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Do China's greenfield foreign direct investments promote short-term innovation output growth in host countries?

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ABSTRACT

We examine the impact of China's greenfield OFDI on the short-term innovation outputs of host countries using a panel dataset covering 46 countries in 2003–21. Our findings provide evidence that challenges concerns about the threat posed by China's greenfield OFDI.

1. Introduction

Foreign direct investments (FDI) are essential for bridging technology gaps between nations (Jude, 2016). The flow of foreign investments facilitates the diffusion and spillover of knowledge and new technologies (Jiang et al., 2024), promoting technological progress in host countries and contributing to economic growth convergence across nations (Barro and Sala-i-Martin, 1997). Greenfield FDI are one of the forms involving investments to establish new enterprises in host countries. Nocke and Yeaple (2008) suggest that firms investing in greenfield FDI are systematically more efficient than those investing in other forms such as mergers and acquisitions (M&A). Greenfield FDI is expected to be more conducive to the development of host countries (Nocke and Yeaple, 2007). As Liu and Zou (2008) suggested, greenfield FDI can facilitate technological spillovers to host countries through R&D activities.

Greenfield FDI is anticipated to contribute more positively to the development of host countries. As Liu and Zou (2008) suggest, greenfield FDI can facilitate technological spillovers to host countries through R&D activities.

China plays an important role in global finance (Horn et al., 2021) and it's outward foreign direct investment (OFDI) has grown rapidly in this century (Yao et al., 2016), which reached USD 178.82 billion in 2021, almost 63 times the outflows in 2003. However, concerns and skepticism about these investments have increased, particularly following the introduction of the Belt and Road Initiative (BRI) in 2013, which aims to deepen regional economic and trade cooperation through large-scale bilateral trade (Word Bank, 2019) and investments (Fang et al., 2024). The share of China's non-financial OFDI in BRI member countries reached 18 percent of China's total in 2021. However, some studies argue the BRI exacerbates host countries' environmental risks (Nugent and Lu, 2021) and debt vulnerabilities (Bandiera and Tsiropoulos, 2020; Horn et al., 2023).

Given these concerns, we are interested in studying whether China's OFDI promotes the growth of short-term innovation output in the host countries. We specifically examine the impact of China's greenfield OFDI on patent applications in host countries. If a positive relationship is confirmed, it would suggest that China's greenfield OFDI contributes to fostering innovation in these countries, thereby supporting their economic development.

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2. Empirical model

Patent applications are widely regarded in the literature as a measure of short-term innovation output (Palangkaraya et al., 2017). Studies, including those by Liang et al. (2024) and Zhang et al. (2024), discuss the impact of China's foreign trade and OFDI on the innovation output of host countries. Based on previous studies, we use the number of patent applications to measure the short-term innovation output and develop the following empirical model to study the impact of China's greenfield OFDI:

$$lnP_{it} = \beta_0 + \beta_1 lnFDI_{it} + \beta_2 lng_{it} + \beta_3 lnl_{it} + \beta_4 lne_{it} + \beta_5 lnd_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where the dependent variable P_{it} denotes the innovation output of host country i in year t. It consists of two parts, i.e., residents' patent applications PR_{it} and nonresidents' patent applications PN_{it}. The key independent variable is FDI_{it}, representing China's greenfield OFDI in host country i and year t. We use two indicators to measure FDI_{it}, namely the outflows of China's greenfield OFDI ($gcap_{it}$) and the number of the employees ($gemp_{it}$). To address potential endogeneity concerns, we also include other types of China's OFDI outflows ($ocap_{it}$), aside from greenfield investments, for comparative analysis.

We also control several variables widely used in the existing literature on studying innovation outputs. A host country's economic development, often measured by GDP per capita, is widely recognized as a significant contributor to its innovative capacity. However, it may also shape the home country's OFDI decision-making. To account for potential endogeneity risks, we examine the correlations among the variables (see Appendix A). Additionally, we incorporate the one-year lagged value of real GDP per capita $g_{i,t-1}$, i.e., the one-year lagged GDP per capita at constant 2015 USD, for prudent reasons. l_{it} denotes the lending rate, which may have two possible effects on innovative activities. In theory, low interest rates reduce the cost for firms to invest in production and R&D, thereby encouraging an increase in innovation outputs. In practice, however, governments tend to lower lending rates to stimulate economic activity during economic downturns, when both innovation activities and investments are typically low. Conversely, governments tend to adopt higher lending rates to prevent bubble inflation during buoyant economic periods, precisely when investments and innovations tend to grow. e_{it} denotes the exchange rate. d_{it} denotes the weighted mean tariff rate of all products (%) controlling for the impact of tariff barriers. μ_i and γ_t control for the individual- and time-fixed effects, respectively. ε_{it} denotes the residual term. Specifically, robust errors are clustered at the country level.

The key independent variable we focus on is China's greenfield OFDI, for which data are available from 2003 to 2021. We conduct empirical analyses using an annual panel dataset of 46 host countries (see Appendix B), which provides more complete data. Data on China's greenfield and non-greenfield OFDI, patent applications, and other variables are from fDi Intelligence (Financial Times Ltd.), the Ministry of Commerce of PRC, and the World Bank's WDI database.

3. Empirical findings

Based on equation (1), we first examine the impact of China's greenfield OFDI outflows on the total number of patent applications. The results reported in column (1) of Table 1 show that the outflows significantly contribute to the growth of patent applications, with an average elasticity coefficient of 1.9 %. We further differentiate the dependent variables into residents' and non-residents' patent applications, with the results reported in columns (2) and (3), respectively. The outflows significantly contribute to the former but not the latter. This finding indicates that China's greenfield OFDI has a positive impact on the short-term innovation output growth of host countries.

To address potential endogeneity bias in the empirical design, we introduce an alternative regression that replaces the independent variables with China's non-greenfield OFDI outflows ($ocap_{it}$). The effect of $ocap_{it}$ on short-term innovation output growth is reported in columns (4)–(6) of Table 1. China's non-greenfield OFDI significantly impacts patent applications in host countries, and importantly, these effects are substantial for patents filed by both residents and non-residents. In other words, China's non-greenfield OFDI does not exhibit the same heterogeneity as observed in greenfield counterparts. This comparison partially supports the robustness of the findings on the effects of China's greenfield OFDI, as the empirical designs using $gcap_{it}$ and $ocap_{it}$ face the same potential endogeneity risks.[1]

We further focus on the BRI. 24 countries in our samples are BRI members, while the other 22 are not (see Appendix B). Subsample analyses are conducted on the two groups to examine whether the effects of China's greenfield OFDI are heterogeneous. The results are presented in columns (7) and (8), showing a significant elasticity of around 3.0 % for BRI members, compared to 2.5 % for the other group. We further assess whether the two elasticities are significantly heterogeneous by conducting a Chow test, which is reported in the last row of Table 1. These findings reveal a small but significant difference in the effects of China's greenfield OFDI on BRI members compared to non-BRI countries, which somewhat counters the argument regarding the BRI threat.[2]

In addition, several control variables are found to impact innovation performance. GDP per capita significantly contributes to the increase in patent applications. This is in line with the common intuition that innovation and technological progress typically originate in developed economies. Besides, the lending rate is found to impact patent applications positively. This may be due to the lending rate serving as an indicator of economic vitality. Governments typically raise the lending rate during periods of economic buoyancy to mitigate bubbles when innovation and investment activities are often enthusiastic. Thus, the lending rate, or the level of economic vitality implied by it, has been found to have a significant positive impact on the growth of patent applications. Exchange rates negatively impact patent applications, particularly in samples participating in the BRI. This indicates that a depreciation of host countries' local currencies diminishes their attractiveness for FDI. This, in turn, results in a corresponding decline in technological spillovers and short-term innovation outputs associated with FDI.

On this basis, we further carry out a robustness check. China's greenfield OFDI outflows reflect movements in related funds, which have the same dimension and a moderate correlation with host countries' GDP per capita (see Appendix A). Despite the use of one-year lagged values of GDP per capita to address potential endogeneity bias in the empirical design, concerns remain. To further mitigate this issue, the number of employees in China's greenfield OFDI ($\ln gemp_{it}$) is introduced as a proxy for outflows. This variable operates on a different dimension than GDP per capita and shows a strong correlation with outflows while exhibiting a weak correlation with GDP per capita, as indicated by the correlation statistics. A robustness check is conducted using two-stage least squares, considering that employees in greenfield OFDI may not solely be residents of the host country but can also include foreign nationals. Table 2 reports the results, showing that China's greenfield OFDI's effects on promoting short-term innovation outputs in host countries remain significant, consistent with the previously mentioned findings.

[1] We are very grateful to the reviewer for this valuable suggestion.

[2] We also conducted subsample analyses using non-residents' patent applications as the dependent variable, and the results are consistent with those in column (3), indicating that the impact of China's greenfield OFDI is insignificant. These findings are not reported in this paper to conserve space.

Table 1
Results of China's greenfield OFDI outflows on patent applications.

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Group	all	all	all	all	all	all	BRI	Not BRI
DV	$\ln P_{it}$	$\ln PR_{it}$	$\ln PN_{it}$	$\ln P_{it}$	$\ln PR_{it}$	$\ln PN_{it}$	$\ln PR_{it}$	$\ln PR_{it}$
$\ln gcap_{it}$	0.019***	0.027***	0.014				0.030***	0.025**
	(0.006)	(0.007)	(0.009)				(0.009)	(0.011)
$\ln ocap_{it}$				0.019***	0.025***	0.017*		
				(0.007)	(0.009)	(0.010)		
$\ln g_{i,t-1}$	0.298*	0.330*	0.430*	0.298*	0.330*	0.430*	0.493**	0.528*
	(0.153)	(0.190)	(0.237)	(0.151)	(0.192)	(0.236)	(0.222)	(0.292)
$\ln l_{it}$	0.238**	0.168	0.319**	0.239**	0.170	0.321**	0.454**	−0.070
	(0.103)	(0.138)	(0.155)	(0.099)	(0.132)	(0.153)	(0.178)	(0.148)
$\ln e_{it}$	−0.206	−0.119	−0.213	−0.184	−0.091	−0.193	−0.400*	0.298
	(0.154)	(0.205)	(0.159)	(0.154)	(0.209)	(0.157)	(0.202)	(0.175)
$\ln d_{it}$	0.042	0.020	0.095	0.040	0.017	0.094	0.082	−0.019
	(0.069)	(0.088)	(0.099)	(0.069)	(0.090)	(0.099)	(0.111)	(0.100)
Constant	2.009	−0.130	−1.167	1.922	−0.227	−1.248	−2.170	−4.994
	(2.719)	(3.439)	(4.225)	(2.705)	(3.470)	(4.214)	(3.613)	(5.648)
Obs.	822	822	822	822	822	822	415	407
R-squared	0.095	0.062	0.088	0.101	0.066	0.091	0.164	0.107
Chow test							2.71(0.000)	

Notes: 1. Robust standard errors in parentheses. 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. 3. Country fixed-effect and Year fixed-effect are controlled.

Table 2
Results of the robustness check with two stage least squares.

Column	(1)	(2)	(3)	(4)	(5)
Group	all	all	all	BRI	Not BRI
DV	$\ln P_{it}$	$\ln PR_{it}$	$\ln PN_{it}$	$\ln PR_{it}$	$\ln PR_{it}$
$\ln gemp_{it}$	0.018***	0.023***	0.015	0.020*	0.024**
	(0.006)	(0.008)	(0.010)	(0.010)	(0.011)
Covariates	yes	yes	yes	yes	yes
Observations	822	822	822	415	407
R-squared	0.977	0.970	0.959	0.947	0.981
Kleibergen-Paap rk F	245.416	245.988	243.967	123.563	120.640

Notes: 1. Robust standard errors in parentheses. 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. 3. Country fixed-effect and Year fixed-effect are controlled. 4. Results of control variables and constants are omitted to save pages.

4. Conclusion

China's OFDI has raised concerns regarding its potential negative impact on the development of host countries, especially following the introduction of BRI. This paper empirically examines the short-term innovation-enhancing effect of China's greenfield OFDI using a panel dataset comprising 46 host countries from 2003 to 2021. China's greenfield OFDI has been found to significantly contribute to the growth of patent applications in the host countries. Importantly, this growth primarily originates from the residents of the host countries rather than the non-residents. In other words, China's greenfield OFDI can stimulate local innovation activities in host countries, fostering their short-term technological advancement. We further conducted subsample analyses to distinguish between BRI member countries and non-BRI countries. Our findings indicate that the growth effects of China's greenfield OFDI on patent applications are significant in both groups, with the elasticity of the former being slightly but significantly higher than that of the latter. These results may provide empirical evidence to address concerns regarding China's OFDI.

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Appendix A. Correlation statistics of variables

We use the GDP per capita to control the widely recognized impact of host countries' economic development on their innovation outputs. However, this variable may be correlated with OFDI decisions of home countries, potentially resulting in endogeneity issues. The results in Table A1 show that the correlation statistic between China's greenfield OFDI outflows and the GDP per capita of host countries is around 0.31, implying a moderate correlation based on empirical values. Therefore, we alternatively use the one-year lagged GDP per capita at constant 2015 prices to conduct regressions.

Table A1
Correlation statistics of variables.

	$\ln PR_{it}$	$\ln PN_{it}$	$\ln gcap_{it}$	$\ln gemp_{it}$	$\ln ocap_{it}$	$\ln g_{it}$	$\ln g_{i,t-1}$	$\ln l_{it}$	$\ln e_{it}$	$\ln d_{it}$
$\ln PR_{it}$	1.000									
$\ln PN_{it}$	0.758	1.000								
$\ln gcap_{it}$	0.561	0.564	1.000							
$\ln gemp_{it}$	0.558	0.556	0.959	1.000						
$\ln ocap_{it}$	0.544	0.535	0.724	0.707	1.000					
$\ln g_{it}$	0.441	0.413	0.311	0.287	0.332	1.000				
$\ln g_{i,t-1}$	0.442	0.436	0.296	0.270	0.308	0.985	1.000			
$\ln l_{it}$	−0.477	−0.380	−0.303	−0.277	−0.320	−0.628	−0.619	1.000		
$\ln e_{it}$	−0.258	−0.233	−0.206	−0.194	−0.225	−0.455	−0.453	0.342	1.000	
$\ln d_{it}$	−0.158	−0.082	−0.190	−0.124	−0.230	−0.498	−0.482	0.347	0.269	1.000

Appendix B. List of sample countries (regions)

The sample in this paper consists of the following 46 countries (or regions):

24 BRI members joined the BRI between 2013 and 21: Armenia, Bangladesh, Belarus, Bosnia-Herzegovina, Bulgaria, Chile, Croatia, Egypt, Georgia, Indonesia, Jordan, South Korea, Malaysia, Mongolia, New Zealand, Peru, Philippines, Russian Federation, Serbia, Singapore, Sri Lanka, Thailand, Ukraine, and Vietnam.

22 other countries (regions): Argentina, Australia, Belgium, Bhutan, Brazil, Canada, Colombia, Denmark, France, Germany, Guatemala, Iceland, India, Japan, Mexico, Netherlands, Norway, Spain, Sweden, Switzerland, UK, and US.

Data availability

Data will be made available on request.

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