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Foreign direct investment and the innovation performance of local enterprises

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Based on the micro data set of Chinese manufacturing enterprises, this study examines in detail the impact of foreign direct investment on the innovation performance of Chinese local enterprises and its mechanism. Results show that foreign direct investment helps to improve the innovation performance of Chinese local enterprises, and spillover effect and competition effect are important ways for foreign direct investment to affect the innovation performance of local enterprises. In addition, the impact of foreign direct investment on the innovation of local enterprises of different types varies. Foreign direct investment has significantly promoted the innovation of high-productivity, capital-intensive, non-coastal, export, and non-state-owned enterprises. This study enriches the research literature on foreign direct investment and enterprise innovation and provides new micro evidence for understanding the impact of foreign direct investment on the innovation performance of local enterprises.

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Introduction

Over the past 40 years of reform, specifically after China's accession to the World Trade Organization (WTO), China has attracted considerable foreign direct investments (FDI) with its rapid economic growth and an increasingly open investment environment. In 2018, China's actual use of FDI reached 134.97 billion US dollars. China has already become the second-largest country to attract FDI after the United States. The large influx of FDI not only promoted China's economic growth and export trade at the macro-level (Sun, 2012), but also had an important impact on markups (Sembenelli and Siotis, 2008), productivity (Keller and Yeaple, 2009; Iwasaki and Tokunaga, 2016; Zhang, 2017; Lin et al., 2020), enterprise employment structure (Hsieh and Woo, 2005), and other micro-performances of China's enterprises. As innovation is the driving force and source of national economic growth and economic structural adjustment and optimization, the impact of FDI on the innovation performance of Chinese local enterprises has attracted widespread attention from scholars and policymakers.

From the theoretical level, foreign direct investment will have an impact on the innovation performance of local enterprises through spillover effects and competition effects. First, FDI not only provides capital but also brings advanced technology, equipment, and management experience, which can produce spillover effects, such as demonstration, learning, and staff turnover effects. FDI is helpful in improving the innovation performance of local enterprises. For example, with the entry of foreign-funded enterprises, local enterprises can learn the technology and management experience of foreign-funded enterprises and imitate and increase their investment in research and development (R&D) (Ito et al., 2012). With the implementation of the policy of attracting talents into local enterprises, those R&D personnel who have worked in foreign-funded enterprises or have received good skills training will partly flow to local enterprises, which will help in enhancing the innovation performance of local enterprises. Therefore, from this perspective, the positive spillover effect of FDI can have a positive impact on the innovation performance of local enterprises.

Second, the entry of a large amount of foreign capital will seize high-quality resources in the domestic market, which will inevitably intensify the market competition in the industry. The intensification of market competition will have an important impact on enterprise innovation (Amiti and Konings, 2007; Goldberg, et al., 2010). On the one hand, according to "Escape from the competition effect", innovation can reduce the cost of enterprises, and the innovation profit obtained by technology leaders is higher than the discounted profit shared with other companies (Hashmi, 2013). Enterprises can escape from their competitors through innovation, which means that increased market competition will stimulate local enterprises to innovate. On the other hand, according to the "Schumpeter effect", innovation is driven by high expected profits, and the intensification of the market competition will reduce innovation profits, which will restrain the innovative R&D of local enterprises. When the degree of market competition is relatively low, the "Escape from competition effect" will play a leading role (Fernandes, 2007), and the intensification of competition brought by FDI will promote local enterprises to innovate. When the degree of competition is high, the "Schumpeter effect" begins to dominate (Aghion et al., 2005), and the intensification of competition brought by FDI will inhibit the innovation of local enterprises.

The existing relevant empirical literature analyzed how foreign direct investment affects the innovation performance of local enterprises. Several earlier works suggested that FDI or foreign ownership should lead to additional product innovation (Lai, 1998; Girma et al., 2009). Cheung and Ping (2004) also suggested that FDI can benefit innovation activities in the host country through spillover channels, such as reverse engineering, skilled labor turnover, demonstration effects, and supplier–customer relationships. Vahter (2011) examined the impact of FDI on product innovation of domestic enterprises based on the firm-level panel data of Estonian and found that FDI has a significant positive impact on the innovation of enterprises. Based on European cross-country data, Sandu and Ciocanel (2014) suggested that FDI will positively affect the R&D expenditure of different industries by promoting exports, which is conducive to the innovation of enterprises. Crescenzi et al. (2015) explored the impact of foreign mergers and acquisitions on the innovation activities of domestic enterprises by using the data of British multinational enterprises. The results show that FDI can significantly improve the innovation performance of domestic enterprises. Olabisi (2017) found that enterprises that received FDI also tend to engage highly in product innovation. Gorodnichenko et al. (2020) also found that FDI and trade have strong positive spillover effects on innovation by domestic firms.

By contrast, Chen and Zhang (2019) found that conditional on the firm's R&D investment, the FDI has no significant impact on the patenting for inventions. Brambilla et al. (2009) also found that the increased FDI presence in a given industry leads to imitation, but not necessarily innovation, by domestic firms. García et al. (2013) utilized the data from Spanish manufacturing enterprises and examined the impact of FDI on the innovation of enterprises. They found that foreign investment tends to inhibit the innovation of local enterprises. Similarly, Buckley et al. (2002) and Lu et al. (2017) found a negative spillover effect of FDI.

Numerous studies have been conducted on the impact of foreign direct investment on the innovation performance of local enterprises, but no consistent conclusion has been reached. The reason is mainly due to the following aspects. First, different scholars adopted different research methods, samples, and measurement indicators of enterprise innovation ability. Different scholars used different indicators to measure the enterprise innovation ability, such as productivity, R&D investment, and output value of new products, and they mostly used industry-level data to estimate the innovation spillover effect of FDI. Thus, identifying accurately whether the innovation spillover effect of FDI exists is impossible. Taking the total factor productivity (TFP) as an example, which is commonly used as a proxy variable for enterprise innovation in the existing literature, the improvement of TFP is not necessarily related to technological innovation activities. Crépon et al. (1998) found that the innovation output of enterprise (the number of patents and output value of new products) is weakly related to TFP. Second, the emergence of spillover effect of FDI is conditional. Numerous studies found that the spillover effect of FDI does not occur automatically. Such an effect is because domestic enterprises face the gap between domestic and foreign enterprises and take the initiative to imitate and learn. As the absorber of spillover effects, the heterogeneity of domestic enterprises (e.g., the type of enterprise ownership) will affect the innovation spillover effect of FDI (Khachoo et al., 2018). Therefore, the heterogeneity of different types of local enterprises should be fully considered when analyzing the impact of FDI on the innovation performance of local enterprises.

Based on the micro data set of Chinese manufacturing enterprises from 2000 to 2007, this study discusses the impact of FDI on the innovation performance of Chinese local enterprises by using the output value of new products to measure the innovation of enterprises. Compared with existing studies, the main contribution of this study is reflected in the following aspects: First, this study focuses on the innovation of enterprises. This study conducts a detailed investigation on how FDI affects the

innovation performance of Chinese local enterprises by using the output value of new products to construct the indicator of measuring the innovation of enterprises. After a series of robustness tests, such as the substitution of key indicators, instrumental variables (IV) estimation, and controlling other policy changes, this study verifies the conclusion that FDI significantly improves the innovation performance of Chinese local enterprises. This study is a beneficial enrichment of the relevant literature. Second, this study empirically tests whether spillover effect and competition effect are important ways for FDI to affect the innovation performance of Chinese local enterprises by constructing the corresponding intermediary effect model. On the one hand, FDI has a positive impact on enterprise innovation by promoting R&D investments of enterprises. On the other hand, as the market competition increases, the positive effect of FDI on the innovation performance of local enterprises gradually weakens. The analysis of the influence mechanism is evidently conducive to deepening the understanding of the relationship between FDI and enterprise innovation. Third, considering that the emergence of foreign direct investment spillover effect is conditional, this study also analyzes the heterogeneous impact of FDI on the innovation performance of different types of local enterprises (different factor intensity types, productivity types, ownership types, regional types, and export and non-export enterprises). This study provides a rich perspective for a comprehensive understanding of the innovation effects of FDI by exploring the differences in the impact of FDI on the innovation performance of different types of local enterprises.

The remainder of this paper is organized as follows: Section "Empirical model and data" outlines the empirical models and presents the data. Section "Results" presents the empirical results. Section "Influence channel and heterogeneous impact analysis" examines the influence mechanism and discusses the heterogeneous impact of FDI on the innovation performance of different types of local enterprises. Section "Conclusion" concludes and discusses the policy implications.

Empirical model and data

Empirical specification. To analyze the impact of FDI on the innovation performance of Chinese local enterprises, by following Lu et al. (2017), this study sets the following benchmark regression model:

$$Innov_{ijkt} = \beta_1 FI_{jt} + \delta X_{ijkt} + \upsilon_i + \alpha_k + \gamma_t + \mu_{ijkt} \quad (1)$$

where the subscripts i, j, k, and t represent the enterprise, industry, province, and year, respectively, and the industry indicated by j is the four-digit code industry in the national economic industry classification of China. The dependent variable $Innov_{ijkt}$ is the innovation performance of the local enterprise i in industry j in region k in year t. Following Girma et al. (2009) and Olabisi (2017), this study uses the logarithm of the output value of new products of local enterprises to measure $Innov_{ijkt}$ The core explanatory variable FI_{jt} measures the amount of FDI in industry j in year t. X_{ijt} represents a set of other control variables. γ_t denotes year fixed effects, α_k denotes province fixed effects, υ_i denotes firm fixed effects, μ_{ijkt} denotes random disturbance term.

Following Javorcik (2004), Lu et al. (2017), and Lin et al. (2020), this study constructs the following indicators to measure the foreign direct investment (FI_{jt}):

$$FI_{jt} = \frac{\sum_{i\in\Delta jt}\left(FI\_firm_{ijt} \times Y_{ijt}\right)}{\sum_{i\in\Delta jt} Y_{ijt}} \quad (2)$$

where the subscripts i, j, and t represent the enterprise, industry, and year, respectively. FI_firm_{ijt} represents the proportion of foreign capital to the paid capital of the enterprise i in year t in industry j. Y_{ijt} represents the total output of enterprise i in industry j in year t.

Similarly, following Khachoo et al. (2018), Chen and Zhang (2019), and Lin et al. (2020), this study introduces the following control variables into Eq. (1): ① Enterprise size (*Size*). This study uses the logarithm of the enterprise sales to measure the enterprise size. ② Factor intensity (*KI*). This study uses the logarithm of the ratio of capital to labor to measure the factor intensity, where capital is the logarithm of the annual average net value of the firms' fixed assets deflated by the price index of fixed assets investment, whereas labor is the logarithm of the annual average number of firms' employees. ③ Average wage (*Wage*), which is measured as the logarithm of the ratio of total wages payable to the number of employees. ④ Enterprise age (*Age*), which is measured as the logarithm of the number of years since the establishment of the enterprise. ⑤ Government subsidies (*Subsidy*), which is measured as the ratio of subsidies that enterprises obtain from the government to enterprise sales. ⑥ Industry concentration (*HHI*), which is measured by the Herfindahl–Hirschman index for each four-digit industry.

Data. The data used in the empirical analysis come from the Annual Survey of Industrial Firms (ASIF) compiled by the National Bureau of Statistics of China. The ASIF data set includes all SOEs and firms of other ownership types with turnover of more than 5 million RMB. The firms included in the data set accounted for approximately 90% of the gross output in the manufacturing industry in China (Brandt et al., 2012). The sample period is from 2000 to 2007, which is consistent with the existing related studies, such as Xiang et al. (2017). To obtain reliable results, this study only selected enterprises in the manufacturing industry as research objects. Similar to the approach of Brandt et al. (2012) and Yu (2015), this study processed the original industrial firm data by removing the samples of missing variables, excluding the samples of enterprises with less than eight employees, and deleting some samples of enterprises that violate accounting common sense (e.g., total assets are less than net fixed assets or paid-up capital is less than or equal to zero).

This study mainly discusses the impact of FDI on the innovation performance of local enterprises. Following Ding et al. (2013), this study defined enterprises with foreign capital accounting for more than 50% of the registered capital of enterprises as foreign-funded enterprises to distinguish between local and foreign-funded enterprises. All foreign-funded enterprises are excluded from the subsequent regression samples. Table 1 shows the descriptive statistics of main variables used in the empirical analysis.

Results

Baseline results. This study estimated Eq. (1) using the micro data set of Chinese manufacturing enterprises from 2000 to 2007, and Columns (1) to (3) of Table 2 show the corresponding regression results where firm, province, and year fixed effects are included. In Column (1), the study directly regressed the enterprise innovation (*Innov*) on foreign direct investment (*FI*) without any control variables. The result shows that the estimated coefficient of FDI is positive and significant, which indicates that with the increasing of FDI, the innovation performance of local enterprises will increase accordingly. In Column (2), five enterprise-level control variables were added: enterprise size, factor density, average wage, enterprise age, and government subsidy. The regression results are similar to those in Column (1): the coefficient of FDI is significantly positive, indicating that FDI is conducive to

Table 1 Summary statistics.

Variables	Observations	Mean	P25	P50	P75	SD
Innov	783,879	0.941	0.000	0.000	0.000	2.880
FI	783,879	0.039	0.018	0.033	0.052	0.029
Size	783,879	10.100	9.220	9.950	10.800	1.330
KI	783,879	3.520	2.790	3.590	4.340	1.250
Age	783,879	0.647	0.327	0.666	0.970	0.450
Wage	783,879	2.480	2.130	2.520	2.870	0.677
Subsidy	783,879	4.48×10^{-5}	0.000	0.000	0.000	3.490
HHI	783,879	0.025	0.006	0.013	0.029	0.043

Table 2 Baseline results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
FI	0.6582*** (0.1641)	0.5606*** (0.1638)	0.5859*** (0.1643)	2.5032*** (0.2406)	1.0489*** (0.2249)	0.8168*** (0.2270)
Size		0.2982*** (0.0058)	0.2981*** (0.0058)		0.5746*** (0.0036)	0.5745*** (0.0036)
KI		0.0013 (0.0046)	0.0013 (0.0046)		0.0808*** (0.0025)	0.0807*** (0.0025)
Wage		−0.0167** (0.0066)	−0.0167** (0.0066)		0.1407*** (0.0055)	0.1402*** (0.0055)
Age		0.0283** (0.0129)	0.0283** (0.0129)		0.4467*** (0.0071)	0.4460*** (0.0071)
Subsidy		−0.0395 (0.0368)	−0.0390 (0.0368)		−0.0006*** (0.0001)	−0.0006*** (0.0001)
HHI			−0.2005* (0.1044)			1.2990*** (0.1616)
Firm FEs	Yes	Yes	Yes	No	No	No
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs	No	No	No	Yes	Yes	Yes
Observations	783,879	783,879	783,879	783,878	783,878	783,878
R-squared	0.009	0.014	0.014	0.081	0.155	0.155

Note: Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

improving the innovation performance of Chinese local enterprises. In Column (3), the industry-level control variable Herfindahl–Hirschman index (*HHI*) was further added. The estimated coefficient of FDI remains significantly positive, indicating that FDI will have a significant positive impact on the innovation performance of local enterprises. This finding is consistent with that of Gorodnichenko et al. (2020). They found that FDI improved the innovation performance of local enterprises in general. Columns (4)–(6) of Table 2 present the results of re-estimating Eq. (1) by adding industry fixed effects. The estimated coefficients of FDI are still positive and significant, which is similar to the regression results obtained by controlling firm fixed effect before.

Throughout the regression results of Table 2, although the addition of control variables will change the magnitude of the coefficient of foreign direct investment (*FI*), the symbol and significance of the coefficient have not changed. This finding shows that the impact of FDI on the innovation performance of Chinese local enterprises will not change with the change in control variables. Specifically, looking at the regression results in Column (3), the coefficient of foreign direct investment (*FI*) is 0.5859 and passes the significance test of 1%, which shows that for every one percentage point increase in the proportion of FDI in the industry, the output value of new products of enterprises will increase by 0.59% on average.

Robustness tests

Endogeneity problems. This study aims to explore the impact of FDI on the innovation performance of local enterprises. The dimension of the dependent variable is the enterprise level, whereas the measurement dimension of FDI is the industry level. Therefore, the possibility of endogenous problems caused by reverse causality is relatively low, which is also the reason why most enterprise micro-level research literature regards foreign direct investment variables as exogenous (Javorcik, 2004). Nevertheless, some unobserved factors (e.g., macroeconomic fluctuations) may affect FDI and enterprise innovation. If these unobservable factors are omitted, then they will also cause endogenous problems.

In order to avoid the potential endogenous problem, this study tries to construct the corresponding instrumental variables (IVs), and then use the two-stage least squares method for estimation. Firstly, considering that the Chinese government has continuously relaxed the controlling for FDI through policy opening during the sample period, following Lu and Yu (2015), this study uses the logarithm of the number of foreign-funded enterprises at the industry level as the instrumental variable for regression. The results are shown in column (1) of Table 3. Secondly, following Ahsan (2013), this study further selects the amount of foreign investment in the initial year of the sample period as the instrumental variable to estimate Eq. (1). The results are shown in column (2) of Table 3. It can be seen that the estimated coefficients of foreign direct investment are both significantly positive. This shows that the previous benchmark regression results are less likely to be disturbed by endogenous problems.

Alternative variable measures. On the one hand, the dependent variable in the previous analysis is measured by the logarithm of the output value of the enterprise's new product. For the sake of robustness, in this part, following Ito et al. (2012) and García et al. (2013), the logarithm of the total number of enterprise patent applications was employed to re-measure the innovation performance of local enterprises. The patent data of enterprises come from the patent database of all state-owned and above-scale industrial enterprises issued by the China Intellectual Property Office from 1985 to 2013. This study summarized the number of annual patent applications by enterprises[1]. Similarly, following

Table 3 Robustness test results.

	IV estimation		Alternative variable measures			Excluding the impact of other policy changes	
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
FI	4.4345*** (1.4165)	2.3858*** (0.7195)	0.4074* (0.2324)			0.5861*** (0.2084)	1.1705** (0.5148)
Size	0.2952*** (0.0069)	0.2827*** (0.0069)	0.1417*** (0.0125)	0.2982*** (0.0058)	0.2982*** (0.0058)	0.2463*** (0.0070)	0.0415*** (0.0147)
KI	−0.0007 (0.0047)	−0.0060 (0.0055)	0.0059 (0.0106)	0.0013 (0.0046)	0.0013 (0.0046)	−0.0090* (0.0053)	−0.0452*** (0.0095)
Wage	−0.0163** (0.0066)	−0.0161** (0.0077)	0.0273* (0.0146)	−0.0167** (0.0066)	−0.0166** (0.0066)	−0.0021 (0.0080)	0.0610*** (0.0135)
Age	0.0346** (0.0152)	0.0204 (0.0154)	−0.0648** (0.0263)	0.0281** (0.0129)	0.0277** (0.0129)	0.0233 (0.0158)	−0.0502 (0.0430)
Subsidy	−0.0556 (0.0484)	−0.0201 (0.0380)	−0.0559 (0.1898)	−0.0390 (0.0368)	−0.0389 (0.0368)	0.0081 (0.0663)	−0.1880 (0.2448)
HHI	−0.5422*** (0.1743)	−0.3940*** (0.1356)	0.1004 (0.1466)	−0.1938* (0.1044)	−0.1710 (0.1049)	−0.4495*** (0.1343)	−0.6139 (0.4194)
FI_A				0.4274*** (0.1541)			
FI_S					0.2821** (0.1438)		
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	687,835	491,008	33,876	783,879	783,811	645,167	338,428
R-squared	–	–	0.063	0.014	0.014	0.012	0.001

Note: Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

He et al. (2018), this study matched the patent data with the ASIF data set. Based on this matched samples, Eq. (1) was re-estimated using the number of enterprise patent applications to measure the innovation performance. From the regression results in Column (3) of Table 3, the estimated coefficient of FDI is still significantly positive, which is similar to the previous baseline regression results.

On the other hand, when constructing the measure index of FDI in Eq. (2), this study used the total output of enterprises as the weight. Some existing related studies also used the enterprise's sales or value added as the weight to construct the measure index of FDI (Javorcik 2004; Lu et al., 2017). For the sake of robustness, the enterprise's sales and value added were also used as the weight to reconstruct the measure index of FDI before re-estimating Eq. (1). From the regression results of Columns (4) and (5) of Table 3, whether the measure index of FDI is constructed with the enterprise sales as the weight (*FI_S*), or with the enterprise added value as the weight (*FI_A*), the estimated coefficients of FDI remain significantly positive, which is also similar to the previous baseline regression results.

Excluding the impact of other policy changes. The sample period of this study is from 2000 to 2007. During this period, two important policy changes deserved attention: One is that China officially joined the WTO at the end of 2001 and the process of China's reform was further accelerated (Xiang et al., 2017); the other is that China implemented the reform of the RMB exchange rate system in 2005. Since then, the RMB exchange rate has continued to appreciate. The changes of these two policies may have a relatively large impact on the inflow of foreign capital and likely result in bias in previous estimations. For the sake of robustness, this study re-estimated Eq. (1) based on the following two reconstructed sub-samples: First, the sample data of enterprises before China joined the WTO were deleted to eliminate the influence of China's accession to WTO. Column (6) of Table 3 shows the regression results. Second, only the sample data of the enterprises after the exchange rate reform were retained to eliminate the impact of this policy change. Column (7) of Table 3 shows the results. The estimated coefficients of FDI are still significantly positive. Therefore, the previous baseline regression results are less disturbed by the two policies of China's accession to WTO and RMB exchange rate reform.

Influence channel and heterogeneous impact analysis

Influence channel analysis. The previous estimation results have shown that FDI significantly improves the innovation performance of Chinese local enterprises. In this part, the channels through which FDI promotes the innovation performance of local enterprises will be further analyzed.

According to the previous analysis, FDI may have a positive effect on the innovation performance of local enterprises through positive spillover effects, such as demonstration and learning effects. To test this, this study selects the R&D investment of enterprises as the intermediary variable and estimates the corresponding intermediary effect model to verify whether FDI has a positive impact on the innovation performance of local enterprises by promoting R&D investment of enterprises. The complete intermediary effect model is set as follows:

$$Innov_{ijkt} = a_1 FI_{jt} + \delta X_{ijkt} + \upsilon_i + \upsilon_k + \upsilon_t + \mu_{ijkt} \quad (3)$$

$$RD_{ijkt} = b_1 FI_{jt} + \delta X_{ijkt} + \upsilon_i + \upsilon_k + \upsilon_t + \mu_{ijkt} \quad (4)$$

$$Innov_{ijkt} = d_1 FI_{jt} + d_2 RD_{ijkt} + \delta X_{ijkt} + \upsilon_i + \upsilon_k + \upsilon_t + \mu_{ijkt} \quad (5)$$

where *RD* denotes the R&D investment of enterprises, which is measured by the logarithm of the R&D investment of the enterprise in the current period. All other subscripts and variables have the same meaning as in Eq. (1).

Table 4 Influence channel analysis.

	Spillover effects		Competition effects
Variables	(1)	(2)	(3)
FI	0.4104* (0.2211)	0.1683 (0.3352)	−0.0880 (0.2911)
Size	0.1645*** (0.0065)	0.0894*** (0.0099)	0.2986*** (0.0058)
KI	0.0105** (0.0044)	−0.0335*** (0.0067)	0.0013 (0.0046)
Wage	0.0481*** (0.0067)	0.0645*** (0.0102)	−0.0167** (0.0066)
Age	−0.0432** (0.0171)	−0.0221 (0.0260)	0.0271** (0.0129)
Subsidy	0.1930*** (0.0708)	−0.0401 (0.1073)	−0.0388 (0.0368)
HHI	−0.1212 (0.1653)	−1.0348*** (0.2507)	−0.2013* (0.1044)
RD		0.1068*** (0.0030)	
FI × HHI			17.1078*** (6.1010)
Firm FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes
Observations	480,860	480,860	783,879
R-squared	0.008	0.007	0.014

Note: Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 4 shows the estimated results of the intermediary effect model. The estimation result of Eq. (3) is not reported in this part for it is just the previous baseline regression result. Column (1) of Table 4 reports the estimation result of Eq. (4), in which the dependent variable is the enterprise's R&D investment. The estimated coefficient of FDI is significantly positive, indicating that FDI has significantly improved the enterprise's R&D investment, which is consistent with Olabisi (2017). This result is mainly because foreign-funded enterprises often have advanced production technologies and management experience. After entering the host country market, they will have a demonstration effect on local enterprises in the same industry. Moreover, R&D personnel who have worked in foreign-funded enterprises or have received good skills training may partially flow to local enterprises. The effect of personnel turnover will also enhance the R&D capabilities of local enterprises. Column (2) reports the estimation result of Eq. (5). The estimated coefficient of the intermediary variable (*RD*) is significantly positive, which means that the increasing enterprise R&D investment will significantly improve the innovation performance of enterprises. This result is consistent with the usual expectations. The regression results of Eqs. (3) and (5) show that the estimated coefficient value and significance level (*t*-value) of foreign direct investment (*FI*) have a large decline after adding the intermediary variable (*RD*), which preliminarily shows the existence of the intermediary effect of "enterprise R&D investment".

For the sake of robustness, following the method of Sobel (1987), this study further tested whether the product term of the regression coefficient on the path of the intermediary variable is significant. That is, to test H_0: $b_1 d_2 = 0$: If the original hypothesis is rejected, then the intermediary effect is significant; Otherwise, the effect is insignificant. The test result shows that the original hypothesis should be rejected, which further verifies the existence of the intermediary effect of "enterprise R&D investment". These results indicate that promoting the increase of enterprise R&D investment is an important channel for FDI to affect enterprise innovation.

According to the previous analysis, FDI may also affect the innovation performance of local enterprises through competition effects. However, this mechanism will have different effects based on the degree of competition in the industry. If the industry competition is fierce, then the "Schumpeter effect" will weaken the positive impact of the "Escape from competition effect" on enterprise innovation. In this situation, the market incentive effect of FDI on enterprise innovation will be relatively weak. On the contrary, if the industry competition is insufficient, then the market incentive effect of foreign investment on enterprise innovation will be relatively strong. Based on this, this study uses the industry HHI to measure the degree of market competition and used the interaction between the industry HHI and FDI to analyze the mechanism of "competition effects of FDI affecting enterprise innovation". Column (3) of Table 4 shows the results. The estimated coefficient of the interaction term ($FI \times HHI$) is significantly positive, which means that if the degree of market competition is low, then FDI can highly promote the innovation performance of local enterprises. This result is mainly because FDI effectively disintegrates the high monopoly of the industry and stimulates market competition. The incentive effect of market competition caused by FDI also has a relatively large impact on enterprise innovation, that is, the "Escape from competition effect" of market competition is absolutely dominant. However, with the increasing market competition, the "Schumpeter effect" has gradually strengthened and will weaken the positive effect of "Escape from competition effect". The positive effect of FDI on the innovation performance of local companies was gradually weakened. To a certain extent, this finding verifies that the competition effect is also an important way for FDI to affect the innovation performance of local enterprises.

Heterogeneous impact analysis

Different types of productivity. Substantial differences in the productivity level of different enterprises were observed, which may make them react differently to the fierce external competition caused by FDI. This study estimated the TFP of enterprises following the method of Ackerberg et al. (2015) to explore whether a significant difference exists in the impact of FDI on the innovation performance of different productivity enterprises. Then, using the median of the TFP of enterprises in the sample as the critical value to divide the sample into two sub-samples, based on which Eq. (1) was then re-estimated. Columns (1) and (2) of Table 5 show the results. Foreign direct investment does not significantly affect the innovation performance of low-productivity enterprises, but will significantly improve that of high-productivity enterprises. The possible reasons are as follows: On the one hand, in the face of the fierce market competition caused by FDI, only enterprises with high-productivity and close to the cutting-edge technology are able to deal with the threat of

competition through R&D and innovation. For enterprises with low-productivity and far away from the cutting-edge technology, the intensification of competition reduces the expected profit of innovation investment, thus reducing the innovation incentive of such enterprises (Aghion et al., 2005; Baghdasaryan et al., 2016). On the other hand, enterprises with high-productivity tend to have high absorptive capacity and competitiveness, and therefore are relatively highly motivated to imitate and learn foreign advanced technology and knowledge and introduce corresponding technical equipment. They can obtain more spillover effects from foreign direct investment.

Different types of factor intensity. The traditional factor endowment theory emphasizes the important role of production factors in enterprise production activities. Varying factor-intensive enterprises have great differences in factor input, production technology, organization, and so on. Is there a significant difference in the impact of FDI on the innovation performance of local enterprises with different factor intensities? To this end, using the median of the factor density of enterprises in the sample as the critical value, this study divided the sample into two sub-samples: the labor-intensive enterprises with low capital–labor ratio and the capital-intensive enterprises with high capital–labor ratio. Using the two sub-samples, Eq. (1) was re-estimated. Columns (3) and (4) of Table 5 show the results. FDI does not have a significant impact on the innovation performance of labor-intensive enterprises, but significantly improves that of capital-intensive enterprises. This result is consistent with our expectations. Generally, capital-intensive enterprises will pay more attention to equipment renewal and R&D investment than labor-intensive ones, and obtaining great positive spillover effects from the demonstration and staff turnover effects brought about by FDI is easy. In contrast, labor-intensive enterprises often rely more on labor input and less on innovation and advanced technology. Therefore, FDI mainly improves the innovation performance of capital-intensive enterprises.

Different types of region. The regional economic development in China has differences. Compared with non-coastal areas, coastal ones have a higher degree of economic openness and development, relatively better transportation and infrastructure construction, and more active attraction of FDI. Differences between regions likely lead to varying effects of FDI on the innovation performance of local enterprises in different regions. To this end, this study divided all provinces into coastal and non-coastal areas according to whether they are near the sea or not[2]. Using the sub-samples composed of enterprises in these two areas, Eq. (1) was re-estimated. Columns (1) and (2) of Table 6 show the results. Foreign direct investment significantly improves the innovation performance of local enterprises in non-coastal areas but not that of local enterprises in coastal areas. The reason may be that due to the higher economic openness and development level and more complete legal systems, the competition among enterprises in coastal areas is relatively fierce. Foreign direct investment has further intensified the market competition, making the "Schumpeter effect" gradually enhanced and dominant, weakening the positive spillover effect brought by FDI. Hence, the effect of FDI in promoting the innovation performance of local enterprises in coastal areas is insignificant. In the case of insufficient competition in non-coastal areas, the "Escape from competition effect" may still dominate, and that of FDI in promoting the innovation performance of local enterprises in non-coastal areas is relatively evident.

Export and non-export enterprises. Since the reform and opening up, the export trade has made an indelible contribution to the rapid development of China's economy. Considering that non-export (i.e., pure domestic enterprises) and export enterprises face different product markets, the degree of competition in different markets may impose a significant difference in the impact of FDI on the innovation performance of export and non-export enterprises. To this end, this study divided all sample enterprises into exporting and non-exporting enterprises according to whether they export or not. Using the sub-samples composed of these two types of enterprises, Eq. (1) was re-estimated. From the regression results of Columns (3) and (4) of Table 6, foreign direct investment significantly improves the innovation performance of exporting and non-exporting enterprises. However, compared with non-exporting enterprises, FDI has a relatively greater positive effect on export enterprise innovation. The reason may be that as some products of export enterprises are oriented to overseas markets, export enterprises often face more fierce international competition. Thus, export enterprises need to pay attention to the improvement of production efficiency. A strong sense of suffering may allow export enterprises to obtain great positive spillover effects from the demonstration and staff turnover effects brought by FDI.

Different types of ownership. China's unique institutional settings have made the ownership structure become an important factor affecting the performance of Chinese enterprises (Hu and Liu, 2014). Following Ding et al. (2013), this study divided all enterprises into state-owned enterprises (SOEs) and non-state-owned enterprises (Non-SOEs) according to the proportion of registered capital invested by enterprises, so as to analyze whether differences exist in the impact of FDI on the innovation performance of local enterprises of different ownership types. Using the sub-samples composed of SOEs and Non-SOEs, Eq. (1) was re-estimated. Columns (5) and (6) of Table 6 show the results. For Non-SOEs, the estimated coefficient of FDI is significantly positive, whereas for SOEs, the estimated coefficient of FDI is also positive, but does not pass the significance test. This finding shows that the effect of FDI in promoting the innovation performance of Chinese local enterprises is more reflected in Non-SOEs than SOEs. The reasons may be that SOEs have a weak awareness of intellectual property rights and lack a strong sense of competition and crisis under the protection of the government. Hence, they do not have sufficient motivation to learn to imitate the cutting-edge knowledge and advanced technology of foreign-funded enterprises. Similarly, their innovative activity may be discouraged due to the increasing competition through foreign direct investment (Aghion et al., 2005). On the contrary, non-SOEs have a higher absorptive capacity and willingness to learn. They can adapt to the fierce market competition, survive and develop, and eventually obtain additional spillover effects of FDI.

Conclusion

Over the past 40 years of reform, specifically after China's accession to the WTO, China has attracted considerable foreign direct investments with its rapid economic growth and an increasingly open investment environment. What impact will considerable foreign direct investments have on the innovation performance of Chinese local enterprises? Based on the micro data of Chinese manufacturing enterprises from 2000 to 2007, this study analyzes the impact of FDI on the innovation performance of Chinese local manufacturing enterprises. After a series of robustness tests, this study found that FDI significantly improves the innovation performance of Chinese local manufacturing enterprises. The analysis of the impact mechanism shows that the spillover effect and competitive effect are important ways for FDI to affect the innovation performance of Chinese local enterprises. On the one hand,

Table 5 Regression results by different types of productivity and factor intensity.

Variables	Low-productivity (1)	High-productivity (2)	Labor-intensive (3)	Capital-intensive (4)
FI	0.1197 (0.2409)	0.8665*** (0.2792)	0.2362 (0.2214)	0.7394*** (0.2683)
Size	0.3682*** (0.0096)	0.2630*** (0.0094)	0.1944*** (0.0083)	0.3812*** (0.0095)
KI	0.0264*** (0.0075)	−0.0272*** (0.0072)	0.0166** (0.0069)	−0.0260** (0.0118)
Wage	−0.0416*** (0.0112)	0.0018 (0.0102)	−0.0171* (0.0090)	−0.0088 (0.0113)
Age	0.0705*** (0.0198)	0.0132 (0.0217)	0.0100 (0.0177)	0.0521** (0.0217)
Subsidy	−0.1826 (0.1396)	−0.0019 (0.0451)	−0.0162 (0.0439)	−0.0693 (0.0636)
HHI	−0.2105 (0.1575)	−0.1682 (0.1711)	−0.0894 (0.1399)	−0.1323 (0.1726)
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes
Observations	394,712	389,167	393,022	390,857
R-squared	0.018	0.013	0.009	0.017

Note: Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 6 Additional results of heterogeneous impact analysis.

Variables	Non-coastal (1)	Coastal (2)	Non-exporters (3)	Exporters (4)	Non-SOEs (5)	SOEs (6)
FI	1.9107*** (0.3423)	0.1458 (0.1841)	0.4337*** (0.1605)	0.8943** (0.4122)	0.7096*** (0.1786)	0.2374 (0.4550)
Size	0.3451*** (0.0112)	0.2871*** (0.0067)	0.1810*** (0.0054)	0.6064*** (0.0179)	0.2638*** (0.0063)	0.3732*** (0.0159)
KI	−0.0322*** (0.0091)	0.0179*** (0.0052)	0.0058 (0.0042)	0.0467*** (0.0138)	−0.0022 (0.0048)	0.0086 (0.0156)
Wage	0.0846*** (0.0125)	−0.0729*** (0.0078)	−0.0131** (0.0060)	−0.1080*** (0.0207)	−0.0201*** (0.0072)	0.0335* (0.0180)
Age	−0.0156 (0.0248)	0.0655*** (0.0151)	0.0206* (0.0122)	0.0978*** (0.0368)	0.0187 (0.0138)	−0.1037** (0.0525)
Subsidy	−0.0740 (0.0808)	−0.0304 (0.0404)	−0.0349 (0.0304)	−0.1304 (0.2315)	−0.0469 (0.0455)	−0.0218 (0.0610)
HHI	−0.2428 (0.2054)	−0.1940 (0.1197)	−0.2995*** (0.0988)	0.1479 (0.2876)	−0.1842 (0.1169)	0.2810 (0.2517)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	232,242	551,637	604,569	179,310	705,423	78,456
R-squared	0.029	0.015	0.006	0.040	0.015	0.015

Note: Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

FDI has a positive impact on enterprise innovation by promoting the R&D investment of enterprises. On the other hand, the positive effect of FDI on the innovation performance of local enterprises gradually weakens with the increasing market competition.

Further analysis of the different types of enterprises shows the following: First, FDI significantly improves the innovation performance of high-productivity enterprises but does not significantly affect the innovation performance of low-productivity enterprises. Second, FDI does not have a significant impact on the innovation performance of labor-intensive enterprises but can significantly improve the innovation performance of capital-intensive enterprises. Third, FDI can promote the innovation performance of local companies in non-coastal areas but does not significantly affect the innovation performance of local companies in coastal areas. Fourth, FDI promotes the innovation performance of local export enterprises but does not significantly affect the innovation performance of local non-export enterprises. Fifth, FDI does not significantly affect the innovation performance of SOEs, while the effect of FDI in promoting the innovation performance of local Chinese enterprises is reflected in non-SOEs.

The research conclusions of this study also have strong policy implications: First, foreign direct investment significantly improves the innovation performance of local companies. To this end, the government should further introduce and improve relevant policies to attract FDI. The government may protect the legitimate rights and interests of foreign investors through legislation. Similarly, the government may also learn from the management model of "pre-entry national treatment" and "negative list" to minimize and standardize the administrative approval process for the inflow of foreign capital and continuously optimize the business environment and improve the level of facilitation of foreign direct investment. Second, the government should also timely adjust the corresponding policy of attracting FDI. When formulating the policy of attracting FDI, local governments should pay attention to optimizing the innovation environment and adjusting the inflow direction of foreign capital to maximize the spillover effects of FDI. Similarly, the analysis of this study shows that the impact of FDI on the innovation performance of varying factor-intensive enterprises, ownership enterprises, and regional enterprises is different. Therefore, when formulating and adjusting the corresponding policies to attract FDI, the government should attach great importance to the different impact of FDI on different types of enterprises.

It should be noted that the data used in this study came from the ASIF compiled by the National Bureau of Statistics of China. The sample spans from 2000 to 2007. Owing to the limitation of data, this paper cannot use the latest data to study the impact of FDI on the innovation performance of Chinese local enterprises, which has to be said to be a major limitation of this study. Therefore, in future research, using the latest data to analyze how FDI affects the innovation performance of Chinese local enterprises through spillover effects and competitive effects will undoubtedly provide more timely policy implications.

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Notes

1 For further information on this database, see Chen and Zhang (2019).
2 The coastal area includes 11 provinces: Liaoning, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, and Hainan. The remaining provinces belong to non-coastal areas.

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