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The Promotion Effect of China (Shanghai) Pilot Free Trade Zone Policy on Foreign Investment

Based on Nonparametric Synthetic Control Method

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***Abstract*—This paper uses the Nonparametric Synthetic Control Method to study the dynamic impact of free trade zone (FTZ) policy on attracting foreign direct investment (FDI) by taking the Shanghai pilot free trade zone as a case. Empirical results show that the pilot free trade zone policy increased the stock of foreign direct investment in Shanghai by 205.26 billion Yuan from 2013 to 2015, with an average annual spillover of 68.42 billion Yuan, and an average annual spillover rate of 14.2 percent; and the cumulative flow of foreign direct investment in Shanghai increased by 133.06 billion Yuan, with an average annual spillover of 44.35 billion Yuan and an average annual spillover rate of 116.2 percent. A series of robustness tests, such as synthetic control method and double difference method, show that the pilot free trade zone policy has a positive spillover effect on attracting foreign investment in the region, and the empirical conclusion is robust.**

Keywords—program evaluation; nonparametric synthetic control method; China (Shanghai) Pilot Free Trade Zone; FDI effect

I. INTRODUCTION

The construction of pilot free trade zones is an important front for China to comprehensively deepen reform at present and in the future. By the end of 2018, China had approved the establishment of 12 pilot free trade zones, forming the "Wild Goose Queue" pattern of "1+3+7+1" pilot free trade zones. Being out in front in the construction of China's pilot free trade zones, Shanghai has been at the forefront of the reform, opening up and innovation of the pilot free trade zone. To integrate with advanced international investment rules, in September, 2013, After the China (Shanghai) Pilot Free Trade Zone was officially launched, it has mainly explored the management pattern of pre-establishment national treatment (PENT) with a negative list, leading to the boost in foreign investment facilitation and standardization, openness, transparency and so on, which was widely recognized domestically and internationally. As an important reform measure, how effective is its policy pilot to attract foreign direct investment (FDI) in the region? This is an important question worth exploring. In view of this, this paper chooses Shanghai, the first pilot city, as the reference object of the analysis, to conduct a scientific evaluation on the spillover effect of FDI of Shanghai free trade policy.

At present, the study of the pilot free trade zone has become an academic hotspot in China. Scholars have conducted multi-angle studies, mainly focusing on the macro-economic and social impact and the discussion of regulatory construction, such as Chen Zongsheng, Wu Zhiqiang (2016), Jin Zehu and Li Qingqing (2016), Huang Qicai (2017a), and Li Jing (2015). Due to the short implementation time of policies and the difficulty in obtaining data, quantitative studies have only emerged in recent literatures, such as Li Qian et al. (2016) and Zhao Jing (2016). Due to the small number of data samples, their analysis is based on monthly data, and the research objects are limited to the pilot provinces and cities of the free trade policy, without the comparison based on all provinces data, which cannot solve the problem of selection bias.

In order to solve the problem of sample selection bias and policy endogeneity, scholars inside and outside China use the difference in differences (DID) method and propensity score matching (PSM) method for quantitative analysis, such as Bernardo and Fageda (2017), Lee and Lim (2015), Shi Bingzhan (2012), Xi Yanle and He Lifang (2015). However, in some cases, such as the long-term policy intervention, the policy intervention group and the control group cannot meet the common trend hypothesis, and it is difficult for the economic policy intervention, as a quasi-natural experiment, to meet the conditional independence hypothesis. Therefore, the standard "DID" method and "PSM" method will have estimation bias. In order to avoid the problems caused by DID method and PSM method. In recent years, some scholars have used the synthetic counterfactual method to analyze the policy effect. Abadie, and Gardeazabal (2003) and Abadie et al. (2010) proposed the Synthetic Control Method and analyzed the economic cost of political conflicts and the economic impact of tobacco control projects. Meanwhile, synthetic counterfactual methods have been widely concerned by China's scholars and have been used in domestic policy evaluation, such as Wang Xianbin and Nie Haifeng (2010), Yu Jingwen and Wang Chunchao (2011), Liu Jiayan and Fan Ziying (2013), Su Zhi and Hu Di (2015), Huang Qicai (2017b).

However, Cerulli (2017) believes that the shortcoming of synthetic control method is that the weight of synthetic control objects is time-invariant. Therefore, he extended the method nonparametric and used kernel-vector distance method to calculate the weight of the synthetic control object in each year at the early stage of policy intervention, and the final weight was the average of all years. Therefore, the nonparametric control method proposed by Cerulli (2017) is used to evaluate the policy effects of the pilot free trade zone.

II. EMPIRICAL MODEL

A. Nonparametric Synthetic Control Method

Shanghai, the first pilot free trade zone, was taken as the policy treatment unit, and other non-pilot provinces and cities as the policy control group. Since only the foreign direct investment in Shanghai during the policy pilot from 2013 to 2015 was analyzed, the other 10 pilot free trade zones which were established after 2015 should also be included in the policy control group. In short, there is one policy treatment unit and 30 policy control group objects (excluding Hong Kong, Macao and Taiwan), with a total number of 31 individuals. The initial time of policy intervention is 2013. Without loss of generality, the policy treatment unit is set as individual 1, and the units from individual 2 to individual 31 are all policy control group units.

The outcome variable concerned in the policy intervention is Y_{it}, $i \in [1,31]$, $t \in [1,T]$. Y_{it}^N represents the value of result variable of individual i in the circumstances of no policy intervention at the time of t. Y_{1t} represents the value of result variable of individual 1(policy treatment unit) at the time of t.

$$Y_{1t} = \begin{cases} Y_{1t}^N & t \in [1, T_0 - 1] \\ Y_{1t}^I & t \in [T_0, \ T] \end{cases}$$

Before policy intervention, $t = 1,...,T_0\text{-}1$, the value of Y_{1t} is Y_{1t}^N, which is observable variable; in the process of policy intervention, $t \geq T_0$,the value of Y_{1t} is Y_{1t}^I, which is observable variable, however the value of Y_{1t}^N when $t \geq T_0$ is unobservable. Since individual 1 carried out the policy pilot, it is impossible to be in the circumstances of no policy experiment, which violates the fact of policy intervention. Therefore, when $t \geq T_0$, Y_{1t}^N is called the counterfactual variable of Y_{1t}^I.Compared with the policy treatment unit, none of the policy control group units implemented the pilot free trade zones policy when $t \in [1,T]$. The value of result variable is Y_{it}^N, $i \in [2,31]$, which are all observable variable.

In the policy intervention period, $[T_0, T]$, the net intervention effect of the policy treatment unit can be expressed as $Y_{1t}^I - Y_{1t}^N$, as follows:

$$Y_{1t}^I = \alpha_{1t} D_{1t} + Y_{1t}^N, \quad D_{1t} = \begin{cases} 1 & t \geq T_0 \\ 0 & \text{Other} \end{cases}$$

In this formula, α_{1t} is the effect size of policy treatment unit at the time of t, and the dynamic effect of the policy intervention is $(\alpha_{1T_0},...,\alpha_{1T})$. In the policy treatment period, Y_{1t}^I is observable while Y_{1t}^N is not. Therefore, it is required that Y_{1t}^N should be estimated before the estimation of α_{1t}.

The result variable concerned most by policy intervention in this paper is FDI. In order to get the dynamic effect of the pilot free trade zone, it is necessary to estimate Y_{1t}^N when the policy is not implemented in the pilot area. By selecting the optimal weight vector W^*, the synthetic counterfactual method weights the policy control group objects to make the feature vector X_0 of policy control objects and the feature vector X_1 of the policy treatment unit as similar as possible. Thus a control object is synthesized which is completely similar to the policy treatment unit, and by taking $\sum_{j=2}^{31} w_j^* . Y_{jt}^N$ as an unbiased estimator of $\hat{Y}_{1t}^N$, the unbiased estimator of policy intervention effect α_{1t} can be get as follows: $\hat{\alpha}_{1t} = Y_{1t}^I - \hat{Y}_{1t}^N = Y_{1t}^I - \sum_{j=2}^{31} w_j^* . Y_{jt}^N, \quad t \geq T_0$.

As for the optimal weight vector W^*, Abadie et al. (2003, 2010) proposed synthetic control method (SCM): to solve it through a nested optimization problem, which is to get $W^*(V)$ through the minimum distance $\| X_1 - X_0 W \|_V = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$, and get V^* through $\arg\min_V (Z_1 - Z_0 W^*(V))' (Z_1 - Z_0 W^*(V))$, and get $W^* = W^*(V^*)$ through putting V^* in the first optimization problem. In this process, the value of V^* is related to the explanatory ability of each prediction variable to the result variable. When $t \in [1, T_0 - 1]$, the W^* in SCM is time-invariant, while that in the nonparametric synthetic control method (NPSCM) proposed by Cerulli (2017) is time-variant.

The nonparametric synthetic control method uses the kernel vector distance method (K-V-D) to calculate the distance weight between each control group unit j and policy treatment unit 1 each year, as follows:

$$W_{t,j}^1(h) = K\left(\frac{\left\| X_{t,j} - X_{t,1} \right\|}{h}\right), t \in [1, t_0 - 1]$$

In this formula, $K(.)$ is the kernel function; parameter h is the window width, $\left\|X_{t,j}-X_{t,1}\right\|$ is the distance between control group unit j and policy treatment unit 1 at the time of t. The distance weights of kernel vectors can be represented by "Fig. 1".

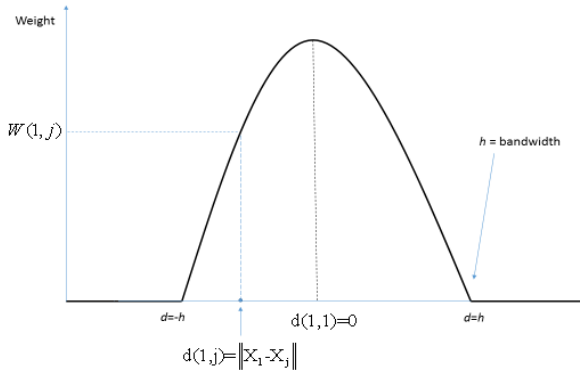

Fig. 1. The kernel-vector-distance weight function.

According to "Fig. 1", in the range of h, the closer the feature vector X_j of policy control group unit j is to the feature vector X_1 of policy treatment unit, the greater its weight value will be.

B. Description of Variables and Data

The nonparametric synthetic control method is used to compare and analyze the foreign direct investment in Shanghai during the pilot free trade zone policy from 2013 to 2015, with the entire sample period of empirical analysis as $[1,T]=[2000,2015]$, the early period before policy intervention as $[1,T_0-1]=[2000,2012]$ and the policy intervention period as $[T_0,T]=[2013,2015]$. According to the availability of data, the selected result variable is the total foreign direct investment (FDI_stock). Then, foreign direct investment (FDI_flow) is calculated according to the increment. The forecast variables include the proportion of secondary and tertiary industries in GDP (Structure), local fiscal tax revenue (Fiscal), total retail sales of consumer goods (Expenditure), total foreign direct investment and foreign direct investment in a special year. The descriptive statistics of each variable are shown in "Table I".

TABLE I. VARIABLE DESCRIPTIVE STATISTICS

Variables	Unit	Sample	Mean	SD	Min	Max
FDI stock	100Million Yuan	496	709.8	1193.4	3.3	7821.5
FDI flow	100Million Yuan	465	80.3	165.2	-644.5	1799.4
Expenditure	100Million Yuan	496	4215.4	4892	42.5	31517.6
Fiscal	100Million Yuan	496	1096.8	1344.8	5.4	9364.8
Structure	%	496	87.2	6.6	63.6	99.6
FDI stock(2008)	100Million Yuan	31	729.5	1056.7	5.5	4159.3
FDI flow(2008)	100Million Yuan	31	64.2	100.9	-138.4	369.5
FDI stock(2009)	100Million Yuan	31	775.2	1116.5	6.3	4443.9
FDI flow(2009)	100Million Yuan	31	45.6	66.1	-63.2	284.6

[a.] Notes: Variables' data are from Wind Database.

III. EMPIRICAL ANALYSIS

Based on the nonparametric synthetic control method proposed by Cerulli (2017), the optimal window width h is firstly selected, then the weight of the synthetic control object is calculated, and the policy effect is compared at last.

A. Selection of Optimal Window Width-h

Cerulli (2017) provided 6 kinds of kernel form, namely Triangular, Epan, Normal, Biweight, Uniform and Tricube. Through comprehensive comparison, this paper chooses the kernel function of Triangular. The optimal window width h should be selected according to the minimum root mean square prediction error (RMSPE).

"Fig. 2" shows the image of the RMSPE (h) function. When h=0.2, there exist a minimum value of RMSPE. Therefore, this value of h should be selected as the optimal window width.

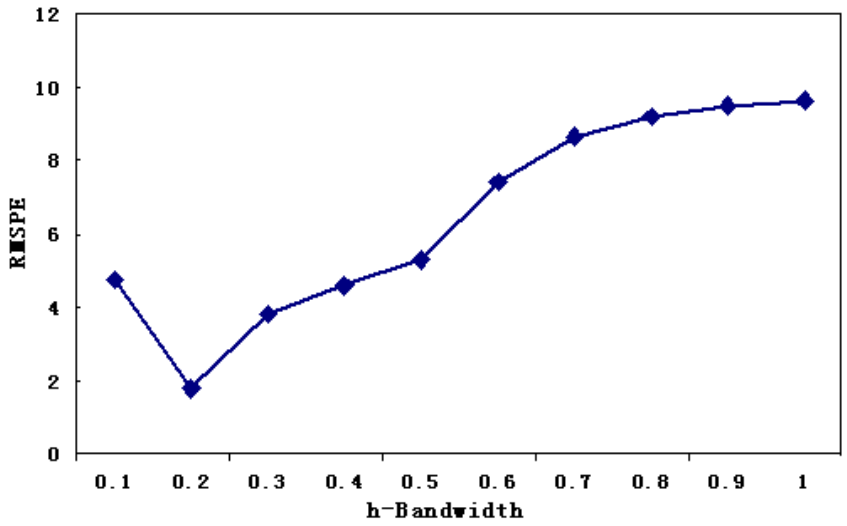

Fig. 2. The bandwidth used within the triangular kernel function.

B. *Weight of Synthetic Control Objects*

After the calculation of $W_{t,j}^{1}(h)$ through the nonparametric synthetic control method, an average is taken: $\overline{W}^{1}_{j}(h) = \frac{1}{t_0 - 1}\sum_{t=1}^{t_0-1} W_{t,j}^{1}(h)$, so the weight of each policy control group unit can be obtained. "Table II" shows the province weights combination constituting the synthetic Shanghai. Mainly four provinces are selected, among which Jiangsu Province has the largest weight (0.454), and the other provinces with large weight are Zhejiang Province, Guangdong Province and Hainan Province in order, the weighted average of those four provinces can be used as the control object of Shanghai.

TABLE II. PROVINCE WEIGHTS IN THE SYNTHETIC SHANGHAI

Province	Weight (NPSCM)	Weight (SCM)	Province	Weight (NPSCM)	Weight (SCM)
Anhui	0	0	Hunan	0	0
Beijing	0	0	Jilin	0	0
Fujian	0	0	Jiangsu	0.454	0.283
Guangdong	0.114	0.386	Jiangxi	0	0
Guangxi	0	0	Liaoning	0	0
Guizhou	0	0	Inner Mogolia	0	0
Hebei	0	0	Helongjiang	0	0
Henan	0	0	Hubei	0	0
Sichuan	0	0	Hainan	0.111	0.167
Chongqing	0	0	Gansu	0	0
Ningxia	0	0	Tianjin	0	0.163
Zhejiang	0.321	0	Qinghai	0	0
Shandong	0	0	Tibet	0	0
Shanxi	0	0	Xinjiang	0	0
Shaanxi	0	0	Yunnan	0	0

[a.] Notes: Province in the synthetic Shanghai doesn't include Taiwan, Hong Kong and Macau.

C. Assessment of Dynamic Effects of Policies

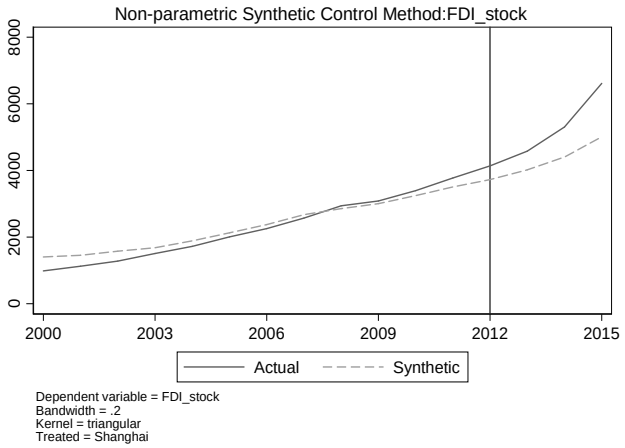

Fig. 3. FDI stock of real and synthetic Shanghai.

In "Fig. 3", the solid line represents the observable actual FDI_stock of Shanghai, and the dotted line represents the synthetic FDI_stock of Shanghai that cannot be observed. The left side of the vertical solid line represents the early period before policy intervention, and the right side of the vertical solid line represents the late period after policy intervention. The synthetic Shanghai, as the counterfactual variable, represents the development trend of Shanghai without pilot free trade zone policy.

"Fig. 3" shows that during the policy intervention period from 2013 to 2015, the actual FDI_stock of Shanghai was always larger than the synthetic FDI_stock of Shanghai. This shows that compared with Shanghai's original level of attracting foreign direct investment, the attraction of Shanghai to foreign direct investment has increased after the establishment of pilot free trade zone, that is, the policy of pilot free trade zone has brought positive spillover effect to Shanghai.

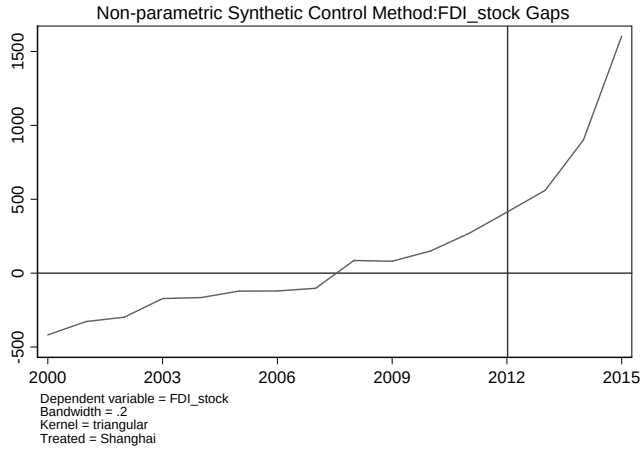

Fig. 4. FDI_stock gaps of real and synthetic Shanghai.

"Fig. 4" reflects the significant differences of foreign direct investment in Shanghai before and after the establishment of the pilot free trade zone. Prior to the establishment of the Shanghai pilot free trade zone, the gap between the actual FDI_stock and synthetic FDI_stock in Shanghai fell within a small range. After the pilot free trade policy in 2013, a large gap gradually has appeared between the actual FDI_stock and synthetic FDI_stock, and this gap is far beyond the average level before policy intervention. These facts show that, compared with the situation without the pilot free trade zone policy, the pilot free trade zone policy has significantly promoted the growth of FDI in Shanghai, and the policy influence is increasing with the steady operation of the pilot free trade zone, and the promotion effect on foreign direct investment is also increasing.

The calculation results of nonparametric synthetic control method show that, from the perspective of FDI_stock, in the first year of policy intervention, the actual FDI_stock of Shanghai is 16.79 billion more than that of synthetic FDI_stock; in the second year of policy intervention, the gap was 52.88 billion; and the third year, above 100 billion. From 2013 to 2015, the pilot free trade zone policy contributed to a cumulative growth of 205.26 billion Yuan of Shanghai's FDI_stock, with an average annual spillover of 68.42 billion Yuan and an average annual spillover rate of 14.2%. From the perspective of FDI_flow, Shanghai FDI_flow has a similar dynamic spillover effect. From 2013 to 2015, the cumulative increase of FDI_flow was 133.06 billion Yuan, with an average annual spillover of 44.35 billion Yuan and an average annual spillover rate of 116.2%.

The dynamic effect of policy intervention in Shanghai shows that, as a new thing in China, foreign investors were very cautious about the pilot free trade zone policy. Therefore, the scale of FDI of Shanghai in the first year of policy intervention was not large. However, with the gradual familiarity with the pilot free trade zone policy and the continuous introduction of various policy innovation and opening measures in the pilot free trade zone in Shanghai, foreign investors' confidence in the pilot free trade zone has been gradually enhanced, and the scale of foreign direct investment has also shown a rising trend. At last, the promotion effect of Shanghai pilot free trade zone policy on FDI was greatly improved in the third year of policy intervention.

IV. ROBUSTNESS TEST

Next, robustness tests are performed by using two other methods: the synthetic control method (SCM) and the difference in differences (DID) method.

A. Test Through Synthetic Control Method

In order to compare with the nonparametric synthetic control method (NPSCM), the same predictive variables are selected for the synthetic control method (SCM). The weight of the comparison group is shown in "Table II", and the measurement results of the policy effect are shown in "Table III".

TABLE III. FDI EFFECT WITH NPSCM AND SCM

Methods	Year	FDI_stock			FDI_flow		
		Real	Synthetic	Effect	Real	Synthetic	Effect
NPSCM	2013	4579.3	4411.4	167.9	441.6	299.1	142.6
	2014	5304.7	4775.9	528.8	725.3	364.4	360.9
	2015	6612.7	5256.8	1355.9	1308.1	480.9	827.1
	Mean	5498.9	4814.7	684.2	825	381.5	443.5
	SD	1030.5	424	609.1	441.7	92.1	349.7
SCM	2013	4579.3	4117.4	461.9	441.6	262.1	179.6
	2014	5304.7	4483.4	821.3	725.3	366	359.3
	2015	6612.7	5048.2	1564.6	1308.1	564.8	743.3
	Mean	5498.9	4549.7	949.3	825	397.6	427.4
	SD	1030.5	468.9	562.4	441.7	153.8	288

In terms of FDI_flow, the policy effects measured by the synthetic control method (SCM) and the nonparametric synthetic control method (NPSCM) are similar. Compared with the nonparametric synthetic control method (NPSCM), in terms of FDI_stock, the policy effect calculated by the synthetic control method (SCM) is relatively large.

B. Test Through Difference in Differences Method

In the DID analysis, the predictive covariates of the intervention and control groups are the same as those of the NPSCM. Before the policy intervention, all variables are averaged, and after the policy intervention, the DID analysis is carried out annually. Specific results are shown in "Table IV".

TABLE IV. FDI EFFECT WITH DID

Variables	FDI_stock			FDI_flow		
	2013	2014	2015	2013	2014	2015
C	-220.7 (-0.19)	-359.5 (-0.32)	-643.6** (-2.18)	-240.17** (-2.52)	-192.39** (-2.16)	-95.71 (-1.16)
Expenditure	-0.12** (-2.09)	-0.11** (-2.1)	-0.09** (-2.07)	-0.005 (-1.27)	-0.006*** (-2.9)	-0.05* (-1.82)
Fiscal	1.32*** -4.54	1.26*** -4.62	1.17*** -5.45	0.08*** -3.95	0.09*** -8.35	0.28** -2.43
Structure	1.59 -0.11	3.35 -0.23	6.94** -2	2.94** -2.51	2.31** -2.1	1.13 -1.14
Treated	499.6* -1.81	529.7** -1.98	568.9*** -2.87	88.09*** -2.88	81.49*** -3.08	-69.31 (-0.66)
D13	-840.8*** (-4.59)			-80.17*** (-3.71)		
D14		-865.8*** (-4.63)			-72.23*** (-3.66)	
D15			-727.3*** (-3.87)			-40.63 (-1.06)
Gd	611.1* (-1.81)	929.3** -2.26	1256.9*** -2.89	102.7*** -4.22	311.77*** -2.83	360.61* -1.38
Num of obs	62	62	62	62	62	62
R^2	0.7686	0.8871	0.8982	0.7686	0.9013	0.697

[a.] Notes: C is a constant. Treated is a grouping variable of policy intervention. D13, D14 and D15 are indicative variables of policy intervention period, which are 1 in 2013, 2014 and 2015, 0 in other years respectively. GD is the effect variable of policy intervention. ***,*** denotes statistically significant t-statistic at 10%,5%,1% level respectively.

Compared with the Nonparametric Synthetic Control Method (NPSCM), the policy effect measured by DID method is relatively large, but similar to that of the synthetic control method (SCM); in terms of FDI flows, the policy effect calculated by DID method is relatively small.

On the whole, the calculated results of SCM and DID are close to those of NPSCM, indicating that the empirical results of this paper are robust.

V. CONCLUSION

As an experimental field for China's reform and innovation, Shanghai pilot free trade zone is actively in line with advanced international investment rules. The most important institutional innovation in the field of foreign investment is to fully implement the foreign investment management model of pre-establishment national treatment

plus negative list. The innovation of the investment management system in China (Shanghai) pilot free trade zone has promoted the reform of the business registration system and the streamlining administration and decentralization of investment project examination and approval. At the same time, it has accelerated the transformation of the government into an open, transparent and efficient management mode, and finally created a transparent and friendly business environment for foreign capital flows. The fact that a large number of foreign enterprises swarm into China (Shanghai) pilot free trade zone shows that the pilot free trade zone has become an engine to attract foreign capital, and proves the success of this system innovation. Not only in the Shanghai pilot free trade zone, the FTZ policy has also played a significant role in promoting the growth of foreign direct investment in Shanghai. The evaluation of the policy effect of Shanghai pilot free trade zone shows that the pilot reform of China's FTZ is successful. Especially the system innovation of investment management has a great spillover impact on the policy pilot province. The investment attraction effect of Shanghai's FTZ policy also shows that currently, foreign capital not only pays attention to the hard conditions such as land and tax preference where it invests, but also pays more attention to the soft environment such as service and business there, which has certain reference significance for China's other provinces to attract foreign direct investment in the future.

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