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The impact of bank interest rate deregulations on firm exports: Evidence from China

Guangya Sun [a], Yaping Sun [b,*], Jing Guo [c]

[a] Shantou University, School of Business, No.5 Cuifeng Road, Chenghai District, Shantou City, Guangdong Province, 515800, China
[b] Zhejiang University of Finance and Economics, School of Economics, No.18, Xueyuan Street, Xiasha Higher Education Park, Hangzhou City, Zhejiang Province, 310018, China
[c] Nanjing Audit University, School of Statistics and Data Science, 86 West Yushan Road, Pukou District, Nanjing city, Jiangsu Province, 211815, China

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ABSTRACT

We exploit a quasi-natural experiment in China, where the deregulation of bank interest rates in 2013 increased the availability of bank credit, to identify the impact of credit constraints on firm exports. Using a difference-in-differences estimation strategy, we find that firms experienced significant increases in export values post-2013 compared to prior years. We also show that credit constraints are an important pathway from the deregulation of bank interest rates to export values growth. To isolate the export-specific effects of the deregulation, we analyze its impact on the intensive and extensive margins of exports. Our findings indicate that firms increased their export values within existing country-product markets, diversified their product ranges, and entered additional foreign markets following the deregulation. These results suggest that firms faced financing constraints on both fixed and variable export costs, as evidenced by the changes in intensive and extensive margins.

1. Introduction

Access to sufficient external funding is crucial for enterprises to enhance their export trade. Consequently, extensive research has focused on the impact of financial frictions on export performance (Chor and Manova, 2012; Manova et al., 2015; Muuls, 2015). However, the external financing environment for Chinese enterprises remains suboptimal. According to the World Bank's 2020 Business Environment Report, China ranks 80th out of 190 economies in terms of external financing ease, indicating a significant gap compared to developed countries like the United States, New Zealand, and Australia. The 2017 Chinese Business Operator Questionnaire Tracking Survey Report revealed that 31.7 % of business operators identify high financing constraints and limited funds as primary operational challenges, highlighting the severe financing difficulties faced by many small and medium-sized private enterprises. The developmental contributions of these enterprises are not proportionate to the support provided by the formal financial system.

The Chinese financial system is characterized by a distinct dual financial structure, marked by the parallel development of both formal and informal markets. As a prototypical bank-led financial system, bank loans account for 70 % of total social financing, serving

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* Corresponding author.
E-mail address: 1872616965@qq.com (Y. Sun).

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as the primary channel for corporate funding. Within this framework, dominated by state-owned banks and regulated interest rates, large financial institutions typically extend credit to large enterprises. Consequently, small and medium-sized private enterprises face significant challenges in accessing bank credit resources (Gertler and Gilchrist, 1994; Brandt et al., 2003; Guiso et al., 2004; Borisova and Megginson, 2011; Gou et al., 2018; Manova et al., 2015). Given ongoing financial system reforms, an important question arises: Are small and medium-sized private enterprises now more likely to secure bank loans? Additionally, how might these reforms impact their export behavior?

We investigate the impact of credit constraints on firm exports by leveraging a natural experiment in China, where the deregulation of bank interest rates in 2013 increased bank credit availability. These deregulations were not aimed at specific banking sector or real economy objectives (Qian et al., 2015) and were not influenced by firm export activities or other firm-specific characteristics. Thus, the deregulation of bank interest rates was exogenous to firm trade, providing a unique analytical opportunity. Using a panel dataset of listed firms from 2010 to 2016, we employ a difference-in-differences methodology to compare the performance of state-owned and private firms (large and small firms) before and after the deregulation. This approach controls for nationwide economic shocks or policy changes by incorporating firm and year fixed effects. We also conduct various robustness checks to address potential confounding factors.

Our analysis reveals a significant increase in export values for private firms (small firms) in the post-2013 period relative to 2010–2012. An event analysis indicates that, prior to 2013, export values for state-owned and private firms (both large and small) exhibited similar trends. However, between 2013 and 2016, there was a pronounced increase in the export values of private firms (small firms). Robustness checks demonstrate that these findings are not driven by confounding factors. This robustness is ensured with alternative datasets, the application of alternative model specifications, the exclusion of state-owned enterprises, the removal of extreme export values, the including foreign-owned firms, the excluding interference from other policies and sample selection bias. Exploring the pathway from the deregulation of bank interest rates to export values growth, private (small) firms experience a greater reduction in credit constraints.

We further assess the impact of bank interest rate deregulation on different trade margins. We find that financial friction from bank interest rate regulations restricts exporters' value within the country-product market, product scope, the number of destinations, and the number of destination-product markets. These results indicate that firms face credit constraints in the financing of both fixed and variable trade costs, since the former affect market entry while the latter influence the scale of export. The evidence on firms' intensive and extensive margins also indicates how exporters would respond to financial reforms, especially those related to the supply of credit.

This study builds upon a conceptual framework that synthesizes two strands of literature. The first investigates the role of credit constraints in trade, demonstrating that financial market development enhances international competitiveness by easing firms' liquidity constraints (Beck, 2002; Matsuyama, 2005; Svaleryd and Vlachos, 2005; Ju and Wei, 2011; Chaney, 2016). The second examines the effects of banking deregulation, with prior research assessing its impact on bank competition, firm entry and exit, size distribution, and lending patterns (Black and Strahan, 2002; Zarutskie, 2006; Rice and Strahan, 2010). Bertrand et al. (2007) analyze how deregulation influences firms' real economic activities and industry structure, while Cornaggia et al. (2015) investigate its effect on innovation through changes in interstate bank branching laws. Liu et al. (2021) provide empirical evidence that interest rate liberalization improves intra-sectoral capital allocation but worsens cross-sectoral misallocations. Despite these advancements, research on how banking deregulations influence firms' export behavior remains scarce. By integrating these perspectives, this study contributes to the literature by examining how macro-level financial reforms shape micro-level firm behavior, yielding important policy implications for regulators, investors, and financial institutions.

Credit constraints are proxied by the implementation of interest rate liberalization, leveraging a natural experiment in China—the deregulation of bank lending rates in 2013—to establish a causal link between credit constraints and export performance. Berman and Hericourt (2010) examined the effect of financial development on firms' export decisions and volumes using the ratio of total debt or cash flow to total assets, while Minetti and Zhu (2011) employed firm-specific credit rationing measures derived from survey responses to estimate its impact on exports. Similarly, Muuls (2015) constructed a dataset integrating firm-level trade transactions, balance sheets, and credit scores to analyze the interaction between credit constraints and trading behavior. However, these studies often grapple with endogeneity and measurement issues. The impact of interest rate deregulation on firms' export activities is particularly pronounced in China, where the financial system remains predominantly bank-centric (Allen et al., 2005), and the country consistently ranks as the world's largest exporter. According to Allen et al. (2005), China's banking sector not only surpasses its stock market in scale but also exerts a greater influence relative to capital markets than in other countries under their study, including economies with historically strong banking sectors such as Germany. As a result, regulatory shifts in China's banking sector tend to induce more pronounced effects on corporate behavior than in economies where capital markets play a dominant role. Consequently, the deregulation of bank lending rates constitutes an exogenous shock to firms' export behavior, providing a unique empirical setting for this analysis.

Drawing on the comprehensive datasets from the China Stock Market & Accounting Research (CSMAR) database and the Chinese General Administration of Customs, this study examines the export behavior of private (small) firms versus state-owned (large) firms in the post-2013 period relative to 2010–2012. Since credit market frictions and financial constraints exert a disproportionately adverse impact on private and small firms (Acharya and Xu, 2017; Aiello et al., 2024), these firms not only encounter more severe information asymmetries with financial intermediaries but also exhibit greater risk aversion and a more limited diversification of funding sources compared to state-owned and large firms. Accordingly, the classification criteria for the treatment and control groups in this study facilitate a rigorous assessment of the nexus between credit constraints and export performance.

The structure of this paper is as follows. Section 2 offers an overview of the evolution of bank interest rate deregulation alongside the theoretical underpinnings. Section 3 details the empirical strategy, including data sources and summary statistics. Section 4

examines the results of export performance estimations. Section 5 discusses the results of credit constraints estimations. Section 6 explores the impact on different trade margins, imports and risk. Section 7 provides the conclusions and policy implications.

2. Institutional and theoretical background

2.1. Institutional background

Government regulation of interest rates can significantly deviate from market equilibrium, leading to inefficient fund allocation and distorted behavior among financial institutions and enterprises. To mitigate financial risks and ensure the stability of the financial system, China has initiated gradual reforms towards interest rate marketization. The primary goal is to set interest rates according to market supply and demand, thereby guiding capital flows, optimizing resource allocation, and promoting sustainable economic growth.

The strategic framework for interest rate marketization was established at the Third Plenary Session of the 14th Central Committee of the Communist Party of China in 1993. In 2004, substantial progress was made as China began to relax the upper limit on loan interest rates and broaden the floating range for these rates. By July 2013, the lower limit of 0.7 times the benchmark loan interest rate was removed, allowing financial institutions to independently set loan interest rates. This marked the comprehensive relaxation of loan interest rate controls by financial institutions.

The series of reform measures not only heightens the market sensitivity of interest rates, thereby promoting a more effective allocation of financial resources as noted by Song et al. (2011), but also reduces governmental regulatory costs and curtails corporate rent-seeking, significantly alleviating the credit constraints of small to medium-sized private enterprises. Notably, after the deregulation of the lower bounds of loan interest rates, financial institutions have provided enhanced credit support to high-quality firms (Chen et al., 2019). In summary, the market-oriented interest rate reforms have strengthened the efficiency and vibrancy of the financial sector by decentralizing interest rate control mechanisms, significantly impacting the operational dynamics of Chinese businesses.

2.2. Theoretical background

An ideal capital market eliminates credit frictions, meaning there is no distinction between the costs of internal and external financing for firms (Modigliani and Miller, 1958). However, real-world capital markets are inherently imperfect, with credit frictions leading to higher costs for external financing relative to internally generated funds (Greenwald et al., 1984; Stewart and Nicholas, 1984). One such friction results from government interventions, such as regulated interest rates. For instance, prior to interest rate deregulation, small private firms faced significant challenges in securing bank loans due to banks' inability to adjust rates in response to higher perceived risks. Conversely, large state-owned firms were discouraged from borrowing, viewing interest rates as excessively high relative to their creditworthiness.

In this context, banks face the inherent trade-off between loan yields and associated risks, as pursuing higher-yield projects invariably entails greater risk exposure. Guided by modern portfolio theory (Markowitz, 1991), banks typically diversify their portfolios by blending high-risk and low-risk borrowers, thereby optimizing returns while mitigating risks (Tirole, 2010). Before the deregulation of interest rates, commercial banks operated under the constraints of central bank-mandated benchmark rates, which imposed ceilings and floors on interest rates, thereby limiting their autonomy in pricing loans. This lack of flexibility in adjusting rates based on borrower risk effectively restricted banks from engaging in potentially high-yield, high-risk projects.

However, following the liberalization of interest rates, heightened competition among banks eroded their pricing power, compressing profit margins. In response, banks have adopted strategies to offset profit losses, such as relaxing lending standards and collateral requirements (Ayyagari et al., 2011), broadening the scale and scope of their loan portfolios, and improving corporate access to credit (Love and Peria, 2015). At the same time, intensified competition has incentivized banks to restructure their credit portfolios, increasing allocations toward long-term and higher-risk loans (Jimenez et al., 2014). This strategic shift reflects a growing risk appetite, as banks exhibit greater tolerance for "high-risk-high-return" projects, thus enhancing access to credit for such ventures (Obstfeld, 1992).

Moreover, existing research underscores that private and smaller enterprises, under similar conditions, often encounter greater financing challenges, including smaller loan amounts, shorter loan terms, and additional costs tied to relationship-based lending (Gertler and Gilchrist, 1994; Brandt et al., 2003; Guisoet al., 2004; Borisova and Megginson, 2011; Gou et al., 2018; Manova et al., 2015).

With the liberalization of interest rates, banks are no longer constrained by regulatory limits on rate setting, enabling interest rates to more accurately reflect firms' credit risks and thereby mitigate credit constraints by aligning rates with risk profiles more effectively (Wu et al., 2024). The removal of the interest rate floor further allows banks to extend loans at lower rates to state-owned (large) firms, which, due to their strong bargaining power, gain increased access to diverse lending institutions, intensifying competition within the banking sector (Barajas et al., 2000). Consequently, banks are increasingly targeting private (small) firms for high-yield, high-risk projects, creating enhanced financing opportunities for these smaller, private enterprises. Hence, we propose the following hypothesis:

Proposition 1. Following the deregulation of interest rates, private (small) firms tend to experience a more substantial increase in access to bank financing or a more pronounced alleviation of credit constraints relative to state-owned (large) enterprises.

International trade fundamentally depends on routine access to external financing, with the efficiency of financial institutions

playing a pivotal role in facilitating global exchanges of goods and services. Exporting firms often encounter substantial initial costs, rendering credit constraints a critical impediment to their trade activities (Manova, 2013; Muuls, 2015; Konte and Ndubuisi, 2021). The reliance of exporters on external financing arises from three primary considerations (Feenstra et al., 2014). First, entering foreign markets involves significant fixed costs, including market research, establishing, and maintaining overseas distribution channels. Moreover, variable costs, such as transportation, customs, and freight insurance, add to the financial burden. Second, the extended lead time required for the international transportation and delivery of goods heightens the demand for working capital. Third, the elevated risks inherent in international trade necessitate additional investments in trade insurance.

Credit constraints obstruct firms' ability to meet both fixed and variable costs associated with exporting. Frictions in financing variable costs distort the intensive margin, reducing the value of firm sales in specific markets or product lines, whereas frictions in financing fixed costs constrain the extensive margin by limiting the number of export destinations and product diversity. As previously noted, the deregulation of interest rates often enhances private and small firms' access to commercial bank loans. Therefore, it is reasonable to expect that these firms will exhibit improved export performance in the aftermath of deregulation. Based on this reasoning, we formulate the following hypotheses:

Proposition 2. Private (small) firms experience a significantly greater increase in export value than state-owned (large) firms following the deregulation of interest rates.

Proposition 3. Private (small) firms exhibit a significantly larger improvement in the intensive margin of exports compared to state-owned (large) firms after the deregulation of interest rates.

Proposition 4. Private (small) firms demonstrate a significantly greater expansion in the extensive margin of exports than state-owned (large) firms following the deregulation of interest rates.

3. Empirical strategy and data

3.1. Empirical specifications

To empirically investigate the impact of bank interest rate deregulation on firm exports, we estimate the following benchmark specification:

$$Export_{it} = \alpha + \beta \times (treat_i \times post_t) + \gamma \times X_{it} + \delta_i + \varphi_t + \varepsilon_{it} \quad (1)$$

where $Export_{it}$ denotes the natural logarithm of firm i's export value in year t, aggregated across both destinations and products. We utilize two distinct measures of $treat_i$ to categorize the intensity of credit constraints: $treat_{i,1}$ and $treat_{i,2}$. The first measure, $treat_{i,1}$, is a binary variable indicating ownership, set to 1 for private firms and 0 for state-owned firms. The second measure, $treat_{i,2}$, classifies firms by size, with 1 assigned to small firms (those below the median size of the sample) and 0 to large firms (those above the median). The variable $post_t$ is a binary indicator set to 1 for the years 2013 and onwards, and 0 for earlier years. The coefficient β, representing the interaction between $treat_i$ and the post-2013 dummy, captures the differential impact of bank interest rate deregulation on private

Table 1
Systematic differences of firm characteristics.

Panel A					
	State-owned firms		Private firms		Mean-differences
Variables	Mean	SD	Mean	SD	
Bdsize	2.8410	0.0149	2.1092	0.0106	−0.7318***
Indsize	0.5617	0.0291	0.3028	0.0210	−0.2589***
Wsame	0.3718	0.0224	0.1972	0.0137	−0.1746***
Industry1	0.3579	0.0561	0.6421	0.0719	0.2841***
Industry2	0.2480	0.0617	0.7520	0.0891	0.5040***
Pgdp	10.2067	0.1792	10.4101	0.1801	0.2034
Panel B					
	Large firms		Small firms		Mean-differences
Variables	Mean	SD	Mean	SD	
Bdsize	3.2010	0.0167	2.4618	0.0128	−0.7392***
Indsize	0.6305	0.0310	0.4291	0.0171	−0.2014***
Wsame	0.4002	0.0320	0.2891	0.0207	−0.1111***
Industry1	0.2044	0.0532	0.7956	0.0673	0.5912***
Industry2	0.2318	0.0621	0.7682	0.0707	0.5364***
Pgdp	10.7192	0.1971	10.2911	0.1761	0.4281

Notes: This table presents the systematic differences of firm characteristics in this study. The data were derived from the China Stock Market & Accounting Research (CSMAR) database and Chinese custom data.

versus state-owned firms (small versus large firms), with the hypothesis predicting a positive β.

The firm characteristics of the treatment group (private enterprises/small enterprises) and the control group (state-owned enterprises/large enterprises) may exhibit significant heterogeneity in aspects such as management practices, industry distribution, and regional economic conditions. To account for these potential disparities, we first compare key firm-level characteristics, including board size (Boardsize, measured as the logarithm of the number of directors), the proportion of independent directors (Indsize, defined as the ratio of independent directors to total directors), and whether the roles of chairman and general manager are combined (Wsame). Additionally, we examine industry classification—whether the firm operates in the primary sector (Industry1) or the secondary sector (Industry2)—as well as the economic development level of the city in which the firm is located (Pgdp, proxied by the logarithm of per capita GDP). The results, presented in Table 1, reveal significant differences in several firm characteristics (Boardsize, Indsize, Wsame, Industry1, Industry2) between the treatment and control groups. To mitigate potential biases arising from these systematic differences, we incorporate these firm-level characteristics into regression model (1) as control variables.

Building on prior studies, including Ding et al. (2018) and Fan et al. (2015), our model integrates key firm-specific attributes, denoted as X_{it}. These attributes encompass total factor productivity (TFP), estimated via the Levinsohn and Petrin (2003) approach using input-output data; capital intensity (CI), measured as the ratio of total assets to total revenue; firm size (FZ), proxied by the logarithm of total revenue; foreign investment ratio (FIR), defined as the share of foreign-held capital relative to total equity; leverage ratio (LR), calculated as total liabilities divided by total assets; ownership concentration, represented by the proportion of shares held by the top 10 shareholders (T10); return on assets (ROA), expressed as net income over total assets; board size (Bdsize); the proportion of independent directors (Indsize); dual leadership structure (Wsame), indicating whether the chairman and general manager roles are combined; and industry classification dummies, including primary industry (Industry1) and secondary industry (Industry2).

The vector δ_i represents firm-specific fixed effects, controlling for firm-specific time-invariant factors such as managerial ability and connections that may affect a firm's exports. Thus, the identification of β relies on firms recorded in the sample at least once before and after 2013, a strategy that mitigates biases from firm entry and exit. The vector φ_t comprises a complete set of year fixed effects to control for nationwide economic shocks or uniform policy impacts, such as changes in monetary policy.

3.2. Data sources

In this study, we integrate data from two distinct sources to explore the impact of credit constraints on the export behaviors of firms. The primary dataset comes from the China Stock Market & Accounting Research (CSMAR) database, which provides comprehensive financial and accounting details for all listed Chinese companies. Our secondary dataset is sourced from the Chinese General Administration of Customs, which includes exhaustive records of Chinese import and export transactions at the highly detailed 8-digit HS product level, spanning the years 2000 to 2021. Each record in this customs dataset includes data on the value and quantity of imports or exports, measurement units, product descriptions, origin or destination countries, and specific firm details such as names, ownership structures, and contact information.

This paper employs a combination of fuzzy matching and manual verification to align enterprise names from listed companies with those recorded in customs data. The procedure involves two primary steps: initially, we conduct an annual fuzzy match between the names of listed companies and those in the customs database, retaining matches with a score of 1. For matches scoring below 1, manual verification is undertaken. This verification considers factors such as the enterprise's city, postal code, legal representative, telephone number, and the relevance of the export product to the listed company's operations. Our analysis is confined to domestic private and state-owned enterprises. Foreign-owned firms are excluded due to their ambiguous interactions within the Chinese capital market and potential resource allocation biases that local banks may exhibit towards them, as highlighted by Manova et al. (2015). This exclusion is intended to mitigate estimation biases.

We have applied several filters to refine our sample. First, we exclude financial and insurance firms due to their distinct economic characteristics. Second, to ensure a robust comparison, we include only firms with data available for both the pre- and post-event

Table 2
Summary statistics of firm characteristics.

Variables	N	Mean	SD	Minimum	Maximum
Export	6300	17.7890	2.5156	3.5326	24.2270
TFP	6300	8.4733	1.0127	5.5385	12.3285
CI	6300	2.1040	1.6275	0.1314	36.1188
size	6300	21.2740	1.3903	17.6159	27.5900
FIR	6300	0.0070	0.0421	0.0000	0.6975
LR	6300	0.4070	0.2191	0.0075	2.8610
T10	6300	0.4496	0.2014	0.1009	0.9849
ROA	6300	0.0368	0.0942	−3.9944	2.6372
Bdsize	6300	2.1567	0.2004	1.5261	2.7812
Indsize	6300	0.3671	0.0534	0.0921	0.5681
Same	6300	0.2341	0.3971	0	1
Industry1	6300	0.0672	0.0961	0	1
Industry2	6300	0.6512	0.1821	0	1

Notes: This table presents the summary statistics for the main variables in this study. The data were derived from the China Stock Market & Accounting Research (CSMAR) database and Chinese custom data.

periods, excluding those with incomplete data. Third, we exclude firms lacking comprehensive accounting records from the CSMAR database. After applying these filters, our matched sample comprises 6317 observations. The sample covers the period from 2010 to 2016 for two main reasons: post-2016, the customs database does not provide comprehensive company name information; and the extensive literature documents the significant impact of the 2007–2009 financial crisis on firms' export behaviors, which informs our period selection (Paravisini et al., 2015; Bricongne et al., 2012; Bolton et al., 2011). Additionally, since all variables in the original databases are in nominal terms, we deflate the primary variables using the price index to obtain real values, standardized to 2010. To align the export values (in U.S. dollars) in the Chinese customs database with variables like total assets and total revenue (in RMB) in the CSMAR database, we use exchange rate data from 2010 to 2016 for adjustment. Table 2 presents the summary statistics of the characteristics of the firms included in the study.

Subsequently, we examine the variations in borrowing levels before and after interest rate deregulation across different firms. Table 3 presents summary statistics of borrowing amounts among firms for each year within the sample period. Columns (1) and (2) display the averages of the natural logarithms of borrowings for state-owned and private firms in year *t*, respectively. Notably, state-owned firms consistently show higher borrowing amounts than private firms, suggesting less severe credit constraints for state-owned entities. This observation aligns with the existing finance literature, which indicates that state-owned firms often face fewer credit barriers than private firms (Brandt et al., 2003; Borisova and Megginson, 2011; Gou et al., 2018). Column (3) outlines the differential between columns (1) and (2). This differential widened between 2010 and 2012 but showed a decreasing trend post-2013, signifying a narrowing of the credit constraints gap between state-owned and private firms following the deregulation of bank interest rates. Borrowing patterns between large and small firms exhibited similar trends, consistent with the literature suggesting that smaller firms typically face greater credit constraints compared to larger ones (Gertler and Gilchrist, 1994; Guiso et al., 2004; Manova et al., 2015).

Table 4 shows the size of controlling and treated groups. It can be seen that the number of state-owned enterprises is smaller than that of private enterprises every year. The number of state-owned and private enterprises varies little from year to year. Because of the median division used by large and small businesses, the sample size is the same for both.

4. The effect of bank interest rate deregulations on firm export

4.1. Regressive analysis

Our study examines the effects of deregulating bank interest rates on firms' export performance, as specified in Specification (1). Results presented in Table 5, columns (1) and (2), illustrate the impact of deregulation on the export performance of state-owned and private firms. Specifically, column (2) shows that the interaction term $treat_{i,1} \times post_t$ is positively correlated with export performance and statistically significant, indicating that private firms exhibit greater export growth compared to their state-owned counterparts in the post-deregulation period. Economically, the coefficient estimates suggest a 17.81 % increase in the export value of private firms following deregulation, as shown in column (2).

Furthermore, the effects of deregulation on firms of different sizes are analyzed in columns (3) and (4). In column (4), the interaction term $treat_{i,2} \times post_t$ is positive and statistically significant, suggesting that deregulation disproportionately enhances the export growth of small firms relative to large firms. The coefficient estimates suggest a 16.02 % increase in small firms' export value post-deregulation, as reported in column (4). This evidence provides support for Proposition 2, underscoring the heterogeneous impacts of interest rate deregulation based on firm size and ownership structure.

4.2. Event analysis

Although the difference-in-differences method addresses numerous identification challenges, there remains a risk of bias if intensely treated firms exhibit non-linear differential time trends. To confirm the parallel nature of these trends prior to the intervention and to align the observed effects with the timeline of the bank interest rate deregulation policy, we analyzed event study graphs from Eq. (2). These graphs illustrate the differential impacts on various firm categories (state-owned vs. private; large vs. small) on an annual basis. Following the methodology proposed by Che and Zhang (2018), our initial analysis focuses on the varied effects of the bank interest rate deregulation policy across different firms, using the year 2012 as the benchmark.

$$Export_{it} = \alpha + \sum_{t=2010}^{2016} \beta_t \times (treat_i \times dumyear_t) + \gamma \times X_{it} + \delta_i + \varphi_t + \varepsilon_{it} \tag{2}$$

Where, the term $dumyear_t$ represents a year-specific dummy variable. All other variables consistent with those specified in Eq. (1). The graph displays the coefficients β_t. We anticipate that β_t will not significantly differ from zero prior to the bank interest rate deregulation policy, suggesting that the pre-trends are parallel.

Fig. 1 presents the event study results for specification (2). Panels A and B illustrate the effects using the variables $treat_{i,1}$ and $treat_{i,2}$, respectively. This visual representation is essential for assessing the impact of policy on firm exports, especially as state-owned and large firms are believed to be less influenced by the policy. The graphs confirm that the observed treatment effects are not attributable to pre-existing trends, indicating no significant policy impact on the outcomes for state-owned or large firms. Additionally, the absence of pre-trends supports the conclusion that our regression results are not confounded by reverse causality, where an increase in firm exports could spur the implementation of bank interest rate deregulation policies.

Table 3
Summary statistics of borrowing amount across firms.

Year	State-owned firms (1)	Private firms (2)	Difference (3)	Large firms (4)	Small firms (5)	Difference (6)
2010	20.3452	19.0897	1.2555	20.9947	18.8491	2.1455
2011	20.5202	19.1416	1.3786	21.0133	18.7734	2.2399
2012	20.5492	19.1352	1.4140	20.9710	18.7498	2.2212
2013	20.6981	19.3053	1.3928	21.0680	18.8059	2.2621
2014	20.6991	19.3269	1.3723	21.0601	18.8736	2.1865
2015	20.7203	19.4994	1.2209	21.0544	18.9509	2.1035
2016	21.5747	20.4204	1.1544	21.6835	19.5990	2.0845

Notes: This table presents the summary statistics of the borrowing amounts across firms for each year. The calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

Table 4
The size of controlling and treated groups.

Year	State-owned firms (1)	Private firms (2)	Large firms (4)	Small firms (5)
2010	353	416	320	320
2011	365	584	420	420
2012	339	612	507	507
2013	345	589	511	511
2014	332	606	523	524
2015	319	596	500	500
2016	339	505	368	369

Notes:This table presents the size of controlling and treated groups for each year. The calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

Table 5
The effect of bank interest rate deregulations on firm exports.

	Export (1)	Export (2)	Export (3)	Export (4)
$treat_{i,1} \times post_t$	0.1972***	0.1781***		
	(0.0361)	(0.0301)		
$treat_{i,2} \times post_t$			0.1831***	0.1602***
			(0.0410)	(0.0330)
X_{it}		Y		Y
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	6300	6300	6300	6300
R^2	0.7932	0.8439	0.7913	0.8520

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on exports across firms (state-owned vs. private firms; large vs. small firms). Columns (1) and (3) exclude control variables. Columns (2) and (4) include the control variables, as well as firm and year fixed effects. The control variables comprise total factor productivity, capital intensity, the logarithm of total revenue, the ratio of foreign investment, total liability divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are enclosed in parentheses. *, **, and *** represent the significance levels of 10 %, 5 %, and 1 %, respectively. The data are derived from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

4.3. Robustness

Next, we conduct robustness checks to demonstrate that our results are not driven by confounding factors such as sample selection or other determinants of firm exports.

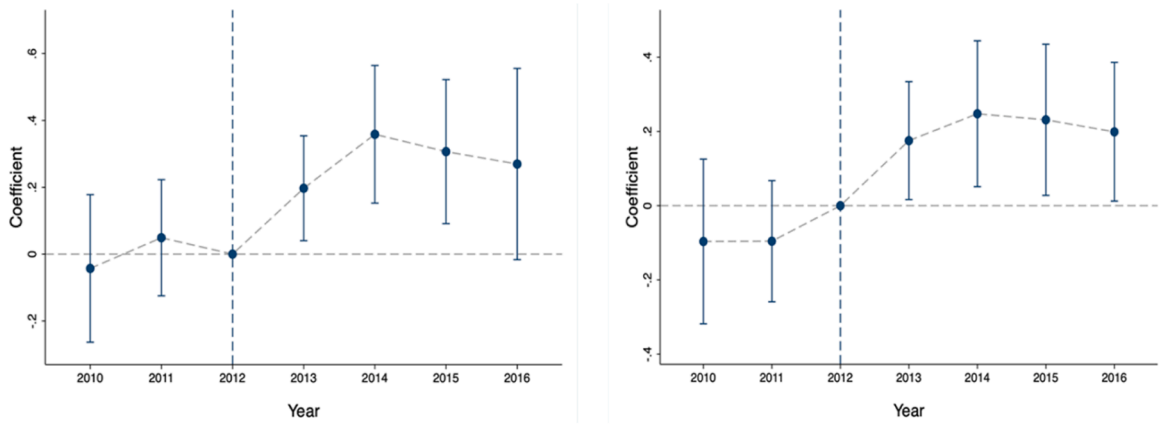

Fig. 1. Event study graphs for the bank interest rate deregulations.
Notes: These graphs display the coefficients for the interaction $treat_i \times dumyear_t$. $treat_{i,1}$ is an indicator variable for the ownership of firm i (1 assigned for private firms, 0 for state-owned firms), while $treat_{i,2}$ is an indicator variable for the size of firm i (1 assigned for small firms, defined as those below the median size of the sample, and 0 for large firms, defined as those above the median of the sample). Confidence intervals are set at the 95 percent level.

4.3.1. Alternative data

In our primary regression, we used data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs spanning 2010 to 2016. The marginally smaller sample size over these years may introduce sampling biases, potentially undermining the reliability of our estimates. Previous studies primarily used data from the Annual Surveys of Industrial Firms (ASIF) by the National Bureau of Statistics of China to examine firms' export behaviors (Kee and Tang, 2016; Che and Zhang, 2018). To bolster our analysis, we included ASIF data from 2011 to 2014.[1] This dataset encompasses all state-owned and private enterprises in the mining, manufacturing, and utilities sectors with annual revenues exceeding 5 million yuan, providing insights into firm-specific characteristics and financial indicators from balance sheets, income statements, and cash flow statements. We carefully aligned the selection of variables and the econometric modeling with the baseline regression specifications to ensure consistency and comparability, thereby performing an essential robustness check.

Table 6, Columns (1) and (2), display results using the variables $treat_{i,1}$ and $treat_{i,2}$,[2] sourced from the ASIF database. The difference-in-differences methodology confirms a substantial positive influence of bank interest rate deregulations on firm exports, supported by ASIF data. This evidence is consistent with our preliminary regressions in Table 5, thereby solidifying the validity and dependability of our findings.

4.3.2. Alternative model specification

One might critique the decision to categorize the sample based on the binary classification of firms into state-owned versus private (large versus small) due to the arbitrary nature of such divisions by ownership (size). To address this issue, our analysis forgoes the binary treatment variable and instead incorporates the continuous variable 'size' along with its interaction with 'post', represented as $size \times post$, in our difference-in-differences model (1).[3] The results, displayed in Column (3) of Table 6, pertain to the removal of bank interest rate regulations. These findings corroborate our primary results from Table 5, indicating that the $size \times post$ interaction term is significantly negative following the deregulation of bank interest rates. This methodological adjustment strengthens the robustness of our initial regression outcomes.

Research consistently demonstrates that a borrower's profitability is a crucial determinant for banks when assessing creditworthiness (Bertrand et al., 2007). As a result, firms with higher profitability typically receive more substantial banking support and face fewer credit constraints. To evaluate this, we employ firm profitability as a measure to assess credit restrictions. We categorize firms into groups of high profitability and low profitability, denoted by $treat_{i,3}$. This variable indicates the profitability status of firm i, assigning 1 to low-profitability firms (those below the sample's median profitability) and 0 to high-profitability firms (those above the median). Column (4) of Table 6 illustrates how deregulations in bank interest rates influence exports across firms of varying profitability levels. The interaction term $treat_{i,3} \times post_t$ produces a positive and significant coefficient, suggesting that deregulation in bank

[1] The sample in this paper covers the years 2011 to 2014 for three main reasons. First, the company name information in the ASIF database is only available up to 2014. Second, extensive literature demonstrates the impact of bank credit shocks on the export behavior of firms during the 2007-2009 financial crisis (Paravisini et al., 2015; Bricongne et al., 2012; Bolton et al., 2011). Third, the ASIF database significantly lacks data for the year 2010, thereby excluding it from the sample period.

[2] Since the ASIF database does not include an indicator of total business revenue, the logarithmic transformation of total assets is used as an alternative measure of enterprise size.

[3] All 'size' measurements are consistent, expressed as the logarithm of total revenue.

Table 6
Robustness (alternative data and alternative model specification).

	Alternative Data(ASIF)		Alternative Model Specification	
			Continuous Variable	Profitability
	Export	Export	Export	Export
	(1)	(2)	(3)	(4)
$treat_{i,1} \times post_t$	0.0714***			
	(0.0216)			
$treat_{i,2} \times post_t$		0.0670***		
		(0.0100)		
$size_i \times post_t$			−0.0782**	
			(0.0314)	
$treat_{i,3} \times post_t$				0.1068*
				(0.0840)
X_{it}	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	114,913	114,913	6300	5059
R^2	0.8969	0.8907	0.7958	0.7924

Notes: This table presents difference-in-differences estimates to evaluate the impact of bank interest rate deregulation policy. It employs alternative data sets and an alternative model specification. Columns (1) and (2) use data from ASIF2011–2014, while columns (3) and (4) implement an alternative model specification. All columns include control variables, firm, and year fixed effects. Control variables in columns (1) and (2) comprise total factor productivity, capital intensity, the logarithm of average wages, establishment years, the logarithm of total assets, and the ratio of total liabilities to total assets. In column (3) and (4), control variables include total factor productivity, capital intensity, the logarithm of total revenue, foreign investment ratio, total liability divided by total assets, the proportion of shares held by the top 10 shareholders, return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are shown in parentheses. The symbols *, **, and *** indicate significance levels of 10 %, 5 %, and 1 %, respectively.

interest rates significantly enhances exports more for firms with lower profitability compared to those with higher profitability. These findings support our initial predictions and affirm the robustness of our analytical approach.

4.3.3. *The adjustment of some samples*

4.3.3.1. Exclusion of state-owned enterprises samples. State-owned enterprises often prioritize social objectives over profit maximization and may benefit from non-financial governmental preferences (Bai et al., 2000), which could bias export-related analyses. Consequently, our analysis robustly excludes state-owned firms and focuses solely on private enterprises. These are categorized into large and small firms using the $treat_{i,2}$ metric. We detail the effects of bank interest rate deregulation on exports by these private entities in Table 7, column (1). The results closely align with our initial projections, demonstrating the robustness of our analytical framework.

4.3.3.2. Excluding export extremes. To address potential data biases stemming from extreme export values, we implement Winsorization at the 5th and 95th percentiles of the export distribution. The adjusted estimates, reported in Columns (2) and (3) of Table 7,

Table 7
Robustness (exclusion of state-owned enterprises samples and excluding export extremes).

	Exclusion of State-owned Enterprises Samples	Excluding Export Extremes	
	Export	Export	Export
	(1)	(2)	(3)
$treat_{i,1} \times post_t$		0.2630***	
		(0.0675)	
$treat_{i,2} \times post_t$	0.2594***		0.1966***
	(0.0977)		(0.0609)
X_{it}	Y	Y	Y
Firm FE	Y	Y	Y
Year FE	Y	Y	Y
Observations	3986	5646	5646
R^2	0.7988	0.8279	0.8277

Notes: This table presents difference-in-differences estimates to assess the impact of bank interest rate deregulation policies excluding samples of state-owned firms and export extremes. Column (1) excludes samples of state-owned firms. Columns (2) and (3) exclude export extremes. Columns (1), (2), and (3) include control variables, firm-specific, and year fixed effects. All columns include control variables, firm, and year fixed effects. Control variables comprise total factor productivity, capital intensity, log of total revenue, foreign investment ratio, total liabilities to total assets ratio, the proportion of shares held by the top 10 shareholders, return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are shown in parentheses. The symbols *, **, and *** denote significance levels at 10 %, 5 %, and 1 %, respectively.

evaluate the effect of bank interest rate deregulation on firm exports, strengthening the robustness of our baseline regression results.

4.3.3.3. Including foreign-owned firms. The exclusion of foreign-owned firms may restrict the analysis of deregulation's effects on firms with varying ownership structures and capital sources. To mitigate this constraint, this study incorporates foreign-owned firms to provide a more comprehensive examination of how interest rate liberalization influences enterprise exports. The revised estimates, presented in Column (1) of Table 8, align with our initial expectations and further validate the robustness of our empirical strategy.

4.3.4. Excluding interference from other policies

In addition to implementing the loan interest rate liberalization policy, China introduced the benchmark loan prime rate (LPR) centralized quotation and release mechanism (hereinafter referred to as the LPR mechanism) in 2013. Given that the LPR mechanism also influences credit market fund allocation, it may, in turn, impact firms' export behavior. To mitigate potential confounding effects, and considering that the LPR is derived from the actual lending rates of the nine quoting banks, this study excludes firms that have exclusively obtained loans from these banks. The regression results, presented in Columns (2) and (3) of Table 8, align with our preliminary findings in Table 5, further reinforcing the robustness and credibility of our results.

4.3.5. Sample selection bias

To mitigate potential sample selection bias arising from restricting the analysis to exporters, we employ a binary Exporter/Non-Exporter indicator rather than the value of export sales to examine the impact of bank interest rate deregulation on firm export behavior. The regression results, presented in Table 9, indicate that interest rate liberalization significantly enhances firms' probability of exporting, reinforcing the robustness and reliability of our findings.

5. The effect of bank interest rate deregulations on credit constraints

In this paper, we hypothesize that deregulation of bank interest rates leads to alterations in bank lending behaviors, which in turn affect borrowers' export activities. In this section, we employ a difference-in-differences approach to assess the impact of interest rate deregulation on credit constraints.

To assess firms' credit constraints (*Credit*), we utilize several measures that elucidate the difficulties firms encounter when obtaining bank loans. The primary measures include the firms' borrowing amounts from banks, represented by the natural logarithm of the amount borrowed by firm i in year t,[4] denoted as $Borrowing_{it}$. We also examine the firms' borrowing ratio, $Borrowing\_ratio_{it}$, calculated as the ratio of firm i's borrowing to its total assets in year t. Higher values of both $Borrowing_{it}$ and $Borrowing\_ratio_{it}$ indicate greater access to bank funds, thus suggesting lower credit constraints for firms.

Our analysis introduces a third criterion for measuring credit constraints, focusing on the diversity of optimal asset configurations across firms. We assess this by examining the proportion of tangible assets, which indicates a firm's liquidity and its ability to pledge assets as collateral. This is measured by the ratio of plant, property, and equipment to total book-value assets. According to the optimal capital structure theory posited by Harris and Raviv (1991), enterprises in developing countries often struggle to invest in fixed assets due to limited access to long-term financing. Financial institutions consider tangible assets like factory plants and equipment more secure for safeguarding credit than commercial credits. A high ratio of tangible assets ensures significant collateral for firms, alleviating their credit constraints. For instance, private firms often face credit discrimination because banks lack visibility into their operational efficiencies. A substantial collateral base can mitigate these limitations, enhancing their borrowing capacity. Thus, higher $Tangible_{it}$ values indicate lower credit constraints and improved access to bank financing.

This study examines the impact of bank interest rate deregulation on credit constraints, employing the model outlined in specification (1). The dependent variable, credit constraint (*Credit*), and other variables remain consistent throughout the analysis. Panel A of Table 10 shows the differences in credit constraints between state-owned and private firms following bank interest rate deregulation. We use *Borrowing*, *Borrowing_ratio*, and *Tangible* as proxies for credit constraints. In columns (2), (4), and (6), the interaction term $treat_{i,1} \times post_t$ yields positive and statistically significant coefficients, indicating that deregulation has helped reduce credit constraints for private firms, thereby narrowing the gap between state-owned and private entities. This evidence supports the idea that deregulating bank interest rates is crucial in alleviating credit constraints among private firms. Panel B of Table 10 presents the impact of bank interest rate deregulation on credit constraints, distinguishing between large and small firms using the proxies *Borrowing*, *Borrowing_ratio*, and *Tangible*. Columns (2), (4), and (6) feature the interaction term $treat_{i,2} \times post_t$ which shows positive and statistically significant coefficients. This suggests that post-deregulation, the disparity in credit constraints between large and small firms has decreased. These findings support the role of bank interest rate deregulation in alleviating credit constraints for small firms. These results are consistent with our proposition 1.

6. Further analysis

We proceed to investigate the mechanisms by which banking interest rate regulations influence the export performance of firms, focusing on their impact across various trade margins, imports and risk.

[4] Bank borrowing amounts are the sum of long-term loans, short-term loans, and loans due within one year.

Table 8
Robustness (including foreign-owned firms and excluding interference from other policies).

	Including Foreign-owned Firms	Excluding Interference from other Policies	
	Export (1)	Export (2)	Export (3)
$treat_{i,1} \times post_t$		0.1382***	
		(0.0371)	
$treat_{i,2} \times post_t$	0.1469**		0.1028***
	(0.0502)		(0.0211)
X_{it}	Y	Y	Y
Firm FE	Y	Y	Y
Year FE	Y	Y	Y
Observations	6916	5561	5410
R^2	0.7812	0.7912	0.8912

Notes: This table presents difference-in-differences estimates to assess the impact of bank interest rate deregulation policies including foreign-owned firms and excluding interference from other policies. Column (1) includes foreign-owned firms. Columns (2) and (3) excludes interference from other policies. Columns (1), (2), and (3) include control variables, firm-specific, and year fixed effects. All columns include control variables, firm, and year fixed effects. Control variables comprise total factor productivity, capital intensity, log of total revenue, foreign investment ratio, total liabilities to total assets ratio, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are shown in parentheses. The symbols *, **, and *** denote significance levels at 10 %, 5 %, and 1 %, respectively.

Table 9
Robustness (sample selection bias).

	Export_dummy (1)	Export_dummy (2)
$treat_{i,1} \times post_t$	0.0309*	
	(0.0204)	
$treat_{i,2} \times post_t$		0.0488*
		(0.0371)
X_{it}	Y	Y
Firm FE	Y	Y
Year FE	Y	Y
Observations	6912	6833
R^2	0.7659	0.8556

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on imports and whether to export across firms (state-owned vs. private firms; large vs. small firms). Columns (1) to (2) include control variables, as well as firm and year fixed effects. Control variables include total factor productivity, capital intensity, log of total revenue, ratio of foreign investment, total liabilities divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are reported in parentheses. *, **, and *** denote significance at the 10 %, 5 %, and 1 % levels, respectively. Calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

6.1. Intensive margin

Financing frictions related to variable costs distort the intensive margin by diminishing the revenue potential from a firm's sales in specific export markets or for distinct export products. We analyze the export market at the level of country-product pairs and define the exports of product p from i to country d in year t as $Export_{ipdt}$. This study examines the effects of bank interest rate deregulation on the intensive margin, employing the following model design:

$$Export_{ipdt} = \alpha + \beta \times (treat_i \times post_t) + \gamma \times X_{it} + \delta_i + \mu_p + \theta_d + \varphi_t + \varepsilon_{ipdt} \tag{3}$$

Where the term $Export_{ipdt}$ represents the log export value of firm i exporting product p to county d in year t. The export value is evaluated at the Harmonized System (HS) 6-digit product level. This specification includes firm and year fixed effects and controls for product and country fixed effects, allowing for a clearer isolation of the impact of bank interest rate regulations.

The μ_p terms account for cross-product variations in quality, functionality, technical adoption, appearance, and other unobserved characteristics. The θ_d terms account for cross-country variations in market size, consumer income, exchange rates, and trade costs (such as tariffs, non-tariff barriers, and infrastructure). The remaining variables are as specified in Eq. (1). With this comprehensive set of fixed effects, the coefficient on the interaction term measures the additional increase in $Export_{ipdt}$ after 2013, relative to prior years, for private firms compared to state-owned firms.

Table 10
The effect of bank interest rate deregulations on credit constraints.

Panel A: State-owned firms vs Private firms						
	Borrowing		*Borrowing_ratio*		*Tangible*	
	(1)	(2)	(3)	(4)	(5)	(6)
$treat_{i,1} \times post_t$	0.4174***	0.4082***	0.0265***	0.0243***	0.0218***	0.0177***
	(0.0503)	(0.0516)	(0.0047)	(0.0046)	(0.0039)	(0.0039)
X_{it}		Y		Y		Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	12,561	12,561	14,844	14,844	16,339	16,339
R^2	0.8548	0.8591	0.7407	0.7511	0.8396	0.8439
Panel B: Large firms vs Small firms						
	Borrowing		*Borrowing_ratio*		*Tangible*	
	(1)	(2)	(3)	(4)	(5)	(6)
$treat_{i,2} \times post_t$	0.0603*	0.0784*	0.0085**	0.0082**	0.0090**	0.0084**
	(0.0458)	(0.0445)	(0.0038)	(0.0038)	(0.0039)	(0.0038)
X_{it}		Y		Y		Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	13,225	13,225	14,722	14,722	16,339	16,339
R^2	0.8519	0.8659	0.7959	0.7998	0.8389	0.8436

Notes: This table presents difference-in-differences estimates of the effects of bank interest rate deregulation on credit constraints among firms, comparing state-owned versus private firms (large versus small firms). Columns (1), (3), and (5) exclude control variables in Panels A and B, whereas columns (2), (4), and (6) include these controls, along with firm and year fixed effects in Panels A and B. Control variables comprise total factor productivity, capital intensity, log of total revenue, foreign investment ratio, total liabilities to total assets ratio, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are presented in parentheses. The symbols *, **, and *** denote significance levels at 10 %, 5 %, and 1 %, respectively. Calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database.

Table 11 presents the results of the impact of bank interest rate deregulations on the export intensive margin of firms, differentiating between state-owned and private firms (both large and small). The interaction terms $treat_{i,1} \times post_t$ and $treat_{i,2} \times post_t$ yield positive and statistically significant coefficients. This indicates that private firms and small firms experience systematically higher export values at the country-product level following the implementation of bank interest rate deregulations.

Table 11
The effect of bank interest rate deregulations on the intensive margin.

	$Export_{ipdt}$	
	(1)	(2)
$treat_{i,1} \times post_t$	0.0479*	
	(0.0327)	
$treat_{i,2} \times post_t$		0.0790*
		(0.0444)
X_{it}	Y	Y
Firm FE	Y	Y
Product FE	Y	Y
Country FE	Y	Y
Year FE	Y	Y
Observations	594,720	648,459
R^2	0.3985	0.4516

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on the intensive margin of exports. Columns (1) and (2) include control variables, firm, product, country, and year fixed effects. Control variables include total factor productivity, capital intensity, log of total revenue, the ratio of foreign investment, total liabilities divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are enclosed in parentheses. *, **, and *** represent significance levels of 10 %, 5 %, and 1 %, respectively. Author's calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

6.2. Extensive margin

Financing frictions related to fixed trade costs can restrict the extensive margin by reducing the number of markets firms can enter and the diversity of products they can sell. In this section, we explore the effects of bank interest rate deregulations on the extensive margin of exports. The granularity of our data allows for multiple definitions of the extensive margin, enabling us to avoid assumptions about the specific levels at which firms incur fixed trade costs or achieve cost synergies across different destinations and products.

We employ three measures of the extensive margin and re-estimate specification (1) using each measure as the dependent variable. The number of destinations, denoted as $country_{it}$, reflects the number of countries that firm i serves in year t. The export product scope, represented by $product_{it}$, indicates the number of HS-6 products that firm i sells in year t. The number of destination-product markets, denoted as $coun\_prod_{it}$, counts the trading relationships of firm i at the country-product level in year t.

Table 12 illustrates the impact of bank interest rate deregulation on the export extensive margin for different types of firms, distinguishing between state-owned and private firms, as well as large and small firms. Columns (1)-(4) of Table 12 show that the interaction terms $treat_{i,1} \times post_t$ and $treat_{i,2} \times post_t$ have positive and statistically significant coefficients. This indicates that, following deregulation, private (small) firms tend to enter more export markets and diversify their product range more than state-owned (large) firms. As a result, private (small) firms develop more trading relationships than state-owned (large) firms, as evidenced by columns (5)-(6) of Table 12.

The observed patterns suggest that bank interest rate regulations hinder firms' ability to enter new markets, diversify product lines, establish new trading partnerships, and increase export volumes. Our findings indicate that firms face fewer financial constraints on both fixed and variable export costs after the deregulation of bank interest rates, as shown by the reduction in distortions to the extensive and intensive margins. These results support propositions 3 and 4.

6.3. Imports

A firm's export performance may be influenced by import market dynamics. Engaging in import trade entails various costs, including information acquisition costs and sunk costs in the initial phase of import activities, as well as rising fixed and variable costs as import volumes expand. Therefore, this paper further examines the impact of interest rate liberalization on firms' import behavior, with the regression results presented in Columns (1) and (2) of Table 13. The findings indicate that interest rate deregulation facilitates firms' import activities. A possible explanation is that interest rate liberalization broadens firms' financing sources, alleviates financial constraints, and subsequently promotes their import activities.

6.4. Risk

As deregulation enables banks to extend greater volumes of credit to firms, an essential question arises: how does this shift affect banks' risk exposure? Do they internalize the heightened risk, or is it transferred to borrowing firms? The subsequent analysis explores these critical dynamics.

Using annual panel data from 108 Chinese commercial banks from 2009 to 2017, this study employs the following model to examine the impact of interest rate liberalization on bank risk-taking:

$$Risk_{jt} = \alpha + \beta\left(Rate_j \times post_t\right) + \gamma Control_{jt} + \lambda_j + \mu_t + \varepsilon_{jt} \tag{4}$$

The dependent variable, $Risk_{jt}$, captures the risk exposure of bank j at time t, proxied by the non-performing loan (NPL) ratio. The key variable, $Rate_j$, denotes the degree of interest rate liberalization, where a higher value indicates reduced policy intervention. The model controls for various bank-level characteristics, including size, capital-to-asset ratio, return on assets, cost-to-income ratio, and net interest margin ($Control_{jt}$). Bank-specific fixed effects (λ_j) are included to account for time-invariant heterogeneity across banks, while time fixed effects (μ_t) control for macroeconomic shocks and systemic factors affecting all banks.

Table 14 presents the regression results on the impact of interest rate liberalization on bank risk-taking. The significantly negative coefficient of the interaction term suggests that interest rate liberalization has heightened bank risk. Similarly, Table 15 reports the regression results for corporate risk, where the negative and significant coefficient indicates that interest rate liberalization has mitigated corporate risk exposure. Collectively, these findings suggest that while the implementation of interest rate liberalization policies has increased bank risk, it has concurrently reduced corporate risk, implying that banks have been unable to pass on their risk to firms.

7. Conclusions and policy implications

7.1. Conclusions

We exploit the 2013 deregulation of the floor on bank lending interest rates as a quasi-natural experiment and employ a difference-in-differences framework to identify the causal impact of interest rate liberalization on firms' export behavior. Our findings demonstrate that, following the removal of the lending rate floor, private firms (small firms) experienced a significantly greater increase in export values relative to state-owned firms (large firms), a result that remains robust across extensive sensitivity tests.

Mechanism analysis suggests that interest rate deregulation strengthens firms' export capacity by alleviating credit constraints.

Table 12
The effect of bank interest rate deregulations on the extensive margin.

	$country_{it}$		$product_{it}$		$coun\_prod_{it}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$treat_{i,1} \times post_t$	0.0686*		0.1147**		0.1377**	
	(0.0398)		(0.0485)		(0.0535)	
$treat_{i,2} \times post_t$		0.0621*		0.0580*		0.0728*
		(0.0388)		(0.0491)		(0.0539)
X_{it}	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	5767	4904	5767	5472	6251	5700
R^2	0.8811	0.8719	0.8441	0.8245	0.8523	0.8548

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on the extensive margin of export, using three measures: $country_{it}$, $product_{it}$, and $coun\_prod_{it}$. Columns (1) to (6) include control variables, as well as firm and year fixed effects. Control variables include total factor productivity, capital intensity, log of total revenue, ratio of foreign investment, total liabilities divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are reported in parentheses. *, **, and *** denote significance at the 10 %, 5 %, and 1 % levels, respectively. Calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

Table 13
The effect of bank interest rate deregulations on firm imports.

	Import (1)	Import (2)
$treat_{i,1} \times post_t$	0.0421***	
	(0.0011)	
$treat_{i,2} \times post_t$		0.0372**
		(0.0144)
X_{it}	Y	Y
Firm FE	Y	Y
Year FE	Y	Y
Observations	13,711	12,896
R^2	0.6622	0.7844

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on imports (state-owned vs. private firms; large vs. small firms). Columns (1) to (2) include control variables, as well as firm and year fixed effects. Control variables include total factor productivity, capital intensity, log of total revenue, ratio of foreign investment, total liabilities divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are reported in parentheses. *, **, and *** denote significance at the 10 %, 5 %, and 1 % levels, respectively. Calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

Examining the effects across different trade margins, we find that firms not only expanded export values within existing country-product markets but also diversified their product portfolios and entered new international markets post-deregulation. These findings align with the view that financing constraints impede firms' ability to cover both fixed and variable export costs, thereby distorting firm behavior along both the extensive and intensive trade margins.

7.2. Policy implications

Our findings have several key policy implications. First, the Chinese government should persist in advancing market-oriented interest rate reforms by optimizing the mechanisms of interest rate formation and reinforcing market forces in resource allocation. Further, improving the transmission channels that enable interest rate reforms to benefit firms, enhancing competitive pricing dynamics, dismantling financial monopolies, and limiting protective pricing practices are crucial for lowering corporate financing costs and bolstering financial support for export activities.

Second, given the heterogeneous impact of interest rate liberalization on export performance across firms with distinct characteristics, financial institutions should refine their service structures to align with firms' differentiated financial needs and strengthen the transmission of market-based interest rates, thereby ensuring that enterprises across various industries receive targeted financial

Table 14
Regression results of interest rate liberalization on bank risk-taking.

	(1) NPL	(2) NPL
$Rate_j \times post_t$	−0.703***	−0.544**
	(0.193)	(0.210)
$Control_{jt}$		Y
Bank FE	Y	Y
Year FE	Y	Y
Observations	821	821
R^2	0.034	0.467

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on bank risk-taking. Columns (1) exclude control variables, and columns (2) include these controls, along with bank and year fixed effects. Control variables comprise size, capital-to-asset ratio, return on assets, cost-to-income ratio, and net interest margin. Robust standard errors, clustered at the bank level, are presented in parentheses. The symbols *, **, and *** denote significance levels at 10 %, 5 %, and 1 %, respectively. Calculations are based on data from the 108 Chinese commercial banks.

Table 15
Regression results of interest rate liberalization on firm risk.

	(1)	(2)
$treat_{i,1} \times post_t$	−0.211***	
	(0.043)	
$treat_{i,2} \times post_t$		−0.177***
		(0.038)
X_{it}	Y	Y
Firm FE	Y	Y
Year FE	Y	Y
Observations	6498	6498
R^2	0.543	0.551

Notes: This table reports difference-in-differences estimates of the effect of bank interest rate deregulations on firm risk (state-owned vs. private firms; large vs. small firms). Columns (1) to (2) include control variables, as well as firm and year fixed effects. Control variables include total factor productivity, capital intensity, log of total revenue, ratio of foreign investment, total liabilities divided by total assets, the proportion of shares held by the top 10 shareholders, and return on assets, board size, the proportion of independent directors, dual leadership structure, primary industry and secondary industry. Robust standard errors, clustered at the firm level, are reported in parentheses. *, **, and *** denote significance at the 10 %, 5 %, and 1 % levels, respectively. Calculations are based on data from the China Stock Market & Accounting Research (CSMAR) database and Chinese customs data.

support to enhance their export capabilities.

7.3. Limitations

This study has several limitations. First, China's interest rate liberalization has been a gradual, multi-phase process spanning over two decades, and this paper does not fully capture the dynamic effects of this progressive reform. Future research should account for incremental policy adjustments to provide a more precise assessment of the long-term impact of interest rate liberalization. Second, fluctuations in market demand and macroeconomic conditions in China's export destination countries also affect export performance, yet these factors are excluded due to data constraints. To strengthen the empirical analysis of the relationship between interest rate liberalization and firm-level exports, future studies should leverage more comprehensive datasets.

CRediT authorship contribution statement

Guangya Sun: Writing – review & editing, Visualization, Resources, Project administration, Funding acquisition, Conceptualization. **Yaping Sun:** Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Jing Guo:** Data curation, Methodology, Writing – review & editing.

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