Processing vs. Ordinary Trade

Kalina Manova
Stanford University and *NBER*

Zhihong Yu
University of Nottingham

PRELIMINARY AND INCOMPLETE

December 15, 2011

Abstract. This paper examines why firms choose to service foreign markets via ordinary or processing trade and how this decision affects companies' profitability. Using matched customs and balance sheet data on Chinese exporters, we establish two empirical regularities. First, profits, profitability and value added systematically decrease as producers re-orient sales from ordinary towards processing trade, and from import-and-assembly towards pure assembly. Second, more productive firms and less liquidity constrained firms are more likely to pursue ordinary trade relative to processing exports. Within processing, more efficient and financially healthier manufacturers are more prone to undertake import-and-assembly than pure assembly. We rationalize these results with a model of international trade that incorporates credit constraints and imperfect contractibility in companies' choice over trade regimes.

JEL Classification codes: F10, F13, F14, F23, F34, G32
Keywords: trade regimes, processing trade, optimal trade policy, credit constraints.

We thank Pol Antràs, Davin Chor and Bob Staiger for insightful conversations. Kalina Manova (corresponding author): *manova@stanford.edu*, Department of Economics, Stanford University, 579 Serra Mall, Stanford, CA 94305. Zhihong Yu: *zhihong.yu@nottingham.ac.uk*.

1 Introduction

The rapid decline in transportation costs and trade policy barriers over the last few decades has dramatically increased international trade flows. It has in particular enabled the exchange of not only final consumer goods, but also of intermediate inputs for further processing and assembly. This has in turn contributed to the rise in multinational activity and in cross-border linkages. The splicing of global production chains has raised a number of questions of first-order importance to policy makers. How should trade policy be designed when different stages of the manufacturing process occur in different countries? What are the aggregate welfare and distributional consequences of such trade flows and policies? How does trade in intermediates affect exchange-rate pass-through and the transmission of supply and demand shocks across nations?

To begin to answer these questions, economists first need to understand the benefits and disadvantages of processing trade and the characteristics of the firms that conduct it. Two aspects of China's trade activity make it particularly well-suited for studying these issues. First, for over 30 years China has exempted materials imported for further processing and re-exporting from import duties. Intended as a means of export promotion, this policy has been extremely successful at boosting foreign sales. In 2005, 31.7% of Chinese exporters conducted processing trade and contributed 54.6% of total exports, making China a key link in global supply chains. Second, within the processing trade regime, Chinese exporters choose between two operating modes. Under pure assembly (PA), the Chinese producer receives foreign inputs at no cost from a trade partner abroad to whom it also sends the final product. Under processing with imports (PI), also known as import-and-assembly, the Chinese firm pays for all imported materials and chooses where to source them from and whom to ultimately export to. These two institutional features introduce wedges between the costs and returns associated with ordinary trade (OT), PI and PA.

Using matched customs and balance sheet data on the universe of Chinese exporters, this paper examines why firms select into different trade regimes and how this selection affects their performance. We establish two main results. First, export profitability varies systematically across companies with different trading strategies. In particular, profits, profitability and value added decrease as producers re-orient sales from ordinary towards processing trade, and from import-and-assembly towards pure assembly. Second, exporters' productivity and financial health together determine their trade regime choice. More productive firms and less liquidity constrained firms are

more likely to pursue ordinary trade relative to processing exports.[1] Within processing, more efficient and more capital rich manufacturers are more prone to undertake import-and-assembly than pure assembly. We identify the impact of financial frictions by exploiting the variation in short-term liquidity and leverage across firms in an industry, as well as the variation in financial vulnerability across sectors within firms.

To rationalize these results, we develop a stylized model that incorporates credit constraints and imperfect contractibility in companies' export decisions. We let producers choose between three trade regimes with distinct working capital requirements. Up-front expenditures and therefore liquidity needs are highest for ordinary exporters who bear all domestic and foreign input costs, import duties and distribution outlays associated with production and trade. Processing with imports entails lower up-front expenses because it avoids import tariffs and marketing costs. Pure assembly demands the least financial resources as it involves only the payment for domestic materials and labor. Firms thus sort into trade modes based on their access to finance. When working capital requirements exogenously vary across sectors, industries' financial dependence also affects the export decision. When the expenditures described above have a fixed-cost component, heterogeneity in firm productivity further predicts that less efficient exporters concentrate on processing trade, and pure assembly in particular.

In the model, Chinese firms transact with a foreign buyer who incurs any costs not covered by the Chinese supplier. All expenses represent relationship-specific investments with low liquidation value outside the bilateral arrangement. The two partners split revenues according to Nash bargaining that assigns bargaining power based on each party's share of total costs. This generates systematically higher profits for the Chinese producer under ordinary trade relative to processing exports, and under import-and-assembly relative to pure assembly.

Our theoretical and empirical results suggest that financial frictions influence the design of optimal international trade contracts (PI vs. PA) and producers' choice over organizationally different methods of servicing foreign markets (OT vs. PI vs. PA). Relative to ordinary trade and processing with imports, pure assembly can be seen as a codified form of trade credit extended by the foreign buyer to the Chinese supplier for the purpose of financing imported materials. The three trading regimes represent decisions over the integration of different stages of the value added chain (input sourcing, final good production, and export distribution) under the control of a

[1] Dai et al. (2011) also find that processing exporters are less productive than ordinary exporters in China.

Chinese exporter. Our paper thus adds to previous work on the use of trade credit in cross-border transactions (Antràs and Foley 2011). It also resonates with the effect of financial considerations on multinationals' decision to off-shore intra-firm or at arm's length (Antràs, Desai and Foley 2009, Manova, Wei and Zhang 2009).

Our conclusions shed new light on the gains from trade and the role of trade policy in the context of trade in intermediate goods. First, they imply that facilitating access to imported materials can improve a country's export performance. This is particularly relevant for less advanced economies that rely on trade for growth. It is consistent with findings in the prior literature that sourcing foreign inputs of superior quality than domestic parts enables firms in developing countries to produce high-quality goods and thereby earn greater export revenues (Kugler and Verhoogen 2008, 2009, Manova and Zhang 2009). Similarly, import liberalization has been shown to increase the variety of imported intermediates and thus allow manufacturers to expand product scope (Goldberg, Khandelwal, Pavcnik and Topalova 2010). To the extent that multilateral reductions in import tariffs would encourage trade in both intermediate and final goods between trade partners, global production chains also point to complementarities in trade policies across countries (Antràs and Staiger 2011).

Second, our findings highlight the differential effects of trade policies across heterogeneous firms. Specifically, less productive and more liquidity constrained manufacturers might benefit more from import liberalization. The processing regime in China can potentially allow producers that would have otherwise been unable to pursue any cross-border operations to share in the gains from trade. Imperfect financial markets might thus provide some justification for government intervention in the regulation of international trade flows. In other words, trade policy can serve as a second best when improving financial institutions proves challenging.

More broadly, our analysis contributes to two recent literatures. It speaks to the growing evidence that credit constraints impede firms' export activity and distort aggregate trade flows, both in normal times and during crisis episodes (Manova 2007, Berman and Héricourt 2008, Chor and Manova 2009, Bricongne et al. 2010, Amiti and Weinstein 2011, Minetti and Zhu 2011). Our contribution is in identifying a novel mechanism - choice of trading contract and regime - through which liquidity constraints impact firms' export outcomes and ultimately profitability. There has also been growing interest in understanding the structure of global production chains and their implications for the transmission of shocks across countries during the recent financial crisis

(Johnson 2011, Bems et al. 2011, Levchenko et al. 2010). To this line of research we add a better understanding of how and why firms operate at different stages along the value added chain.

The remainder of the paper is organized as follows. We provide institutional background on China's trade regimes in the next section. After developing a stylized theoretical framework in Section 3, we introduce the data in Section 4 and present our empirical results in Section 5. The last section concludes.

2 Institutional Background

For the past 30 years, China has used a variety of trade policy instruments to stimulate export activity. A particularly consequential intervention has been the exemption of imported inputs for further processing and re-exporting from import duties. In place since the mid-1980s, this provision substantially reduces the cost of sourcing intermediate goods from abroad. This benefits exporters already using foreign inputs and encourages more firms to engage in processing trade. It also incentivizes more overseas companies to move parts of their production process to China via arms-length contracts or owned-and-operated subsidiaries. Finally, it can allow Chinese entrepreneurs to manufacture new products requiring materials that are not available domestically. Similarly, Chinese firms might be able to upgrade product quality by importing inputs of higher quality than locally attainable, and thereby be more competitive in foreign markets.

The Chinese Customs authorities distinguish between two key regimes: processing trade and ordinary trade.[2] Processing trade is officially 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".[3] In order for a processing firm to claim import duty exemption, at the time of importing it must show proof of a contractual agreement with a foreign buyer to whom the firm will export the processed goods.

The processing trade regime comprises two very different sub-categories: import-and-assembly and pure assembly. The latter is also known as processing with foreign client-supplied materials. It refers to "business activities in which the operating enterprise receives materials/parts

[2] There are a number of other trade regimes that capture less than 4% of total exports. These include capital goods and equipment for foreign-invested enterprises, capital goods for the production of processed exports, border trade, compensation trade, transactions by international organizations, etc.

[3] The three trade regime definitions in this section come 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.

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, import-and-assembly, also known as processing with imported materials, 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".

In other words, under both types of processing trade, the import duty is waived, the Chinese party pays for all domestic manufactured inputs and labor expenses, and the foreign buyer is responsible for the marketing and distribution of the final product abroad. However, under pure assembly, the Chinese firm does not participate in identifying appropriate foreign materials and incurs no cost for using them. By contrast, under import-and-assembly, the Chinese firm decides what intermediates to source from abroad, from which countries, and at what prices. It retains full control over these decisions and has to pay foreign suppliers for any imported inputs. This foreign input supplier will typically not be the party to whom the Chinese firm ultimately exports. Whichever trade partner secures a given input also preserves ownership rights over it.

Ordinary Chinese imports incur regular import duties and are not subject to any exemptions. They include final goods purchased from abroad for sale in China, as well as foreign materials used in production for the domestic market. Ordinary exports are often manufactured exclusively with local inputs. However, some firms might import intermediates from abroad, combine them with domestic parts, and then sell both in China and in foreign markers. This makes it prohibitively difficult for the Chinese Customs to ascertain what fraction of the imported goods by value will eventually be used towards production for exporting at the time of importing. This is especially true of Chinese firms exporting under their own brand. Conversely, if a Chinese manufacturer (such as a garment-maker) uses imported materials in order to sell domestically under its own brand (e.g. Youngor) and to export abroad under a foreign brand (e.g. Nike, Gap), its imports would be recorded separately and it would enjoy the tax waiver on the processing imports but not on the inputs used for domestic production.

Compared to processing firms, ordinary exporters therefore face higher up-front production costs because they have to pay for any foreign inputs at a surcharge. They also bear full responsibility for identifying potential input suppliers and final buyers abroad.

The creation of the processing trade regime has significantly contributed to the expansion in China's trade activity. In 2005, for example, 54.6% of all exports represented processing trade. While China's import duties have declined substantially 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 2011).

3 Theoretical Framework

We develop a stylized model of firms' export choices in the presence of the three trade regimes described above. Our main interest is in highlighting how limited access to external finance affects operation decisions, export outcomes and ultimately firm profitability. To this end, we have intentionally simplified the framework and abstracted away from many complicating and economically relevant factors. This allows us to quickly illustrate the main mechanisms and intuitions at play. We then discuss how incorporating a number of more realistic features into the model would modify and amplify its empirical predictions. We have refrained from introducing these in our baseline approach since our data does not allow us to test them directly.

3.1 Set up

Consider a manufacturer (M) producing for a foreign market. Export demand is fixed and normalized to 1, such that potential revenues from sales abroad are R. Production requires the use of domestic intermediate inputs and labor worth C_D and foreign materials worth C_F. Servicing consumers abroad entails an additional outlay F for marketing and managing a distribution network. M chooses to operate under one of three possible trade regimes: ordinary trade (OT), import-and-assembly (PI, for processing with imports), and pure assembly (PA). When foreign materials are imported under processing trade (PA or PI), they do not incur any additional customs duties. Foreign parts sourced under ordinary trade face an ad-valorem tariff τ at the time of import since border agents cannot ensure that the inputs will be processed and re-exported. For expositional simplicity, our baseline model assumes that this tax is rebated at the time the final product is shipped abroad. Section 3.6 discusses the consequences of dropping this assumption. All relevant characteristics of the three trade regimes are summarized in Table 1.

3.2 Firm costs

The manufacturer's choice over trade regimes determines how the costs associated with the export transaction will be shared between M and any foreign party. Note that ex-post, after any tariff rebates, total expenses are always C_D+C_F+F.

Under pure assembly, M establishes a contractual relationship with a buyer (B) overseas who commits to providing all necessary foreign inputs free of charge to M and is responsible for marketing and distribution abroad. Since the transfer of foreign materials occurs under processing trade, it avoids any import duties. The up-front costs to M and B are therefore C_D and C_F+F respectively.

Under import-and-assembly, M secures an agreement with a foreign buyer (B) who manages the sale of the product to consumers abroad. The manufacturer retains control over the sourcing of all production inputs and is in charge of any associated expenses. No import duties are imposed on foreign intermediates as they enter the country under the processing regime. The up-front costs to M and B are therefore C_D+C_F and F respectively.

Under ordinary trade, M operates completely independently and manages all aspects of the cross-border sale. The firm secures its own domestic and foreign inputs, and organizes its distribution network in the destination market. It transacts directly with final consumers abroad who bear no costs.[4] Imported parts are taxed at the time of purchase, but these duties are refunded once the export transaction is complete. The up-front costs to M and B are therefore $C_D+(1+\tau)C_F+F$ and 0 respectively.

3.3 Firm profits

Contracts are imperfectly enforced and this exposes firms to the risk of hold-up problems once costs have been incurred. Should the relationship break-up, both parties are able to recoup their costs, M by selling the final product to another buyer at marginal cost and B by offering its distribution services to another supplier at a price equal to its expenses. Trade partners therefore negotiate over the surplus from the relationship, $R-C_D-C_F-F$. In particular, the two parties engage in Nash bargaining with bargaining weights corresponding to their relative contribution to the relationship. To fix ideas, we assume these weights reflect the share of costs born by a party.

The manufacturer's profits under the three trade regimes are therefore given by:

[4] Our results will be qualitatively unchanged if the firm sold to a foreign retailer who is responsible for some of the distribution costs. All that is required in that case is that those costs are incurred after the exporter has been paid. The cost F to the manufacturer can then be interpreted as the cost of searching and matching with this foreign retailer which is not required under processing trade.

PA: $\pi_{PA} = -C_D + C_D + \beta_{PA}(R - C_D - C_F - F) = \frac{C_D}{C_D + C_F + F}(R - C_D - C_F - F)$

PI: $\pi_{PI} = -C_D - C_F + C_D + C_F + \beta_{PI}(R - C_D - C_F - F) = \frac{C_D + C_F}{C_D + C_F + F}(R - C_D - C_F - F)$

OT: $\pi_{OT} = -C_D - C_F - F + C_D + C_F + F + \beta_{OT}(R - C_D - C_F - F) = 1 \cdot (R - C_D - C_F - F)$

3.4 Credit constraints and trade regime choice

All costs associated with exporting are incurred up-front, before production takes place. Export revenues and any payoffs are realized after trade has occurred. For simplicity, we assume that the foreign buyer does not face any liquidity needs and can cover all expenditures with cash flows from operations. The manufacturer, on the other hand, is unable to retain earnings from one period to the next because all profits have to be paid out as dividends to stockholders (for example because of moral hazard issues). Thus whether *M* can engage in any trade activity and if so, under what organizational mode, depends on *M*'s ability to raise external finance in order to fund his expenses. Let the producer have access to bank loans in the amount *L*.

In the very stylized set-up we consider, there is a clear ranking of *M*'s export profits (π) and total up-front costs (*TC*) across trade regimes: both are lowest with pure assembly, higher with import-and-assembly, and highest with ordinary trade.

Profits: $\pi_{PA} < \pi_{PI} < \pi_{OT}$

Liquidity needs: $TC_{PA} < TC_{PI} < TC_{OT}$

Ordinary trade would therefore be the dominant export strategy in the absence of credit constraints. With financial frictions, however, the manufacturer will pursue the most profitable trade regime it can given its available external capital *L*.

Proposition 1 *Most financially constrained exporters export under pure assembly and earn low profits. Less financially constrained exporters export under import-and-assembly and earn higher profits. Least financially constrained exporters export under ordinary trade and earn the highest profits.*

3.5 Mixed export strategies

Proposition 1 has the stark implication that each firm manufactures one particular product and chooses a unique trade mode. If the producer makes multiple goods in one or more sectors, and if

these goods have different cost and revenue structures, it can be optimal for the firm to export some merchandise via processing trade and some via ordinary trade. This decision will depend on the seller's total access to capital. Firms will allocate their limited financial resources to different product lines so as to maximize total profits. The most advantageous allocation will balance the trade-off companies face between expanding product scope and pursuing higher-return transactions: On the one hand, processing trade (especially pure assembly) uses up less liquidity per product line than ordinary exports and thereby allows the firm to manufacture more goods. This tends to increase the extensive margin of firm revenues. On the other hand, processing exporters (especially pure assemblers) face lower-profit margins. This tends to decrease the intensive margin of firm revenues.

While this profit-maximizing problem is complex, its solution is rather intuitive. Manufacturers will optimally choose ordinary trade for products with relatively low up-front costs (C_D+C_F+F) and high revenue potential (R). By contrast, they will opt for processing with imports for goods with intermediate cost and revenue levels. Firms will finally settle for pure assembly for articles with high liquidity requirements but limited revenues. To the extent that even very disaggregated trade flows are recorded for product categories that plausibly include multiple goods, firms could appear to follow mixed export regime strategies. This suggests systematic differences in companies' proclivity to use different trade regimes across sectors.

Proposition 2 *Across sectors within a firm, 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' liquidity needs.*

Note that exporters with more access to finance will differ from capital-scarce firms in two respects. For any given product or sector, less constrained manufacturers will be more likely to select into ordinary trade relative to processing trade, and into import-and-assembly relative to pure assembly (as per Proposition 1). In addition, capital-rich producers may be able to trade in more goods, especially in sectors with higher liquidity needs. Aggregating to the firm level, this implies a "smoothed" version of Proposition 1.

Proposition 3 *Across firms, 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 firms' liquidity*

constraint. Across firms, profits fall 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* $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$.

3.6 Discussion

Although the stylized framework we have developed rests on a number of simplifying assumptions, we believe the main predictions it delivers would be robust to a wide range of alternative set-ups. Here we discuss a few potential extensions that would retain our central results in richer environments.

Endogenous inputs and outputs

We have so far restricted firms to producing fixed output levels with fixed input supplies and implicitly ruled out moral hazard. If parties actively choose the quantity or quality of input materials and exert effort in production, however, output levels and revenues would be endogenous to the trade regime choice. This would arise because of a standard agency problem from the theory of the firm (Grossman and Hart 1986, Hart and Moore 1990): While parties incur the full cost of a given input, they receive only a share β of its marginal revenue due to imperfect contractibility and Nash bargaining. This leads to underinvestment and suboptimal output levels.

Moral hazard could play out in a number of ways in the context we consider. In all three trade regimes, the Chinese producer might need to exert effort in locating domestic materials and hiring local labor that are both well suited to the manufacturing process and at an attractive price. The same could be true of sourcing foreign parts under ordinary exports and processing with imports (but not with pure assembly when the trade party presumably does so). *M* might also be responsible for managing plant operations and converting inputs into a final product. The higher his bargaining weight β, the more effort *M* would have the incentive to put in and the higher sales *R* would presumably be. This modification would preserve the ranking of trade regimes but magnify the difference in revenues across them. Moral hazard issues can thus accentuate the negative impact of liquidity constraints on firms' profitability.

Ordinary trade without foreign inputs

Our baseline model assumes that ordinary exporters use domestic and foreign inputs in the same proportion as processing firms. Companies selling abroad under the ordinary trade regime, however, may choose to use only domestic intermediates or fewer imported parts. If local

materials are cheaper, this strategy could reduce up-front production costs, especially in the absence of a tariff rebate (see below). Pure assembly would remain the trade mode with the lowest liquidity requirements, but the relative ranking of total costs under ordinary exports and processing with imports would become theoretically ambiguous. It would be preserved provided that the distribution cost F is sufficiently large, foreign inputs sufficiently important for production, and/or the Chinese materials not too cheap.

If expected sales are not influenced by the switch towards domestic parts, ordinary trade could become even more profitable relative to both processing modes. Output quality and therefore revenues might suffer, however, when local materials are inferior and make the product less appealing to foreign consumers. This could introduce ambiguity in the ranking of trade regimes by profitability as well. Such reversals would be less likely than in the sorting by financial needs, though, because of the differences in bargaining weights across regimes. Moreover, when manufacturers' effort responds to incentives as discussed above, ordinary exporters would invest the most of all three types in identifying complimentary inputs and marketing the product. This would serve to improve firm profitability.

Ultimately, theoretical ambiguities indicate that which mechanism dominates is an empirical matter and could work against us in the empirical analysis.

No tariff rebate

In reality, ordinary exporters cannot claim refunds on the duties they paid on imported inputs. This increases their total costs and reduces expected profits. Once again, firms' sorting into the two types of processing trade would be unaffected. The relative position of the ordinary trade regime in terms of working capital requirements and profitability could, however, be overturned if import tariffs are sufficiently large. Given that they averaged 9% in 2005 (the year in our data), as well as the discussion of endogenous input choices above, this does not appear very likely.

Productivity Heterogeneity

Our stylized framework has abstracted away from heterogeneity across firms along dimensions other than liquidity constraints. It is well established in the literature, however, that productivity is an important determinant of export outcomes. To the extent that productivity and access to finance are imperfectly correlated, both factors would likely matter for firms' trade regime choices in a richer model. For example, each of the three expenses considered (C_D, C_F, and F) plausibly has a

fixed-cost and a variable-cost component. In the spirit of Melitz (2003), this could imply that most productive manufacturers self select into ordinary trade, less productive companies pursue processing with imports, and yet less productive exporters undertake pure assembly. Some very inefficient enterprises might be unable to engage in any form of cross-border activity.

The literature has also argued that more productive firms are endogenously less credit constrained because their expected revenues are higher and they can therefore provide stronger incentives to financiers to fund their operations (Manova 2007). This mechanism would suggest that conditioning on firm productivity should leave no additional explanatory power for firms' financial health per se. We explore the relative importance of productivity and access to capital for exporters' trade regime choices in Section 5.2.

Endogenous credit constraints

Finally, we discuss the possibility that firms' access to internal and external capital might be endogenous to their choice of trade regime. First, entrepreneurs might be able to retain some or all of their earnings from one period to the next. A dynamic extension of our model with retained earnings would reinforce the theoretical results because the more profitable export modes are also the ones with lower liquidity needs. Second, banks might be more willing to fund firms with higher expected profits. Once again, this would magnify the sorting of firms into trading methods. We discuss this particular type of endogeneity at greater length in Section 5.4. Finally, exporters might be able to secure trade credit from their foreign buyer. Evidence by Antràs and Foley (2011) suggests that such trade-credit relationships develop over time as they rest on trust and reputation effects. In some sense, the buyer's willingness to provide foreign inputs free of charge under pure assembly is a manifestation of trade credit. To the extent that firms exporting under ordinary trade or processing with imports are able to obtain more trade credit, their liquidity constraints would be relaxed and our results biased downwards.

4 Data

Our analysis makes use of two recently released proprietary datasets on the activities of Chinese firms in 2005. The first one comes from the Chinese Customs Office and contains detailed information about the universe of trade transactions.[5] It reports the value of firm exports (free on

[5] Manova and Zhang (2008) describe the data and stylized facts about firm heterogeneity in Chinese trade.

board) and imports (cost, insurance and freight included) in U.S. dollars by product and trade partner for 243 destination/source countries and 7,526 different products in the 8-digit Harmonized System.[6] The records also indicate whether each cross-border operation occurs under ordinary trade, processing with imports or pure assembly. This allows us to construct indicators of the proclivity for using different trade regimes at the firm- or firm-sector level.

The second database we employ is the Chinese Census of Manufacturers. It provides standard balance sheet data for all state-owned enterprises (SOEs) and all private companies with sales above 5 million Chinese Yuan[7]. The main variables of interest to us are measures of firm profitability and access to finance, which we discuss in greater detail below. We also use information on employment, capital and material inputs to construct proxies for firm size and productivity. Firms are legally required to complete both the census and the customs declaration forms, and compliance is strictly enforced by different government agencies.

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 firms' names and key contact information, including addresses and phone numbers.[8] While imperfect, this procedure generates a large and representative sample. We are able to obtain balance sheet data for 30% of all exporters and trade data for 67% of all producers in the census with positive export activity. As Table 2 shows, the matched exporters have similar trade patterns to the unmatched ones. Likewise, the balance sheets of the matched firms from the census are comparable to those of the unmatched.

Some Chinese corporations (mostly SOEs) are pure export-import companies that do not engage in manufacturing but serve exclusively as intermediaries between domestic producers (buyers) and foreign buyers (suppliers). Following standard practice in the literature, we identify such wholesalers using keywords in firms' names and exclude them from our sample.[9] We do so in order to focus on the operations of firms that both make and trade goods since we are interested

[6] 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..
[7] This is equivalent to 0.6 million USD based on the USD-CNY exchange rate in 2005.
[8] See Wang and Yu (2011) for a detailed description of the matching procedure.
[9] We drop 29,982 wholesalers who mediate 22.3% of China's trade. Using the same data, Ahn et al. (2011) identify intermediaries in the same way in order to study wholesale activity.

in how access to finance affects their export decisions. Trading enterprises face very different choices and financing needs, whose study we leave to future work.

Table 2 illustrates the substantial variation in performance and trade activity across the 50,606 Chinese firms in our matched sample. (Log) profits and (log) value added average 7.33 and 9.23, with a standard deviation of 1.95 and 1.48 respectively. The dispersion in profitability, measured by the ratio of profits to sales, is even greater with a mean of 0.03 and standard deviation of 0.20.

Our analysis examines four indicators of firms' choice over trade regimes. The first represents the share of processing exports (both pure assembly and import-and-assembly) in total exports and is labeled (PA+PI) / (PA+PI+OT). The second distinguishes between the two processing modes and gives the share of pure assembly in total processing exports, PA/(PA+PI). The last two measures capture the trade-off between each of the processing regimes and ordinary exports, i.e. PA/(PA+OT) and PI/(PI+OT). In Table 2, all of these ratios have been constructed based on aggregated firm sales across destinations and individual product categories. As evident from the summary statistics, the trade-regime composition of export activity varies significantly across firms in the sample. For some empirical specifications we further explore the variation across industries within exporters and calculate these shares for each firm-sector pair.

While many Chinese producers operate in one unique trade mode, a sizable group transact under multiple regimes. Figure 1 provides a Venn diagram which shows the percentage share of firms engaged in each of 7 possible combinations of export methods (PA; PI; OT; PA and PI; PA and OT; PI and OT; PA, PI and OT). The reported percentages sum to 100%. 56.3% of all sellers ship only ordinary exports, while 1.7% and 11.2% conduct exclusively pure assembly and processing with imports, respectively. The remaining 30.8% pursue mixed trade strategies, with 4.4% of all exporters undertaking some activity under all three regimes. As illustrated in Figure 2, similar patterns obtain when we look at a finer level of disaggregation and consider firm-sector pairs instead of firms.

Given that manufacturers use different modes of servicing export markets, it is not surprising that they also source foreign materials in different ways. In addition, companies exporting under more than one trade regime acquire intermediates under multiple regimes as well. Figure 3A summarizes the use of imported inputs by firms reporting any ordinary exports (left bar) and firms reporting any processing exports (right bar). Ordinary exporters are significantly

more likely to use no foreign parts. Conditional on importing materials, they are also more likely to do so under ordinary trade. These patterns are even more extreme when we focus on suppliers engaged exclusively in either ordinary or processing exports but not both (Figure 3B).

We use balance sheet data to construct two main measures of firms' financial health that are relatively standard in the literature.[10] Liquidity gives the difference between current assets and current liabilities, scaled by total assets. It is meant to capture firms' availability of external finance. Leverage reflects the share of short-term debt in current assets. Higher leverage indicates that firms have more financial obligations in the short run, less freedom in managing their cash-flows, and greater difficulty in raising additional capital. We thus expect exporters with high liquidity and low leverage to be less constrained.

Finally, 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.[11] These variables are meant to reflect technologically-determined characteristics of each sector that are inherent to the nature of the manufacturing process and beyond the control of individual firms.

There are systematic differences across sectors 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 capture these differences with the ratio of inventories to sales ($Invent_i$). It proxies the duration of the manufacturing process and the working capital firms need in order to maintain inventories and meet demand. For robustness, we also use sectors' external finance dependence ($ExtFin_i$), constructed as the share of capital expenditures not financed with internal cash flows from operations. We further exploit 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 a good can be manufactured and successfully marketed. Note that $ExtFin_i$ and RD_i primarily reveal firms' long-term requirements for outside capital and thus reflect in large part fixed costs. $Invent_i$, on the other hand, indexes producers' liquidity needs in the short run, which are associated mainly with variable costs including the cost of intermediate inputs.

Sectors vary not only in firms' reliance on external finance, but also in firms' endowment of hard assets that can serve as collateral. We thus also use a measure of asset tangibility ($Tang_i$), defined as the share of net plant, property and equipment in total book-value assets.

[10] See for example Greenaway, Guariglia and Kneller (2007).

[11] These sector measures come from Kroszner, Laeven and Klingebiel (2007), and 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, and appear very stable over time.

As is 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, using the U.S. as the reference country eliminates the potential for the measure of sectors' financial vulnerability to endogenously respond to China's level of financial development. In fact, if the most financially vulnerable industries in the U.S. use 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 in the empirical analysis 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. Kroszner, Laeven and Klingebiel (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.

The four indicators of financial vulnerability are available for 29 sectors in the ISIC 3-digit classification system. In our empirical analysis, we match Chinese HS 8-digit product codes to these ISIC 3-digit sector categories.

5 Empirical Results

Our empirical analysis proceeds in three steps. We first explore the relationship between exporters' profitability and choice of trade regimes. We then examine the effect of firms' financial health and sectors' financial vulnerability on companies' decision over export modes. Finally, we provide corroborative evidence based on manufacturers' use of imported inputs. After establishing these main results, we discuss endogeneity and a series of robustness checks.

5.1 Trade regimes and firm profitability

We begin by analyzing the link between firm performance and trading modes. According to Proposition 3, profitability should increase monotonically as exporters re-orient foreign sales from pure assembly to processing with imports to ordinary trade. In order to test each pair-wise

comparison, we therefore consider four different indicators of the composition of companies' shipments abroad. In particular, we study 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 $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$. We also directly examine the trade-off between each of the processing regimes and ordinary trade with the ratio of pure-assembly sales to the sum of pure-assembly and ordinary flows (i.e. $\frac{X_{PA}}{X_{PA}+X_{OT}}$), as well as the ratio of import-and-assembly sales to the sum of import-and-assembly and ordinary flows (i.e. $\frac{X_{PI}}{X_{PI}+X_{OT}}$). We construct these trade shares at the firm level, after summing exports across all destinations serviced and products sold.

Using each of these indicators one at a time, we estimate the following specifications in our matched sample of exporters with balance-sheet data:

$$\log Profits_f = \alpha_0 + \beta \cdot Trade\ Share_f + \gamma \cdot \log Employment_f + \varphi_{own} + \varphi_{pi} + \varepsilon_f \quad (1)$$

$$\frac{Profits_f}{Sales_f} = \alpha_0 + \beta \cdot Trade\ Share_f + \gamma \cdot \log Employment_f + \varphi_{own} + \varphi_{pi} + \varepsilon_f$$

Here $\log Profits_f$ represents firm f's profits from all domestic and foreign operations, and $\frac{Profits_f}{Sales_f}$ measures f's profitability. The census records producers' location in China and the main sector in which they operate. This allows us to use province-industry pair fixed effects φ_{pi} in order to account for systematic differences across 31 regions and 738 sectors (4-digit GBT codes) that might affect all manufacturers. These capture differences in factor costs, factor intensities, transportation costs, financial market development, institutional frictions, tax treatment, etc. that might favor one export mode over another and directly impact profitability. We additionally control for firm size, as proxied by (log) employment. Finally, we condition on the ownership status of the firm since foreign-owned corporations might have distinct incentives and attributes compared to local companies. We thus include 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.

We are primarily interested in β, which reflects (the sign of) the conditional correlation between firms' profitability and choice over trade regimes. This coefficient is identified purely from the variation across exporters within narrowly defined province-industry segments of the economy. We emphasize that we cannot and do not want to give β a causal interpretation since

producers' profits and export activity are both affected by firms' financial health in our model and are the joint outcome of firms' maximization problem. In practice, other firm attributes ignored by our theoretical framework might also influence both variables.

The results in Table 3 strongly suggest that profitability indeed varies in systematic ways with firms' trade regime choices in a pattern consistent with our model. Manufacturers' profits increase with the share of processing exports in total foreign sales (Panel A) and with the share of pure assembly in processing trade (Panel D). Concentrating activity in either processing regime is also associated with higher profits relative to ordinary exports (Panels B and C). These patterns are independent of the fact that bigger firms (as proxied by the size of the labor force) tend to be more profitable.

The variation in profitabilty across trading modes is economically large. A 10% shift in export activity from processing towards ordinary trade is associated with 1.4% higher profits. Re-allocating 10% of foreign processing sales from pure-assembly to import-and-assembly is accompanied by a 3.5% rise in profits.

As standard with balance sheet data, Chinese firms do not report profits separately for domestic and foreign sales. To the extent that trade regime choices affect revenues abroad but not operations at home, the results in Table 3 are likely to be an underestimate of the importance of trade modes for export profitability. As an imperfect but nevertheless informative way to shed light on this, in Table 4 we focus specifically on firms that sell exclusively in foreign markets but not domestically. While these "pure exporters" represent only about 20% of our matched sample, we can be sure that the profits reported on their balance sheets capture only cross-border activities. As anticipated, we indeed obtain higher point estimates in this group of producers. A re-shuffling of 10% of exports from processing to ordinary trade, and from pure assembly to import-and-assembly is now consistent with a 2.6% and 4.2% rise in profits respectively.

Note that the value added in the manufacturing process does not depend on firms' export regime in our stylized set-up. It is instead equivalent to the surplus from the bilateral partnership and given by $R\text{-}C_D\text{-}C_F\text{-}F$. As discussed in Section 3.6, however, value added might vary systematically across trading modes if input and output choices are endogenous and parties exert effort proportionately to their bargaining power in the sharing of revenues. The evidence in Column 3 of Tables 3 and 4 lends support to this conjecture. We find that a higher share of

processing exports, and of pure assembly in particular, are associated with lower levels of value added, even after controlling for firm size.

5.2 Trade regimes and credit constraints

We next examine the effects of credit constraints on exporters' decisions over alternative trade regimes. To this end, we first exploit the variation in financial health across firms within a sector. Given the cost and demand structure in an industry, we expect producers with more limited access to capital to concentrate foreign activity in processing trade, and pure assembly in particular. We then explore the variation in liquidity needs and ability to raise outside funds across sectors within firms. Conceptually, this allows us to infer how financial considerations affect trade regime choices and the allocation of financial resources across sectors within multi-product exporters. As we discuss in Section 5.4, it also makes it possible to circumvent concerns with endogeneity and reverse causality.

We use two proxies for firms' financial health: liquidity and leverage. While the former captures firms' current availability of finance, the latter reflects producers' debt obligations in the short run and potential difficulties in raising additional capital. We thus believe exporters with high liquidity and low leverage to be less constrained. Armed with these two measures, we estimate the following specification[12]:

$$Trade\ Share_f = \alpha_0 + \beta \cdot Fin\ Health_f + \gamma \cdot \log Employment_f + \varphi_{own} + \varphi_{pi} + \varepsilon_f \quad (2)$$

where $Trade\ Share_f$ refers to one of the four trade regime shares, $Fin\ Health_f$ is interchangeably firm f's liquidity or leverage, and φ_{pi} are province-industry fixed effects as before. We continue to condition on firm size and to report robust standard errors.

As the results in Table 5 indicate, exporters' liquidity and leverage ratios strongly predict their choice of trade regime. Manufacturers with more financial resources and less short-term debt exposure typically earn more of their foreign revenues from ordinary exports (Columns 1-3). They also conduct a greater proportion of their processing trade with imported inputs as opposed to pure assembly (Column 4). All of these findings are highly statistically significant, with the exception of the relationship between firm leverage and the relative importance of import-and-assembly and

[12] In all specifications, we use the same symbols for the intercept, coefficients, fixed effects and error terms as in equation (1). This is only for expositional convenience; these objects will of course differ across specifications.

ordinary trade, $\left(\frac{X_{PI}}{X_{PI}+X_{OT}}\right)$. This is consistent with the ranking of trade regimes in Proposition 3. It also suggests that our stylized framework performs well in accounting for the patterns in the data, although some of the factors discussed in Section 3.6 might be responsible for the insignificant results for $\left(\frac{X_{PI}}{X_{PI}+X_{OT}}\right)$ in Column 3. In robustness checks we have ensured that similar results obtain when we lag firms' measured financial health by a year.

The effects we have identified appear to be economically meaningful. A one standard deviation improvement in liquidity (leverage) would result in a 1% (0.5%) shift in the composition of foreign sales from processing towards ordinary trade. The contribution of pure assembly towards total processing exports would also decline by 1% (2.5%). For reference, the average of these two trade shares is 30% for $\left(\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}\right)$ and 19% for $\left(\frac{X_{PA}}{X_{PA}+X_{PI}}\right)$.

Recall from Section 3.6 that firms' heterogeneity in productivity can affect their export decisions directly (because of fixed costs) and indirectly (by determining access to finance). In order to shed light on these mechanisms, in Table 6 we re-estimate (2) controlling explicitly for companies' productivity.[13] When we do so, the estimated coefficient on manufacturers' financial health is halved but largely retains its statistical significance. Firm productivity enters negatively and significantly in its own right. This suggests that production efficiency is positively but imperfectly correlated with financial health, and impacts trade regime choices via both channels. In other words, both less productive entities and more liquidity constrained enterprises self-select into processing trade, and pure assembly in particular. Comparative statics indicate that the two firm characteristics have similar economic significance.

We next turn to Proposition 2 and examine the variation in trade activity across sectors within firms. To this end, we exploit the detailed nature of the customs data and measure the contribution of different trade regimes for each firm-sector pair. We adopt the following estimating equation:

$$Trade\ Share_{fi} = \alpha_0 + \beta \cdot Fin\ Vuln_i + \gamma \cdot Ind\ Controls_i + \varphi_f + \varepsilon_{fi} \qquad (3)$$

Here $Trade\ Share_{fi}$ corresponds to a relevant export ratio for firm f in industry i, while $Fin\ Vuln_i$ is one of four alternative measures of sectors' financial vulnerability. Since the unit of

[13] We obtain very similar results whether we measure productivity according to Levinsohn and Petrin (2003) or with value added per worker.

observation is now at the firm-industry level, we are able to include firm fixed effects φ_f. These control for a range of observed and unobserved firm characteristics that can affect trade outcomes in all industries, including financial health, productivity, size, ownership type, familiarity with foreign markets, etc. The effect of $Fin\,Vuln_i$ is thus identified purely from the variation across sectors within multi-sector producers. It indirectly reflects the way in which exporters allocate financial resources across trade modes and industries with different liquidity needs.

Note that this specification does not permit industry fixed effects. We nevertheless want to ensure that any impact of financial vulnerability we identify does not capture the role of other sector characteristics that might influence firms' choice over trade regimes for reasons unrelated to credit constraints. For this reason, we condition on industry's physical and human capital intensity, as well as the importance of relationship-specific investments in input production. These control variables come from Braun (2003) and Nunn (2007).[14]

As illustrated in Table 7, the results from this stringent specification strongly suggest that exporters choose different means of servicing foreign markets based on the financial characteristics of the sector. Firms actively pursue processing trade, and pure-assembly in particular, in industries with high working capital requirements as proxied by the inventories-to-sales ratio (Panel A). A doubling of short-run liquidity needs would translate into a 36% increase in the share of revenues generated through processing trade. It would also imply a 23% rise in the share of pure assembly in processing exports.

We next examine the importance of sectors' reliance on outside finance for long-term investment (i.e. capital and R&D expenditures). As anticipated, industries' external capital dependence and R&D intensity are both strong predictors of the choice between ordinary trade and either processing regime: We find large and very significant effects on $\frac{X_{PA}+X_{PI}}{X_{PA}+X_{PI}+X_{OT}}$, $\frac{X_{PA}}{X_{PA}+X_{OT}}$ and $\frac{X_{PI}}{X_{PI}+X_{OT}}$ in Panels B and C. The trade-off between pure assembly and processing with imports, on the other hand, appears unrelated to the financing of long-run capital projects. These results are consistent with the presumption that the two processing regimes differ only with regard to the financing of short-run variable input costs. By contrast, fixed distribution costs and potentially equipment constitute a key distinction between processing and ordinary exporting.

[14] The baseline results we report in Table 7 cluster errors by firm, in order to account for the potential correlation in cost or demand shocks across sectors within firms. Qualitatively similar patterns obtain if we instead cluster by industry, drop the firm fixed effects, or remove the sector controls.

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 either processing trade regime over ordinary exports in industries with softer assets (Columns 1-3). As with the financing of long-term investment, asset tangibility too appears unimportant for the distinction between the two processing methods (Column 4).

In unreported results available on request, we have explored the effects of firms' financial health on their export trade shares at different levels of sectors' financial vulnerability. More specifically, we have estimated an expanded version of specification (3) which includes the interaction of firms' liquidity or leverage ratio with one of the industry indicators at a time. We consistently find that limited access to finance induces companies to pursue processing over ordinary trade relatively more in financially vulnerable sectors than in financially less dependent sectors. It also makes processing producers more likely to re-orient away from import-and-assembly and towards pure assembly in financially vulnerable industries. These findings corroborate our conclusion that financial considerations importantly shape the export decisions of Chinese manufacturers.

5.3 Sensitivity analysis

Endogeneity

Our identification strategy has relied on exploiting the variation in liquidity constraints across firms and the variation in financial vulnerability across sectors. We believe this allows us to establish a causal effect of financial frictions on exporters' trade regime choices and consequently on profitability. In particular, our empirical approach makes it possible to circumvent two potential concerns with endogeneity and reverse causality.

The first such concern involves the estimated relationship between producers' financial health and relevant trade shares. In the absence of frictions in capital markets, manufacturers would be free to raise all the necessary finance in order to pursue their optimal export strategy. Since liquidity needs decline as suppliers re-orient activity from ordinary trade to processing with imports to pure assembly, so would their observed usage of capital. This could potentially explain our findings for exporters' liquidity and leverage. We argue this is an unlikely explanation for two reasons. First, our results are robust to using lagged values of these balance sheet variables, that

are arguably less subject to this concern. Second and more importantly, we document substantially higher profits from import-and-assembly relative to pure assembly, and even greater returns to ordinary trade. Were Chinese exporters financially unconstrained, they would have therefore preferred to pursue these more profitable regimes. That they don't is strong confirmation that limited access to capital indeed distorts companies' trade choices and ultimately performance.

The second potential concern with reverse causality is more subtle. Consider the possibility that firms sort into different trade regimes for reasons unrelated to financial considerations. Assume further that profitability falls with the share of processing exports, and pure assembly in particular, as we have established. If financiers are more willing to fund more profitable ventures, exporters more active in trade regimes with lower returns would record lower liquidity and higher leverage ratios. Once again, this could provide an alternative explanation for the link between firms' financial health and trade shares in Table 5. This rationalization, however, would fail to account for the systematic variation in cross-border activity we document across sectors within a given exporter. Our industry measures of financial vulnerability are by construction exogenous from the perspective of individual firms and reflect sector characteristics innate to the nature of the manufacturing process. Their important effect on how entrepreneurs choose to service foreign markets signals that financial considerations are of considerable consequence.

Binary trade regime choice

As Figure 3 illustrates, a large proportion of firms operate exclusively under one export regime. For this reason, the four trade shares we have constructed frequently take on a value of 0 or 1. On average, about a quarter to a third of the observations in a given regression are associated with trade shares strictly between 0 and 1. In unreported specifications, we have ensured that our results continue to hold when we adopt a binary indicator variable instead of the continuous trade shares.

Variation across destinations

As a final robustness check, we explore the variation in exporters' trade shares across destinations. In particular, we re-estimate equations (2) and (3) with the outcome variable at the firm-country or firm-sector-country respectively. This allows us to implicitly control for differences in trade costs, demand conditions and the broad economic environment across export markets with destination fixed effects. Reassuringly, we obtain quantitatively and qualitatively similar results at this more disaggregated level as well (available on request).

8 Conclusion

This paper examines why firms choose to service foreign markets via ordinary or processing trade and how this decision affects export profitability. Using matched customs and balance sheet data on the universe of Chinese exporters, we establish two empirical facts. First, export profitability varies systematically across companies with different trading strategies. In particular, profits, profitability and value added decrease as producers re-orient sales from ordinary towards processing trade, and from import-and-assembly towards pure assembly. Second, exporters' productivity and financial health together determine their export mode decisions. More productive firms and less liquidity constrained firms are more likely to pursue ordinary trade relative to processing exports. Within processing, more efficient and more capital rich manufacturers are more prone to undertake import and assembly than pure assembly. We rationalize these results with a model of international trade that incorporates credit constraints and imperfect contractibility in companies' choice over trade regimes.

Our findings suggest that financial frictions influence the design of optimal international trade contracts and producers' choice over organizationally different methods of exporting. Our analysis thus highlights a novel mechanism through which liquidity constraints impact firms' export outcomes and ultimately profitability. Our conclusions also shed new light on the gains from trade in the context of trade in intermediate goods and on the distributional consequences of trade policy in the presence of financial frictions. More broadly, we provide one of the first studies of processing trade and thus inform current discussions of the effects of global production chains on optimal trade policy, exchange-rate pass-through and the transmission of supply and demand shocks across nations.

References

Ahn, J.B., Khandelwal, A. and S.-J. Wei (2011). "The Role of Intermediaries in Facilitating Trade." *Journal of International Economics* 84(1), p.73-85.

Amiti, M. and D. Weinstein (2011). "Exports and Financial Shocks." *Quarterly Journal of Economics* 126(4).

Antràs, P., Desai, M. and F. Foley (2009). "Multinational Firms, FDI Flows and Imperfect Capital Markets." *Quarterly Journal of Economics* 124(3), p.1171-219.

Antràs, P. and F. Foley (2011). "Poultry in Motion: A Study of International Trade Finance Practices." NBER Working Paper 17091.

Antràs, P. and R. Staiger (2011). "Offshoring and the Role of Trade Agreements." *American Economic Review (forthcoming)*.

Bems, R., Johnson, R.C. and K.M. Yi (2010). "Vertical Linkages in the Collapse of Global Trade." *American Economic Review Papers and Proceedings* 101(3), p.308-12.

Berman, N. and J. Héricourt (2008). "Financial Factors and the Margins of Trade: Evidence from Cross-Country Firm-Level Data." CES Working Paper 2008.50.

Braun, M. (2003). "Financial Contractibility and Asset Hardness." *University of California - Los Angeles mimeo.*

Bricongne, J.C., Fontagne, L., Gaulier, G., Taglioni, D. and V. Vicard (2010). "Firms and the Global Crisis: French Exports in the Turmoil." *Bank of France mimeo*.

Chor, D. and K. Manova (2009). "Off the Cliff and Back: Credit Conditions and International Trade during the Global Financial Crisis." *Journal of International Economics* (forthcoming).

Claessens, S. and L. Laeven (2003). "Financial Development, Property Rights, and Growth." *Journal of Finance* 58(6), p.2401-37.

Dai, M., Maitra, M. and M. Yu (2011). "Unexceptional Exporter Performance in China? The Role of Processing Trade." *Peking University mimeo.*

Goldberg, P., Khandelwal, A., Pavcnik, N. and P. Topalova (2010). "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India." *Quarterly Journal of Economics* 125(4), p.1727-67.

Greenaway, Guariglia and R. Kneller (2007). "Financial Factors and Exporting Decisions." *Journal of International Economics* 73(2), p.377-95.

Grossman, S. and O. Hart (1986). "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy* 44, p.691–719.

Hart, O. and J. Moore (1990). "Property Rights and the Nature of the Firm." *Journal of Political Economy* 48, p.1119–58.

Johnson, R. (2011). "Accounting for Intermediates: Production Sharing and Trade in Value Added." *Journal of International Economics* (forthcoming).

Klingebiel, D., Kroszner, R. and L. Laeven (2007). "Banking Crises, Financial Dependence, and Growth." *Journal of Financial Economics* 84(1), p.187-228.

Kugler, M. and E. Verhoogen (2008). "Prices, Plant Size, and Product Quality." *Review of Economic Studies (forthcoming)*.

Kugler, M. and E. Verhoogen (2009). "Plants and Imported Inputs: New Facts and an Interpretation." *American Economic Review Papers and Proceedings* 99(2), p.501-507.

Lemoine, F. and D. Ünal-Kesenci (2004). "Assembly Trade and Technology Transfer: The Case of China." *World Development* 32(5), p.829-50.

Levchenko, A., Lewis, L. and L. Tesar (2010). "The Collapse of International Trade during the 2008-2009 Crisis: In Search of the Smoking Gun." *IMF Economic Review* 58, p.214-53.

Levinsohn, J. and A. Petrin (2003). "Estimating Production Functions Using Inputs to Control for Unobservables." *Review of Economic Studies* 70(2), p.317-42.

Manova, K. (2007). "Credit Constraints, Heterogeneous Firms and International Trade." NBER Working Paper 14531.

Manova, K. and Z. Zhang (2008). "China's Exporters and Importers: Firms, Products, and Trade Partners." NBER Working Paper 15249.

Manova, K. and Z. Zhang (2009). "Export Prices across Firms and Destinations." *Quarterly Journal of Economics* (forthcoming).

Manova, K., Wei, S.-J. and Z. Zhang (2009). "Firms Exports and Multinational Activity under Credit Constraints." NBER Working Paper 16905.

Melitz, M. (2003). "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71(6), p.1695-725.

Minetti, R. and S.C. Zhu (2011). "Credit constraints and firm export: microeconomic evidence from Italy." *Journal of International Economics* 83, p.109-25.

Nunn, N. (2007). "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade." *Quarterly Journal of Economics* 122(2), p.569-600.

Rajan, R. and L. Zingales (1998). "Financial Dependence and Growth." *American Economic Review* 88, p.559-86.

Wang. Z. and Z. Yu (2011). "Trading Partners, Trade Products and Firm Performance: Evidence from China's Exporter and Importers." GEP Working Paper 2011/13.

Yu, M. (2011). "Processing Trade, Firm Productivity, and Tariff Reductions: Evidence from Chinese Products." *Peking University mimeo*.

Table 1. Trade Regime Characteristics

This table summarizes the costs, reevenues and profits associated with different export trade regimes.

	Ordinary Trade	Import & Assembly	Pure Assembly
Costs to Chinese Exporter			
Chinese Inputs	C_D	C_D	C_D
Foreign Inputs	$(1+\tau)\, C_F$	C_F	0
Distribution Network	F	0	0
Costs to Foreign Buyer			
Foreign Inputs	0	0	C_F
Distribution Network	0	F	F
Import Tariff Rebate	$\tau\, C_F$	0	0
Export Revenues	R	R	R
Surplus From Relationship	$R - C_D - C_F - F$	$R - C_D - C_F - F$	$R - C_D - C_F - F$
Exporter's Bargaining Weight	$\beta_{OT} = 1$	$\beta_{PI} = \frac{C_D + C_F}{C_D + C_F + F}$	$\beta_{PA} = \frac{C_D}{C_D + C_F + F}$
Exporter's Profits	$R - C_D - C_F - F$	$\beta_{PI}\,(R - C_D - C_F - F)$	$\beta_{PA}\,(R - C_D - C_F - F)$
Exporter's Liquidity Needs	$C_D + (1+\tau)\, C_F + F$	$C_D + C_F$	C_D

Table 2. Summary Statistics

This table provides summary statistics for all firms in the matched sample (Columns 1-3), all firms in the census data (Columns 4-6), and all firms in the customs data (Columns 7-9). 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 liability) / total assets, leverage = short-term debt / current assets, debt ratio = total debt / total assets, or coverage ratio = operating profit / interest payment. PA, PI and OT represent the value of exports under pure assembly, processing with imports, and ordinary trade respectively.

	Matched Sample			All Census Data			All Customs Data		
	N	Mean	St Dev	N	Mean	St Dev	N	Mean	St Dev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Balance Sheet Data									
(log) Sales	50,567	10.64	1.35	75,001	10.43	1.36			
(log) Employment	50,606	5.31	1.14	75,017	5.20	1.15			
(log) Profits	39,844	7.33	1.95	60,558	7.06	1.95			
Profits / Sales	50,582	0.03	0.20	75,017	0.03	0.23			
(log) Value Added	49,801	9.23	1.48	73,944	9.03	1.48			
Productivity (LP)	47,297	4.96	1.17	64,779	4.93	1.15			
Productivity (VA)	49,735	3.93	1.08	73,819	3.84	1.05			
Liquidity	50,574	0.09	0.32	74,974	0.09	0.33			
Leverage	50,567	0.99	1.28	74,957	1.01	1.41			
Debt Ratio	50,606	0.56	0.30	75,010	0.56	0.31			
Coverage Ratio	30,050	34.53	984.20	44,350	40.76	2178.24			
Customs Data: Firm Level									
(log) Total Exports	50,606	13.83	2.08				114,883	13.00	2.26
(log) Total Imports	31,551	12.65	2.90				60,330	12.21	2.84
(PA+PI) / (PA+PI+OT)	50,522	0.30	0.42				114,883	0.27	0.41
PA / (PA+PI)	22,071	0.19	0.37				42,176	0.24	0.41
PA / (PA+OT)	44,854	0.07	0.23				102,125	0.08	0.25
PI / (PI+OT)	49,639	0.26	0.40				111,765	0.22	0.39
Customs Data: Firm-Industry Level									
(log) Total Exports	105,895	11.47	3.56				258,658	10.96	3.22
(log) Total Imports	40,556	11.37	3.39				76,964	10.98	3.36
(PA+PI) / (PA+PI+OT)	105,895	0.23	0.40				258,658	0.18	0.37
PA / (PA+PI)	32,576	0.16	0.35				60,553	0.21	0.40
PA / (PA+OT)	93,712	0.04	0.19				234,395	0.04	0.20
PI / (PI+OT)	104,204	0.21	0.38				253,423	0.15	0.34

Table 3. Trade Regimes and Firm Profitability

This table examines the relationship between firms' profitability and trade activity in 2005. The dependent variable is (log) firm profits, proftiability (the ratio of profits to sales) or (log) value added as indicated in the column heading. Three types of export trade regimes are considered: pure assembly (PA), import and assembly (PI), and ordinary trade (OT). Firms' choice over trade regime is captured by the share of processing exports in total exports (Panel A), the relative importance of PA and OT (Panel B), the relative importance of PI and OT (Panel C), and the share of PA in processing exports (Panel D). All regressions include a constant term, firm ownership dummies and province-sector fixed effects. Robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	(log) Profit	Profit/Sales	(log) Value Added
	(1)	(2)	(3)
Panel A. Processing Trade vs. Ordinary Trade			
(PA + PI) / (PA + PI + OT)	-0.138***	-0.014***	-0.097***
	(-4.82)	(-5.84)	(-5.97)
(log) Employment	0.903***	0.007***	0.895***
	(104.40)	(9.26)	(172.46)
R-squared	0.49	0.33	0.63
# observations	38,888	49,392	49,717
Panel B. Pure Assembly vs. Ordinary Trade			
PA / (PA + OT)	-0.405***	-0.030***	-0.347***
	(-8.63)	(-5.95)	(-13.56)
(log) Employment	0.910***	0.007***	0.892***
	(101.05)	(8.16)	(163.90)
R-squared	0.51	0.35	0.64
# observations	34,977	43,897	44,108
Panel C. Import & Assembly vs. Ordinary Trade			
PI / (PI + OT)	-0.044	-0.008***	-0.002
	(-1.47)	(-3.14)	(-0.14)
(log) Employment	0.900***	0.007***	0.892***
	(103.41)	(9.03)	(171.55)
R-squared	0.50	0.34	0.63
# observations	38,307	48,530	48,844
Panel D. Pure Assembly vs. Import & Assembly			
PA / (PA + PI)	-0.351***	-0.016***	-0.246***
	(-7.82)	(-3.77)	(-10.24)
(log) Employment	0.886***	0.008***	0.904***
	(66.26)	(7.41)	(113.12)
R-squared	0.54	0.25	0.65
# observations	16,210	21,567	21,704
Controls:	Province-Industry FE, Ownership FE		

Table 4. Trade Regimes and Firm Profitability: Pure Exporters

This table examines the relationship between firms' profitability and trade activity in 2005 for firms that export only but do not sell domestically. The dependent variable is (log) firm profits, proftiability (the ratio of profits to sales) or (log) value added as indicated in the column heading. Three types of export trade regimes are considered: pure assembly (PA), import and assembly (PI), and ordinary trade (OT). Firms' choice over trade regime is captured by the share of processing exports in total exports (Panel A), the relative importance of PA and OT (Panel B), the relative importance of PI and OT (Panel C), and the share of PA in processing exports (Panel D). All regressions include a constant term, firm ownership dummies and province-sector fixed effects. Robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	(log) Profit	Profit/Sales	(log) Value Added
	(1)	(2)	(3)
Panel A. Processing Trade vs. Ordinary Trade			
(PA + PI) / (PA + PI + OT)	-0.257***	-0.023***	-0.206***
	(-3.80)	(-5.11)	(-5.95)
(log) Employment	0.830***	0.007***	0.841***
	(41.94)	(5.06)	(75.53)
R-squared	0.47	0.38	0.64
# observations	7,870	10,343	10,491
Panel B. Pure Assembly vs. Ordinary Trade			
PA / (PA + OT)	-0.418***	-0.037***	-0.311***
	(-4.55)	(-3.74)	(-6.68)
(log) Employment	0.848***	0.006***	0.811***
	(35.54)	(3.82)	(59.59)
R-squared	0.50	0.43	0.65
# observations	5,950	7,548	7,628
Panel C. Import & Assembly vs. Ordinary Trade			
PI / (PI + OT)	-0.088	-0.008*	-0.059*
	(-1.26)	(-1.72)	(-1.74)
(log) Employment	0.822***	0.007***	0.833***
	(41.18)	(5.46)	(74.89)
R-squared	0.48	0.42	0.64
# observations	7,652	10,007	10,147
Panel D. Pure Assembly vs. Import & Assembly			
PA / (PA + PI)	-0.417***	-0.026***	-0.215***
	(-4.76)	(-2.99)	(-4.69)
(log) Employment	0.830***	0.007***	0.880***
	(32.64)	(4.14)	(62.99)
R-squared	0.52	0.35	0.66
# observations	4,743	6,594	6,708
Controls:	Province-Industry FE, Ownership FE		

Table 5. Trade Regimes and Firms' Financial Health

This table examines the relationship between firms' trade activity and access to finance in 2005. The dependent variable reflects the composition of firms' trade activity as indicated in the column heading and defined in Table 2. Firms' financial health is measured by liquidity = (current assets - current liability) / total assets (Panel A) or leverage = short-term debt / current assets (Panel B). The point estimates in Panel D are multiplied by 10,000 for readability. All regressions include a constant term, (log) employment, firm ownership dummies and province-sector fixed effects. Robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	(PA+PI)/(PA+PI+OT)	PA/(PA+OT)	PI/(PI+OT)	PA/(PA+PI)
	(1)	(2)	(3)	(4)
Panel A. Liquidity = (current assets - current liability) / total assets				
Liquidity	-0.027***	-0.026***	-0.018***	-0.029***
	(-5.44)	(-5.77)	(-3.54)	(-3.46)
R-squared	0.52	0.30	0.50	0.39
# observations	50,522	44,854	49,639	22,071
Panel B. Leverage = short-term debt / current assets				
Leverage	0.004***	0.008***	-0.000	0.020***
	(2.72)	(4.16)	(-0.07)	(5.33)
R-squared	0.52	0.31	0.50	0.40
# observations	50,515	44,847	49,632	22,070
Controls:	(log) Employment, Province-Industry FE, Ownership FE			

Table 6. Trade Regimes and Firms' Financial Health: Firm Productivity

This table examines the relationship between firms' trade activity and access to finance in 2005. The dependent variable reflects the composition of firms' trade activity as indicated in the column heading and defined in Table 2. Firms' financial health is measured by liquidity = (current assets - current liability) / total assets (Panel A) or leverage = short-term debt / current assets (Panel B). Firm productivity is measured according to the Levinsohn-Petrin method. The point estimates in Panel D are multiplied by 10,000 for readability. All regressions include a constant term, (log) employment, firm ownership dummies and province-sector fixed effects. Robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	(PA+PI)/(PA+PI+OT)	PA/(PA+OT)	PI/(PI+OT)	PA/(PA+PI)
	(1)	(2)	(3)	(4)
Panel A. Liquidity = (current assets - current liability) / total assets				
Liquidity	-0.016***	-0.012**	-0.014**	-0.011
	(-2.84)	(-2.45)	(-2.55)	(-1.32)
Productivity	-0.019***	-0.021***	-0.006***	-0.028***
	(-9.13)	(-12.83)	(-2.91)	(-9.11)
R-squared	0.53	0.31	0.51	0.40
# observations	47,219	41,762	46,381	21,075
Panel C. Leverage = short-term debt / current assets				
Leverage	0.003*	0.007***	-0.001	0.016***
	(1.72)	(3.46)	(-1.03)	(4.80)
Productivity	-0.020***	-0.020***	-0.007***	-0.026***
	(-9.70)	(-12.79)	(-3.68)	(-8.46)
R-squared	0.53	0.31	0.51	0.40
# observations	47,216	41,759	46,378	21,075
Controls:	(log) Employment, Province-Industry FE, Ownership FE			

Table 7. Trade Regimes and Sectors' Financial Vulnerability

This table examines the relationship between firms' trade activity and sectors' financial vulnerability in 2005. The dependent variable reflects the composition of firms' trade activity as indicated in the column heading and defined in Table 2. Sectors' financial vulnerability is measured by the inventories ratio (the ratio of inventories to sales, Panel A), external finance dependence (the share of capital expenditures not financed with cash flows from operations, Panel B), R&D intensity (the share of R&D expenditures in total sales, Panel C), or asset tangibility (the share of net plant, property and equipment in total book value assets, Panel D). Sectors' physical capital (K), human capital (H) and relationship-specific (RS) intensity are defined in the text. All regressions include a constant term and firm fixed effects. Robust standard errors clustered by firm. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Dep Variable:	(PA+PI)/(PA+PI+OT)	PA/(PA+OT)	PI/(PI+OT)	PA/(PA+PI)
	(1)	(2)	(3)	(4)
Panel A. Working Capital Requirement: Inventories Ratio				
Inventories Ratio	0.497***	0.133***	0.411***	0.201***
	(23.43)	(11.85)	(21.22)	(2.77)
K intensity	-0.310***	-0.082***	-0.260***	0.151
H intensity	0.016***	-0.007***	0.023***	-0.016
RS intensity	0.017***	0.002	0.016***	0.002
R-squared	0.86	0.86	0.86	0.97
Panel B. Long-Run Investment Needs: External Finance Dependence				
Ext Fin Dependence	0.050***	0.010***	0.045***	-0.0001
	(21.82)	(7.29)	(21.81)	(-0.03)
K intensity	-0.747***	-0.196***	-0.616***	-0.052
H intensity	0.019***	-0.005**	0.024***	-0.002
RS intensity	0.003	-0.002	0.004	-0.016
R-squared	0.86	0.86	0.86	0.97
Panel C. Long-Run Investment Needs: R&D Intensity				
R&D Intensity	0.988***	0.190***	0.910***	-0.018
	(22.81)	(8.82)	(22.03)	(-0.24)
K intensity	-0.601***	-0.169***	-0.485***	-0.053
H intensity	-0.009**	-0.010***	-0.002	-0.001
RS intensity	-0.022***	-0.006*	0.019***	-0.015
R-squared	0.86	0.86	0.87	0.97
Panel D. Access to Collateral: Asset Tangibility				
Asset Tangibility	-0.208***	-0.066***	-0.165***	-0.038
	(-18.05)	(-11.13)	(-15.67)	(-1.12)
K intensity	-0.036	0.028	-0.054	0.083
H intensity	0.012***	-0.010***	0.021***	-0.008
RS intensity	0.019***	0.003	0.017***	-0.011
R-squared	0.86	0.86	0.86	0.97
Controls:		Firm FE		
# firms	110,018	97,467	106,945	41,041
# observations	252,296	228,727	247,148	59,263

Figure 1. The Distribution of Trade Activity Across Firms

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 more than one type of trade regimes. The percentages reported in the figure sum to 100%.

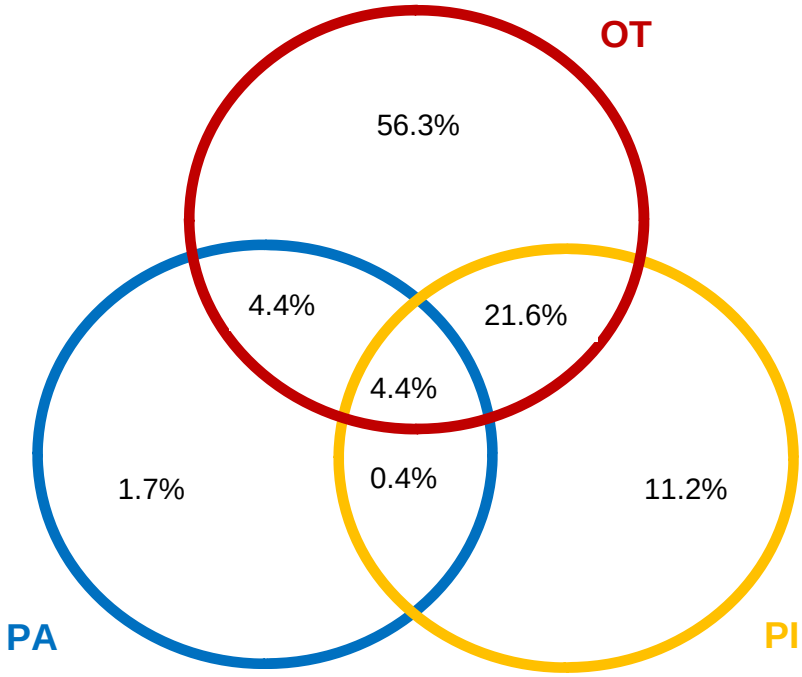

Figure 2. The Distribution of Trade Activity Across Firm-Sector Pairs

This figure replicates Figure 1, but instead of counting firms in each segment, it counts firm-sector pairs.

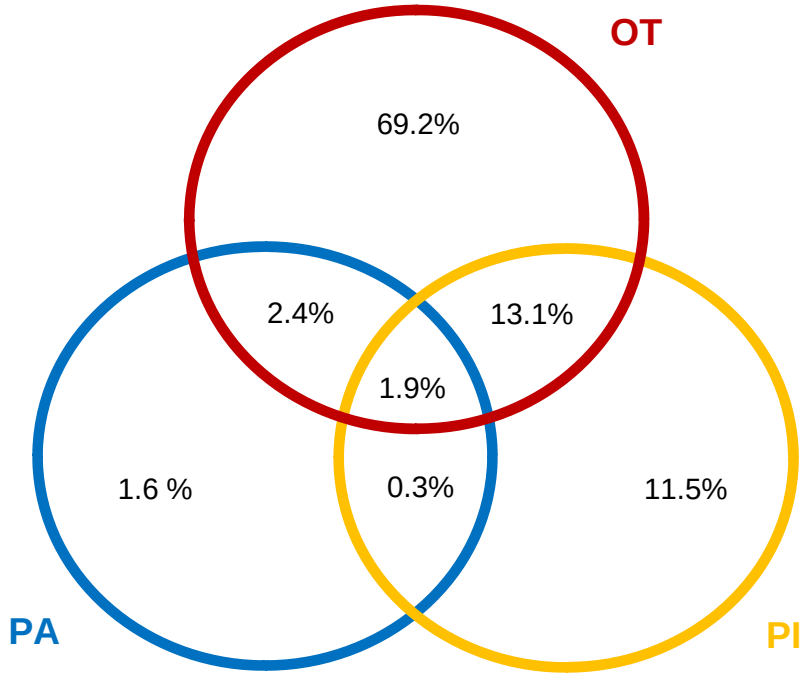

Figure 3. Input Sourcing Strategies Across Firms

This figure summarizes the use of imported inputs by firms reporting ordinary exports (left bar) and firms reporting processing exports (right bar) in 2005. Each segment gives the percentage share of firms using no imported inputs (grey), inputs imported under processing trade (yellow), inputs imported under ordinary trade (blue), and inputs imported under both regimes (red). The percentages reported in each bar sum to 100%.

Figure 3A. Firms reporting both ordinary and processing exports enter both bars

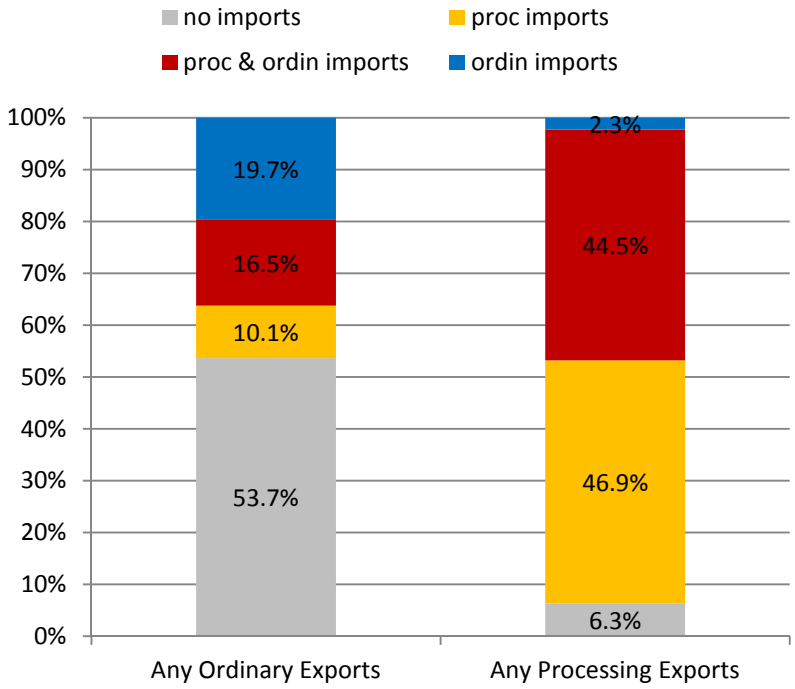

Figure 3B. Firms reporting both ordinary and processing exports are excluded