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How Firms Export: Processing vs. Ordinary Trade with Financial Frictions

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Kalina Manova
Zhihong Yu

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How Firms Export: Processing vs. Ordinary Trade with Financial Frictions

Abstract

The fragmentation of production across borders allows firms to make and export final goods, or to perform only intermediate stages of production by processing imported inputs for re-exporting. We examine how financial frictions affect companies' choice between processing and ordinary trade – implicitly a choice of production technology and position in global supply chains – and how this decision affects performance. We exploit matched customs and balance-sheet data from China, where exports are classified as ordinary trade, import-and-assembly processing trade (processing firm sources and pays for imported inputs), and pure-assembly processing trade (processing firm receives foreign inputs for free). Value added, profits and profitability rise from pure assembly to processing with imports to ordinary trade. However, more profitable trade regimes require more working capital because they entail higher up-front costs. As a result, credit constraints induce firms to conduct more processing trade and pure assembly in particular, and preclude them from pursuing higher value-added, more profitable activities. Financial market imperfections thus impact the organization of production across firms and countries, and inform optimal trade and development policy in the presence of global production networks.

JEL-Codes: F100, F130, F140, F230, F340, G320.

Keywords: China, trade regime, processing trade, global value chain, credit constraints, heterogeneous firms.

*Kalina Manova**
Department of Economics
Standford University
USA - 94305 Stanford CA
manova@stanford.edu

Zhihong Yu
Faculty of Social Sciences
University of Nottingham
United Kingdom – Nottingham NG7 2RD
zhihong.yu@nottingham.ac.uk

*corresponding author

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1 Introduction

The decline in transportation costs and policy barriers over the last few decades has revolutionized global trade by enabling the splicing of production across borders. Firms today can choose to perform only intermediate segments of the supply chain by processing and assembling imported inputs, before re-exporting to final producers and retailers abroad. According to the International Labor Organization, 60 million workers worldwide are employed in 3,500 export processing zones spanning 130 mostly developing countries (Boyenge 2007). This phenomenon raises important policy-relevant questions. How should trade policy be designed when different manufacturing stages occur in different nations? What are the welfare and distributional effects of processing trade and the policies that govern it? Does it shape technology transfer to emerging economies and the transmission of shocks between countries?

To shed light on these questions, we study how firms choose between processing and ordinary trade – implicitly a choice of production technology and position in global supply chains – and how this decision affects company performance. We show that spanning more production stages via ordinary trade increases value added and profitability. However, it also requires more working capital because it entails higher up-front costs. As a result, financial frictions induce firms to conduct more processing trade, and preclude them from pursuing higher value-added, more profitable activities. At the same time, processing trade enables constrained firms that could not undertake ordinary exports to share in the gains from trade. Financial market imperfections thus affect the organization of production across firms and countries, and inform the design of trade and development policy in the presence of global value chains.

We use matched customs and balance-sheet data at the firm level for China, an economy ideally suited to this analysis because of its major role in international production networks. To boost exports, in the mid 1980s China formally introduced a processing trade regime (PT) that exempts materials imported for further processing and re-exporting from import duties. By 2005, 32.7% of Chinese exporters pursued processing trade and contributed 54.6% of total exports. In addition, Chinese firms choose between two operating modes within the processing regime. Under pure assembly (PA), they receive foreign inputs at no cost from the trade partner abroad to whom they also send the final product. Under processing with imports (PI), also known as import-and-assembly, the Chinese firm instead independently sources and pays for imported parts. These institutional features introduce wedges between the costs and returns associated with ordinary trade (OT), PI and PA. Finally, China's financial system is underdeveloped and segmented across provinces. It thus provides a perfect setting for exploring the link between credit constraints and firms' choice of export mode.

We establish two main results. First, profitability varies systematically across trade strategies. Profits, profit-to-sales ratios and value added are higher for companies that undertake more ordinary

relative to processing trade and more import-and-assembly relative to pure assembly. Producers settling for PA or PI must therefore face some constraint that prevents them from doing OT.

Second, limited access to capital poses such a constraint and determines exporters' choice of trade regime. We first demonstrate that (i) in the cross-section of firms within finely disaggregated industries, financially healthier enterprises with more liquid assets and less leverage pursue more ordinary trade relative to processing trade and more import-and-assembly relative to pure assembly. Moreover, (ii) within continuing exporters over time, improvements in financial health are followed by reallocations of trade activity towards regimes with higher working capital needs. Similarly, new exporters' financial health prior to export entry strongly predicts their trade regime upon entry.

Since (i) and to a lesser degree (ii) may arise endogenously, we exploit a series of exogenous sources of variation to establish a causal effect of credit constraints. We show that (iii) following the removal of MFA quotas on textiles and apparel in 2005, new exporters of such products choose different trade modes depending on their financial status before 2005. (iv) Across sectors within firms, exporters conduct more OT than PT and more PI than PA in financially less vulnerable sectors, i.e. sectors that rely less on external capital markets for exogenous reasons. (v) The impact of firms' financial health and sectors' financial vulnerability is bigger in Chinese provinces with weaker financial systems, where liquidity constraints are more likely to bind for the Chinese exporter. By contrast, this impact is stronger for financially more developed export destinations, where the foreign partner is less constrained and can more easily bear the costs that the Chinese seller cannot.

These empirical findings are consistent with liquidity needs and profitability varying across trade regimes such that financial frictions shape firms' choice of export mode. Conceptually, different trade regimes correspond to a different distribution of production stages, costs and profits between Chinese suppliers and foreign buyers. From the perspective of the Chinese manufacturer, ordinary trade requires the most working capital because he pays for product design, domestic and foreign inputs, import duties on foreign inputs, final assembly, and distribution abroad. Processing with imports necessitates less financial liquidity, since it avoids the costs of product design, import tariffs and distribution. Financing needs are lowest under pure assembly, when upfront expenses comprise only domestic inputs and product assembly. When the costs borne by each party represent relationship-specific investments and contracts are incomplete, hold-up problems arise and trade partners split revenues according to Nash bargaining with their contribution to the relationship as bargaining weight. Chinese firms thus sort into trade modes based on their access to capital, and this in turn pins down their profitability.

Our analysis uncovers an important and previously unexplored determinant of firms' export mode: credit constraints. The recent literature has proposed other factors that govern the choice between

processing and ordinary trade in China. These include firm productivity (Brandt and Morrow 2015, Dai et al. 2011, Defever and Riaño 2012), space-based industrial policies (Defever and Riaño 2012), import tariffs (Brandt and Morrow 2015), and incentives for foreign firms to vertically integrate their Chinese supplier (Feenstra and Hanson 2005, Fernandes and Tang 2012). We use a variety of estimation strategies in order to account for these alternative factors, as well as for other observable and unobservable firm and sector characteristics. We control for the variation in aggregate supply and demand conditions with a stringent combination of firms' province, industry and destination fixed effects, and for unobserved company characteristics with firm fixed effects. We establish that the role of firms' financial health is independent from that of firm size, age, productivity, ownership structure (private vs. state, domestic vs. foreign), production technology (capital-, skill-, material intensity), and tariffs on imported inputs. Of note, its effect is economically large relative to that of firm productivity, which is weakly correlated with access to capital due to frictions in Chinese financial markets. We ensure that our results for sectors' financial vulnerability are not driven by the variation in physical capital intensity, human capital intensity, relationship specificity, and upstream import tariffs across sectors.

Our findings suggest that financial frictions influence the organization of global production networks across firm and country boundaries. The three trade regimes correspond to the integration of different segments of the value chain (product design, input sourcing, input processing, final assembly, distribution) under the control of the Chinese exporter. Hence credit constrained firms, and presumably financially underdeveloped countries as a whole, might be stuck in low value-added stages of the supply chain and unable to pursue more profitable opportunities. Strengthening capital markets might thus be an important prerequisite for moving into higher value-added, more profitable activities.

Our study provides a bridge between two active literatures on trade and finance and on global value chains. There is growing evidence that credit constraints impede firms' export activity and distort aggregate trade flows, both in normal times and during crisis episodes (Foley and Manova 2015, Manova 2013, Berman and Héricourt 2010, Bricongne et al. 2012, Amiti and Weinstein 2011, Minetti and Zhu 2011, Chor and Manova 2012, Feenstra et al. 2011). We propose a novel mechanism – choice of trade regime and implicitly global value chain position – through which credit constraints operate. There has also been increased interest in international production networks and their implications for the transmission of shocks across borders during the 2008-2009 crisis (Bems et al. 2011, Levchenko et al. 2010, Baldwin 2012).[1] An important advance in this area has been the inference of domestic value added and production line position from trade flows and input-output tables at the country level (Johnson and

[1] Kim and Shin (2012) model global supply chains with production delays and show that inventories, accounts receivable and productivity are procyclical and track financial conditions.

Noguera 2012, Antràs and Chor 2013, Fally 2011) and in China in particular (Brandt and Morrow 2015, Kee and Tang 2012, Koopman et al. 2011). To this line of research we add one of the first micro-level studies of how and why individual firms operate at different stages along the global value chain. We also shift attention to the decisions of Southern firms, rather than those of Northern manufacturers looking to relocate production to the low-cost South.[2]

Our analysis illustrates how liquidity constraints shape the design of international trade contracts. Compared to OT and PI, PA is a codified form of trade credit extended by the foreign buyer to the Chinese supplier for the purpose of financing imported inputs. Our paper thus extends previous work on the use of trade credit in cross-border transactions (Antràs and Foley 2011, Demir and Javorcik 2014) and on the effect of financial frictions on multinationals' decision to off-shore intra-firm or at arm's length (Antràs et al. 2009, Manova et al. 2015, Javorcik and Spatareanu 2009).

Finally, our conclusions shed light on the gains from trade and the role of trade policy in the presence of processing trade and global supply chains. Our results reinforce recent evidence that facilitating access to imported materials can boost the export performance of developing countries by enabling manufacturers to improve product quality and to broaden product scope (Kugler and Verhoogen 2009, 2012, Goldberg et al. 2010, Manova and Zhang 2012). This is particularly relevant for economies that rely on trade for growth and knowledge spillovers. Our findings further suggest that the international fragmentation of production and its institutionalization with the processing regime in China allow liquidity constrained firms to share in the gains from trade, when they could not have done so otherwise. This highlights the differential effects of trade policy and global value chains across heterogeneous firms in a world with financial market imperfections.

The remainder of the paper is organized as follows. The next section provides institutional background on China's trade regimes. Section 3 outlines a conceptual framework that guides our empirical analysis. We introduce the data in Section 4, and present the empirical results in Section 5. The last section concludes.

2 Institutional Background

For the past 30 years, China has used a variety of policy instruments to stimulate export activity. A particularly consequential intervention has been the establishment of a designated trade regime that exempts imported inputs from import duty as long as they are used for further processing, assembly and ultimately re-exporting on behalf of foreign buyers. In place since the mid-1980s, this provision

[2] See for example Helpman (1984), Hanson et al. (2005), and Yeaple (2003).

encourages the formation of processing-trade relationships between local firms and overseas companies looking to offshore production to China.

Chinese customs authorities distinguish between two carefully enforced trade regimes: processing trade (PT) and ordinary trade (OT).[3] Processing trade is formally defined as "business activities in which the operating enterprise imports all or part of the raw or ancillary materials, spare parts, components, and packaging materials, and re-exports finished products after processing or assembling these materials/parts". A firm conducting processing trade can claim import-duty exemption only if, at the time of importing, it shows proof of a contractual agreement with a foreign buyer to whom it will export the processed goods.

Processing trade comprises two sub-categories: processing with imports (PI) and pure assembly (PA). Pure assembly is also known as processing with foreign-client supplied materials. It refers to "business activities in which the operating enterprise receives materials/parts from a foreign enterprise without needing to pay foreign exchange for the import, and carries out processing or assembling with the materials/parts as per the requirements of the foreign enterprise, only charging for the processing or assembling, while any finished products are to be sold and marketed by the foreign enterprise." By contrast, processing with imports, also known as processing with imported materials or import-and-assembly, refers to "business activities in which the operating enterprise imports materials/parts by paying foreign exchange for their processing, and exports finished processed products for sale abroad".

Under both types of processing trade, the import duty is waived, the Chinese party pays for domestic inputs and labor and customizes the product to the specifications of the foreign buyer, and the foreign buyer handles product design, marketing and distribution. However, under PA, the Chinese firm is not responsible for sourcing foreign materials and incurs no cost for using them. Under PI on the other hand, it decides what parts to source, from which countries, and at what prices. It also has to pay for any imported inputs. The foreign input suppliers are typically not the same party to whom the Chinese firm ultimately exports. From a contractual perspective, whoever purchases a given input preserves ownership rights over it until the processing transaction has been completed.

Firms exporting under ordinary trade often manufacture exclusively with local inputs, but they are allowed to combine foreign and domestic materials and to sell both at home and abroad. This makes it prohibitively difficult for Chinese customs to ascertain what fraction of any imported inputs go towards

[3] There are a number of other regimes that capture less than 4% of exports (e.g. warehousing trade, entrepôt trade by bonded area, international aid, barter trade). All regime definitions are from "Measures of the Customs of the People's Republic of China on the Control of Processing-Trade Goods" released in 2004 and amended in 2008 and 2010.

production for exporting, especially when the Chinese company exports under its own brand name. Ordinary exporters thus incur import tariffs on any foreign intermediates they use.

A Chinese manufacturer may legally undertake both ordinary and processing trade, in which case each of its import and export transactions is recorded and treated separately according to its specified trade regime.[4] For example, a garment maker may use imported materials in order to sell domestically and abroad under its own brand (e.g. Youngor) as well as to export under a foreign brand (e.g. Nike, Gap). It would then enjoy the import tariff waiver on its processing imports but not on the foreign inputs it acquired for its domestic production and ordinary exports.

The introduction of the processing trade regime has significantly contributed to the expansion in China's trade activity. In 2005 – the year our empirical analysis focuses on – 54.6% of all exports by value represented processing trade. While China's import duties have declined over time, the exemption for processing imports remains important: Average tariff rates dropped from 41% in 1992 to 16.8% before entry into the WTO in 2001 and reached 9% in 2005 (Lemoine and Ünal-Kesenci 2004, Yu 2015).

3 Conceptual Framework

Chinese firms can participate in international trade via ordinary trade, processing with imports and pure assembly. We posit that the institutionalized differences among these three trade regimes generate trade-offs between ex-ante costs and ex-post profits: From the perspective of the Chinese company, more profitable export modes are associated with higher up-front expenditures. As a result, financially unconstrained firms are able to conduct the most profitable activity, while firms with limited access to capital are forced into less profitable trade regimes with lower liquidity needs. Credit constraints thus not only directly affect firms' export strategy, but implicitly their production technology as well. This section provides intuition for these economic forces and develops empirically testable hypotheses.

3.1 Key intuitions

We first build intuition by focusing on single-product firms exporting to a single destination. Consider a Chinese firm facing foreign demand for a product such as a toy doll. Manufacturing and selling this product requires multiple activities: product design, input sourcing, input assembly, marketing and distribution. Each activity entails up-front costs that must be incurred before any sales and payoffs are realized. Moreover, not all required inputs are available domestically. For example, plastic molds, paints and hair might have to be imported because local suppliers lack the technological know-how to make

[4] On the import side, ordinary imports include final consumption goods, intermediates used in production for the domestic market, and intermediates used in production for foreign markets by firms exporting under the OT regime.

them or cannot meet the quality standards of foreign consumers. Conversely, malleable plastic, dress cloth and assembly workers can be reliably and cost-effectively secured at home.

The Chinese firm can choose to conduct ordinary trade and sell directly to foreign consumers, or alternatively to engage in processing trade with a foreign party via pure assembly or processing with imports.[5] The up-front expenses and hence liquidity needs of the Chinese firm are lowest under pure assembly, higher under processing with imports, and highest under ordinary trade. With PA, the Chinese firm pays only for domestic inputs and assembly. With PI, it is responsible for domestic inputs, foreign inputs and assembly. With OT, it covers product design, domestic and foreign inputs, import duties on foreign inputs, assembly and distribution abroad. The foreign trade partner bears the cost of any activities not performed by the Chinese firm.

We hypothesize that the profits of the Chinese firm are lowest under pure assembly, higher under processing with imports, and highest under ordinary trade. With OT, it operates completely independently and captures all profits from foreign sales. With PT, on the other hand, trade partners presumably make relationship-specific investments in product design, input sourcing, assembly and distribution. In the presence of incomplete contracting, this would generate a two-sided hold-up problem, such that profit sharing would be determined by ex-post Nash bargaining. The return to the Chinese firm would then be its outside option (i.e. revenues from selling the assembled product to another buyer) plus its share of the surplus rents from the partnership. Since bargaining power stems from parties' relative importance to the relationship, each side's bargaining weight would likely increase with its contribution to total costs. The Chinese firm's profits would thus rise from PA to PI to OT.

The ranking of trade regimes by up-front costs and ex-post profits might be reinforced by three additional factors. To the extent that other forces might make it ambiguous, we would be less likely to find support for our hypotheses. Thus which mechanisms dominate is ultimately an empirical question.

First, given demand, there is a profit-maximizing level of output for each export mode. Producing less would reduce costs and financing needs, but also profits. If a firm has sufficient liquidity for first-best production in one trade regime (e.g. PI) but not in a higher-ranked regime (e.g. OT), it could choose to operate at a second-best scale under the higher-ranked regime. By revealed preference, however, this would still imply greater profits with the higher-ranked regime.

Second, ordinary firms can opt to use fewer imported inputs than processing firms if foreign parts are more expensive than domestic parts, especially if the import tariff is high; processing firms have

[5] This assumes that there is sufficient demand abroad both for final goods supplied by ordinary Chinese exporters and for outsourcing production to China via processing trade. We believe this approximates well the economic environment in China, and it allows us to concentrate on the trade-offs faced by the Chinese entrepreneur. See also Section 6.6.

little flexibility or interest in doing so because they must observe the specifications of the foreign buyer and because they don't incur import duties. This is unlikely to reduce OT costs below PI costs given the high costs of product design and distribution and the loss in profits associated with deviations from the first-best input mix. By revealed preference, an OT firm would therefore substitute towards local inputs only if this still guarantees higher profits than alternative trade regimes.

Finally, imperfect contractibility might generate moral hazard in production: Trade partners would underinvest if they incur the full cost of an input but receive only a share of its marginal revenue. For example, the Chinese producer might have to exert effort in sourcing inputs and managing operations. The higher his bargaining weight, the more effort he would be incentivized to expend and the higher sales and profits would be.[6] This would magnify the difference in profitability across trade modes.

Given the ranking of profits across export regimes, *ceteris paribus* ordinary trade will be the dominant strategy for Chinese firms with the requisite financial liquidity. However, some companies might have restricted access to internal and external capital. The former would arise if they cannot retain sufficient earnings from operations and must transfer profits to stockholders because of principal-agent issues inside the firm. The latter would occur in the presence of credit market frictions due to limited contract enforcement (e.g. endogenous default; weak protection of collateral claims) or asymmetric information between lenders and borrowers (e.g. adverse selection; unobserved cost or demand shocks).

Chinese firms will therefore pursue the most profitable trade mode they can, sorting into different regimes based on their financial health: *Ceteris paribus*, most financially constrained exporters will conduct pure assembly and earn low profits. Less financially constrained exporters will conduct import-and-assembly and earn higher profits. Least financially constrained exporters will conduct ordinary trade and earn the highest profits.

3.2 Empirical hypotheses

We next consider multi-product firms selling to multiple destinations. This accounts for the rich choice set available to manufacturers in reality and sheds more light on underlying mechanisms of interest. It also allows us to develop empirical hypotheses and identification strategies.

Firms actively choose how many products to export, which products to export, and under what trade regime so as to maximize total profits. They must allocate their financial resources across product lines and export modes, recognizing that different products feature different up-front liquidity needs and ex-post payoffs because of different cost and revenue structures. This allocation entails two liquidity-

[6] This assumes that the foreign party doesn't underinvest or its underinvestment is less harmful to production. This would be more likely when it resides in a country with stronger contract enforcement.

profit trade-offs: First, manufacturing more products can increase total revenues but impose higher ex-ante costs. Second, processing trade (especially pure assembly) uses up less liquidity per product than ordinary trade, and can thereby enable a firm to spread its funds across more products. This tends to increase total profits along the extensive margin. However, PT (especially PA) offers lower returns per product than OT. This tends to decrease total profits along the intensive margin.

This complex optimization problem has an intuitive solution. Ordering products by their revenue-to-liquidity-needs ratio, firms will add products in decreasing order of attractiveness until they exhaust their available liquidity, and adjust export modes along the way. Both the level of up-front costs and the ratio of payoffs to up-front costs matter. Pursuing trade regimes that guarantee a bigger share of revenues is only worthwhile if these revenues are sufficiently high relative to the higher liquidity needs that such regimes impose. Firms will thus choose ordinary trade for products with relatively low up-front costs and high revenue potential; processing with imports for goods with intermediate cost and revenue levels; and pure assembly for articles with high liquidity requirements but limited returns.

We expect exporters with more access to finance to differ from capital-scarce firms in a number of respects. First, financially healthier manufacturers can allocate more liquidity to each of their product lines. Hence for any given product, less constrained firms will be more likely to conduct ordinary trade relative to processing trade and import-and-assembly relative to pure assembly. Second, financially healthier producers can export more products. They will go further down the product hierarchy, adding goods with progressively higher liquidity needs that create stronger incentives for processing trade and pure assembly. Aggregating across products to the firm level, the relationship between firms' financial health and overall export composition by trade regime is therefore theoretically ambiguous. Finally, firms with more access to capital will earn higher profits because they can always undertake (weakly) more profitable trading strategies than producers with less access to capital.

This framework implies that firms will adopt a single trade mode per product. In practice, we observe firm exports by destination country and 8-digit product category or 3-digit sector. While each product category and sector arguably groups products with varying cost and revenue structures, we can measure the reliance on external capital for up-front costs only at the sector level. Separately, cross-country differences in consumer demand, product customization and distribution costs can incentivize an exporter to sell the same product to different markets via different trade modes. For these reasons, we anticipate that firms might use multiple trade regimes within a product category or sector.

These arguments imply systematic and smooth variation in profitability and export strategies across firms and sectors. We summarize these predictions with the following three hypotheses:

Hypothesis 1 *Across firms within a sector, profits decrease with the share of processing exports in total exports* $\left(\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}\right)$ *and with the share of pure assembly in processing exports* $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$.

Hypothesis 2 *Across firms within a sector and across firms within a destination-sector pair, the share of processing exports in total exports* $\left(\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}\right)$ *and the share of pure assembly in processing exports* $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$ *decrease with firms' financial health.*

Hypothesis 3 *Across sectors within a firm and across sectors within a firm-destination pair, the share of processing exports in total exports* $\left(\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}\right)$ *and the share of pure assembly in processing exports* $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$ *increase with sectors' financial dependence.*

4 Data

4.1 Trade and balance-sheet data

Our analysis makes use of two proprietary datasets on the activities of Chinese firms in 2005. Firms are legally required to complete both, and compliance is strictly enforced by different government agencies. The first one is the Annual Survey of Industrial Firms (ASIF) conducted by China's National Bureau of Statistics.[7] It provides standard balance-sheet data for all state-owned enterprises (SOEs) and all private companies with sales above 5 million Chinese Yuan[8]. We observe each firms' location in one of 31 provinces and its main industry of activity out of 475 finely disaggregated categories in the Chinese GBT 4-digit classification. The main variables of interest to us are measures of firm profitability and financial status, which we discuss in greater detail below. We also use information on total sales, employment, capital and material inputs to construct proxies for firm size and productivity.

We also utilize the Chinese Customs Trade Statistics (CCTS) collected by the Chinese Customs Office, which contains detailed information about the universe of trade transactions.[9] It reports the value of firm exports (free on board) and imports (cost, insurance and freight included) in U.S. dollars by country and product for 243 destination/source countries and 7,526 products in the 8-digit Harmonized System.[10] The records indicate whether each cross-border sale occurs under ordinary trade, processing with imports or pure assembly. The trade-regime classification thus characterizes individual transactions

[7] As in Wang and Yu (2012), the ASIF data are cleaned by excluding observations according to the following criteria: (a) firms in non-manufacturing industries (2-digit GBT industry code >43 or <13) and tobacco (GBT code 16); (b) observations with negative values for output, sales, exports, capital or intermediate inputs; (c) observations with total assets less than total fixed assets or total liquid assets, or with total sales less than exports.
[8] This is equivalent to 0.6 million USD based on the USD-CNY exchange rate in 2005.
[9] Manova and Zhang (2009) describe the data and stylized facts about firm heterogeneity in Chinese trade.
[10] Product classification is consistent across countries at the 6-digit HS level. The number of distinct product codes in the Chinese 8-digit HS classification is comparable to that in the 10-digit HS trade data for the U.S.

rather than firms. This allows us to construct continuous measures of the proclivity for using different trade regimes at the firm level. Since we are interested in manufacturers' export decisions, we drop export-import companies that serve exclusively as intermediaries between domestic producers (buyers) and foreign buyers (suppliers).[11]

Our empirical analysis critically relies on combining data from both sources. While each is organized around company registration numbers, the authorities have not released a unique firm identifier. We therefore merge the census files to the customs records based on an algorithm that matches firm names and contact information.[12] While imperfect, this procedure generates a large and representative sample. We are able to obtain balance-sheet data for 44% of all exporters in CCTS and trade transactions for 67% of all firms reporting positive exports in ASIF. We have verified that matched exporters exhibit similar trade patterns as the full sample of exporters in the customs registry. Likewise, the balance sheets of the matched exporters are comparable to those of all exporters in the census.

4.2 Summary statistics

Table 1 illustrates the substantial variation in size and performance across the 50,606 Chinese firms in our matched sample. Mean log sales and log exports amount to 10.64 and 13.83, with standard deviations of 1.35 and 2.08 respectively. Log profits and log value added average 7.33 and 9.23, with corresponding standard deviations of 1.95 and 1.48. The dispersion in profitability, measured by the ratio of profits to sales, is greater with a mean of 0.03 and standard deviation of 0.20.

The Venn diagram in Figure 1 shows the distribution of firms operating in a single vs. multiple trade regime. It shows the percentage share of exporters engaged in each of 7 possible combinations of trade modes (PA; PI; OT; PA and PI; PA and OT; PI and OT; PA, PI and OT). The reported percentages sum to 100%. 63.0% of all sellers ship only ordinary exports, while 2.7% and 11.0% conduct exclusively pure assembly and processing with imports, respectively. The remaining 23.3% pursue mixed trade strategies, with 3.5% undertaking some activity under all three regimes. Similar patterns obtain when we look at a finer level of disaggregation and consider firm-sector pairs instead of firms (not shown). Figure 2 replicates Figure 1, but instead of the percentage share of firms in a segment, it reports the percentage share of aggregate exports captured by firms in that segment. Processing trade, especially PI, contributes substantially more to the value of Chinese exports than its number of firms would suggest. This is despite the low value added associated with processing trade and reflects its high import content.

[11] Since the data do not directly flag trade intermediaries, we follow standard practice and use keywords in firm names to identify them (Ahn et al. 2011). We drop 29,982 wholesalers that mediate 22.3% of China's trade.
[12] See Wang and Yu (2012) for a detailed description of the matching procedure.

Table 2 documents the variation in the composition of firm exports in terms of trade regimes. We analyze two indicators: the share of processing exports (both pure assembly and import-and-assembly) in total exports, (PA+PI)/(PA+PI+OT), and the share of pure assembly in total processing exports, PA/(PA+PI). We construct each measure at different levels of aggregation in order to study the variation along different dimensions of trade activity. Table 2 reports summary statistics for all firms in the CCTS data, but similar patterns obtain in the matched ASIF-CCTS sample.

The average firm conducts 27% of its exports via processing trade and 24% of its processing exports via pure assembly. However, there is considerable variation in activity across firms – standard deviations are 41% and 41%. We observe comparable means and standard deviations when we compute the two trade shares separately for each firm-ISIC sector pair, each firm-ISIC-destination triplet, each firm-HS product pair, or each firm-HS-destination triplet. On the other hand, we see less variation in trade regime choices across sectors or products within firms; even less across sectors or products within firm-destination pairs; and the least across destination markets within firm-product or firm-sector pairs. This can be inferred by comparing respective standard deviations and means. For example, the standard deviation of (PA+PI)/(PA+PI+OT) across destinations within firm-ISIC pairs is 5% relative to a mean of 18%, while its overall standard deviation across firms is 41% relative to a mean of 27%.

Manufacturers' use of foreign inputs is consistent with their choice of export mode. For instance, ordinary exporters are less prone to import parts from abroad, while companies exporting under more than one trade regime import intermediates under multiple regimes as well. Accounting for province, industry and firm ownership fixed effects, the conditional correlation between the share of processing exports in total exports and the share of processing imports in total imports is 0.603 across firms and significant at 0.1%. Likewise, the conditional correlation between the share of pure-assembly exports in total processing exports and the share of pure-assembly imports in total processing imports is 0.946 across firms and significant at 0.1%.

4.3 Measuring financial constraints

We employ four different proxies for sectors' financial vulnerability, which have been commonly used in the literature on the role of credit constraints for trade and growth. These variables are meant to identify technologically-determined characteristics of each sector that are inherent to the nature of the manufacturing process and beyond the control of individual firms. They are available from Kroszner et al. (2007) for 29 ISIC 3-digit sectors, which we match to the Chinese HS 8-digit products.[13]

[13] The measures are constructed following the methodology of Rajan and Zingales (1998) and Claessens and Laeven (2003). They are averaged over the 1980-1999 period for the median U.S. firm in each sector.

There are systematic differences across sectors in firms' reliance on external capital for funding operations. These arise because of variation in the relative importance of up-front costs and the lag between the time when production expenses are incurred and the time when revenues are realized. We use the ratio of inventories to sales ($Invent_i$) to proxy the duration of the manufacturing process and the working capital firms require in order to maintain inventories and meet demand. This measure indexes producers' liquidity needs in the short run, which are associated mainly with variable costs such as the cost of labor and intermediate inputs. We exploit two indicators of firms' funding needs for long-term investments that comprise mostly fixed costs. The classic measure is sectors' external finance dependence ($ExtFin_i$), obtained as the share of capital expenditures not financed with internal cash flows. We also study the share of R&D spending in total sales (RD_i), since research and development typically occur at the beginning of a production cycle before manufacturing and marketing can commence.

Sectors vary not only in firms' reliance on external finance, but also in firms' ability to raise external finance. We proxy the latter with the endowment of hard assets that companies can pledge as collateral when accessing capital markets. This is gauged by asset tangibility ($Tang_i$), defined as the share of net plant, property and equipment in total book-value assets.

As standard in the literature, these sector measures are constructed from data on all publicly traded U.S.-based companies from Compustat's annual industrial files. This approach is motivated by a number of considerations. First, the United States have one of the most advanced and sophisticated financial systems, which makes it reasonable that the behavior of U.S. companies reflects firms' optimal asset structure and use of external capital. Second, having the U.S. as the reference country eliminates the concern that sectors' financial vulnerability might endogenously respond to China's level of financial development. In fact, if the most financially vulnerable industries in the U.S. employ more internal financing and tangible assets in China because of the worse financial system there, our results would be biased downwards. Finally, what is required for identification is not that industries have the same tangibility and liquidity needs in the U.S. and China, but rather that the ranking of sectors remain relatively stable across countries. To the extent that it doesn't, measurement error would once again bias our estimates down. Kroszner et al. (2007), Rajan and Zingales (1998) and Claessens and Laeven (2003), among others, argue that the measures of financial vulnerability capture a large technological component that is innate to a sector and therefore a good proxy for ranking industries in all countries. Consistent with this argument, the measures vary substantially more across industries than across firms within an industry, and the hierarchy of sectors is quite stable over time.

In addition to these sector indicators, we also construct two standard balance-sheet measures of firms' financial health.[14] Liquidity gives the difference between current assets and current liabilities, scaled by total assets. It signals firms' availability of liquid capital. Leverage is the ratio of current liabilities to current assets.[15] Firms with higher leverage have more financial obligations outstanding in the short run and less freedom in managing cash flows or raising additional external capital. We thus expect exporters with high liquidity and low leverage to be financially healthier and less constrained.

A first glimpse at the variation in trade activity with firms' financial health and sectors' financial vulnerability reveals patterns consistent with our hypotheses (Figure 3). We divide firms into two subsamples with liquidity above and below the median.[16] While the average share of processing trade in total exports is 29.4% for high-liquidity firms, it is 31.2% for low-liquidity firms. The corresponding numbers are 17.7% and 19.4% for the share of pure assembly in processing exports. When we distinguish between sectors with working capital needs above and below the median, we observe substantially bigger differences. In industries with high inventory-to-sales ratios, the typical firm conducts 19.9% of its exports via processing trade and 22.7% of its processing exports via pure assembly. By contrast, these shares drop to 14.3% and 14.6% for industries with low inventory-to-sales ratio.

5 Firm Profitability and Attributes across Trade Regimes

The empirical analysis proceeds in two steps. In this section, we first examine the variation in profitability and other firm attributes across Chinese exporters engaged in different trade regimes. In Section 6, we then analyze the effect of financial frictions on companies' choice of trade regimes.

According to Hypothesis 1, firm profitability should increase as the composition of foreign sales shifts from pure assembly to processing with imports to ordinary trade. To assess the empirical validity of this prediction, we construct the share of processing exports in total exports $\left(\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}\right)$ and the share of pure assembly in processing exports $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$ for firm *f*, after summing *f*'s exports across all of its destinations and products. We estimate the following specification separately for each $Trade\ Share_f$ in the matched ASIF-CCTS sample of exporters with balance-sheet data:

$$Profitability_f = \alpha + \beta \cdot Trade\ Share_f + \Gamma \cdot Z_f + \varphi_p + \varphi_i + \varphi_{own} + \varepsilon_f \quad (1)$$

[14] See for example Whited (1992), Fazzari and Petersen (1993), Greenaway et al. (2007), and Ding et al. (2013).
[15] Leverage is often defined as short-term debt / current assets. In standard Chinese accounting practices, short-term debt and current liability correspond to the same variable on firms' balance sheets, "Liu Dong Fu Zhai".
[16] We control for systematic differences in liquidity across firms with different ownership structures by defining these medians separately for private domestic firms, state-owned enterprises, joint ventures and foreign affiliates.

Here $Profitability_f$ represents f's log total profits or profit-to-sales ratio. We include 31 province φ_p and 475 industry φ_i fixed effects using ASIF information on firms' location and main industry of activity in the Chinese GBT 4-digit classification. These fixed effects capture exogenous supply and demand conditions that might both favor certain export modes and impact profits, such as factor costs, factor intensities, transportation costs, tax treatment, institutional and financial market frictions. We account for the role of firm size and ownership status with log employment and dummies for state-owned enterprises, joint ventures, and wholly-owned multinational affiliates, the excluded category being private domestic firms. We employ Huber-White heteroskedasticity robust standard errors ε_f.

The coefficient of interest β reflects the sign of the conditional correlation between firms' profitability and trade regime. It is identified from the variation across exporters within narrowly defined segments of the economy. We cannot and do not want to give β a causal interpretation since profits and export activity are joint outcomes of firms' maximization problem that are affected by producers' financial health. Other firm attributes unrelated to credit constraints might also influence both variables.

The results in Columns 1 and 3 of Table 3 indicate that manufacturers' profits and profitability indeed vary systematically with their trade strategy: they both decrease with the share of processing exports in total exports and with the share of pure assembly in processing exports. These patterns are independent of the fact that bigger firms tend to be more profitable (the unreported coefficient on employment is positive). They are also economically significant. A one-standard-deviation fall in $\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}$ is associated with 0.66% higher profit-to-sales returns, while processing exporters with a one-standard-deviation lower share $\frac{X_{PA}}{X_{PA}+X_{PI}}$ enjoy 0.54% higher profitability. The profit levels of two companies whose trade shares are one standard deviation apart differ by 6.2% and 11.4%, respectively.

As customary with balance-sheet data, Chinese firms report consolidated profits from worldwide sales. To the extent that trade-regime choices affect foreign revenues but not home operations, the findings above may underestimate the importance of trade modes for export profitability. In Columns 2 and 4, we repeat the analysis for the subset of firms that sell exclusively abroad but not domestically. While "pure exporters" represent only 20% of the sample, we can be sure that their profits capture solely cross-border activities. As anticipated, we obtain 50% bigger point estimates in this group of producers.

The rest of Table 3 illustrates other differences among companies with varying export strategies. Each cell reports the coefficient β from estimating specification (1) for a different firm characteristic as the outcome variable.[17] First, firms that conduct more processing trade have lower total sales, value

[17] Domestic sales are calculated as the difference between total sales and total exports. TFP is constructed as in Levinsohn and Petrin (2003), by 2-digit industry and ownership type (foreign vs. domestic) using the complete ASIF

added and domestic sales, but higher export revenues. Among processing exporters, those that pursue more pure assembly record lower sales, exports and value added. Second, more productive firms are less likely to undertake processing trade and especially pure assembly, where we measure productivity with TFP or value added per worker. Third, capital, skill and material intensity generally rise with (X_{PA} + X_{PI}) / (X_{PA} + X_{PI} + X_{OT}) and fall with X_{PA} / (X_{PA} + X_{PI}). Finally, exporters that perform more processing trade and especially pure assembly have higher imports and a bigger share of processing imports.

These findings suggest that multiple firm characteristics might determine or be correlated with the choice of trade regimes. Our analysis below ensures that the estimated effects of financial frictions do not capture the role of other factors such as company size, productivity, capital and skill intensity.

6 Financial Frictions and Firms' Choice of Trade Regimes

Having established that profitability differs across trade regimes, we next show that credit constraints prevent entrepreneurs from pursuing more profitable regimes. We perform a series of complementary tests of Hypotheses 2 and 3 in order to establish causality and examine the channels through which financial frictions operate. In particular, we explore the variation in financial health across firms and within firms over time; the variation in financial vulnerability across sectors within firms; and the variation in financial market development across space.

6.1 Firms' financial health: cross-section

We first study the relationship between firms' financial health and export activity in the cross section with the following specification:

$$Trade\ Share_f = \alpha + \beta \cdot Fin\ Health_f + \Gamma \cdot Z_f + \varphi_p + \varphi_i + \varphi_{own} + \varepsilon_f \qquad (2)$$

$Trade\ Share_f$ refers to one of the two trade regime shares. We proxy $Fin\ Health_f$ interchangeably with f's liquidity or leverage ratio lagged by one year, where firms with more liquid assets and fewer debt obligations are deemed less constrained. We lag the financial health measures to alleviate concerns with reverse causality since concurrent indicators are more likely to respond to trade activity; using concurrent liquidity and leverage delivers qualitatively similar results of slightly greater magnitudes.

We allow for any dispersion in supply and demand conditions across Chinese regions and economic sectors with province φ_p and industry φ_i fixed effects based on the location and primary GBT-4 industry affiliation of each firm. We further control for systematic differences among producers of

panel for 2001-2006. Skill, capital and material intensity are measured respectively with the log average wage, the ratio of net fixed assets to the wage bill, and the ratio of material purchases to the wage bill.

different organizational structures with ownership dummies. This extensive set of fixed effects accounts for many independent factors determining the choice of trade regime, such as space-based industrial policies (e.g. special economic zones, Defever and Riaño 2012) and the optimal organization of production across firm boundaries (e.g. domestic vs. foreign ownership, Feenstra and Hanson 2005 and Fernandes and Tang 2012). In robustness checks, we consider the role of other firm characteristics Z_f as discussed below. We report robust standard errors ε_f.

Table 4 indicates a strong link between companies' financial status and choice of export regime. Manufacturers with lower liquidity and higher leverage conduct more processing trade (Column 1). Conditional on performing processing trade, they also engage in more pure assembly relative to import-and-assembly (Column 2). These results are highly statistically significant and economically meaningful. Improving liquidity or leverage by one standard deviation would reduce the share of processing exports by 1-1.5% and the share of pure assembly in processing exports by up to 1%.

In unreported regressions, we have confirmed that companies' financial health is related to their use of foreign inputs in a manner consistent with their choice of export regime: Credit-constrained firms are more likely not only to export, but also to import under processing trade, especially pure assembly.

A number of factors other than credit constraints could affect firms' choice of trade regime and bias our estimates. We next show that our baseline results survive a series of robustness checks that alleviate such concerns and help us rule out alternative explanations.

Firm size and productivity

One potential concern is omitted variable bias arising from the relationship between financial health and other firm characteristics. The key issue is whether these other characteristics impact companies' trade regime directly through non-finance channels, indirectly by determining access to finance which in turn affects trade outcomes, or both. This will depend on the nature of financial market imperfections.

Consider first firm productivity. Evidence suggests that Chinese firms conducting processing trade are less productive than ordinary exporters (Brandt and Morrow 2015, Dai et al. 2011, Defever and Riaño 2012). This could have three distinct implications for our results. First, productivity might be the primitive attribute that pins down all firm outcomes, including access to capital, choice of inputs and production technology, size, and export mode. For example, if financiers observe firm productivity but are vulnerable to endogenous default, they will extend more credit to more productive firms with higher expected profits, and some less productive firms will be credit constrained (credit underprovision). Regressing firms' trade regime on firms' financial health alone would then correctly capture the effect

of access to capital in equation (2). Controlling for productivity or outcomes of the firm's maximization problem such as size would bring β down to zero but not invalidate the finance channel.

Second, productivity might not perfectly predict firms' financial health (credit misallocation). For instance, there might be asymmetric information between lenders and borrowers due to unobserved firm-specific shocks, or access to capital might depend on political or family connections. In this case, conditioning on productivity in specification (2) would reduce β without forcing it to zero such that β would underestimate the effect of financial frictions on trade regime choices.

Third, productivity might directly affect export activity through non-finance channels because of economies of scale. Product design, marketing and distribution impose fixed costs on ordinary exporters which processing exporters avoid. When trade regimes differ in profitability, more productive firms with higher revenues will self-select into more profitable regimes with higher fixed costs. If financial health is correlated with productivity, omitting the latter from regression (2) would bias the β estimate.

Firm size could similarly impact both access to financing and trade participation. Evidence in the finance literature suggests that bigger firms are less credit constrained *ceteris paribus* (e.g. Beck et al. 2008, Guiso et al. 2004). If fixed costs vary across trade regimes, bigger companies might pursue more ordinary trade both because they dispose of more liquidity and because they can more easily amortize higher fixed costs. While the former is consistent with the credit mechanism that we emphasize, the latter implies that our results might be spurious.

In sum, firm size and productivity are not classic omitted variables in our context. Including them as controls Z_f in equation (2) could inform the microfoundations of firms' credit constraints but bias β downwards, while excluding them could bias β upwards.[18] In Columns 3-4 of Table 4, we explicitly control for companies' lagged total factor productivity and lagged log employment.[19] The coefficient on financial health retains its statistical significance. Its magnitude is approximately halved in the case of $(X_{PA} + X_{PI}) / (X_{PA} + X_{PI} + X_{OT})$ and less affected in the case of $X_{PA} / (X_{PA} + X_{PI})$. This suggests that firm size and productivity are imperfectly correlated with access to capital, in line with priors about inefficient financial markets in China. Moreover, comparative statics indicate that the role of financial health is an order of magnitude greater than that of the other two firm characteristics: A one-standard-deviation rise in leverage, TFP and size is associated respectively with a change of 0.3%, 0.02% and 0.08% in $(X_{PA} + X_{PI}) / (X_{PA} + X_{PI} + X_{OT})$ and a change of 0.9%, 0.02% and 0.01% in $X_{PA} / (X_{PA} + X_{PI})$. To guard against omitted variable bias, we always condition on firm size and productivity in the rest of the analysis.

[18] Pairwise correlations between our financial health measures and the various firm controls we consider are typically statistically significant but small in magnitude. For example, the raw correlations of liquidity with productivity, log employment, capital-, skill-, material intensity, and age are 0.14, -0.09, -0.13, 0.10, 0.01, and 0.02, respectively.
[19] Similar results obtain if we use value added per worker instead of TFP or log sales instead of log employment.

Production technology

We address concerns with other omitted variables related to firms' production technology in Columns 5-6 of Table 4. In particular, we control for exporters' log age, lagged capital intensity (ratio of net fixed assets to total wage bill), lagged skill intensity (log average wage), and lagged material intensity (ratio of material inputs to total wage bill).[20] To the extent that these characteristics constitute endogenous firm choices over inputs and production technology, they might be determined jointly with trade outcomes by financial health and/or productivity. If so, including them in Z_f would produce lower-bound estimates for β. On the other hand, if financial health is correlated with these firm characteristics but they affect trade outcomes through non-finance channels, omitting them could bias β. Reassuringly, this robustness check leaves our results qualitatively unchanged. To remain conservative, henceforth we always include the full set of firm-level controls as in Column 5-6 (see footnote 18).

Bilateral trade shares

The set of export destinations varies significantly across firms in our sample. Since countries differ in trade costs, demand conditions and the broader economic environment, different trade regimes might be best suited to serving different markets for reasons unrelated to financial frictions. To rule out the possibility that our results are driven by compositional effects, we construct exporters' trade shares by destination *d* and estimate a modified version of equation (2) that adds country fixed effects φ_d:

$$Trade\ Share_{fd} = \alpha + \beta \cdot Fin\ Health_f + \Gamma \cdot Z_f + \varphi_p + \varphi_i + \varphi_d + \varphi_{own} + \varepsilon_{fd} \qquad (2`)$$

We employ the full set of firm controls Z_f discussed above and cluster errors by firm to account for the potential correlation in ε_{fd} across markets within producers. This stringent specification delivers qualitatively similar estimates of greater magnitudes than our firm-level analysis (Columns 7-8 in Table 4). We ensure that the market composition of firms' exports does not affect our subsequent results by presenting evidence at both the firm and the firm-country levels.

Binary trade shares

Given that many Chinese exporters operate under a single trade regime (c.f. Figure 1), the linearity assumptions implicit in ordinary least squares might generate misspecification bias. In our sample, $Trade\ Share_f$ and $Trade\ Share_{fd}$ fall strictly between 0 and 1 for a quarter to a third of the observations. This is consistent with our hypotheses, and appears inconsequential econometrically: Our

[20] Krishna et al. (2015) study how Chinese firms learn from exporting directly vs. indirectly through trade intermediaries. While learning from exporting might also vary across trade regimes, the productivity and age controls account for that.

findings remain unchanged or become statistically and economically more significant when we replace the continuous trade shares with binary indicators set to 1 for all values above 0. Columns 9-10 in Table 4 present point estimates based on a linear probability model applied to disaggregated data at the firm-destination level, for which $Trade\ Share_{fd} = \{0,1\}$ holds more frequently than at the firm level. Similar patterns however emerge for binary trade shares at the firm level.

Multiple products and sectors per firm

Specifications (2) and (2`) explore the variation in trade outcomes across firms within 475 finely disaggregated GBT 4-digit industries, where each firm is assigned its main industry as reported in ASIF. This ignores the fact that many exporters are in fact active in multiple industries and products. We address this by exploiting the CCTS statistics on firm exports by ISIC 3-digit sector (29 categories) and by HS 8-digit product (5,784 categories). Although the ISIC classification is less granular than GBT-4, we consider it for consistency with our subsequent analysis of ISIC sectors' financial vulnerability.

In Table 5, we estimate the following equations to more rigorously test Hypothesis 2:

$$Trade\ Share_{fi} = \alpha + \beta \cdot Fin\ Health_f + \Gamma \cdot Z_f + \varphi_p + \varphi_i + \varphi_{own} + \varepsilon_{fi} \quad (3)$$

$$Trade\ Share_{fdi} = \alpha + \beta \cdot Fin\ Health_f + \Gamma \cdot Z_f + \varphi_p + \varphi_d + \varphi_i + \varphi_{own} + \varepsilon_{fdi} \quad (3`)$$

We compute the outcome variables separately for each firm-ISIC sector pair in Columns 1-2, each firm-destination-ISIC sector triplet in Columns 3-4, and each firm-destination-HS product triplet (the most disaggregated level available) in Columns 5-6. We include the full set of firm characteristics Z_f. We control for exogenous supply and demand conditions with corresponding ISIC-3 or HS-8 fixed effects φ_i and province fixed effects φ_p in specification (3), and additionally with destination fixed effects φ_d in specification (3`). While many firms pursue a mix of export regimes overall, they often choose a single one for a given industry, and even more frequently for a given industry-destination or product-destination market. We therefore use binary indicators for $Trade\ Share_{fi}$ and $Trade\ Share_{fdi}$; continuous trade shares produce comparable estimates. We cluster standard errors by firm.

Accounting for the fact that firms may be active in multiple product lines or even broader sectors, we find that companies' lagged financial health strongly predicts their choice of trade regime. On average, firms with more access to capital are more likely to select regimes with higher liquidity needs for any given sector or product that they pursue. We have separately checked that the baseline results in Table 4 where we assign firms' total trade flows to their primary industry of activity are robust to controlling for the log number of HS-8 products they export (available on request). Together, these patterns lend further support to Hypothesis 2 and inform the operations of multi-product firms. They

speak to the effects of financial frictions on the intensive margin, i.e. the choice of trade regime for sectors actually exported; we later consider the extensive margin of number of sectors exported.

Robustness

A series of additional robustness checks leave our conclusions unchanged (see Online Appendix Tables 1 and 2). First, we have confirmed our results when proxying size with log sales instead of log employment and material intensity with the ratio of material purchases to total sales instead of to the total wage bill. Second, import tariffs in upstream industries can affect firms' choice between processing and ordinary trade since the former permits duty-free imports of inputs (Brandt and Morrow 2015). Specifications (2)-(3`) implicitly take this into account because the industry fixed effects φ_i subsume the average tariff across imported inputs at the output-industry level. In addition, China's import tariffs were relatively low by 2005: The mean and standard deviation across HS-8 products amounted to 9.7% and 6.6% respectively. Nevertheless, there might be variation in effective import tariffs across exporters in the same output industry if they use inputs in different proportions. We have therefore verified our findings for $(X_{PA} + X_{PI}) / (X_{PA} + X_{PI} + X_{OT})$ controlling for firm-specific import tariffs constructed as the weighted average tariff across all products that a firm imports, using tariff data from WITS and lagged firm imports by product as weights as in Yu (2015).

Finally, we have explored the role of firms' ownership type. Evidence indicates that the affiliates of multinational companies are less credit constrained than domestic firms because the former can tap additional financial resources by accessing foreign capital markets directly or indirectly via internal capital markets. At the same time, multinational affiliates are not completely unconstrained and insensitive to host-country financial conditions.[21] *Ceteris paribus*, financial frictions can thus affect the trade regime choice of both domestic and foreign-owned firms in China. Since we condition on ownership type, our estimates are identified from the variation among producers with the same organizational structure. Split-sample and interaction analyses reveal that qualitatively similar patterns hold for domestic and foreign-owned firms.

6.2 Endogeneity

It is important to assess whether the strong relationship between firms' financial health and choice of trade regime is causal. A priori, even if export *levels* might influence firms' access to finance, it is less obvious how the *composition* of exports would. We nevertheless consider two potential endogeneity

[21] Foley and Manova (2015) review the literature on the effects of financial frictions on multinational activity. For the case of China, Manova et al. (2015) show that fully and partially foreign-owned firms export significantly more than private domestic firms in financially more vulnerable sectors, while Huang et al. (2007) conclude that more credit constrained Chinese firms are more likely to be acquired by foreign firms.

problems that could arise only if financial markets are efficient. Their relevance may thus be limited given the widely recognized inefficiency of Chinese capital markets.

First, with frictionless capital markets, manufacturers can fund and implement their first-best export strategy. Since liquidity needs decline from OT to PI to PA, so would the observed use of external finance across firms with different trade modes. This could spuriously generate our results even though we lag firms' financial health if financial health and trade activity are sufficiently slow-moving. What makes this an unlikely possibility is the substantial variation in profitability across trade regimes: Were Chinese exporters financially unconstrained, they would have pursued ordinary trade *ceteris paribus*.

Second, if firms face no credit constraints and profitability falls from OT to PI to PA due to non-finance factors (unlike in Section 3.1), firms might sort into trade regimes for exogenous reasons. If investors are more willing to fund more profitable ventures, exporters more active in trade regimes that happen to have higher returns would exhibit stronger financial health. While not impossible, this rationalization is hardly credible as it requires a very special alignment of exogenous forces.

Of note, reverse causality could lead us not only to overestimate, but also to underestimate the true impact of financial frictions on exporters' activity. If partnerships with foreign buyers under processing trade increase the trustworthiness of Chinese firms as borrowers, conducting PA or PI might improve their access to external finance in the Chinese capital market, as well as to trade credit from input suppliers. We would then be less likely to find empirical support for our hypotheses.

Finally, some of our results might be spurious because of how standard accounting practices affect measured financial health. Recall that liquidity and leverage are defined respectively as (current assets – current liabilities) / total assets and current liabilities / current assets.[22] Since current assets include input inventories, inventories of foreign inputs provided by foreign buyers do not enter the financial ratios of Chinese firms under PA, whereas inventories of foreign inputs acquired by Chinese firms under OT and PI do. It is not obvious if this systematically affects the measured liquidity of firms with different export regimes: Foreign-input inventories enter both the numerator and the denominator, and their outstanding cost is netted out of the numerator since accounts payable are part of current liabilities. It is also unclear how foreign input *inventories* might vary across trade modes, even if foreign input *purchases* do. As for leverage, it might be mechanically higher for firms conducting more PA relative

[22] Current assets ("Liu Dong Zi Chan") include inventories, cash, accounts receivable, investments, and pre-paid expenses, where inventories comprise finished products in the process of being sold and materials and inputs intended for future production. Note that the latter differs from the value of inputs used in production. Current liabilities ("Liu Dong Fu Zhai") include short-term loans, accounts payable, and accrued liabilities, where accounts payable may include input purchases that have not yet been settled. Total assets ("Zong Zichan") are the sum of fixed and current assets.

to PI and OT because foreign input inventories enter only the denominator. This concern would be mitigated to the extent that their outstanding cost is part of accounts payable in the numerator.

To establish the causal effect of credit constraints on firms' choice of trade regime, we complement the evidence above based on the cross-firm variation in financial health with a series of results that exploit other sources of variation in the data for identification purposes.

6.3 Firms' financial health: dynamics

We next provide consistent time-series evidence for the relationship between firms' financial health and export activity using panel data for 2002-2006.[23] We separately examine export entrants and continuing exporters to assess how changes in financial status affect trade behavior upon entry and subsequently. We also study how firms respond to an exogenous shock to export demand depending on their access to capital prior to the shock – the cleanest set-up for identifying causal effects in the time series.

Changes within firms over time

We explore whether changes in financial health lead continuing exporters to reorient operations across trade regimes by including firm fixed effects φ_f in a panel version of equations (2`) and (3`):

$$Trade\ Share_{fdt} = \alpha + \beta \cdot Fin\ Health_{f,t-1} + \Gamma \cdot Z_{f,t-1} + \varphi_f + \varphi_d + \varphi_t + \varepsilon_{fdt} \quad (4)$$

$$Trade\ Share_{fdit} = \alpha + \beta \cdot Fin\ Health_{f,t-1} + \Gamma \cdot Z_{f,t-1} + \varphi_f + \varphi_d + \varphi_i + \varphi_t + \varepsilon_{fdit} \quad (4`)$$

The unit of observation in these regressions is either the firm-destination-year or firm-ISIC industry-destination-year. The φ_f's subsume the role of firms' ownership type, province and primary industry affiliation, and control for time-invariant unobserved firm characteristics such as entrepreneurial ability or stable bank relationships that permanently improve access to credit. Coefficient β is thus identified purely from adjustments across trade modes within firms over time. We allow for common cost and demand shocks across manufacturers with destination φ_d, ISIC industry φ_i, and year φ_t fixed effects. We also condition on the full set of time-variant firm controls Z_{ft} introduced above, and cluster standard errors by firm.[24] We report results using binary indicators as the outcome variable, but qualitatively similar patterns hold with continuous measures.

Of note, we have less identification power in the panel than in the cross-section: While the averages (standard deviations) of liquidity and leverage are 0.09 (0.32) and 0.99 (1.28) in the cross-section for 2005, they are 0.08 (0.13) and 1.04 (0.34) within the average firm over the 2002-2006 period. At the

[23] Customs data are available 2000-2006, but the census panel begins in 2001 and we use 1-year lagged $Fin\ Health_f$. We have verified that our baseline cross-sectional results hold in the pooled panel with year fixed effects.
[24] Since we observe material intensity only in 2004, it is subsumed by the firm fixed effects in the panel regressions.

same time, there is significant turnover, with many firms entering and exiting different markets and frequent changes in the trade-regime composition of exports within surviving firm-destinations over time. For instance, 7.2% of firm-destinations with 100% processing exports in 2002 have switched to 100% ordinary exports by 2006, while another 21.8% have adopted mixed export strategies. Of firm-destinations with mixed trade regimes in 2002, 25.4% switch to purely ordinary exports by 2006, and another 34.7% reduce their share of processing trade closer to 0. Of firm-destinations with 100% ordinary exports in 2002, only 13% initiate processing trade by 2006. A sizeable number of firm-destinations thus gradually move from processing to ordinary exports, although the opposite trajectory also exists. The composition of processing exports in terms of PA and PI behaves similarly.

Table 6 indicates that improvements in financial health within firms are indeed followed by export activity shifting away from processing trade towards ordinary trade and away from pure assembly towards processing with imports (Columns 1-4). The estimates for β are, however, substantially smaller than in Tables 4 and 5. This suggests that continuing exporters do not modify operations on an annual basis, possibly because of sunk adjustment costs and uncertainty about future demand and credit conditions. Combined with our earlier results, this implies that financial frictions are an important determinant of the variation in trade activity across firms, but play a lesser role in surviving exporters' dynamics in the short run. The latter may be more responsive over a longer horizon than our panel permits us to study. For example, exporters that begin with processing trade may be able to accumulate sufficient financial resources through retained earnings and gradually transition into ordinary trade.

Export entry and MFA reform

We next turn to first-time exporters, and study how financial health prior to entry affects companies' choice of trade regime upon entry. We postulate that if a producer begins exporting in year *t*, he will be more likely to choose trade modes with lower liquidity requirements if he had access to less financial capital in year *t-1*. We test this hypothesis by re-estimating specifications (4) and (4`) in the subsample of firms exporting for the first time in year *t*.[25] We once again report results for binary outcome variables, but similar patterns hold for continuous trade shares. As expected, new exporters with ex ante less liquidity and more leverage conduct more processing trade and more pure assembly at export entry (Columns 5-8). These effects are typically 2-3 times bigger than those for financial health in the cross-section: A one-standard-deviation improvement in liquidity (leverage) prior to export entry translates into 1.3% (2.1%) lower probability of processing trade and 1.2% (2.3%) lower probability of pure

[25] We consider a firm to be a new exporter in year *t* if it did not export in years *t-1* and *t-2*. Our results are not sensitive to making this filter stricter, for example by requiring that *f* also did not export in year *t-3*, or by focusing only on entry in 2005 conditional on no exports in 2000-2004.

assembly conditional on processing trade upon entry. By contrast, lagged productivity is frequently not a significant determinant of the trade-regime composition of export entrants (not reported).

These findings reinforce our conclusion that the extensive margin of export entry is an important channel through which financial frictions impact firms' trading strategy, as constrained firms cannot easily switch across trade regimes once they begin exporting.

The results for export entry also strengthen the case for a causal effect of credit constraints. To the extent that a firm and its lenders do not have complete information about export profitability before export entry, lagged financial health is less likely to be endogenous to the future trade regime of new exporters than of continuing exporters. Lagged financial ratios are also not subject to concerns with the accounting of future foreign input inventories. Endogeneity would be especially unlikely if export entry occurs in response to an exogenous shock to foreign demand that is beyond the control of individual firms. We next provide consistent evidence using precisely such a natural experiment.

An important reform during our sample period was the removal of restrictive quotas on Chinese exports of textiles and apparel to the US, Canada and EU-25 on January 1, 2005 as part of the Multi-Fiber Agreement (MFA). Not all textile and apparel products were affected, and not all MFA-affected products faced binding quotas prior to 2005 (i.e. actual quantities shipped exceeding 90% of the specified limit). We test whether Chinese firms that began exporting MFA-affected products to the US, Canada and EU-25 in 2005 after the exogenous reforms chose trade regimes based on their prior financial status. In Columns 9-10 of Table 6, we estimate equation (4) in the cross-section of such firms and find patterns very similar to those in the panel of export survivors and entrants. Analogous results obtain for new exporters of quota-bound products, which we can identify in the case of the US (available on request).

6.4 Sectors' financial vulnerability

While the evidence in Sections 6.1 and 6.3 strongly supports Hypotheses 1 and 2, there might be sources of simultaneity bias that we are unable to address even with our analysis of export dynamics, because this still uses balance-sheet measures of firms' financial health. To more convincingly establish the causal effect of financial frictions, we next test Hypothesis 3 and examine the variation in export activity within firms across sectors at different levels of financial vulnerability. Financial vulnerability is technologically determined and reflects innate characteristics of the manufacturing process in an industry. It is by construction exogenous to individual firms, allowing us to circumvent concerns with endogeneity due to reverse causality, omitted variables or accounting bias.

Exploiting the rich customs data, we estimate two specifications using four alternative measures of sectors' financial vulnerability $Fin\ Vuln_i$:

$$Trade\ Share_{fi} = \alpha + \beta \cdot Fin\ Vuln_i + \Gamma \cdot Z_i + \varphi_f + \varepsilon_{fi} \quad (5)$$

$$Trade\ Share_{fdi} = \alpha + \beta \cdot Fin\ Vuln_i + \Gamma \cdot Z_i + \varphi_f + \varphi_d + \varepsilon_{fdi} \quad (5`)$$

The outcome variable of interest is the share of different trade regimes in firm *f*'s exports by ISIC industry *i* in equation (5) and by ISIC-industry *i* and destination *d* in equation (5`).[26] We include firm fixed effects φ_f to control for observed and unobserved company characteristics that affect trade activity in all sectors, such as financial health, productivity, size, ownership type, familiarity with foreign markets, etc. The effect of $Fin\ Vuln_i$ is hence identified solely from the exogenous variation across sectors within multi-sector producers.[27] It reflects the way in which exporters allocate their limited financial resources across trade modes and industries with different liquidity needs. Importantly, even if firms' total access to capital were endogenous to their trade operations, a significant β would imply that financial factors determine companies' export strategy. We cluster errors by firm, to account for the potential correlation in cost or demand shocks across industries and destinations within firms.[28]

We are careful to isolate the impact of financial vulnerability from that of other sector characteristics Z_i that might influence firms' trade regime. Since specifications (5) and (5`) do not permit industry fixed effects, we condition on sectors' physical and human capital intensity, as well as on the importance of relationship-specific investments in input production. These variables come from Braun (2003) and Nunn (2007). We also use four different measures of sectors' financial sensitivity that are imperfectly correlated with each other. This makes it difficult for a single omitted industry characteristic to simultaneously explain robust results for all four measures.

Table 7 clearly indicates that exporters choose different means of servicing foreign markets based on the financial characteristics of the sector. Firms actively pursue processing trade, especially pure assembly, in industries with high working capital requirements as proxied by the inventories-to-sales ratio (Columns 1-2 in Panel A). Increasing short-run liquidity needs by 20% would translate into 10% rise in the share of foreign revenues generated through processing trade and 4% uptake in the share of pure assembly in processing exports. These magnitudes are large relative to the means of the two trade shares (30% and 19% respectively).

[26] Since this analysis does not require any balance-sheet data, we are no longer restricted to the matched sample of firms with both customs and census data, and are able to include the universe of exporting firms.

[27] 45% of all exporters in the sample are active in two or more ISIC 3-digit sectors. They capture the vast majority of trade flows and of the observations in regressions (5) and (5`), ranging 64%-77% across columns in Table 7.

[28] Moulton (1990) argues that errors should be clustered at the most aggregate level at which the relevant explanatory variable varies in the sample, which in our case is the sector. However, Angrist and Pischke (2008) show that standard error asymptotics require a sufficiently large number of groups (50) that exceeds the number of sectors in our data (29). We have nevertheless confirmed that qualitatively similar results obtain if we instead cluster by sector.

We next examine the importance of sectors' reliance on outside finance for long-term investment in capital and R&D. As expected, industries' external finance dependence and R&D intensity affect the choice between ordinary and processing trade (Panels B and C). The trade-off between pure assembly and processing with imports, on the other hand, appears unrelated to the funding of long-run investment projects. This is consistent with the idea that the two processing regimes differ only in terms of the financing of short-run, variable input costs. By contrast, fixed costs incurred in product design, equipment purchases, marketing and distribution constitute a key distinction between processing and ordinary trade.

We finally turn to industries' asset tangibility in Panel D. While the three sector measures above capture liquidity needs, tangibility reflects the capacity to raise capital by pledging collateral. Our results confirm that exporters are indeed more likely to choose processing over ordinary exports in industries with softer assets (Column 1). As with the financing of long-term investment, asset tangibility too seems less important for the choice between the two processing methods (Column 2).

In terms of economic significance, financial frictions are a key determinant of firms' choice of trade regime across sectors. Based on our estimates, the effect of a one-standard-deviation change in $Fin\ Vuln_i$ on the share of processing exports in total exports is similar across the four measures (1.8%-2.5%). Compared to the implied impact of a one-standard-deviation change in other sector characteristics, financial vulnerability exerts an effect 5.6 times as large as that of physical capital intensity, 6 times that of human capital intensity, and 16 times that of relationship specificity.

Even within narrowly defined industry categories, the optimal trade strategy might depend on characteristics of the export market. We account for this possibility by estimating equation (5`) for the firm-industry-destination as the unit of observation, adding destination country fixed effects. We obtain consistent results for all four sector measures of financial vulnerability in Columns 3-4. In Columns 5-6, we record stable patterns when we instead use binary trade shares set to 1 for all values above 0.

These findings are robust to a number of specification checks presented in Online Appendix Table 3. First, we exploit the full granularity of the data, and define the outcome variable for each firm-HS product-destination triplet instead of at the firm-ISIC sector-destination level. Second, while the firm fixed effects in the regression control for the average tariff each firm pays for its imported inputs, effective import tariffs might vary systematically across output industries within a firm because different output industries combine inputs in different proportion. Our results survive when we control for the

average imported input tariff by output sector,[29] or alternatively, when we exclude firms that face import duties because they import inputs under the ordinary trade regime.

One implication of the conceptual framework in Section 3 is that financially healthier firms should be able to sustain export activity in more sectors and in more financially sensitive sectors. While other factors also influence the operations of multi-sector firms, we provide evidence consistent with this pattern in Online Appendix Table 4. We show that companies with higher (lower) levels of lagged liquidity (leverage) export a bigger number of ISIC sectors. Moreover, the average financial vulnerability of firm exports is higher for less constrained companies, where we calculate the former as the unweighted or weighted average $Fin\ Vuln_i$ across all industries i in firm f's export portfolio, using f's exports by industry as weights.

While Section 3 makes clear predictions for the direct effects of firms' financial health and sectors' financial vulnerability on exporters' choice of trade regime, it has ambiguous implications for the differential impact of firms' access to capital across sectors with different financial sensitivities. Regardless of its financial health, any firm would prefer export modes with lower liquidity requirements in financially more dependent sectors, compared to financially less dependent sectors (Hypothesis 3). In any industry, less constrained firms would be more likely to pursue trade regimes with higher liquidity needs, compared to more constrained firms (Hypothesis 2). However, the regime choices of less constrained firms might be equally, more or less reactive to sectors' financial dependence relative to those of more constrained firms, because all three scenarios would be consistent with firms' profit maximization. Interaction analysis suggests that in practice, all firms adjust their trade shares proportionately in response to sectors' financial vulnerability (not reported).

6.5 Provinces' financial development

Hypotheses 2 and 3 are valid only in the presence of financial market imperfections: Firms' need for external capital will distort their export activity only if they face financial constraints. Otherwise, producers will freely obtain the outside finance they need to implement their first-best export strategy, and Hypotheses 2 and 3 will not apply. We can therefore exploit exogenous differences in the strength of financial institutions across space to provide more causal evidence for Hypotheses 2 and 3.

The financial sector in China is known to be segmented, with banks typically serving firms in the same geographic region (World Bank 2005). This generates variation in the availability of external capital across Chinese provinces that is exogenous to individual firms. We thus expect the export

[29] We thank Brandt and Morrow (2014) for sharing their import tariff data by GBT-4 output industry, which we concord to ISIC-3 industries.

decisions of manufacturers in financially more developed areas to be less sensitive to their measured financial health and to industries' financial vulnerability. In other words, the effect of low liquidity on the proclivity for processing trade and pure assembly should be smaller for companies based in financially advanced regions relative to companies based in financially lagging regions. Similarly, across sectors within a firm, the effect of sectors' financial dependence on the two trade shares should be mitigated for firms operating in financially more developed provinces.

We test these predictions by expanding specifications (2`) and (5`) to include respectively interactions of firms' liquidity and of sectors' inventory-to-sales ratio with a measure of financial development in the firms' home province:

$$Trade\ Share_{fd} = \alpha + \beta \cdot Fin\ Health_f + \Gamma \cdot Z_f + \delta \cdot Fin\ Health_f \cdot High\ Fin\ Devt_p + \\ + \varphi_p + \varphi_i + \varphi_d + \varphi_{own} + \varepsilon_{fd} \quad (6)$$

$$Trade\ Share_{fdi} = \alpha + \beta \cdot Fin\ Vuln_i + \Gamma \cdot Z_i + \delta \cdot Fin\ Vuln_i \cdot High\ Fin\ Devt_p + \varphi_f + \varphi_d + \varepsilon_{fdi} \quad (6`)$$

Here $High\ Fin\ Devt_p$ is a binary indicator set to 1 for provinces with financial development above the sample median. Following common practice in the literature, we proxy regional financial conditions with the ratio of total credit to GDP from the Almanac of China's Finance and Banking (e.g. Héricourt and Poncet 2015). To account for different trade conditions across countries, we study bilateral trade shares by firm or firm-sector and include destination fixed effects φ_d. As above, in equation (6) we add the full set of firm controls Z_f, province φ_p, ownership φ_{own}, and industry φ_i fixed effects using information on the firm's primary industry from ASIF. By contrast, equation (6`) exploits the variation across sectors within firms by conditioning on firm fixed effects φ_f and sector controls Z_i. The main effect of $High\ Fin\ Devt_p$ is subsumed by either φ_p or φ_f. We continue to cluster errors by firm.

We report results for binary bilateral trade shares in Columns 1-2 and 5-6 of Table 8. As expected, $Fin\ Health_f$ and $Fin\ Vuln_i$ enter as before, while the interaction terms are significant and of the opposite sign. Comparing the estimates for β and δ, financial health affects firms' proclivity for processing trade 2.7 times more in financially underdeveloped regions in China than in financially advanced provinces. Raising sectors' working capital needs by 10% makes processing exports 12.5% more likely when firms face a weak banking system, but only 4.7% more likely when they can access strong capital markets.

These results are robust to the inclusion of an extensive set of control variables in Columns 3-4 and 7-8. First, we add the interactions of $Fin\ Health_f$ or $Fin\ Vuln_i$ with other province characteristics: GDP per capita, contract enforcement, physical- and human capital abundance. This ensures that we isolate the effect of financial development separately from that of overall economic development,

broader institutions and factor endowments. Second, in equation (6) we control for the interaction of firm productivity with financial development. Third, in equation (6`) we include the interactions of other sector characteristics (capital-, skill- and relationship-specific intensity) with corresponding regional characteristics (capital endowment, skill endowment and contract enforcement). Finally, we introduce industry fixed effects in specification (6`) to absorb unobserved industry characteristics. We then identify only the interaction term, but not the main effect of $Fin\ Vuln_i$. Our findings remain qualitatively the same, while the coefficients on most control variables are insignificant.

These results bolster the case for causal effects of financial frictions on firms' trade regime choices: While concerns with the endogeneity of $Fin\ Health_f$ or omitted sector characteristics correlated with $Fin\ Vuln_i$ might bias the level effects β, they could not explain the differential impacts δ in provinces with exogenously weaker bank systems because any estimation biases would be invariant across space.

6.6 Additional evidence

We have so far considered the optimal choice of trade regime from the exporter's point of view. The three export modes, however, entail different financial terms that the Chinese seller and foreign buyer must jointly agree on. What regime the Chinese producer pursues thus also depends on the incentives and financial capacity of his trade partner: The foreign buyer should be willing to bear more of the financing costs of the transaction if he has access to cheaper capital and if doing so increases the probability of successful production and delivery.

The data reveal two patterns consistent with this idea (available on request). Both are difference-in-differences results that would be difficult to attribute to reverse causality or omitted variable bias, lending further support to our main conclusions.

First, we exploit the variation in financial development across export markets as a proxy for the foreign party's access to external finance. Superior financial development in the destination makes it more likely for Chinese exporters to choose processing trade, especially pure assembly, in sectors with higher working capital needs. The impact of industries' inventory ratio on both trade shares is doubled for destinations with private-credit-to-GDP ratio above the median relative to countries below the median. This aligns with recent theoretical and empirical evidence that the relative cost of capital in the exporting and importing country affects the choice between cash-in-advance and post-shipment payment in international transactions (Antràs and Foley 2015, Demir and Javorcik 2014, Hoefele et al. 2013).

Second, we study the cross-sector variation in the importance of product customization via relationship-specific investments in production. The extent of relationship specificity can affect firms' ability to raise external capital and hence choice of trade regime. Financiers can better monitor a

borrower to alleviate moral hazard if they can more easily ascertain that contractual agreements about input sourcing and assembly have been observed.[30] Similarly, the higher the outside market value of a product, the greater the expected return to an investor in case of default, as he could seize and liquidate assets more profitably. If lenders are less likely to fund Chinese firms in industries with more relationship-specific investments, credit constraints would be more binding for such firms and their foreign buyers induced to provide more funding to ensure production. Indeed, interaction analysis indicates that firms' financial health (liquidity) and sectors' financial vulnerability (inventory ratio) affect the choice of trade regime relatively more in relationship-specific intensive sectors.

7 Conclusion

This paper examines how firms choose to participate in international trade and how this decision affects performance. We study three export modes that implicitly capture firms' production technology and position in the global value chain: ordinary trade, processing trade with imported inputs, and processing trade via pure assembly. Using matched customs and balance-sheet data for China, we show that conducting more steps of the supply chain increases value added and profits. However, it requires more working capital because it entails higher up-front costs. As a result, credit constraints restrict firms to low value-added stages of production, and preclude them from pursuing more profitable opportunities.

Our findings highlight a novel mechanism through which liquidity constraints impact firms' export outcomes and ultimately profitability. They further suggest that financial frictions influence the design of international trade contracts and the organization of global production across firm and country boundaries. Strengthening financial markets in developing countries might thus be instrumental in increasing aggregate value added, profits and income. A promising direction for future research is the potential for firms and entire economies to grow over time by starting with processing trade restricted to few assembly tasks and gradually expanding along the value chain into more profitable activities.

These conclusions shed light on the gains from trade in the context of global production networks and on the distributional consequences of trade policy in the presence of financial frictions. In particular, processing trade may allow more credit constrained firms to share in the gains from trade when they would have otherwise been unable to engage with global markets. More broadly, we provide one of the first firm-level studies of processing trade and inform current discussions of the effects of global value chains on optimal trade policy, exchange-rate pass-through, and the transmission of supply and demand shocks across nations.

[30] See Antràs et al. (2009) for a formal model of a similar mechanism.

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Table 1. Summary Statistics: Firm Performance

This table provides summary statistics for all exporting firms in the matched sample of firms with ASIF and CCTS data. Productivity is constructed as value added per worker (VA) or according to Levinsohn-Petrin (2003) (LP). Firms' financial health is measured by liquidity = (current assets - current liabilities) / total assets or leverage = current liabilities / current assets.

	N	Mean	St Dev
	(1)	(2)	(3)
(log) Sales	50,567	10.64	1.35
(log) Value Added	49,801	9.23	1.48
(log) Employment	50,606	5.31	1.14
(log) Total Exports	50,606	13.83	2.08
(log) Total Imports	31,551	12.65	2.90
(log) Profits	39,844	7.33	1.95
Profits / Sales	50,582	0.03	0.20
Productivity (LP)	47,297	4.96	1.17
Productivity (VA)	49,735	3.93	1.08
Liquidity	50,574	0.09	0.32
Leverage	50,567	0.99	1.28

Table 2. Summary Statistics: Trade Activity

This table provides summary statistics for all exporting firms in the CCTS data. PA, PI and OT represent the value of exports under pure assembly, processing with imports, and ordinary trade respectively. Columns 1-3 report summary statistics for the share of processing exports in total exports. Columns 4-6 report summary statistics for the share of pure assembly in total processing exports. A sector is a 3-digit ISIC category. A product is an 8-digit HS category.

	(PA+PI) / (PA+PI+OT)			PA / (PA+PI)		
	N	Mean	St Dev	N	Mean	St Dev
Variation Across:	(1)	(2)	(3)	(4)	(5)	(6)
Firm	114,883	0.27	0.41	42,176	0.24	0.41
ISIC within Firm		0.25	0.09		0.24	0.03
HS within Firm		0.24	0.09		0.24	0.04
Firm-ISIC	258,658	0.18	0.37	60,553	0.21	0.40
Firm-ISIC-Destination	1,160,175	0.20	0.39	269,758	0.14	0.34
Dest within Firm-ISIC		0.18	0.05		0.21	0.02
ISIC within Firm-Dest		0.24	0.07		0.14	0.02
Firm-HS	937,432	0.16	0.36	172,306	0.31	0.46
Firm-HS-Destination	2,248,027	0.20	0.39	483,251	0.19	0.39
Dest within Firm-HS		0.16	0.04		0.31	0.02
HS within Firm-Dest		0.23	0.07		0.15	0.02

Table 3. Trade Regimes and Firm Characteristics

This table examines the relationship between firms' export trade regimes and other characteristics. Each cell reports the coefficient from regressing the variable in the row heading on the trade share indicated in the column heading. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. All regressions include firm size (log employment), province, industry, and ownership fixed effects (using the main GBT 4-digit industry of each firm). Columns 2 and 4 restrict the sample to pure exporters with no domestic sales. T-statistics based on robust standard errors reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	(PA+PI) / (PA+PI+OT)		PA / (PA+PI)	
	All Exporters	Pure Exporters	All Exporters	Pure Exporters
Outcome variable:	(1)	(2)	(3)	(4)
(Log) Profits	-0.151***	-0.221***	-0.275***	-0.289***
Profits / Sales	-0.016***	-0.023***	-0.013***	-0.019***
(Log) Total Sales	-0.063***	-0.199***	-0.451***	-0.584***
(Log) Domestic Sales	-0.320***	-	0.024	-
(Log) Exports	0.960***	0.166***	-0.259***	-0.101**
(Log) Value Added	-0.108***	-0.149***	-0.229***	-0.227***
TFP	-0.136***	-0.280***	-0.187***	-0.212***
Value Added / Worker	-0.108***	-0.156***	-0.231***	-0.245***
(Log) Wage	0.001	0.047***	-0.038***	0.016
Net Fixed Assets / Wage Bill	0.927***	1.153***	-0.888***	-1.122***
Material Inputs / Wage Bill	3.880***	-1.319	-5.057***	-5.220***
(Log) Imports	7.416***	8.874***	0.225***	0.364***
Proc Imports / Imports	0.598***	0.494***	0.040***	0.039***
Size; Own, Prov, Ind FE	Y	Y	Y	Y

Table 4. Trade Regimes and Firms' Financial Health

This table examines the relationship between firms' export trade regimes and financial health in the cross section. The unit of observation is the firm in Columns 1-6 and the firm-destination in Columns 7-10. All variables are defined in the text. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable is continuous in columns 1-8 and equals 1 for all values above 0 in Columns 9-10. Columns 3-10 control for lagged productivity and log employment. Columns 5-10 further control for age and lagged capital-, skill-, and material intensity. All regressions include province, industry, and ownership fixed effects (using the main GBT 4-digit industry of each firm). T-statistics reported in parentheses based on robust standard errors in columns 1-6 and clustered by firm in columns 7-10. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Baseline		Productivity, Size Control		Full Control		Bilateral Trade Share		Binary Bilateral Trade Share	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. Liquidity										
Lag Liquidity	-0.044***	-0.020***	-0.012**	-0.015**	-0.011*	-0.017**	-0.011*	-0.029**	-0.017**	-0.026*
	(-8.72)	(-2.73)	(-2.18)	(-2.03)	(-1.96)	(-2.21)	(-1.68)	(-2.21)	(-2.04)	(-1.96)
Lag Productivity			-0.017***	-0.018***	-0.024***	-0.015***	-0.023***	-0.023***	-0.018***	-0.023***
			(-9.42)	(-6.71)	(-11.57)	(-5.12)	(-7.45)	(-6.02)	(-5.82)	(-5.80)
Lag Log Employment			0.068***	-0.011***	0.069***	-0.014***	0.070***	-0.002	0.080***	0.0004
			(41.35)	(-4.47)	(38.03)	(-5.21)	(27.37)	(-0.59)	(29.89)	(0.12)
R-squared	0.42	0.23	0.44	0.23	0.45	0.23	0.43	0.22	0.40	0.24
# observations	46,573	20,555	43,125	19,145	43,103	19,134	379,941	126,489	379,941	126,489
Panel B. Leverage										
Lag Leverage	0.005***	0.007**	0.002**	0.007*	0.002**	0.007*	0.004**	0.013***	0.004***	0.012***
	(3.50)	(2.00)	(2.40)	(1.89)	(2.39)	(1.93)	(2.57)	(4.02)	(3.25)	(3.91)
Lag Productivity			-0.018***	-0.018***	-0.024***	-0.015***	-0.023***	-0.022***	-0.019***	-0.022***
			(-9.93)	(-6.63)	(-12.03)	(-5.11)	(-7.70)	(-5.98)	(-6.16)	(-5.74)
Lag Log Employment			0.068***	-0.011***	0.069***	-0.014***	0.070***	-0.002	0.081***	-0.00003
			(42.17)	(-4.45)	(38.85)	(-5.21)	(27.97)	(-0.72)	(30.62)	(-0.01)
R-squared	0.42	0.23	0.44	0.23	0.44	0.23	0.43	0.22	0.40	0.24
# observations	46,557	20,545	43,113	19,137	43,092	19,127	379,893	126,466	379,893	126,466
Own, Prov, Ind FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age; K, H, M Intensity	--	--	--	--	Y	Y	Y	Y	Y	Y
Destination FE	--	--	--	--	--	--	Y	Y	Y	Y

Table 5. Trade Regimes and Firms' Financial Health: Extensions

This table examines the relationship between firms' export trade regimes and financial health in the cross-section. The unit of observation is the firm-sector in Columns 1-2, the firm-sector-destination in Columns 3-4, and the firm-product-destination in Columns 5-6, where sectors are ISIC 3-digit and products are HS 8-digit. All variables are defined in the text. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable equals 1 for all values above 0. All regressions include firms' age and lagged productivity, size, capital-, skill-, and material intensity, as well as province, industry, and ownership fixed effects. The industry fixed effects are based on ISIC sectors in Columns 1-4 and HS products in Columns 5-6. T-statistics based on robust standard errors clustered by firm reported in parentheses. ***, **, and * indicate significance at the 1%, 5%,

	Binary Trade Share by ISIC Sector		Binary Bilateral Trade Share by ISIC Sector		Binary Bilateral Trade Share by HS Product	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Liquidity						
Lag Liquidity	-0.008*	-0.021**	-0.017*	-0.022*	-0.011*	-0.048***
	(-1.68)	(-2.37)	(-1.70)	(-1.72)	(-1.67)	(-3.26)
R-squared	0.28	0.21	0.32	0.17	0.41	0.38
# observations	92,370	28,487	498,203	153,732	887,777	274,508
Panel B. Leverage						
Lag Leverage	0.003**	0.012***	0.003***	0.016***	0.004**	0.016***
	(2.33)	(4.82)	(2.63)	(6.74)	(2.13)	(6.36)
R-squared	0.28	0.21	0.32	0.17	0.41	0.39
# observations	92,347	28,474	498,138	153,704	887,675	274,465
Productivity; Size; Age; K, H, M Intensity	Y	Y	Y	Y	Y	Y
Own, Prov FE	Y	Y	Y	Y	Y	Y
Destination FE	--	--	Y	Y	Y	Y
Industry FE	ISIC-3	ISIC-3	ISIC-3	ISIC-3	HS-8	HS-8

Table 6. Trade Regimes and Firms' Financial Health: Export Dynamics

This table examines the relationship between firms' export trade regimes and financial health in the panel. The unit of observation is the firm-destination-year in Columns 1-2 and 5-6, the firm-destination-year-ISIC sector in Columns 3-4 and 7-8, and the firm-destination in Columns 9-10. The sample covers all firms in 2002-2006 in Columns 1-4, only firms with positive exports in year t but not in the previous two years in Columns 5-8, and only firms exporting MFA-affected products to the US, Canada and/or EU-25 in 2005 but not in the previous two years in Columns 9-10. All variables are defined in the text. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable equals 1 for all values above 0. All regressions include firms' age and lagged productivity, size, capital-, and skill intensity, as well as firm, year, and destination fixed effects. Industry fixed effects are included based on the main GBT-4 digit industry of each firm in Columns 5-6 and 9-10 and on ISIC-3 digit industries in Columns 3-4 and 7-8. T-statistics based on robust standard errors clustered by firm reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Full 2002-2006 Panel				Export Entry in 2002-2006 Panel				Export Entry after MFA Reform	
	Binary Bilateral Trade Share		Binary Bilateral Trade Share by ISIC		Binary Bilateral Trade Share		Binary Bilateral Trade Share by ISIC		Binary Bilateral Trade Share	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. Liquidity										
Lag Liquidity	-0.007**	-0.005*	-0.008**	-0.008**	-0.035***	-0.070**	-0.042***	-0.066**	-0.052*	-0.075*
	(-2.50)	(-1.92)	(-2.17)	(-2.55)	(-2.82)	(-2.50)	(-3.27)	(-2.29)	(-1.89)	(-1.91)
R-squared	0.82	0.89	0.70	0.85	0.35	0.40	0.32	0.42	0.44	0.40
# observations	1,427,114	507,415	1,868,108	619,636	78,194	13,465	94,691	14,996	3,731	1,339
Panel B. Leverage										
Lag Leverage	0.0003*	0.0004**	0.0006*	0.0004*	0.007**	0.023**	0.009**	0.018*	0.008***	0.013***
	(1.67)	(2.20)	(1.85)	(1.91)	(2.20)	(2.17)	(2.49)	(1.68)	(4.77)	(2.96)
R-squared	0.82	0.89	0.70	0.85	0.35	0.40	0.32	0.42	0.44	0.41
# observations	1,427,041	507,382	1,867,978	619,598	78,184	13,465	94,677	14,996	3,731	1,339
Productivity; Size; Age; K, H Intensity	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year, Dest FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	--	--	--	--	--	--
Industry FE	--	--	ISIC-3	ISIC-3	GBT4	GBT4	ISIC-3	ISIC-3	GBT4	GBT4

Table 7. Trade Regimes and Sectors' Financial Vulnerability

This table examines the relationship between firms' export trade regimes and sectors' financial vulnerability in the cross-section. The unit of observation is the firm-ISIC 3-digit sector in Columns 1-2 and the firm-destination-ISIC 3-digit sector in Columns 3-6. All variables are defined in the text. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable is continuous in Columns 1-4, and equals 1 for all values above 0 in Columns 5-6. All regressions include sectors' physical capital (K), human capital (H) and relationship specific (RS) intensity, as well as firm fixed effects. Columns 3-6 also include destination fixed effects. T-statistics based on robust standard errors clustered by firm reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Baseline		Bilateral Trade Share		Binary Bilateral Trade Share	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Working Capital Requirements: Inventories Ratio						
Inventories Ratio	0.497***	0.201***	0.538***	0.084**	0.675***	0.149***
	(23.43)	(2.77)	(20.90)	(1.99)	(22.75)	(3.01)
K intensity	-0.310***	0.151	-0.176***	0.021	-0.277***	0.033
H intensity	0.016***	-0.016	0.026***	-0.011	0.018***	-0.026***
RS intensity	0.017***	-0.002	0.024***	0.024*	0.046***	0.063***
R-squared	0.86	0.97	0.83	0.94	0.77	0.92
Panel B. Long-Run Investment Needs: External Finance Dependence						
Ext Fin Dependence	0.050***	-0.0001	0.049***	-0.002	0.060***	0.0004
	(21.82)	(-0.03)	(18.23)	(-0.46)	(19.40)	(0.08)
K intensity	-0.744***	-0.052	-0.734***	-0.066	-0.979***	-0.128***
H intensity	0.019***	-0.002	0.031***	-0.004	0.024***	-0.016*
RS intensity	0.003	-0.016	-0.002	0.017	0.013*	0.050***
R-squared	0.86	0.97	0.83	0.94	0.77	0.92
Panel C. Long-Run Investment Needs: R&D Intensity						
R&D Intensity	0.988***	-0.018	0.901***	-0.032	1.026***	0.008
	(22.81)	(-0.24)	(16.68)	(-0.55)	(17.17)	(0.13)
K intensity	-0.601***	-0.053	-0.611***	-0.069*	-0.836***	-0.127***
H intensity	-0.009**	-0.001	0.005	-0.003	-0.003	-0.016*
RS intensity	-0.022***	-0.015	-0.020***	0.018	-0.007	0.050***
R-squared	0.86	0.97	0.83	0.94	0.77	0.92
Panel D. Access to Collateral: Asset Tangibility						
Asset Tangibility	-0.208***	-0.038	-0.207***	-0.028	-0.248***	-0.074***
	(-18.05)	(-1.12)	(-15.94)	(-1.42)	(-16.15)	(-3.41)
K intensity	-0.036	0.083	0.026	0.029	-0.066	0.133
H intensity	0.012***	-0.008	0.025***	-0.009	0.018***	-0.028***
RS intensity	0.019***	-0.011	0.023***	0.021	0.044***	0.061***
R-squared	0.86	0.97	0.83	0.94	0.77	0.92
Firm FE	Y	Y	Y	Y	Y	Y
Destination FE	--	--	Y	Y	Y	Y
# firms	110,018	41,041	110,018	41,041	110,018	41,041
# observations	252,296	59,263	1,142,871	264,585	1,142,871	264,585

Table 8. Financial Development across Chinese Provinces

This table examines the relationship between firms' export trade regimes and home-province financial development. All variables are defined in the text. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The unit of observation is the firm-destination in Columns 1-4 and the firm-destination-ISIC 3-digit sector in Columns 5-8. The outcome variable equals 1 for all values above 0. High Fin Devt is a dummy set to 1 for Chinese provinces with financial development above the median. Columns 1-4 include firms' age and lagged productivity, size, capital-, skill-, and material intensity, as well as ownership, province, and destination fixed effects. Columns 5-8 include sectors' physical capital (K), human capital (H) and relationship specific (RS) intensity, as well as firm and destination fixed effects. Industry fixed effects are included based on the main GBT-4 digit industry of each firm in Columns 1-4 and on ISIC-3 digit industries in Columns 7-8. T-statistics based on robust standard errors clustered by firm reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Financial Measure:	Firm Fin Health (Lagged Liguidity)				Sector Fin Vulnerability (Inventories Ratio)			
	Baseline		Extended Controls		Baseline		Extended Controls	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial Measure	-0.027**	-0.079***	0.005	-0.036	1.252***	0.324**		
X High Fin Devt	0.017*	0.081***	0.024**	0.069**	-0.787***	-0.220**	-1.210***	-0.326**
X High GDP Per Capita			-0.053	-0.059			0.133	-0.502
X Contract Enforce			-0.001	-0.001			-0.042***	-0.048*
X K Abundance			-0.023	-0.040*			0.325***	0.238
X H Abundance			0.004	0.006			0.010	-0.024
TFP X High Fin Devt			-0.005	0.018***				
K Intensity X K Abundance							-0.130***	-0.015
H Intensity X H Abundance							-0.001	-0.001
RS Intensity X Contract Enforce							-0.003***	0.001
R-squared	0.40	0.24	0.40	0.24	0.77	0.92	0.83	0.94
# observations	379,941	126,489	379,941	126,489	1,142,871	264,585	1,142,871	264,585
Productivity; Size; Age; K, H, M Intensity	Y	Y	Y	Y	--	--	--	--
Own, Prov, Dest FE	Y	Y	Y	Y	--	--	--	--
K, H, RS Intensity	--	--	--	--	Y	Y	Y	Y
Firm, Dest FE	--	--	--	--	Y	Y	Y	Y
Industry FE	GBT-4	GBT-4	GBT-4	GBT-4	--	--	ISIC-3	ISIC-3

Figure 1. The Distribution of Firms Across Trade Regimes

This figure summarizes the composition of firms' trade activity in 2005. Each segment gives the percentage share of firms active in a given set of export trade regimes. Firms in the red circle are engaged in ordinary trade (OT); in the blue circle - in pure assembly (PA); and in the yellow circle - in import and assembly (PI). Firms in overlapping segments of the three circles export under multiple trade regimes. The percentages reported sum to 100%.

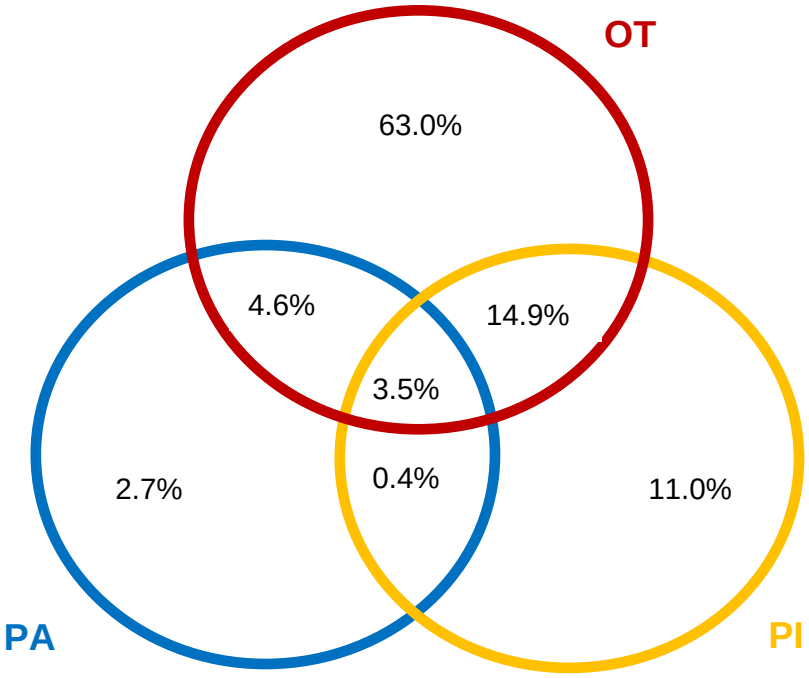


Figure 2. The Distribution of Export Value Across Trade Regimes

This figure replicates Figure 1, but instead of showing the percentage share of firms in a segment, it reports the percentage share of total exports captured by firms in that segment.

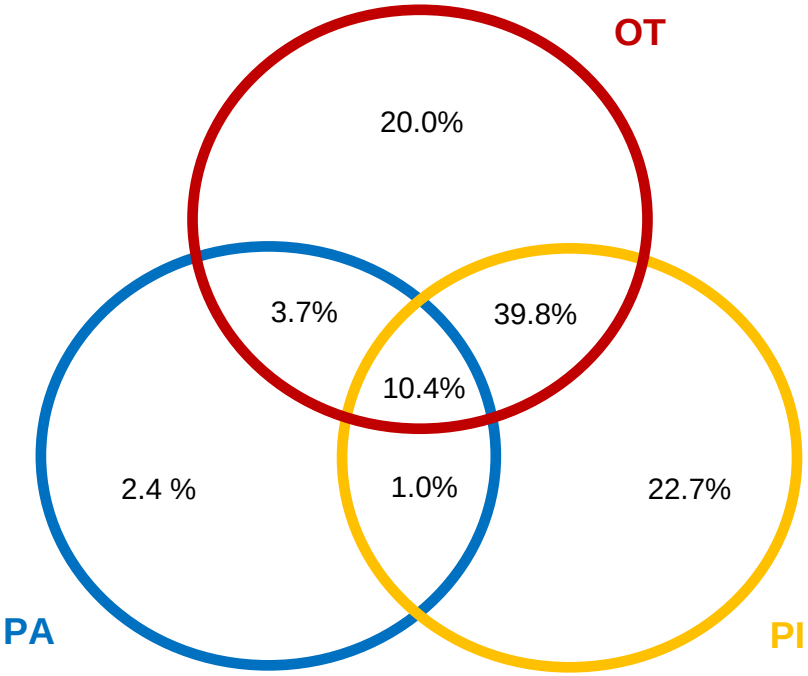


Figure 3. Trade Shares Across Firms and Sectors

This figure shows how the propensity for firms to pursue different trade regimes varies with firms' financial health and with sectors' working capital requirements in 2005. In Figure 3A, firms are split into two subsamples with liquidity above and below the sample median. In Figure 3B, sectors are split into two subsamples with inventory ratios above and below the median. The left bars (red) report the average share of processing trade in total exports across firms in a sample. The right bars (yellow) report the average share of pure assembly in processing trade across firms in a sample.

Figure 3A. Firms' financial health

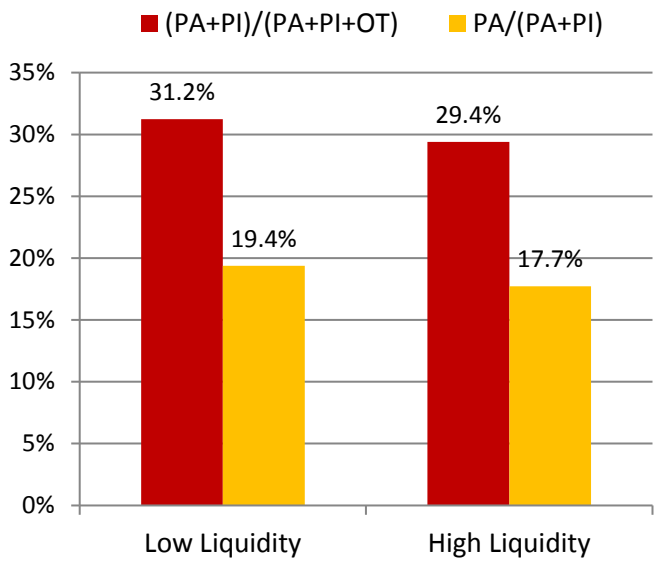
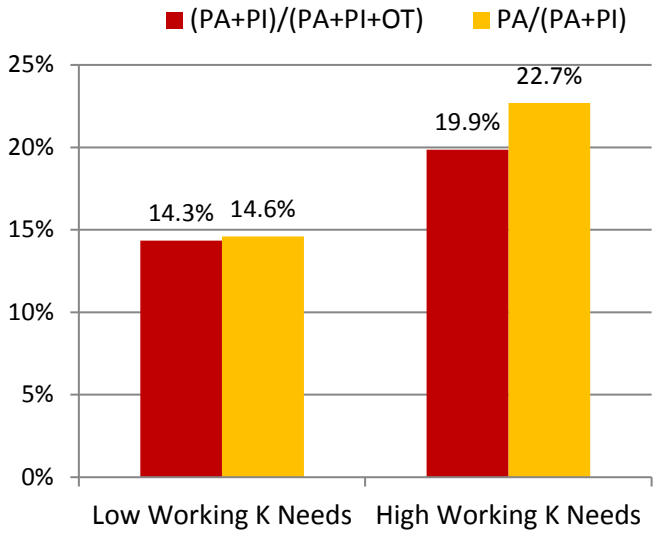


Figure 3B. Sectors' working capital requirement



Online Appendix Table 1. Trade Regimes and Firms' Financial Health: Robustness

This table examines the relationship between firms' export trade regimes and financial health in the cross-section. The unit of observation is the firm in Columns 1, 2, 7, the firm-destination in Columns 3, 4, 8, and the firm-destination-ISIC 3-digit sector in Columns 5, 6, 9. All variables are defined in the text and measured as in Table 4, except that in Columns 1-6 firm size is measured by log sales instead of log employment and material intensity with the ratio of material inputs to total sales instead of the ratio of material inputs to the total wage bill. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable equals 1 for all values above 0 in Columns 3-6 and 8-9. All regressions include firms' age and lagged productivity, size, capital-, skill-, and material intensity, as well as province, industry, and ownership fixed effects. Columns 3-6 and 8-9 also include destination fixed effects. The industry fixed effects are based on the main GBT 4-digit industry of each firm in Columns 1-4 and 7 and on ISIC 3-digit sectors in Columns 5-6 and 9. T-statistics reported in parentheses, based on robust standard errors in Columns 1-2 and 7 and clustered by firm in Columns 3-6 and 8-9. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Firm Size = Log Sales, Material Intensity = Materials / Sales						Firm-Specific Import Tariff		
Unit of Analysis:	Firm		Binary Firm-Destination		Binary Firm-Dest-ISIC		Firm	Binary Firm-Destination	Binary Firm-Dest-ISIC
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA+PI}{PA+PI+OT}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Liquidity									
Lag Liquidity	-0.020***	-0.028***	-0.021**	-0.038***	-0.024**	-0.037***	-0.011*	-0.021**	-0.023*
	(-3.73)	(-3.46)	(-2.54)	(-3.04)	(-2.37)	(-2.86)	(-1.71)	(-2.21)	(-1.87)
Lag Import Tariff							0.013***	0.013***	0.010***
							(24.26)	(14.69)	(10.84)
R-squared	0.44	0.26	0.39	0.27	0.32	0.21	0.43	0.37	0.29
# observations	43,097	19,129	379,862	126,429	498,098	153,655	25,748	249,409	343,848
Panel B. Leverage									
Lag Leverage	0.004***	0.007**	0.005***	0.011***	0.006***	0.015***	0.002*	0.002**	0.003***
	(3.23)	(1.97)	(4.13)	(3.85)	(4.15)	(5.41)	(1.78)	(2.18)	(2.62)
Lag Import Tariff							0.013***	0.009***	0.010***
							(24.23)	(15.44)	(10.83)
R-squared	0.44	0.27	0.39	0.27	0.32	0.22	0.43	0.28	0.29
# observations	43,086	19,122	379,814	126,406	498,033	153,627	25,742	63,020	343,817
Productivity; Size; Age; K, H, M Intensity	Y	Y	Y	Y	Y	Y	Y	Y	Y
Own, Prov FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Destination FE	--	--	Y	Y	Y	Y	--	Y	Y
Industry FE	GBT-4	GBT-4	GBT-4	GBT-4	ISIC-3	ISIC-3	GBT-4	GBT-4	ISIC-3

Online Appendix Table 2. Trade Regimes and Firms' Financial Health: Firm Ownership Type

This table examines the relationship between firms' export trade regimes and financial health in the cross-section. The unit of observation is the firm in Columns 1-2, 7-8, the firm-destination in Columns 3-4, 9-10, and the firm-destination-ISIC 3-digit sector in Columns 5-6, 11-12. The sample covers all domestic firms in Columns 1-6 and all foreign-owned firms in Columns 7-12. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable equals 1 for all values above 0 in Columns 3-6 and 9-12. All regressions include firms' age and lagged productivity, size, capital-, skill-, and material intensity, as well as province, industry, and ownership fixed effects. Columns 3-6 and 9-12 also include destination fixed effects. The industry fixed effects are based on the main GBT 4-digit industry of each firm in Columns 1-4 and 7-10 and on ISIC 3-digit sectors in Columns 5-6 and 11-12. T-statistics reported in parentheses, based on robust standard errors in Columns 1-2 and 7-8 and clustered by firm in Columns 3-6 and 9-12. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Domestic Firms						Foreign Firms					
Unit of Analysis:	Firm		Binary Firm-Destination		Binary Firm-Dest-ISIC		Firm		Binary Firm-Destination		Binary Firm-Dest-ISIC	
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. Liquidity												
Lag Liquidity	-0.022***	-0.033	-0.012*	-0.079**	-0.001*	-0.091***	-0.005	-0.014*	-0.015	-0.017*	-0.019*	-0.013
	(-3.33)	(-1.00)	(-1.71)	(-2.10)	(-1.72)	(-3.37)	(-0.67)	(-1.70)	(-1.03)	(-1.66)	(-1.71)	(-1.63)
R-squared	0.21	0.32	0.24	0.39	0.12	0.27	0.39	0.24	0.35	0.24	0.29	0.17
# observations	16,775	3,020	154,699	17,534	187,847	18,258	26,328	16,114	225,242	108,955	310,356	135,474
Panel B. Leverage												
Lag Leverage	0.004*	0.018**	0.001*	0.051***	-0.005	0.047***	0.002*	0.006*	0.004***	0.011***	0.004***	0.015***
	(1.75)	(2.03)	(1.69)	(3.09)	(-1.11)	(3.18)	(1.91)	(1.82)	(3.07)	(3.81)	(3.43)	(7.32)
R-squared	0.21	0.33	0.24	0.39	0.12	0.28	0.39	0.24	0.35	0.25	0.29	0.18
# observations	16,772	3,020	154,688	17,534	187,836	18,258	26,320	16,107	225,205	108,932	310,302	135,446
Productivity; Size; Age; K, H, M Intensity	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Own, Prov FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Destination FE	--	--	Y	Y	Y	Y	--	--	Y	Y	Y	Y
Industry FE	GBT-4	GBT-4	GBT-4	GBT-4	ISIC-3	ISIC-3	GBT-4	GBT-4	GBT-4	GBT-4	ISIC-3	ISIC-3

Online Appendix Table 3. Trade Regimes and Sectors' Financial Vulnerability: Robustness

This table examines the relationship between firms' export trade regimes and sectors' financial vulnerability in the cross-section.The unit of observation is the firm-destination-HS 8-digit product in Columns 1-2, the firm-ISIC 3-digit sector in Columns 3 and 5, and the firm-destination-ISIC 3-digit sector in Columns 4 and 6. PA, PI, and OT denote pure assembly, processing with imports, and ordinary trade, respectively. The outcome variable equals 1 for all values above 0. All regressions include sectors' physical capital (K), human capital (H) and relationship specific (RS) intensity, as well as firm fixed effects. Columns 1-2, 4, and 6 also include destination fixed effects. Columns 3-4 include a sector-specific imported-input tariff. Columns 5-6 exclude firms with only ordinary imports. T-statistics based on robust standard errors clustered by firm reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

	Bilateral Trade Share by Firm-HS Product		Industry-Specific Import Tariff		No Firms with OT Imports Only	
			Baseline	Bilateral Trade Share	Baseline	Bilateral Trade Share
Dep Variable:	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA}{PA+PI}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA+PI}{PA+PI+OT}$	$\frac{PA+PI}{PA+PI+OT}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Working Capital Requirements: Inventories Ratio						
Inventories Ratio	0.486***	0.163***	0.715***	0.710***	1.089***	0.654***
	(18.41)	(3.73)	(22.09)	(20.15)	(9.27)	(8.71)
Input Tariff			0.006***	-0.002**		
			(6.64)	(-2.47)		
R-squared	0.75	0.91	0.79	0.77	0.77	0.77
Panel B. Long-Run Investment Needs: External Finance Dependence						
Ext Fin Dependence	0.040***	0.002	0.081***	0.065***	0.106***	0.068***
	(16.71)	(0.41)	(25.81)	(20.87)	(9.53)	(8.40)
Input Tariff			0.017***	0.009***		
			(19.41)	(13.72)		
R-squared	0.75	0.91	0.79	0.77	0.77	0.77
Panel C. Long-Run Investment Needs: R&D Intensity						
R&D Intensity	0.703***	-0.009	1.203***	1.037***	1.521***	1.116***
	(14.03)	(-0.21)	(21.96)	(17.39)	(8.69)	(8.11)
Input Tariff			0.015***	0.006***		
			(17.10)	(9.71)		
R-squared	0.75	0.91	0.79	0.86	0.77	0.77
Panel D. Access to Collateral: Asset Tangibility						
Asset Tangibility	-0.1863***	-0.071***	-0.222***	-0.233***	-0.383***	-0.270***
	(-14.57)	(-3.63)	(-13.63)	(-13.92)	(-5.65)	(-4.90)
Input Tariff			0.011***	0.002***		
			(12.96)	(3.19)		
R-squared	0.75	0.91	0.79	0.86	0.77	0.76
K, H, RS Intensity	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Destination FE	Y	Y	--	Y	--	Y
# firms	110,018	41,041	110,018	110,018	23,435	23,435
# observations	2,226,506	477,343	252,296	1,142,871	43,816	194,297

Online Appendix Table 4. Firms' Financial Health and Multi-Sector Activity

This table examines the relationship between firms' export activity in multiple sectors and financial health in the cross-section. The unit of observation is the firm. The outcome variable in Column 1 is the number of ISIC 3-digit sectors in which a firm exports. The outcome variable in Columns 2-5 is the weighted average financial vulnerability of a firm's exports using its exports by sector as weights and the four sector measures of financial vulnerability in Table 7. All regressions include firms' lagged productivity and size, as well as province, industry, and ownership fixed effects. The industry fixed effects are based on the main GBT-4 industry of each firm. T-statistics basd on robust standard errors reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	# ISIC	Average Financial Vulnerability of Exports			
		Inventories Ratio	Ext Finance Dependence	R&D Intensity	Asset Tangibility
	(1)	(2)	(3)	(4)	(5)
Panel A. Liquidity					
Lag Liquidity	0.101***	0.002***	0.014***	0.004***	-0.007***
	(3.74)	(3.62)	(3.28)	(9.34)	(-4.58)
R-squared	0.06	0.07	0.01	0.03	0.08
# observations	42,322	42,322	42,322	42,322	42,322
Panel B. Leverage					
Lag Leverage	-0.020***	0.0001	-0.002	-0.0005***	-0.0002
	(-3.29)	(1.07)	(-1.56)	(-3.03)	(-0.56)
R-squared	0.06	0.07	0.01	0.03	0.08
# observations	42,310	42,310	42,310	42,310	42,310
Productivity, Size	Y	Y	Y	Y	Y
Own, Prov, Ind FE	Y	Y	Y	Y	Y