chinese government. It is necessary to identify the impacts of development zones on firms' innovation (hereinafter referred to as "innovation effects") as well as the possible knowledge spillover of development zones. Different types of zones, due to their different administrative levels and original purposes of establishment, may have different innovation effects. In this paper, the innovation effects of the Shanghai development zones are identified by using the geographic range of Shanghai development zones as well as geographic coordinates, patents, and research and development (R&D) data of manufacturing firms. The research results robustly show that there are significant and positive innovation effects of development zones. Through the use of regression analysis and by using firm data on both sides of zone boundaries, we observe

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knowledge spillovers. We also test a possible mechanism for the innovation effects of development zones.

Keywords: Development zone; innovation effects; knowledge spillover; selection effect; agglomeration effect.

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1. Introduction

The first economic and technological development zone (hereinafter referred to as the "development zone") was built with the approval of the Chinese government on September 25, 1984, which was an important reform and opening-up measure adopted by China due to the opening of 14 coastal cities. Typically, Chinese local governments delimited the areas on the edge of the cities to build development zones that were designed to facilitate the transformation of Chinese firms from an extensive type into an intensive type, and from a trade type into an independent innovation type. In 2021, 219 national development zones had a regional gross domestic production (GDP) of 9,136.4 trillion yuan,[1] which accounted for 12% of the national GDP, thus assuming a dominant role in the national economy. Over the past four decades, development zones' annual economic growth rate was 25% on average, driving China's national average up.

It has been discovered that some Chinese firms have relabeled some of their expenditure items as R&D expenditures in order to be recognized as high-tech firms to enter the development zones and benefit from tax reductions (Chen *et al.*, 2021). According to this discovery, if this relabeling method is widely used, the R&D and innovation capabilities of these firms entering the development zones will not improve as expected in comparison to other firms. Therefore, through this, we analyze the clustering effect and innovation spillover effect of development zones by using more detailed geographic information. The impact of development zones should be investigated further, as relabeling R&D expenditures determines whether firms can enter the zones in order to enjoy tax breaks. It is also worth studying the objective clustering and possible selection effects that development zones create geographically, which determine the sustained growth and innovation capacity of firms after entering the zones. Furthermore, the quality of audit and financial data varies significantly across regions in China, while Shanghai, the country's largest economic center, has a higher level of governance. Hence, we base our analysis on a sample of development zones and companies in Shanghai. This lessens the effect of rebranding to some degree.

The development zones constructed by China are dated from the regional experimental method that is often adopted during its transformation into the market economy. During the 1980s and 1990s, China developed and opened up cities such as Shenzhen and Shanghai

[1] *Data source*: The website of the Ministry of Commerce of the People's Republic of China, accessed May 23, 2022, http://wzs.mofcom.gov.cn/article/ezone/tjsj/nd/202205/20220503313451.shtml.

through the use of development zones, which were an important policy experiment made by the Chinese government to attract foreign capital, develop science and technology, and expand the urban economy on a large scale. China's development zones play a key role in many aspects, including introducing advanced technologies and facilitating the combination of technologies with firm production. The contribution of the paper lies in the fact that we identify the impacts of development zones on firm innovation (innovation effects) using geographical coordinate data and further analyze the knowledge spillover and sources of innovation effects of development zones based on various indicators, which include patent applications and R&D expenditure.

2. Background and Literature Review

2.1. *Background*

Chinese development zones[2] indicate specific regions of a certain range divided by a local government and in which special policies and management measures are adopted to attract external economic factors to boost local development. Development zones have relevant management committees and investment firms in charge of funding, constructing, and developing the zones, with the nature of a governmental functional department. Their main administrative staff are generally the senior administrative staff of the local government. According to China's policies for foreign enterprises, development zones provide tax relief (e.g. corporate income tax) to encourage projects of foreign direct investment (FDI) firms, and the purpose is to use industrial land provided at a preferential price as well as other preferential policies to further attract various firms to run factories by virtue of funds and technologies. Generally, development zones are located at the urban fringe, covering a large area and equipped with complete infrastructure facilities, which can boost the local economy after attracting investments. It is worth noting that the same management model has been adopted by the industrial parks built abroad with the assistance of China. Taking the China–Belarus Great Stone Industrial Park as an example, the Chinese industrial park management model was replicated in the form of the China–Belarus Great Stone Industrial Park Co., Ltd., which was built to take charge of land development, investment attraction, as well as the operation and management of the park.

The Chinese development zones often play as a key factor in contributing to the innovation and various implementations of industrial policies. It can be seen that the innovation capacities of firms within the zones are directly improved, thanks to the implementation of various preferential policies, which will then promote urban economic development and productivity growth. The investment attraction policies of development zones are mainly manifested by tax preference, simplified governmental approval process, talent introduction and cultivation, as well as a good software and hardware environment. It is worth noting that the policy measures for firm innovation with prominent meaning

[2] Sometimes called Industrial Parks. However, the industrial park is one of the types of development zones. Chinese development zones include economic and technological development zones, bonded zones, hi-tech development zones, and national tourist resort.

include: (i) Building materials, production devices, raw materials, parts as well as accessories, components, traffic tools and office articles imported by the firms in development zones for private use, tariff and import tax exemption; (ii) talent introduction and cultivation: attracting or cultivating top talents and high-level management and technical talents in possession of key technologies and proprietary intellectual property rights or with a high level of management at home and abroad through many forms such as allowance for talent introduction and talent apartment; and (iii) encouraging firms to use high technology, new processes, and intelligent tools in their manufacturing through technical innovation and transformation.

From 1992 to 2003, China embraced a boom of development zones. In addition to the continuous and rapid growth of development zones in coastal areas, inland cities began to establish development zones in order to reverse the situation of unbalanced regional development. However, this resulted in considerable confusion and a massive resource misallocation. In November 2003, development zones were revoked, and from 2004 to 2006, rectified by the State Council, which effectively solved the waste of land resources caused by the blind expansion of development zones. From 2006 to the present, China's development zones have entered a period of stable development.

2.2. *Literature review*

2.2.1. *Market-formed agglomeration and its effects*

Studies on spatial agglomeration and innovation in development zones are mainly based on Marshall's industrial district theory, Weber's theory of industrial location, and Hoover's optimal scale location theory. Marshall, an early representative of the New Classical Economics, first introduced the concept of "industrial district" in his *Principles of Economics* (Marshall, 1890), arguing that agglomeration refers to the geographical concentration of enterprises and industries as well as their geographical proximity, and that the economic motivation for agglomeration is economies of scale and external economic effects. In an industrial zone, a large number of enterprises gather here to provide a wide variety of jobs, which makes the labor market highly concentrated, thus making it easier and closer for enterprises and professionals to contact each other, thus effectively reducing the search and matching costs in the process of mutual matching between the two demand sides, and the neighboring enterprises can also share those production service facilities with large investments (Garfamy, 2011). The establishment of development zones in areas with more productive resources can create industrial agglomerations for sustainable growth and further enhance the external economic effects of industrial zones, such as scale effects and technology (Lin *et al.*, 2006).

Based on Marshall's industrial district theory, German economist Weber (1913) was the first to introduce the term "agglomeration economy" and analyzed the cost factors affecting the spatial location of industrial clusters, while location factors are the cost advantages obtained when industrial economic activities occur at specific costs. Hoover (1936), building on the theories of Marshall and Weber, looked at the effects of many factors on location, such as the fact that production inputs can be switched out and that transportation costs are getting more complicated.

Further research by Vedovello (1997) argued that geographic proximity does not have a large influence on firm-university linkages. By studying science parks in the United States, Link and Scott (2003) discovered that the development of academic-to-technological applications is directly related to the geographic proximity of universities and science parks; Löfsten and Lindelöf (2002) argued that due to their geographical proximity, firms in the parks tend to have more connections with local universities and have higher innovation capacity and market competitiveness. In contrast, according to Siegel *et al.* (2003), firms outside the parks have relatively lower R&D capabilities and productivity compared to those inside the parks.

The new theory of economic geography opens up new horizons on this issue. According to Krugman (1991) who delved into the micro-mechanisms of industrial agglomeration and industrial transfer, it can provide new explanations for phenomena such as imperfect competition and the transfer of industries alongside economies of scale. Therefore, the study of micro-mechanisms like enterprise efficiency under this theoretical perspective will be able to enrich the research perspectives, including the study of the relationship between enterprise spatial agglomeration and enterprise efficiency. According to Fujita and Hu (2001) and Amiti (2005), a major difference between the new economic geography and the related traditional theories in explaining industrial agglomeration is the consideration of economies of scale and imperfect competition, thus providing a new theoretical basis for explaining the inner mechanisms of the industrial agglomeration process. It can be found that the formation mechanism of industrial agglomeration is studied from the perspective of new economic geography in the research on construction and development of development zones, where the industrial agglomeration is a dynamic and complex process, requiring a comprehensive analysis of the influence of factor flows, agglomeration rents, and location factors on the way of development of the zones, in addition to factors such as the evolution of the industry itself, technological evolution, and the dynamics of enterprise cooperation.

2.2.2. *Development zone policies in China*

The above studies show that spontaneous market-formed industrial agglomeration has positive externalities, but studies of government-led regional policies tend to find the opposite. There has been more research on regional policies and firm site election and agglomeration brought by them (Rosenthal and Strange, 2004; Arzaghi and Henderson, 2008; Greenstone *et al.*, 2010; Neumark and Kolko, 2010; Rossi-hansberg *et al.*, 2010; Kline and Moretti, 2014). However, it is generally concluded that only the economic resources of some regions are transferred to another region under regional policies. Such "zero-sum" adjustments will not result in new growth but may potentially result in resource misallocation due to intervention. However, such a viewpoint may not be supported in China's development zones, for which streamlined administration as well as institute decentralization, tax relief, talent, and preferential policies are attached to development zone policies in China. Therefore, by bringing together firms with efficiency in the optimal software and hardware environment, more growth and innovation may be realized.

By using data at the administrative level of the minimum unit, Lu *et al.* (2015) investigated the effects of development zone policies on employment, investment output, and firm news (entry and exit). Wang (2013) studied the influence of whether there was a development zone on the attraction of FDI by using county-level data. It is found that development zones have successfully helped improve China's FDI level. It's also important to note that the area's productivity went up without affecting the money that was invested in the area. Zheng *et al.* (2017) judged whether the firm was inside the industrial park according to the firm's longitude and latitude positioning to identify the productivity spillover effect of the industrial park and its influences on surrounding businesses and real estate. According to the information available, the positive role of development zones in these three aspects was confirmed, providing the Chinese local government with comprehensive opinions for reference to weigh the benefits and drawbacks of building development zones. By referring to the method Zheng *et al.* (2017) used at the firm level, the influence of development zones on firm innovation is mainly studied in this paper using geographical data.

2.2.3. *Agglomeration effect*

The agglomeration of economic activities includes simple geographic proximity and the geographic clustering of upstream and downstream enterprises (usually referred to as industrial agglomeration).

First of all, simple geographical proximity focuses mainly on how productivity and innovation change when firms come together. Feldman (1999), for example, said that the specific ways in which agglomeration affects innovation can be summed up as the innovation production function, the citation of patents, and the flow of technical workers and goods. Ellison and Glaeser (1999) looked into how endowment affects the way a region's economy grows together. Through difference-in-differences (DID), Greenstone *et al.* (2010) found a link between the number of large manufacturing firms in a region and the total factor productivity (TFP) of that region after a few years. It is concluded that the productivity agglomeration spillover effect of large firms is remarkable.

Secondly, research on industrial agglomeration appears to have generated more comprehensive conclusions. Blasio and Addario (2005) looked at how industrial agglomeration affects many things, such as the wages of workers, the flow of workers, jobs, and entrepreneurs. Freedman (2008) also came to the same conclusion that industrial agglomeration makes it easier for workers in the high-tech industry to move from one job to another. Previous research on the relationship between industrial concentration and the flow of workers shows that the agglomeration spillover effect can be caused by the exchange of staff. Besides, there are some studies associating the agglomeration with industry. Fan and Scott (2003) looked into the phenomenon of economic agglomeration in East Asia, especially in China. It is fair to say that industrial agglomeration had more positive effects on

TFP in China, where market-based economic reform was put into place more quickly. Lu and Tao (2009) used data from Chinese companies to study the economic and spatial agglomeration of China from 1998 to 2005. During this time, China experienced rapid economic agglomeration, according to the findings. However, the local governments' industrial protection evolved into a force that hampered the agglomeration. Aside from Marshallian Externalities, resource endowment, and scale economy, it was found that economic agglomeration was a major factor.

2.2.4. *Selection effect*

Besides thinking that productivity can be improved through agglomeration, Behrens *et al.* (2014) and Combes *et al.* (2012) found that large cities can attract firms with higher productivity to settle in through selection effect modeling of large cities. Thus the phenomena, including right advertence and broken tail, emerged on the left side of the productivity distribution of firms in large cities. Chinese development zones were built by relying on policies. However, the artificial "town in town" was objectively formed, which was similar to the agglomeration and selection effect of large cities. Below are some other similar studies. Luttmer (2007) believed that the reason for the fast urban economic growth was the improvement in productivity brought by the selection of successful firms. Integrating the firm heterogeneity model provided by Melitz (2003) with new economic and geographical models, Baldwin and Toshihiro (2006) found that firms with high productivity choose to settle in core regions with a larger market to proceed with production, while those with low productivity choose to settle in peripheral areas with a smaller market to proceed with production. If such a self-selection effect is not taken into account, the agglomeration effect may be overestimated. By the same token, such a selection mechanism also exists for labor. The labor with stronger capability chooses to be employed in the city and get a higher salary (Gould, 2005); even if the labor has information asymmetry on his understanding of his peer's ability, the labor with stronger capability will also choose to be employed in the city, which is a part of the reason that the urban productivity level is higher (Venables, 2011).

2.2.5. *Research hypothesis*

Under preferential policies and the relatively advanced administrative management system of development zones, the innovation capacity of the firms in the zones can be realized through two indirect mechanisms: (i) Selection effect: (potential) Innovative firms will be attracted to move into development zones from non-development zones under a series of tax revenue, talent, and preferential conditions. Meanwhile, hi-tech talents are also attracted to start-up businesses in development zones. Non-innovative firms or outdated capacity may be eliminated from development zones where there is an exit mechanism. To be noticeable, innovative firms choose to settle in development zones that are more favorable for innovation, which is different from the fact that innovative firms are passively distributed to development zones by governments; (ii) Agglomeration effect: In development zones, numerous firms are in geographic proximity to each other. When there are enough innovative firms in the zones, the knowledge will generate positive externalities and economies of scale through communication between the firms and their employees. Agglomeration may also lead to congestion effects and an increase in the cost of a firm's land rent and employees' cost of commuting; then the firms' innovation will be further affected. Through analysis of related theories and literature, the following research hypotheses are put forward in the paper:

Hypothesis 1: Development zones have significant and positive effects on firm innovation. And there is significant knowledge spillover from firms inside to outside.

Hypothesis 2: The innovation effects of development zones on manufacturing firms are realized through two mechanisms: The selection effect and the agglomeration effect.

Compared to the previous literature, the editorial contributions of this paper are as follows: (i) The effect of government-created development zones on firm innovation is discussed using precise geolocation data. This is not common in the previous literature, and the advantage of this is that we can identify a sample by precisely selecting a certain distance from the boundary or center of a development zone, which avoids the possible bias caused by identifying the effects of development zones through address keywords or fuzzy positioning. (ii) This paper focuses on identifying and distinguishing the sources of impacts on innovation (selection effect and agglomeration effect) and evaluating the two effects in the context of actual cases. Previous literature has affirmed the economic advantages of agglomeration while denying the effectiveness of government-led industrial zone policies. This paper gives some explanation through case study and empirical analysis that the ineffectiveness of industrial zone policies may mainly come from the disadvantages of the selection effect. The selection effect is often accompanied by subjective factors and rent-seeking risks, while the agglomeration effect is more objective and closer to the description of industrial agglomeration advantages in classical economic geography theory. Distinguishing between these two effects can help development zones weed out bureaucratic influences. The rest of the paper is organized as follows: In Sec. 3, we introduce the data, variables, and identification strategies; in Sec. 4, we empirically identify the direct and indirect influences of development zones on firm innovation; in Sec. 5, we deal with some in-depth discussions; we conclude and give some policy suggestions in Sec. 6.

3. Research Design

3.1. *Identification strategies*

The influences of development zones on firm innovation are mainly explored in the paper. The regression strategy is as follows:

$$\mathrm{Inno}_{ijtp} = \alpha_0 + \alpha_1\ \mathrm{Park}_{ijtp} + \alpha_2 X_{ijtp} + \lambda_j + \lambda_t + \lambda_p + \mu_{ijtp}, \tag{3.1}$$

where Inno_{ijtp} indicates a firm's innovation capacity, including innovative output and input; Park_{ijtp} is a dummy variable indicating whether the firm is within a development zone; X_{ijtp}

indicates the control variable of the geography and firm level; λ_j indicates the fixed effect of the industry; λ_t indicates the fixed effect of the year; λ_p indicates the fixed effect of the development zone boundary. As the addresses of most firms remain unchanged, firm fixed effect is not added. μ_{ijtp} indicates the error item. We used cluster errors on the firm level.

3.2. *Data*

The following are some of the reasons for using Shanghai firm data in the paper: (i) Shanghai, as China's most important economic center, has a good institutional environment. Overinvestment in infrastructure in the middle and western regions is avoided overall (Shi and Huang, 2014); (ii) Shanghai is among the provinces and cities that had various development zone systems during the early stages. The complete development zone construction system consists of one national high-tech development zone system (i.e. Shanghai Hi-Tech Development Zone) and one highly important financial reform pilot zone system (i.e. Lujiazui Finance and Trade Zone); (iii) the Chinese Industrial Enterprises Database (CIED) has the detailed information about the geographical locations of the firms in Shanghai, according to which the accurate longitudes and latitudes can be obtained. The scholars carrying out research by adopting similar methods also include Ding (2004) and Zheng and Kahn (2008).

The firm-level data are sourced from the CIED. As the micro-foundation for the industrial statistical yearbooks of the National Bureau of Statistics, the database records mainly the information as well as financial data of state-owned firms and large-scale non-state-owned firms across the country in detail, which includes the R&D inputs as well as the firm addresses. The data of the three time periods with high data quality are selected to carry out an empirical study, namely the data from 2001 to 2003, from 2005 to 2007, and from 2011 to 2013. Besides, the data are processed by referring to the methods adopted by Yu (2015). Corresponding longitudes and latitudes are also obtained according to the firm addresses provided by the CIED and by virtue of web service in Amap API.[3]

The geographical locations of the development zones are from the Announcement on the Catalogue of Boundaries of National Development Zones in Four Directions released by the former Ministry of Land and Resources (hereinafter referred to as the "Boundary Announcement").[4] The geographical ranges of all development zones are drawn by using ArcGIS software according to the ranges described by the Boundary Announcement. The firms' longitudes and latitudes are combined to determine whether they are located within the development zones. Taking the data from 2011 to 2013 as an example, the methods for judging whether a firm is inside the development zone can be differentiated by two

[3] Amap API address: https://lbs.amap.com/. There exists fixed conversion mode among Amap and international universal WGS1984 geographical coordinate system. The coordinate system of Amap is converted into WGS1984 coordinate system.

[4] Auxiliary information of development zones in Shanghai including year of establishment, features and historical origin is from Shanghai Municipal Commission of Economy and Informatization. The author is grateful to Shanghai Municipal Commission of Economy and Informatization for its help. WGS1984 coordinate system is also used for the map of the development zones.

Table 1. The difference in two methods.

Geographical coordinates \ Keywords		Whether inside the development zone: Yes	No	Total
Whether inside the development zone	Yes	2,294	5,204	7,498
	No	336	18,126	18,462
Total		2,630	23,330	25,960

Source: Authors collected from the CIED.

keywords, i.e. geographical coordinate positioning and address (Table 1), from which it can be found that most firms in the zone are identified as non-zone firms by judging whether the keywords, such as development zone, industrial park and industrial district, are included in the firm address. However, it is more accurate through geographical coordinate positioning.

3.3. *Variable definition and data description*

The explanatory variables in the paper are a firm's patent applications per hundred people and 100 *(R&D expenditure) per sale, which are used to weigh the firm's innovation input and output, respectively. In terms of patent applications, the number of patents applied for by the firm conducting the research in the year is used in the paper (including patents that have been issued since then). The data for the firm's patent applications are sourced from the website of the Shanghai Intellectual Property Information Service Platform.[5] The number of patent applications held by every hundred employees of the firm is utilized as the main explanatory variable to exclude the impact of the firm's size. Through fuzzy matching of the name of the firm sending patent applications with that in the CIED according to the methods adopted by He *et al.* (2016), a total of 102,100 patent applications are searched out, accounting for 39.4% of the patent applications after natural persons are eliminated. In terms of R&D expenditure, this paper reflects the algorithm of R&D expenditure after the price index of the fixed asset with the base period of 2000 is subtracted. Similarly, the proportion of R&D in the revenue is used as the explanatory variable to eliminate the influence of the firm's size. As there is a lack of data from 2011 to 2013 for R&D expenditure, the patent application is mainly used as the explanatory variable while R&D expenditure is used as the observation index of the robustness test.

When it comes to the control variable, the variable of geographical level includes the distance from the firm to the city center (Shanghai People's Square). As the financial firms are mainly located in the downtown of Shanghai, the degree of a firm's participation in the financial industry and its land rent level can be controlled in part by the distance to the city center. It is also worth noting that for the firms that settle in the development zones, their innovation activities will be influenced. As for the distance (Zheng *et al.*, 2017) to the main

[5] http://www.shanghaiip.cn/wasWeb/index.jsp.

Table 2. Descriptive statistics of variables.

Variable name	Symbol	Observation	Mean value	Standard deviation	Minimum value	Maximum value
Patent application	Patent	94,846	0.189	0.802	0	8.438
R&D expenditure	R&D	61,518	0.091	0.451	0	5.034576
Development zone	Park	94,846	0.203	0.402	0	1
Distance to the city center	kmToC	94,846	24.360	12.571	0.313	99.556
Distance to the universities	kmToU	94,846	15.306	10.085	0.027	90.561
Distance to the traffic hubs	kmToT	94,846	18.485	11.348	0.174	86.842
State-owned	SOE	94,846	0.050	0.218	0	1
Productivity	TFP	94,846	5.747	2.656	−3.765	16.029
Firm age	Age	94,846	10.425	10.476	0	151

Source: Authors collected from the CIED.

nearest universities (comprehensive and science and engineering universities among the former 211/985 universities) and traffic hubs (Hongqiao Railway Station, Shanghai Railway Station, Shanghai South Railway Station, Hongqiao Airport, and Pudong Airport), the former is used to control the influence on the firms brought by the knowledge spillover of the universities, while the latter is used to control the cost of the firms' staff and goods transportation. It should be noted that the distance to a university cannot fully measure the impact of knowledge spillovers from universities on firm innovation, as some firm-university collaborative research and development (R&D) activities are not distance-dependent. In general, closer geographic proximity increases the likelihood of communication between universities and firms.

The unit of the distance is the kilometer. The distance between the firm level includes the state-owned firm dummy variable (Girma *et al.*, 2009), TFP (calculated through the OP method) (Olley and Pakes, 1996), and firm age (Huergo and Jaumandreu, 2004). For descriptive statistics of variables, please refer to Table 2.

4. Regression Results

4.1. *Benchmark results*

We use the above data and a regression model to study the impact of development zones on firm innovation. The results of benchmark regression are shown in Table 3. Although this paper focuses on the impact of manufacturing-oriented development zones, there are also service-oriented development zones such as the Lujiazui Finance and Trade Zone in Shanghai. Nevertheless, we still treat the firms in this type of development zone as a treatment group in Column (1) of Table 3. Beverelli *et al.* (2017) and others believed that the opening and development of a modern service industry will be able to promote innovation and increase productivity in the manufacturing industry. The term "development zone" in the strict sense of this paper still refers to those manufacturing-oriented as well as, more importantly, the technology-oriented development zones. For this reason, in

Table 3. Benchmark regression.

	Patent application				Patent of invention	R&D
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Park	0.039***	0.044***	0.045***	0.041***	0.003**	0.063***
	(0.00804)	(0.008)	(0.008)	(0.008)	(0.001)	(0.007)
kmToC			0.001	0.001	0.000***	−0.002***
			(0.001)	(0.001)	(0.000)	(0.001)
kmToU			−0.001	−0.000	0.000	0.000
			(0.001)	(0.001)	(0.000)	(0.000)
kmToT			−0.002***	−0.002***	−0.001***	−0.000
			(0.001)	(0.001)	(0.000)	(0.000)
SOE				0.008	−0.003	0.059***
				(0.011)	(0.002)	(0.015)
TFP				0.040***	0.003***	0.022***
				(0.004)	(0.000)	(0.002)
Age				0.000	0.000***	0.002***
				(0.000)	(0.000)	(0.000)
Constant	−0.052***	−0.013	−0.001	−0.005	−0.001	−0.036***
	(0.0138)	(0.011)	(0.012)	(0.012)	(0.002)	(0.009)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	No	No	No	No	Yes	Yes
Observation	94,846	94,846	94,846	94,846	94,846	61,890
R^2	0.037	0.037	0.038	0.041	0.006	0.047

Note: ***indicates 1% significance level; **indicates 5% significance level.
Source: Authors collected from the CIED.

Columns (2)–(4), we treat firms in the service industry development zones as control groups.

In Columns (1)–(4), it is not difficult to find out that the development zones have a significant effect on the promotion of firm patent applications. It remained robust after controlling the geographical and firm-level variables in Columns (3) and (4). Benchmark regression results show that firms in the development zones have roughly 0.04 more patent applications than firms outside the development zones. Considering that the mean value of patent applications is only 0.189 patents per 100 people, the impact of the development zones is tremendous. The control variables that have a significant impact on corporate innovation include the distance to the transportation hub and firm productivity. The closer the distance is to the transportation hub, the more conducive it is to firm innovation. The higher the productivity, the more the patent applications will be. In Column (5), we use the number of invention patents per 100 people as the explanatory variable. For invention patents, they are more difficult to apply for than other types of patents. We find that the number of invention patent applications by firms in the development zones is also significantly higher than firms outside. In Column (6), the explanatory variables are replaced by the proportion of R&D expenditure in revenue, which shows that the innovation effect of development zones is very significant and stable. As the ratio of R&D spending to revenue is an important way to measure a company's innovation input and has a direct effect on the company's innovation output, we will use it as the main indicator of robustness in what follows.

4.2. *Endogeneity problem*

The positive externalities of knowledge lead to spillover effects of R&D and productivity (Grossman and Helpman, 1991; Zheng *et al.*, 2017; Boschma, 2005). The firms on both sides of the boundary will learn, influence, and penetrate each other, which will lead to a convergence in innovation levels. Therefore, regressions can be performed using samples of firms within some ranges on both sides of a development zone boundary. If the coefficient of the development zones becomes larger, this indicates the existence of spillover effects. This is because, when the range is small, the spillover of knowledge may bring the innovations of firms inside and outside the boundary very close. Table 4 shows the results

Table 4. Boundary regression results.

	Patent application			R&D expenditure		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Range	500 m	1000 m	500–1000 m	500 m	1000 m	500–1000 m
Park	0.038***	0.040***	0.045**	0.043***	0.059***	0.094***
	(0.013)	(0.011)	(0.020)	(0.009)	(0.008)	(0.015)
kmToC	0.006	0.008	0.007	0.033***	0.021***	0.017**
	(0.013)	(0.008)	(0.011)	(0.010)	(0.006)	(0.008)
kmToU	0.001	−0.001	0.000	−0.013**	−0.006	−0.001
	(0.008)	(0.005)	(0.007)	(0.006)	(0.003)	(0.005)
kmToT	−0.013	−0.011*	−0.009	−0.026***	−0.021***	−0.018***
	(0.009)	(0.006)	(0.008)	(0.007)	(0.004)	(0.006)
SOE	0.043	0.017	−0.017	0.068*	0.046*	0.016
	(0.032)	(0.024)	(0.031)	(0.040)	(0.024)	(0.032)
TFP	0.054***	0.042***	0.027***	0.021***	0.028***	0.036***
	(0.007)	(0.005)	(0.006)	(0.006)	(0.004)	(0.005)
Age	−0.002**	−0.001**	−0.001	0.001**	0.002***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	−0.014	−0.021	0.327	−0.356**	−0.257***	−0.340***
	(0.226)	(0.178)	(0.366)	(0.152)	(0.096)	(0.125)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	19,636	32,571	12,918	11,415	19,517	8,088
R^2	0.055	0.048	0.045	0.069	0.065	0.078

Note: ***indicates 1% significance level; **indicates 5% significance level; *indicates 10% significance level.
Source: Authors collected from the CIED.

of "boundary regression." In addition, by choosing firms closer to location, we partially exclude the effects of unobservable geographic variables and partially coped with endogenous problems caused by the missing variable.

Results in Table 4 show that the firms on the inside of the development zones have significantly higher per capita patent applications and R&D expenditures/revenue than those on the outside. The regression coefficient of the development zones is about 0.04, which is very close to the result of the benchmark regression. At the same time, with the expansion of the geographic range, the significant gap between the inside and the outside also becomes larger. The coefficient of the development zones in Column (6) reaches 0.094. This shows that there is a clear spillover effect of knowledge and innovation in the development zones. The closer it is to the development zone boundary, the more knowledge spillovers are received by firms. Compared with Columns (1) and (3), the coefficients of the same distance range are significantly different (a steady increase), which at least indicates that the firms entering the development zones are not all mediocre relying on relabeling (Chen *et al.*, 2021). The innovation and R&D capabilities of firms inside and outside the development zones should be heterogeneous, otherwise such large differences in coefficients will not arise.

It is worth mentioning that there still exists an endogeneity problem that may influence the result as the local government will distribute certain innovative firms to the development zones when approving the application for the range of the development zones. However, such firms have a lot of patent applications. Due to the selection bias of the sample, the role of the development zones may be overestimated. The work below is done to solve the problems of inspecting and coping with endogeneity.

For example, by taking the proportion of migrant populations (PMP) in all towns and streets where the firms are located in 2000 as the instrumental variable, foregoing endogeneity problems can be avoided through regression of the instrumental variable. The population index data are sourced from the 6th population census in 2000. As the instrument variable for the year 2000 may have a weakened correlation with explanatory variables after 2010, we only use data from 2001 to 2003 and 2005–2007 in this section. In Table A.1, we present the regression results using the proportion of non-Shanghai residents in the sixth population census in 2010 as the instrument variable and data from 2011 to 2013. We find that the regression results using the instrument variable are relatively similar. However, the coefficient of the first-stage regression becomes smaller, which may be due to the diminishing effect of the instrument variable after 2010 as Shanghai developed rapidly and the delineation of development zones became increasingly stable. For the regression result, please refer to Table 5. The reason for taking the population index of a town and street level as the instrumental variable is that the local government tends to distribute the street or town with dense migrant populations into a development zone when delimiting the range of the development zones. In this regard, first, it is convenient for the firms to recruit migrant workers. Second, the place where the native people live is usually livable and convenient, but the housing price is high and the cost of turning it into industrial land is also quite high. Furthermore, social problems can be easily caused. Many development zones in Shanghai are delimited along with the towns and

Table 5. Instrument variable regression.

Range	500 m			1,000 m		
	First stage (1)	Second stage (2)	Reduced form (3)	First stage (5)	Second stage (6)	Reduced form (7)
PMP	0.866***		0.220***	0.546***		0.128*
	(0.066)		(0.091)	(0.046)		(0.073)
Park		0.238***			0.235*	
		(0.104)			(0.133)	
kmToC	−0.030***	0.007	0.002	−0.025***	0.022**	0.016**
	(0.009)	(0.012)	(0.011)	(0.005)	(0.009)	(0.008)
kmToU	0.032***	−0.011	−0.007	0.011***	−0.010*	−0.007
	(0.006)	(0.009)	(0.008)	(0.003)	(0.005)	(0.005)
kmToT	0.011	−0.004	−0.003	0.017***	−0.016**	−0.012**
	(0.007)	(0.008)	(0.008)	(0.004)	(0.006)	(0.006)
SOE	−0.020	0.033	0.030	−0.081***	0.032	0.013
	(0.028)	(0.034)	(0.034)	(0.020)	(0.026)	(0.024)
TFP	0.005	0.030***	0.031***	0.009***	0.023***	0.025***
	(0.003)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)
Age	−0.004***	−0.001	−0.001**	−0.003***	−0.000	−0.001**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Constant	0.152	−0.004	0.015	0.195*	−0.256	−0.214
	(0.165)	(0.237)	(0.237)	(0.114)	(0.178)	(0.172)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	4,828	4,828	4,828	9,304	9,304	9,304
R^2	0.127	0.020	0.026	0.133	0.016	0.021
F statistics	173.43***			141.96***		
Cragg–Donald Wald *F* statistics		266.12***			188.53***	

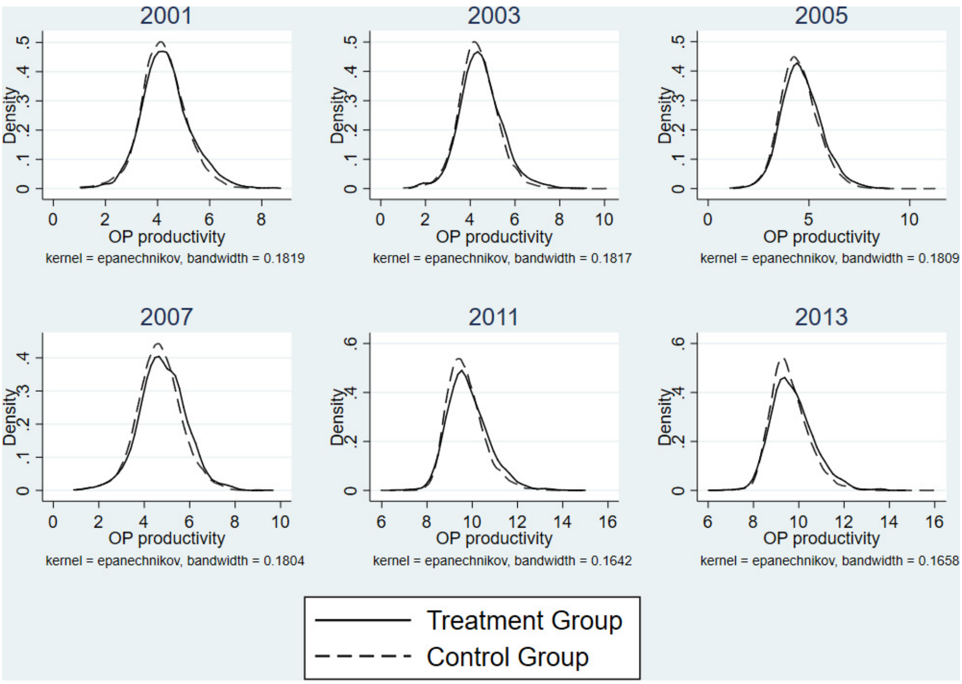
Note: ***indicates 1% significance level, **indicates 5% significance level, and *indicates 10% significance level.
Source: Authors collected from the CIED.

streets. Therefore, the firms in the towns and streets with dense migrant populations may be delimited within the range of the development zones. However, the proportion of migrant populations in the towns and streets can only have an influence on the firm innovation in the form of development zone. Therefore, the proportion of migrant populations can be taken as an instrumental variable.

In order to enhance the exogeneity of the instrumental variable, the firms on the development zone boundaries established after 2000 are used for regression analysis to control the fixed effect of the industry, time, and development zone boundary. For the regression result, please refer to Columns (1)–(3) of Table 4. The Phase-I F value and Cragg–Donald Wald F statistics exclude the possibility of weak instrumental variables. In Table 5, we use patent application as the dependent variable, and show the results of first stage, second stage, and reduced form. The coefficients of development zones and instruments are all positive and significant, which is robust in Table 4. The only one that is unexpected is that the coefficient of the development zones does not become larger as the range expands from 500 m to 1,000 m. Instrumental variables tend to amplify the coefficient of empirical results by about nine times (Jiang, 2017), which means the absolute value of coefficients in IV regression is difficult to control. In addition, as the instrumental variable regression is local average treatment effect (LATE), the estimated coefficient can only represent the influence of development zones where a proportion of migrant populations really helps zones to be established while the spillover effect may not be captured by the LATE.

4.3. *Robustness check*

Due to the preferential development zone policies, some innovative non-R&D firms choose to settle in the development zones to obtain a "policy-based lease." The ways to settle in the development zones may include political relevance, financial fraud (especially in the R&D expenditure projects). In this case, there is a certain error in the regression result. According to the study carried out by Combes *et al.* (2012), many factors, including agglomeration factors, may lead to the right advertisement and expansion of firm productivity. The selection effect may lead to the broken tail phenomenon on the left side of the productivity distribution of firms in the development zones. Fig. 1 shows the



Source: Made by the authors.

Fig. 1. Distribution of productivity of firms in and outside development zones.

productivity and kernel density distribution of firms inside and outside the development zones in many years. There indeed exists right advertisement and an expansion of productivity of firms inside the development zones, but there does not exist the broken tail phenomenon on the left side, which shows the rent-seeking firms with low productivity also settled in the development zones. This may also be due to firms' relabeling of R&D expenditures. (Chen *et al.*, 2021).

We artificially build a sample of "left-side tail-breaking" to exclude rent-seeking firms by deleting the treatment samples with the lowest productivity of 10% of the year. The regression results are shown in Table 6, where columns (1), (2), and (3) are results of patent applications as the dependent variable, and columns (4), (5), and (6) are regression results of R&D as the dependent variable. Compared with the benchmark regression, the coefficients of each development zone are basically lowered, but the conclusion is robust, and the law of increasing coefficients between different scopes still exists. This shows that while the development zone policies bring rent-seeking behavior, its innovation effect is still significant.

In addition, the Chinese government has rectified the development zones since 2003, and this work continued until 2006, after which China's development zones entered a period of stable development. We analyze the data of firms and patents from 2011 to 2013 in order to eliminate any possible measurement errors that may exist before and during the rectification. The results are shown in Columns (7)–(9) in Table 6. It can be found that as the distance range changes, the law of innovation spillover does not change, and the coefficients are significant and positive. It is worth noting that the coefficient of the development zones is greater than the benchmark regression result, which shows that the innovation effect of the development zones has been enhanced with the growth of the Chinese economy.

4.4. *Different types of development zones*

As mentioned earlier, there are various types of development zones in Shanghai, such as national-level zones, city-level zones, high-tech zones, processing trade zones, modern service industry zones, and specific industrial development zones. This paper intends to explore the heterogeneous impacts of various functional zones to test the possible differences in innovation effects of the zones as well as the administration levels and orientations of the zones associated with different policy influences on innovation effects directly. We use firms within a range of 1,000 m on both sides of the development zone boundaries to test the role of different types of development zones on innovation. The regression results for patent applications are shown in Table 7. Table 8 shows results for R&D expenditure.

First of all, the regression coefficient of national development zones is significantly higher than that of municipal development zones and even higher than 0.04 in the benchmark regression. The coefficient of city development zones is only 0.0267. Secondly, development zones with different functions play different roles in promoting firm innovation. We examine the impact of high-tech development zones and export processing zones, respectively. The results show that the role of high-tech development zones in

Table 6. Robustness check.

	Patent application			R&D expenditure			Patent application		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Range	500 m	1000 m	500–1000 m	500 m	1000 m	500–1000 m	500 m	1000 m	500–1000 m
Park	0.0321**	0.0365***	0.0410*	0.0416***	0.0579***	0.0921***	0.0541*	0.0766***	0.0960**
	(0.0127)	(0.0106)	(0.0210)	(0.00908)	(0.00852)	(0.0166)	(0.0273)	(0.0231)	(0.0445)
kmToC	0.00143	0.00761	0.0113	0.0272***	0.0176***	0.0171**	0.0118	−0.0123	−0.0491**
	(0.0138)	(0.00847)	(0.0116)	(0.00976)	(0.00586)	(0.00862)	(0.0333)	(0.0202)	(0.0245)
kmToU	0.00191	−0.00236	−0.00390	−0.0108*	−0.00324	0.000459	0.0153	0.0150	0.00952
	(0.00912)	(0.00584)	(0.00786)	(0.00596)	(0.00371)	(0.00502)	(0.0186)	(0.0129)	(0.0151)
kmToT	−0.00958	−0.00939	−0.0101	−0.0230***	−0.0191***	−0.0202***	−0.0267	−0.00376	0.0365**
	(0.0101)	(0.00594)	(0.00802)	(0.00637)	(0.00402)	(0.00627)	(0.0244)	(0.0139)	(0.0175)
SOE	0.0425	0.0161	−0.0192	0.0897*	0.0578**	0.0193	0.0756	−0.0140	−0.0868
	(0.0374)	(0.0256)	(0.0310)	(0.0465)	(0.0276)	(0.0352)	(0.0935)	(0.0706)	(0.0920)
TFP	0.0837***	0.0678***	0.0483***	0.0484***	0.0563***	0.0626***	0.147***	0.117***	0.0690***
	(0.0124)	(0.00862)	(0.00975)	(0.00942)	(0.00658)	(0.00858)	(0.0251)	(0.0174)	(0.0199)
Age	−0.00112	−0.000929	−0.000492	0.00221***	0.00329***	0.00530***	−0.00267	−0.00336**	−0.00529**
	(0.000768)	(0.000622)	(0.00104)	(0.000744)	(0.000711)	(0.00124)	(0.00183)	(0.00159)	(0.00242)
Constant	−0.0141	0.327	−0.257***	−0.0215	−0.356**	−0.340***	−1.210*	−0.534	0.731
	(0.226)	(0.366)	(0.0958)	(0.178)	(0.152)	(0.125)	(0.634)	(0.503)	(0.781)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	17,779	29,428	11,635	10,427	17,783	7,345	6,632	10,539	3,904
R^2	0.057	0.050	0.048	0.075	0.072	0.086	0.053	0.045	0.060

Note: ***indicates 1% significance level; **indicates 5% significance level; *indicates 10% significance level.
Source: Authors collected from the CIED.

Table 7. Patent applications in different types of development zones.

	Patent application			
Dependent variable	(1) National-level zones	(2) High-tech zones	(3) City-level zones	(4) Processing trade zones
Types				
Park	0.073***	0.322***	0.027*	0.029
	(0.024)	(0.078)	(0.016)	(0.030)
kmToC	0.016	−0.318***	0.005	−0.082
	(0.022)	(0.092)	(0.012)	(0.058)
kmToU	−0.007	0.032	0.001	0.012
	(0.009)	(0.051)	(0.007)	(0.028)
kmToT	−0.011	0.319***	−0.010	0.066
	(0.024)	(0.098)	(0.008)	(0.059)
SOE	0.025	−0.028	0.023	−0.085
	(0.058)	(0.039)	(0.045)	(0.054)
TFP	0.047***	0.055***	0.039***	0.018*
	(0.009)	(0.016)	(0.009)	(0.010)
Age	0.002***	0.002*	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	−5.054***	−3.129	−0.676	−0.912
	(1.790)	(1.985)	(1.686)	(2.938)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes
Observation	11,042	2,515	22,232	3,620
R^2	0.050	0.103	0.049	0.056

Note: ***indicates 1% significance level; *indicates 10% significance level.
Source: Authors collected from the CIED.

Table 8. R&D expenditure in different types of development zones.

	R&D expenditure			
Dependent variable	(1) National-level zones	(2) High-tech zones	(3) City-level zones	(4) Processing trade zones
Types				
Park	0.109***	0.225***	0.008	0.101**
	(0.020)	(0.074)	(0.010)	(0.040)
kmToC	0.014	−0.009	0.010	0.047
	(0.020)	(0.077)	(0.008)	(0.129)
kmToU	−0.014*	−0.118***	−0.002	−0.043
	(0.007)	(0.039)	(0.004)	(0.043)
kmToT	−0.014	0.075	−0.008	−0.007
	(0.018)	(0.093)	(0.005)	(0.084)

(*Continued*)

Table 8. (*Continued*)

	R&D expenditure			
Dependent variable	(1) National-level zones	(2) High-tech zones	(3) City-level zones	(4) Processing trade zones
State	0.063	−0.044	0.054*	−0.007
	(0.052)	(0.075)	(0.032)	(0.122)
TFP	0.040***	0.049*	0.011***	0.032*
	(0.009)	(0.026)	(0.004)	(0.017)
Age	−0.003*	−0.004	−0.001	0.000
	(0.001)	(0.003)	(0.001)	(0.003)
Constant	5.230**	8.363	2.080	−0.641
	(2.465)	(5.736)	(1.520)	(4.722)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes
Observation	6,846	1,695	13,248	2,172
R^2	0.094	0.162	0.033	0.098

Note: ***indicates 1% significance level; **indicates 5% significance level; *indicates 10% significance level.
Source: Authors collected from the CIED.

promoting innovation is very high. The coefficient of development zones is as high as 0.322. This coefficient is similar to the result of the regression of instrumental variables. While in the processing trade zone, the regression coefficient is 0.029, which is not statistically significant. The regression results in Table 8 are similar to those in Table 7 and will not be discussed further.

In summary, the development zones have a significant promotion effect on firm innovation input and output and a significant knowledge spillover effect. This conclusion is still sound after using boundary differences, dealing with endogeneity, and a rent-seeking problem. National development zones and high-tech development zones have a bigger impact, and high-tech development zones have an even bigger impact. This may show that China's policies for development zones have been more successful in encouraging corporate innovation.

5. Selection Effect and Agglomeration Effect

5.1. *Selection effect*

The selection effect of development zones is to attract new firms with higher innovation capabilities to settle in the development zones. To estimate the size of this selection effect, we define new firms inside or close to development zones, which were established after the development zones, as "Newfirms," and add the interaction term between the explanatory variable "Park" and "Newfirms" to the regression equation. By examining the changes in the explanatory variable coefficient and the significance and magnitude of the interaction term coefficient, we can estimate the impact of the development zones on both new and old

Table 9. Selection effect.

	Patent application			R&D expenditure		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Range	500 m	500–1000 m	1000 m			
Park	0.009	0.010	0.035	0.018	0.024	0.025
	(0.015)	(0.009)	(0.023)	(0.019)	(0.028)	(0.017)
Park × Newfirms	0.028***	0.040***	0.059*			
	(0.007)	(0.014)	(0.030)			
Park × Agglomeration				0.000	0.001	0.001
				(0.002)	(0.003)	(0.002)
kmToC	0.004	0.017**	0.024**	0.001	0.001	0.001
	(0.011)	(0.008)	(0.012)	(0.001)	(0.001)	(0.001)
kmToU	−0.009	−0.008	−0.002	−0.001	−0.001	−0.001
	(0.008)	(0.005)	(0.008)	(0.001)	(0.001)	(0.001)
kmToT	−0.005	−0.013**	−0.022**	−0.002***	−0.002***	−0.002***
	(0.008)	(0.006)	(0.009)	(0.001)	(0.001)	(0.001)
SOE	0.029	0.013	−0.018	−0.007	−0.008	−0.006
	(0.034)	(0.025)	(0.032)	(0.010)	(0.010)	(0.010)
TFP	0.031***	0.025***	0.018***	0.022***	0.022***	0.022***
	(0.005)	(0.004)	(0.006)	(0.003)	(0.003)	(0.003)
Age	−0.001*	−0.001*	−0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Constant	0.061	−0.137	−0.018	−0.020	−0.021	−0.025
	(0.225)	(0.166)	(0.399)	(0.015)	(0.017)	(0.016)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	19,636	12,918	32,571	94,846	94,846	94,846
R^2	0.026	0.022	0.028	0.015	0.015	0.015

Source: Authors collected from the CIED.
Notes: ***indicates 1% significance level; **indicates 5% significance level; *indicates 10% significance level.

firms. We still use the firms within 500 m, 1,000 m, and 500–1,000 m on both sides of the boundary for regression. The regression results are shown in Table 9.

Table 9 uses the patent application as the explanatory variable. After including the interaction term between the explanatory variable and "Newfirms", we find that the coefficient of the explanatory variable becomes smaller and is no longer statistically significant. However, the coefficient of the interaction term is significantly positive. For example, for the firms located within 500 m on both sides of the boundary, the average effect of the development zones on the innovation of "in-place firms" is 0.009, while the average effect on the innovation of new firms is 0.037, which is similar to the benchmark result. The regression with the interaction term indicates that the innovation effect of the development zones mainly comes from new firms. After excluding the effect shown by the interaction term, the coefficient of the explanatory variable represents that on in-place firms, and we find that this effect becomes very small and insignificant.

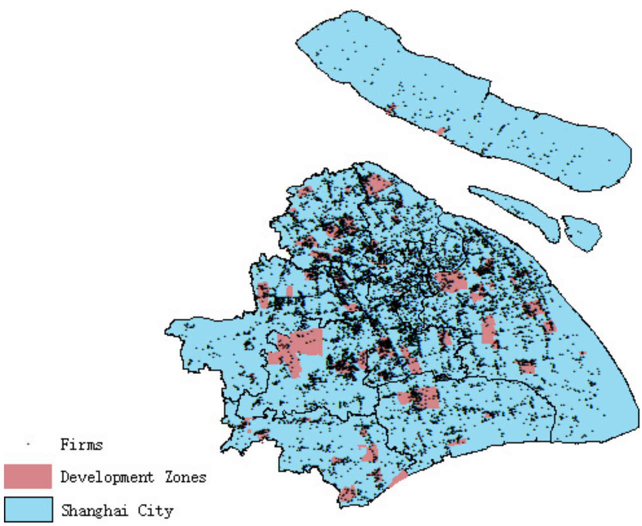
5.2. *Agglomeration effect*

It is well known that knowledge has spillover effects, which makes it possible for any firm to absorb the knowledge produced by other firms. This absorption can occur through learning, imitation, and dissemination. The geographical proximity facilitates communication between firms, and the knowledge spillover is more obvious. Glaeser *et al.* (1992) called this innovative mechanism as "Jacobs' Externality." We refer to the settings of Desmet and Rossi-Hansberg (2010) and Rossi-Hansberg (2004), and set the agglomeration index of firms as follows:

$$\mathrm{Agg}_{it} = \sum_{i \neq j} e^{-\delta d_{ijt}}, \tag{5.1}$$

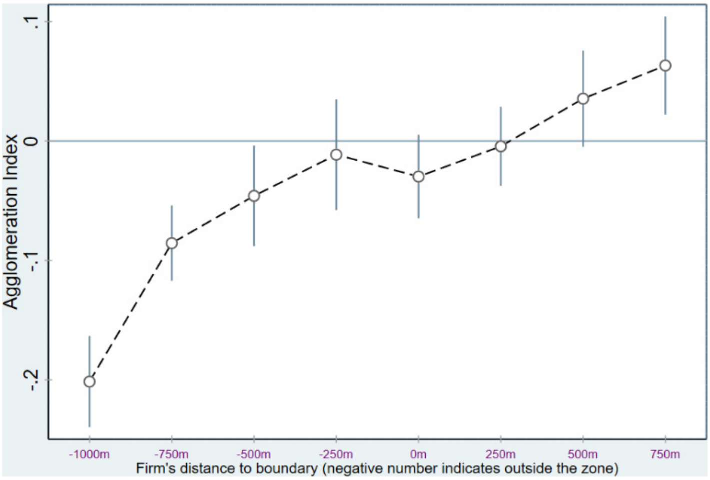
where d_{ijt} indicates distance between firms i and j. Here, we set the coefficient $\delta = 0.05$.

First of all, the establishment of development zones have brought about geographical agglomeration of firms, which can be seen intuitively from Fig. 2. Secondly, we segment the distance from the firms to the boundaries of development zones and use the obtained dummy variable as the independent variable to regress on firm agglomeration index. We plot the regression coefficients and 95% confidence intervals in Fig. 3, and it is obvious that the closer to the center of the development zones, the stronger the degree of agglomeration will be. This increase in agglomeration is an important channel for innovation, and will lead to an increase of spillover effects in development zones.



Source: Made by the authors.

Fig. 2. Distribution of firms (2007) and development zones in Shanghai.



Source: Made by the authors.

Fig. 3. Degree of agglomeration inside and outside the development zones.

Columns (4)–(6) in Table 9 present the regression results with the inclusion of interaction terms between explanatory variables and agglomeration index. To prevent the influence of distant firms from entering into the calculation process of Eq. (5.1), we limit the distances between firms in Eq. (5.1) to 5 kilometers and 10 kilometers, and the results are shown in Columns (5) and (6), respectively. We find that, firstly, the coefficients of the benchmark regression become smaller, and secondly, the coefficients of the interaction terms are no longer significant. This suggests that although the development zones bring about geographical agglomeration of firms, the agglomeration does not lead to innovation effects. It is generally believed that geographical agglomeration may lead to both knowledge spillovers and congestion effects (Desmet and Rossi-Hansberg, 2010), with the former being more favorable for innovation. However, our study of Shanghai's development zones shows that such knowledge spillovers are not significant.

6. Conclusion

This paper reviews the literature on development zones, selection effects, and economic agglomeration before proposing research hypotheses based on the findings. We next utilize a combination of geographic data, patent data, and firm R&D data to determine if development zones can encourage innovation and the spillover of innovation effects. We also investigate the influence of selection and agglomeration effects in development zone innovation promotion. The conclusions of this paper mainly include the following: The development zones have a considerable and stable impact on innovation, and there are certain spillover effects. Among them, high-tech zones and national-level zones, which are designed to promote high-tech development, have a greater impact on firm innovation, indicating that China's development zones are not simply agglomerations of firms. We study the mechanism behind this innovation effect and discover that development zones incubate more innovative entrepreneurial firms through the selection effect, and the development zones have greatly improved the degree of geographical agglomeration of firms, but agglomeration does not seem to bring innovation.

In fact, local governments in China play key role in distributing firms into development zones. This empirical study finds that the selection effect explains most of the innovation effect of the zone, but it is also the biggest risk factor. On the one hand, it increases the risk of companies entering the zones through financial fraud, and on the other hand, it increases the possibility of companies getting more support through rent-seeking in the zones, which can lead to a waste of good resources and an overall loss of welfare in the zones. The agglomeration effect, on the other hand, is relatively more objective and less man-made. If the knowledge spillover brought by geographical agglomeration can be enhanced and the congestion effect can be reduced, the development zone policies in China may bring better innovation effects.

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Appendix A

Table A.1. Instrumental variable regression (2011–2013).

	500 m			1000 m		
Range	First stage (1)	Second stage (2)	Reduced form (3)	First stage (5)	Second stage (6)	Reduced form (7)
PMP	0.449***		0.098	0.400***		0.230*
	(0.063)		(0.159)	(0.045)		(0.133)
Park		0.220***			0.577*	
		(0.053)			(0.340)	
kmToC	0.041***	0.006	0.015	0.003	−0.008	−0.007
	(0.012)	(0.036)	(0.033)	(0.009)	(0.020)	(0.021)
kmToU	−0.013**	0.017	0.014	−0.005	0.016	0.013
	(0.006)	(0.020)	(0.018)	(0.005)	(0.014)	(0.013)
kmToT	−0.031***	−0.022	−0.028	0.004	−0.008	−0.005
	(0.009)	(0.026)	(0.025)	(0.007)	(0.013)	(0.014)
SOE	−0.087*	0.088	0.073	−0.138***	0.048	−0.026
	(0.051)	(0.095)	(0.093)	(0.039)	(0.088)	(0.070)
TFP	0.028***	0.143***	0.149***	0.032***	0.103***	0.120***
	(0.007)	(0.026)	(0.025)	(0.004)	(0.018)	(0.017)

Table A.1. (*Continued*)

	500 m			1000 m		
Range	First stage (1)	Second stage (2)	Reduced form (3)	First stage (5)	Second stage (6)	Reduced form (7)
Age	−0.004***	−0.002	−0.003	−0.004***	−0.002	−0.004**
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Constant	−0.361	−1.207*	−1.293**	−0.227	−0.594	−0.714
	(0.259)	(0.632)	(0.639)	(0.199)	(0.542)	(0.517)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Boundary FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	2,414	2,414	2,414	4,653	4,653	4,653
R^2	0.109	0.049	0.053	0.122	0.006	0.045
F test	49.29***			78.42***		
Cragg–Donald Wald F statistics		58.63***			92.47***	

Note: ***indicates 1% significance level; **indicates 5% significance level; *indicates 10% significance level.
Source: Authors collected from the CIED.

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