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Does technology-seeking OFDI improve the productivity of Chinese firms under the COVID-19 pandemic?

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ARTICLE INFO

JEL classifications:
F43
G10
G15
G15

Keywords:
Technology-seeking OFDI
Productivity
COVID-19
External shock
Investment heterogeneity

ABSTRACT

This paper empirically investigates the impact of technology-seeking outward foreign direct investment (OFDI) on firms’ productivity under the influence of negative external shocks, taking as a sample the investment data of Chinese firms before and during COVID-19. The results show that technology-seeking OFDI improves productivity, but not under negative external shocks. The dampening effect of such shocks is more significant when the host country is a developed country and in firms with multiple branches. Technology-seeking OFDI particularly improves the productivity of research and development and processing firms, and among the productivity measures tested it most prominently affects total factor productivity.

1. Introduction

Against the backdrop of China’s orderly promotion of a comprehensive open economy, local enterprises have been increasing their international competitiveness, continuing to accumulate foreign exchange reserves and increasing the scale of outbound investments (Kong, Peng, Ni, Jiang, & Wang, 2020b). Outward foreign direct investment (OFDI), an important form of cross-border capital flow, has an obvious impact on a country’s technological progress, industrial adjustment, and economic growth (Gustafsson & Segerstrom, 2011). In 2019, China’s OFDI flow and stock reached $136.91 billion and $219.88 billion, respectively, with outbound investments steadily ranking among the top in the world, according to data from the China Outbound Investment Cooperation Development Report (2020). Technology-seeking OFDI accounts for an increasing proportion of these outward investments and is gradually replacing resource-oriented OFDI. Enterprise OFDI has become the leading force in China’s opening up to the outside world and has promoted China’s outward-oriented economy (Zhang, Du, & Chen, 2019a). China states that it should “innovate the way of outward investment” and “adhere to the road of peaceful development” in international trade. Under the guidance of relevant policies, China urgently needs to promote outward investment to a high-quality development stage, focusing on improving innovation capabilities and building international brands (Yang, Wei, & Yu, 2018; Zhang, Zhuge, & Freeman, 2020c; Kong et al., 2021).

However, in developing an export-oriented economy, we also need to pay attention to an important fact: dramatic changes to the domestic and international economic and social environments will bring serious exogenous shocks to OFDI (Kong, Peng, Ruijia, & Wang, 2021a; Zhang, Guo, Wang, & Chen, 2020a). The sudden COVID-19 epidemic in 2020 has had a huge impact on both China and the global economy, weakening the global economy, complicating the trade environment, and causing an economic downturn. So,
against the backdrop of both the demand for high-quality domestic development and the spread of a global epidemic, is technology-seeking OFDI conducive to improving Chinese enterprises’ production efficiency?

Even if a country has become a major foreign investment country, OFDI will still have a profound and lasting impact on the economic development of the home country as well as on the development of enterprises in the host country (Chou, Chen, & Mai, 2011; Friedman, Gerlowski, & Silberman, 1996; Kong, Guo, Wang, Sui, & Zhou, 2020a; Zhang, Tong, & Li, 2020b). Existing studies have focused on the impact of OFDI on the economic growth of home countries. The most influential theory is the investment development path (IDP) theory proposed by Dunning (2012). He developed a dynamic analytical framework at the macro level to empirically analyze the association between multicity foreign direct investment and economic development stages. Subsequently, scholars have proposed theories of small-scale technology (Wells Jr., 1977), technological innovation and industrial upgrading (Cantwell & Tontin, 1990), long-run international capital flows (Koizumi & Kopecky, 1977), the substitution effect of OFDI and economic growth (Stevens & Lipsey, 1992), and the complementarity effect (Desai, Foley, & Hines, 2005; Zhang, Du, Zhuge, Tong, & Freeman, 2019b) to study the effect of OFDI on different dimensions of economic growth in home countries.

To prove these theories, many scholars have used real data and constructed models to conduct empirical tests. For example, Herzer (2008) and Cheng, Wang, Peng, and Kong (2020) suggest that the economic growth effect of OFDI is closely related to domestic resources and market size. Denzer et al. (2011) demonstrates the positive impact of OFDI on the home country’s economic growth, while Feng and Cai (2012) argue that the long-term growth effect of OFDI on China’s regional economic growth is significantly larger than the short-term growth effect. Most researchers have confirmed the contribution of OFDI to the home country’s economic growth (Zhang & Guo, 2019). But these studies mainly focus on macro-level economic growth; few studies have looked at firm productivity.

China has long been on the demand side of the capital equation. With China becoming a net exporter of investment since 2014, Chinese firms are shifting from passively integrating into global value chains to building global value chains controlled by local firms. China’s outbound investment tends to be in developed economies, with investment flows from China to developed countries increasing by 94% in 2016 as compared to the previous year. This is an effective path for China to acquire advanced technologies and standards from overseas and improve innovation efficiency (Yu, 2013; Zhang, Mohsin, Rasheed, Chang, & Taghizadeh-Hesary, 2021). Technology-seeking OFDI can give home country firms proximity to the rich research and development (R&D) resources of the host country and thus acquire the reverse technology spillover from the host country (van de la Potterie and Lichtenberg, 2001; Wang & Yao, 2017; Yao, Wang, Zhang, & Ou, 2016) to better promote industrial optimization and economic efficiency in the home country (Kong, Shen, Sun, & Shao, 2020c). In particular, the real growth trajectory of the integrated emerging economies shows that their rise has benefited to a large extent from technology-seeking OFDI (Goh, Wong, & Tham, 2013). Emerging economies and developing countries have become the main forces driving the strong recovery of the global economy. China is the developing country most involved in overseas investment, and promoting technological progress and improving production efficiency of domestic enterprises is one of the important objectives of China’s continuous opening-up (Kong, Tong, Peng, Wong, & Chen, 2021c). However, number of foreign branches and scope of operations vary across firms, so the effects of technology-seeking OFDI on firm productivity may also vary and need to be tested empirically.

Further, the focus of OFDI must be adjusted to account for exogenous shocks to the economy. The existing literature examines the economic impact of shocks on technological progress, capital accumulation, demographics, and governmental policies. Few studies discuss the impact of infectious disease, though the economic costs of mass infectious diseases are enormous. Researchers generally agree that the short-term impact of epidemics is negative, but their long-term effects are not well understood. Epidemics not only directly cause economic losses but also affect the behavioral decisions of economic agents, which produce long-term effects on the economy (Adda, 2016; Kong, Shen, Peng, & Wong, 2021b). In addition, the impact of epidemics on the economy is complex and markedly heterogeneous. The mechanisms of epidemics’ effects on the economy differ from one historical period to another and from one specific condition to another, mainly because modern medicine may greatly reduce long-term economic and social impacts. At the same time, the various measures taken to control an epidemic as well as panic and other behaviors can affect short-term economic performance (Noy & Shields, 2019). And significant differences between epidemics in mode of transmission, transmission capacity, incubation period, and lethality give each epidemic a unique impact on the economy (Barro, Ursúa, & Weng, 2020).

This paper attempts to clarify the effect of technology-seeking OFDI on Chinese enterprises’ productivity. This is undoubtedly of great theoretical and practical value in promoting the quality of China’s economic growth. We argue that such research must include exogenous shocks in the analytical framework; doing so can enrich the existing research results and predict the impact of COVID-19 on China’s foreign economy.

The rest of this paper is organized as follows. The second section introduces the measurement model, estimation methods, variable construction, and data sources. The third section examines whether the impact of technology-seeking OFDI on Chinese firms’ productivity differs along four dimensions: firm attributes, investment target countries, number of foreign branches, and business scope. The fourth section summarizes the research in this paper and makes recommendations to promote technology-seeking OFDI to drive Chinese enterprises to high-quality development.

2. Research design

2.1. Estimation model

To study the relationship between firm productivity and the size of technology-seeking OFDI as rationally and comprehensively as possible, we build a model at the micro level through the following steps. First, we study the impact of technology-seeking OFDI on productivity at the firm level through propensity matching. China’s research on technology-seeking OFDI started late, with Du and Zhu...
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at enhancing the firm seeking OFDI enterprises) for paired tests, and establish a dummy variable, sample enterprises into a treatment group (a set of technology-seeking OFDI enterprises) and a control group (a set of non-technology-seeking OFDI enterprises) for paired tests, and establish a dummy variable, sample enterprises into a treatment group (a set of technology-seeking OFDI enterprises) and a control group (a set of non-technology-seeking OFDI enterprises). To proxy firm productivity we use input-output ratio (roi), value-added ratio (v), labor productivity (lp), and total factor productivity (tfp). Following Heckman, Ichimura, and Todd (1997), we represent the difference between the input-output ratios of firm i in the presence and in the absence of technology-seeking OFDI by the following model.

$$E(\text{roi}_i^1 - \text{roi}_i^0) = E(\text{roi}_i^1 | \text{ofdi}_i = 1) - E(\text{roi}_i^0 | \text{ofdi}_i = 1)$$ (1)

Suppose a reasonable adjustment is made to Eq. (1), so that we can obtain difference models for the value-added ratio, labor productivity, and total factor productivity both with and without technology-seeking OFDI. In Eq. (1), roi$_i^1$ is the input-output ratio when firm i still has technology-seeking OFDI in year t after the technology-seeking OFDI, while roi$_i^0$ denotes the input-output ratio if firm i does not continue with technology-seeking OFDI in year t. If a firm does not invest abroad after its first technology-seeking OFDI, then E(roi$_i^1$ | ofdi$_i$ = 1) is an invalid state, making it impossible to reasonably estimate Eq. (1). Instead, to investigate the difference in input-output ratio between the two states we seek an appropriate control group for technology-seeking OFDI firms. Following Girma, Greenaway, and Kneller (2004), we suggest that if there are firms in the sample period whose technology-seeking OFDI behavior is consistently unobservable, then their input-output ratio can be used to proxy the input-output ratio of firms that are not engaged in technology-seeking OFDI. That is, E(roi$_i^1$ | ofdi$_i$ = 1) = E(roi$_i^0$ | ofdi$_i$ = 0), which leads to Eq. (1). To increase the robustness of the results, we use nearest-neighbor matching to select the nearest control sample for technology-seeking OFDI firms.

We follow Helpman, Melitz, and Yeaple (2004) and Hijzen, Jean, and Mayer (2011) to select matching criteria that importantly influence firms’ technology-seeking OFDI: capital intensity (the ratio of net fixed assets to the number of employees), firm size, number of employees, total profit, and total assets. The matching ratio is set at 1:3. Table 1 shows no significant difference between the treatment and control groups in any of these five matching indicators, confirming that a suitable control group has been selected.

Next, we construct a binary variable, time$_t$ = {0, 1}, where time$_t$ = 0 indicates the period before technology-seeking OFDI and time$_t$ = 1 indicates the period after it. We then build a model to measure the differences in input-output ratio between firms with and without technology-seeking OFDI.

$$\text{roi}_i = \alpha_0 + \alpha_1 \text{ofdi}_i \times \text{time}_t + \beta \text{Controls}_i + \nu_i + \epsilon_i,$$ (2)

where k and t denote region and year, respectively. The subscript s represents the base period of the technology-seeking OFDI, so where t > s, t denotes a year after the investment is made. An ofdi$_i$ value of one indicates that firm i has conducted a technology-seeking OFDI in year s. The coefficient $\alpha_1$ of ofdi$_i$ × time$_t$ represents the result of the matched multiplier estimation of the effect of the firm’s technology-seeking OFDI on economic growth. If $\alpha_1$ is obtained, it means that the input-output ratio changes more in the treatment group than in the control group from before to after the investment, meaning that the technology-seeking OFDI contributes to the firm’s productivity growth. The Controls$_i$ term is a control variable (see Subsection 2.2 for details of the measurement), $\nu_i$ is the time fixed effect, $\nu_i$ is the firm fixed effect, and $\epsilon_i$ is a random perturbation term.

To examine the impact of technology-seeking OFDI on the input-output ratio of Chinese firms under COVID-19, in Eq. (3) we add an exogenous shock (I) as a moderating variable:

$$\text{roi}_i = \alpha_0 + \alpha_1 \text{ofdi}_i \times \text{time}_t \times I + \alpha_2 \text{ofdi}_i \times \text{time}_t + \alpha_3 \text{ofdi}_i \times I$$

$$+ \alpha_4 \text{time}_t \times I + \beta \text{Controls}_i + \nu_i + \nu_i + \epsilon_i.$$ (3)

Finally, we divide OFDI into OFDI in developed versus developing countries, multibranch versus single-branch OFDI, and R&D versus trade sales OFDI, and build a model to test for differences—a slight variation of Eq. (3), which is omitted here.

Table 1
Alignment test.

| Matching indicator | Before matching | | | After matching | | | |
|--------------------|----------------|------------|----------------|----------------|------------|----------------|
|                     | OFDI | Non-OFDI | P-values | OFDI | Non-OFDI | P-values |
| Capital intensity   | 3.797 | 4.345 | 0.000 | 3.797 | 3.882 | 0.541 |
| Enterprise size     | 11.215 | 9.763 | 0.000 | 11.215 | 11.333 | 0.554 |
| Number of employees | 1285.4 | 309.8 | 0.000 | 1285.4 | 1565.4 | 0.432 |
| Total profits       | 36,989 | 6991.7 | 0.123 | 36,989 | 32,891 | 0.834 |
| Total assets        | 610,000 | 130,000 | 0.001 | 610,000 | 670,000 | 0.801 |

Notes: The data are from 2009 to 2013 China Industrial Enterprise Database and China Outward Foreign Direct Investment Statistics Bulletin. In this paper, the input-output ratio of enterprises is selected as the dependent variable for matching; the results of matching using other dependent variables are similar.
2.2. Selection of indicators

The variable to be explained is firm productivity. The academic community has not yet come to a consensus on how to measure productivity at the firm level; methods vary according to research objectives and interpretations of the meaning of enterprise productivity. The classical indicators are technical level (intermediate input-output ratio), value-added rate, and efficiency improvement (Dai, 2015; Fan, Jiang, & Liu, 2017; Shen & Fu, 2010).

The formula for the intermediate input-output ratio is \( \text{roi} = \frac{\text{vad}}{\text{minp}} = \frac{\text{vad}}{\text{minp}}, \) where \( \text{roi} \) is the intermediate input-output ratio of an enterprise, \( \text{vad} \) and \( \text{minp} \) represent its value added and intermediate input, respectively, and \( \text{vad} \) and \( \text{minp} \) represent the value added per capita of the firm and intermediate input per capita of the firm, respectively.

The second indicator is the rate of value added. The gross national product of an economy is equal to total output minus intermediate inputs, which can be represented mathematically as \( Y_t = (1 - x)Q_t, \) where \( x \) is the fraction of total output used as intermediate inputs. The \( x \) term can be called the intermediate inputs coefficient, and the rate of value added is given by \( v = 1 - x. \)

The third indicator is labor productivity: value added, divided by the average number of employees in the period (i.e., the average of the number of employees at the beginning of the period and the number at the end).

There are two methods of measuring total factor productivity (TFP). The OP method (Olley & Pakes, 1992) takes the natural logarithm of both sides of a production function of C-D form to obtain a linear equation. According to Solow’s residual method, the linear equation’s error term are the productivity. The error term is then decomposed into total factor productivity (TFP) and the true error term. The TFP is then obtained by using investment as a proxy variable for productivity and using methods such as polynomial estimation method and Probit model.

Whereas the OP method uses the amount of investment as its proxy variable, the LP method (Levinsohn & Petrin, 2003) uses the input indicator of intermediate goods as its proxy variable.

We test two core explanatory variables: the ofdi dummy variable for whether or not a firm makes technology-seeking OFDI in year \( t \), and the exogenous shock variable \( l \). This paper draws on the work of Pan and Yuan (2014) and selects a sample of 26 countries from the Organisation for Economic Co-operation and Development (OECD), excluding Turkey, Australia, Mexico, and Ireland, as the target countries for China’s technology-seeking OFDI.

Another central explanatory variable of interest in this paper is the exogenous shock variable. Because there are limited data on microfirms, we examine the impact of exogenous shocks on OFDI firms in general and measure exogenous shocks by their outcomes. Following Aghion, Askenazy, Berman, Cette, and Eymard (2012), we use a firm’s revenue growth rate to distinguish between positive and negative exogenous shocks. An exogenous shock is defined as positive if a firm’s current operating income rises, negative if the opposite is true. Because of the epidemic, most enterprises’ current operating incomes are declining. Therefore, this paper focuses on the negative shock perspective. The advantage of this approach is twofold: it takes into account firm differences, and it allows us to

### Table 2
Baseline results.

| Variable | Input-output rate | Value-added rate | Labor productivity | TFP |
|----------|------------------|------------------|--------------------|-----|
|          | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
| Ofdi*time | 0.0126*** (2.15) | 0.0195*** (5.17) | 0.0263 (0.73) | 0.0314** (2.41) | 0.0148** (2.10) | 0.0221** (2.39) | 0.1047** (2.26) | 0.0875*** (5.24) |
| Time*I   | 0.0541 (0.91) | 0.0397 (0.64) | 0.0548 (0.94) | 0.1172* (1.81) | 0.1057* (1.73) | 0.0691 (0.78) | 0.0861 (0.75) | 0.1005*** (0.73) |
| Ofdi*I   | 0.0376 (0.46) | 0.0548 (0.94) | 0.1172* (1.81) | 0.1057* (1.73) | 0.0691 (0.78) | 0.0861 (0.75) | 0.1005*** (0.73) | 0.1057* (1.73) |
| Ofdi*time*I | –0.0165* (5.98) | –0.0570*** (6.35) | –0.0393** (2.29) | –0.0436** (2.17) | –0.0105*** (2.41) | –0.0257*** (2.41) | –0.0436** (2.17) | –0.0257*** (2.41) |
| Capital intensity | 0.0083*** (9.25) | 0.0109*** (10.34) | 0.0126*** (8.77) | 0.0229*** (9.36) | 0.0035*** (9.68) | 0.0103*** (10.29) | 0.0094*** (7.85) | 0.0257*** (11.25) |
| Time of establishment | 0.0011 (1.51) | 0.0039 (1.41) | 0.0101 (1.72) | 0.0085* (1.72) | 0.00210** (2.21) | 0.00021** (2.32) | 0.0061 (2.41) | 0.0105*** (2.41) |
| Firm size | 0.0137*** (7.53) | 0.0076*** (6.51) | 0.0049*** (6.90) | 0.0213*** (5.42) | 0.0037* (1.85) | 0.0331 (1.13) | 0.0507*** (7.65) | 0.0514*** (6.17) |
| SOE      | –0.2504*** (–7.83) | –0.5706*** (–6.12) | –0.0783 (–0.53) | –0.0519 (–0.78) | –0.2153*** (–7.08) | –0.3925*** (–8.12) | –0.5075*** (7.63) | 0.4137*** (6.94) |
| FIE      | 0.5290*** (10.20) | 0.5290*** (8.65) | 1.0539 (0.85) | 0.7911* (1.83) | 0.3029** (2.09) | 0.2916** (4.99) | 1.0290*** (2.20) | 0.8376*** (2.37) |
| Constant | –0.3974 (–1.39) | –0.5727 (–1.46) | 1.2321 (2.29) | 0.8487** (2.38) | 0.1788** (2.38) | 0.1694** (2.41) | –0.3074 (–0.62) | –0.6419 (–0.83) |
| Year FE  | yes     | yes     | yes     | yes     | yes     | yes     | yes     | yes     |
| City FE  | yes     | yes     | yes     | yes     | yes     | yes     | yes     | yes     |
| Industry FE | yes    | yes     | yes     | yes     | yes     | yes     | yes     | yes     |
| R²       | 0.1394 (5618) | 0.2883 (5618) | 0.3044 (5618) | 0.4298 (5618) | 0.3184 (5618) | 0.4131 (5618) | 0.3394 (5618) | 0.5267 (5618) |
| N        | 5618    | 5618    | 5618    | 5618    | 5618    | 5618    | 5618    | 5618    |

Notes: Values in parentheses are t-statistics corrected for heteroskedasticity. ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively.
infer industry characteristics from consistent responses to a certain type of shock across a group of firms.

In the propensity matching process, we use the following firm-level control variables: capital intensity, time of establishment, firm size, whether the firm is a state-owned enterprise (SOE), and whether the firm is a foreign-invested enterprise (FIE). Capital intensity is measured by the ratio of net fixed assets to the number of employees. Time of establishment is the time since the establishment of the firm. Firm size is the average number of employees per year. The SOE term takes a value of one if the firm is state owned and zero otherwise. The FIE term takes a value of one if the firm is a Hong Kong, Macao, Taiwan, or foreign-funded enterprise and zero otherwise.

2.3. Data resource

The data for both experimental and control groups are taken from the 2009–2013 OFDI Enterprise Directory and the Chinese Industrial Enterprise Database published by the Ministry of Commerce. We also identify enterprises that have made outward investments from information such as the names of parent firms and branches, etc.) released by the Ministry of Commerce. These data, matched with the Chinese Industrial Enterprise Database, yielded a total of 254,182 enterprises. Since the raw data obtained after matching are still in rough form, we follow Xie, Rawski, and Zhang (2008), Yu (2011), and Zhou (2015) to eliminate samples with missing codes, incorrect dates of establishment, unclear industry affiliations, omissions of important financial indicators, or fewer than ten employees. Following Cai and Liu (2009) and Feenstra, Li, and Yu (2017), we also remove firms with negative paid-in capital, fixed assets less than current assets, total assets less than total fixed assets, or total assets less than net fixed assets. Finally, we obtain a sample of 2817 firms with foreign investments that satisfies general accounting principles.

3. Empirical results

3.1. Baseline regression results

We first test the relationship between OFDI and firm input-output rate, value-added rate, labor productivity, and total factor productivity for our matched samples in the context of exogenous negative shocks. In Table 2, the odd columns are regression results obtained from a difference-in-difference model, and the even columns are regression results obtained from a difference-in-difference-in-difference model. Each column adds control variables for capital intensity, time of establishment, firm size, state ownership, foreign ownership, and all controls for city, year, and industry fixed effects.

The odd column results show that, with controls for other variables, all of the coefficient estimates of di * time are significant at the 5% level or better, except for the rate of value added by firms. This indicates that in general, OFDI promotes firm productivity measured by input-output rate, labor productivity, and total factor productivity. The even column results show that the coefficient estimates of the core explanatory variable, ofdi * time * I, are significantly negative for all four indicators of firm productivity after we account for negative exogenous shocks. In absolute terms, the strongest dampening effect of the shocks is that on value added. In other words, under negative exogenous shocks, technology-seeking OFDI significantly impairs firm productivity, with the negative effect on firm value-added rates being most prominent.

Among the control variables, capital intensity is positively associated with firm input-output rate, value-added rate, labor productivity, and total factor productivity at the 1% significance level, reflecting the importance of R&D innovation generated by capital intensity in improving firm productivity. Whether a firm is state-owned is significantly and positively correlated with total factor productivity, while it is significantly and negatively correlated with input-output rate, value-added rate, and labor productivity. Cross-sectional comparison of the regression results for the four indicators of firm productivity, some of which pass the 1% significance level test and some of which are significant at only the 5% level, generally indicates that the results are robust.

### Table 3
Estimated results based on the level of development of the host country.

| Variable               | Input-output rate | Value-added rate | Labor productivity | TFP       |
|------------------------|-------------------|------------------|--------------------|-----------|
| Ofdi*time*I*dev_ofdi   | –0.0165***        | –0.2369          | –1.0816**          | –0.8915** |
|                        | (8.32)            | (0.58)           | (2.09)             | (2.13)    |
| Ofdi*time*I*undev_ofdi| –0.0032           | –0.0532          | –0.0045            | –0.0432   |
|                        | (0.23)            | (1.34)           | (1.09)             | (1.13)    |
| Constant               | –0.4173           | –1.0598          | –0.7606            | –0.3439   |
|                        | (–0.52)           | (–1.10)          | (–1.25)            | (–0.97)   |
| Controls               | yes               | yes              | yes                | yes       |
| Year FE                | yes               | yes              | yes                | yes       |
| City FE                | yes               | yes              | yes                | yes       |
| Industry FE            | yes               | yes              | yes                | yes       |
| R²                     | 0.4405            | 0.3011           | 0.3024             | 0.5067    |
| N                      | 5618              | 5618             | 5618               | 5618      |

Notes: Values in parentheses are t-statistics corrected for heteroskedasticity. ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively.
3.2. Development level of the host country

Table 3 shows that under negative exogenous shocks, compared with investment in developing countries, OFDI in developed countries depresses firm productivity, especially labor productivity and total factor productivity. Moreover, the test results for all four indicators of firm productivity are similar, indicating that the results are robust. A possible reason is that investment in frontier technology in developed countries is more dependent on the high-end international market and therefore carries greater inherent uncertainty and risk. Further, exogenous negative shocks hit local enterprises harder, impairing input-output efficiency in the home country and thus the high-quality development of enterprises. Negative shocks also inhibit the effect of OFDI in developing countries on firm productivity, but not significantly.

3.3. Number of branches of OFDI firms

Since the technology spillover that firms can obtain from technology-seeking OFDI may be limited by the depth of the investment, we separate our sample into firms with multibranch OFDI and those with single-branch OFDI. As Table 4 shows, the regression coefficients for the effect of $ofi * time * I * multi_{ofdi}$ on the input-output rate, value-added rate, and total factor productivity of enterprises are significantly negative, and the coefficient for the effect on $ofi * time * I * multi_{ofdi}$ on the labor productivity of enterprises is positive but insignificant. In contrast, the regression coefficients for the effect of $ofi * time * I * single_{ofdi}$ on firms’ input-output rate, labor productivity, and total factor productivity are significantly positive, while the coefficient for the effect on firms’ value-added rate is significantly negative. These results indicate that under an exogenous negative shock, investing in a larger number of branches abroad may reduce the firm’s productivity.

The reason may be that multibranch OFDI deepens the investment and thus connects home firms more closely to the host country’s economic situation. If the host country is more deeply hurt by exogenous shocks, the fluctuations in the host country to some extent squeeze out capital that the home country firm could have invested in R&D and inhibit that firm’s productivity growth. Small, single-branch investments may be more prudent because they can lead to effective management by the parent firm under negative shocks and thus tend to increase productivity. To a certain extent, this phenomenon inspires Chinese enterprises’ cross-border investment. Cross-border investment decisions should be made rationally while paying attention to and maintaining R&D at home headquarters, as expanding overseas investments may not always be a good thing.

3.4. Business scope of OFDI firms in the hosts country

Next, we divide OFDIs into R&D-processing OFDIs and trade-sales OFDIs (see Table 5). Under negative exogenous shocks, R&D processing-based OFDI increases the firm’s input-output rate, labor productivity, and total factor productivity and reduces its value-added rate—all at significance levels of 5% or lower. In contrast, trade-sales OFDI increases the firm’s input-output and value-added rates, but decreases labor productivity and total factor productivity, although only the coefficient on input-output rate passed the significance test.

We conclude that when faced with negative external shocks, R&D-processing OFDI enterprises are less dependent on the flow of human and material resources, and with the support of Internet technology, they can still maintain their original scales of development. In the face of common negative shocks, cooperation among countries can help enterprises acquire rigorous local management modes and absorb R&D capabilities (Zhang & Vigne, 2021). For example, there is a certain reverse technology spillover effect in the healthcare industry, promoting the sustainable and stable development of OFDI enterprises. However, OFDI firms tend to expand their international market share and trade by establishing overseas branch structures. This is not conducive to the China’s capacity to control the scale of the negative impact, resulting in barriers to Chinese enterprises, making it difficult to achieve tangible results in the short term and impeding their development.

Table 4

| Variable              | Input-output rate  | Value-added rate  | Labor productivity | TFP     |
|----------------------|--------------------|-------------------|--------------------|---------|
| Ofdi*time * I*multi_ofdi | -0.0182*** (-7.71) | -0.0314** (-2.31) | 0.0214             | -0.0592*** (-6.87) |
| Ofdi*time * I*single_ofdi | 0.1168*** (6.45)   | -0.0546* (1.81)   | 0.1103**           | 0.3068*** (5.28) |
| Constant             | -0.4715 (-0.72)    | 1.2629 (1.13)     | 0.2812             | -0.5609 |
| Controls             | Yes                | Yes               | Yes                |         |
| Year FE              | Yes                | Yes               | Yes                |         |
| City FE              | Yes                | Yes               | Yes                |         |
| Industry FE          | Yes                | Yes               | Yes                |         |
| R²                   | 0.3932             | 0.4372            | 0.6356             | 0.5923  |
| N                    | 5618               | 5618              | 5618               | 5618    |

Notes: Values in parentheses are t-statistics corrected for heteroskedasticity. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.
Table 5
Results based on OFDI business scope.

| Variable                | Input-output rate | Value-added rate | Labor productivity | TFP  |
|------------------------|-------------------|------------------|--------------------|------|
| OFdi*time*rd_ofdi*I    | 0.0268***         | −0.1025**        | 0.0560***          | 0.1286** |
|                         | (2.13)            | (−2.36)          | (7.52)             | (2.04) |
| OFdi*time*sale_ofdi*I | 0.0092**          | 0.0417           | −0.0254           | −0.0316 |
|                         | (1.99)            | (1.08)           | (−1.27)           | (−0.96) |
| Constant               | −0.4613           | 1.0269           | 0.1803**          | 0.4112 |
|                         | (−0.87)           | (1.76)           | (2.44)            | (1.09) |
| Controls               | Yes               | Yes              | Yes               | Yes  |
| Year FE                | Yes               | Yes              | Yes               | Yes  |
| City FE                | Yes               | Yes              | Yes               | Yes  |
| Industry FE            | Yes               | Yes              | Yes               | Yes  |
| R²                     | 0.3671            | 0.4551           | 0.5141            | 0.5936 |
| N                      | 5618              | 5618             | 5618              | 5618  |

Notes: Values in parentheses are t-statistics corrected for heteroskedasticity. ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively.

4. Conclusion and policy implications

Our results show that technology-seeking OFDI improves firm productivity growth when negative shocks are not considered—but not during the pandemic. In general, negative external shocks inhibit the effect of technology-seeking OFDI on firm productivity, especially when the investment host country is a developed country or the investing firm has set up multiple branches abroad. Technology-seeking OFDI improves the productivity of R&D processing firms as a whole and especially improves total factor productivity.

These findings suggest the following policy recommendations. First, adhere to the basic national policy of opening up to the outside world and encourage the sustainable development of technology-seeking OFDI. The results of this paper’s benchmark regression verify that, in a general sense, technology-seeking OFDI improves productivity. Therefore, given globalization, it is still necessary to insist on pursuing opportunities abroad. In the process of opening up to the outside world, China should make full use of external resources and markets to provide new kinetic energy for high-quality development. The government should promote its important position in China’s outward investment, focus on improving relevant institutional mechanisms, enhance investing enterprises’ innovation capacities, guide strong enterprises to build cooperative zones abroad, build overseas investment exchange platforms, and play a leading role in the industrial chain. Second, risk prevention work should be done to improve China’s ability to respond to public emergencies. Our empirical results show that the productivity effects of technology-seeking OFDI can be greatly reduced by external shocks. In the face of COVID-19, the inherent challenges and risks of Chinese OFDI remain. This fact, coupled with the risk of the business environment, the risk of political instability, and the threat of public emergencies, hinders the long-term healthy development of Chinese enterprises and seriously affects the high-quality development of China’s economy. However, the impact of COVID-19 on the macroeconomy is temporary and limited. The government should play a guiding role in macroeconomic control, prioritize control of the epidemic, and protect enterprises’ and workers’ legitimate rights and interests. At the same time, the government should take into account firms’ specific life-cycle stages, industries, and development situations to provide precise assistance.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (NO. 71303105), the National Social Science Foundation (NO. 19FJYB039), the Key Project of Jiangsu Provincial Social Science Foundation (18EYA004), the Postgraduate Practice Innovation Program of Jiangsu Province (NO. KYCX21_1431), and the Nanjing University Innovation Program for PhD Candidates (NO. CXYJ21-03).

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