Development zone spillover effect: the externality of the gathering of manufacturing enterprises

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Abstract. Using the data of manufacturing enterprises from 2003 to 2013 and the data of the state-level economic and technological development zone and high-tech development zone from 2010 to 2012, this paper uses BD-DD dual robust identification strategy to analyse the impact mechanism of the overflow effect of the establishment of state-level development zones by accurately judging the geographical relationship between enterprises and development zones. The results show that the development zone has a significant spillover effect on the surrounding manufacturing enterprises, and the total factor productivity of enterprises within 1000m is about 9% higher than that of enterprises within 1000m from the boundary of the development zone and the existence of Marshall's adjust theory is tested. Spillover effects have a range of 1000m on innovation, while human capital is only 500m, indicating that knowledge spillover effects established in development zones are the main source of gathering externality. From the different characteristics of manufacturing, high-tech or mature manufacturing enterprises are more affected by spillover effects, possibly because high-tech or mature enterprises and regional enterprises overlap more in factors of production or technology, it is more likely to form Marshall cluster externality.

1 Introduction

The development zone is an important industrial policy for Chinese government to guide the industry to gather, develop the open economy and promote the local economic development. Many studies have also found that development zone has a catalysing effect on the output, investment and efficiency of enterprises(Wang,2013;Zhang et al,2016).[3]-[4] If the production efficiency of enterprises outside the scope of the development zone has also improved after the policy, it means that in addition to the efficiency improvement brought about by the adjust of enterprises in the development zone, it also plays a positive role in promoting the local economy, which is also an important purpose of the development zone policy-making.

However, there is a lack of means to judge the relative geographical location of enterprises, and the research on the effect of development zone pays more attention to the influence brought about by the clustering effect. From the perspective of local government's economic development, the overall impact of the development zone on the local economy is more important. Zheng et al. (2017) has the similar ideas with the study: the impact of the spillover effects of the development zone on TFP and consumer activities such as retail and real estate in the surrounding regions was analyzed using micro-enterprise data.[5] But Zheng et al. (2017) The single-center city hypothesis is that the same area from the city center is completely replaceable, which is difficult to coincide with the current situation of

urban development in China, and cross-sectional regression is difficult to control the interference of factors that change over time.[5]

The reasons why the spillover effect in the development zone causes concern is the necessity and importance of the study from the perspective of explaining the mechanism causes of the spillover effect. Domestic scholars on the above spillover effects of the study is very few.

Therefore, this paper analyzes the characteristics and impact paths of the spillover effects of the establishment of development zones on local enterprises using manufacturing enterprise data for 2003-2013 and national development zone data for 2010-2012. This study will provide a new perspective for assessing the impact of development zone policies on the local economy and provide a reference for future economic policy formulation.

2 Theoretical Framework and Hypothesis

The starting point of this paper is that the development zone will produce the externality of enterprise ad collecting, and this externality can have spillover effects in labour market, intermediate products, knowledge spillover and so on. We first guide our empirical study by establishing a simple homogeneity enterprise model that shows how the spillover effects of the development zone affect the local decisions of the surrounding

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enterprises, and then incorporating the heterogeneity of the enterprise into the model to examine the differences in the impact of the spillover effects on different types of enterprises.

2.1. Effecting Mechanism

Based on Marshall's economic theory of a clustering, the spillover effect of the development zone is the manifestation of the externality of the enterprise a cluster, and the enterprises gathered around the development zone increase productivity by sharing the thick labour market, low-cost intermediate products, and obtaining knowledge spillover with the enterprises in the region.

Development zones create a thick labour market, and external enterprises close to the border are able to share the labour market with enterprises in the region, thereby improving the quality of their human capital.

The knowledge spillover generated by the innovation activities of enterprises in the development zone will also improve the innovation level of the surrounding enterprises. The development zone promotes innovation between enterprises in the region in terms of policy incentives and enterprise screening.

Finally, companies around the development zone can also share the intermediates market with companies in the region to increase productivity by providing quality services and middlemen (Glaeser and Kohlhase,2003) at a lower cost.[1]

2.2 Homogeneity enterprises

Consider a fully competitive market, and the enterprises around the development zone use labour, capital, and land for production at a given price (standardized to 1). The enterprise chooses labour Capital and land the amount of input to maximize profits:

$$\textbf{Max}\, f\,(A,L,K,T)\text{-}wL\text{-}rK\text{-}qT \qquad (1)$$

Above this, w, r and q represents the factor price, A represents total factor productivity (TFP)for an enterprise. The change of A represents the spillover effect. Under the condition that the endo-technology of the enterprise is unchanged, the spillover effect of enterprise can affect the enterprise TFP by affecting the human capital quality (H)and innovation level(N) of the enterprises around the development zone. It is generally believed that the quality and level of innovation of human capital in an enterprise is positively related to TFP: $\partial A/\partial H>0,\partial A/\partial N>0$. In order to explore the mechanism of spillover effect affecting enterprise TFP, the quality of capital and the level of enterprise innovation are the distance(d) from the boundary of the development zone Functions of : H=H(d),N=N(d). At the same time, because the development zone is full of high-tech enterprises, and has a sound infrastructure, so we believe that the closer to the boundary of the development zone, the higher the quality of human capital and the level of enterprise innovation: $\partial H/\partial d<0,\partial N/\partial d<0$.

The optimal factor input and labor supply function and land supply function are substituted to solve the expression of enterprise profit maximization:

$$\pi^*=f\,(A(H(d),N(d)),L^*\,(w(d),r,q(d)),K^*\,(w(d),r,q(d)),T^*\,(w(d),r,q(d)))\,\text{-}wL^*\,(w(d),r,q(d))\text{-}rK^*\,(w(d),r,q(d))\text{-}qT^*\,(w(d),r,q(d)) \qquad (2)$$

It can be seen that the enterprise TFP,wages and land prices are the distance from the boundary of the development zone the function of . Pair the upper sides to the distance(d), then we find a guide:

$$\partial\pi^*/\partial N=(\partial f/\partial A)^*(\partial A/\partial N)\text{-}[(\partial w/\partial N)L^*+(\partial q/\partial N)T^*\,]+[(\partial L^*/\partial w)^*(\partial w/\partial N^*)+(\partial L^*/\partial q)^*(\partial q/\partial N)(\partial f/\partial L^*\,\text{-}w)]\,+[(\partial K^*/\partial w)^*(\partial w/\partial N)+(\partial K^*/\partial q)^*(\partial q/\partial N)(\partial f/\partial K^*\text{-}r)]+[\,(\partial T^*/\partial w)^*(\partial w/\partial N)+(\partial T^*/\partial q)^*(\partial q/\partial N)(\partial f/\partial T^*\,\text{-}q)] \qquad (3)$$

In a fully competitive market, the marginal output of the factor is equal to its price, so the upper can be simplified to:

$$\partial\pi^*/\partial d=(\partial f/\partial A)^*[(\partial A/\partial H)^*(\partial H/\partial d)+(\partial A/\partial N)^*(\partial N/\partial d)]\,\text{-}(\partial w/\partial d)\,L^*+(\partial q/\partial d)T^*\,) \qquad (4)$$

2.3 Heterogeneous Enterprises

Since the market is completely competitive, in the long run the excess profit earned by the company due to its position advantage is zero, and we get:

$$(\partial f/\partial A)^*[(\partial A/\partial H)^*(\partial H/\partial d)+(\partial A/\partial N)^*(\partial N/\partial d)]=(\partial w/\partial d)\,L^*+\partial q/\partial d\,T^*\,) \qquad (5)$$

We set φ=[(∂A∕∂H)(∂H∕d)+(∂A∕∂N)(∂N∕d)], simplified to:

$$(\partial f/\partial A)^*\varphi=(\partial w/\partial d)\,L^*+(\partial q/\partial d)\,T^* \qquad (6)$$

Two types of enterprises are considered: high-tech enterprises and low-tech enterprises, and assuming that the two types of enterprises have the same distance to the boundary of the development zone, the price of the land they use should also be equal.

Suppose that both types of enterprises use - production techniques, in the case of the same number of factor inputs for both types of enterprises: $\partial f_H/\partial A_H = \partial f_L/\partial A_L$, and we get:

$$|\varphi_H\,|>|\varphi_L\,| \qquad (7)$$

This suggests that in the long run, the spillover effect of the development zone may have a greater impact on high-tech enterprises than that of low-tech enterprises. Similarly, assuming that the quality of human capital of mature enterprises is higher than that of young enterprises, mature enterprises may be more affected by spillover effects. The reason may be that the development zone is full of high-tech enterprises, high-tech or mature enterprises in human capital, technology, intermediate input and other aspects of the overlap with

enterprises in the region is higher, so it is easier to form cooperation and learning effects.

2.4 Assumptions

We get four study hypotheses:

Hypothesis 1: The cluster of enterprises around the development zone is due to the existence of spillover effects, which make the TFP of enterprises around the development zone higher than that of enterprises farther away.

Hypothesis 2: The spillover effect may improve the TFP of the enterprise by improving the quality of human capital of the surrounding enterprises, so the quality of human capital of the enterprises around the development zone will be higher than that of the enterprises farther away.

Hypothesis 3: The spillover effect may improve the TFP by improving the innovation ability of the surrounding enterprises, so the innovation level of the enterprises around the development zone will be higher than that of the distant enterprises.

Hypothesis 4: Because high-tech or mature enterprises in the region have higher overlap in factors of production or technology, the spillover effect on mature enterprises and high-tech enterprises is more obvious.

3 Empirical Model

The implementation effect of development zone policy may vary from region to region or type, and the resulting spillover effect size may vary, so we need to identify and control the implementation effect of development zone policy first. Within the framework of BD-DD analysis, we use the methods of Lu et al(2019) and Miguel and Kremer(2004)to identify the impact of development zone spillover effects on the productivity of surrounding businesses.[2] We assume that there is a range of spillover effects in the development zone, e.g. enterprises within 1000m of the boundary of the development zone will be affected by the spillover effect, while enterprises other than 1000m will not be affected by the spillover effect or will have a very weak impact." We can then estimate the size of the spillover effect by comparing the difference between enterprise TFP within 1000m and 1000m from the development zone boundary. Specifically, we build the following model:

$$Ln\ TFP_{it}=\gamma+\alpha_0\ D_i+\alpha_1*D\_vicinity_i+\alpha_2\ D\_vicinity_i \cdot Post_t+\alpha_3 D\_vicinity_i \cdot Post_t \cdot D_i+\alpha_4 Post_t+X_{it}'\boldsymbol{\beta}+\varepsilon_{it} \qquad (8)$$

Based on the idea of identifying spillover effect, we can further take the enterprises around the development zone as the experimental group, and the enterprises in the far region as the control group, and use the differential method to conduct mechanism test and heterogeneity analysis. Specifically, we build the following differential model:

$$Y_{it}=\alpha+\beta_1 D\_near_i+\beta_2 Post_t+\beta_3 D\_near_i \cdot Post_t+X_{it}'\beta+\mu_{it} \qquad (9)$$

4 Data and Variables

The Industrial Enterprise database records the business details address, and we search Google Maps for the business address and get the geographic coordinates provided by the Googles Geocoding API.

In particular, four to four directions (south, north, west, east) to villages, communities, roads and other border information.

TFP, firm_expy and human_quality are core interpretation variables. D, D_near, D_vicinity and Post are core explanation variables. Others are control variables.

5 Benchmark Regression and Robustness Test

5.1 Baseline Regression Analysis

As noted above, we define an external enterprise within 1000m from the development zone boundary as an enterprise in a neighbouring develoment zone and1000m-2000m as an enterprise away from the development zone. Nevertheless, there is some flexibility in the selection of sample groups for regression. Therefore, in order to test the robustness of the main conclusions in this article, referring to the practice of Zheng et al(2017),we have taken different bandwidth areas for regression (the size of the bandwidth is based on the development zone boundary).[5] Table 1 reports the regression results of the baseline model.

Table 1. The results of the regression of the baseline model

	(1)	(2)	(3)	(4)	(5)
Inner ring	0-500m	0-500m	0-500m	0-1000m	0-1000m
Outer ring	500-1000m	1000-1500m	1000-2000m	1000-1500m	1000-2000m
Explanatory Variable	tfp_lp	tfp_lp	tfp_lp	tfp_lp	tfp_lp
D_vicinity*Post*D	-0.0218	0.0277	0.0947*	0.0569	0.101**
	(0.0806)	(0.0539)	(0.0495)	(0.0478)	(0.0458)
D_vicinity*Post	0.109	0.204***	0.0878**	0.192***	0.0904**
	(0.0856)	(0.0555)	(0.0432)	(0.0488)	(0.0387)
Control variables	Y	Y	Y	Y	Y
Provincial fixed effect	Y	Y	Y	Y	Y
Industry fixed effect	Y	Y	Y	Y	Y
N	8,252	12,380	17,646	15,300	20,566

The inner ring in Table 1 refers to the area bandwidth of the adjacent development zone and the outer ring refers to the area bandwidth away from the development zone. We use two defining methods for inner and outer ring bandwidth: inner ring 0-500m and 500-1000m, outer ring 1000-1500m and 1000-2000m. As can be seen from-of columns(2)-(6),the interaction factors we are concerned about D_vicinity are significantly positive, indicating that the development area has spillover effects on the surrounding area and improves the TFP of the surrounding enterprises. This conclusion is still stable under the condition of adding control variables and fixed effects. In addition, it should be noted that in column (1) we hypothetically define the outer ring as 500-1000m for regression as a placebo test. The regression results show that the D_vicinity (the "post") coefficient is not significant, which is in line with our expectations. This indicates that the spillover effect of the development zone on the surrounding area is approximately 1000m near its boundary. The baseline regression results provide evidence for Hypothesis I.

5.2 Robustness Test of the Return of the Benchmark

In order to ensure the reliability of the benchmark regression results, we again use the double differential method to test the spillover effect of the development zone. Specifically, we take the inner ring(0-1000m) enterprise as the experimental group, and the outer ring (1000-2000m) enterprise as the control group to regression of (2). Table 2 reports regression results.

Table 2. The robustness test for baseline regression

	(1)	(2)	(3)	(4)
Inner ring	0-500m	0-500m	0-1000m	0-1000m
Outer ring	1000-1500m	1000-2000m	1000-1500m	1000-2000m
Explanatory variable	tfp_lp	tfp_lp	tfp_lp	tfp_lp
D_near	-0.0656	-0.0362	-0.0182	0.0303
	(0.0536)	(0.0487)	(0.0309)	(0.0262)
Post	0.293***	0.295***	0.266***	0.289***
	(0.0413)	(0.0302)	(0.0398)	(0.0296)
D_near*Post	0.200**	0.195**	0.123**	0.0857*
	(0.0872)	(0.0790)	(0.0554)	(0.0479)
Control variables	Y	Y	Y	Y
Provincial fixed effect	Y	Y	Y	Y
Industry fixed effect	Y	Y	Y	Y
N	4,810	7,978	7,730	10,898

As can be seen from the regression(1)-(3) results of the interactions(D_near*Post), the interactions we are concerned with are significantly positive at 5% level, but the interaction coefficients in column(4) are significantly positive at 10% level, possibly because the spillover effect has weakened considerably at close to 1000m.

Overall, the robustness test results still support the main conclusions of our benchmark regression.

6 Main Conclusions and Implications

First, hypothesis 1 is verified by benchmark regression. We find that the development zone has spillover effect on the surrounding area of about 1000 m, which is manifested in improving the TFP, of the surrounding enterprises, which is consistent with the conclusion of the Zheng et al (2019).[8] Secondly, the double difference method is used to verify hypothesis two and hypothesis three, which shows that the positive influence of spillover effect on the TFP of surrounding enterprises is mainly caused by the externality of agglomeration effect. Finally, this paper also examines the heterogeneity of spillover effects on enterprises with different technical levels and ages. It is found that high-tech and mature enterprises benefit more from spillover effect, which may be due to the higher overlap of production factors or technologies between high-tech enterprises or mature enterprises and regional enterprises. Therefore, it is easier to form cooperation and learning effect.

Based on the above conclusions, we have the following enlightenment: The development zone not only needs to cultivate high-tech industries to promote the upgrading of industrial structure, but also undertakes the task of driving regional economic development, and the micro basis of economic development is the growth of enterprises (Li, Wu,2018)[6]. Based on the research, it is found that the development zone has spillover effect on the enterprises in the range of about 1000 m, and the high-tech or mature enterprises are more affected by the spillover effect. This shows that the local government should consider the influence of the policy on the overall industrial agglomeration structure when implementing the development zone policy. If the new industrial agglomeration structure cannot be formed around the development zone, then the establishment of the development zone will inevitably reduce the original industrial agglomeration level. This will not be conducive to the long-term development of the industry.

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