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Research paper

Exchange rate pass-through and importers' credit constraints: Evidence from China☆

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ABSTRACT

This paper examines the patterns of exchange rate pass-through (ERPT) into import prices among Chinese firms, and investigate the role played by credit constraints as well as sourcing diversity in shaping the degree of ERPT. Using highly dis-aggregated firm-product-country-level transaction data from 2000 to 2007, we find that (1) the average level of ERPT into import prices in China is around 73%; (2) for importers in financially more constrained sectors, ERPT tends to be more complete; (3) a higher extent of firms' import sourcing diversity leads to a less complete pass-through and partially offsets the effects of credit constraints. Our findings provide convincing evidence of the significance of credit constraints in affecting ERPT into import prices. Furthermore, a more diversified import sourcing network can enhance the ability of importers to cope with exchange rate shocks and help alleviate the impact of financial constraints on exchange rate fluctuations. Finally, we provide theoretical explanations for the findings.

1. Introduction

One of the core puzzles in international economics is: why exchange rate fluctuations do not always result in price changes of the same magnitude (Obstfeld and Rogoff, 2000)? A large body of studies has shown that exchange rate pass-through (ERPT), defined as the elasticity of local price changes to exchange rate fluctuations, varies significantly across countries, industries, and time. Uncovering the key determinants of ERPT has important implications not only for understanding the trading behaviors of firms, but also for formulating various policies, including trade policy, monetary policy, inflation targeting, and the balance of payments.

In this paper, we examine to what extent do import prices faced by firms change in response to exchange rate shocks, and examine the role that financial constraints and sourcing diversity play in shaping this response. Using Chinese micro-level trade data from 2000 to 2007, we estimate the elasticity of import prices with respect to real exchange rates, i.e., the import-side ERPT. Following the literature, we employ panel regressions with first-order differences and show that the average ERPT into import prices for Chinese firms is around 73%, indicating an incomplete ERPT. Then using measures of sector-level financial constraints

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following Manova et al. (2015), we explore the effect of credit constraints on importers' ERPT. Our empirical analysis shows that import prices for firms in sectors with tighter credit constraints are more sensitive to exchange rate shocks, exhibiting more complete ERPT. Finally, we construct the measures of an importer's sourcing diversity, including the number of sourcing origins. We find that importers with a higher degree of sourcing diversity could offset part of the impact of credit constraints on ERPT and better absorb exchange rate shocks, leading to a less complete ERPT.

To support our empirical findings, we conduct six sets of robustness checks. First, we consider alternative measures of credit constraints from Fan et al. (2015a). Second, we isolate countries that use the US dollar as their fiat currency or adapt the USD-pegged exchange rate regime. Third, we repeat the regressions for two-way traders only, who conduct both export and import and represent the majority of bilateral trade flows. Next, we control the ownership types of Chinese firms: domestic private firms, state-owned enterprises, and multinational firms. In addition, we estimate the firm-level markup following De Loecker and Warzynski (2012) and test whether markups, as a measure of output-side market power of importers, affect our main results. Finally, we utilize alternative estimation methods, such as alternative fixed effects and cross-sectional specifications. Our main results remain stable to all the robustness checks: even after we control these confounding factors, credit constraints and sourcing diversity still play important roles in determining import exchange rate pass-through.

Building on Alviarez et al. (2023), we provide a theoretical framework that explains how financial constraints and sourcing diversity influence ERPT on the import side. When the import price is determined through bilateral negotiation between the importer and the exporter, tighter financial constraints faced by the importer increase its demand elasticity of imports with respect to exchange rate shocks. For example, when the RMB depreciates against some currency, leading to upward pressure on the corresponding import price, financially constrained firms experience a greater reduction in demand from the local supplier. This reduced demand weakens the importer's bargaining power within this buyer-seller relationship, limiting its ability to negotiate lower prices, which in turn results in import prices more closely aligning with exchange rate movements. This explains why financial constraints lead to a higher degree of ERPT into import prices.

Sourcing diversity, however, operates through a different channel. When the exporter's production exhibits decreasing returns to scale, reduced demand from some importers lowers the firm's marginal cost of production, creating room for the supplier to reduce the markup charged as a way to stabilize prices and prevent trade diversion of the importer. The reduced demand is stronger when the importing firm's expenditure is more diversified across multiple foreign suppliers, ultimately leading to a lower degree of ERPT. The observed import ERPT is thus a combination of these two channels (along with the other factors), and we are able to disentangle their effects by leveraging information on firms' financial constraints and sourcing diversity.

Our analysis focuses on the exchange rate pass-through on the import side, a critical margin for productivity growth (e.g., Amiti and Konings, 2007; Brandt et al., 2012) and for global trade participation of domestic firms (e.g., Bernard et al., 2018; Li et al., 2024). Estimating import ERPT reveals the extent of exchange rate shocks as an import barrier for Chinese firms. Moreover, we provide a novel perspective for studying financial conditions in emerging markets, where firms are more vulnerable to credit constraints. The fact that financially constrained importers absorb more exchange rate fluctuations highlights the role of financial development in facilitating firms' global sourcing activities. A remedy based on our findings is that importers could choose to diversify their sourcing origins to cope with exchange rate fluctuations, especially when facing tougher credit constraints.

This paper contributes to two main strands of literature. First, it speaks to recent endeavors in addressing exchange rate disconnect puzzles, particularly on the response of trade pricing to exchange rate fluctuations (Campa and Goldberg, 2005). Previous studies primarily focus on the export-side ERPT, demonstrating that various exporter characteristics influence its extent, including productivity (Berman et al., 2012; Li et al., 2015), product quality (Chen and Juvenal, 2016; Auer et al., 2018), import activity (Amiti et al., 2014; Wang and Yu, 2021), market shares (Auer and Schoenle, 2016; Devereux et al., 2017), and information access (Garetto, 2016). More recently, scholars have shifted the focus to reveal the import-side ERPT and examine the role of the bargaining between exporters and importers in this process (e.g., Goldberg and Tille, 2013; Apaitan et al., 2021; Alviarez et al., 2023). Our study aligns with Antoniades and Zaniboni (2016) and Goldberg and Tille (2016) in estimating ERPT into firms' import prices but diverges in two key aspects. On one hand, we investigate the financial characteristics and global sourcing strategy of firms, rather than market share or invoicing currency. On the other hand, we focus on the responses of manufacturing firms, as opposed to retailers in Antoniades and Zaniboni (2016). These distinctions offer a complementary contribution to the existing studies. Our findings highlight the pivotal role that financial constraints play in shaping firms' responses to exchange rate shocks, while also demonstrating how firms can partially mitigate such constraints by strategically organizing their global sourcing strategies. Our paper thus advances the understanding of the exchange rate disconnect puzzle.

Second, this paper relates to the literature on credit constraints and international trade. Cross-border logistics is more risky and expensive than domestic trade, making participating firms rely on external capital to pay trade fixed costs (e.g., Manova, 2013; Chaney, 2016; Kohn et al., 2020). A vast number of studies including (Feenstra et al., 2014; Manova et al., 2015; Fan et al., 2015a) provide comprehensive theoretical explanations and empirical evidence from China on how credit constraints affect firm export through incomplete information, cross-country links, and quality. In the context of exchange rate pass-through, several studies have documented the significance of credit constraints in shaping firms' price adjustments to exchange rate shocks. Strasser (2013) employs a firm-level survey to show that financially constrained exporters pass exchange rate shocks to prices more completely. Xu and Guo (2021) demonstrate that the estimated exchange rate elasticity of the export volume is negatively correlated with the financial constraints of the sector. Using the firm-level export records in China, Dai et al. (2021) find that ERPT to export prices denominated in home currency is lower for firms under tighter financial constraints. Our study contributes to this branch of literature by showing how credit constraints affect firms' import prices. Given the crucial role of import sourcing in determining firms' production costs and productivity, our exercises show that credit constraints constitute significant obstacles not only to firms' global

sourcing strategy but also to their productivity enhancement. In addition, we assess the interaction between credit constraints and ERPT using more detailed firm-product-country-level data for Chinese importers. By doing so, we offer a rich investigation into the impacts of various factors from different margins in guiding the influence of credit conditions on import-side ERPT.

The remainder of this paper is organized as follows. Section 2 describes the data and measurements. Section 3 introduces our empirical identification strategies and the main results on ERPT. Section 4 examines the robustness of empirical findings. Section 5 provides a further discussion. Section 6 provides a theoretical background. Section 7 concludes.

2. Data and measurements

Our empirical analysis relies on comprehensive data on Chinese firms' import activities. We complement the firm-level data with aggregate exchange rate series and other macro-level variables. This section describes these data and measurements of key variables.

2.1. Data

We perform our empirical tests using data from various sources: (1) country-level exchange rates and other macro data from the Penn World Table (PWT) 10.0 and International Financial Statistics (IFS); (2) transaction-level data from the General Administration of Customs of China (GACC); (3) and firm-level accounting information the Annual Survey of Industrial Enterprises (ASIE) of the National Bureau of Statistics of China. Here, we briefly introduce each dataset and the sample construction processes.

2.1.1. Country-level macro data

We obtain annual bilateral nominal exchange rates from the Penn World Table (PWT) version 10.0 and consumer price indices (CPI) from the International Financial Statistics.[1] We keep all countries with full records of exchange rates and CPI from 1999 to 2011 and those that are trading partners with China, resulting in 154 countries and regions. These trading partners account for more than 95% of China's overall import volume.

The bilateral nominal exchange rate (NER_{ct}) is defined as the units of domestic currency required to purchase one unit of foreign currency. By this definition, an increase in NER_{ct} means a nominal depreciation of the Chinese Renminbi (RMB) against the currency of country c in year t. Following Li et al. (2015), the CPI-based real exchange rate (RER_{ct}) is defined as the nominal exchange rate multiplied by the foreign consumer price index CPI_{ct} over China's consumer price index CPI_{CHNt} in the same year,[2] which is

$$RER_{ct} = NER_{ct} \times \frac{CPI_{ct}}{CPI_{CHNt}}. \tag{1}$$

Similarly, an increase in RER_{ct} means a real depreciation of the Chinese RMB against the foreign country c's currency. In later specifications, we mainly use the first difference of the logarithm of the real exchange rate to represent exchange rate changes.

Fig. 1 presents the time series of both nominal and real exchange rates between the U.S. dollar and the euro relative to the Chinese RMB from 1999 to 2011. We observe that the real exchange rate against the US dollar remained relatively stable from 2000 to 2004, primarily due to China's nominal pegging scheme. In July 2005, China lifted this peg, resulting in a slight appreciation of the RMB against the US dollar. In contrast, the exchange rates of the RMB against the euro and other floating currencies exhibited significant fluctuations throughout the entire period.[3]

2.1.2. Chinese customs and firm-level data

We utilize transaction-level records from the General Administration of Customs of China (GACC) spanning from 2000 to 2007 to investigate the import activities of Chinese firms. This comprehensive dataset encompasses detailed information on all Chinese import transactions, including each firm's import value (denominated in US dollars), quantity, unit of measure, product code, and country of origin. Following Li et al. (2015), we exclude erroneous observations from our sample.[4] The basic unit of our analysis is a firm-product-country-year combination, with products coded at the Harmonized System 6-digit level (HS-6). By leveraging these detailed trade records, we calculate the unit value for each observation, which serves as a proxy for the import price.

We complement the customs sample with firm-level production and financial information from the Annual Surveys of Industrial Enterprises in China (ASIE, 1998–2007) conducted by the National Bureau of Statistics of China. The ASIE encompasses the representative sample of Chinese manufacturing firms, including all state-owned enterprises and above-scale firms with annual sales exceeding 5 million Chinese RMB. It provides detailed information on firms' identification codes, ownership structures, industry

[1] For more information about the Penn World Table dataset, see Feenstra et al. (2015).

[2] Consumer price indices (CPIs) for all countries are calculated as a weighted average market basket of consumer goods and services purchased by households by the International Financial Statistics (IFS). To calculate real exchange rate movements, all countries used their 2010 price level as the CPI benchmark value. Note that the CPI here cannot be used as a cross-country comparison of purchasing power.

[3] In addition, we incorporate the real GDP of foreign countries using data from the PTW. By controlling for changes in the real GDP of foreign country c denoted as $\Delta RGDP_{ct}$, we aim to isolate the impact of aggregate economic growth and market demand on the movements of import prices. All macroeconomic variables, including exchange rates and real GDP figures, are measured on an annual basis.

[4] Specifically, we remove (1) transactions with inconsistent or missing information regarding unit or quantity; (2) special product categories such as arms (HS2 = 93), antiques (HS2 = 97), and others (HS2 = 98 and 99); and (3) transactions that exist for only one year without any changes over time.

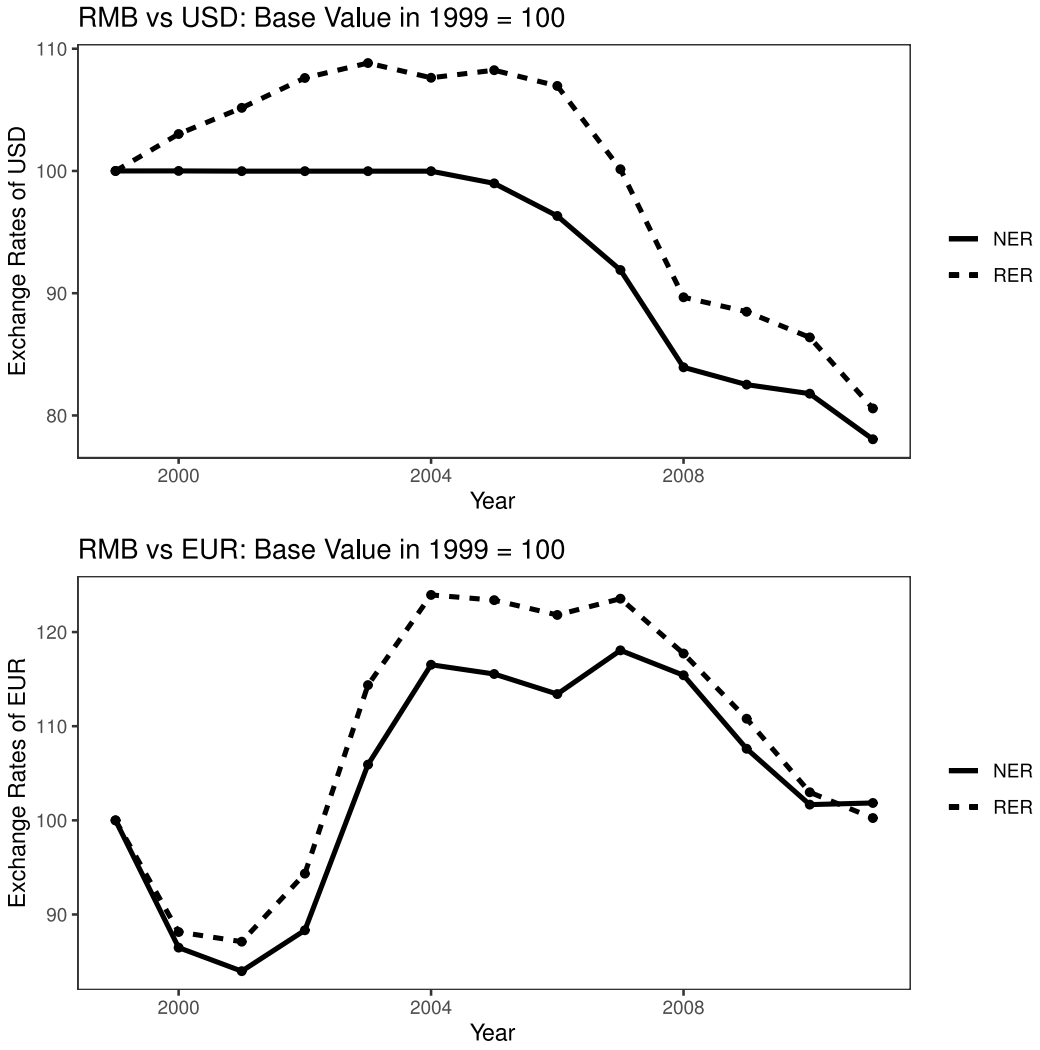

Fig. 1. Exchange rates of Chinese RMB against USD and euro (1999–2011).
Notes: The upper figure presents the time series of both nominal and real exchange rates between the Chinese Renminbi (RMB) and the U.S. dollar from 1999 to 2011, while the lower figure illustrates the corresponding exchange rates between the RMB and the euro over the same period. All series are normalized to the values in the year 1999.

types, and various accounting variables derived from their balance sheets.[5] We exclude firms with fewer than ten employees and those with incomplete information or discrepancies, such as negative sales or input usage. Finally, we follow standard procedures to merge customs samples with firm-level data based on firms' contact information, as in Fan et al. (2015b).

The matched sample merging customs and ASIE firm-level data ranges from 2000 to 2007 in annual frequency. We follow the convention of using the empirical literature using Chinese Customs data and ASIE, which usually ends in 2007, for several reasons: (1) Earlier data are likely to be more reliable and consistent, especially before major changes in data collection methods. (2) Data before 2008 reflect trade patterns before the global financial crisis and allow for a clearer analysis of trends without the effects of

[5] The company information variables include each firm's number of employees, total wage payments, fixed asset values, sales income, total operational input, among others. Additionally, we categorize firms based on their registration types into state-owned enterprises (SOEs), domestic private enterprises (DPEs), multinational firms (MNEs), and joint ventures (JVs). In subsequent analyses, we utilize these variables to examine how the effects of exchange rate shocks on import prices vary with firm characteristics.

Table 1
Summary statistics for exchange rates, chinese customs data, and firm-level data.

	Mean	Median	Std. Dev	P10	P90	# Obs
Panel A: Exchange rate changes (Country-year level)						
Annual real exchange rate changes	0.0213	0.0118	0.0871	−0.0653	0.1173	1232
Annual nominal exchange rate changes	−0.0243	−0.0100	0.1350	−0.1355	0.0949	1232
Panel B: Customs matched sample (Firm-product-country-year level)						
Annual import price change	−0.0851	−0.0018	1.4129	−1.3406	1.1411	1,478,176
Value per firm-product-country (in 1000 USD)	1140.97	14.81	18,807.06	0.34	689.87	1,478,176
# Sources per firm-product	2.07	1	2.27	1	4	1,478,176
Market share per firm-product-country pair	0.0744	0.0021	0.2060	0.00003	0.1891	1,478,176
Panel C: Firm information of importers (Firm level)						
Sales income (in 1000 RMB)	165,888	36,158	998,179	8903	260,976	69,609
Employment (persons)	443	186	1173	50	897	69,609
Fixed asset (in 1000 RMB)	57,166	8953	398,608	1173	91,835	69,609
Operation input (in 1000 RMB)	120,507	25,237	753,663	5877	187,138	69,609
Current wage payable (in 1000 RMB)	7144	2505	28,658	634	13,591	69,609
Import intensity (imported inputs over costs)	0.2108	0.0667	0.2838	0.0004	0.6850	69,609

Notes: This table shows the summary statistics of key variables used in regressions. Panel A describes annual real and nominal exchange rate changes. Panel B describes the price change, the value per transaction, and the number of sources from which each firm imports a certain HS6 product, and the market share taken by each firm-product-country pair for the matched sample. The observations in panel B are at the firm-product-country-year level. The money values in panel B are in thousands of USD. Panel C describes sales and cost information of Chinese manufacturing firms during 2000–2007. The observations in panel C are at the firm-year level. The money values in panel C are in thousands of RMB.

the crisis. (3) Major trade and monetary policy changes in China and globally after 2007 may complicate comparisons, so previous researchers may prefer to select this stable period for analysis.

The summary statistics of the firm-level data and the final matched sample of importers are presented in Table 1, respectively. A notable observation is that the distribution of trade value is highly uneven and exhibits a right long-tail shape, with a few large transactions accounting for most of the total trade value.[6]

2.2. Measurements of credit constraints

Central to our empirical analysis are the measurements of credit constraints. Drawing on the literature examining the role of credit constraints in international trade (e.g., Rajan and Zingales, 1998; Manova, 2013; Manova et al., 2015; Fan et al., 2015a), we use several proxies for sector-level financial vulnerability to capture the credit constraints faced by Chinese importers. These measures are constructed to remain invariant over time to address potential endogeneity concerns. They represent the "technological" part of investments that must be funded externally and reflect each industry's inherent credit needs and resilience to financial risks—characteristics that can be considered exogenous to individual firms. By doing so, we ensure that our proxies accurately represent the sector-specific financial environments without being influenced by firm-level dynamics.

The first measure of financial vulnerability is external finance dependence ($ExtFin_s$), defined as the proportion of capital expenditures not financed through operational cash flows. A higher degree of external finance dependence indicates that an industry relies more on external funding, making it more financially vulnerable and its firms more likely to face credit constraints.

The second measure is asset tangibility ($Tang_s$), which represents the ratio of the net value of tangible assets that firms can pledge as collateral to their total book value. Industries with higher asset tangibility are less financially vulnerable, as their firms have greater access to secured financing.

The third measure is the inventory-to-sales ratio ($Invent_s$), the value of average inventory holding to its annual sales, capturing the duration of the production cycle and the working capital required to maintain inventory levels and meet demand. A higher inventory-to-sales ratio suggests a longer production cycle and greater working capital needs, making firms in such industries more susceptible to credit constraints.

In the following analysis, we will focus primarily on external finance dependence and asset tangibility, while using the inventory ratio as a robustness check. One key reason is that these two measures can be directly linked to firms' exposure to, and resistance to, financial frictions. By contrast, the inventory ratio may reflect inventory management efficiency rather than liquidity or financing considerations. We also construct a first principal component, FPC_s, which increases with external finance dependence and decreases with asset tangibility, to synthesize these dimensions. An industry with a higher FPC_s is more financially sensitive, as its firms require more external funding yet possess fewer collateralizable assets. Thus, FPC_s serves as an aggregated measure of financial constraints, incorporating information from both external finance dependence and asset tangibility.

[6] Our finding is consistent with Fan et al. (2015b), who report that the average and median firm-product-country prices from 2001 to 2006 increased by 9.14% and 13.3%, respectively.

Table 2
Summary statistics of measures of credit constraints.

	Mean	Median	Std. dev	P10	P90	# Obs
Panel A: US						
FPC_s	0	0.030	1.000	−0.898	1.426	414
$ExtFin_s^{US}$	0.019	−0.040	0.317	−0.22	0.37	414
$Tang_s^{US}$	0.295	0.275	0.093	0.180	0.427	414
$Invent_s^{US}$	0.164	0.17	0.032	0.100	0.196	414
Panel B: China						
$ExtFin_s^{CN}$	−0.643	−0.440	0.664	−1.340	−0.100	414
$Tang_s^{CN}$	0.323	0.294	0.068	0.235	0.432	414
$Invent_s^{CN}$	0.121	0.117	0.033	0.083	0.174	414
$R\&D_s^{CN}$	0.017	0.014	0.013	0.007	0.028	414

Notes: This table shows the summary statistics of credit constraint measures in the base year 2005 following Kroszner et al. (2007) and Manova et al. (2015). Panel A describes the measures calculated using US data, while panel B shows the alternative measures from Chinese data. FPC_s denotes the first principal components of external finance dependence and asset tangibility. $ExtFin_s$ denotes external finance dependence, the proportion of capital expenditures not financed through operational cash flows. $Tang_s$ denotes asset tangibility, the ratio of the net value of tangible assets that firms can pledge as collateral to their total book value. $Invent_s$ denotes the inventory-to-sales ratio, the value of average inventory holding to its annual sales. $R\&D_s$ denotes R&D intensity, the R&D spending over total sales.

To utilize the U.S. sector-level credit measures from the literature, we align China's CIC industry classification system with the International Standard Industrial Classification (ISIC) system.[7] This process enables us to assign the sector-level credit constraint measures to each firm in the ASIE sample.[8] This approach ensures that each Chinese firm is assigned a credit measure value based on its operating industry.

We rely on U.S.-based credit constraint measures in our main regressions for two reasons. First, using the U.S. data helps mitigate distortions arising from limited credit supply in China, allowing us to focus on the credit demand aspects tied to sector-level characteristics. Because the U.S. has a well-developed credit market, there is less concern that credit shortages might bias the true demand estimation. Second, previous studies (Kroszner et al., 2007; Manova et al., 2015; Fan et al., 2015a) confirm that sector-level credit demand rankings observed in the U.S. persist in cross-country settings, particularly when industries are defined at a broad classification level. While absolute financial needs may vary across countries, the relative ranking of industries' financial demands is largely determined by the sector's inherent technological and structural attributes.

Alternatively, we also compute all credit measures — external finance dependence ($ExtFin_s$), asset tangibility ($Tang_s$), and inventory ratio ($Invent_s$) — using Chinese firm-level data from the ASIE database. Following Fan et al. (2015a), we adopt their estimated values for external finance dependence. We then calculate the inventory ratio as inventories over sales, asset tangibility as fixed assets over total assets, and R&D intensity as R&D spending over total sales. We use the median firm-level value within each CIC 2-digit industry category to avoid endogeneity issues as the industry-level measure. In addition, we consider a fourth measure, R&D intensity (RD_s), as an auxiliary proxy. R&D activities generally require substantial upfront investments, making firms in R&D-intensive industries more financially vulnerable. However, because R&D expenditure data are only available starting in 2005 — restricting our sample — we use R&D intensity primarily as a robustness check. Note: For R&D intensity, since many firms report zero R&D spending, we use the average rather than the median when aggregating to the industry level.[9]

The summary statistics for the sector-level credit constraint measures are reported in Table 2. Panel A presents the baseline measures calculated using the U.S. data, while Panel B provides the alternative measures derived from Chinese data.[10]

3. Empirical analysis

This section outlines our empirical strategy and presents the results. We begin with the baseline estimation of exchange rate pass-through into import prices. Next, we explore how credit constraints faced by importers influence the degree of pass-through. Finally, we examine the role played by the diversity of an importer's import sourcing portfolio in this process, paying particular attention to how it interacts with the firms' credit constraints.

[7] We start from the 3- and 4-digit ISIC Revision 2 codes used by Manova et al. (2015), convert them into the newest ISIC Revision 3 format, and then match these to adjusted CIC codes from the ASIE datasets.

[8] For cases where multiple source industries correspond to a single target industry, we use the average value across matched industries.

[9] The assumption required for principal component analysis combining external financial dependence and tangibility that the covariance matrix is invertible is not robust in the case of using Chinese data. We decided to delete the FPC calculated from the Chinese data for technical rigor.

[10] See Table A.1 for correlations of different credit constraint measures.

3.1. Incomplete exchange rate pass-through into import prices

Previous literature on exchange rate pass-through (ERPT) has primarily focused on exporters' price-setting behaviors. However, importers are likely to play a more active role than mere price takers, offering a fresh perspective on ERPT.[11] Our paper will delve deeper into how real exchange rate fluctuations impact import prices, aiming to fill in the gap in the literature.

Our primary objective in the empirical analysis is to quantify import-side ERPT as the elasticity of import price changes in response to exchange rate fluctuations, utilizing detailed firm-product-country-level observations. We employ a panel regression model to estimate the elasticity à la (Amiti et al., 2014) and (Li et al., 2015). The baseline specification is in Eq. (2).

$$\Delta \ln P_{ijct} = \alpha + \beta \Delta \ln RER_{ct} + \gamma' Y_{ct} + \xi_{ijc} + \tau_t + \varepsilon_{ijct}, \tag{2}$$

where P_{ijct} is the import price of product i imported by firm j from country c in year t, measured by the unit value in this firm-product-country pair. Although prices are not directly recorded, the customs records contain disaggregated trade values (denominated by US dollars) and quantities for each HS6 product i, imported by firm j from each country c in year t, denoted by V_{ijct} and Q_{ijct}. We first convert the value of the goods into the local currency (RMB) using the average USD-RMB exchange rate for the year. Then, we use unit values as the proxy of import prices, defined as $P_{ijct} = \frac{V_{ijct} \times NER_{USt}}{Q_{ijct}}$, where NER_{USt} is the annualized nominal exchange rate of US dollars in terms of RMB in year t. Because product categories are highly subdivided, we believe that the unit value is an ideal proxy for the transaction price. We will exclude observations with the annual growth rate of unit value in the top or bottom one percentile in the distribution within each HS2 product category and year group to avoid results being affected by outliers other than exchange rate adjustments. RER_{ct} is the bilateral real exchange rate between Chinese RMB and country c's currency.[12]

To deal with possible non-stationarity, we use the first difference of the logarithms for prices $\Delta \ln P_{ijct}$, bilateral real exchange rates $\Delta \ln RER_{ct}$ and real GDP of the source country $\Delta \ln RGDP_{ct}$ to represent their annual rates of changes. This transformation allows us to convert the dynamic panel model into a fixed-effects regression framework. The estimated coefficient of interest $\beta \in [0, 1]$ represents the degree of ERPT into import prices. Since the real prices for import P_{ijct} are denominated in Chinese RMB, the level of coefficient β measures the *completeness* of import ERPT. Specifically, a higher β indicates that Chinese importers experience greater volatility in import prices induced by exchange rate fluctuations. ξ_{ijc} denotes the firm-product-country level fixed effects to capture unobserved time-invariant factors for a combination of firm, product, and destination. τ_t, the time fixed effect, controls for macro-shocks that are common to all firms. The main results remain stable to alternative fixed effects. These multi-dimensional fixed effects restrict unit value changes to price adjustments rather than other product or supplier switching decisions.

Table 3 presents the estimation results using specification (2). As shown in column (1), the average ERPT for Chinese importers is about 73%, indicating that a 10% real depreciation in RMB leads to around 7.3% increase in the import prices faced by Chinese firms. In other words, Chinese importers absorb more than two-thirds of exchange rate shocks, while the remaining portion is borne by foreign suppliers.[13] The estimated ERPT remains stable and stands at around 72%, after controlling for the sales income, employment, and estimated TFP of firms. By accounting for these factors, we control for the role of firm size and market power in driving firms' response to exchange rate shocks. Our estimated ERPT remains stable to controlling for firm size.

The existing literature primarily focuses on import-side ERPT at the aggregate level, documenting that ERPT estimates vary widely across countries and time horizons (Burstein and Gopinath, 2014). Short-run ERPT ranges from 0.2 in the U.S. to 0.75 in Japan, while long-run ERPT spans from 0.51 in the U.S. to 0.97 in France. Our estimates in the short run fall within the reasonable range in the literature, slightly above the average level for the U.S. and other OECD countries. In addition, the choice of currency plays a significant role in ERPT. In the U.S., Gopinath et al. (2010) finds that the average ERPT for transactions denominated in the local currency (USD) is 0.25, whereas for those denominated in other currencies, it is 0.95. Although we lack detailed information on the currencies in which China's imports are denominated, anecdotal evidence suggests that most Chinese imports are priced in U.S. dollars, with a small portion denominated in Chinese RMB.[14]

3.2. Credit constraints and exchange rate pass-through

Financial conditions faced by importers can significantly influence the pass-through of exchange rate shocks into import prices, as participating in international trade often requires access to external capital. For example, importing inputs from foreign suppliers frequently involves cash-in-advance requirements, where the importer must pre-pay part or all of the cost of the goods before they are received. Since the importer relies on these inputs for production and must sell the final goods to generate revenue, this prepayment obligation necessitates borrowing external finance, which is repaid after production is complete. As a result, financial

[11] Alviarez et al. (2023) shows that for the U.S. importers, their estimated bargaining power (ϕ) ranges from 0.67 to 0.77, while exporters hold a bargaining power between 0.23 and 0.33 (1-ϕ). This significantly deviates from scenarios where importers are assumed to be price takers.

[12] The country GDP control $RGDP_{ct}$ represents the real GDP of the source country deflated to the constant price level, serving as a proxy for the market condition in the source country.

[13] In Appendix Table A.2, we repeat the same exercise using alternative samples of importers, and show that there is not much change in the estimates for ERPT into import prices.

[14] We conduct a robustness test by excluding the U.S. and other countries that use the U.S. dollar as their official currency or whose currency is pegged to the U.S. dollar. The estimated import ERPT from the rest of the world, excluding USD-pegged countries, is 84.9% in column (1) of Table A.2, slightly higher than the 73.2% observed in the matched sample.

Table 3
Exchange rate pass-through to import prices and credit constraints.

	(1)	(2)	(3)	(4)	(5)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$				
	Baseline	FPC	External finance	Tangibility	Inventory
$\Delta \ln RER_{ct}$	0.732***	0.351***	0.493***	1.986***	−0.930**
	(0.075)	(0.064)	(0.065)	(0.258)	(0.420)
$\Delta \ln RER_{ct} \times FPC_s$		0.573***			
		(0.089)			
$\Delta \ln RER_{ct} \times ExtFin_s$			1.749***		
			(0.266)		
$\Delta \ln RER_{ct} \times Tang_s$				−5.111***	
				(0.960)	
$\Delta \ln RER_{ct} \times Invent_s$					9.536***
					(2.460)
Median marginal ERPT		0.726	0.540	0.896	0.834
Country GDP control	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (2)–(5) use different measures of credit constraints calculated using U.S. data. The median marginal ERPT denotes the marginal effects of exchange rate changes on import prices with a median-level value of credit constraints (in each measure). All regressions include firm-product-country fixed effects and year fixed effects.

constraints can make importers more sensitive to price changes caused by exchange rate fluctuations, ultimately affecting the degree of ERPT during negotiations with foreign suppliers.

Based on this idea, the second objective of this paper is to evaluate how financial constraints faced by Chinese importers affect the degree of ERPT. While the traditional view of the role of credit constraints on exporters' pricing decisions in response to exchange rate shocks primarily involves adjustments related to profit margins (e.g., Manova, 2013; Chaney, 2016), financial constraints may influence import prices by increasing firms' reliance on external financing to provide the necessary cash or liquid funds for transactions, including cash-in-advance requirements, monitoring costs, and shipping expenses.

To formally test this, we incorporate an interaction term between sector-level financial constraints and changes in real exchange rates into our empirical specification:

$$\Delta \ln P_{ijct} = \alpha + \beta_1 \Delta \ln RER_{ct} + \beta_2 \Delta \ln RER_{ct} \times FC_s + \gamma' Y_{ct} + \xi_{ijc} + \tau_t + \epsilon_{ijct}, \tag{3}$$

where FC_s denotes various measures of financial (credit) constraints within sector s to which firm j belongs, while all other variables remain consistent with those in the baseline equation. Intuitively, firms operating in financially vulnerable industries typically have limited access to sufficient funds to support their international trade activities; in other words, they encounter stricter credit constraints.[15] The interaction coefficient β_2 captures the effect of credit constraints on ERPT. A positive β_2 indicates that importers facing greater credit constraints exhibit a more complete exchange rate pass-through into import prices. Consequently, the average ERPT into import prices within sector s is given by $\beta_1 + \beta_2 FC_s$.

According to our hypothesis, financially constrained firms exhibit a higher demand elasticity to import price changes induced by exchange rate fluctuations. When domestic currency depreciation against some foreign currency raises import prices for the corresponding foreign suppliers, these importers experience a more pronounced decline in demand from foreign suppliers, limiting their capacity to push prices downward in negotiation and resulting in a complete ERPT. Conversely, when domestic currency appreciation increases demand, the importer's bargaining position is strengthened, putting downward pressure on negotiated prices and again leading to a complete ERPT. Both effects should be stronger for more financially constrained firms. Therefore, we expect that the interaction coefficients on FPC_s and $ExtFin_s$ will be positive, indicating that tighter financial constraints lead to a more complete pass-through of exchange rate shocks into import prices. Conversely, we anticipate that the coefficient on $Invent_s$ will be negative, suggesting that greater asset tangibility mitigates the extent of pass-through by providing firms with more collateralizable assets, thereby reducing their vulnerability to exchange rate fluctuations.

Columns (2)-(5) in Table 3 present differences in exchange rate pass-through into import prices resulting from the industry-level credit heterogeneity. In column (2), we utilize the first principal component of external finance dependence and asset tangibility FPC_s to measure financial constraints and show that ERPT into import prices is more complete in financially vulnerable sectors compared to less vulnerable ones. Columns (3) and (4) separately examine the effects of external finance dependence and asset tangibility. Consistent with the notion that a higher degree of external finance dependence indicates tighter credit constraints, we observe a positive coefficient for β_2, implying that ERPT into prices is more complete under tighter financial constraints. Conversely,

[15] In this paper, we treat credit constraints and financial constraints as synonymous.

a higher degree of asset tangibility (i.e., more collateralizable assets) can alleviate financial constraints, which is reflected in the negative coefficient for asset tangibility. In addition, using the inventory ratio $Invent_s$ as an auxiliary measure, column (5) further demonstrates a positive and significant effect of financial constraints on ERPT.

Antoniades and Zaniboni (2016) find that larger retailers exhibit higher ERPT because they charge lower markups and/or have lower local costs. If credit constraints correlate with smaller importers, our findings might appear inconsistent. However, their study focuses on firm size, whereas we emphasize financial constraints — specifically, reliance on external finance and asset tangibility — which reflect sectoral financial characteristics rather than firm size.[16] Second, our analysis centers on manufacturing firms. Among Chinese manufacturing firms, there is a strong positive correlation (0.72, p value = 0.002) between firm sales income and markup, indicating that larger manufacturers tend to charge higher markups—unlike retailers. Thus, our focus on financial constraints and the manufacturing sector helps explain why our findings differ from Antoniades and Zaniboni (2016)'s results.

Using the coefficients and the descriptive statistics of credit constraint measures, we can have a back-of-envelope calculation for the marginal effects of real exchange rate shocks at the observed levels. A firm in a sector with average-level credit constraints measured by FPC will have an average ERPT of 35.1%. If we pick the "unspecified food manufacturing" sector as an example, in which there are the largest number of firms among all CIC 4-digit categories, its FPC is −0.6371 and the average pass-through is 36.7%. If the firm operates in a sector with credit constraints at one standard deviation higher than the average level, the average ERPT will be at 92.4%, which is close to complete. Recalling that the overall average exchange rate pass-through in China is around 73.2%, we can infer that firms with higher-than-average credit constraint levels consist of a larger proportion in the overall importer sample.[17]

Our empirical findings support the hypothesis that exchange rate fluctuations tend to be absorbed into import prices for firms in more financially vulnerable industries. More reliance on external funding or limited ways to liquidate assets results in more financial burden when firms engage in import and make them more sensitive to changes in negotiated prices. Consider the case where there is a depreciation in RMB against the US dollar, i.e., an increase in RER_{ct}. The direct effect of this depreciation is higher RMB-denominated import prices for Chinese firms, prompting them to reduce their demand for U.S. products. Unable to negotiate more favorable terms with U.S. suppliers, these firms are placed at a bargaining disadvantage, allowing suppliers to dictate conditions. Faced with tight credit constraints, importers have limited capacity to absorb such cost increases, forcing them to bear the brunt of the exchange rate fluctuations. This dynamic illustrates how importers' credit constraints shape ERPT by influencing the bargaining position of importers.

It is worth noting that the exchange rate pass-through here is estimated by the at-the-dock import price in our specification. This measure of import price includes pre-landing insurance and shipping costs but excludes any impact on credit constraints on post-landing costs, such as local distribution and logistics costs. In other words, the impact of credit constraints on import costs found here works mainly by affecting the suppliers' pricing behavior. Since importers' characteristics cannot influence suppliers' marginal costs, import price pass-through is almost entirely determined by suppliers' markups. If the supplier's markup is rather more fixed, then the exchange rate pass-through is more complete. Intuitively, firms in more credit-constrained industries are more sensitive to price changes, and product prices are more likely to be pegged to the US dollar (vehicle currency pricing, VCP) or the currency of the exporting country (producer currency pricing, PCP, less pricing-to-market), so at-the-dock prices respond more to exchange rate fluctuations regardless of any domestic market factor.

Although credit constraints affect exchange rate pass-through similarly on both the export and import sides (Strasser, 2013), the underlying mechanisms may differ. On the export side, a higher external finance premium raises marginal costs, compelling financially constrained firms to set higher prices and face a more elastic demand curve. In response to an exchange rate shock, the optimal choice is to adjust markups; however, such firms can only do this to a limited extent because of their narrower profit margins.

On the import side, credit constraints influence the demand elasticity for imported inputs. Adequate credit or cash reserves make an importer's demand for foreign inputs less sensitive to price changes, thus preserving its previous bargaining position and enabling longer-term — or more stable — pricing arrangements that shift more exchange rate risk onto foreign suppliers. In contrast, a financially weaker importer lacks the capacity to transfer risk, prompting it to adjust import demand more sharply, shift bargaining position substantially, thus exposing itself to greater price volatility.

3.3. Sourcing diversity and exchange rate pass-through

Next, we take a step further to explore the mechanism. Through what channels do credit constraints affect the ability of importers to cope with exchange rate shocks? What other factors related to a firm's sourcing power would exacerbate or diminish this effect? Are the effects of credit constraints fully explained by these factors? To answer the questions, we add a vector $\mathbb{Z}_{jt}$ to include additional factors and apply it to control terms and the interaction terms with real exchange rate changes:[18]

$$\begin{aligned}\Delta \ln P_{ijct} =& \alpha + [\beta_1 + \beta_2 \times FC_s + \beta_3 \times \mathbb{Z}_{jt}]\Delta \ln RER_{ct} \\ &+ \gamma' Y_{ct} + \eta' \mathbb{Z}_{jt} + \xi_{ijc} + \tau_t + \epsilon_{ijct}.\end{aligned} \tag{4}$$

[16] In our data, the correlation between an industry's average firm size and its financial constraints is weak (0.02) and statistically insignificant (p-value = 0.924). Moreover, our empirical results remain robust after controlling for firm size.

[17] In addition, from the credit constraints for the 10 and 90 percentile quartiles, the exchange rate pass-through estimates for some industries may be outside the range of zero to one, and these outliers may be related to industry-specific properties.

[18] We will also use its lagged form $\mathbb{Z}_{jt-1}$, the initial time value $\mathbb{Z}_{jt_0}$ or mean level $\bar{\mathbb{Z}}_{jt}$ to eliminate possible simultaneous endogeneity in the robustness check.

Table 4
Import sources, credit constraints, and exchange rate pass-through.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	Current sources				Initial sources			
	#Sources	#Sources+ FPC	#Sources+ external finance	#Sources+ tangibility	#Sources	#Sources+ FPC	#Sources+ external Finance	#Sources+ tangibility
$\Delta \ln RER_{ct}$	0.950***	0.550***	0.696***	2.375***	0.930***	0.548***	0.683***	2.282***
	(0.055)	(0.058)	(0.054)	(0.146)	(0.054)	(0.059)	(0.054)	(0.147)
$\Delta \ln RER_{ct} \times \#Source_{ijt}$	−0.059***	−0.059***	−0.057***	−0.081***	−0.066***	−0.071***	−0.065***	−0.076***
	(0.009)	(0.010)	(0.009)	(0.024)	(0.010)	(0.012)	(0.010)	(0.028)
$\Delta \ln RER_{ct} \times FPC_s \times \#Source_{ijt}$		−0.015**				−0.011		
		(0.007)				(0.009)		
$\Delta \ln RER_{ct} \times FPC_s$		0.670***				0.637***		
		(0.046)				(0.047)		
$\Delta \ln RER_{ct} \times ExtFin_s \times \#Source_{ijt}$			−0.064***				−0.058**	
			(0.020)				(0.025)	
$\Delta \ln RER_{ct} \times ExtFin_s$			2.113***				2.024***	
			(0.137)				(0.140)	
$\Delta \ln RER_{ct} \times Tang_s \times \#Source_{ijt}$				0.049				−0.005
				(0.098)				(0.116)
$\Delta \ln RER_{ct} \times Tang_s$				−5.665***				−5.374***
				(0.537)				(0.552)
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm-product level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) use the number of source countries in the current year, while columns (5)–(8) use the number of source countries in the initial year. All regressions include firm-product-country fixed effects and year fixed effects.

$$\Delta \ln P_{ijct} = \alpha + [\beta_1 + \beta_2 \times FC_s + \beta_3 \times \mathbb{Z}_{jt} + \beta_4 \times FC_s \times \mathbb{Z}_{jt}]\Delta \ln RER_{ct} + \gamma' Y_{ct} + \eta' \mathbb{Z}_{jt} + \xi_{ijc} + \tau_t + \varepsilon_{ijct}. \quad (5)$$

With the estimation strategy in Eq. (4) and Eq. (5), we can analyze various factors that may directly or indirectly affect exchange rate pass-through. The coefficient of the interaction term between additional factors and real exchange rate movement β_3 represents the direct effects of those factors on the exchange rate pass-through other than financial constraints. In Eq. (5), the triple interaction coefficient β_4 represents the indirect effects of these factors on the pass-through of the exchange rate through financial constraints. The same sign of β_4 and β_2 means that this additional factor improves the effect of credit constraints, while the opposite sign means it alleviates the effect of credit constraints.

In the face of exchange rate shocks, firms are at risk of import price changes and will try to stabilize their imports to avoid production disruptions due to input shortages. Diversification of import linkages will help firms maintain more resilient supply relationships. An intuitive explanation for this is that it is more costly for firms to find new suppliers in countries they have never entered before, whereas it is cheaper to increase imports from suppliers with whom they already have a relationship or to purchase from new suppliers in countries where they already have sourcing experience. Firms sourcing from only a few countries are more exposed to exchange rate shocks than firms sourcing in a decentralized manner. Firms sourcing from only a few countries are more exposed to exchange rate shocks than firms that diversify their sourcing. In this part, we will examine how sourcing diversity affects exchange rate pass-through for firms subject to different levels of credit constraints.

Following the literature, an importer's sourcing diversity could increase its bargaining power in import prices in addition to its production characteristics. We argue that the more diverse a firm's sourcing choices are, the more flexible it is in adjusting its import sources when facing shocks. If a firm can respond to shocks by adjusting its supply network more flexibly, its uncertainty about cost prices should diminish. Therefore, a potential mechanism through which financial constraints affect an importer's bargaining power with foreign suppliers is its outside sourcing options. Companies with more trading partners can flexibly switch to another supplier or adjust the weight of imports from different countries. Firms with heterogeneous sourcing capacity may therefore be affected by credit constraints to a different extent.

Therefore, we want to test how importers' sourcing diversity affects exchange rate pass-through. First, we will use the number of source countries $Source_{ijt}$ from which an importer j imports a certain type of HS6 product i in year t to measure the firm-product level sourcing diversity. We employ Eq. (5) that includes the number of import sources for each firm-product pair. The estimation results of sourcing diversity are reported in Table 4.

The estimates for intersection terms between import sources and real exchange rate changes are shown in column (1). We find that an importer who imports a certain product from more sources will have a less complete pass-through. This is consistent with our hypothesis that importers with more alternative sourcing options will have less complete pass-through. In other words, the diversity

Table 5
Robustness check: alternative credit constraints measures from Chinese data.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Measures of credit constraints from Chinese data			
	External finance	Tangibility	Inventory	R&D intensity
$\Delta \ln RER_{ct}$	0.943***	3.427***	−0.966***	0.215*
	(0.113)	(0.395)	(0.267)	(0.110)
$\Delta \ln RER_{ct} \times ExtFin_s^{CN}$	0.327**			
	(0.134)			
$\Delta \ln RER_{ct} \times Tang_s^{CN}$		−9.321***		
		(1.286)		
$\Delta \ln RER_{ct} \times Invent_s^{CN}$			14.919***	
			(2.433)	
$\Delta \ln RER_{ct} \times R\&D_s^{CN}$				26.607***
				(5.291)
Median marginal ERPT	0.789	0.778	0.796	0.639
Country GDP control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The dependent variable is the price change $\Delta \ln P_{ijct}$. Columns (1)–(4) use different measures of credit constraints calculated using Chinese data. The median marginal ERPT denotes the marginal effects of exchange rate changes on import prices with a median-level value of credit constraints (in each measure). All regressions include firm-product-country fixed effects and year fixed effects.

of import sources for the same product can significantly enhance the stability of import prices. After adding interactions, we find the effects of credit constraints still exist while the triple interaction terms with the number of sources have the opposite while still significant coefficients in columns (2) and (3). The triple interaction term in column (4) is not significant, probably because the offsetting effect of sourcing diversity is mainly for industries more dependent on external financing than weaker collateralization capabilities. Columns (5)-(8) repeat the above test using the number of source countries in the initial year (the year in which the firm appeared for the first time in this sample) as the measure of sourcing diversity to deal with possible simultaneous endogeneity problems.[19]

The results show that a wider sourcing base will mitigate the effects of credit constraints and their direct effects on exchange pass-through into import prices. The opposing effects of credit constraints and sourcing diversity on exchange rate pass-through confirm the existence of the bargaining power of importers. We show that if a firm can import the same product from more sources, even in a financially demanding industry, it can utilize these outside options to escape the unfavorable bilateral exchange rate risk from a certain source country. The firm with a more diverse sourcing network can either switch from one supplier to another to reduce its input costs (i.e., trade diversion effect) or make a more credible threat by negotiating a more stable price. Therefore, firms with more import sources will be better cushioned against fluctuations in the cost of imported inputs due to changes in exchange rates.

4. Robustness checks

This section provides robustness checks for our empirical findings. First, we use alternative measures of credit constraints using Chinese data. Second, we incorporate additional control variables into our regressions to address potential omitted variable bias. The newly added variables encompass trade modes, firm ownership types, industry size, and firm import intensity. Finally, we adopt alternative estimation methods, including different fixed effects specifications and cross-sectional estimations, to test the robustness of our main results. Our main results remain consistent in all those tests.

4.1. Alternative measures of credit constraints

In this section, we use alternative credit constraint measures using Chinese firm data to verify our baseline results. The purpose is to avoid potential bias from differences in the attributes of industry credit demand in different countries. The details of constructing these Chinese variables are discussed in Section 2.2. Although China's financial markets are less mature than the U.S., the relative rankings of the degree of credit constraint in different sectors are similar (Manova, 2013). Therefore, the credit constraint measures calculated based on Chinese data are expected to be consistent with the main findings with US measures.

[19] Since our fixed effects include firm-product combinations, we have already excluded the effect of firm size on the demand for the specific product.

Our results using Chinese sector-level measures are reported in Table 5.[20] Columns (1)-(4) of Table 5 present the effects of external finance dependence, tangibility, inventory ratio, and R&D intensity on exchange rate pass-through into import prices, respectively. All interaction term coefficients exhibit the same signs and significance as above, confirming the validity of the effects of credit constraints on the exchange rate pass-through shown in the previous section. Even column (4) using the auxiliary measure R&D intensity shows that firms in industries with greater R&D investment also have more complete exchange rate pass-through. With alternative measures calculated using Chinese data, we can conclude that financially more constrained importers have more complete exchange rate pass-through into prices than those less constrained.

4.2. Additional control variables

We acknowledge that manufacturing firms participating in trade involve different types of trade. We will perform multiple tests to control different sector-level and firm-level variables to avoid spurious correlations.

First, some importers may source from foreign suppliers while others may be "two-way traders" who export and import within the same year. Simultaneous exports and imports could interact with each other and affect their exchange rate pass-through. For example, exporting importers may pass part of the price fluctuations of imported intermediate goods caused by exchange rate shocks to their export destination to hedge the exchange rate risk. To test this two-way effect, we control a "two-way" indicator with which we identify firms importing and exporting simultaneously.[21] Besides, some importers may be registered as "processing trade", who sign contracts with foreign customers to import raw materials and intermediate inputs from those customers by credit for domestic processing and re-export (Manova and Yu, 2016). Economists usually believe that processing-trade firms may behave differently from other firms in their trading behaviors. Being cautious about our estimation of exchange rate pass-through concerning processing trade, we control its trade mode indicator in the robustness checks.[22] The results are shown in column (1)-(2) of Table 6.[23]

Second, firms' connection to their owners and their access to credit are highly correlated. Firm ownership may be another potential factor affecting credit constraints, as importers can obtain additional credit support from their parent firms or owners to finance a larger share of extra trade costs. Given the underdevelopment of Chinese financial markets, firms with different types of ownership are likely to have other credit access in addition to their credit demand based on industry characteristics. To test this, we add ownership information as additional controls of firm characteristics into the estimations. Specifically, we will use two different ownership classification criteria. First, we use the 3-digit registration type codes in the ASIE and divide these different registration codes into four categories: state-owned enterprises (SOE), domestic private enterprises (DPE), multinational enterprises (MNE), and joint ventures (JV), among which DPE is set as the default group. Second, we will assign an "affiliation" indicator for each importer using matching correspondence data between parent firms and subsidiaries, which takes the value of 1 when an importer is not a subsidiary of another company. The impacts of ownership type and affiliation on firm-level credit access are controlled in columns (3)-(4) of Table 6.[24]

Third, we add relevant sector-level characteristics such as the importing industries' total size and average firm size to exclude any possible spurious correlation due to omitted variable bias. The firm size is believed to be less endogenous than many other sorting variables. For example, we can account for firm-level economies of scale and market power since larger firms or industries might exert more market power, affecting their pricing strategies and the degree of pass-through. Firms in larger industries might have collaborative bargaining power compared to firms in minor sectors. Finally, we add controls for the firm's import intensity, defined as the share of imported inputs over total inputs, as a measure of buyer market power in the import market. After controlling for import intensity, the coefficients on the interaction terms will include only the effects of industry-level credit constraints. We include these variables in the estimations in columns (5)-(7) of Table 6.[25]

Table 6 is a summary of results with those additional control variables, in which we will only show FPC_s as the measure of credit constraints. We find that coefficients of interaction with credit constraints remain in the same sign and significant in all columns, suggesting that the effect of importer credit constraints on exchange rate pass-through that we find is not fully absorbed by these additional control variables.

4.3. Alternative estimation methods

Our estimation strategy includes multiple data dimensions, including product, source country, and time. Therefore, the baseline estimation of exchange rate pass-through adapts panel fixed-effects regression, in which ξ_{ijc}, the firm-product-country level three-dimensional fixed effects and τ_t, the time fixed effects, thereby lead to accurate estimation of price changes only due to exchange rate shocks. In this section, we will try alternative estimation methods to check the robustness of our results.

[20] We also extend our analysis using time-varying firm-level measures of credit constraints using sector-level measures as instruments because of endogeneity concerns. The magnitudes of coefficients are even larger in the 2SLS tests using time-varying firm-level measures (−18.38 for tangibility and 32.11 for inventory ratio).

[21] We take the value of 1 when a firm only imports or 0 when it imports and exports in the same year.

[22] We take the value of 1 when a transaction belongs to ordinary trade or 0 when it belongs to processing trade. Ordinary trade accounts for more than 2/3 of the total transactions in our sample. Therefore, the pricing patterns based on ordinary trade should dominate the overall Chinese trade.

[23] Detailed results about two-way traders and processing trade are shown in Table A.3.

[24] Detailed results about ownership and affiliation are shown in Table A.4.

[25] Detailed results about industry size are shown in Table A.5 while results about import intensity are shown in Table A.6.

Table 6
Summary of robustness checks: additional control variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$						
$\Delta \ln RER_{ct}$	0.384***	0.766***	0.191	0.645***	−3.069***	−1.444***	−0.991***
	(0.077)	(0.096)	(0.211)	(0.045)	(0.588)	(0.438)	(0.131)
$\Delta \ln RER_{ct} \times FPC_s$	0.562***	0.565***	0.403***	0.402***	0.465***	0.356***	0.461***
	(0.089)	(0.088)	(0.052)	(0.053)	(0.081)	(0.089)	(0.084)
Median marginal ERPT	0.752	1.136	0.455	0.773	0.613	0.704	
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Two-way indicator	Processing indicator	Ownership category	Affiliation indicator	Industry Total sales income	Average Firm sales income	Import intensity
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,168	1,449,168	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The dependent variable is the price change $\Delta \ln P_{ijct}$. The median marginal ERPT denotes the marginal effects of exchange rate changes on import prices with a median-level value of credit constraints (in FPC_s). In columns (5)–(7) we further use the median values of interacted sales income and import intensity. All regressions include firm-product-country fixed effects and year fixed effects.

Table 7
Summary of robustness checks: alternative estimation methods.

	(1)	(2)	(3)	(4)	(5)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$				
	Alternative fixed effects			One-year sample	Between estimator
$\Delta \ln RER_{ct}$	0.567***	0.626***	0.493***	1.986***	0.736***
	(0.042)	(0.04)	(0.065)	(0.258)	(0.064)
$\Delta \ln RER_{ct} \times FPC_s$	0.139***	0.086**	0.266***	0.483***	0.102***
	(0.035)	(0.038)	(0.056)	(0.129)	(0.037)
Country GDP control	Yes	Yes	Yes	Yes	Yes
Firm-year FE	Yes	Yes	No	No	No
Firm-country FE	No	No	Yes	No	No
Firm-product FE	No	No	No	Yes	Yes
Product-country FE	No	Yes	No	No	No
Product-year FE	No	No	Yes	No	No
Product FE	Yes	No	No	No	No
Country FE	Yes	No	No	No	No
Observations	1,428,072	1,416,558	1,406,629	239,338	706,717

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The dependent variable is the price change $\Delta \ln P_{ijct}$. All regressions include firm-product-country fixed effects and year fixed effects.

First, we will check whether other fixed-effect combinations yield similar results. In the following tests, we will combine firm-year fixed effects $\tilde{\xi}_{jt}$ with two-dimensional product-country fixed effects λ_{ic} or separately with product fixed effects λ_i and country fixed effects λ_c. Besides, we also test product-year fixed effects $\tilde{\xi}_{it}$ with two-dimensional firm-country fixed effects.

Second, to avoid firm endogeneity, our measures of credit constraints only capture the cross-sectional pattern, i.e., the industry-level credit needs measures are persistent and thus averaged over time. Therefore, to fully sort out the time variation effect, we also conduct cross-sectional estimation using both a one-year sample in 2007[26] and between estimators,[27] with the following equation:

$$\overline{\Delta \ln P_{ijc}} = \alpha + \beta_1 \overline{\Delta \ln RER_c} + \beta_2 \overline{\Delta \ln RER_c} \times FC_s + \gamma \overline{\Delta \ln RGDP_c} + \bar{\xi}_{ij} + \varepsilon_{ijc} \tag{6}$$

A simplified summary using those alternative estimation methods is shown below in Table 7, in which we will only show FPC_s as the measure of credit constraints. We find that interaction term coefficients are statistically significant and robust in all columns, suggesting that our baseline findings still hold under those different estimations.[28]

5. Discussions about import market share

In this section, we further investigate the heterogeneity of firms in import bargaining power and its impacts on firms' responses to exchange rate movements. Although our results and robustness checks show that financial constraints adequately explain the

[26] The year 2007 is randomly picked in the sample period, and the results with other years are not shown here but are available upon request.
[27] The between estimator with bars indicate average variables and therefore the time variation has been averaged out.
[28] More detailed tables containing different credit constraint measures under alternative estimation methods will be shown in Table A.7 and Table A.8.

Table 8
Heterogeneous market share, credit constraints, and exchange rate pass-through.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.832***	0.438***	0.579***	2.003***
	(0.070)	(0.079)	(0.069)	(0.258)
$\Delta \ln RER_{ct} \times MS_{ijct-1}$	−0.975***	−0.728***	−0.791***	−0.782***
	(0.130)	(0.123)	(0.126)	(0.122)
$\Delta \ln RER_{ct} \times FPC_s$		0.555***		
		(0.088)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.705***	
			(0.264)	
$\Delta \ln RER_{ct} \times Tang_s$				−4.859***
				(0.960)
Country GDP control	Yes	Yes	Yes	Yes
Market share control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1%. MS_{ijct-1} denotes the fraction of a firm j's import value to the total value imported by all Chinese importers of product i from source c in the previous year $t-1$. Columns (2)–(4) use different measures of credit constraints calculated using U.S. data. All regressions include firm-product-country fixed effects and year fixed effects.

fluctuations in import costs, we will discuss further whether and how buyer-side bargaining power works in affecting the exchange rate pass-through.

In addition to the extensive diversity measured by the number of import sources, we use a firm's share in a specific import market to describe its intensive competitiveness. Following Amiti et al. (2014) and Devereux et al. (2017), we define the "import market share" as the fraction of a firm's import value to the total value imported by all Chinese importers from the same source, within a given HS6 product category and a given year.

$$S_{ijct} \equiv \frac{v_{ijct}}{\sum_{j' \in J_{ict}} v_{ij'ct}},$$

where J denotes the set of potential competitors in the same product-specific market; therefore, from the definition, a single firm can have multiple import market shares for different imported products. Our definition of market share is also year-specific, so a firm's import market share can vary over time.[29] We assume that the external competitive stance in a particular product-source pair is common for all Chinese importers purchasing from the same country. Hence, our measure captures all relevant variations in sourcing market power between firms in our sample.

We first provide the regression results of Eq. (4) using the market share in Table 8. The coefficient estimates for β_2 and β_3 can be used to describe the effects of credit constraints and market shares on exchange rate pass-through, respectively. In column (1), we add the market share terms to the ERPT baseline estimation. In columns (2)-(4), we also include the effects of industry-level credit constraints. We find evidence of a negative relationship between import pass-through and market share.[30] In conclusion, relatively large Chinese buyers have a degree of market power in the segmented sourcing market relative to competitors.

Since the buyer's market share is a direct measure of sourcing market power, our finding confirms the argument that larger buyers in a certain product market will face lower price changes during exchange rate fluctuations, even if they import from the same sources as before. Therefore, the bilateral market forces cannot be ignored in any future discussion of the impact of exchange rate transmission or credit constraints on trade pricing. The theoretical assumption that exporters set prices unilaterally and importers are price takers will be misleading (Alviarez et al., 2023). However, the effect of industry-level credit constraints on exchange rate pass-through remains robust, suggesting that market shares do not fully explain the effect of credit constraints.

6. Theoretical framework

To rationalize our empirical findings, we develop a simple partial equilibrium model of price determination in firms' import sourcing choices, built upon (Alviarez et al., 2023). The primary focus is to investigate how financial constraints and sourcing diversity influence the degree of exchange rate pass-through into import prices. For simplicity and clarity, we present only the key intuitions here and defer the technical details to Appendix B.

[29] The market share S_{ijct} is relative to other Chinese firms since we only use customs data from China.

[30] In the literature, Auer and Schoenle (2016) suggest that the response of prices to an exchange rate shock is U-shaped in the export market share. Devereux et al. (2017) argue that the market share of the importing firm is negatively correlated with the pass-through and positively with the local currency price (LCP).

In the model, we focus on a specific type of financial constraint that is commonly encountered in international transactions: the importer is required to prepay a fixed fraction of the ordered import value before receiving the inputs from foreign suppliers.[31] We assume that the importer does not have initial assets and must borrow from banks to make the required prepayment at some (exogenous) interest rates. It then repays the loan and interests once it generates profits after selling the final goods to consumers. The prepayment requirement acts like additional variable cost to each import transaction, as the amount of prepayment is proportional to the bilateral trade flows. Therefore, tighter financial constraints (e.g., higher interest rate imposed on the borrowing or higher fraction of prepayment) makes the importer more sensitive to price fluctuations induced by exchange rate shocks, leading to a higher demand elasticity of imports.

When an exchange rate shock raises a foreign supplier's price (e.g., depreciation in RMB), the importer's demand for that particular input decreases. This reduction in demand limits the importer's ability to lower the negotiated price within this buyer-seller relationship and make the price move align with the exchange rate change, which constitutes a force of *complete* pass-through into the import price. Financial constraint amplifies this effect by making the importer more sensitive to price increases, thereby leading to a higher demand reduction in response to the exchange rate shock. Consequently, tighter financial constraints lead to a more complete exchange rate pass-through by amplifying the importer's demand response.

On the other hand, for the supplier, when its production technology exhibits decreasing returns to scale, reduced demand from an importer lowers the supplier's marginal cost of production. This reduction in marginal cost provides the supplier with greater flexibility to stabilize the price by lowering its markup in response to positive cost shocks. This results in a channel of *less* complete pass-through. Through this channel, increased sourcing diversity plays a role: when the importer's initial demand is more dispersed across multiple suppliers, the importer's demand elasticity for each supplier's input becomes larger. This higher elasticity means that one unit of cost shock leads to a higher reduction in demand for this supplier, and eventually amplifies the endogenous adjustments in the supplier's marginal cost, further contributing to an even less complete pass-through.

To summarize, the observed exchange rate pass-through into import prices can be decomposed into several channels, as outlined in Alviarez et al. (2023). In our context, financial constraints and sourcing diversity play distinct roles in shaping the degree of ERPT. Financial constraints increase importers' demand elasticity, significantly altering their bargaining position in response to exchange rate fluctuations. In contrast, sourcing diversity influences suppliers' production costs, providing scope for price stabilization on the supplier side. Here, we focus on discussing the potential mechanisms at play, leaving the detailed calibration of model parameters to future work.

7. Conclusions

This paper provides evidence at a highly disaggregated level for the incomplete exchange rate pass-through to import prices in China. Our research contributes to the literature by revealing how importers' characteristics, especially the degree of financial constraints that they face, affect exchange rate price pass-through patterns. Utilizing unit value information from Chinese customs data, we find that (1) the average exchange pass-through into import prices in China is not complete, at around 73% (2) for firms in industries with more stringent credit constraints, the import exchange rate pass-through tends to be more complete; (3) import sourcing diversity (i.e., more sourcing options) can effectively reduce import price pass-through and partially offset the effect of credit constraints. A novelty of our empirical strategy is to focus on the role of the global sourcing network in determining the responses of firms to exchange rate fluctuations. We believe that the extent of micro-level exchange pass-through into import prices measures the ability of Chinese firms to withstand risks in global sourcing from a new perspective.

There are several directions for future studies. First, scholars could explore the underlying mechanism by which credit constraints affect exchange rate pass-through. At this stage, we only verify this effect based on a reduced-form approach. Even after controlling for some potential channels claimed by the literature, we are not yet clear about how the remaining effects of credit constraints work. Future work can contribute by establishing a structural model to identify the detailed channels. Second, it is worth studying how import and export behaviors influence each other. The dominance of two-way traders in China's international trade is a key fact that cannot be ignored. Adjustments on the import and export sides are two sides of the same coin for firms to face exchange rate shocks. Third, we should pay attention to China's exchange rate pass-through trend over time. The trend may reflect the change in the market power of Chinese firms and their pricing patterns concerning market behaviors. Ideally, future research could quantitatively distinguish each factor's contribution to the exchange rate pass-through trend.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[31] Prepayment, or cash-in-advance payment, refers to the financial arrangement in which an importer pays for goods before they are shipped or delivered by the supplier. This payment method is widely used in international trade to mitigate risks faced by foreign suppliers yet it brings a financial burden for the importer. We focus on this type of payment due to its commonality in practice and its tractability in our model. For more details on cash-in-advance and other payment methods used in international trade, see the International Trade Administration's website: https://www.trade.gov/methods-payment.

Table A.1
Correlations of different credit constraint measures.

	FPC_s	$ExtFin_s^{US}$	$Tang_s^{US}$	$Invent_s^{US}$	$ExtFin_s^{CN}$	$Tang_s^{CN}$	$Invent_s^{CN}$	$R\&D_s^{CN}$
FPC_s	1.0000							
$ExtFin_s^{US}$	0.8545	1.0000						
$Tang_s^{US}$	−0.8655	−0.4795	1.0000					
$Invent_s^{US}$	0.5437	0.2519	−0.6756	1.0000				
$ExtFin_s^{CN}$	−0.1965	−0.0040	0.3280	−0.3461	1.0000			
$Tang_s^{CN}$	−0.5775	−0.3028	0.6836	−0.6992	0.3109	1.0000		
$Invent_s^{CN}$	0.4578	0.4908	−0.3001	0.2458	−0.0777	−0.1983	1.0000	
$R\&D_s^{CN}$	0.3055	0.2774	−0.2486	0.1986	0.1590	−0.3794	0.1947	1.0000

Notes: This table presents correlations among different measures of credit constraint from the US and Chinese data. The measures are the same as in Table 2.

Table A.2
ERPT estimation with alternative samples of importer.

	(1)	(2)	(3)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$		
	No USD peg	Top 50	Top 20
$\Delta \ln RER_{ct}$	0.849***	0.723***	0.658***
	(0.086)	(0.064)	(0.066)
Year FE	Yes	Yes	Yes
Country GDP control	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes
Observations	1,147,027	1,439,301	1,343,150

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Column (1) uses the subsample excluding the U.S. and other countries that use the US dollar as their official currency or whose currency is pegged to the US dollar. Columns (2) and (3) use sub-samples with only China's top 50 and top 20 partners ranked by total trade value. All regressions include firm-product-country fixed effects and year fixed effects.

Appendix A. Empirical appendix

A.1. More about data and measurements

See Table A.1 for correlations of different credit constraint measures.

A.2. ERPT estimation with alternative samples

See Table A.2 for ERPT estimation with imports only from non-USD-pegged countries and top 50 or top 30 trading partners.

A.3. Supplementary tables for robustness checks

See Tables A.3–A.8 for more details of robustness checks in Table 6 and Table 7.

A.4. Discussion about geographical distance

In Table A.9, we will use geographical distances as alternative measures of import sourcing diversity. Intuitively, firms that can import a certain good from more distant countries generally have greater sourcing power because they can afford the cost of transportation over long distances. Those firms should also be able to choose from more diversification options during shocks. We, therefore, consider product-specific distances as another indicator of sourcing diversity. We used straight-line distances between the most populated cities (simple distances), and population distribution-weighted distances as measures of trade distance, and the results remained consistent. As we expected, the results using geographic distance and the results using the number of sources are nearly identical in terms of the sign and significance of the coefficients. However, we acknowledged that it could be more than one reason to interpret our empirical results and the mechanism of these results should be left for open discussion.

Table A.3
Robustness check: trade type controls for two-way traders or processing trade.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	Two-way traders controls				Processing trade controls			
	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.767***	0.384***	0.525***	1.964***	1.152***	0.766***	0.886***	2.493***
	(0.065)	(0.077)	(0.066)	(0.258)	(0.092)	(0.096)	(0.092)	(0.278)
$\Delta \ln RER_{ct} \times FPC_s$		0.562***				0.565***		
		(0.089)				(0.088)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.727***				1.664***	
			(0.265)				(0.265)	
$\Delta \ln RER_{ct} \times Tang_s$				−4.922***				−5.383***
				(0.966)				(0.960)
$\Delta \ln RER_{ct} \times oneway_s$	−0.851***	−0.602***	−0.718***	−0.610***				
	(0.200)	(0.196)	(0.198)	(0.196)				
$\Delta \ln RER_{ct} \times process_s$					−0.787***	−0.768***	−0.716***	−0.826***
					(0.093)	(0.095)	(0.095)	(0.096)
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The dependent variable is the price change $\Delta \ln P_{ijct}$. Column (1)–(4) add one-way dummy interaction terms (1 for pure importers and 0 for two-way traders). Column (5)–(8) add processing trade interaction terms (1 for processing trade and 0 for ordinary trade). All regressions include firm-product-country fixed effects and year fixed effects.

Table A.4
Robustness check: ownership controls for registration type and affiliation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	Ownership registration controls				Affiliation controls			
	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.412**	0.191	0.265	1.187***	0.908***	0.645***	0.725***	1.648***
	(0.197)	(0.211)	(0.204)	(0.207)	(0.037)	(0.045)	(0.039)	(0.154)
$\Delta \ln RER_{ct} \times FPC_s$		0.403***				0.402***		
		(0.052)				(0.053)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.361***				1.362***	
			(0.153)				(0.155)	
$\Delta \ln RER_{ct} \times Tang_s$				−3.033***				−3.006***
				(0.576)				(0.580)
$\Delta \ln RER_{ct} \times SOE_j$	0.254	0.217	0.195	0.249				
	(0.248)	(0.265)	(0.263)	(0.257)				
$\Delta \ln RER_{ct} \times MNE_j$	0.633***	0.594***	0.599***	0.607***				
	(0.215)	(0.217)	(0.216)	(0.216)				
$\Delta \ln RER_{ct} \times JV_j$	0.307	0.255	0.262	0.274				
	(0.211)	(0.213)	(0.213)	(0.212)				
$\Delta \ln RER_{ct} \times Affiliate_j$					−0.486***	−0.470***	−0.494***	−0.461***
					(0.122)	(0.122)	(0.123)	(0.122)
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,168	1,449,168	1,449,168	1,449,168	1,449,168	1,449,168	1,449,168	1,449,168

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) include controls of registration type while columns (5)–(8) include controls of affiliation. All regressions include firm-product-country fixed effects and year fixed effects.

A.5. Discussion about firm-level markup

We have argued that credit constraints will affect the "absorptive capacity" of exchange rate shocks. Referring to previous studies on exchange rate pass-through to export prices, firms with various levels of markup have the heterogeneous ability to pass on fluctuations in the exchange rate to the export market (Amiti et al., 2019). From the fact that "big sellers are also big buyers" (Amiti et al., 2014), we want to check whether our arguments for credit constraints and exchange rate pass-through into import prices still hold after controlling for revenue-based estimated firm-level markups.

On the one hand, for two-way traders, export prices could act as a "pressure-reducing valve" for import costs. A firm that can pass more exchange rate fluctuations to destination prices has more room to absorb price fluctuations of imported inputs. In this

Table A.5
Robustness check: industry controls for industry size and average firm size.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	Industry total size				Industry average firm size			
	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	−3.531***	−3.069***	−3.012***	−2.102***	−1.854***	−1.444***	−1.322***	−0.787
	(0.636)	(0.588)	(0.584)	(0.632)	(0.455)	(0.438)	(0.454)	(0.527)
$\Delta \ln RER_{ct} \times FPC_s$		0.465***				0.356***		
		(0.081)				(0.089)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.442***				1.056***	
			(0.242)				(0.273)	
$\Delta \ln RER_{ct} \times Tang_s$				−3.921***				−3.083***
				(0.875)				(0.878)
$\Delta \ln RER_{ct} \times \ln Sales_{st}$	0.381***	0.312***	0.317***	0.340***				
	(0.058)	(0.053)	(0.053)	(0.055)				
$\Delta \ln RER_{ct} \times \ln \overline{Sales_{st}}$					0.588***	0.440***	0.433***	0.517***
					(0.108)	(0.107)	(0.110)	(0.105)
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) include controls of industry total sales while columns (5)–(8) include controls of average firm sales in the industry. All regressions include firm-product-country fixed effects and year fixed effects.

Table A.6
Robustness check: controls of import intensity.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Shares of imported inputs over total inputs			
	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	−0.776***	−0.991***	−0.922***	0.155
	(0.116)	(0.131)	(0.126)	(0.268)
$\Delta \ln RER_{ct} \times FPC_s$		0.461***		
		(0.084)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.521***	
			(0.248)	
$\Delta \ln RER_{ct} \times Tang_s$				−3.512***
				(0.956)
$\Delta \ln RER_{ct} \times \ln \varphi_{jt}^{imp}$	2.582***	2.422***	2.473***	2.460***
	(0.205)	(0.200)	(0.200)	(0.202)
Country GDP control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Product-country FE	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) include controls of shares of imported inputs over total inputs (import intensity). All regressions include firm-product-country fixed effects and year fixed effects.

way, the export and import prices of the same firm will be positively correlated under shocks. On the other hand, advantages in a firm's competitiveness, either explicit ones shown in its markup or productivity or implicit ones like foreign networks, may lead to greater bargaining power in the trade market and thus cause less complete price pass-through into both export and import prices.

Our firm-level data contains production information so that we can connect the exchange rate pass-through with estimated firm-specific markup. In this part, we will control markups to check our arguments. Following Brooks et al. (2021), we can estimate the firm-level markup without direct prices and marginal cost measures using the structural assumptions of De Loecker and Warzynski (2012) and the GMM estimation method. Specifically, we derive the firm-specific markup as the ratio of an input factor's output elasticity to its firm-specific factor payment share $\mu_t = \theta_t^X \left(\alpha_t^X\right)^{-1}$, where α_t^X is the share of expenditures on input X in total sales and θ_t^X denotes the output elasticity on input X. We apply the methodology of Ackerberg et al. (2015) to calculate the firm-specific output elasticity concerning materials using estimated firm-specific production functions, assuming a 3rd-order translog gross output

Table A.7
Robustness check: alternative fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$											
	Firm-year + Product + Country FEs				Firm-year + Product-Country FEs				Product-year + Firm-Country FEs			
	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.670***	0.567***	0.593***	0.946***	0.691***	0.626***	0.639***	0.841***	0.742***	0.552***	0.608***	1.262***
	(0.035)	(0.042)	(0.037)	(0.111)	(0.036)	(0.044)	(0.038)	(0.120)	(0.042)	(0.052)	(0.045)	(0.165)
$\Delta \ln RER_{ct} \times FPC_s$		0.139***				0.086**				0.266***		
		(0.035)				(0.038)				(0.056)		
$\Delta \ln RER_{ct} \times ExtFin_s$			0.456***				0.297***				0.872***	
			(0.095)				(0.104)				(0.164)	
$\Delta \ln RER_{ct} \times Tang_s$				−1.139***				−0.623				−2.150***
				(0.429)				(0.467)				(0.627)
Country GDP control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Firm-country FE	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Product-country FE	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Product-year FE	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
Country FE	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
Observations	1,428,072	1,428,072	1,428,072	1,428,072	1,416,558	1,416,558	1,416,558	1,416,558	1,406,629	1,406,629	1,406,629	1,406,629

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) include firm-year, country, and product fixed effects. Columns (5)–(8) include firm-year and country-product fixed effects. Columns (9)–(12) include product-year and firm-country fixed effects.

Table A.8
Robustness check: cross-sectional estimations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	One-year sample				Between estimator			
	Baseline	FPC	External finance	Tangibility	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	2.841***	2.463***	2.541***	3.797***	0.766***	0.693***	0.714***	0.973***
	(0.143)	(0.175)	(0.160)	(0.405)	(0.039)	(0.047)	(0.043)	(0.117)
$\Delta \ln RER_{ct} \times FPC_s$		0.483***				0.102***		
		(0.129)				(0.037)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.673***				0.326***	
			(0.401)				(0.112)	
$\Delta \ln RER_{ct} \times Tang_s$				−4.006**				−0.852*
				(1.587)				(0.456)
Country GDP control	Yes	Yes	Yes	Yes	Yes			
Firm-product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	239,338	239,338	239,338	239,338	706,717	706,717	706,717	706,717

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) report results using a one-year sample in 2007, while columns (5)–(8) report results using between estimators (average over 2000–2007). All regressions include firm-product fixed effect.

production function in capital k, labor l, and material inputs m in the form of: $y_t = \beta_k k_t + \beta_l l_t + \beta_i m_t + \beta_{k2} k_t^2 + \beta_{l2} l_t^2 + \beta_{m2} m_t^2 + \beta_{kl} k_t l_t + \beta_{km} k_t m_t + \beta_{lm} l_t m_t + \beta_{k3} k_t^3 + \cdots + \omega_t + \epsilon_t$.[32]

In the literature, firms with different sales markups have heterogeneous responses to exchange rate shocks. The same logic may also apply to import exchange rate pass-through. Li et al. (2018) provide micro evidence that internal finance and external credit supply significantly promote firms' sales growth rates. Now we add estimated firm-level markup into interactions, and the results are shown in Table A.10: the effects of credit constraints on exchange rate pass-through are significant after controlling for importers' revenue-based markups. This indicates that markup cannot fully explain the effect of credit constraints, which is consistent with the finding in Xu and Guo (2021).

However, the explanation for import-side absorptive capacity is more complicated than for exporters' markup. Berman et al. (2012) documents that more productive firms react to depreciation or appreciation by adjusting more markups and less export volume, keeping local market prices relatively stable (less complete pass-through). This explanation hinges on endogenous markups

[32] In practice, we construct four production variables in logarithmic form: real output value y_t, persons engaged l_t, real fixed assets at current value k_t, and real material inputs m_t. Output values are deflated by output deflators, while fixed assets and material inputs are deflated by investment deflators and input deflators. The deflators are constructed as in Brandt et al. (2012).

Table A.9
Import sources, credit constraints, and exchange rate pass-through: geographical distance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$							
	Simple distance				Population-weighted distance			
	Distance	FPC	External finance	Tangibility	Distance	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	1.099***	0.494***	0.688***	2.652***	1.099***	0.477***	0.675***	2.680***
	(0.107)	(0.117)	(0.101)	(0.417)	(0.112)	(0.120)	(0.104)	(0.432)
$\Delta \ln RER_{ct} \times Distance_{ijt}$	−0.090***	−0.039**	−0.055***	−0.188***	−0.090***	−0.036**	−0.052***	−0.194***
	(0.018)	(0.015)	(0.015)	(0.062)	(0.019)	(0.016)	(0.016)	(0.067)
$\Delta \ln RER_{ct} \times FPC_s * Distance_{ijt}$		−0.063***				−0.068***		
		(0.020)				(0.022)		
$\Delta \ln RER_{ct} \times FPC_s$		0.805***				0.827***		
		(0.141)				(0.146)		
$\Delta \ln RER_{ct} \times ExtFin_s * Distance_{ijt}$			−0.222***				−0.242***	
			(0.057)				(0.061)	
$\Delta \ln RER_{ct} \times ExtFin_s$			2.653***				2.738***	
			(0.418)				(0.433)	
$\Delta \ln RER_{ct} \times Tang_s * Distance_{ijt}$				0.441**				0.465**
				(0.206)				(0.221)
$\Delta \ln RER_{ct} \times Tang_s$				−6.572***				−6.697***
				(1.543)				(1.590)
Country GDP control	Yes	Yes	Yes	Yes	Yes			
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210	1,449,210

Notes:Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. Columns (1)–(4) use the simple distance between the most populated cities of the two countries while columns (5)–(8) use the population-weighted harmonic mean distance between the two countries. All regressions include firm-product-country fixed effects and year fixed effects.

Table A.10
Robustness check: markup controls.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.763**	0.543*	0.725**	2.121***
	(0.331)	(0.322)	(0.322)	(0.426)
$\Delta \ln RER_{ct} \times FPC_s$		0.589***		
		(0.094)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.786***	
			(0.284)	
$\Delta \ln RER_{ct} \times Tang_s$				−5.272***
				(1.015)
$\Delta \ln RER_{ct} \times Markup_{jt}$	−0.030	−0.161	−0.186	−0.080
	(0.240)	(0.236)	(0.238)	(0.237)
Country GDP control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes
Observations	1,343,563	1,343,563	1,343,563	1,343,563

Notes: Robust standard errors clustered at firm level; *, **, and *** indicate significance at 10%, 5% and 1%. All columns include firm-level markup levels and their interactions with $\Delta \ln RER_{ct}$ as controls. Firm-level markup is estimated using the method of De Loecker and Warzynski (2012). Columns (2)–(4) use different measures of credit constraints calculated using U.S. data. All regressions include firm-product-country fixed effects and year fixed effects.

over marginal costs, where less elastic demand allows more extensive markup adjustments during exchange rate shocks. However, on the import side, other factors concerning sourcing capacity and buyers' market power also play a remarkable role in exchange rate pass-through. In any case, the effects of credit constraints on import prices are not offset or replaced by seller-side markups.

A.6. Discussion about imported product types

In addition to buyer market share, the nature of the product can also lead to different market forces. Previous empirical results have found that most of China's importing industrial firms are also exporters, implying that imported intermediate inputs

Table A.11
Imported product types: intermediate, consumption, and capital goods.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	0.279***	0.039	0.138**	1.147***
	(0.060)	(0.076)	(0.065)	(0.246)
$\Delta \ln RER_{ct} \times \mathbf{1}\{i \in Consumption\}_{ijct}$	0.050	0.085	0.076	0.077
	(0.126)	(0.126)	(0.126)	(0.126)
$\Delta \ln RER_{ct} \times \mathbf{1}\{i \in Capital\}_{ijct}$	3.955***	3.783***	3.776***	3.864***
	(0.231)	(0.227)	(0.227)	(0.229)
$\Delta \ln RER_{ct} \times FPC_s$		0.388***		
		(0.085)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.169***	
			(0.247)	
$\Delta \ln RER_{ct} \times Tang_s$				−3.501***
				(0.938)
Country GDP control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes
Observations	1,449,033	1,449,033	1,449,033	1,449,033

Notes: Robust standard errors clustered at firm-product level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The default group is intermediate goods. $\mathbf{1}\{i \in Consumption\}$ denotes that the imported good is a consumption good. $\mathbf{1}\{i \in Capital\}$ denotes that the imported good is a capital good. Columns (2)–(4) use different measures of credit constraints calculated using U.S. data. All regressions include firm-product-country fixed effects and year fixed effects.

constitute an important part of total imports by Chinese manufacturing firms.[33] Therefore, we will divide our sample into final consumption goods and intermediates and discuss whether different types of product imports lead to different degrees of exchange rate pass-through.

Previous literature documents that the pass-through to import prices should be less complete if a significant proportion of local distribution costs are denominated in the currency of the importing country (Campa and Goldberg, 2005). Although we do not have an explicit measure of the distribution costs in China, we can use imported product types as a proxy, since the distribution cost and the degree of pricing-to-market for consumer goods are usually higher than for inputs. In addition, imported goods are used for different purposes and, therefore, have different elasticities of demand for importers. After China acceded to the WTO, Chinese firms with increasing productivity and scale expansion use more imported intermediate inputs and equipment, which are usually of better quality or embedded with more advanced technology. If Chinese manufacturing firms highly depend on imported inputs and equipment, the price pass-through for Chinese firms importing these goods may be more complete than for consumption goods.

To test this hypothesis, we classify each HS6 product category into consumption, intermediate, and capital goods using the United Nations Classification by Broad Economic Categories (UN-BEC) concordance and check whether there is a significant difference in price response patterns between different products.[34] We add the dummy variables of consumption ($\mathbf{1}\{i \in Consumption\}$) and capital goods ($\mathbf{1}\{i \in Capital\}$) as interaction terms while using intermediate inputs as the default group. The results are shown in Table A.11. We find no significant difference in pass-through between consumption and intermediate goods, while the pass-through of capital goods is significantly higher than the other two categories.[35]

Market structure and contractual arrangements probably explain the higher exchange rate pass-through for capital goods. First, capital goods markets often have unique competitive dynamics, with fewer firms holding significant market power. This oligopolistic nature gives greater pricing power, enabling them to pass on exchange rate changes more fully to import prices. This explanation is supported by the literature on industrial organization and international trade, which highlights how firms with greater market power can influence pricing strategies (Campa and Goldberg, 2005). Second, capital goods transactions often involve long-term contracts and foreign currency invoicing, which can lead to a more direct and immediate pass-through of exchange rate changes. The literature on international pricing and invoicing practices (Gopinath et al., 2010) discusses how foreign currency invoicing can lead to higher ERPT, as prices are directly affected by exchange rate fluctuations without the buffer of currency conversion. This is particularly relevant for capital goods, where such contractual practices are more common due to the nature of the transactions.

Besides, we classify all imported products into homogeneous goods, which are defined as the products either traded in standard exchange or with referenced prices and differentiated goods (for which exporters have relatively more bargaining power) by HS6

[33] In our sample, intermediate goods accounted for 79.9% of the total number of import transactions and 72.7% of the total import value. Consumption goods accounted for 6.9% of the total number of import transactions and 4.7% of the total import value. Capital goods accounted for 13.3% of the total number of import transactions and 22.6% of the total import value.

[34] We used the fourth edition of UN-BEC, updated in 2002, and matched it to the HS classification. In addition to those three categories, we exclude other products that do not fall into these three categories (e.g., motor spirit, passenger motor cars, and goods not specified elsewhere).

[35] The difference between the prices of consumer goods and intermediate inputs is not significant, which may be due to the low share of local distribution costs in total costs in China, or to the fact that consumer goods account for a low share of imports because only manufacturing firms are included in our sample.

Table A.12
Imported product types: homogeneous vs. differentiated goods.

	(1)	(2)	(3)	(4)
Dependent Var:	Import prices $\Delta \ln P_{ijct}$			
	Baseline	FPC	External finance	Tangibility
$\Delta \ln RER_{ct}$	1.172***	0.782	0.910***	2.078***
	(0.082)	(0.095)	(0.082)	(0.280)
$\Delta \ln RER_{ct} \times \mathbf{1}\{i \in Homogeneous\}$	−1.939***	−1.691***	−1.741***	−1.775***
	(0.095)	(0.090)	(0.089)	(0.092)
$\Delta \ln RER_{ct} \times FPC_s$		0.512***		
		(0.096)		
$\Delta \ln RER_{ct} \times ExtFin_s$			1.656***	
			(0.281)	
$\Delta \ln RER_{ct} \times Tang_s$				−3.839***
				(1.059)
Country GDP control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm-product-country FE	Yes	Yes	Yes	Yes
Market share control	Yes	Yes	Yes	Yes
Observations	1,176,767	1,176,767	1,176,767	1,176,767

Notes: Robust standard errors clustered at firm-product level; *, **, and *** indicate significance at 10%, 5%, and 1% levels. The default group is differentiated goods. $\mathbf{1}\{i \in Homogeneous\}$ denotes that homogeneous goods, which are traded in standard exchange or with referenced prices, and differentiated goods. Columns (2)–(4) use different measures of credit constraints calculated using U.S. data. All regressions include firm-product-country fixed effects and year fixed effects.

codes following the method in Rauch (1999).[36] In Table A.12, we find that the import prices of homogeneous goods are less affected by exchange rate changes. This result is consistent with the previous finding in Table A.11 that machinery, equipment, and capital goods typically contain embedded technology from foreign suppliers and therefore have greater differentiation. An intuitive explanation is that homogeneous goods have more standardized pricing, so importers have more alternatives in the market. If the seller changes the local currency (RMB) price because of exchange rate changes, the buyer can switch to an external option, so the exchange rate pass-through will be lower for this category of products, while heterogeneous products may be those whereas sellers have more market power and can transfer the exchange rate risks to their customers. This logic is consistent with that a higher sourcing diversity leads to a less complete degree of exchange rate pass-through.

Appendix B. Theory appendix

The section presents details for the model setting and how to solve the bargaining problem and eventually derive the pass-through equation.

Model setting. Consider a firm (importer) j in an industry with a finite set of foreign suppliers, denoted by M_j. We focus on the price bargaining between the firm and its suppliers, with M_j assumed to be fixed.[37] The firm purchases a differentiated variety of intermediate inputs from each supplier and combines them in a CES manner, with elasticity $\rho > 1$. The foreign composite input is then combined with domestic input to produce final goods for the consumer.[38] When selling to downstream consumers, the firm faces an iso-elastic demand curve with elasticity $\nu = -\frac{d \ln q_j}{d \ln p_j} > 1$, where q_j and p_j are the quantity and price of the final goods, respectively.

Each supplier $i \in \mathsf{M}_j$ offers a unique variety of foreign intermediate inputs, and the supplier's total cost function is given by: $TC(q_i) = \Phi \left(q_i\right)^{\frac{1}{\theta}}$, where Φ represents the supplier's productivity, exchange rate, and other factors affecting its production cost, while q_i is the quantity of inputs produced by supplier i. The parameter $\theta \in (0, 1]$ captures the returns to scale of the supplier's production. The marginal cost of production for supplier i is: $c_i = \Phi \frac{1}{\theta} q_i^{\frac{1}{\theta}-1}$.

[36] In practice, we use the conservative version of the classification standards for homogeneous goods in Rauch (1999). The results using the liberal version of the standard are similar and are available upon request.

[37] A foreign supplier should be interpreted as a product-country pair in our empirical tests. Furthermore, fixing the set of suppliers is consistent with our empirical strategy where we examine the price changes within a supply relationship over time.

[38] We assume unit substitution elasticity between foreign and domestic inputs. This implies a constant output elasticity to foreign input, given by: $\frac{d \ln q_j}{d \ln q_j^f} = \gamma \in (0, 1)$ where q_j represents the total output of firm j and q_j^f represents the foreign input. γ also represents the share of foreign input in total cost and the elasticity of the firm's marginal cost to the price index of foreign input, i.e., $\gamma = \frac{p_j^f q_j^f}{c_j q_j} = \frac{d \ln c_j}{d \ln p_j^f}$ where c_j is the firm's marginal cost and p_j^f is the price index of foreign input.

Financial constraints. In the model, we focus on a specific type of financial constraint that is commonly encountered in international transactions: the importer is required to prepay a fixed fraction δ_{ij} of the ordered import value before receiving the inputs from foreign suppliers. We assume that the importer does not have initial assets and must borrow from banks to make the required prepayment given (exogenous) interest rate r. It then repays the loan and interests once it generates profits after selling the final goods.

Bargaining problem. Firm j and supplier i negotiate bilaterally over the input price p_{ij}, and the price solves the following generalized Nash product:

$$\max_{p} \left(\pi_i(p) - \tilde{\pi}_{i(-j)}\right)^{1-\phi} \times \left(\pi_j(p) - \tilde{\pi}_{j(-i)}\right)^{\phi}, \tag{7}$$

where $\pi_i(p)$ and $\pi_j(p)$ are the profit functions for supplier i and firm (importer) j, respectively, and $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ represent the outside options for the supplier and the firm. The parameter $\phi \in (0,1)$ represents the exogenous bargaining power of firm j. We assume that each supplier serves multiple customers, so that $\tilde{\pi}_{i(-j)} > 0$ represents the positive outside option for the supplier.

Profit of supplier i. Under a successful negotiation, the supplier i's profit function can be written as

$$\pi_i = p_{ij}q_{ij} + \sum_{k\neq j} p_{ik}q_{ik} - \theta c_i q_i,$$

where $\theta c_i q_i = TC(q_i)$ is the overall production cost and c_i is the marginal cost. The derivative of this profit function to p_{ij} is then

$$\frac{d\pi_i}{dp_{ij}} = q_{ij}\left(1 - \varepsilon_{ij} + \varepsilon_{ij}\frac{1}{p_{ij}}c_i\right),$$

where $\varepsilon_{ij} = \left(1 - s_{ij}\right)\rho + s_{ij}\left(1 - \gamma + \nu\gamma\right) + \nu\gamma r\frac{\delta_{ij}s_{ij} - \sum_k \delta_{kj}s_{kj}s_{ij}}{\Delta}$ with $\rho > \nu$. $\Delta \equiv 1 + r\gamma\sum_{k\in \mathsf{M}_i}\delta_{kj}s_{kj}$ measure the extent of financial constraints faced by the firm, as shown in the firm j's problem.

Its outside profit from serving firms other than j is given by

$$\tilde{\pi}_{i(-j)} = \sum_{k\neq j} p_{ik}q_{ik} - \theta\tilde{c}_i\sum_{k\neq j} q_{ik},$$

where $\tilde{c}_i$ is the marginal cost for supplier i in the case of failed negotiation with j. Note that $c_i = \Phi\frac{1}{\theta}q_i^{\frac{1}{\theta}-1}$ implies

$$\tilde{c}_i = c_i\left(1 - x_{ij}\right)^{\frac{1-\theta}{\theta}},$$

where $x_{ij} = \frac{q_{ij}}{\sum_k q_{ik}}$ is the quantity share of supplier i's production to firm j.

Hence we have

$$\pi_i - \tilde{\pi}_{i(-j)} = q_{ij}\left(p_{ij} - c_i\mu_{ij}^{oligopsony}\right),$$

where $\mu_{ij}^{oligopsony} \equiv \theta\left(\frac{1-\left(1-x_{ij}\right)^{\frac{1}{\theta}}}{x_{ij}}\right)$.

Profit of firm j. Under a successful negotiation, firm j's profit function can be written as

$$\begin{aligned}
\pi_j &= \left(p_j - c_j\right)q_j - r\sum_{k\in \mathsf{M}_i}\delta_{kj}p_{kj}q_{kj} \\
&= \left(p_j - c_j\right)q_j - r\gamma c_j q_j\sum_{k\in \mathsf{M}_i}\delta_{kj}\frac{p_{kj}q_{kj}}{\sum_{k'} p_{k'j}q_{k'j}} \\
&= \left(p_j - \left(1 + r\gamma\sum_{k\in \mathsf{M}_i}\delta_{kj}s_{kj}\right)c_j\right)q_j \\
&= (\mu - 1)\left(\Delta c_j\right)^{1-\nu}\mu^{-\nu}D_j,
\end{aligned}$$

where μ is the constant markup charged by firm j on its final goods, D_j is the exogenous demand shifter, and $\Delta \equiv 1 + r\gamma\sum_{k\in \mathsf{M}_i}\delta_{kj}s_{kj}$ measure the extent of financial constraints. Here we use the fact that $\gamma = \frac{p_j^f q_j^f}{c_j q_j} = \frac{\sum_{k\in \mathsf{M}_i} p_{kj}q_{kj}}{c_j q_j}$.

The derivative of this profit function to p_{ij} is then

$$\frac{d\pi_j}{dp_{ij}} = (1 - \nu)\left(\mu_j - 1\right)q_{ij}\hat{\Delta},$$

where $\hat{\Delta} \equiv \frac{\nu(\delta_{ij} - \sum_k \delta_{kj}s_{kj})}{\Delta} + 1$.

Its outside profit from sourcing inputs from suppliers other than i is given by

$$\tilde{\pi}_{j(-i)} = (\mu - 1)\left(\tilde{\Delta}\tilde{c}_j\right)^{1-\nu}\mu^{-\nu}D_j,$$

where $\tilde{\Delta} \equiv 1 + r\gamma \sum_{k \in \mathsf{M}_i, k \neq i} \delta_{kj} \tilde{s}_{kj}$. The marginal cost for firm j in this scenario, $\tilde{c}_j$, can be derived as

$$\tilde{c}_j = c_j \left(1 - s_{ij}\right)^{\frac{\gamma}{1-\rho}}.$$

Therefore, we have

$$\pi_j - \tilde{\pi}_{j(-i)} = (\mu - 1)\, c_j q_j \Delta^{1-\nu} \left(1 - \left(\frac{\tilde{\Delta}}{\Delta}\right)^{1-2\nu} \left(1 - s_{ij}\right)^{\frac{(1-\nu)\gamma}{1-\rho}}\right).$$

Solving the bargaining problem. The first order condition can be written as

$$\begin{aligned} 0 &= \frac{d}{dp_{ij}} \left(\pi_i(p) - \tilde{\pi}_{i(-j)}\right)^{1-\phi} \times \left(\pi_j(p) - \tilde{\pi}_{j(-i)}\right)^{\phi} \\ &= \frac{d\pi_i}{dp_{ij}} + \bar{\phi} \frac{\left(\pi_i(p) - \tilde{\pi}_{i(-j)}\right)}{\left(\pi_j(p) - \tilde{\pi}_{j(-i)}\right)} \frac{d\pi_j}{dp_{ij}}, \end{aligned}$$

where $\bar{\phi} \equiv \frac{\phi}{1-\phi}$. Plugging in the derived terms yields the pricing rule as follows:

$$p_{ij} = \underbrace{\left((1 - \omega_{ij}(r, \delta_{ij}))\mu_{ij}^{oligopoly} + \omega_{ij}(r, \delta_{ij})\mu_{ij}^{oligopsony}\right)}_{\equiv \mu_{ij}} c_i,$$

where

$$\omega_{ij}(r, \delta_{ij}) \equiv \frac{\bar{\phi}\lambda_{ij}(r, \delta_{ij})}{\bar{\phi}\lambda_{ij}(r, \delta_{ij}) + 1},$$

and

$$\lambda_{ij}(r, \delta_{ij}) \equiv \frac{\gamma(\nu - 1)s_{ij}}{\varepsilon_{ij} - 1} \times \hat{\Delta} \left(1 - \left(\frac{\Delta}{\tilde{\Delta}}\right)^{2\nu-1} \left(1 - s_{ij}\right)^{\frac{\gamma(1-\nu)}{1-\rho}}\right)^{-1}.$$

Note that $\lambda_{ij}(r, \delta_{ij})$ is an increasing function in both r and δ_{ij}, and consequently, $\omega_{ij}(r, \delta_{ij})$ is also increasing in these variables.

Exchange rate pass-through. Firm j and supplier i negotiate bilaterally over the input price p_{ij}, and the price solves a Nash-in-Nash bargaining game.[39] Then given the price formula, we examine the degree of exchange rate pass-through into the negotiated import price, which is manifested as a shift in the supplier's marginal cost, denoted by φ_i. The import price pass-through elasticity to a change in φ_i can be derived as:

$$\begin{aligned} \boldsymbol{\Phi}_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \varphi_i} &= \frac{1}{1 + \Gamma_{ij}^{s}(\rho - 1)\left(1 - s_{ij}\right) + \Gamma_{ij}^{x}\varepsilon_{ij}\left(1 - x_{ij}\right) + \frac{1-\theta}{\theta} x_{ij}\varepsilon_{ij}} \\ &\simeq \boldsymbol{\Phi}_{SC} \times \boldsymbol{\Phi}_{SS} \times \boldsymbol{\Phi}_{TT} \leq 1. \end{aligned} \tag{8}$$

The pass-through degree is decomposed into three components. First, $\boldsymbol{\Phi}_{SC} \equiv \frac{1}{1+\Gamma_{ij}^{s}(\rho-1)\left(1-s_{ij}\right)} \leq 1$ captures how the oligopoly markup of the supplier responds to exchange rate shocks. Since $\boldsymbol{\Phi}_{SC} \leq 1$, it serves as a source of *incomplete* pass-through. Intuitively, a positive shock to the supplier i's cost makes firm j to divert to alternative suppliers. To prevent this, the supplier lowers its price, resulting in less complete pass-through. Second, $\boldsymbol{\Phi}_{SS} \equiv \frac{1}{1+\Gamma_{ij}^{x}\varepsilon_{ij}\left(1-x_{ij}\right)} \geq 1$ reflects how the oligopsony markdown of the importer is influenced by exchange rate shocks. This term represents the source of *complete* pass-through. The logic is that when a cost shock increases supplier i's price, firm j's demand for this input decreases, reducing the firm's role in this bargaining relationship and leading to a higher price charged by the supplier. Finally, $\boldsymbol{\Phi}_{TT} \equiv \frac{1}{1+\frac{1-\theta}{\theta} x_{ij}\varepsilon_{ij}} \leq 1$ captures the endogenous changes in the exporter's marginal cost to the initial impact of the shock and is another source of *incomplete* pass-through. Through this channel, reduced demand from firm j leads to a lower marginal cost for i, if we assume decreasing return to scale in suppliers' production, and therefore leaves more room for the supplier to limit the price fluctuations.

Pass-through equation. The price setting equation can be expressed as

$$\ln p_{ij} = \ln \mu_{ij} + \ln c_i + \ln \varphi_i.$$

Taking a full log-differential leads to:

$$d \ln p_{ij} = \Gamma_{ij}^{s} d \ln s_{ij} + \Gamma_{ij}^{x} d \ln x_{ij} + d \ln c_i + d \ln \varphi_i,$$

where

$$\Gamma_{ij}^{s} \equiv \frac{d \ln \mu_{ij}}{d \ln s_{ij}^{f}}, \quad \Gamma_{ij}^{x} \equiv \frac{d \ln \mu_{ij}}{d \ln x_{ij}}.$$

[39] We lay out the problem and solution in Appendix B.

Then the pass-through rate is given by

$$\Phi_{ij} = \frac{d \ln p_{ij}}{d \ln \varphi_i} = \left(\Gamma^s_{ij} \frac{d \ln s_{ij}}{d \ln \varphi_i} + \Gamma^x_{ij} d \frac{\ln x_{ij}}{d \ln \varphi_i} + \frac{d \ln c_i}{d \ln \varphi_i} \right) + 1.$$

Next, we derive the terms one-by-one. First, we have

$$\frac{d \ln s_{ij}}{d \ln \varphi_i} = (1-\rho)(1-s_{ij}) \left(\frac{d \ln p_{ij}}{d \ln \varphi_i} + \frac{d \ln p_{(-i)j}}{d \ln \varphi_i} \right),$$

and

$$\frac{d \ln x_{ij}}{d \ln \varphi_i} = -(1-x_{ij}) \left(\varepsilon_{ij} \frac{d \ln p_{ij}}{d \ln \varphi_i} + \frac{d \ln q_{i(-j)}}{d \ln \varphi_i} \right).$$

Similarly, we have

$$\frac{d \ln c_i}{d \ln \varphi_i} = \frac{d \ln c_i}{d \ln q_i} \frac{d \ln q_i}{d \ln \varphi_i} = \frac{1-\theta}{\theta} \left(-\varepsilon_{ij} x_{ij} \frac{d \ln p_{ij}}{d \ln \varphi_i} + (1-x_{ij}) \frac{d \ln q_{i(-j)}}{d \ln \varphi_i} \right).$$

Using the markup equation and approximating $\omega_{ij} \simeq \omega$ as a constant, we have

$$\Gamma^s_{ij} \equiv \frac{d \ln \mu_{ij}}{d \ln s^f_{ij}} = \frac{(1-\omega)\mu^{oligopoly}_{ij}}{(1-\omega)\mu^{oligopoly}_{ij} + \omega \mu^{oligopsony}_{ij}} \frac{1}{\varepsilon_{ij}-1} \frac{\rho - \varepsilon_{ij}}{\varepsilon_{ij}},$$

and

$$\Gamma^x_{ij} \equiv \frac{d \ln \mu_{ij}}{d \ln x_{ij}} = \frac{\omega \mu^{oligopsony}_{ij}}{(1-\omega)\mu^{oligopoly}_{ij} + \omega \mu^{oligopsony}_{ij}} \left(\frac{(1-x_{ij})^{\frac{1}{\theta}-1}}{\mu^{oligopsony}_{ij}} - 1 \right).$$

Plugging all the derived terms into the equation Φ_{ij} and rearranging, we reach to Eq. (8).

Implications of financial constraints and sourcing diversity. Now armed with the decomposition above, we provide brief discussions about the role of financial constraints and sourcing diversity in shaping the degree of pass-through. To begin with, tighter financial constraints affect the pass-through rate mainly through its impact on Φ_{SS}. As mentioned, more financially constrained firms are more sensitive to price changes. We can show that Φ_{SS} is an increasing function of financial constraints, i.e., r, δ_{ij}, leading to a higher degree of pass-through for firms within financially constrained sectors.[40]

Sourcing diversity plays a countervailing role, primarily through Φ_{TT}. We use $s_{ij} \equiv \frac{p_{ij} q_{ij}}{\sum_{k \in M_j} p_{kj} q_{kj}}$ to denote the import cost share of supplier i in firm j's total import expenditure—a measure of sourcing diversity. As s_{ij} decreases, the firm's demand elasticity for this input increases, further amplifying the endogenous cost changes for the supplier.[41] Consequently, firms with more diversified supplier bases experience less complete exchange rate pass-through.[42]

Data availability

The data that has been used is confidential.

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[40] Financial constraints also limit the influence of Φ_{SC} and results in a less incomplete pass-through.

[41] We can show that $\varepsilon_{ij} = (1-s_{ij})\rho + s_{ij}(1-\gamma+\nu\gamma)$ is the demand elasticity for the supplier i. We assume $\rho > \nu$, suggesting that ε_{ij} is decreasing in s_{ij}.

[42] Sourcing diversity also affects the other two terms, Φ_{SC} and Φ_{SS}. Specifically, Φ_{SC} shows U-shaped responses to changes in s_{ij}: its role in driving incomplete pass-through diminishes when $s_{ij} \to 0$ or $s_{ij} \to 1$. Φ_{SS} is decreasing in s_{ij}: a smaller supplier faces higher demand elasticity and chooses to increase the price when facing a positive shock to its marginal cost. Under reasonable parameter values, it is Φ_{TT} that plays the dominant role (Alviarez et al., 2023).

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