The Impact of Pilot Free Trade Zones on Entrepreneurship: Evidence from a Quasi-natural Experiment in China

By Zhaohua Li and Suqin Pang*

Exploiting China's pilot free trade zones (FTZs) as an exogenous shock of institutional quality improvement, this study explores the impact of FTZs on urban entrepreneurship. We find that cities with FTZs are associated with higher entrepreneurship. The positive influence of FTZs is more pronounced in western and northern cities, and cities with high administrative levels. The entrepreneurship in service industries is promoted significantly by FTZs. In addition, we find that Shanghai FTZ and Fujian FTZ, rather than Tianjin FTZ and Guangdong FTZ, play a non-negligible function in encouraging new firm creation. Then, mechanism analysis shows that FTZs foster entrepreneurship by promoting opening-up upgradation of foreign investment and foreign trade, and accelerating financial development. Last, we also identify the spatial spillover effects and find that entrepreneurship responses to pilot FTZs are significantly stimulated in adjacent cities without FTZs. These findings offer important implications for FTZ's planning and spurring economic growth in developing countries. (***JEL* L26, F13, P33**)

Keywords: *Free trade zones; Entrepreneurship; Institutional quality;*

I. Introduction

Entrepreneurship is widely recognized as one of the crucial engines of economic growth because of the characteristic of "creative destruction" (Hatem Afi et al., 2022, Jorge Guzman and Aleksandra Kacperczyk, 2019, J.A. Schumpeter, 1912), particularly in developing countries. As the largest developing country, China faces many challenges with economic growth slowing, such as changing the growth pattern, optimizing the economic structure, and adjusting the drivers of growth. Enhancing entrepreneurship is a crucial measure to address the above challenges validly (Linhui Yu et al., 2023). Given the critical role of entrepreneurship, Chinese government has dedicated to improving institutional quality, thereby ensuring that the institution plays a positive function in fostering entrepreneurship. The fact that a sound institutional quality can stimulate entrepreneurship also has been verified (Jieyi Chen and Zhao Zhou, 2023, Andreas Freytag and Roy Thurik, 2007, Lucio Fuentelsaz et al., 2018). Rather surprisingly, how institutional quality improvement impacts entrepreneurship in developing countries has been insufficiently explored. Our study, therefore, sets out to provide novel evidence of the institution-entrepreneurship nexus in developing countries. Specifically, we investigate how institutional quality improvement may affect China's entrepreneurship by exploiting China's pilot free trade zones (FTZs) as a quasi-natural experiment.

According to the overall plan promulgated by the State Council, China's FTZs have three major tasks, namely, opening-up of investment sectors, transformation of foreign trade models, and innovation of financial services (Lihui Wang et al., 2022). To accomplish these tasks, FTZs have introduced a series of new policies to build a "testing ground" for institutional innovation in China. Institutional innovation mainly lies in four fields: foreign investment management, foreign

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trade execution, financial reform, and administrative system adjustment, which have a profound influence on local institutional quality (Daqing Yao and John Whalley, 2016). The changes in institutional quality have triggered international trade growth and had widespread economic consequences (Susong Ba et al., 2021, Hao Chen et al., 2021, Wanling Chen et al., 2022, Chenghua Guan et al., 2023, Sujuan Li et al., 2021).

In this study, we examine the impact of the FTZs on entrepreneurship in China. To do this, we first narrowly define the entrepreneurship at city-level as the number of newly registered firms per 10,000 people. Then, regarding the FTZs as a quasi-natural experiment, we use the difference-in-difference (DID) method to evaluate the policy effects of FTZs on urban entrepreneurship. To exclude potential endogeneity problem, we use the dummy for whether a city was a treaty port or proactively open port in the late Qing dynasty as an instrument for FTZs. We further investigate the heterogeneity and underlying influence mechanism. Finally, we explore spatial spillover effects of FTZs by using the spatial DID (SDID) method.

Our study makes three marginal contributions to current literature: First, from the perspective of FTZs, this study provides a novel idea for the inspiration of entrepreneurship, and responds to the actual demands of developing countries on the strategy of stimulating economic growth. A fast-expanding literature has long strived to investigate the determinants of entrepreneurship in advanced countries at the individual-, enterprise- industry- and country-level (Ivano Dileo and Thaís García Pereiro, 2019, Isabel Grilo and Roy Thurik, 2008, Peter Van Der Zwan et al., 2013). Yet, only a few of the research explores entrepreneurship in developing countries. For example, in the India context, Ejaz Ghani et al. (2014) report that the quality of infrastructure and workforce education at the industry-level are strongly associated with the possibility of establishment entry. Based on the China background, L. Brandt et al. (2018) and C. E. Bai et al. (2021) study the influence of the state sector on entrepreneurship. Mengsha Liu et al. (2023) focus on high-speed rail's impact on entrepreneurial activities. Dongmin Kong et al. (2021) and Dongmin Kong and Ni Qin (2021) emphasize the effect of China's anticorruption campaign and minimum wage policy, respectively. Ruixue Jia et al. (2021) discuss the role of parental background in entrepreneurship at the individual level. The research closest to ours is Chuantao Cui and Leona ShaoZhi Li (2023), who clarify the impact of external institutional quality improvement from the perspective of trade policy uncertainty reduction. In comparison, we employ an exogenous shock, namely pilot FTZs, to show the role of internal institutional quality improvement on domestic entrepreneurship.

Second, this paper is the first attempt to identify the impact of FTZs on domestic entrepreneurship, which contributes to the growing attention on the economic consequences of FTZs. The recent line of study empirically analyzes effects of FTZs on economic growth (Dechun Huang et al., 2017), income disparity (Huifang Cheng et al., 2020), poverty (Marta Castilho et al., 2019), trade development and transformation (Wanling Chen, Yao Hu, Bei Liu, Hui Wang and Mingbo Zheng, 2022, Lianghu Wang and Jun Shao, 2022), financial development (Lihui Wang, Zhihong Liu and Huailong Shi, 2022), knowledge spillovers (Haoqiang Li et al., 2020) and industrial structure upgrading (Chenghua Guan, Jinyuan Huang, Ruyue Jiang and Wanting Xu, 2023, Mingjie Ji et al., 2015). From a micro perspective, Sujuan Li, Jiaguo Liu and Yudan Kong (2021) and Jean Pierre Chauffour and Jean Christophe Maur (2011) unpack the causal relationship between FTZs and performance of port firms. The existing literature has provided a comprehensive and in-depth discussion on the economic effects of FTZs but with little attention paid to entrepreneurship, a key driver in sustainable economic growth. Our study expands the

increasing literature by delineating the linkage between FTZs and entrepreneurship and offers insight into the potential gains of improved institutional quality on economic performance.

Third, the discussion of the mechanism by which FTZs achieves entrepreneurship promotion not only helps understand the detailed picture of the influence of FTZs on entrepreneurship, but also provides suggestions for FTZs construction enabling the positive effect on entrepreneurship to be maximized. Additionally, we use instrumental variable (IV) method to address the possible endogeneity in this study, which improves the accuracy of estimation. Also, the analysis of the multidimensional heterogeneity and spatial spillover effect offer a new research perspective and practical reference for the layout of FTZs

The remainder of this paper is organized as follows. Section 2 describes a brief background of FTZs and presents the influence mechanism; Section 3 introduces identification strategy and data; Section 4 presents evolution of entrepreneurship in China and discusses the results of baseline regression, heterogeneity analysis, impact mechanism check and spatial spillover effects analysis; and Section 5 summarizes main conclusions and policy implications.

II. Background of the pilot free trade zones and influence mechanism

A. Background of the pilot free trade zones

Free trade zones in this study refer to open geographical areas designated unilaterally by a country through administrative means, distinguishing them from free trade areas (FTAs) that are established through multilateral negotiations between sovereign countries (Shanping Yang and Inmaculada Martinez-Zarzoso, 2014, Daqing Yao and John Whalley, 2016). To further deepen its open economy, China approved its first FTZ in 2013, namely Shanghai FTZ. With the expectation of transforming the economic development model from factor-driven to innovation-driven, Shanghai FTZ not only inherited traditional measures implemented in the FTAs such as tariff exemptions, non-tariff barriers elimination, and special customs supervision, but also introduced some institutional innovations such as pre-establishment national treatment[1], negative list[2] and post-execution[3]. Over the years, its functions as an international trading and financing hub have been continuously improved. To replicate these experiences, 20 FTZs were established in China after 2013, as shown in Fig. 1. In 2015, the State Council approved the second batch of FTZs, including Tianjin FTZ, Guangdong FTZ, and Fujian FTZ, with the third batch of FTZs was established in 2017, including Liaoning FTZ, Zhejiang FTZ, Henan FTZ, Hubei FTZ, Chongqing FTZ, Sichuan FTZ and Shaanxi FTZ. The fourth batch of FTZs established in 2018 includes Hainan FTZ. The fifth batch of FTZs was set up in 2019 in Shandong, Jiangsu, Guangxi, Hebei, Yunnan, and Heilongjiang provinces. In 2020, the sixth batch covering Beijing FTZ, Anhui FTZ, and Hunan FTZ was approved. To date, 21 FTZs have been approved in China, shaping a pattern of point-to-line to the surface. With the popularizing of FTZs, it will have far-reaching influences on foreign trade, inward foreign investment, financial and other aspects, thereby promoting high-quality development.

[1] Pre-establishment national treatment refers to the treatment given to foreign investors and their investments during the investment access stage, which is not lower than that given to their domestic counterparts.
[2] Negative list refers to special administrative measures for regulating the access of foreign investment in specific fields, as stipulated by the State. Foreign investment is forbidden in any field included in the negative list, while other fields not mentioned in the list are open to foreign investment.
[3] Post-execution implies that the government administration is post-supervision.

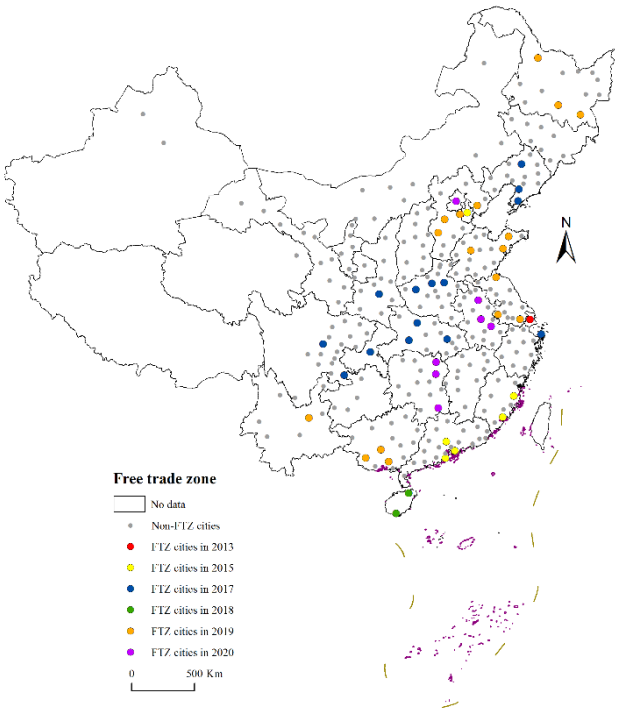


Fig. 1. Geographical distribution of FTZs.

B. Influence mechanism

Pilot FTZs is a concrete practice to improve institutional quality. It influences entrepreneurship by opening-up upgradation and financial development, in which the former consists of opening-up foreign investment and foreign trade. We shed light on these impact mechanisms based on the previous literature in this part (See Fig. 2).

Regarding the opening-up of foreign investment, FTZs can effectively enhance it in two ways. On the one hand, FTZs cancel most market access restrictions for foreign investment, which is reflected in the implementation of pre-establishment national treatment and negative list. The pre-establishment national treatment creates a level-paying market access environment for foreign investment (Hao Chen, Bo Yuan and Qi Cui, 2021), and the negative list greatly expands the scope of foreign investment access compared with the previous positive list (Daqing Yao and John Whalley, 2016), thereby providing a prerequisite for opening-up of foreign investment. On the other hand, FTZs reform the administrative government system and optimize the legal environment, which reduce the uncertainty of foreign investment and ultimately promotes openness (Sujuan Li, Jiaguo Liu and Yudan Kong, 2021). Specifically, FTZs carry out a "decentralization, regulation, and service" reform to weaken government intervention and strengthen functions in services for foreign investors. They also introduce a series of regulations to protect intellectual property rights and investors' rights, so that the investment risks decrease and income expectations increase (Lihui Wang, Zhihong Liu and Huailong Shi, 2022). Faced with the lower uncertainty, an increasing amount of foreign investment will be attracted to the FTZs.

Foreign investment plays an important role in encouraging new firm creation (Meghana Ayyagari and Renáta Kosová, 2010, Jieyi Chen and Zhao Zhou, 2023). First, foreign firms generate new demand for local products and services, which creates new business opportunities that can foster entrepreneurship (Renáta Kosová, 2010). Second, foreign investment brings novel

technological and managerial knowledge to host countries (Mico Apostolov, 2017, Rajeev K. Goel and James W. Saunoris, 2017). New knowledge likely diffuses by employee turnover and demonstration effect, stimulating entrepreneurial opportunity recognition of individuals. Third, foreign capital-invested firms hire and cultivate employees with abundant expertise, and these people tend to be potential entrepreneurs (Haiyang Li and Yu Li, 2018). Therefore, foreign investment indeed promotes local entrepreneurship through pooling human capital. Based on the above discussion, we propose hypothesis 1:

Hypothesis 1. FTZs can promote entrepreneurship by opening-up foreign investment.

Regarding the opening-up of foreign trade, FTZs contribute to it by reducing trade costs. In particular, FTZs not only reduce or exempt tariffs on products via negotiations but also adopt some measures for trade facilitation, such as paperless customs access and regional customs clearance integration, further reducing trade hurdles and costs (Zheng Wan et al., 2014). Additionally, as a new trade mode, cross-border e-commerce is encouraged in FTZs, which expands traditional trade mode and creates a more open environment for foreign trade (Wanling Chen, Yao Hu, Bei Liu, Hui Wang and Mingbo Zheng, 2022).

Foreign trade is beneficial to the birth of startups by adjusting market structure. For one thing, the opening-up of export trade increases the likelihood for firms in gaining access to the international market and providing a variety of products. Under the market expansion effect, the expected return of potential entrepreneurs is improved, thereby substantially spurring business generation (Hernán Herrera-Echeverri et al., 2014). For another, the liberalization of import trade allows for more foreign products and services into domestic markets, resulting in tough market competition, which provides a greater variety and cheaper intermediate inputs for entrepreneurial activities (ChihHai Yang, 2019). This, in turn, reduces start-up costs and fosters entrepreneurship. Moreover, similar to foreign investment, foreign trade is positively associated with knowledge spillover (Andrea Fracasso and Giuseppe Vittucci Marzetti, 2015), so that individual is more likely to spot entrepreneurship opportunities, which is entry-promoting. Based on the above discussion, we propose hypothesis 2:

Hypothesis 2. FTZs can promote entrepreneurship by opening-up foreign trade.

As for financial development, FTZs boost it through financial agglomeration and marketization of the financial system. Pilot FTZs have implemented a set of innovative measures to reform the financial system, including building an international financial market, supporting the cross-border use of RMB, accelerating the convertibility of capital accounts, and setting up free trade accounts, which improves the degree of openness of financial market (Daqing Yao and John Whalley, 2016). The increasingly optimized financial development environment has attracted more and more domestic and foreign financial institutions to agglomerate within the FTZs, thus expanding the scale of financial resources (Hao Chen, Bo Yuan and Qi Cui, 2021). The agglomeration of financial institutions also will further lead to a higher degree of competitiveness in the local financial market, this provides external incentives to improve the efficiency of financial services (Susong Ba, Hongrui Chai, Yunlong Fang and Bo Wang, 2021). Meanwhile, FTZs promote marketization operation of financial system, due to the weakening of government intervention in financial markets. With a market-oriented financial market, an increasing amount of financial capital will be allocated to industries with comparative advantages, meaning an improvement of the efficiency of financial services (Lihui Wang, Zhihong Liu and Huailong Shi, 2022).

Considering potential entrepreneurs, financial development can satisfy their demand for financing, which is advantageous to start a business. First, a sufficient amount of financial capital allows potential entrepreneurs to access external credit at lower costs, reducing financing constraints and start-up costs (Nabamita Dutta and Daniel Meierrieks, 2021). Second, the risk associated with entrepreneurial activity is especially high, which makes it hard to attract external investment. A developed financial service system can offer approaches and information for investors to manage and diversify investment risk, which encourages them to participate in new firm formation, again easing the financing constraints of entrepreneurs (Ross Levine, 1997), and consequently incentivizing entrepreneurial endeavors. According to the above analysis, we propose hypothesis 3:

Hypothesis 3. FTZs can promote entrepreneurship through financial development.

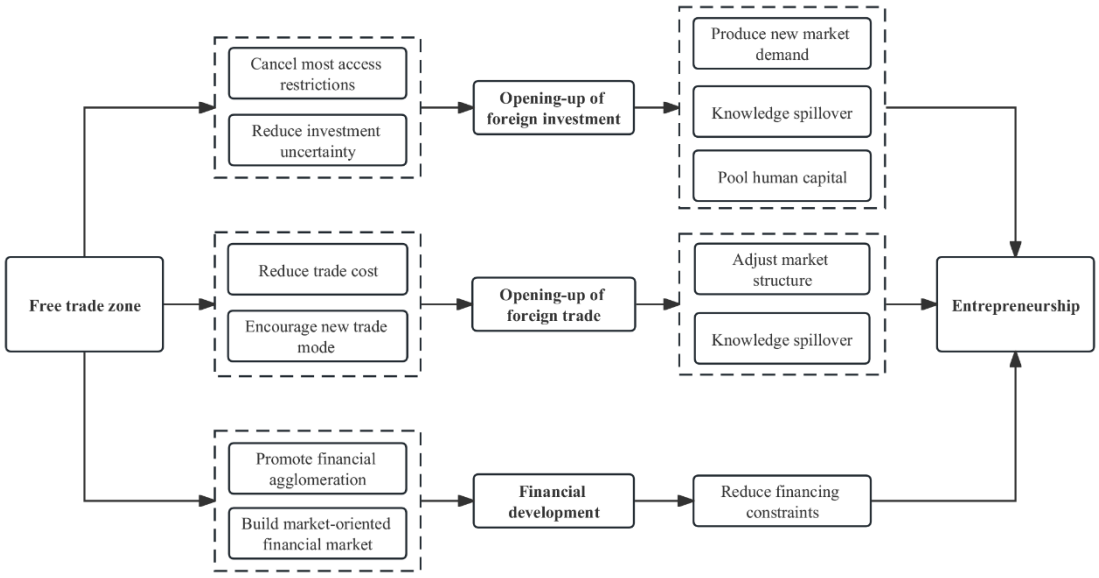


Fig. 2. Influential mechanism of FTZs on entrepreneurship.

III. Identification strategy and data

A. Model specification

To quantitatively examine whether the FTZs establishment impacts entrepreneurship, we use DID model, which is a valid method to evaluate the effect of exogenous shocks. We specified the model as follows:

$$ENT_{it} = \alpha_0 + \alpha_1 FTZ_{it} + \delta X_{it} + \mu_t + \eta_i + \varepsilon_{it} \quad (1)$$

where ENT_{it} denotes dependent variable for entrepreneurship of city i in year t; FTZ_{it} is independent variable for the FTZs establishment; X_{it} is a set of control variables to capture the influence of other factors on entrepreneurship, including economic development, governmental interference, population density, internet infrastructure, human capital, industrial structure; μ_t and η_i represent year and city fixed effect, respectively; ε_{it} is error term. We mainly focus on the estimated parameters α_1, which reflects the effect of FTZs on entrepreneurship.

B. Variables and data

Entrepreneurship (*ENT*). Referring to William R. Kerr and Ramana Nanda (2009), Giulia Faggio and Olmo Silva (2014) and Dongmin Kong and Ni Qin (2021), we capture city-level entrepreneurship by the number of the new firm registration. In detail, we calculate the natural logarithm of the new firm establishment counts per 10,000 people to obtain the dependent variable.

Free trade zones establishment (*FTZ*). The independent variable is a dummy, which is defined according to the list and establishment time of FTZs. If a city establishes an FTZ in a certain year, it equals 1 in that year and thereafter; otherwise, it equals 0. Its coefficient captures the impact of the FTZs on entrepreneurship, and is therefore our interest.

To obtain FTZs' net effect on entrepreneurship, we also introduce some control variables that may affect entrepreneurial activities:

Economic development. It is measured by the log value of GDP per capita, with a constant 2004 price. Prior researches have failed to reach a consensus on the impact of economic development on entrepreneurship. For one thing, economic development hurts entrepreneurship. This is mainly because of the "recession-push" effects, that is, existing firms tend to provide more new job openings during the economic boom, which increases the opportunity cost of the entrepreneurial activity, resulting in low entrepreneurship (Ruta Aidis et al., 2012). For another, economic development has a positive relationship with entrepreneurship. The possible reason is the "prosperity-pull" effects. The developed cities bring entrepreneurs with abundant production elements and high potential returns from entrepreneurial activity, thereby attracting entrepreneurial entry (Simon C. Parker, 2004). Based on these, it is deemed essential to introduce the economic development as a control variable in the baseline regression model.

Governmental interference. It is calculated as the proportion of the government's financial expenditure in GDP. The impact direction of governmental interference on entrepreneurship is uncertain either. On the one hand, greater governmental interference may reduce barriers to entrepreneurial behavior by providing strong institutions such as effective property rights protection (Ruta Aidis, Saul Estrin and Tomasz Marek Mickiewicz, 2012). On the other hand, a higher level of the governmental interference implies larger financial spending, namely weaker budget constraints. This may lead to higher social welfare, which weakens incentives for entrepreneurship (Magnus Henrekson, 2007, Philipp Koellinger and Maria Minniti, 2009). In addition, greater governmental interference may reduce entrepreneurs' expected returns by increasing taxes, hampering entrepreneurship (Simon C. Parker, 2004). Hence, we select governmental interference as a control variable to capture its effect on entrepreneurship.

Population density. It is defined by the ratio of the resident count in a city to the urban built-up area. Generally speaking, a city with a dense population has greater market potential, resulting in the agglomeration of entrepreneurs, which implies that population density may have a positive relationship with entrepreneurship (Yifan Wei, 2022). Therefore, referring to Xuan Tian and Jiajie Xu (2022), we use population density as a covariate.

Internet infrastructure. It is measured by the proportion of internet users in total households. The construction of internet infrastructure is conducive to promoting entrepreneurship. Some studies contribute this result to the convenience of information acquisition and knowledge dissemination derived from the popularity of the internet, which is conducive to recognizing entrepreneurial opportunities for entrepreneurs (David B. Audretsch et al., 2015). Meanwhile, the internet opens up some new business models like online education and e-commerce, which in turn

facilitates startup activities (Qi Luo et al., 2022). Based on these, we introduce the internet infrastructure as a control variable to reflect its impact on entrepreneurship.

Human capital. It is measured by the number of college students. Cities with higher levels of human capital have stronger entrepreneurship. On the one hand, in general, highly educated people have more capacity and motivation to start a business (Mark Doms et al., 2010). On the other hand, the highly educated cities tend to attract entrepreneurs since the creation and operation of the new firms need a highly educated labor force. Therefore, human capital is one of the factors impacting urban entrepreneurship, which is selected as a covariate.

Industrial structure. It is defined by the proportion of outputs of manufacturing and service sectors in GDP. The greater the share of manufacturing and service sectors, the higher the entrepreneurship rates of the cities. Because of less entrepreneurial risk and higher profits of secondary and tertiary industries compared with primary industries, entrepreneurs are prone to enter these industries. Based on this, we use the industrial structure as a covariate to control its influence on entrepreneurship.

Considering the availability of the main data, cities with significant missing observations data and administrative changes are eliminated such as Hong Kong, Macau and Hami. We obtain panel data covering 283 cities, of which 41 cities have established FTZs during the study period (see Fig.1). The time span of the sample is from 2004 to 2019.

Urban firm registration data is obtained from the State Administration for Industry and Commerce of China (SAIC) database, which provides records of the registration of China's firms since 1985. We obtain FTZ establishment data from the website of the China Development Zone. We collect data about control variables from China statistical yearbooks and China city statistical yearbooks from 2005 to 2020. All covariates are adjusted into the form of the logarithm. A descriptive statistic for samples of the above-mentioned variables is reported in Table 1.

Table 1--A descriptive statistic for samples.

Variable	Observation	Mean	Standard deviation	Min	Max
ENT	4528	4.2489	0.7113	1.0512	7.2430
FTZ	4528	0.0216	0.1455	0	1
Economic development	4528	10.3049	0.7842	7.5213	15.6752
Governmental interference	4528	-1.6542	0.7320	-3.1582	2.1813
Population density	4528	5.7314	0.9118	1.6094	7.9227
Internet infrastructure	4528	3.5409	1.2459	-3.7443	8.5514
Human capital	4528	10.3014	1.4241	5.4381	13.9579
Industrial structure	4528	4.4530	0.1063	3.9142	4.6049

IV. Results and discussion

A. Characteristics of the entrepreneurship

Fig. 3 describes the spatiotemporal distribution of entrepreneurship in 2004 and 2019. We have three main findings. First, there are significant improvements in entrepreneurship from 2004 to 2019, indicating the rapid growth of entrepreneurial activity. Second, entrepreneurship is spatially imbalanced. Specifically, the entrepreneurship of the eastern cities is ahead of the central and western cities over the research period. Finally, urban entrepreneurship shows spatial agglomeration features. The Yangtze River Delta city cluster and Pearl River Delta city cluster are

areas with high entrepreneurship, which almost do not change within the study period. The Beijing-Tianjin-Hebei city cluster presents high-value agglomeration in 2004, but the agglomeration features are not obvious in 2019. The city clusters in central and western areas almost show low-value agglomeration. In summary, entrepreneurship in China varies significantly in terms of time and spatial dimensions.

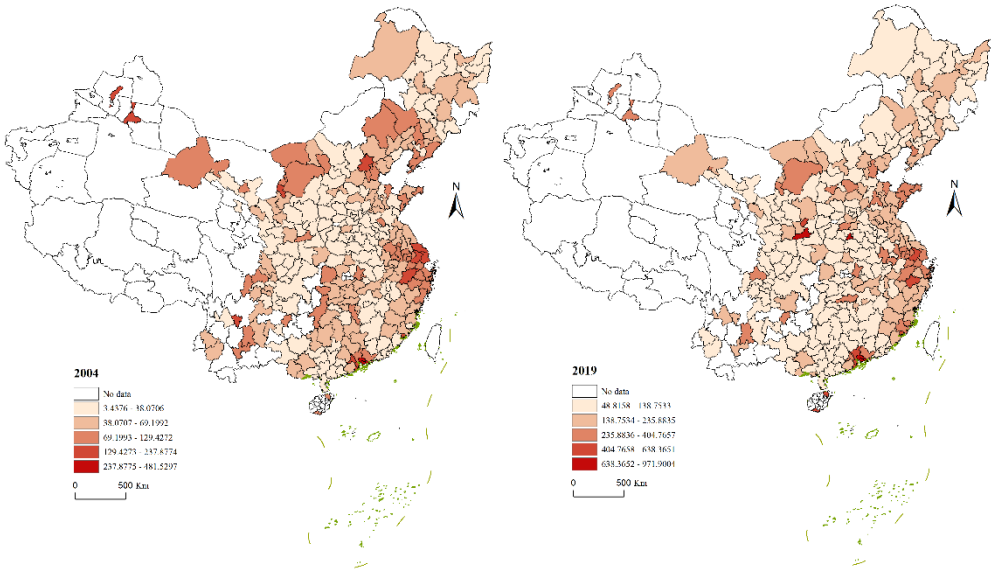


Fig. 3. Spatial distribution of entrepreneurship in China's 283 cities in 2004 and 2019.

B. Baseline results

We explore the effects of the FTZs on entrepreneurship based on Eq. (1), and report the estimated results in Table 2. Column (1) shows regression results using the city and year two-way fixed effect model. Columns (2) and (3) list results using the city fixed effect model and year fixed effect model, respectively. Column (4) represents results using the random effect model. Given that the two-way fixed effect model can address the endogeneity problem to a certain extent, it provides a more unbiased estimation. Thus, the results in column (1) are our concerns, and the results in columns (2)-(4) are used to verify robustness. As shown in column (1), the coefficient of the explanatory variable is positive at 5% significance level, suggesting that cities with FTZs are associated with relative improvement in the entrepreneurship by 9.31% over the study period. The results in columns (2)-(4) also indicate that FTZs have a favorable effect on China's entrepreneurship, which test the robustness.

Regarding control variables, the coefficients for the economic development and governmental interference are positive at the 5% significance level, indicating that a high level of economic development and governmental intervention is beneficial to improve entrepreneurship. These regression results are in accord with the conclusions of Qi Luo, Haoyu Hu, Dawei Feng and Xiaogang He (2022) and Yifan Wei (2022). Similarly, industrial structure is positively correlated to entrepreneurship at the significance level of 1%, demonstrating that a higher proportion of the secondary and tertiary industries is required to promote entrepreneurship, which is in line with our expectations. In addition, the coefficients of the population density, internet infrastructure, and human capital are positive but statistically insignificant, implying that population density, degree of broadband infrastructure development and human capital level are not determinants of the

entrepreneurial activity in our research.

Table 2--The results of baseline regression.

Variable	(1)	(2)	(3)	(4)
FTZ	0.0931**	0.3627***	0.1704***	0.4247***
	(0.0444)	(0.0464)	(0.0427)	(0.0443)
Economic development	0.0774**	0.1737***	0.2137***	0.2581***
	(0.0363)	(0.0312)	(0.0439)	(0.0309)
Governmental interference	0.0371**	0.1655***	0.0450**	0.1519***
	(0.0174)	(0.0122)	(0.0193)	(0.0116)
Population density	0.2999	0.5554**	-0.0715**	-0.1410***
	(0.2656)	(0.2636)	(0.0288)	(0.0278)
Internet infrastructure	0.0218	0.2198***	0.0395**	0.1969***
	(0.0191)	(0.0212)	(0.0187)	(0.0187)
Human capital	0.0001	0.0916***	0.0345**	0.0377**
	(0.0223)	(0.0278)	(0.0164)	(0.0169)
Industrial structure	0.8075***	0.4537	1.0370***	0.9943***
	(0.3091)	(0.3227)	(0.2960)	(0.2793)
Constant	-2.2531	-4.2004**	-2.8319**	-2.8740***
	(1.8871)	(1.9413)	(1.0940)	(1.0914)
Year effect	Yes	No	Yes	No
City effect	Yes	Yes	No	No
Observations	4528	4528	4528	4528
R-squared	0.7362	0.6687	0.7302	0.6611

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

C. Verifying the parallel trend assumption

The parallel trend assumption is a critical precondition for using DID model to identify real policy effects, which claims that the time trends of entrepreneurship in FTZs cities and non-FTZs cities should be consistent in the absence of the FTZs project. Following Yanchao Feng et al. (2021) and KeLiang Wang et al. (2022), we employ the Event Study method to verify it. We specify the regression model as follows:

$$(2) \qquad ENT_{it} = \beta_0 + \beta_1 FTZ_{it}^{-4} + \beta_2 FTZ_{it}^{-3} + \cdots + \beta_7 FTZ_{it}^{2} + \beta_8 FTZ_{it}^{3} + \delta X_{it} + \mu_t + \eta_i + \varepsilon_{it}$$

where FTZ_{it}^{-j} is a dummy. Specifically, FTZ_{it}^{-j}=1 when a city *i* in the *j*th year before FTZs establishment; otherwise, FTZ_{it}^{-j}=0. Similarly, FTZ_{it}^{j}=1 when a city *i* in the *j*th year after FTZs establishment; otherwise, FTZ_{it}^{j}=0. The other variables are defined in the same way as in Eq. (1).

Fig. 4 shows the estimated coefficients of the parallel trend assumption. As shown, the coefficients in the pre-treatment period are all not significant, implying that the disparities of entrepreneurship between FTZs cities and non-FTZs cities are not obvious in the period prior to the FTZs establishment. This result confirms the parallel trend assumption. Furthermore, the dynamic effect of the FTZs on entrepreneurship also can be captured based on the regression results in Fig. 4. The coefficient of the FTZ_{it}^{j} is not significant in the first treated year, while it turns significant in the second, third and fourth years. This means that the effect of the FTZs on entrepreneurship has a time lag. In addition, we can find that the value of the coefficient decreases year by year, suggesting that FTZs' positive impact on entrepreneurship is gradually diminishing.

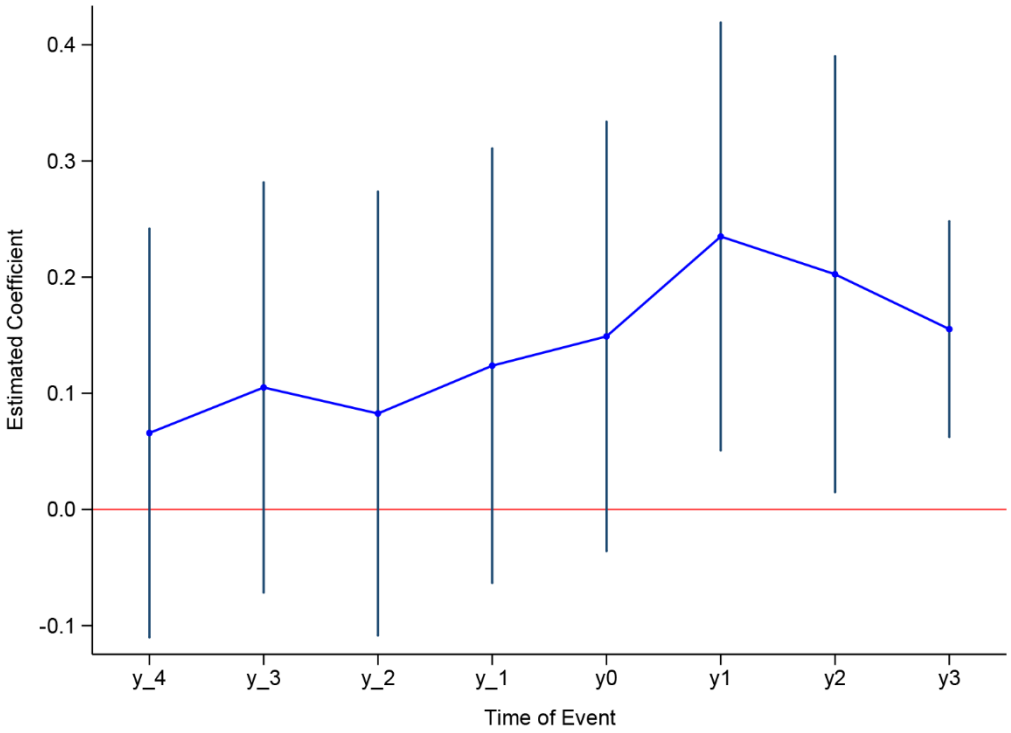


Fig.4. Parallel trend analysis.

D. Robustness checks

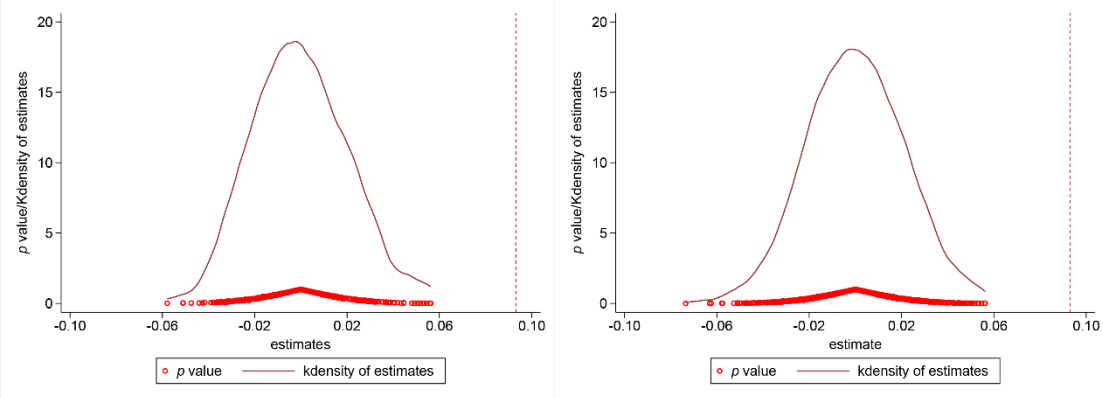
Replacing dependent variable: The new firm establishment count per 10,000 people is employed as the dependent variable in the baseline regression. Given that the number of newly registered firms may be determined by a lot of factors, which is not conducive to best capturing independent variable's effect. Drawing on the practices of Yifan Wei (2022) and Aurora A. C. Teixeira and Anabela S. S. Queirós (2016), we replace the originally dependent variable with the year-upon-year growth ratio of the newly registered firm counts for a robustness check. The regression results are reported in column (1) in Table 3. We can find that the coefficient of *FTZ* is still positive at 5% significance level, implying that the finding of the baseline regression model is robust.

Combining DID model with PSM: The differences in other characteristics between the experimental group and control group may be responsible for the improvement of entrepreneurship, leading to a biased estimation. We employ Propensity Score Matching (PSM) method to eliminate this concern. In particular, we first calculate propensity score based on the probit model. The independent variables and dependent variable in the probit model are covariates and dummy variable *FTZ* used in the baseline regression model, respectively. We then match cities in the experimental group with those in the control group according to the propensity scores. Finally, the unmatched cities are removed, obtaining newly matched samples. On this basis, we then use DID model to examine FTZs' influence on entrepreneurship. We perform kernel PSM and nearest-neighbor PSM, and the corresponding results are displayed in columns (2) and (3) in Table 3, respectively. It can be found that the results support a positive relationship between FTZs and entrepreneurship.

Placebo test: The promotion in entrepreneurship may attribute to many unrecognizable

factors, which results in the estimation error. Thus, we conduct a placebo test used by mainstream researches. Following Xuemei Zheng et al. (2021), we design a counterfactual event. In doing so, the establishment time of the FTZs is advanced to 3 years and 5 years respectively, and further perform regression using Eq. (1). If the regression results show that FTZs still significantly increase new business formation, implying that the potential impacts of other unidentified factors on entrepreneurship exist, that is, the prior results are biased. Otherwise, the results are robust. We report the regression results of the counterfactual event in columns (4) and (5). The coefficients of the *FTZ* are not significant, which verifies the robustness of the baseline regression results.

In addition to changing the start time of the FTZs, we also create another counterfactual event by randomly assigning trial groups from all samples (Xueliang Zhang et al., 2020). We generate a virtual establishment status of FTZs, and obtain a new independent variable. We then estimate the coefficient of *FTZ* based on Eq. (1). To get reliable results, the abovementioned procedure is repeated 500 and 1000 times. Fig. 5(a) shows the probability distribution of the coefficient of *FTZ* with 500 repetitions. We can find that the coefficients cluster closer to 0 and far away from the actual value (0.0931) that we get from the baseline regression, supporting the robustness of the main conclusion. The results of the 1000 times repetitions in Fig. 5(b) also confirm the reliability of the empirical results.



(a) **(b)**

Fig. 5. Placebo test.

Excluding control cities adjacent to the FTZs: Another concern is that the FTZs may impact entrepreneurship in adjacent control cities because of the spatial spillover effects, which violates the stable unit treatment value assumption (SUTVA) and leads to unconfirmed empirical results. To address this concern, we repeat the regression process in a subsample excluding control cities adjacent to the FTZs. The regression results are reported in column (6). The results suggest that FTZs still have a significant positive effect on local entrepreneurship. Hence, our main conclusion is valid.

Table 3-- Robustness test results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
FTZ	0.0631**	0.0953**	0.1094**	0.0557	0.0732	0.1043**
	(0.0319)	(0.0455)	(0.0468)	(0.0416)	(0.0489)	(0.0459)
Constant	-0.0379	-2.5725	-2.2282	-2.3193	-2.2743	-2.0096
	(0.9123)	(1.9133)	(1.8935)	(1.8776)	(1.8760)	(2.2041)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
City effect	Yes	Yes	Yes	Yes	Yes	Yes

Observations	4245	4487	4511	4528	4528	2928
R-squared	0.0948	0.7356	0.7356	0.7361	0.7364	0.7354

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Excluding disturbing policies: Considering that other policies that are implemented during the research period may influence entrepreneurship, the role of the FTZs will be biased. To rule out this concern, we search for some disturbing policies or events related to entrepreneurship, such as the high-speed railway opening (*HSR*) (Liya Ma et al., 2021), the National Innovative City Pilot policy (*NICP*) (Junhong Bai et al., 2022) and Intellectual Property Rights Demonstration City policy (*IPRD*) (Xing Gao et al., 2022). In addition, since FTZs are important hubs and platform of the One Belt One Road initiative (*OBOR*), they have similarities in terms of their role. Therefore, it is also inevitable to exclude the impact of the One Belt One Road initiative when exploring FTZs' effect on entrepreneurship. We add dummy variables representing these disturbing policies into the baseline regression model to control their effects on entrepreneurship. Table 4 shows the regression results. We find that the coefficients of the independent variable *FTZ* are significantly positive, indicating that the FTZs have a positive effect on entrepreneurship.

Table 4--Robustness test results of excluding disturbing policies.

Variable	(1)	(2)	(3)	(4)	(5)
FTZ	0.0927**	0.0925**	0.0917**	0.1031**	0.1013**
	(0.0444)	(0.0442)	(0.0443)	(0.0319)	(0.0442)
HSR	-0.0056				-0.0093
	(0.0219)				(0.0226)
NICP		0.0100			0.0067
		(0.0432)			(0.0437)
IPRD			0.0090		0.0055
			(0.0439)		(0.0445)
OBOR				-0.0543*	-0.0544*
				(0.0326)	(0.0327)
Constant	-2.2624	-2.2706	-2.2612	-2.0045	-2.0363
	(1.8911)	(1.8876)	(1.8854)	(1.9059)	(1.9064)
Control variable	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes
City effect	Yes	Yes	Yes	Yes	Yes
Observations	4528	4528	4528	4528	4528
R-squared	0.7363	0.7363	0.7363	0.7369	0.7370

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Treatment of endogenous problem: It is likely that the omission of the unobservable factors affecting entrepreneurship results in endogenous problem. To address this, we adopt the IV method to explore the effects of the FTZs on entrepreneurship. Based on the criteria of the correlation and exclusivity, the dummy for whether a city was a treaty port or proactively open port in the late Qing dynasty (*POR*) is used as the IV for the FTZs establishment. In terms of the correlation, the former ports are among the first to capitalize the new globalization opportunities after large-scale economic reforms in 1978, as shown by prosperous foreign trade (Ruixue Jia, 2014, Bo Bernhard Nielsen et al., 2017), and are therefore more likely to be approved as FTZs. By and large, the IV used here meets the criteria of the correlation. In terms of exclusivity, the port in late Qing dynasty is historical information, which cannot impact contemporary entrepreneurship, implying the exclusivity of the IV is guaranteed. Table 5 displays the regression results of the IV

method. The Kleibergen-Paap rk *F*-statistic exceeds Stock-Yogo's 10% maximal bias threshold of 16.38, thereby rejecting the hypothesis of the weak IV and affirming the validity of the IV. Additionally, the Kleibergen-Paap rk *LM*-statistic is significant at 5% significance level, which rejects the null hypothesis of the insufficient identification of the IV. The results of the first stage show that the IV is positively correlated with the FTZs establishment, as expected. The results of the second stage are consistent with the baseline model, that is, FTZs significantly promote entrepreneurship.

Table 5--Results of IV method.

Variable	(1)	(2)
	First stage	Second stage
	FTZ	*ENT*
FTZ		0.3457***
		(0.1035)
POR	0.8990***	
	(0.0492)	
Constant	-0.0163	-4.5034***
	(0.0384)	(0.9083)
Control variable	Yes	Yes
Kleibergen-Paap rk *F*	334.29	
Kleibergen-Paap rk *LM*	17.84***	
Observations	4528	4528

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

E. Heterogeneity analysis

Heterogeneity analysis in geographical location: Based on previous analysis, we can find that FTZs are bound to improve entrepreneurship. However, there are obvious regional differences in economic development and openness across the eastern, middle and western areas, which may cause the heterogeneous impact of FTZs on entrepreneurship. To this end, we categorize all samples into the eastern, middle and western groups according to geographical location, and further conduct regression analysis employing DID model to check heterogeneity. The regression results are shown in columns (1)-(3) in Table 6. It can be seen that the coefficient of *FTZ* in the western group is significantly positive, while it is not significant in the eastern and middle groups. This suggests that FTZs can effectively improve entrepreneurship in western cities. The reason for this heterogeneity is that the western area has lower economic development level and poorer technological conditions compared with the eastern and middle areas, which restrict firm creation. Pilot FTZs bring high-quality resources such as technology and talents to the western cities, thereby largely ameliorating the local entrepreneurial environment. Consequently, FTZs in western cities have a greater effect.

Moreover, we further analyze whether the FTZs' effect varies across the southern and northern areas of China. Specifically, all sample is divided into southern group and northern group following the Qinling-Huaihe line, which is an accepted geographical dividing line. We perform regression analysis for the above two groups respectively, and report results in columns (4) and (5) in Table 6. We can find that the positive effect of FTZs on entrepreneurship is not significant in the southern group. We conjecture that the possible reason for this may be the differences in entrepreneurial culture between southern and northern China. Characterized by active commercial

activities, the south has developed a stronger entrepreneurship culture compared to the north as described by Victor. Nee and Sonja. Opper (2012), which means that southern cities have a higher level of entrepreneurship even without the FTZs. Therefore, the impact of FTZs in the south may not be as pronounced.

Table 6--Results of heterogeneity analysis in geographical location.

Variable	(1)	(2)	(3)	(4)	(5)
	East	Middle	West	South	North
FTZ	0.0739	0.0172	0.2711*	0.0448	0.1673*
	(0.0446)	(0.0895)	(0.1616)	(0.0425)	(0.0857)
Constant	-3.5095	-7.7508***	5.0899**	-4.0375	-5.0341*
	(3.3191)	(2.9400)	(2.3419)	(2.8341)	(2.5825)
Control variable	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes
City effect	Yes	Yes	Yes	Yes	Yes
Observations	1600	1600	1328	2448	2080
R-squared	0.7654	0.7498	0.7753	0.7476	0.7607

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Heterogeneity analysis in city status: The impact of FTZs on entrepreneurship may be heterogeneous among cities with different statuses. To clarify this heterogeneity, we divide all cities into the central group and noncentral group based on the administrative levels, in which central government municipalities and provincial capitals with higher administrative level are classified in the central group, and the rest is included in the noncentral group. We list the regression results in columns (1) and (2) in Table 7. The coefficients of *FTZ* in the two groups are positive at 10% significance level, while the value is larger in the central group, demonstrating that the higher status the city, the larger the promotional effect of FTZs on entrepreneurship. This is the case since the fact that provincial capital cities tend to embrace superior infrastructure and a developed market economy, which are indispensable conditions for starting entrepreneurial activities (Yifan Wei, 2022).

Heterogeneity analysis in industry: The impact of FTZs on entrepreneurship may vary across industries due to the differences in sensitivity to entrepreneurial conditions. For this reason, we separately calculate the number of newly registered firms in manufacturing and services, and use them as dependent variables to explore heterogeneity in industry. The results are reported in columns (3) and (4) in Table 7. The results show that compared to services, the marginal effect of FTZs on entrepreneurship is less prominent in manufacturing. One possible explanation could be that hurdles for new entrants are lower in services than in manufacturing (Meghana Ayyagari and Renáta Kosová, 2010), making it easier to start a business with the support of FTZs. Additionally, one of the important objectives of establishing FTZs is to promote the modernization of the domestically-protected service industry, including financial, logistics and cultural industries (Chenghua Guan, Jinyuan Huang, Ruyue Jiang and Wanting Xu, 2023), so the pilot has a particular focus on services and formulates various favorable policies. As a result, FTZs significantly incentive entrepreneurship in services.

Table 7--Results of heterogeneity analysis in city status and industry.

Variable	(1)	(2)	(3)	(4)
	Central	Non-central	Manufacturing	Service industry
FTZ	0.1276*	0.1001*	-0.0765	0.1001**
	(0.0693)	(0.0597)	(0.0612)	(0.0468)

Constant	-32.6228***	-3.2921	-5.5497**	-2.0134
	(1.9436)	(2.0550)	(2.2616)	(1.8363)
Control variable	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
City effect	Yes	Yes	Yes	Yes
Observations	544	3984	4528	4528
R-squared	0.8218	0.7340	0.1727	07266

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Heterogeneity analysis in different FTZs: The previous analysis has verified the entrepreneurship promotion effect of China's FTZs, but neither distinguishes nor compares effects in different FTZs. To make up for this shortcoming, we use synthetic control methods (SCM) proposed by Alberto Abadie and Javier Gardeazabal (2003) for further analysis. This method uses the weighted average of several objects not impacted by the policy intervention to synthesize a counterfactual control group with similar characteristics to each treatment group, which can effectively avoid endogenous problems stemming from the subjective selection of the control groups. The gaps between the actual treatment group and the synthetic control group after the policy implementation intuitively show the policy's effect.

Considering that the intervention time of the third, fourth and fifth batch FTZs is later, their effects may not be fully demonstrated during the study period. Therefore, we take the first batch (Shanghai FTZ) and second batch pilots (Tianjin FTZ, Fuzhou FTZ, Xiamen FTZ, Guangzhou FTZ, Shenzhen FTZ and Zhuhai FTZ) as the treatment groups. Since Fuzhou FTZ and Xiamen FTZ are geographically and administratively incorporated in Fujian province, they share strategic orientation and development path, so we merge the two FTZs as Fujian FTZ. Similarly, the Guangzhou, Shenzhen and Zhuhai FTZs are merged as Guangdong FTZ. Consequently, there are four treatment groups, namely Shanghai FTZ, Tianjin FTZ, Fujian FTZ and Guangdong FTZ.

Fig.6 displays the results of SCM, wherein the solid line depicts the track of entrepreneurship in actual FTZs, the dotted line depicts the track of entrepreneurship in synthetic FTZs, and the vertical dotted line indicates the starting year of FTZs. As shown in Fig.6, the change path of entrepreneurship in real and synthetic FTZs almost coincides prior to FTZs establishment, which implies that the synthetic groups can better fit the treatment group. After the FTZs establishment, there are evident deviations between the actual FTZs and corresponding synthetic FTZs in terms of entrepreneurship, and the deviations are different in each FTZ. Specifically, in Shanghai and Fujian, the real track always exceeds the synthetic track after the FTZs intervention, which indicates that Shanghai FTZ and Fujian FTZ have a positive effect on entrepreneurship; as for Tianjin and Guangdong, FTZs promote entrepreneurship in the first year of the pilot (2015), while the positive impact disappears after 2015. The reason may be that the institutional innovation in Tianjin FTZ and Guangdong FTZ did not combine well with the local development bases and advantages.

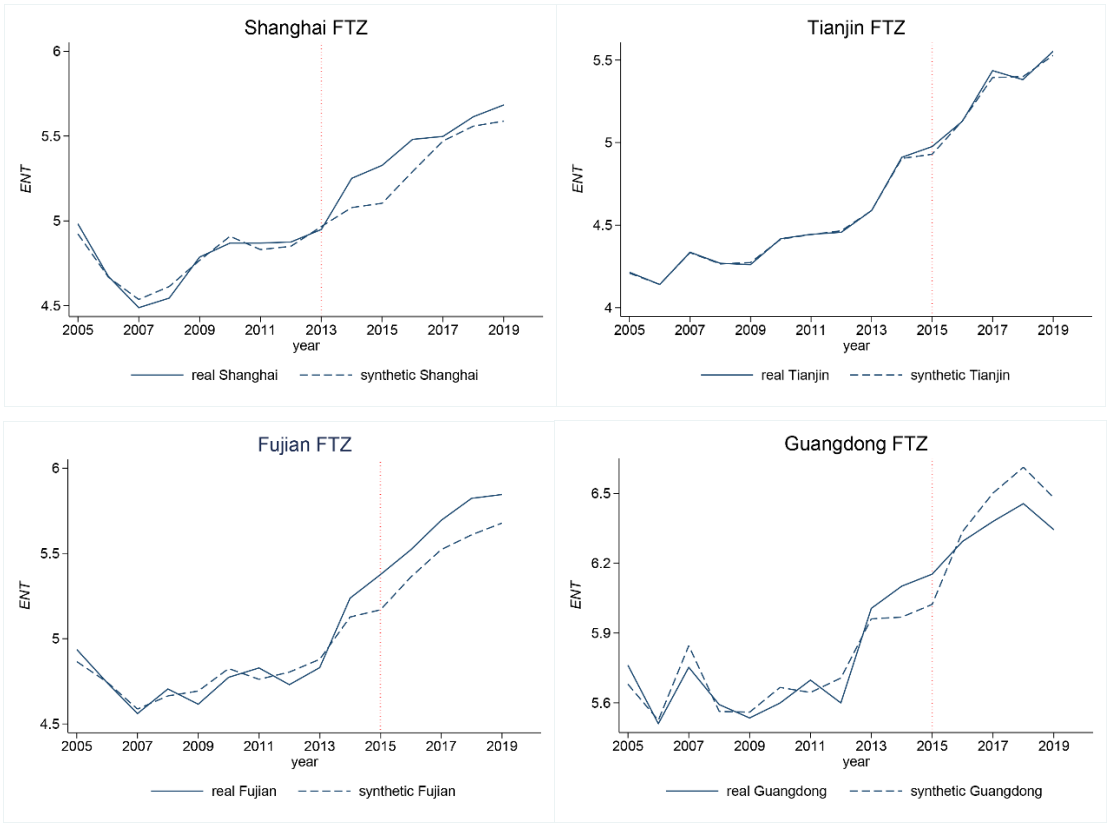


Fig.6. Comparison of the track of entrepreneurship between the real and synthetic FTZs.

F. Mechanism analysis

What is the impact mechanism by which the introduction of FTZs leads to the promotion of entrepreneurship? According to the analysis in Section 2.2, we identify two influence channels from the perspective of opening-up upgradation and financial development. Taking opening-up upgradation as an example, we employ the following Eq. (3) to examine it:

$$OPE_{it} = \lambda_0 + \lambda_1 FTZ_{it} + \delta X_{it} + \mu_t + \eta_i + \varepsilon_{it} \tag{3}$$

where OPE_{it} denotes the degree of the opening-up, and we use foreign direct investment and foreign trade to reflect it. The former is characterized by the amount of the total utilized foreign direct investment, the latter is measured by the amount of the total import and export. The rest of the variables are defined as in Eq. (1). In terms of the level of financial development, we use the ratio of the deposit and loan balance of the financial institutions to the total population to measure it. The estimation results of the mechanism exploration are represented in Table 8. We can find that the coefficients of the independent variable are significantly positive, indicating that FTZs stimulate entrepreneurial endeavors by promoting opening-up upgradation and financial development.

Table 8--Results of the impact mechanism.

Variable	(1)	(2)	(3)
	Foreign direct investment	Foreign trade	Financial development
FTZ	0.3892***	0.1103*	0.0780***
	(0.1309)	(0.0607)	(0.0132)
Constant	-2.3764	-5.1972***	0.0348

	(5.0366)	(1.3028)	(0.3809)
Control variable	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
City effect	Yes	Yes	Yes
Observations	4528	4528	4528
R-squared	0.2526	0.5481	0.6662

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

G. Spatial spillover effects analysis

The first law of geography states that all things are interconnected, but near things have a stronger relationship than distant ones (W. R. Tobler, 1970). Given this, FTZs may not only impact local entrepreneurship, but also generate cross-regional influence, namely spatial spillover effect. Identifying the spillover effect is beneficial to accurately evaluate FTZs' effect on entrepreneurship, thereby providing more theoretical guidance and policy implications for the further development of FTZs. Therefore, we further investigate spatial spillover effect of FTZs on entrepreneurship using a SDID model, which nests the spatial econometric model and traditional DID model.

Spatial autocorrelation test: The most common prerequisite for employing SDID model is the existence of spatial autocorrelation. To examine it, we calculate the global and local Moran index (Moran's *I*) for entrepreneurship respectively, in which the former provides information on the overall degree of spatial autocorrelation, and the latter measures the spatial autocorrelation of the individual units. The global Moran's *I* is calculated as follows:

$$Moran's\ I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} W} \times \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W(x_i - \overline{x})(x_j - \overline{x})}{\sum_{i=1}^{n}(x_i - \overline{x})^2} \tag{4}$$

where n denotes the number of samples; x_i and x_j indicate the entrepreneurship in the city i and j, respectively; $\overline{x}$ is the average value; W denotes the commonly-used geographical adjacency matrix where the element equals 1 if city i and j are adjacent, otherwise 0. Generally, if the global Moran's *I* is larger than 0 and significant at least at 5% level, there is a clustered spatial pattern. Table 9 shows the global Moran's *I* of entrepreneurship. We find that global Moran's *I* is positive at 1% significance level over the years, implying a positive spatial correlation for entrepreneurship among cities.

Table 9--The Moran's *I* of entrepreneurship during 2004-2019.

Year	Global Moran's *I*	Z(I)	*p*-value
2004	0.511***	12.523	0.000
2005	0.500***	12.260	0.000
2006	0.532***	13.025	0.000
2007	0.565***	13.827	0.000
2008	0.518***	12.690	0.000
2009	0.525***	12.841	0.000
2010	0.515***	12.606	0.000
2011	0.519***	12.710	0.000
2012	0.493***	12.079	0.000

2013	0.472***	11.610	0.000
2014	0.482***	11.837	0.000
2015	0.490***	12.017	0.000
2016	0.496***	12.183	0.000
2017	0.479***	11.759	0.000
2018	0.463***	11.361	0.000
2019	0.421***	10.324	0.000

Note: *** p < 0.01, ** p < 0.05, * p < 0.1.

Following Ruining Jia et al. (2021), we also draw the scatter plot of the local Moran's *I* for 2004, 2009, 2014 and 2019 as shown in Fig.7. The scatter in this plot represents the observation city, and four quadrants represent the cluster type of high-high (H-H), low-high (L-H), low-low (L-L) and high-low (H-L), respectively. Clearly, most of the scatters are located in the first and third quadrants, which means that entrepreneurship shows significant spatial autocorrelation. Based on the above tests, it is rational to use the SDID model to analyze the spatial spillover effect of FTZs.

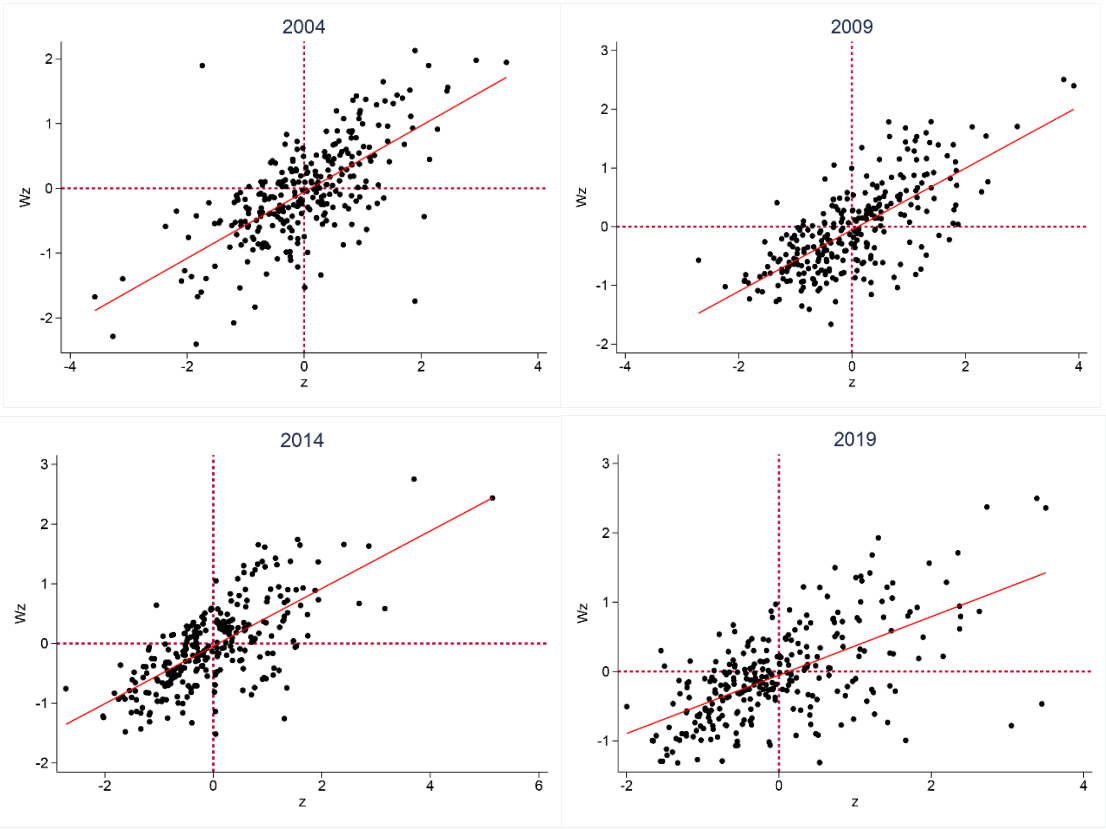


Fig. 7. Scatter figure of the local Moran's *I* of entrepreneurship for 2004, 2009, 2014 and 2019, respectively.

Results of the spatial spillover effect: We employ the model proposed by Solmaria Halleck Vega and J. Paul Elhorst (2015) to examine the spillover effect of FTZs. The regression specification is as follows:

$$ENT_{it} = \gamma_0 + \gamma_1 FTZ_{it} + \delta_1 X_{it} + \gamma_2 (W \times FTZ_{it}) + \delta_2 (W \times X_{it}) + \mu_t + \eta_i + \varepsilon_{it} \quad (5)$$

where $W \times FTZ_{it}$ is a spatial lag term of the independent variable, and its coefficient captures the spatial spillover effect of FTZs on adjacent cities; the other variables are consistent with Eq. (1). The regression results based on Eq. (5) are reported in column (1) in Table 10. We can find that the coefficient of spatial lag term is significantly positive, suggesting that FTZs can promote

entrepreneurship in proximity cities, that is, there is a positive spillover effect. This implies that FTZs provide entrepreneurial opportunities and stimulate individuals' entrepreneurial decisions through institutional quality improvement, which is a process of creating entrepreneurial resources rather than siphoning resources from untreated cities to treated cities. In addition, note that we only obtain an average effect by estimating Eq. (5), without considering that the incidence of the spillover effect may be heterogeneous between treated and untreated neighboring cities. In light of this, drawing on the practices of André L. S. Chagas et al. (2016), we reconstruct an SDID model to decompose the spatial spillover effect, as follows:

$$ENT_{it} = \rho_0 + \rho_1 FTZ_{it} + \delta_1 X_{it} + \rho_2 (W_{T,T} \times FTZ_{it}) + \rho_3 (W_{NT,T} \times FTZ_{it}) + \delta_2 (W \times X_{it}) + \mu_t + \eta_i + \varepsilon_{it} \quad (6)$$

where $W_{T,T} \times FTZ_{it}$ and $W_{NT,T} \times FTZ_{it}$ describe the spillover effect of FTZs on the treated cities and untreated cities, respectively[4]; We list the regression results in column (2) in Table 10. The results indicate that FTZs effectively and positively promote entrepreneurship in untreated neighboring cities, but this effect is not supported in treated neighboring cities.

Table 10--The results of the spatial spillover effect.

Variable	(1)	(2)
FTZ	0.1068**	0.1084*
	(0.0443)	(0.0571)
$W \times FTZ$	0.0405*	
	(0.0250)	
$W_{T,T} \times FTZ$		0.0062
		(0.0595)
$W_{NT,T} \times FTZ$		0.0448*
		(0.0255)
Constant	-0.7675	-2.2197
	(1.2417)	(1.8802)
Control variable	Yes	Yes
Year effect	Yes	Yes
City effect	Yes	Yes
Observations	4528	4528
R-squared	0.7360	0.7367

Note: The robust standard errors that cluster to the city are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

V. Conclusions and policy implications

Rationally stimulating urban entrepreneurship through pilot FTZs is an important way to accelerate the model transformation of economic growth and to achieve high-quality development. Regarding China's FTZs establishment as a quasi-natural experiment, we systematically assess effects of FTZs on entrepreneurship by employing DID model based on annual panel data at the prefecture-level from 2004 to 2019. Then, we discussed the heterogeneity of FTZs' effects and the underlying mechanism. Finally, we further explore the spatial spillover effects, with the following main conclusions.

Pilot FTZs can significantly enhance entrepreneurship, and this finding is confirmed by

[4] $W_{T,T}=D_{it}\times W\times D_{it}$, where D_{it}= diag(FTZ_{it}) is a matrix with independent variable (FTZ_{it}) in the main diagonal and 0 elsewhere; $W_{NT,T}=D_{it}^{C}\times W\times D_{it}$, where$D_{it}^{C}$=diag($I_{it}$- D_{it}), with I_{it} an identity matrix.

parallel trend tests and various robustness checks. The heterogeneity analysis finds that western cities, northern cities, cities with high administrative levels, and service industries experience a more significant increase in entrepreneurship. With the utilization of the SCM in effects comparison, we find that the effect on entrepreneurship varies among FTZs in China. Specifically, Shanghai FTZ and Fujian FTZ induce a more positive effect on entrepreneurship than Tianjin FTZ and Guangdong FTZ. The mechanism analysis verifies that FTZs promote entrepreneurship via promoting opening-up upgradation and financial development. The spatial spillover effect analysis shows that FTZs improve entrepreneurship in neighboring non-FTZs cities instead of neighboring FTZs cities.

Based on the above conclusions, we put forward policy recommendations as follows:

The strategy of pilot FTZs should be continually encouraged to release the entrepreneurial promotion effect. In FTZs, efforts should be made to enhance the degree of opening-up and foster financial development relying on institutional innovations. In particular, the government should formulate policies to support trade facilitation and encourage cross-border e-commerce, therefore promoting the opening-up of foreign trade. The sectors on the negative list for foreign investment should be further decreased to drive the opening-up of foreign investment. It is necessary to strengthen financial innovation and focus on the marketization operation of the financial system, contributing to financial development.

The urban characteristics should be taken into account by the government when deciding on the layout of FTZs. Specifically, from the perspective of entrepreneurship promotion effect, the FTZs strategy should be implemented in western cities, northern cities, and cities with high administrative levels. Furthermore, due to the significantly positive effect of FTZ on entrepreneurship in the service sectors, the government should introduce more policies to promote the prosperity of the service industry within the FTZs.

Given the evident variations in the policy dividends across different FTZs, the government should not blindly replicate experiences arising from other FTZs, but should develop a differentiated path based on their advantages, thereby stimulating a positive effect on entrepreneurship. For example, Guangdong FTZ could make full use of the geographical advantage of proximity to Hong Kong and Macao, and actively attract the inflow of investment while enhancing cooperation in trade and finance; As an important port serving the Beijing-Tianjin-Hebei urban agglomeration, Tianjin FTZ should strive to build into shipping center and logistics center, thus contributing to the acceleration of its opening-up.

Considering the positive spatial spillover effect of FTZs on entrepreneurship in surrounding non-FTZs cities, the government of the non-FTZs cities should actively absorb the advanced experience of the FTZs and continually strengthen cooperation with FTZs in terms of stimulating entrepreneurship, thereby maximizing the spillover effect.

Reference

Abadie, Alberto and Javier Gardeazabal. 2003. "The Economic Costs of Conflict: A Case Study of the Basque Country." *American Economic Review*, 93(1), 113-32.

Afi, Hatem; Sabri Boubaker and Anis Omri. 2022. "Do Foreign Investment and Economic Freedom Matter for Behavioral Entrepreneurship? Comparing Opportunity Versus Necessity Entrepreneurs." *Technological Forecasting and Social Change*, 181, 121761.

Aidis, Ruta; Saul Estrin and Tomasz Marek Mickiewicz. 2012. "Size Matters: Entrepreneurial Entry and Government." *SMALL BUSINESS ECONOMICS*, 39(1), 119-39.

Apostolov, Mico. 2017. "The Impact of Fdi on the Performance and Entrepreneurship of Domestic Firms." *Journal of International Entrepreneurship*, 15(4), 390-415.

Audretsch, David B.; Diana Heger and Tobias Veith. 2015. "Infrastructure and Entrepreneurship." *SMALL BUSINESS ECONOMICS*, 44(2), 219-30.

Ayyagari, Meghana and Renáta Kosová. 2010. "Does Fdi Facilitate Domestic Entry? Evidence from the Czech Republic." *Review of International Economics*, 18(1), 14-29.

Ba, Susong; Hongrui Chai; Yunlong Fang and Bo Wang. 2021. "Does the Establishment of the Pilot Free Trade Zone Improve the Efficiency of Financial Services for the Real Economy?" *World Economy Studies*, 12, 3-12.

Bai, C. E.; R. Jia; H. Li and X. Wang. 2021. "Entrepreneurial Reluctance: Talent and Firm Creation in China." *NBER Working Papers*.

Bai, Junhong; Yixuan Zhang and Yuanchao Bian. 2022. "Does Innovation-Driven Policy Increase Entrepreneurial Activity in Cities—Evidence from the National Innovative City Pilot Policy." *China Industrial Economics*, 6(6), 61-78.

Brandt, L.; G. Kambourov and K. Storesletten. 2018. "Barriers to Entry and Regional Economic Growth in China," *2018 Meeting Papers.*

Castilho, Marta; Marta Menéndez and Aude Sztulman. 2019. "Poverty Changes in Manaus: Legacy of a Brazilian Free Trade Zone?" *Review of Development Economics*, 23(1), 102-30.

Chagas, André L. S.; Carlos R. Azzoni and Alexandre N. Almeida. 2016. "A Spatial Difference-in-Differences Analysis of the Impact of Sugarcane Production on Respiratory Diseases." *Regional Science and Urban Economics*, 59, 24-36.

Chauffour, Jean Pierre and Jean Christophe Maur. 2011. "Preferential Trade Agreement Policies for Development: A Handbook." *World Bank Publications.*

Chen, Hao; Bo Yuan and Qi Cui. 2021. "Does the Pilot Free Trade Zone Policy Attract the Entering of Foreign-Invested Enterprises? The Evidence from China." *Applied Economics Letters*, 28(14), 1162-68.

Chen, Jieyi and Zhao Zhou. 2023. "The Effects of Fdi on Innovative Entrepreneurship: A Regional-Level Study." *Technological Forecasting and Social Change*, 186, 122159.

Chen, Wanling; Yao Hu; Bei Liu; Hui Wang and Mingbo Zheng. 2022. "Does the Establishment of Pilot Free Trade Test Zones Promote the Transformation and Upgradation of Trade Patterns?" *Economic Analysis and Policy*, 76, 114-28.

Cheng, Huifang; Y. I. Zhang and Hongyi Li. 2020. "Effects of Free Trade Zone Policy on China's Income Disparity." *The Singapore Economic Review*, 67(02), 709-32.

Cui, Chuantao and Leona ShaoZhi Li. 2023. "Trade Policy Uncertainty and New Firm Entry: Evidence from China." *Journal of Development Economics*, 163, 103093.

Dileo, Ivano and Thaís García Pereiro. 2019. "Assessing the Impact of Individual and Context Factors on the Entrepreneurial Process: A Cross-Country Multilevel Approach." *International Entrepreneurship and Management Journal*, 15(4), 1393-441.

Doms, Mark; Ethan Lewis and Alicia Robb. 2010. "Local Labor Force Education, New Business Characteristics, and Firm Performance." *Journal of Urban Economics*, 67(1), 61-77.

Dutta, Nabamita and Daniel Meierrieks. 2021. "Financial Development and Entrepreneurship." *International Review of Economics & Finance*, 73, 114-26.

Faggio, Giulia and Olmo Silva. 2014. "Self-Employment and Entrepreneurship in Urban and Rural Labour Markets." *Journal of Urban Economics*, 84, 67-85.

Feng, Yanchao; Xiaohong Wang; Zhou Liang; Shilei Hu; Yu Xie and Guoyong Wu. 2021. "Effects of Emission Trading System on Green Total Factor Productivity in China: Empirical Evidence from a Quasi-Natural Experiment." *Journal of Cleaner Production*, 294, 126262.

Fracasso, Andrea and Giuseppe Vittucci Marzetti. 2015. "International Trade and R&D Spillovers." *Journal of International Economics*, 96(1), 138-49.

Freytag, Andreas and Roy Thurik. 2007. "Entrepreneurship and Its Determinants in a Cross-Country Setting." *Journal of Evolutionary Economics*, 17(2), 117-31.

Fuentelsaz, Lucio; Juan P. Maicas and Javier Montero. 2018. "Entrepreneurs and Innovation: The Contingent Role of Institutional Factors." *International Small Business Journal*, 36(6), 686-711.

Gao, Xing; Jing Meng; Yantao Ling; Maolin Liao and Mengqiu Cao. 2022. "Localisation Economies, Intellectual Property Rights Protection and Entrepreneurship in China: A Bayesian Analysis of Multi-Level Spatial Correlation." *Structural Change and Economic Dynamics*, 61, 156-65.

Ghani, Ejaz; William R. Kerr and Stephen O'Connell. 2014. "Spatial Determinants of Entrepreneurship in India." *Regional Studies*, 48(6), 1071-89.

Goel, Rajeev K. and James W. Saunoris. 2017. "Dynamics of Knowledge Spillovers from Patents to Entrepreneurship: Evidence across Entrepreneurship Types." *Contemporary Economic Policy*, 35(4), 700-15.

Grilo, Isabel and Roy Thurik. 2008. "Determinants of Entrepreneurial Engagement Levels in Europe and the Us." *Industrial and Corporate Change*, 17(6), 1113-45.

Guan, Chenghua; Jinyuan Huang; Ruyue Jiang and Wanting Xu. 2023. "The Impact of Pilot Free Trade Zone on Service Industry Structure Upgrading." *Economic Analysis and Policy*, 78, 472-91.

Guzman, Jorge and Aleksandra Kacperczyk. 2019. "Gender Gap in Entrepreneurship." *Research Policy*, 48(7), 1666-80.

Halleck Vega, Solmaria and J. Paul Elhorst. 2015. "The Six Model." *Journal of Regional Science*, 55(3), 339-63.

Henrekson, Magnus. 2007. "Entrepreneurship and Institutions Economics of Entrepreneurship." *Comparative Labor Law & Policy Journal*, 28(4), 717.

Herrera-Echeverri, Hernán; Jerry Haar and Juan Benavides Estévez-Bretón. 2014. "Foreign Direct Investment, Institutional Quality, Economic Freedom and Entrepreneurship in Emerging Markets." *Journal of Business Research*, 67(9), 1921-32.

Huang, Dechun; Vu Van; Md Ekram Hossain and Zhengqi He. 2017. "Shanghai Pilot Free Trade Zone and Its Effect on Economic Growth: A Counter-Factual Approach." *Journal of Social Sciences*, 5, 73-91.

Ji, Mingjie; Mimi Li and Brian King. 2015. "The Impacts of China's New Free-Trade Zones on Hong Kong Tourism." *Journal of Destination Marketing & Management*, 4(4), 203-05.

Jia, Ruining; Shuai Shao and Lili Yang. 2021. "High-Speed Rail and Co_2 Emissions in Urban China: A Spatial Difference-in-Differences Approach." *Energy Economics*, 99, 105271.

Jia, Ruixue. 2014. "The Legacies of Forced Freedom: China's Treaty Ports." *The Review of Economics and Statistics*, 96(4), 596-608.

Jia, Ruixue; Xiaohuan Lan and Gerard Padró i Miquel. 2021. "Doing Business in China: Parental Background and Government Intervention Determine Who Owns Busines." *Journal of Development Economics*, 151, 102670.

Kerr, William R. and Ramana Nanda. 2009. "Democratizing Entry: Banking Deregulations, Financing Constraints, and Entrepreneurship." *Journal of Financial Economics*, 94(1), 124-49.

Koellinger, Philipp and Maria Minniti. 2009. "Unemployment Benefits Crowd out Nascent Entrepreneurial Activity." *Economics Letters*, 103(2), 96-98.

Kong, Dongmin and Ni Qin. 2021. "China's Anticorruption Campaign and Entrepreneurship." *Journal of Law Economics*, 64(1), 153-80.

Kong, Dongmin; Ni Qin and Junyi Xiang. 2021. "Minimum Wage and Entrepreneurship: Evidence from China." *Journal of Economic Behavior & Organization*, 189, 320-36.

Kosová, Renáta. 2010. "Do Foreign Firms Crowd out Domestic Firms? Evidence from the Czech Republic." *The Review of Economics and Statistics*, 92(4), 861-81.

Levine, Ross. 1997. "Financial Development and Economic Growth: Views and Agenda." *Journal of Economic Literature*, 35(2), 688-726.

Li, Haiyang and Yu Li. 2018. "How Does Fdi Stimulate Domestic Entrepreneurship in an Emerging Market? Evidence from China." *Proceedings*, 2018(1), 18359.

Li, Haoqiang; Jihong Chen; Zheng Wan; Huaxin Zhang; Maoxin Wang and Yun Bai. 2020. "Spatial Evaluation of Knowledge Spillover Benefits in China's Free Trade Zone Provinces and Cities." *Growth and Change*, 51(3), 1158-81.

Li, Sujuan; Jiaguo Liu and Yudan Kong. 2021. "Pilot Free Trade Zones and Chinese Port-Listed Companies Performance: An Empirical Research Based on Quasi-Natural Experiment." *Transport Policy*, 111, 125-37.

Liu, Mengsha; Yan Jiang; Xiaokun Wei; Qingsong Ruan and Dayong Lv. 2023. "Effect of High-Speed Rail on Entrepreneurial Activities: Evidence from China." *Socio-Economic Planning Sciences*, 87, 101538.

Luo, Qi; Haoyu Hu; Dawei Feng and Xiaogang He. 2022. "How Does Broadband Infrastructure Promote Entrepreneurship in China: Evidence from a Quasi-Natural Experiment." *Telecommunications Policy*, 46(10), 102440.

Ma, Liya; Dongxiao Niu and Weizeng Sun. 2021. "Transportation Infrastructure and Entrepreneurship: Evidence from High-Speed Railway in China." *China Economic Review*, 65, 101577.

Nee, Victor. and Sonja. Opper. 2012. *Capitalism from Below: Markets and Institutional Change in China*. Cambridge: Harvard University Press.

Nielsen, Bo Bernhard; Christian Geisler Asmussen and Cecilie Dohlmann Weatherall. 2017. "The Location Choice of Foreign Direct Investments: Empirical Evidence and Methodological Challenges." *Journal of World Business*, 52(1), 62-82.

Parker, Simon C. 2004. *The Economics of Self-Employment and Entrepreneurship*. Cambridge: Cambridge University Press.

Schumpeter, J.A. 1912. *The Theory of Economic Development*. Cambridge: Harvard University Press.

Teixeira, Aurora A. C. and Anabela S. S. Queirós. 2016. "Economic Growth, Human Capital and Structural Change: A Dynamic Panel Data Analysis." *Research Policy*, 45(8), 1636-48.

Tian, Xuan and Jiajie Xu. 2022. "Do Place-Based Policies Promote Local Innovation and Entrepreneurship?" *Review of Finance*, 26(3), 595-635.

Tobler, W. R. 1970. "A Computer Movie Simulating Urban Growth in the Detroit Region." *Economic Geography*, 46, 234-40.

Van Der Zwan, Peter; Ingrid Verheul; Roy Thurik and Isabel Grilo. 2013. "Entrepreneurial Progress: Climbing the Entrepreneurial Ladder in Europe and the United States." *Regional Studies*,

47(5), 803-25.

Wan, Zheng; Yang Zhang; Xuefeng Wang and Jihong Chen. 2014. "Policy and Politics Behind Shanghai's Free Trade Zone Program." *Journal of Transport Geography*, 34, 1-6.

Wang, KeLiang; SuQin Pang; FuQin Zhang; Zhuang Miao and HuaPing Sun. 2022. "The Impact Assessment of Smart City Policy on Urban Green Total-Factor Productivity: Evidence from China." *Environmental Impact Assessment Review*, 94, 106756.

Wang, Lianghu and Jun Shao. 2022. "Can China's Pilot Free Trade Zone Improve Trade Efficiency?" *Journal of International Commerce, Economics and Policy*, 13(02), 2250006.

Wang, Lihui; Zhihong Liu and Huailong Shi. 2022. "The Impact of the Pilot Free Trade Zone on Regional Financial Development." *China World Economy*, 30(5), 154-84.

Wei, Yifan. 2022. "Regional Governments and Opportunity Entrepreneurship in Underdeveloped Institutional Environments: An Entrepreneurial Ecosystem Perspective." *Research Policy*, 51(1), 104380.

Yang, ChihHai. 2019. "Foreign Entrants and Domestic Entrepreneurship: Evidence from Vietnam." *Review of Development Economics*, 23(4), 1725-47.

Yang, Shanping and Inmaculada Martinez-Zarzoso. 2014. "A Panel Data Analysis of Trade Creation and Trade Diversion Effects: The Case of Asean–China Free Trade Area." *China Economic Review*, 29, 138-51.

Yao, Daqing and John Whalley. 2016. "The China (Shanghai) Pilot Free Trade Zone: Background, Developments and Preliminary Assessment of Initial Impacts." *China World Economy*, 39(1), 2-15.

Yu, Linhui; Xuepeng Tang and Xianhai Huang. 2023. "Does the Business Environment Promote Entrepreneurship?—Evidence from the China Household Finance Survey." *China Economic Review*, 79, 101977.

Zhang, Xueliang; Yuqi Hu and Yongran Lin. 2020. "The Influence of Highway on Local Economy: Evidence from China's Yangtze River Delta Region." *Journal of Transport Geography*, 82, 102600.

Zheng, Xuemei; Chengkuan Wu and Shijun He. 2021. "Impacts of China's Differential Electricity Pricing on the Productivity of Energy-Intensive Industries." *Energy Economics*, 94, 105050.