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Financing constraints and ODI margins: Evidence from China

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ABSTRACT

Using a novel firm-level dataset on China, this paper examines the effects of financing constraints on enterprises' outward direct investment (ODI) from the perspective of binary margins of ODI. The main findings of the paper are threefold. First, financing constraints show a negative effect on enterprises' ODI for both the intensive and extensive margins, with a more significant effect on the extensive margin. Second, the negative effect is mostly significant in the energy industry, while it is not significant in non-energy industries. Finally, financing constraints show a negative effect on state-owned enterprises for both margins, while the effect is less significant for non-state-owned enterprises. The findings in the paper have policy implications for understanding and promoting ODI in emerging economies.

1. Introduction

Over the past decade, the pace of Chinese enterprises investing abroad has accelerated. Furthermore, the global financial crisis brought an important opportunity for Chinese enterprises with the 'going out' strategy. Meanwhile, the increase in China's economic strength and foreign exchange reserves has provided a solid and realistic foundation for Chinese companies expanding abroad. According to data released by the Ministry of Commerce of the People's Republic of China, Chinese outward direct investment (ODI) has been growing rapidly from about USD 3 billion in 2003 to about USD 180 billion in 2017, making China the second largest ODI player in terms of net capital exports worldwide. More importantly, Chinese ODI should grow more rapidly with the progress of the *Belt and Road Initiative* and the initiation of the Asian Infrastructure Investment Bank, which significantly affect the development level of China's open economy. With China being the largest ODI developing country, studying the effects of financial constraints on Chinese ODI will provide instructive guidelines for other developing countries' ODI.

Chinese ODI exhibits some typical characteristics. One is that ODI in the energy industry forms a large share of total ODI (see Fig. 1). According to the Global Investment Tracker database (The Heritage Foundation, 2015), during 2005–2014, China's ODI in the energy sector reached USD 482.8 billion. The overseas investments of energy enterprises are mainly driven by two factors, namely domestic energy shortages and energy security. Additionally, China's overseas energy investment is mainly concentrated in the oil, natural gas and power industries, which are still dominated by state-owned enterprises (SOEs). Despite its rapid development, China's ODI in the energy industry also faces many uncertainties and risks, including political conflicts and economic instability, as well as

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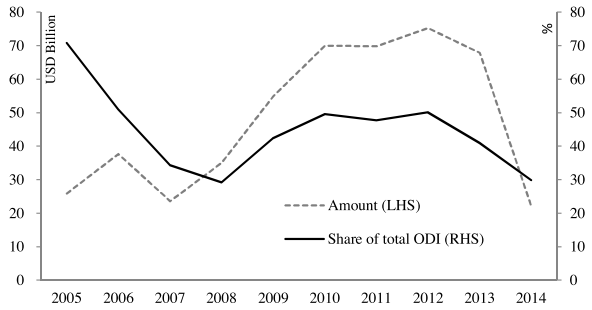

Fig. 1. Chinese outward direct investment in energy industry. Data source: The Heritage Foundation (2015).

inadaptability to local communities. According to the Chinese National Development and Reform Commission, failed ODI projects in the energy industry amounted to USD 89.3 billion during 2005–2014, accounting for 36.3% of total failed ODI. Since an increasing number of countries have realized the important strategic position of the energy sector, most energy countries have formulated a series of policies to restrict FDI in the energy industry, especially against China, which directly dampened Chinese ODI in the energy industry.

Firms in developing countries typically cite credit constraints as the primary obstacle to investment, which may also be the main reason for project failure (Wang et al., 2016). Moreover, cash payments are an important means for developing countries' cross-border mergers and acquisitions, and the main way for an enterprise to obtain cash flows is through corporate earnings and bank loans (Gaiotti, 2013). Therefore, financing constraints may negatively affect enterprises' ODI.

In this paper, we conduct a more comprehensive empirical analysis of the effects of financing constraints on enterprises' investment behaviour in developing countries using a new database that contains detailed firm-level ODI data, namely the Global Investment Tracker. The database is jointly compiled by the American Enterprise Institute and the Heritage Foundation (2015). Matching the database with listed firms' data on financing constraints from the Wind database, we construct a dataset that covers information on both firm-level ODI and corporate financing.

Using these firm-level data, the paper examines the effects of financing constraints on ODI from the perspective of binary margins—intensive and extensive margins. While the intensive margin indicates the average scale of a firm's ODI, the extensive margin indicates its scope. Therefore, the binary margins reflect ODI structure characteristics, broadening the perspective of existing research and deepening related analyses. Moreover, to identify the different effects of financing constraints among industries and ownership types, this paper conducts a comparative analysis between energy and other industries, as well as between SOEs and non-SOEs. The paper finds that both ODI margins are negatively affected by enterprises' financing constraints, especially for the energy industry and SOEs.

This paper contributes to the literature in several aspects. First, there are few studies on the relationship between financial constraints and enterprises' investment behaviour or ODI in developing countries, especially in China, mainly due to difficulties in obtaining firm-level data. The literature mainly focuses on macro-level cross-country analysis (Cheung and Qian, 2009; Contessi and De Pace, 2012; Wang and Huang, 2012) and less on firm-level analysis in developing countries. For instance, Wang et al. (2016) use firm-level panel data on Zhejiang Province in China and find that lowering a firm's financial constraints can increase both the probability and scale of investment. Further, current research on China rarely focuses on the micro-level perspective. Although some scholars (Tian and Yu, 2015) have employed micro-level data, their studies only focused on specific provinces rather than the entire country. Based on the micro-level perspective, this paper provides a complementary analysis at the macro-level on the effects of financing constraints on ODI. Second, it attempts to explore the impacts of financial constraints on a firm's internationalization behaviour, with a focus on enterprises in different industries and with different ownership types. Specifically, we compare the effects of financial constraints on enterprises' ODI between the energy and non-energy industries and SOEs and non-SOEs, which has important policy implications. Finally, this paper investigates the impacts of financial constraints on enterprises' ODI, with a focus on the perspective of binary margins—intensive and extensive—which, to the best of our knowledge, has not been analysed in previous studies on China. Overall, our findings provide micro-level evidence for ODI policy optimization and shed light on the decision-making in Chinese ODI behaviour.

The rest of the paper is organized as follows. Section 2 briefly reviews the relevant literature, Section 3 describes the model specification and data, Section 4 reports the empirical analysis, and Section 5 concludes with policy implications.appen

2. Literature review

2.1. Financial constraints and investment

In the early 1970s, McKinnon (1973) and Shaw (1973) put forward that financial repression had a negative impact on investment and growth by suppressing domestic savings and distorting the allocation of credit. The subsequent literature on emerging markets mostly focuses on the impacts of financial liberalization on firm investment; for example, Harris et al. (1994) on Indonesia, Günçavdı et al. (1998) on Turkey, Gelos and Werner (2002) on Mexico, O'Toole (2012) and Costantini et al. (2013) on other developing

countries. Overall, the existing research argues that financial liberalization can promote investment by easing firms' financial constraints. For instance, using firm-level data covering 57 developing and transitioning countries, O'Toole (2012) analyses the effects of financial liberalization on firms' access to investment finance and indicates that financial liberalization reduces firms' probability of being credit-constrained. Costantini et al. (2013) show that investment is sensitive to the conditions on the global capital market and the uncertainty of exchange rates.

Aghion et al. (2012) use firm-level panel data for France over the period 1993–2004 and find that the share of R&D investment in total investment is countercyclical without credit constraints, but becomes more countercyclical as firms face tighter credit constraints. Gaiotti (2013) finds that the elasticity of a firm's investment to the availability of bank credit has been significant in periods of economic contraction, and the ability to tap alternative finance sources is crucial. Using Chinese firm data for 2000–2007, Ding et al. (2013) find that firms characterized by high working capital display high sensitivities for investment in working capital to cash flow and low sensitivities for investment in fixed capital to cash flow.

2.2. The effects of financial constraints on ODI

Compared with research on domestic investment, the literature analysing the impacts of financing constraints on ODI is rather lacking. There is even less research regarding the effects from the firms' viewpoint, largely due to a lack of high quality firm-level ODI data on developing countries. As previously mentioned, the literature is mainly focused on macro-level cross-country analyses (Cheung and Qian, 2009; Contessi and De Pace, 2012; Wang and Huang, 2012). For example, Wang and Huang (2012) use annual ODI data for 22 industrialized countries and 44 developing countries to demonstrate that financial repression significantly promotes ODI from developing countries. However, there is less research of firm-level analysis. Wang et al. (2016) use firm-level panel data for the Zhejiang Province in China and find that lowering a firm's financial constraints can increase both the probability and volume of ODI. Moreover, productivity cannot offset the negative effects of financial constraints on private firms' ODI.

Further, the impact of financial constraints on the energy industry's ODI may be more serious owing to the features of investment in this sector. Specifically, energy projects are typically capital-intensive, large, lumpy, and have long pay-back periods, and thus their financing is more problematic. Ekholm et al. (2013) discuss the implications of financing constraints for future energy and climate scenarios, finding that the emission price required to meet given emission targets increases considerably when compared to a case that disregards capital constraints. Zhou et al. (2010) find that energy companies' ODIs are significantly affected by host countries' GDP, foreign policy and trade links within China. Yildiz (2014) provides empirical results on the relevance of financial citizen participation within the German renewable energy sector and briefly reviews the technical, political and legal framework that leads to significant developments in the field of financial citizen participation.

2.3. Binary margins of ODI

Meanwhile, given the deepening of research on ODI, the more recent literature began to study the structural characteristics of ODI from the perspective of binary margins, intensive and extensive. As previously mentioned, the intensive margin refers to the scale of a firm's ODI, while the extensive margin refers to its scope. The concept of binary margins, originating from the field of international trade, reflects the structural characteristics of trade (Melitz and Redding, 2012) and proves useful in studying ODI. According to Sui (2010) and Liu and Nie (2015), the ODI's intensive margin (defined as the average investment value of the enterprise's ODI for an industry-country pair over a year) reflects the scale of ODI projects, while its extensive margin (defined as the number of the enterprise's ODI industry-country pairs over a year) reflects the diversification degree of ODI projects (Keuschnigg, 2008; Tian and Yu, 2015). Therefore, the perspective of binary margins provides a comprehensive interpretation of ODI structure, that is, the decision on overseas investment depends on the marginal return of capital and the scale of investment is determined accordingly (i.e. the intensive margin of ODI); at the same time, the scope of ODI increases as enterprises invest more in host countries and industries (i.e. the extensive margin of ODI). After the introduction of the concept of binary margins, the literature on ODI improved significantly and some of its conclusions have been modified.

However, the effects of financing constraints on enterprises' ODI from the perspective of binary margins have yet to be studied. Contributing to the literature, this paper aims to reveal the impacts of financial constraints on firm's internationalization behaviour, with a focus on the binary margins of enterprises' ODI. Specifically, we examine how financing constraints affect enterprises' ODI from the perspective of binary margins and compare energy and non-energy industries.

3. Data and model specification

3.1. Definition and measurement of ODI binary margins

3.1.1. Intensive and extensive margins of ODI

Referring to the definition of binary margins in the literature (Keuschnigg, 2008; Tian and Yu, 2015), we define an ODI player's binary margins as follows: the intensive margin of ODI is the average value of an enterprise's industry-country ODI pair and the extensive margin the number of industry-country ODI pairs.[1] The specific calculation formula is as follows:

[1] The definition is similar to the binary margins of trade. According to Bernard et al. (2009) and Melitz and Polanec (2015), an exporter's intensive

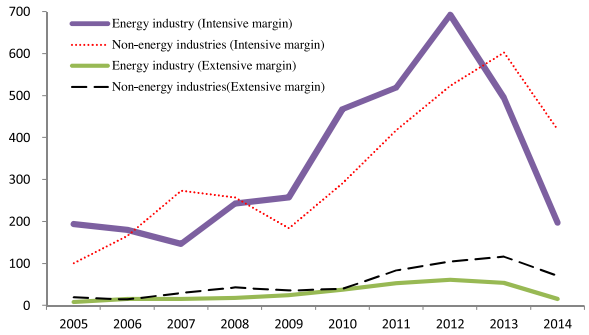

Fig. 2. Binary margins of ODI: Comparison of energy and non-energy industries. Notes: The units for the intensive and extensive margins are in billion USD and number of enterprises, respectively. There are 305 enterprises in the energy industry and 552 enterprises in other industries. Data source: The Heritage Foundation (2015).

Table 1
Binary margins of Chinese ODI: Comparison of ownership.

Ownership	Intensive margin (USD 0.1 billion)		Extensive margin	
	Total sample	Energy industry	Total sample	Energy industry
Central SOEs	6343.40	3146.53	877	314
Local SOEs	832.60	347.55	111	29
Public Enterprises	166.30	12.40	24	4
Private Enterprises	232.20	58.10	65	13
Foreign Enterprises	92.50	3.80	5	1
Total	7667	3568.38	1082	361

Notes: Collective enterprises are included in the statistics of public enterprises due to the limitations of the data sample.

$$ofdi_{it} = \sum_{j=1,h=1} odivalue_{ijht} = \underbrace{(indvalue_{it})}_{\text{intensive}} \times \underbrace{\left(\sum_{h=1} indnum_{iht}\right)}_{\text{extensive}}, \tag{1}$$

where $ofdi_{it}$ indicates the total value of ODI of enterprise i in year t; $odivalue_{ijht}$ indicates the value of ODI of an enterprise i in industry j, country h and year t; $indvalue_{it}$ indicates the average value of an industry-country ODI pair of enterprise i in year t; $indnum_{iht}$ represents the number of the enterprise's ODI industry-country pairs in year t; and subscripts j and h denote an industry and country, respectively. Therefore, $indvalue_{it}$ indicates the measurement of the intensive margin of an enterprise's ODI, while $\sum_{h=1} indnum_{iht}$ indicates the measurement of the extensive margin of an enterprise's ODI. As illustrated above, ODI's intensive margin reflects the scale of an ODI project, while its extensive margin reflects the diversification degree of ODI projects. Therefore, the perspective of binary margins provides a comprehensive interpretation of the ODI structure in the scale and scope of ODI.

3.1.2. The development of the binary margins of China's ODI in the energy industry

Fig. 2 reports the measurement of the binary margins of China's ODI. Both the intensive and extensive margins present an increasing trend, with significant fluctuations during 2005-2014. Meanwhile, there are also large differences in enterprises' ODI binary margins across industries.

In addition to the concentration of ODI in the energy industry, as seen in Table 1, China's ODI also shows an agglomeration of SOEs within this industry due to several reasons. First, based on China's domestic industrial structure, SOEs form the main body of the Chinese domestic energy industry. Chinese overseas energy investment is basically a mapping or reflection of Chinese domestic energy industry investment, whose participants are mostly SOEs. Second, overseas energy investment usually has high requirements regarding capital, technology, market influence and risk tolerance, which makes it difficult for many private companies to participate in the competition for overseas energy investment. Moreover, in any country, the energy industry is considered a lifeline industry, meaning that national strategic planning for energy is reflected by the economic behaviour of enterprises on the market. However, SOEs, especially the large central ones, are the most appropriate subjects to conduct these strategies and can thus get more internal support for overseas investment.

(*footnote continued*)
margin is defined as the average value of a product-country pair and the extensive margin as the number of product-country pairs.

3.2. Model specification

As mentioned previously, this paper investigates the effects of financing constraints on ODI from the perspective of binary margins. Referring to the model specifications of Berman and Héricourt (2010) and Buch et al. (2014), the econometric model is specified as follows:

$$margin_{ijht} = \alpha \cdot finance_{ijht} + \beta \cdot tfp_{ijht} + \varphi \cdot U_{ijht} + \delta \cdot C_{iht} + \mu_j + \sigma_t + \varepsilon_{it}, \quad (2)$$

where i, j, h and t denote enterprise, industry, country and year, respectively; $margin_{ijht}$ indicates the intensive and extensive margins of enterprises' ODI, and the same model and dataset are used for both margins; $finance_{ijht}$ indicates the degree of financing constraints of an enterprise; tfp_{ijht} indicates the total factor productivity (TFP) of an enterprise; U_{ijht} indicates other enterprise-level control variables; C_{iht} indicates country-level control variables; μ_j and σ_t denote industry effect and year effects, respectively; and ε_{it} is the error term.

To measure the financing constraints of an enterprise, following Minetti and Zhu (2011), we choose two alternative indicators, namely *cashflow* (defined as profits net of tax expenditures plus depreciation and normalized by total assets) and *liquidity* (defined as current assets minus current liabilities and normalized by total assets). The larger the two indicators are, the less severe are the financing constraints.

We control for firm-level *TFP* as an explanatory variable. The classical heterogeneous firm trade theory argues that only enterprises with the highest productivity will carry out ODI, while those with the lowest productivity can only participate on the domestic market or may even drop out of the market (Helpman et al., 2004; Melitz, 2003). Tian and Yu (2015) provide empirical evidence that high-productivity firms are more likely to invest abroad.

We here use the LP method proposed by Levinsohn and Petrin (2003) to estimate TFP to measure firms' production efficiency. Referring to Yuan (2009), the main indicators used in this paper to estimate TFP are as follows:

1) Value added of a firm = fixed asset depreciation + employee compensation + business tax and additional tax + net profit of main business;

2) Intermediate input = cost of main business + expenses of sales, finance, management – fixed asset depreciation – employee compensation;

3) Labour input, measured as the number of currently employed workers;

4) Capital input, measured using the perpetual inventory method, calculated by the following formula: $K_{i,t} = K_{i,t-1}(1 - D) + I_{it}$. When an enterprise is listed, its assets will be liquidated and revalued. Hence, we use the net assets from when the firm was listed as its initial capital stock, while investment is measured as the difference between the original value of fixed assets between the current and previous periods; we adopt a depreciation rate of 5% for fixed assets, with reference to Perkins (1988) and Yan and Yu (2003) as well as China's National Bureau of Statistics.

The enterprise-level factors U_{ijht} include the following variables. First, the size of an enterprise (*size*) is measured as the logarithm of the net fixed assets as the index of an enterprise's scale. The new trade theory emphasizes that firm-level economies of scale have obvious comparative advantages for trade competition on the international market. Second, capital intensity (*capital*) is measured as the ratio of net fixed assets to the number of employees. The competition in GDP growth among local governments in China tends to yield various preferential policies for capital-intensive industries, which may enhance capital-intensive enterprises' advantages in 'going out'. Third, the ownership of enterprises (*ownership*) is categorized into four types: state-owned, private, collective and foreign enterprises. Many studies show that the current financial system in China still shows suppressed characteristics of financial repression. Particularly, the banking system still exhibits 'ownership discrimination' in lending activities, making private enterprises more vulnerable to credit discrimination and credit rationing (Lin, 2008). Therefore, it is beneficial to analyse the effects of financing constraints by considering the different ownership types. In China's case, as an important player in ODI, SOEs are often regarded as being privileged in getting access to financing sources. Therefore, we further specify the dummy variable *state*, which takes the value 1 for SOEs and 0 otherwise. Variables such as size and ownership are useful as a priori classifications of financing constraints (Beck et al., 2003).

Further, the country-level control variables, C_{iht}, include several variables. The first is the GDP per capita of a host country (*gdpper*), which reflects the host country's economic development level. The second is the length since the effective date of a bilateral investment agreement with China (*bit*). Against the background of capital globalization and capital flows, the need for a coordination mechanism for international investment has become increasingly prominent. As an alternative design to the frustrated attempts involving multilateral mechanisms, bilateral investment agreements became a major means of regulation for foreign direct investment (Desbordes and Vicard, 2009; Neumayer and Spess, 2005). By the end of 2014, China had signed bilateral investment treaties with 134 countries and many agreements have been put into practice. Therefore, we control for the length of bilateral investment agreements. The third variable is the trade dependency of a host country (*openness*), which is measured as the ratio of trade to GDP as a percentage.

3.3. Data sources and descriptive statistics

The data used in the empirical analysis come from two main sources. The first one is the China Global Investment Tracker, which is jointly compiled by the American Enterprise Institute and the Heritage Foundation (2015). Due to the unavailability of non-listed companies' data, the database covers 1151 ODI projects of 457 Chinese listed companies in 131 countries, with investment amounts

above USD 100 million. Although these samples are listed companies with large deals, they are a representative group of all Chinese ODI in terms of both investment scale and geographical distribution.

The data cover firm-level ODI information, including the name of the investor, the quantity of ODI in millions, share size, partner/target, sector, subsector, country and region. It thus has an advantage compared to the ODI enterprise directory provided by the Chinese Ministry of Commerce. While data for ODI above USD 100 million may cause sample selection bias, it is the best data available at present and makes it more likely to underestimate rather than overestimate the effects of financing constraints on ODI, because small and medium firms are subject to more severe financing constraints.

The second data source is the WIND information statistics database, with listed firms' data on financing constraints. It is complementary to the first dataset with corporate financial information such as total assets, net value of fixed assets, sales, corporate profits and number of employees.

Matching the two datasets with the name of the enterprise, we construct a dataset that covers information on both firm-level ODI and corporate financing. We thus obtain combined data of 803 observations that contain information on corporate R&D input, cash flow, interest expenses, sales, total assets, opening time, financial variables, area code, and the four-digit industry code.

Additional data on host countries' GDP, GDP deflator, trade and GDP per capita come from the World Bank database. Data on host countries' distances come from the CEPII database,[2] which provides four measurements of bilateral distances in 225 countries, from which the one based on the distance from the main population is weighted by the proportion of the total population. The data on bilateral investment agreements come from the law department of the Ministry of Commerce: *A List of China's Signed Bilateral Investment Agreements* and *UNCTAD International Policy Hub*.

Table 2 reports the descriptive statistics of the dependent and independent variables in the model specification. As shown in the table, there are no extreme values in the sample. It is worth mentioning that, in terms of the standard deviation compared to the mean value, the variation of the extensive margin is larger than that of the intensive margin of an enterprise's ODI. With respect to enterprises' financial constraints, there are large variations in *cashflow* and *liquidity* as well as *cis*, suggesting that enterprises face significantly different degrees of financial constraints.

4. Empirical analysis

4.1. Baseline estimation results

Potential endogeneity problems may exist due to reverse causality between financing constraints and ODI, as benefits (or loss) from ODI may alleviate (or worsen) domestic firms' credit constraints. According to Héricourt and Poncet (2009), incoming foreign investments in China play an important role in alleviating domestic firms' credit constraints. To handle the potential endogeneity problems, we use the two-stage least squares (2SLS) regression method with two alternative instrumental variables for financing constraints, namely the net cash flow generated from corporate financing activities (*netcashflow1*) and the net cash flow generated from investing activities (*netcashflow2*). The instrumental variables used are appropriate, as shown by the Wald tests on whether an instrument variable is exogenous and the F-tests on whether instrumental variables are weak.[3] In addition to the benchmark estimation, we also use fixed effects (FE) and random effects (RE) panel models. We obtain consistent results under the different estimation methods, suggesting the robustness of the results in the paper.

Table 3 reports the regression results of ODI's intensive and extensive margins. For the overall effects, as shown in columns (1) and (2), the estimated coefficients on both *cashflow* and *liquidity* are significant and positive, suggesting a negative effect of financing constraints on the intensive margin of ODI. Similarly, as shown in columns (3) and (4), the estimated coefficients on both *cashflow* and *liquidity* are also significant and positive, suggesting a negative effect of financing constraints on the extensive margin of ODI. The intuition is straightforward. When an enterprise is facing financing constraints, its ability to invest abroad is limited, leading to a smaller scale and narrower scope of ODI.

In addition to the 2SLS estimation, we conducted FE and RE regressions as robustness checks. The estimation results are reported in Tables A1 and A2 in the Appendix. The results are also robust under different estimation methods.

For the control variables, which are not entirely consistent with Chatterji and Montagna (2008); Helpman et al. (2004) and Tian and Yu (2015), firms' productivity has a significantly positive effect on the extensive margins of ODI, but a negative effect on the intensive margins of ODI. This provides more evidence for the 'self-selection' hypothesis that enterprises with higher productivity are more likely to carry out ODI projects, compared to the hypothesis that enterprises carry out ODI for productivity gains from 'going out' (Bernard and Jensen, 2004; Crespo and Fontoura, 2007). Additionally, firm size has similar effects to firm productivity on the binary margins of ODI, which is consistent with the new trade theory that firm-level economies of scale have comparative advantages for competition on the international market. Moreover, as expected, host countries' investment environments, such as GDP per capita and trade dependency, also have some effects on enterprises' investment behaviour.

[2] For details, see the CEPII database:http://www.cepii.fr/.

[3] In the 2SLS regressions, the F-value of the first stage estimation is greater than the critical value of 16.38 that Stock and Yogo (2005) set at the 10% significance level, suggesting no problem of weak instrumental variables, and thus the set of instrumental variables is appropriate.

Table 2
Descriptive statistics.

Variable	Indicators	Obs.	Mean	Std. dev.	Min	Max
Dependent variables						
Intensive	Log of intensive margin of an enterprise's ODI	803	6.092	1.002	4.605	9.622
Extensive	Extensive margin of an enterprise's ODI	803	1.067	0.320	1	4
Independent variables						
cashflow	Cash flow of an enterprise	803	0.046	0.050	−0.521	0.280
Liquidity	Liquidity of an enterprise	803	0.043	0.159	−0.503	0.849
tfp	Productivity of an enterprise	803	1.836	1.323	0.003	7.879
capital	Capital intensity of an enterprise	803	14.31	2.246	7.088	18.98
size	Size of an enterprise	803	9.993	2.158	3.045	13.22
Country-level control variables						
gdpper	GDP per capita of a host country	803	6.341	3.710	0.000	11.12
bit	Bilateral investment agreement	803	3.192	7.261	0	29
openness	Trade dependency of a host country	803	60.29	62.84	0.000	439.7
state	State-owned enterprises	803	0.712	0.453	0	1
energy	Energy industry	803	0.144	0.351	0	1
cis	A measurement of financing constraints	803	1.339	1.852	0.0385	41.47

Table 3
Estimation results of ODI's binary margins (2SLS).

	Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)
cashflow	9.804*		19.96*	
	(1.92)		(1.84)	
liquidity		8.382***		31.88**
		(2.80)		(2.40)
tfp	−0.0772***	−0.0791***	0.767***	0.191
	(-5.67)	(-3.20)	(4.38)	(0.30)
capital	0.100	0.106**	−0.185	2.680***
	(1.55)	(2.07)	(-0.73)	(2.78)
size	−0.0868***	−0.0896***	0.725***	−0.719
	(-3.19)	(-2.68)	(3.87)	(−1.17)
lgdpper	0.00731	0.00689	−0.112***	0.0117
	(0.45)	(0.46)	(−4.76)	(0.16)
bit	0.000102	0.0000926	−0.00485	−0.0555***
	(0.03)	(0.03)	(-0.55)	(-7.78)
open	−0.00184***	−0.00181***	0.00254***	0.00335
	(-7.04)	(-8.30)	(5.07)	(1.50)
_cons	5.623***	5.594***	−3.705	−29.20***
	(7.02)	(9.16)	(-0.95)	(-3.86)
industry	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes
Adjusted R^2	0.658	0.637	0.623	0.672
DWH Chi^2/F (p-value)	47.38 (0.00)	58.03 (0.00)	67.28 (0.00)	69.13 (0.00)
First stage F	34.59	43.26	44.29	33.16
N	518	518	518	437

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. T values or Z values are in parentheses. T or Z statistics are computed using robust standard errors clustered at the firm level (Wooldridge, 2002).

4.2. Further analysis

Based on the benchmark analysis, we conduct further analysis, considering the different characteristics of industries and ownership.

4.2.1. Differences between energy and non-energy industries

As previously mentioned, there are significant differences between the energy and non-energy industries. We thus conduct separate regressions for these industries, as well as interacting the financial variables with dummies.

Table 4 reports the estimation results for separate regressions. For the energy industry, as shown in columns (1) and (2), the estimated coefficients on both *cashflow* and *liquidity* are significant and positive, suggesting that the negative effects of financing constraints on the intensive margin of ODI are significant in the energy industry. However, for non-energy industries, as shown in columns (5) and (6), while the estimated coefficients on both *cashflow* and *liquidity* are positive, they are not significant, suggesting no

Table 4
Estimation results of separate regressions for the energy and non-energy industries.

	Sub-sample of the energy industry				Sub-sample of non-energy industries			
	Intensive margin		Extensive margin		Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
cashflow	2.526***		28.73***		2.760		18.13	
	(5.32)		(5.18)		(0.74)		(1.57)	
liquidity		3.302***		26.24**		0.479		19.57
		(4.82)		(2.49)		(0.59)		(1.64)
tfp	−0.106*	−0.264***	0.827**	0.822***	0.0162	−0.00748	0.882***	0.895**
	(-1.96)	(-4.35)	(2.45)	(10.47)	(0.29)	(-0.10)	(5.33)	(2.17)
capital	0.0500	−0.122	−0.0312	2.730***	−0.0622	0.00128	−0.387	1.560*
	(1.39)	(-0.66)	(-0.09)	(3.69)	(-0.84)	(0.02)	(-1.54)	(1.70)
size	−0.134***	−0.0169	1.090***	−0.765	0.0224	−0.0158	0.791***	−0.0958
	(-2.68)	(-0.19)	(3.19)	(-0.76)	(0.33)	(-0.25)	(4.23)	(-0.17)
lgdpper	0.0274***	0.0292***	−0.0520**	−0.0833	−0.00188	−0.00144	−0.119**	−0.000781
	(3.22)	(3.27)	(-2.03)	(-1.25)	(-0.08)	(-0.07)	(-2.18)	(-0.01)
bit	−0.00645	−0.00511	−0.00370	−0.0261***	0.00592	0.00483	0.000524	−0.0506**
	(-0.98)	(-0.58)	(-0.48)	(-3.18)	(1.52)	(1.34)	(0.12)	(-2.27)
open	−0.00194***	−0.00218***	0.00193	0.00546**	−0.00175***	−0.00160***	0.00155	0.00208
	(-11.01)	(-7.48)	(0.71)	(2.41)	(-2.66)	(-3.15)	(0.68)	(0.86)
_cons	6.677***	7.832***	−9.895	−29.91***	6.499***	6.127***	−2.354	−20.33***
	(8.87)	(4.20)	(-1.26)	(-5.28)	(11.82)	(12.83)	(-1.31)	(-3.02)
industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.658	0.637	0.623	0.672	0.523	0.427	0.503	0.627
DWH Chi^2/F (p-value)	47.38 (0.00)	58.03 (0.00)	67.28 (0.00)	69.13 (0.00)	47.82 (0.00)	59.42 (0.00)	45.12 (0.00)	39.42 (0.00)
First stage F	34.59	43.26	44.29	33.16	34.89	42.63	36.89	52.63
N	223	223	223	209	295	295	295	228

Notes: See the notes for Table 3.

significant effects of financing constraints on the intensive margin of non-energy industries' ODI. The significant difference between the effects on the energy and non-energy industries reflects the special feature of the energy industry in terms of ODI and financing mode. Energy projects are typically capital-intensive, large and lumpy and have long pay-back periods, and thus their financing is a difficult task. Therefore, the firm's financing constraints exert a negative impact on the energy ODI scale, as the intensive margin. Similarly, regarding the regression results on ODI's extensive margin, for the energy industry, the estimated coefficients on both *cashflow* and *liquidity*, as shown in columns (3) and (4), are significant and positive, suggesting a negative effect of financing constraints on the extensive margin of the energy industry's ODI. However, for the non-energy industry, as shown in columns (7) and (8), the estimated coefficients on both *cashflow* and *liquidity* are not significant, suggesting no significant effect of financing constraints on the extensive margin of non-energy industries' ODI.

In sum, financing constraints negatively affect the energy industry's ODI under both the intensive and extensive margins. However, the effects are not significant for non-energy industries. This significant difference reflects the special financing needs of the energy industry in terms of ODI and calls for special financing support for the energy industry's ODI. Considering the importance of energy ODI to the economy and safety, it is worth working out a special financing plan to support the energy industry's ODI.

Rather than estimating separate regressions for the energy and non-energy industries, Table 5 estimates a model on the full sample and interacts the financial variables with dummies for both industry categories. This method allows us to use more degrees of freedom and, more importantly, to test whether the coefficients on the financial variables in the energy and non-energy sectors are statistically different. As shown in columns (1) and (2), the coefficients on *energy*'s interactions with both *cashflow* and *liquidity* are significant and positive, while the coefficients on *cashflow* and *liquidity* themselves are still significant after introducing the interaction variables. This effect is also significant with respect to ODI's extensive margin, as shown in columns (3) and (4). The results suggest that financing constraints are a more significant obstacle for the energy industry's ODI, which is consistent with the results in the sub-sample analysis. What is even more interesting is that the coefficients on *energy* are all significant and positive. In sum, the results show that, while they are more willing to make ODI under both margins, enterprises in the energy industry are facing more severe financing constraints in doing so.

4.2.2. Considering ownership effects

From the analysis above, corporate financing constraints cause negative impacts on both the intensive and extensive margins of enterprises' ODI. This section further analyses ownership effects by introducing their interactions with financing constraints. The current financial system in China still shows suppressing characteristics. The banking system especially still exhibits 'ownership discrimination' in lending activities, meaning that private enterprises are less favoured by financial institutions, credit discrimination and credit rationing (Jie, 2012; Lin and Sun, 2008). As an important player in China's ODI, SOEs are often regarded as privileged in getting access to

Table 5
Estimation results of binary margins considering the energy industry effect.

	Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)
cashflow	5.235**		43.17**	
	(2.02)		(2.38)	
cashflow*energy	8.332**		44.60***	
	(2.45)		(4.43)	
liquidity		3.325*		32.51***
		(1.71)		(2.97)
liquidity*energy		5.137***		18.19***
		(4.28)		(3.51)
energy	0.352***	0.418***	2.728***	2.550***
	(2.90)	(5.87)	(5.56)	(2.80)
tfp	−0.0807***	−0.0674**	0.907***	0.574***
	(-3.70)	(-2.46)	(5.09)	(2.85)
capital	0.0457	0.00991	−0.256	1.884***
	(0.96)	(0.27)	(-1.00)	(2.90)
size	−0.0468*	−0.0277	0.814***	−0.209
	(-1.95)	(-0.96)	(6.77)	(-0.49)
lgdpper	0.00655	0.00579	−0.0964**	0.0116
	(0.41)	(0.37)	(-2.13)	(0.21)
bit	0.000187	0.000595	−0.00555	−0.0363**
	(0.05)	(0.16)	(-0.71)	(-2.57)
open	−0.00148***	−0.00151***	0.00198*	0.00184
	(-6.93)	(-7.26)	(1.73)	(0.90)
_cons	5.947***	6.194***	−5.218*	−24.39***
	(10.29)	(15.11)	(-1.86)	(-4.90)
industry	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes
Adjusted R^2	0.518	0.607	0.723	0.712
DWH Chi^2/F (p-value)	37.82 (0.100)	35.21 (0.100)	45.12 (0.097)	39.72 (0.092)
First stage F	34.89	44.89	33.13	32.68
N	518	518	518	437

Notes: See the notes for Table 3.

financing sources. Therefore, we introduce the interaction of a financing variable with *state*, a dummy variable for SOEs.

Table 6 reports the estimation results of ownership effects. As shown in columns (1) and (2), the coefficients on *state*'s interactions with both *cashflow* and *liquidity* are significant and positive, while the coefficients on *cashflow* and *liquidity* themselves are also significant after introducing the interaction variables. The results suggest that financing constraints are an obstacle for SOEs' ODI, which is, to some extent, contrary to their domestic performance. This effect is also significant with respect to ODI's extensive margin, as shown in columns (3) and (4). The results show that SOEs are facing financing constraints in foreign direct investment. Similar to the results in the baseline estimation, enterprises' productivity and size as well as host countries' investment environments, such as GDP per capita and trade dependency, also have a positive effect on the investment behaviour of enterprises.

We obtain consistent results when conducting separate regressions for SOEs and non-SOEs (Table 7). However, as there are only 68 observations in the sub-sample of non-SOEs, it is likely that the estimation results for the sub-sample are not as convincing. Therefore, with respect to the ownership effect, it is better to take the results in Table 6 as the benchmark.

5. Robustness checks

Here, we conduct robustness checks by using alternative measurements of financing constraints, employing alternative regression methods and addressing other concerns, such as the impact of the financial crisis. The main findings remain valid after all the robustness checks above, suggesting that the conclusions of the paper are robust.

5.1. Alternative measurements of financing constraints

Alternative measurements of financing constraints are mentioned in the literature. Selecting an appropriate indicator that can reflect enterprises' financing constraints is key to examining the effects of financing constraints on the margins of the energy industry's ODI. Following Ding et al. (2013), we construct an index of enterprises' working capital investment sensitivity (CIS), which is a more comprehensive proxy for financing constraints in that it includes information on an enterprise's cash flow, debt leverage, collateral and equity gains and losses. Estimates of the CIS index are made using the following procedures. First, we estimate a working capital investment equation without operating cash flow and obtain the stochastic error term. Second, we create a weighted average for the stochastic error term using the share of cash flow in total cash flow as weight and then subtract any stochastic error

Table 6
Estimation results of binary margins considering ownership effects.

	Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)
cashflow	13.77***		55.46***	
	(36.52)		(19.85)	
cashflow*state	14.30***		62.82***	
	(38.08)		(18.92)	
liquidity		3.005*		37.41**
		(1.66)		(-2.16)
liquidity*state		3.559**		44.54***
		(2.08)		(5.14)
state	1.169***	1.104***	1.515***	1.487***
	(3.76)	(3.71)	(2.76)	(2.85)
tfp	−0.0601**	−0.0970***	1.050***	1.495**
	(-2.47)	(-2.66)	(3.76)	(2.38)
capital	0.130*	0.138**	0.00604	0.393***
	(1.83)	(2.49)	(0.02)	(4.07)
size	−0.122***	−0.118***	0.364	1.000***
	(-3.92)	(-3.84)	(1.30)	(2.66)
lgdpper	0.0139	0.00648	−0.0189	0.115
	(1.14)	(0.48)	(-0.44)	(0.80)
bit	0.00252	−0.000310	0.0279**	−0.0457
	(0.47)	(-0.10)	(2.38)	(-1.19)
open	−0.00206***	−0.00175***	−0.00108	−0.00201
	(-4.31)	(-9.10)	(-0.23)	(-0.43)
_cons	3.948**	6.123***	−4.391	−31.12**
	(2.38)	(13.68)	(-1.50)	(-2.00)
industry	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes
Adjusted R^2	0.623	0.672	0.523	0.427
DWH Chi^2/F (p-value)	67.28 (0.00)	69.13 (0.00)	47.82 (0.00)	59.42 (0.00)
First stage F	44.29	33.16	34.89	42.63
N	518	518	518	437

Notes: See the notes for Table 3.

terms that are not weighted to obtain the financing constraint proxy variable. Considering the influence of other variables on the operating capital of an enterprise, the following equation is estimated:

$$\left(\frac{CI}{K}\right)_{it} = Q_{it} + \eta_{industry} + \eta_{owernship} + \varepsilon_{it} \tag{3}$$

where CI represents the working capital investment of an enterprise, that is, current assets minus current liabilities, K represents the net fixed capital of the enterprise at the beginning of each period, and i and t denote the enterprise and year, respectively. Control variable Q_{it} denotes enterprise-level variables, including size, debt leverage, long-term loans, and equity investment gains and losses, among others. The regression equation also includes the fixed effects of industry and year, and ε_{it} is the stochastic error term.

If an enterprise's working capital investment is not subject to cash flow, then there should be no significant differences between working capital investment over a higher or lower cash flow period. Consequently, we propose the following formula:

$$CIS_{ijt} = \sum_{i=1}^{n}\left(\frac{\left(\frac{CA}{K}\right)_{ijt}}{\sum_{t=1}^{n}\left(\frac{CA}{K}\right)_{ijt}} * \varepsilon_{ijt}\right) - \frac{1}{n}\sum_{t=1}^{n}\varepsilon_{ijt} \tag{4}$$

where *CA* represents the enterprise's cash flow, that is, the total net cash flow generated by business, financing and investment activities, and n represents the number of year observations for an enterprise.

Obviously, CIS may be a more comprehensive proxy that includes information on an enterprise's financing constraints including enterprises' cash flow, debt leverage, collateral, and equity gains and losses. Therefore, the enterprise's cash flow is the total amount of net cash flow generated by business, financing and investment activities. As a result, *netcashflow1* and *netcashflow2* significantly affect the variable of financial constraints. However, according to Jensen (1986), these two variables reflect the cash flows of domestic business and investment, which have no significant relationship with the scale and scope of enterprises' ODI.

Table 8 reports the regression results with CIS as the measurement of financing constraints. Consistent with the benchmark regression results in Table 3, the estimated coefficients on *cis* are significant and positive for both the intensive and extensive margins, suggesting a negative effect of financing constraints on both margins of the energy industry's ODI. The results are robust under different regression methods.

Table 7
Estimation results of binary margins considering ownership effects.

	Sub-sample of state-owned enterprises				Sub-sample of non-state-owned enterprises			
	Intensive margin		Extensive margin		Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
cashflow	1.276***		20.39*		1.530		4.791***	
	(3.12)		(1.76)		(0.52)		(5.29)	
liquidity		2.523**		43.27**		0.424		0.229***
		(2.29)		(2.21)		(0.54)		(4.39)
tfp	−0.0708***	−0.0784*	0.727***	0.678***	−0.0536**	−0.0651***	0.0420	0.0488
	(-3.36)	(-1.82)	(3.66)	(3.02)	(-2.01)	(-3.47)	(0.76)	(0.74)
capital	0.109	0.146**	−0.228	3.824**	0.0420	0.0752	0.147**	0.191***
	(1.61)	(2.24)	(-0.79)	(2.29)	(0.69)	(1.41)	(2.48)	(7.07)
size	−0.0962***	−0.119***	0.876***	−1.538	−0.129	−0.108*	−0.125***	−0.0243
	(-4.70)	(-2.73)	(4.23)	(-1.55)	(-1.54)	(-1.88)	(-3.50)	(-1.47)
lgdpper	0.0116	0.0128	−0.147***	−0.0167	−0.00786	−0.00801	−0.0293*	−0.0566***
	(0.61)	(0.70)	(-6.45)	(-0.21)	(-0.25)	(-0.24)	(-1.66)	(-7.66)
bit	0.0000322	−0.000121	−0.00494	−0.0852***	−0.00399	−0.00499	0.000831	0.00199
	(0.01)	(-0.04)	(-0.38)	(-3.24)	(-0.36)	(-0.52)	(0.20)	(0.28)
open	−0.00202***	−0.00199***	0.00370***	0.00696***	−0.00137	−0.00151*	0.00287***	0.00377***
	(-8.26)	(-10.90)	(5.41)	(3.89)	(-1.51)	(-1.68)	(3.18)	(14.93)
_cons	5.697***	5.440***	−4.703	−36.32***	6.389***	5.945***	−0.341	−1.385***
	(6.45)	(7.44)	(-1.02)	(-2.68)	(6.36)	(9.72)	(-0.70)	(-3.35)
industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.518	0.537	0.513	0.472	0.523	0.427	0.503	0.627
DWH Chi^2/F (p-value)	37.28 (0.00)	48.63 (0.00)	67.54 (0.00)	59.13 (0.00)	47.80 (0.00)	55.40 (0.00)	42.12 (0.00)	49.42 (0.00)
First stage F	44.59	33.22	34.21	33.17	44.89	32.63	46.90	50.63
N	450	450	450	394	68	68	68	43

Notes: See the notes for Table 3.

Table 8
Estimation results with a more comprehensive measurement of financing constraints (CIS).

	(1) 2SLS Intensive	(2) 2SLS Extensive	(3) FE Intensive	(4) FE Extensive	(5) RE Intensive	(6) RE Extensive
cis	0.427**	3.028***	1.543***	3.456***	0.0749***	1.187***
	(2.38)	(3.42)	(2.61)	(2.83)	(2.65)	(6.75)
tfp	−0.0466***	0.852***	−0.386	3.024***	−0.0761***	1.382***
	(-3.39)	(4.52)	(-0.66)	(3.59)	(-2.61)	(7.34)
capital	0.0625	0.592**	−0.287	−0.932	0.153*	−0.121
	(1.00)	(2.41)	(-0.66)	(-1.07)	(1.79)	(-0.95)
size	−0.0669*	0.607***	0.0573	5.908***	−0.111**	−0.205
	(-1.68)	(6.77)	(0.07)	(4.58)	(-2.54)	(-1.08)
lgdpper	0.0160	−0.0982***	1.847	1.471	0.0126	−0.0715
	(1.32)	(-6.77)	(1.15)	(0.66)	(0.95)	(-1.04)
bit	−0.000337	−0.0303***	0.0225	−0.0834	−0.00163	−0.0373
	(-0.11)	(-6.78)	(0.28)	(-0.46)	(-0.46)	(-1.52)
open	−0.00203***	0.00501***	0.00836	−0.0129	−0.00198***	0.00592
	(-16.56)	(6.41)	(0.87)	(-0.86)	(-8.83)	(1.28)
_cons	5.938***	−16.45***	−3.089	−54.88***	4.849***	5.779***
	(8.19)	(-5.32)	(-0.25)	(-2.59)	(4.50)	(4.66)
industry	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.658	0.637				
DWH Chi^2/F (p-value)	47.38 (0.00)	58.03 (0.00)				
First stage F	34.59	43.26				
N	437	437	437	634	437	634

Notes: See the notes for Table 3.

Table 9
Estimation results of the extensive margin using the Poisson Model (Poisson).

	(1) xtpoisson	(2) xtpoisson	(3) xtpoisson	(4) xtnbreg	(5) xtnbreg	(6) xtnbreg
cashflow	0.102***			0.342*		
	(3.18)			(1.79)		
liquidity		1.056***			1.392***	
		(3.13)			(3.47)	
cis			0.0931***			0.112***
			(3.06)			(6.30)
tfp	0.211***	0.175***	0.231***	0.332***	0.268***	0.359***
	(7.70)	(6.07)	(8.03)	(9.32)	(6.95)	(10.18)
capital	−0.0243	0.0585**	−0.0594***	0.0330	0.135***	−0.0146
	(-1.07)	(1.98)	(-2.70)	(1.22)	(3.52)	(-0.54)
size	−0.0149	−0.0563*	0.0111	−0.0969***	−0.141***	−0.0613*
	(-0.54)	(-1.90)	(0.39)	(-2.70)	(-3.91)	(-1.74)
lgdpper	−0.00739	−0.00436	−0.0161	−0.0117	−0.00739	−0.0213*
	(-0.65)	(-0.38)	(-1.29)	(-0.98)	(-0.62)	(-1.65)
bit	−0.00243	−0.00347	−0.000348	−0.00165	−0.00260	0.000741
	(-0.53)	(-0.76)	(-0.07)	(-0.39)	(-0.62)	(0.17)
open	0.000617	0.000740	0.000637	0.000998	0.000819	0.00116
	(0.79)	(1.02)	(0.75)	(1.28)	(1.06)	(1.48)
Pseudo R^2	0.402	0.510	0.530	0.412	0.502	0.408
_cons	1.693***	0.942***	2.094***	1.462***	0.473	1.895***
	(8.36)	(3.85)	(9.95)	(6.61)	(1.52)	(7.97)
industry	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes	Yes	Yes
lnalpha				−0.626***	−0.648***	−0.672***
				(-10.37)	(-10.90)	(-10.36)
N	715	715	634	715	715	634

Note: See the notes for Table 3.

5.2. Considering the Poisson distribution for ODI's extensive margin

With respect to the analysis of ODI's extensive margin, Wooldridge (2002) and Ramasamy et al. (2012) used Poisson or negative binomial models, as they assume the variable obeys a Poisson or negative binominal distribution, with the distribution function of ODI's extensive margin as follows:

$$f(y_{ijt}|x_{ijt},\ \nu_{ijt}) = \frac{e^{-\lambda_{ijt}\nu_{ijt}}(\lambda_{ijt}\nu_{ijt})^{y_{ijt}}}{y_{ijt}!} \tag{5}$$

where $\lambda_{ijt} = e^{X_{ijt}\beta}$, y_{ijt} is the number of industries in which enterprise i makes ODI in country j in year t, X_{ijt} is a vector of explanatory variables, and ν_{ijt} is a gamma distribution of the following form: $g(v) = \frac{v^{\frac{1-\alpha}{\alpha}}e^{-\frac{v}{\alpha}}}{\alpha^{\frac{1}{\alpha}}\Gamma\left(\frac{1}{\alpha}\right)}$. Of course, when $\alpha = 0$, the negative binominal model in Eq. (5) is equal to the Poisson model.

Referring to Wooldridge (2002) and Ramasamy et al. (2012), this section adopts the Poisson regression model for the empirical analysis of ODI's extensive margin for two reasons. First, the variation is 0.39 times the mean of the dependent variable (ODI extensive margin), and thus it is subject to an over-dispersion problem. Second, the dispersion parameter α is not significant in the negative binominal regression model, further verifying the rationale of using the Poisson regression.

As shown in Table 9, the estimation results are consistent with Table 3. The coefficients on both *cashflow* and *liquidity* are significant and positive, suggesting a negative effect of financing constraints on the extensive margin of ODI. The estimated results for the control variables are also consistent with Table 3.

6. Conclusions and implications

Using firm-level data, this paper examined the effects of financing constraints on enterprises' ODI from the perspective of ODI's binary margins. We explored the effects on both the intensive and extensive margins of ODI and compared these effects between SOEs and other enterprises, as well as between energy and other industries. Several conclusions can be drawn from the empirical analysis and robustness checks. First, financing constraints have a negative effect on enterprises' ODI for both the intensive and extensive margins, with the effect on the extensive margin being more significant. Second, the negative effect is mostly significant in the energy industry, while it is not significant in non-energy industries. Financing constraints have a negative effect on the energy industry's ODI for both the intensive and extensive margins. Third, financing constraints show a negative effect on SOEs for both margins, with the effect being less significant for non-SOEs. Financing constraints have a negative effect on SOEs' ODI for both the intensive and

extensive margins.

In sum, both the intensive and extensive margins of enterprises' ODI are negatively affected by financing constraints, especially for the energy industry and SOEs. One of the main reasons is that most energy ODI in China is conducted by SOEs due to China's special industrial structure. State-owned capital accounts for the largest portion of the Chinese domestic energy sector. Therefore, domestic energy investors are also the main participants in overseas energy investment. Additionally, overseas energy investment generally requires a high demand for capital, technology, market influence and risk tolerance, with most non-SOEs in China rarely able to compete with other overseas investors in these respects. Furthermore, the financial constraint measures are built on the idea of surplus profit (i.e. the sources of internal finance). In practice, the actual ODI relies heavily on bank loan support, among other things. In energy sectors and SOEs, acquirers with surplus profits are expected to obtain abundant domestic bank loan support, which explains our findings to some extent.

Our findings have two main policy implications for understanding and promoting ODI in emerging economies. First, measures should be taken to actively expand diversified financing channels to solve enterprises' financial constraints in making outward investments. To promote enterprises' ODI in the intensive and extensive margins, it is important to actively expand diversified financing channels, such as the development of venture investment funds and equity financing, to help enterprises achieve cross-border capital and reduce their reliance on bank loans. International cooperation mechanisms, including the *Belt and Road Initiatives* and the Asian Infrastructure Investment Bank, would be helpful in this respect. Moreover, China should make further progress in its financial reforms to improve financial markets and reduce the inhibitory effect of financing constraints on ODI.

Second, the findings of the paper suggest that, to a certain extent, SOEs are also restricted by financing constraints for energy outward investments. Due to the features of energy enterprises' ODI in that energy projects are typically capital-intensive, large, lumpy, and with long pay-back periods, financing constraints would restrict the expansion of the scope of energy enterprises' investments. This therefore calls for corresponding financial support, which may be conducive to gaining access to energy resources and help ensure energy security.

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Appendix A

Table A1
Estimation results of binary margins considering ownership effects (FE).

	Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)
cashflow	9.604***		17.13***	
	(3.35)		(2.79)	
liquidity		3.146**		9.404**
		(2.06)		(2.57)
tfp	−0.757**	−0.689*	0.782***	0.832***
	(-2.20)	(-1.67)	(3.45)	(2.66)
capital	0.177	0.201	0.611	0.567
	(0.58)	(0.67)	(0.90)	(0.79)
size	−0.942*	−0.775	1.389	1.772
	(-1.95)	(-1.40)	(1.21)	(1.54)
lgdpper	1.557	1.780	1.033	1.329
	(1.33)	(1.53)	(0.53)	(0.65)
bit	−0.0452	−0.0144	−0.282	−0.210
	(-0.69)	(-0.19)	(-1.48)	(-1.01)
open	0.00118	0.00345	−0.0198	−0.0164
	(0.12)	(0.38)	(-1.28)	(-1.00)
_cons	3.207	0.484	−24.25	−27.51
	(0.38)	(0.05)	(-1.26)	(-1.35)
industry	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes
N	518	518	715	715

Notes: T or Z values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% significance levels, respectively.

Table A2
Estimation results for the intensive margin (RE).

	Intensive margin		Extensive margin	
	(1)	(2)	(3)	(4)
cashflow	3.284***		8.069**	
	(2.85)		(2.39)	
liquidity		2.486***		4.485***
		(3.47)		(2.79)
tfp	−0.0820***	−0.0908***	1.176***	1.067***
	(-6.03)	(-5.08)	(6.86)	(5.90)
capital	0.114*	0.148**	−0.00507	0.374**
	(1.82)	(2.37)	(-0.04)	(2.38)
size	−0.0995***	−0.116***	−0.327*	−0.532***
	(-3.28)	(-3.21)	(-1.87)	(-2.86)
lgdpper	0.000148	0.00318	−0.0431	−0.0313
	(0.01)	(0.20)	(-0.69)	(-0.51)
bit	0.000686	0.0000815	−0.0349	−0.0378*
	(0.19)	(0.02)	(-1.51)	(-1.65)
open	−0.00183***	−0.00186***	0.00433	0.00443
	(-6.68)	(-6.37)	(1.03)	(1.07)
_cons	5.694***	5.350***	4.848***	1.708
	(7.12)	(7.53)	(4.16)	(1.20)
industry	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ownership	Yes	Yes	Yes	Yes
N	518	518	715	715

Notes: T or Z values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

References

Aghion, P., Askenazy, P., Berman, N., Cette, G., Eymard, L., 2012. Credit constraints and the cyclicality of R&D investment: evidence from France. J. Eur. Econ. Assoc. 10 (5), 1001–1024.
Beck, T., Maksimovic, V., Demirgüç-Kunt, A., 2003. Bank competition, financing obstacles, and access to credit. World Bank Policy Research Working Paper.
Bernard, A.B., Jensen, J.B., 2004. Why some firms export. Rev. Econ. Stat. 86 (2), 561–569.
Bernard, A.B., Jensen, J.B., Redding, S.J., Schott, P.K., 2009. The margins of US trade. Am. Econ. Rev. 99 (2), 487–493.
Buch, C.M., Kesternich, I., Lipponer, A., Schnitzer, M., 2014. Financial constraints and foreign direct investment: firm-level evidence. Rev. World Econ. 150 (2), 393–420.
Chatterji, M., Montagna, C., 2008. A note on export-platform foreign direct investment, training and absorptive capacity. J. Intl. Trade Econ. Dev 17 (2), 323–332.
Cheung, Y.W., Qian, X., 2009. Empirics of China's outward direct investment. Pac. Econ. Rev 14, 312–341.
Contessi, S., De Pace, P., 2012. Non-resiliency of foreign direct investment in the United States during the 2007–2009 financial crisis. Pac. Econ. Rev 17 (3), 368–390.
Costantini, M., Demetriades, P.O., James, G.A., Lee, K.C., 2013. Financial restraints and private investment: evidence from a nonstationary panel. Econ. Inq. 51 (1), 248–259.
Crespo, N., Fontoura, M.P., 2007. Determinant factors of FDI spillovers—what do we really know? World Dev. 35 (3), 410–425.
Desbordes, R., Vicard, V., 2009. Foreign direct investment and bilateral investment treaties: an international political perspective. J. Comp. Econ. 37 (3), 372–386.
Ding, S., Guariglia, A., Knight, J., 2013. Investment and financing constraints in China: does working capital management make a difference? J. Bank. Financ. 37 (5), 1490–1507.
Ekholm, T., Ghoddusi, H., Krey, V., Riahi, K., 2013. The effect of financial constraints on energy-climate scenarios. Energy Policy 59, 562–572.
Gaiotti, E., 2013. Credit availability and investment: lessons from the 'great recession'. Eur. Econ. Rev. 59, 212–227.
Gelos, R.G., Werner, A.M., 2002. Financial liberalization, credit constraints, and collateral: investment in the Mexican manufacturing sector. J. Dev. Econ. 67 (1), 1–27.
Günçavdı, Ö., Bleaney, M., McKay, A., 1998. Financial liberalisation and private investment: evidence from Turkey. J. Dev. Econ. 57 (2), 443–455.
Harris, J.R., Schiantarelli, F., Siregar, M.G., 1994. The effect of financial liberalization on the capital structure and investment decisions of Indonesian manufacturing establishments. World Bank Econ. Rev. 8 (1), 17–47.
Helpman, E., Melitz, M.J., Yeaple, S.R., 2004. Export versus FDI with heterogeneous firms. Am. Econ. Rev. 94, 300–316.
Héricourt, J., Poncet, S., 2009. FDI and credit constraints: firm-level evidence from China. Econ. Syst 33 (1), 1–21.
Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance, and takeovers. Am. Econ. Rev. 76 (2), 323–329.
Jie, Z., 2012. The financing constraints, financing channels and enterprise R&D input (in Chinese). J. World Econ. Res. 10, 66–90.
Keuschnigg, C., 2008. Exports, foreign direct investment, and the costs of corporate taxation. Intl. Tax Publ. Financ 15 (4), 460–477.
Levinsohn, J., Petrin, A., 2003. Estimating production functions using inputs to control unobservables. Rev. Econ. Stud. 70, 317–341.
Lin, Y., Sun, X., 2008. Banking structure and economic growth: evidence from chinese provincial panel data. Econ. Res. J. 9 (3), 31–45.
Liu, H., Nie, F., 2015. Empirical study about the motive and bidirectional technical spillovers of China's OFDI based on intensive margin and extensive margin. World Econ. Stud 6, 102–110.
McKinnon, R.I., 1973. Money and Capital in Economic Development. Brookings Institution Press, Washington, D.C.
Melitz, M.J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71 (6), 1695–1725.
Melitz, M.J., Polanec, S., 2015. Dynamic Olley–Pakes productivity decomposition with entry and exit. Rand J. Econ. 46 (2), 362–375.
Melitz, M.J., Redding, S.J., 2012. Heterogeneous firms and trade (No. w18652). Bur. Econ. Res. Bull. Aging Health.
Minetti, R., Zhu, S.C., 2011. Credit constraints and firm export: microeconomic evidence from Italy. J. Intl. Econ 83 (2), 109–125.
Neumayer, E., Spess, L., 2005. Do bilateral investment treaties increase foreign direct investment to developing countries. World Dev. 33 (10), 1567–1585.
O'Toole, C.M., 2012. Does financial liberalisation improve access to investment finance in developing countries? J. Glob. Dev 5 (1), 41–74.
Ramasamy, B., Yeung, M., Laforet, S., 2012. China's outward foreign direct investment: location choice and firm ownership. J. World Bus 47 (1), 17–25.
Shaw, A.S., 1973. Financial Deepening in Economic Development. Oxford University Press, New York.

Stock, J.H., Yogo, M., 2005. Testing for weak instruments in linear IV regression. NBER Tech. Work. Pap 14 (1), 80–108.
Sui, Y., 2010. Dual outward foreign direct investment and trade structure: theory and evidence from China (in Chinese). Intl. Bus 6, 66–73.
The Heritage Foundation, 2015. China Global Investment Tracker. http://www.columnfivemedia.com.
Tian, W., Yu, M., 2015. Distribution outward FDI and productivity heterogeneity: evidence from Chinese firms. CCER Working Paper.
Wang, X., Huang, Y., 2012. Outward direct investment: a financial repression perspective. In: Paper Presented at the International Workshop on 'Understanding Chinese Outward Direct Investment'. 11 November 2012, Peking University, Beijing.
Wang, B., Tan, Y., Yu, M., Huang, Y., 2016. Outward direct investment, firm productivity and credit constraints: evidence from Chinese firms. Pac. Econ. Rev 21 (1), 72–83.
Wooldridge, J.M., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press, Cambridge, MA.
Yildiz, Ö., 2014. Financing renewable energy infrastructures via financial citizen participation–the case of Germany. Renew. Energy 68, 677–685.
Zhou, W., Zhu, B., Fuss, S., Szolgayová, J., Obersteiner, M., Fei, W., 2010. Uncertainty modeling of CCS investment strategy in China's power sector. Appl. Energy 87 (7), 2392–2400.