Unexceptional Exporter Performance in China? The Role of Processing Trade[1]

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Abstract

The firm level trade literature finds exporters are exceptional performers for a wide range of countries and measures. Paradoxically, the one documented exception is the world's largest trader, China. We show that this puzzling finding is entirely driven by the presence of firms that engage in export processing – the activity of assembling tariff exempted imported inputs into final goods for resale in foreign markets. In China roughly a fifth of exporters, accounting for about one-third of total export value, are engaged in processing trade only. These firms are 4% to 30% less productive than non-exporters. Removing processing exporters restores the traditional finding that exporters have superior performance relative to non-exporters. Our results show that distinguishing between processing and ordinary exporters is crucial for understanding firm-level exporting behavior in China. It should also be investigated closely in other countries for which processing trade is important.

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1 Introduction

The nature of international trade has changed – as Grossman and Rossi-Hansberg (2006) put it: "It's not wine for cloth anymore". In the modern world, with rapid progress of communication and technology, production processes increasingly involve global supply chains spanning multiple countries, with different stages of the production taking place in several disparate locations. A particular form of this fragmented production technique is *processing trade*: the activity of assembling tariff exempted imported inputs into final goods for resale in the foreign markets. The iPhone is a classic example: the different components of an iPhone are manufactured in Japan, Korea, Germany, US, and Taiwan from where these are shipped to China for the final assembly at Foxconn, an exclusive iPhone assembler located in Shenzhen, China. All final assembled products are exported back to the US and other markets (Xing, 2011). In terms of its sheer magnitude processing trade in China merits special attention. Processing trade accounts for nearly half of China's exports, exceeding *total* exports for most countries including Japan and France. Processing / assembly have become popular in other developing countries. In 2006, 130 countries have established 3500 Export Processing Zones(EPZs), which employs 66 million people in total. And for many countries (Kenya, Malaysia, Argentina, etc.), exports from EPZs account for over 80 percent of their total exports(International Labor Office,2007).

To the best of our knowledge, this paper is one of the first to study the performance of processing firms vis-à-vis non-processing ones. We demonstrate that processing exporters in China are fundamentally different from the "traditional" exporters, who are found to be exceptional performers for a wide range of countries and measures. Most studies analyzing exporter behavior in China fail to distinguish between the two;[5] however we show that accounting for this difference is crucial. In fact, if all exporters are treated the same in China, a puzzling result emerges: contrary to the accumulated

[5] Papers like Park et al. (2010), Yang and Mallick (2010), Girma et al. (2009); Lu et al. (2010, 2011), Lu (2010) do not distinguish between processing and non-processing exporters – exceptions being Yu (2011), Manova and Zhang (2011).

evidence in the literature, exporters are no longer superior performers (documented by Lu et al.,2010 and Lu, 2010). We show that this finding is entirely driven by processing exporters. Removing these firms restores the traditional finding that exporters have superior performance relative to non-exporters.

In this paper we merge the Chinese Manufacturing Survey data, which provides all firm level information (except firms' processing status), with the Chinese Customs data, which allows us to distinguish firms according to whether or not they engage in processing trade. Our main findings are: (1) Processing exporters are less productive than both non-processing exporters and non-exporters. (2) It is crucial to account for processing trade separately. Once processing exporters are accounted for, the productivity abnormalities documented in previous research (Lu et al.,2010 and Lu ,2010) are eliminated or alleviated. (3) Processing exporters have the lowest profits per worker, pay lowest wages per worker, have lowest R&D per worker, are relatively smaller in terms of sales, and have lower capital intensity. Moreover, processing exporters are concentrated in labor intensive sectors and in Foreign Invested Enterprises (henceforth FIE).

Our results show that not only are processing exporters consistently performing worse than non-processing exporters, but failing to consider the two types of exporters separately make performance of exporters appear worse than non-exporters – even though non-processing exporters' performance is similar to what has been widely documented in the literature. It is thus essential to treat processing and non-processing exporters separately; and henceforth, studies of export performance in China (or countries with large processing trade sectors such as Mexico and Vietnam) should account for this distinction.

We investigate possible explanations behind low productivity of processing exporters. The theories are classified into two groups: (1) Processing exporters are actually less productive. (2) Processing exporters may appear less productive if their pricing policy leads to lower revenue or value added which gets translated into lower revenue based productivity measures. The mechanism consistent with the first idea is

that processing trade is a different activity compared to ordinary trade. Our data shows that processing trade firms pay lower average wages implying that they are more unskilled labor intensive, are relatively less capital intensive, and have low profitability compared to non-processing ones. Given that processing firms pay lower fixed cost (due to government intervention) it makes sense that only the low productivity firms would select into processing trade.

Mechanisms consistent with the second idea are as follows: First, foreign owned processing exporters might be engaging in transfer pricing that make them appear less productive, a result much less pronounced in non-foreign firms where processing exporters are no less productive than non-exporters. Our data provides mixed evidence about transfer pricing by processing exporters. Second, processing trade firms receive contracts from foreign firms to produce the final product. However, the foreign firm owns the patent or blue print of the product and can squeeze the processing exporters' markup and make them behave as price takers – this can lead to lower revenue and hence low productivity. Controlling for market power (levels of export, firm size, markup and industry market share are used as proxies for market power) in the baseline regression does not alter our main result. Thus low market power is not the sole driving force behind low productivity of these firms. Third, processing exporters may appear less productive if the products exported by them are different and fetch lower price and revenue than those exported by the other exporters. Consistent with this theory we find that processing exporters have lower unit prices, indicating that they could be selling low quality products. In summary, our results imply that processing trade involves unskilled intensive jobs with low profitability and production of low quality goods. It also has lower fixed cost because of government policy intervention. Thus, the hypothesis that processing trade is a different activity compared to non-processing trade is the one that receives considerable support from the data.

Our paper is related to the firm level trade literature analyzing the behavior of exporters. It is closely related to two papers documenting counter-Melitz findings in Chinese exporters. The first paper by Lu et al. (2010), shows that the anomalous result

is true only for firms with foreign investments. The second one by Lu (2010) finds that exporters are less productive than non-exporters only in labor intensive sectors. Their explanations do not take into account the role of processing trade. Here we match the firm level data used in the two prior works to the Chinese customs data. The merged data can replicate the prior results; but more importantly it allows us to identify a firm's processing status. We show that the fundamental distinction that matters for the counter-Melitz result is neither foreign investment nor labor intensity, but rather participation in processing trade; because processing exporters are least productive.

This paper is also related to the literature studying global supply chains since processing trade is a special form of vertical specialization. Though many papers, both theory and empirical, have studied vertical specialization and supply chains (Feenstra and Hanson,1996; Hummels et al.,1998; Hummels et al.,2001; Yi ,2003; Feenstra and Hanson, 2005; Hanson et al.,2005; Grossman and Rossi-Hansberg,2008; Costinot et al.,2011; Johnson and Noguera,2011, etc.), none of these papers has investigated the agents who are the conduits of supply chains from a developing country's point of view – we fill this gap.

Lastly, our work is closely related to the literature documenting the special nature of processing trade. Bergin et al. (2008), show that processing industries in Mexico (Maquiladora) are subject to higher volatility. The paper by Koopman et al. (2008) shows that using traditional methods for calculating value added for countries that actively engage in processing trade can overestimate the domestic content of these countries' exports. Yu(2011) shows that the effect of input tariff reduction on firm productivity is small in China due to input tariff exemption policy on processing trade. We show that processing exporters are less productive, and they explain the abnormal productivity of Chinese exporters..

The paper is organized as follows. Section 2 describes the data. Section 3 provides several stylized facts about processing exporters in China and relates them to the productivity abnormality documented about Chinese exporters. Section 4 provides discussion about possible theories that explain processing exporters' unexceptional

performance and how well they are supported by the data. The last section concludes.

2 Data

2.1 Firm Level Data

The firm level data in this paper comes from annual surveys of manufacturing firms conducted by the National Bureau of Statistics of China from 2000 to 2005. The survey includes all State Owned Enterprises (SOE) and those Non-State Owned Enterprises with annual sales of five million yuan (about 650,000 US dollars) or more. The dataset includes information from balance sheet, profit and loss and cash flow statements of firms, includes about 80 variables, and provides detailed information on firm's identification, ownership, export status, employment, capital stock, which are of particular use in this paper. These firms contribute about 98% of total Chinese manufacturing exports in aggregate trade data. To clean the data, following Feenstra et al. (2011), we drop observations that report missing or negative values for any of the following variables: total sales, total revenue, total employment, fixed capital, export value, intermediate inputs, if export value exceeds total sales or if share of foreign asset exceeds one. We include firms with at least eight employees. The final sample we use includes 190312 observations. However, this data provides no information about a firms processing status.

2.2 Transactions Level Customs Data

The transactions level customs data comes from China's general Administration of Customs and spans from 2000-2005. It contains disaggregate product level information of firms' trading price, quantity and value at the HS8 digit level. Importantly, this data provides information on whether a transaction was processing or not – we construct firms' processing status from this dataset. We divide exporting firms into three types depending on their nature of transactions in a given year: (1) processing firms: who only engage in processing transactions; (2) non-processing firms: who only make non-processing transactions; (3) both: if a firm makes both processing and non-processing transactions.

2.3 Combining the Two Datasets

The combining of the firm level data with the transactions level data is problematic because the firm identifiers used in the two datasets are different - a nine digit id in the firm level data vs. an eleven digit id in the customs data, with no common elements. Following Yu (2011), we merge the two datasets by using zip codes and last seven digits of a firm's phone number. The details of the merge variables are provided in Appendix A.1. We are able to merge about 30% of the exporters in the firm level data with the transactions data. One possible issue is selection, since we lose quite a few exporters.[6] Table 1 shows the comparison of exporters in the firm level data that could be matched with the customs data to those that could not be matched. We see that the merged and the unmerged firms look very similar on average. Moreover we show in the Appendix B.1 that the merged data can replicate the counter Melitz finding documented in the previous literature. B.Table 1 shows that exporters are less productive than non-exporters within foreign owned firms. B.Table 2 shows that in terms of value added per worker, exporters are less productive in the labor intensive sectors but in B.Table 3 using TFP (Olley-Pakes) measures we find no such evidence.[7] One explanation could be that the results for value added per worker are driven by the fact that it ignores the role of capital but is sensitive to capital intensity. Similar results are obtained when we use the firm level data without merging with the customs data.

3 Stylized facts about processing exporters

3.1 China's Export-Processing Regime

The Chinese government has been actively promoting export processing since the

[6] We have run all our regressions using only the firm level data by dividing exporters into two types: regular exporters (who sell domestically as well as export; and pure exporters who only export). We find pure exporters are highly correlated with processing trade and pure exporters are the least productive. The reason we prefer to use the merged data is that we find around 30% of pure exporters are doing non-processing trade only, and they are not less productive than non-exporters. This result implies that the processing status (as opposed to export intensity) of a firm is crucial in determining its productivity.

[7] The results are the same for using TFP(OLS) or the Hsieh-Klenow (2008) productivity measures.

1980s. There are altogether 16 specific types of processing trade in China, but two of them are more common: processing with supplied materials (henceforth PWSM) and processing with imported materials (henceforth PWIM).[8] For PWSM, a Chinese firm obtains raw materials and parts from its foreign trading partners without making any payments. After processing/assembly, the product is sold back to the firm who provided the parts and materials. The processing firm only charges a processing fee on the foreign firm. By contrast, for PWIM, the Chinese firm pays for the imported materials. It also has the freedom to choose the export destination of the final processed product.

Export processing in China is subject to very different policy treatment compared to non-processing trade. First, processing activities enjoy favorable taxation. The amount of imported inputs actually used in the making of the finished products for export is exempt from tariffs and import-related taxes. All processed finished products for export are also exempt from export tariffs and value-added tax.[9] Second, the finished products using the tax-exempted materials have to be re-exported, and enterprises are not allowed to sell the tax-exempted materials and parts or finished products in China.[10]

Although processing trade is defined as importing materials and re-exporting the finished products, it should be noted that not all transactions that involve importing and re-exporting are treated as processing trade. A transaction is recorded as processing/assembly by the Customs, and taxes are exempt (or rebated) only if a firm with the legal processing status declares the transaction to be processing. In order to get processing status, a firm needs to: first, obtain the Processing Trade Approval Certificate from the commerce authorities; and second, should then present the

[8] PWSM also refers to "pure assembly" in Feenstra and Hanson (2005) and "processing with assembly" as adopted in Yu (2011). Correspondingly, PWIM is also called "input and assembly" and "processing with inputs".

[9] The taxation policy for PWSM and PWIM are slightly different. For PWSM, import and output tariffs are never levied, for PWIM, however, tariffs on the imported materials are first levied, but then rebated to the firm upon re-exporting of the final products.

[10] If such goods have to be sold in the domestic market for special reasons, approval must be obtained from the commerce authorities in charge of processing trade at provincial level as well as the Customs authorities. If approved to sell domestically, the processing firm must pay all the related taxes plus interest payments.

Processing Trade Approval Certificate and Processing Trade Contract to the customs office where the processing firm is located to complete the filing and registration formalities and to apply for the Processing Trade Registration Handbook. A transaction will be recorded as processing only if a firm declares it to be processing to the Customs by filling out the registration handbook.

3.2 Summary Statistics

We start by showing the importance of processing exports in total Chinese exports. From Table 2 we see that over the sample period, approximately 20% of firms were processing exporters and around 40% each were engaged in non-processing trade or in both types of activities, respectively. In terms of export value, pure processing exporters contribute about 30% of the value. In Table 3a we report the distribution of processing intensity of firms doing both activities. The average processing intensity is higher in FIE firms. Table 3b shows that processing trade is concentrated more in FIE (Foreign Invested Enterprises), with over 80% of the total export value coming from processing trade. For the non-FIE firms processing trade accounts for only about 30% of the total exports. Figure 1 shows that processing intensity is higher in labor intensive sectors. The fact that processing exports are concentrated in FIE and labor intensive sectors suggest that the low productivity of the exporters in these sectors found in previous studies are possibly being driven by low productivity of processing exporters and we will show in the next sub-section that is indeed true. Figure 2 plots productivity (measured by TFP estimated using an extended Olley-Pakes(1996) method, after removing industry-province-year fixed effects) by processing intensity. We find that exporters with processing intensity one (doing processing trade only) have significantly lower productivity than those with processing intensity zero (doing non-processing trade only). Exporters with low processing intensity are more productive than non-processing firms but productivity generally declines as firms' processing intensity increase.

3.3 Econometric Analysis

In order to examine the performance of processing exporters versus non-processing exporters and non-exporters, we estimate the following equation:

$$y_{ijpt} = \alpha + \beta_1 PX_{ijpt} + \beta_2 NPX_{ijpt} + \beta_3 BX_{ijpt} + \gamma D + e_{ijpt} \quad (1)$$

Where y_{ijpt} is the dependent variable of interest (in logs) for firm *i* in industry *j*, province *p* and time *t*. PX_{ijpt} is a dummy which equals one if firm is a processing exporter (i.e. in any given year it only makes processing transactions); NPX_{ijpt} is the dummy for non-processing exporters (i.e. in any given year these firms only report non-processing transactions); BX_{ijpt} is the dummy for exporters doing both processing and non-processing trade (i.e. in any year the firm makes both processing and non-processing transactions); D stands for industry, province and year fixed effects and in some robustness specifications other controls like size and ownership. Our main variables of interest are productivity, including total factor productivity and value added per worker (labor productivity) measures. We calculated TFP using both OLS and the method proposed by Olley and Pakes (1996) [11], the latter uses firm investment to proxy for the unobserved productivity shock. We will show most of our results using TFP (Olley-Pakes) measure, as it takes into account both the role of capital (ignored by value added per worker measure) and the simultaneity of productivity shocks and input selection (ignored by TFP(OLS)). Equation (1) is our baseline regression and tells us if lower productivity of one or all types of exporters is important for explaining the documented unexceptional exporter performance in China.

We carry out regression (1) using different productivity measures. The results are reported in Table 4. We find that in terms of all productivity measures processing exporters are less productive than non-exporters; the coefficient of processing dummy being negative and significant. The results indicate that processing exporters are 4% to 30% less productive than non-exporters. Consistent with Melitz (2003) model, non-processing exporters and exporters doing both processing and non-processing

[11] Details of construction of TFP using Olley-Pakes method is in Appendix A.2

trade are more productive than non-exporters. This table makes it clear that only the processing exporters demonstrate counter-Melitz productivity pattern. In Appendix B.Table 4 we check how productivity of the exporters doing both processing and non-processing trade varies with processing intensity (firm's share of processing exports in total exports). We find that productivity decreases with processing intensity, indicating that less productive firms engage in processing trade more intensively.

We next investigate productivity of the different exporters by ownership: namely FIE and non-FIE firms, since previous literature has demonstrated low productivity of exporters in foreign owned firms.[12] Table 5 shows that processing exporters are less productive than non-processing ones irrespective of ownership type, and is less productive than non-exporters in FIEs, while non-processing firms are actually more productive Thus the finding that exporters are less productive than non-exporters in foreign owned firms is driven by inferior productivity of processing exporters.

We now check how much the anomalous behavior of exporters in the labor intensive sectors documented by Lu (2010) is influenced by processing exporters. We run the baseline regressions by capital intensity of the sector (low, medium or high capital intensity). Following Lu (2010) we define the capital intensity of a sector at the 2 digit industry level as the median capital-labor ratio in the sector. We find exporters are less productive than non-exporters in labor intensive sectors but not in capital intensive sectors when we use value added as our measure of productivity, as shown in B.Table 2 in appendix B.1. However using TFP as our measure of productivity in B.Table 3 we find that exporters are more productive than non-exporters irrespective of the capital intensity of the sector. This difference in the pattern for different productivity measures, as mentioned before, is most likely driven by the fact that value-added per worker does not adjust for the role of capital but is positively correlated to the level of capital. Labor productivity is mechanically higher

[12] We use two methods to identify a firm's ownership type. In the first method, we use the self-reported registration type of the firm, and in the second we calculate a firm's share of stocks owned by foreign partners. Following the definition from the National Bureau of Statistics, we define a FIE to be a firm with over 25% foreign-owned stocks. The two methods yield qualitatively the same results, so we only report results using the first method.

in sectors and firms that use capital more intensively.[13] Moreover in China labor share is only around 50%, hence we should use productivity measures that account for the different factors of production as well.

In Table 6a we look at productivity (in terms of value added per worker) of different types of exporters across capital intensity of the sectors; all exporters are less productive in the labor and medium intensity sector. However processing trade exporters are the least productive irrespective of the capital intensity of the sector; the co-efficient always being negative and significant. In B.Table 5 in the appendix we show that the pattern for value added changes considerably once we control for firm size. Exporters in general become more productive than non-exporters in all sectors but when we look at processing exporters we still find they are the least productive, though the other two types are now more productive than non-exporters. From the discussion it is obvious that the poor labor productivity found in Lu (2010) is in part being driven by low labor productivity of processing exporters. Since value added per worker could be reflecting something other than productivity, we repeat the same exercise using TFP and report the results in Table 6b. As we noted before the counter Melitz pattern for exporters found in Lu (2010) is not discernable when we use TFP as our measure of productivity. Once we look at different exporter types we find positive and statistically significant coefficient for all exporters except processing trades, indicating that the former are always more productive (in terms of TFP) than non-exporters irrespective of industry capital intensity. However, again we find that the behavior of processing exporters is starkly different. They have lower TFP compared to the other exporters regardless of sectors and are less productive than non-exporters except in capital intensive sectors.

Another feature of Chinese exporters is that around 30% of them are pure exporters i.e. they export their entire output. Lu (2010) predicts that pure exporters are less productive than non-exporters in the labor intensive sector. Lu et al.(2010) also

[13] The correlation between labor productivity and capital labor ratio in our data is 0.35, while the correlation between TFP(OP) and capital labor ratio is only 0.02.This means that TFP is much less correlated with capital labor ratio and is therefore a cleaner measure of productivity.

predicts pure exporters to be less productive than non-exporters in FIEs.We re-run our baseline regressions by introducing six types of regressors: for each type of processing status we divide the firms into whether it is a pure exporter (has export intensity one) or a regular exporter (has export intensity between zero and one). Table 8 shows that pure exporters doing processing trade are the least productive, whereas pure exporters doing non-processing trade are more productive than non-exporters, and this holds for all ownership types. Table 9 shows even in labor intensive sectors pure exporters doing non-processing trade are not less productive than non-exporters. These tables again point that only processing trade firms have counter Melitz properties.

3.4 Robustness

In this section we perform a number of checks on the baseline specification (1) to test the robustness of our findings. First, to ensure that our results are not entirely driven by firm size we include control for firm size (in terms of employment) and ownership in our regression analysis. The results are reported in Table 10, column 1. In column 2 we control for industry-province-year fixed effects to account for industry-province-year specific shocks. Pooling over the years might confound our results since China was undergoing changes in the post WTO accession period. So in column 3 we run the regression only for the last year 2005, by which time China had met most of its WTO obligations. In column 4 we weight each firm by its industry value added share, so that large firms receive more weight in the regressions. Column 5 runs our baseline regressions after trimming the top and bottom 1% of the data to ensure that extreme values are not driving our results. Lastly, Hsieh and Klenow (2009) shows that resource misallocation can lower measured TFP in China. In Table 11 we estimate revenue productivity and physical productivity following Hsieh and Klenow (2009) technique to see whether resource misallocation is a reason for the results (processing trade firms receive tax exemptions on imported intermediate inputs; and foreign firms, who provide the bulk of processing exports have better access to credit than domestic firms).

In all the above cases the results are qualitatively similar to our baseline results reported in Table 4 – in that processing exporters are the least productive.

4 Possible Explanations for Unexceptional Performance of Processing Exporters

Our results from section 3 show that processing exporters are not exceptional performers. In this section we provide possible explanations for their poor performance. Since we are using revenue based productivity measures, the possible explanations can be broadly classified into two groups: (1) processing exporters are actually less productive; (2) processing exporters may appear less productive if their pricing policy results in lower revenue or value added which gets translated into lower revenue based productivity measures.

We begin by enumerating ways in which processing exporters might actually be less productive than non-exporters. If processing trade is a more unskilled labor intensive and low profitability job involving lower fixed costs, then only low productivity firms decide to engage in processing trade activity. We find this might very well be the case.[14] Figure 1 shows that across industries processing exporters are concentrated more in labor intensive industries. [15] Table 12a shows that within industries, processing trade exporters are least profitable; pays lower wage per worker indicating that processing is a relatively unskilled labor intensive activity; have lower inputs per unit of sales; are relatively less capital intensive; and have the least R&D per worker probably because these firms receive the technology or blueprint from abroad. If we look at the age profile of firms in Table 12b, we see that processing exporters on average comprise of slightly younger firms. If processing trade involves lower fixed costs (because of government policy) and is a more unskilled labor intensive activity , it might be easier for the new firms to establish as processing trade firms so these firms on average would be younger. From the above

[14] Yu (2011) also finds that low-productive firms self-select to engage in processing trade.

[15] The capital labor ratio is defined as the median capital labor ratio in a two digit industry. Results are qualitatively similar if we use the aggregate capital labor ratio of the industry instead.

discussion we can say that the data provides evidence consistent with the theory that processing trade is a different activity, so we should look at processing and non-processing exporters separately.

We now move on to discuss how processing exporters might appear to be less productive. In our baseline results by ownership in Table 5, we find that for foreign owned firms, processing exporters are less productive than non-exporters as well, and this effect is much less pronounces for non-FIE. Foreign owned processing firms could be engaging in transfer pricing, in which they repatriate profits to a related party located in countries with lower tax rates. They can transfer profits by either selling their output to a related party at a low price or by purchasing inputs from a related party at a high price[16]. Since our productivity measures are revenue based, firms engaging in transfer pricing can appear less productive than they actually are. It might be easier for foreign processing firms to transfer price since there are often no natural benchmarks for the goods exported and imported by processing exporters. We do not have information to compare prices of similar goods sold to related party and those sold to unaffiliated buyer to have direct evidence about transfer pricing, so we rely on indirect information. As mentioned before, the fact that low productivity for processing exporters is most prominent for FIE firms is plausibly consistent with the story that these firms are engaged in transfer pricing. Next we check if systematic relationship exists between profitability difference and degree of differentiation of goods among the different types of exporter. Transfer pricing should be more prominent in sectors that have more differentiated goods, and if processing exporters are engaged in transfer pricing, the difference in profits should be higher in the differentiated goods sectors. Table 13a compares productivity of non-exporters and the different types of exporters by import elasticity of the sectors. We use Broda and Weinstein (2006) import elasticity measures and divide goods into 3 types: those with high, medium and low elasticity; the latter being the most differentiated sector. Table 13a provides evidence consistent with transfer pricing by FIE firms. For FIE firms the

[16] Other ways of repatriating profits could be in the form of royalty payment or license fees that can keep profits low in the host country.

gap in profits between non-exporters and processing exporters is the biggest for low elasticity sector. No similar pattern can be found in non-FIE productivity difference between processing and non-exporters. In Table 13b we compare the price of exports for the three type of exporters and finds that the gap in prices between processing and non-processing exporters is biggest in the medium capital intensity sector for both FIE and non-FIE – an evidence at odds with the transfer pricing hypothesis – we would expect prices to be lower in the differentiated goods sector where opportunity of transfer pricing is the biggest. If we recall Table 12a column 4 we see that input per unit of sales are the lowest for processing trade firms. This is also at odds with the transfer pricing hypothesis, since firms engaged in repatriating profits abroad would want to push up the price of inputs and push down the price of the final goods, thus on average having higher inputs per unit of sales. It is possible that these firms are repatriating profits by using other methods that depress the profits (like royalty payment and license fees). Moreover, a look at Table 11, using Hsieh Klenow (2009) alternative productivity measure shows that processing exporters are less productive than non-exporters even when we consider physical productivity (TFPQ); a measure that knocks off price effect and adjusts for quality and variety difference[17]. Thus it is also possible that the processing trade firms are exporting lower quality goods – we discuss this hypothesis in more detail later in. Though we cannot rule out transfer pricing based on these evidence, it definitely does not look as the sole mechanism behind the results for FIEs. We must keep in mind that the FIE non-exporters are most likely practicing horizontal FDI, and are likely to be more productive than the typical non-exporter on the Helpman, Melitz, Yeaple (2004) type model. Viewed in this light, the fact that processing exporters are less productive than non-exporters particularly for foreign owned firms is not very surprising.

A profit extraction hypothesis is also consistent with why processing exporters may appear to be less productive than non-exporters. Processing trade firms receive contracts from foreign firms to produce output, and the foreign firm owns the patent

[17] This holds for both FIE and non-FIE firms (results not reported).

or blue print of the products hence can squeeze the processing/assembly unit's mark up and make them behave as price takers, which can lead to their low value added and revenue. We use levels of export, firm size, markup and industry market share as different proxies for market power. Following Keller and Yeaple (2009), markup is proxied by revenue over revenue less profits, and market size is proxied by share of firm's sale in total industry sales. Table 14a shows that processing exporters are smaller in terms of sales, markup and market size, so are likely to have less market power and would be easier to bargain with. Table 14b shows the productivity difference between processing traders and other types of firms exist even after controlling market power. Based on this evidence it appears that low productivity of processing/assembly firms are not driven by their low market power only.

Lastly, unobserved product heterogeneity can be another possible explanation for our results. Processing exporters may end up looking less productive if the products exported by them are different and fetch lower price. Table 15 shows processing exporters have lowest unit price among the three types of exporters – consistent with the idea that they sell low quality products.

In summary we can say that though different mechanisms can explain our result, the hypothesis that processing trade is a different activity (these are unskilled intensive jobs, yielding low profits, involve lower fixed costs and produces low quality products) compared to non-processing trade is the one that receives considerable support from the data.

5 Conclusion

Processing trade, in which parts are sourced globally and assembled at one place to be shipped to the final destination, explains bulk of the trade for the exporting powerhouse – China. This paper, merging Chinese firm level data with the customs data, provides new stylized facts about performance of processing exporters. We show that processing exporters are fundamentally different from non-processing firms. The firm level trade literature usually finds exporters to be exceptional performers. However, some recent papers on China document exporters to be less productive than

non-exporters, both among foreign affiliates and in labor intensive sectors. We show that these anomalies are driven by the existence of processing exporters who are the least productive among all types of firms. Removing processing exporters restores the traditional finding since ordinary exporters are more productive than non-exporters. Our results imply that it is essential to consider processing trade separately from ordinary exporting activity when analyzing exporter performance in countries that have large processing trade sectors.

We explain different mechanisms consistent with our result, and find the hypothesis that processing/assembly is a different activity compared to ordinary trade is the one that receives the most support from the data. Our data indicates that processing involves unskilled intensive jobs that yield low profits and produces low quality products. Moreover, since processing requires lower fixed costs (due to government policy), only the low productive firms select into this activity. Transfer pricing can also explain the unexceptional performance of foreign-owned processing trade firms – especially since the low productivity of these firms is very pronounced for FIE but not for non-FIE. The data provides mixed evidence about transfer pricing.

Our findings have important policy implications. First, the re-allocation predictions in the presence of processing exporters are just opposite to that in the Melitz (2003) model, in which a move towards exporting increases average productivity of the sector since exporters are more productive than non-exporters. A processing trade driven export surge, contrary to this belief, would reduce the average productivity since processing firms are the less productive ones. It thus becomes imperative to look into the costs and benefits of export processing. Exporting is often encouraged by countries on the ground that exporters are more productive and grow faster, so that they can act as an engine of growth. Given our findings, it also makes sense to evaluate learning from processing trade. This will have important policy implications for countries conducting processing trade or planning to do so. We plan to study this in the future.

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Table 1

Comparing merged and unmerged exporters in the firm level data

	Merged Exporters	Unmerged Exporters
Log Employment	5.37	5.27
	(1.13)	(1.17)
Log Sales	10.6	10.33
	(1.30)	(1.31)
Value Added per Worker	87.32	71.58
	(203.10)	(147.69)
TFP (Olley Pakes)	4.22	4.12
	(1.15)	(1.12)
N	52955	137357

Note: The above table reports mean of the variables with standard deviation in the parentheses for merged and non-merged exporters.

Table 2

Share of number of firms and export value by processing status (year average)

Firm type	Number of firms	Export value
Non-processing	0.41	0.18
Processing	0.20	0.27
Both	0.39	0.50

Table 3

Table 3a: Processing intensity distribution of exporters doing both processing and non-processing trade

	All Firms	FIE	Non-FIE
Mean	0.60	0.64	0.42
	(0.36)	(0.35)	(0.34)
10th Percentile	0.06	0.08	0.02
25th Percentile	0.25	0.33	0.09
50th Percentile	0.68	0.77	0.34
75th Percentile	0.96	0.97	0.73
90^{th} Percentile	0.99	0.99	0.99

Table 3b: Share of Processing Exports by ownership (2000-2005)

	FIE subsample	Non-FIE Subsample
Share of Processing Exports	0.85	0.28

Table 4

Productivity comparison by processing status

	Dependent variables		
	value added per worker	tfp (Olley-Pakes)	tfp (OLS)
non-processing	0.024*	0.186*	0.099*
	(0.009)	(0.009)	(0.008)
processing	-0.288*	-0.036†	-0.244*
	(0.019)	(0.017)	(0.017)
both	0.052*	0.240*	0.087*
	(0.012)	(0.011)	(0.011)
N	427847	446018	427898
R-squared	0.151	0.338	0.243

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters. All regressions include 4 digit industry, province and year fixed effects as additional control. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 5

Productivity of exporters by subsample

	TFP (Olley-Pakes)		TFP (OLS)	
	FIE	non-FIE	FIE	non-FIE
non-processing	0.090*	0.178*	0.027††	0.078*
	(0.014)	0.011)	(0.014)	(0.010)
processing	-0.085*	0.025	-0.258*	-0.153*
	(0.019)	(0.060)	(0.019)	(0.057)
	0.116*	0.355*	-0.011	0.169*
both	(0.014)	(0.023)	(0.014)	(0.022)
N	74763	371255	72648	355250
R-squared	0.331	0.343	0.205	0.259

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters, by subsamples based on ownership (FIE stands for Foreign Invested Enterprise). All regressions include 4 digit industry, province and year fixed effects as additional control. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 6

Productivity comparison by processing status and capital intensity of the sector

Table 6a

	Dependent variable is value added per worker		
	labor intensive	medium	capital intensive
non-processing	-0.104*	-0.035*	0.048†
	(0.013)	(0.014)	(0.023)
processing	-0.503*	-0.478*	-0.163†
	(0.026)	(0.030)	(0.076)
both	-0.187*	-0.064*	0.122*
	(0.017)	(0.020)	(0.040)
Observations	110,939	189,699	127,209
R-squared	0.141	0.134	0.155

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters, by capital intensity of the sector. All regressions include 4 digit industry, province and year fixed effects. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 6b

	Dependent variable is TFP (Olley Pakes)		
	labor intensive	medium	capital intensive
non-processing	0.10*	0.155*	0.241*
	(0.013)	(0.013)	(0.022)
processing	-0.206*	-0.099*	0.121††
	(0.023)	(0.026)	(0.066)
both	0.083*	0.197*	0.351*
	(0.016)	(0.018)	(0.035)
Observations	116,119	197,065	132,834
R-squared	0.256	0.372	0.294

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters, by capital intensity of the sector. All regressions include 4 digit industry, province and year fixed effects. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 7

Productivity comparison by processing status and sectoral capital intensity (FIE only)

Dependent variable is TFP (Olley-Pakes)

	labor intensive	medium	capital intensive
non-processing	0.062*	0.066*	0.192*
	(0.020)	(0.022)	(0.037)
processing	-0.139*	-0.076*	0.088
	(0.026)	(0.028)	(0.072)
both	0.059*	0.124*	0.270*
	(0.019)	(0.021)	(0.042)
Observations	26559	31305	16899
R-squared	0.293	0.359	0.297

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters, by capital intensity of the sector. Only foreign owned firms are included. All regressions include 4 digit industry, province and year fixed effects. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 8

Productivity of exporters depending on export intensity and processing status

	Dependant variable is TFP (Olley-Pakes)		
	All Firms	FIE	non-FIE
Reg Ex+Non-Processing	0.191*	0.080*	0.191*
	(0.009)	(0.015)	(0.012)
Reg Ex+Processing	0.054*	-0.015	0.078
	(0.021)	(0.023)	(0.068)
Reg Ex+Both	0.278*	0.142*	0.380*
	(0.012)	(0.015)	(0.025)
Pure Ex+ Non-processing	0.162*	0.096*	0.134*
	(0.020)	(0.030)	(0.027)
Pure Ex+Processing	-0.262*	-0.297*	-0.189
	(0.024)	(0.026)	(0.150)
Pure Ex+Both	0.020	-0.067*	0.161†
	(0.024)	(0.026)	(0.074)
N	441765	71592	370173
R-squared	0.338	0.333	0.343

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade for regular and pure exporters separately, omitted group are non-exporters. All regressions include 4 digit industry, province and year fixed effects. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 9

Productivity of exporters depending on export intensity, processing status and capital intensity of sector

Dependant variable is TFP (Olley-Pakes)

	labor intensive	medium	capital intensive
Reg Ex+ Non-Processing	0.098*	0.157*	0.256*
	(0.014)	(0.014)	(0.023)
Reg Ex+Processing	-0.157*	-0.016	0.245*
	(0.029)	(0.031)	(0.075)
Reg Ex+Both	0.109*	0.234*	0.395*
	(0.019)	(0.019)	(0.037)
Pure Ex+ Non-Processing	0.109*	0.155*	0.034
	(0.025)	(0.036)	(0.090)
Pure Ex+Processing	-0.357*	-0.351*	-0.287*
	(0.032)	(0.040)	(0.100)
Pure Ex+Both	-0.049††	-0.119*	-0.054
	(0.029)	(0.048)	(0.094)
N	113577	195762	132426
R-squared	0.255	0.372	0.295

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade for regular and pure exporters separately, omitted group are non-exporters. The regressions are run separately for different capital intensity levels of the sectors. All regressions include 4 digit industry, province and year fixed effects. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 10

Robustness Checks

	size and ownership	Indst-provi nce-year FE	year 2005	Weighted Regressions	Drop Outliers
non-processing	0.124*	0.125*	0.108*	0.075*	0.117*
	(0.009)	(0.009)	(0.012)	(0.028)	(0.008)
processing	-0.168*	-0.164*	-0.256*	-0.058	-0.175*
	(0.017)	(0.018)	(0.024)	(0.051)	(0.015)
both	0.124*	0.125*	0.103*	0.121*	0.116*
	(0.012)	(0.012)	(0.016)	(0.032)	(0.011)
state owned	-0.299*	-0.259*	-0.234*	-0.356*	-0.255*
	(0.010)	(0.010)	(0.019)	(0.030)	(0.009)
foreign owned	0.120*	0.115*	0.090*	0.228*	0.106*
	(0.006)	(0.006)	(0.008)	(0.020)	(0.006)
Observations	446018	446018	131118	426823	437098
R-squared	0.343	0.422	0.346	0.490	0.343

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters. All regressions include 4 digit industry, province, year fixed effects, size and ownership (soe and fie)) as additional controls. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 11

Productivity comparison using Hsieh Klenow (2008) productivity measures

	Revenue Productivity	Physical Productivity
non-processing	0.091*	0.186*
	(0.007)	(0.011)
processing	-0.134*	-0.195*
	(0.014)	(0.022)
both	0.025*	0.132*
	(0.010)	(0.015)
state owned	-0.322*	-0.384*
	(0.009)	(0.012)
foreign owned	-0.119*	0.011
	(0.005)	(0.008)
Observations	417539	417539
R-squared	0.297	0.226

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporters, processing trade exporters and exporters doing both types of trade, omitted group are non-exporters. All regressions include 4 digit industry, province, year fixed effects, size and ownership (soe and fie)) as additional controls. Robust standard errors in parentheses clustered at the firm level.* $p<0.01$, † $p<0.05$, ††$p<0.1$.

Table 12

Table 12a: Processing trade is a different activity

	Dependent variables				
	profit per worker	wage per worker	capital intensity	input over sales	r&d per worker
non-processing	0.025	0.094*	0.024†	0.010*	0.230*
	(0.018)	(0.005)	(0.012)	(0.002)	(0.046)
processing	-0.486*	-0.030*	0.023	-0.038*	-0.196
	(0.034)	(0.010)	(0.021)	(0.006)	(0.120)
both	0.086*	0.144*	0.221*	-0.007†	0.220*
	(0.024)	(0.007)	(0.015)	(0.003)	(0.068)
N	341204	427599	428189	447963	33933
R-squared	0.144	0.263	0.187	0.033	0.213

Note: The above table reports regressions of the dependent variable on non-processing, processing, and both dummies, omitted group is non-exporter. All regressions include industry, province and year fixed effects, size and ownership of firm (soe or fie) as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 12b: Average Age:

	Non Exporter	non-Processing	Processing	Both
Average Age	9.5	9.5	8.6	9.1

Table 13

Table 13a: Evidence of transfer pricing using profits per worker

	Dependant variable is profit per worker					
	high	med	low	high	med	low
		FIE			non-FIE	
non-processing	0.061	0.017	-0.077	0.065††	0.128*	0.012
	(0.044)	(0.046)	(0.054)	(0.036)	(0.036)	(0.043)
processing	-0.246*	-0.264*	-0.393*	-0.278	0.325	0.423
	(0.052)	(0.073)	(0.075)	(0.180)	(0.230)	(0.290)
	0.043	0.245*	0.082	0.293*	0.469*	0.284*
both	(0.040)	(0.048)	(0.052)	(0.070)	(0.083)	(0.092)
N	22481	19408	12365	109412	113104	63452
R-squared	0.239	0.139	0.257	0.145	0.111	0.130

Note: The above table reports regressions of the dependent variable on non-processing, processing, and both dummies, omitted group is non-exporter. All regressions include industry, province and year fixed effects, labor and ownership of firm (soe or fie) as additional control. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 13b: Evidence of transfer pricing using average price of exports

	Dependant variable is average price of exports					
	high	med	low	high	med	low
		FIE			non-FIE	
processing	-0.035	-0.316*	-0.111	-0.035	-0.674†	0.112
	(0.054)	(0.100)	(0.096)	(0.096)	(0.280)	(0.360)
	0.243*	0.413*	0.289*	0.342*	0.347*	0.300*
both	(0.042)	(0.070)	(0.067)	(0.052)	(0.100)	(0.110)
N	14783	10714	8565	8062	6731	4018
R-squared	0.289	0.394	0.400	0.443	0.502	0.440

Note: The above table reports regressions of the dependent variable on non-processing, processing, and both dummies, omitted group is non-exporter. All regressions include industry, province and year fixed effects, size and ownership of firm (soe or fie) as additional control. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 14

Table 14a: Market power comparison across different types of exporters

	Dependant variables			
	Employment	Sales	Markup	Market Size
non-processing	0.626*	0.184*	-0.001	0.184*
	(0.012)	(0.009)	(0.001)	(0.009)
processing	0.891*	-0.123*	-0.013*	-0.134*
	(0.021)	(0.018)	(0.002)	(0.018)
both	0.945*	0.221*	-0.004*	0.227*
	(0.015)	(0.012)	(0.001)	(0.013)
N	449117	449117	448048	448232
R-squared	0.244	0.497	0.037	0.714

Note: The above table reports regressions of the dependent variable on dummies of non-processing exporter, processing exporter, and exporter doing both, omitted group is non-exporter. All regressions include industry, province and year fixed effects, size (except column 1) and ownership of firm (soe and fie) as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 14b: Productivity comparison after controlling for market power

	Dependant variable is TFP (Olley Pakes)		
	Control for Export	Control for markup	Control for market size
non-processing	0.309*	0.127*	0.006
	(0.019)	(0.008)	(0.006)
processing		-0.144*	-0.080*
		(0.017)	(0.011)
both	0.185*	0.132*	-0.023*
	(0.017)	(0.011)	(0.008)
N	43511	445280	445463
R-squared	0.475	0.373	0.578

Note: The above table reports regressions of the dependent variable on non-processing exporter, processing exporter, and exporter doing both, omitted group is non-exporter (except first column where processing firm is the omitted group). All regressions include industry, province and year fixed effects, size and ownership of firm (soe and fie) as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Table 15

Comparing average unit price of exports

	Dependent variable
	Average Price
processing	-0.140*
	(0.041)
both	0.321*
	(0.028)
N	52883
R-squared	0.412

Note: The above table reports regressions of the dependent variable on processing exporter, and exporter doing both processing and non-processing trade, omitted group is non-processing exporter. All regressions include industry, province and year fixed effects, size and ownership of firm (soe or fie) as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

Figure 1

Share of processing exporters across capital intensity of the sectors

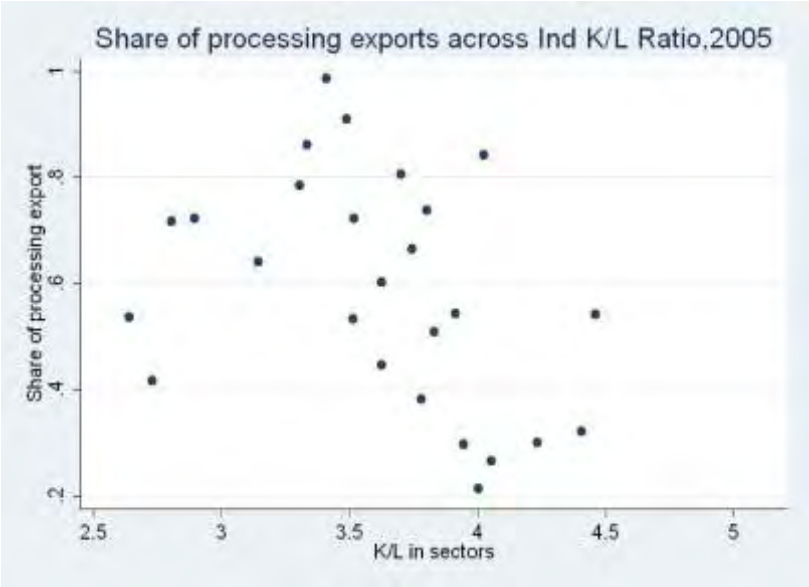
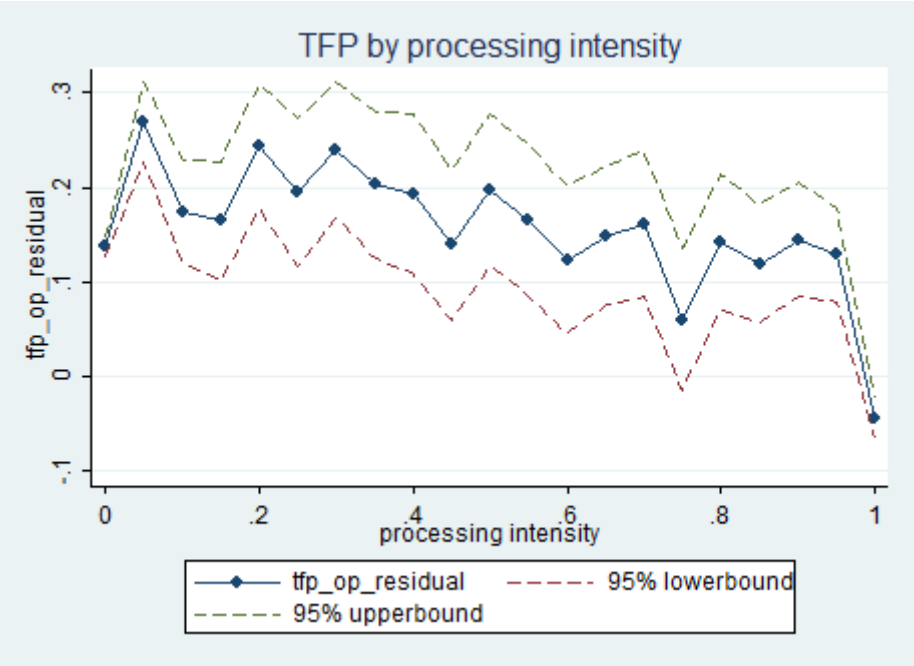


Figure 2

TFP vs. Processing Intensity



Appendix A:

A.1 Merging Firm Level Data with the Transactions Level Customs Data

We use phone number and zip code to merge the two datasets, following Yu (2011). The phone numbers in the product-level trade data include area phone codes and a hyphen, whereas those in the firm-level production data do not. Therefore, we use the last seven digits of the phone number to serve a proxy for firm identification.

A.2 Construction of TFP (Olley-Pakes)

Here we describe in details the Olley-Pakes approach to estimating firm's TFP with some extensions. First, we adopt different price deflators for inputs and outputs. Data on input deflators and output deflators are from Brandt et al. (2011) in which the output deflators are constructed using "reference price" information from China's Statistical Yearbooks whereas input deflators are constructed based on output deflators and China's national input-output table (2002).

Next, we construct the real investment variable using the perpetual inventory method. Rather than assigning an arbitrary number for the depreciation ratio, we use the firm's real depreciation rate provided by the Chinese firm-level dataset.

We work with the standard Cobb-Douglas production function：

$$Y_{it}=\pi_{it}M_{it}^{\beta_m}K_{it}^{\beta_k}L_{it}^{\beta_l} \qquad \text{(A.1)}$$

Where Y_{it} is the output of firm i in year t, K_{it}, L_{it} and M_{it} denotes labor, capital, and intermediate inputs, respectively. By assuming that the expectation of future realization of the unobserved productivity shock, v_{it}, relies on its contemporaneous value, the firm i's investment is modeled as an increasing function of both unobserved productivity and log capital, $k_{it} = \log(K_{it})$. Following previous works, such as van Biesebroeck (2005) and Amiti and Konings (2007), we add the firm's export decision as an extra argument of the investment function since most firms' export decisions are determined in the previous period (Tybout, 2003):

$$I_{it} = \tilde{I}(k_{it}, v_{it}, X_{it}) \qquad \text{(A.2)}$$

where X_{it} is a dummy to measure whether firm *i* exports in year *t*. Therefore, the inverse function of I_{it} is

$$\mathrm{v_{it}} = \tilde{\mathrm{I}}^{-1}(\mathrm{k_{it}}, \mathrm{I_{it}}, \mathrm{X_{it}}) \quad \text{(A.3)}$$

The unobserved productivity also depends on log capital and the firm's export decisions. Accordingly, the estimation specification can now be written as:

$$y_{it} = \beta_0 + \beta_m m_t + \beta_l l_{it} + g(k_{it}, I_{it}, X_{it}) + \epsilon_{it} \quad \text{(A.4)}$$

where $g(k_{it}, I_{it}, X_{it})$ is defined as $\beta_k k_{it} + \tilde{\mathrm{I}}^{-1}(\mathrm{k_{it}}, \mathrm{I_{it}}, \mathrm{X_{it}})$. Following Olley and Pakes (1996) and Amiti and Konings (2007), fourth-order polynomials are used in log-capital, log-investment and firm's export dummy to approximate g(.). In addition, we also include a WTO dummy (*i.e.*, one for a year after 2001 and zero for before) to characterize the function g(.) as follows:

$$g(k_{it}, I_{it}, X_{it}, WTO_t) = (1 + WTO_t + X_{it}) \sum_{r=0}^{4} \sum_{s=0}^{4} \delta_{rs} k_{rs}^{r} I_{rs}^{s} \quad \text{(A.5)}$$

After finding the estimated coefficients $\hat{\beta}_m$ and $\hat{\beta}_l$, we calculate the residual R_{it} which is defined as:

$$R_{it} \equiv \ln Y_{it} - \hat{\beta}_{\mathrm{m}} \ln M_{it} - \hat{\beta}_{\mathrm{l}} \ln L_{it}$$

The next step is to obtain an unbiased estimated coefficient of $\hat{\beta}_k$. We assume firm's productivity follows a exogenous Markov process, $v_{it} = h(v_{it} - 1) + \eta_{it}$. To correct the selection bias due to firm exit, Amiti and Konings (2007) suggested estimating the probability of a survival indicator on a high-order polynomial in log-capital and log-investment. One can then accurately estimate the following specification:

$$R_{it} = \beta_k \ln K_{it} + h\ \hat{g}_{it-1} - \beta_k \quad K_{i,t-1}\ \hat{p}r_{i,t-1}) + \varepsilon^{*}_{it} \quad \text{(A.6)}$$

where $\hat{p}r_{i,t-1}$ denotes the fitted value for the probability of the firm 's exit in the next year., and $\varepsilon^{*}_{it} = \varepsilon_{it} + \eta_{it}$ denotes the composite error. Since the specific "true" functional form of the inverse function h is unknown, it is appropriate to use fourth-order polynomials in g_{it-1} and $k_{i,t-1}$ to approximate that. In addition, (A.6) also requires the estimated coefficients of the log-capital in the first and second term to be identical. Therefore, non-linear least squares is used (Pavcnik, 2002; Arnold, 2005).

Finally, the Olley--Pakes type of TFP for each firm *i* in industry *j* is obtained once the estimated coefficient $\hat{\beta}_k$ is obtained:

$$TFP_{ijt}^{OP} = \ln Y_{it} - \hat{\beta}_m \ln M_{it} - \hat{\beta}_k \ln K_{it} - \hat{\beta}_l \ln Lit \quad (A.7)$$

Appendix B

B.1 Replicating counter-Melitz finding in the merged data

B.Table 1:

Exporters Productivity vs. Ownership

	tfp (Olley Pakes)			tfp(ols)		
	All Firms	FIE	non-FIE	All Firms	FIE	non-FIE
exporters	0.146*	-0.003	0.201*	0.103*	-0.066*	0.191*
	(0.007)	(0.011)	(0.010)	(0.007)	(0.011)	(0.010)
N	446020	74764	371256	427900	72649	355251
R-squared	0.338	0.338	0.343	0.246	0.202	0.267

Note: The above table reports regressions of the dependent variable on exporter dummy, omitted group is non-exporter. All regressions include industry, province and year fixed effects as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

B.Table 2:

Exporter Productivity vs. Capital intensity

Dependent variable is value added per worker

	labor intensive	medium	capital intensive
exporter	-0.189*	-0.118*	0.049†
	(0.012)	(0.012)	(0.022)
Observations	110,940	189,700	127,209
R-squared	0.137	0.132	0.155

B.Table 3:

Dependent variable is TFP (Olley Pakes)

	labor intensive	medium	capital intensive
exporter	0.0511*	0.126*	0.261*
	(0.011)	(0.011)	(0.02)
Observations	116,120	197,066	132,834
R-squared	0.254	0.371	0.294

Note: The above two tables report regressions of the dependent variable on exporter dummy, omitted group is non-exporter. All regressions include industry, province and year fixed effects as additional controls. Regressions are run by capital intensity of the

sectors. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

B.2 Productivity vs. Processing Intensity

B.Table 4

Dependent variables

	tfp(Olley Pakes)	tfp(OLS)
processing share	-0.095*	-0.125*
	(0.026)	(0.027)
N	18022	17865
R-Squared	0.405	0.220

The above table reports regressions only for firms doing both processing and non-processing trade. All regressions include 4 digit industry, province, year fixed effects, size and ownership as additional controls. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.

B.3 Productivity across Sectoral Capital Intensity and Controlling for Size

B.Table 5:

Dependent variable is value added per worker for all firms

	labor intensive	medium	capital intensive	labor intensive	medium	capital intensive
exporter	0.015	0.088*	0.180*			
	(0.012)	(0.013)	(0.022)			
non-processing				0.054*	0.129*	0.163*
				(0.013)	(0.015)	(0.024)
processing				-0.262*	-0.239*	-0.041
				(0.025)	(0.030)	(0.076)
both				0.064*	0.191*	0.289*
				(0.018)	(0.021)	(0.041)
Observations	110,940	189,700	127,209	110,939	189,699	127,209
R-squared	0.204	0.182	0.181	0.206	0.184	0.181

All regressions include 4 digit industry, province and year fixed effects and labor as additional constraint. Robust standard errors in parentheses clustered at the firm level.* p<0.01, † p<0.05, ††p<0.1.