How You Export Matters: Export Mode, Learning and Productivity in China [1]
(Job Market Paper)

Xue Bai
The Pennsylvania State University

Kala Krishna
The Pennsylvania State University, NYU and NBER

Hong Ma
Tsinghua University

December 11, 2013

[1]We are grateful to Jiandong Ju for facilitating the collaboration with Ma. Krishna is grateful to the Cowles Foundation at Yale and to the Economics Department at NYU for support as a visitor, and to the World Bank for research support. The authors are grateful to the National Natural Science Foundation of China (NSFC) for support under Grant No. 71203114. We are extremely grateful to Mark Roberts for his intellectual generosity and for sharing his codes with us. We also thank Andrew Bernard, Paula Bustos, Russell Cooper, Paul Grieco, Wolfgang Keller, Jicheng Liu, Nina Pavcnik, Joel Rodrigue, Neil Wallace, Shang Jin Wei, Adrian Wood, Stephen Yeaple, and Jing Zhang for extremely useful comments on an earlier draft. We would like to thank participants at the Penn State-Tsinghua Conference on the Chinese Economy, 2012, the CES-IFO Area Conference on the Global Economy, 2012, the Midwest International Trade Meetings, 2012, the Tsinghua-Columbia Conference in International Economics, 2012, the Yokohama Conference, 2012, the NBER ITI spring meetings, 2013, the Penn State JMP conference, 2013, the Cornell PSU Macro Conference, 2013, ERWIT, 2013, InsTED, 2013, Princeton Summer Workshop, 2013 and the Yale International Trade workshop 2013 for comments.

Abstract

Firms can choose how they export: directly or through intermediaries. What are the costs and benefits of such choices? Firms may choose to trade directly, even if this is more costly in the short run, if doing so results in better future outcomes. A policy pursued by China gives us a unique chance to look at such trade-offs in the real world. Before China's accession to the WTO, a large share of domestic Chinese firms were not allowed to export directly, only through intermediaries. These restrictions on direct trading may have been a double-edged sword: while firms may have been spared the costs of direct exporting, they may also have been barred from obtaining any benefits of doing so. We use frontier techniques to estimate a structural dynamic model and use it to evaluate the consequences of removing restrictions on direct trading, a major policy reform in China.

We develop and estimate a dynamic discrete choice model where firms choose their export mode. We recover not only the sunk and fixed costs of exporting according to mode, but also the evolution of productivity and demand under different export modes. We find that the evolution of both demand and productivity is more favorable under direct exporting. However, on average, starting direct exporting requires significantly higher start-up costs than starting indirect exporting. It is also more costly to remain a direct exporter than to remain an indirect one. Moreover, climbing the export ladder by starting off as an indirect exporter and then transitioning into direct exporting is cheaper than exporting directly to begin with.

Our counterfactual experiment suggests that these restrictions on direct trading reduced Chinese export growth considerably. Exports would have been 30 percent less and the export participation rate would have been 37 percent lower had there been no liberalization of trading rights.

In addition, we compare the effects of different trade policies, namely export subsidies and subsidies on export costs. For export subsidies, it is better to target direct exporters over indirect ones, both for increasing the number of exporters and in terms of exports per dollar expended. However for cost subsidies, the opposite is true.

1 Introduction

Governments have long had a tendency to intervene in markets, often with what they see as the best of reasons. However, such interventions can have unanticipated, and often, detrimental effects.[1] By using frontier techniques to estimate a structural dynamic model that incorporates both learning-by-exporting and intermediation in international trade, we look at the effects of the restrictions on exporting that were in force in China before its accession to the WTO in 2001. These restrictions prevented domestically owned firms, both private and state-owned, from exporting directly. They had to export only through intermediaries unless their registered capital was quite large. These restrictions were part and parcel of China's being a planned economy.[2] In the early years, certain state-owned intermediaries were designated to conduct foreign trade. Later on, direct trading rights were restricted so that smaller domestic firms could not export directly. The ability to export via those with direct trading rights, both intermediaries and eligible domestic producers, provided small firms with the opportunity to engage in foreign trade without incurring the many costs associated with entering foreign markets directly. Had these intermediating firms been efficient and competitive, forcing smaller domestic firms to use them might not have been particularly damaging. However, had there been other losses created by limiting the firms' options in this manner, the regulations could have been quite costly. With learning-by-exporting, for example, the extent and process of learning may differ across modes of exporting. Since firms who export through intermediaries usually do not engage in direct contact with their foreign buyers and they do not maintain employees in foreign markets, the pass-through of knowledge may be less effective than that of directly exporting. Such a policy could have created large costs if there was more learning through direct exporting.

In this paper we estimate a dynamic discrete choice model where firms choose their export mode: export directly or via an intermediary. We recover not only the sunk and fixed costs of exporting according to mode, but also the evolution of productivity and demand under different export modes. We find that the evolution of both demand and productivity is more favorable under direct exporting. We also find that on average starting direct exporting

[1] For example, the Multi Fibre Agreement which set bilateral and product-specific quotas on textile, yarn and apparel exported by the majority of less developed countries in most of the last sixty years left the implementation of these quotas up to the developing country exporter. However, many of these countries implemented the quotas in ways that created further distortions instead of just having tradable quota licenses. See Krishna and Tan (1998) for more on this.

[2] Part of the concern was that unrestricted exporting would result in unrestricted importing as exports earn foreign exchange. In planned economies, access to foreign exchange is usually restricted as the exchange rate is not market driven. A statement made by Mr. Long Yongtu (head of the Chinese delegation at the third working party meeting on China's accession to the WTO on March 6, 1997) described the removal of such restrictions as "revolutionary".

requires significantly higher start-up costs than starting indirect exporting. It is also more costly to remain a direct exporter than an indirect one. Moreover, climbing the export ladder by starting off as an indirect exporter and then moving into direct exporting is cheaper than exporting directly to begin with. Our focus is not on modeling the intermediation process. We treat it as just one technology of exporting with associated costs and model it in the simplest way. We examine the static and dynamic trade-offs involved and evaluate the cost of restrictions on direct trading. The policy was a double-edged sword: while firms were prevented from incurring the costs of direct exporting, they did not garnish the rewards of better future outcomes on the demand and cost side.

Our counterfactuals suggest that this policy reduced Chinese export growth considerably. Exports would have been 30 percent lower and the export participation rate would have been 37 percent lower had there been no liberalization of trading rights. Thus, the restrictions on direct exporting seem to have been important and their elimination may be an essential factor in explaining the amazing growth of Chinese exports after it joined the WTO in 2001.

We also conduct a number of other policy experiments. Our results suggest that export subsidies can generate more export revenues than they cost especially if targeted to direct exporters. Fixed or sunk cost subsidies can also generate more export revenues than they cost, though here it is more advantageous to target indirect exporters.

1.1 Related Work

Our work is most closely related to the literature on firm export decisions and learning by exporting. The work of Dixit (1989a,b) and Baldwin and Krugman (1989), among others, drew attention to the hysteresis created by the sunk costs of entering the export market. Using the same dynamic framework, Bernard and Jensen (2004) examine the factors that increase the possibility of U.S. manufacturing plants exporting, but find no effect of spillovers from the export activity of other plants, possibly due to significant entry costs. Das et al. (2007) develop a dynamic structural model of export decisions, which embodies uncertainty, firm heterogeneity in export profits, and sunk entry costs. They quantify the sunk entry costs and obtain estimated sunk costs in Colombian industries that are large.

Most studies find little or no evidence of improved productivity as a result of beginning to export. Clerides et al. (1998) studied export participation and the effect of exporting on learning, and find no evidence of learning-by-exporting using Colombian data. Bernard and Jensen (1999) find evidence among U.S. firms that the more productive firms select into exporting rather than exporting raising productivity.

However, recent research finds some evidence of productivity improvement after entry.

Van Biesebroeck (2005) and De Loecker (2007) find evidence that exporting firms have an advantage in productivity growth after entry into the export market among Saharan African and Slovenian firms. Aw et al. (2011) estimate a dynamic structural model of producers' decision rules for R&D investment and exporting, allowing for an endogenous productivity evolution path. They quantify the linkages between the export decision, R&D investment and endogenous productivity growth. They find that firms that select into exporting and/or R&D investments tend to already be more productive than their domestic counterparts, and the decisions to export and/or to invest in R&D raise exporters' productivity levels further in turn. This paper builds on their work.

We also build on recent work on intermediation which has become a topic of growing interest. There is substantial evidence suggesting that intermediaries facilitate international trade. About 80 percent of Japanese exports and imports in the early 1980s were handled by 300 trade intermediaries (Rossman, 1984). In 2005, roughly half of exporting firms in Sweden were wholesalers (Akerman, 2010). U.S. wholesalers and retailers account for approximately 11 and 24 percent of exports and imports, respectively (Bernard et al., 2007). In China, at least 35 percent of exports in 2000 and 22 percent in 2005 went through intermediaries (Ahn et al., 2011). In some countries, like Columbia, there are few intermediaries or middlemen, and concern has been expressed that this has discouraged potential exporters and suppressed exports (Roberts and Tybout, 1997).

The literature on intermediaries has focused on their role in facilitating trade as they help match firms with potential trade partners and reduce information asymmetries (Rubinstein and Wolinsky, 1987; Biglaiser, 1993). Feenstra and Hanson (2004) find evidence of intermediaries' role in quality control in the context of China's re-exports through Hong Kong between 1988 and 1993. More recent work has either focused on the network and matching process between buyers and sellers (Antràs and Costinot, 2011; Blum et al., 2009), or has extended the model of Melitz (2003) and modeled intermediation as involving lower fixed costs than exporting directly, but lower variable profits as the intermediary takes his cut (Ahn et al., 2011; Akerman, 2010). An insight that emerges is sorting in the cross-sectional distribution of firms across the modes of exporting: the most productive firms choose to export directly, less productive firms export through intermediaries, and the least productive firms sell only to the domestic market.

We build on Ahn et al. (2011) who use a standard static heterogeneous firm setting with costs of exporting that vary by mode. They show that for China, firms sort into export modes based on productivity; that exports by intermediaries are more expensive; and that countries that are harder to access (higher trade costs or smaller market sizes) have relatively

more intermediated trade.[3] We extend their model to be dynamic, incorporate additional heterogeneity on the demand and cost side, and allow for learning by exporting that can vary by export mode.

It is worth noting that much of this work looks for correlations between variables as predicted by theory, i.e., does reduced form analysis rather than structural estimation. In contrast, we estimate a dynamic discrete choice model of firms choosing export modes. This allows us to estimate the structural parameters of interest (like fixed and sunk costs of different modes of exporting and the process of productivity and demand shock evolution) rather than just verify that the patterns in the data are consistent with their existence. It also allows us to do counterfactual exercises.

A tangential but related literature in trade looks at the effects of policy reform. One strand looks at the effect on productivity of greater access to intermediate inputs as well as lower export tariffs. It is well understood that China already had de-facto MFN treatment for its exports to most countries by the time it joined the WTO. Joining the WTO just made it more certain. For example, China obtained MFN status in 1980 from the US and never lost it after that. Even adverse events like Tiananmen square and the Rare Earths controversy did not result in MFN status being revoked, though it may well have come close. Losing MFN status could have been significant as the alternative tariff could have been much higher. Handley and Limão (2013) make the point that "*in 2000 for example, the average U.S. MFN tariff was 4% but if China had lost its MFN status it would have faced an average tariff of 35% with about one fifth of product tariff lines going up to at least 50%.*" They show that, consistent with this idea, products where the difference in the alternative tariff and the MFN tariff was high also tended to grow the most after China joined the WTO. Using data on Chinese exports by industry at the HS 6 level, along with a model that captures how such uncertainty might operate to reduce the willingness to invest by firms, they argue that 22-30% of the growth in exports after China joined the WTO could be due to this one feature. Pierce and Schott (2012) use US Census data to show that the plants in industries where trade policy uncertainty declined more, had greater employment losses, especially of low skilled workers, as these plants substituted towards human and physical capital. They also show using firm level US trade data that products with higher gaps in the alternative and MFN tariffs exhibit larger increases in import value from China relative to all other U.S.

[3]In contrast, Akerman (2010) models wholesalers as having economies of scope as they can spread the fixed cost of exporting over more than one good. In order to cover their fixed cost, wholesalers charge a markup over the manufacturer's price resulting in higher prices and lower sales abroad than direct exporters. The economies of scope in fixed costs and the markup over domestic price cause productivity sorting among producers as regards export mode. Using Swedish cross-sectional data, he finds evidence to support the main prediction of his model that wholesalers export less per firm within a product category than do producers.

trading partners. Their firm level evidence confirms the chilling effect of uncertainty.

China did drop its import tariffs quite significantly as part of joining the WTO and this may have also had positive consequences. Access to a greater variety of intermediate inputs could affect productivity as in Ethier (1979, 1982), where greater variety reduces unit costs of production. Recent work suggests that a reduction in tariffs on intermediate goods can raise domestic productivity and expand product scope and exports by allowing firms access to high quality inputs essential for exporting. See Goldberg et al. (2010) who show that this seems to be the case for India, and Amiti and Konings (2007) for similar results for Indonesia. The latter also show that a fall in tariffs on final goods raises productivity but by half as much. Kasahara and Lapham (2013) use a dynamic structural model to argue that taxing imports destroys exports because policies that inhibit the import of foreign intermediate inputs also have a large adverse effect on the export of final goods. Kasahara and Rodrigue (2008) estimate a dynamic model that incorporates the choice of using imported intermediates using plant-level Chilean manufacturing panel data and show that plant productivity improves by doing so. Zhang (2013), using Colombian plant-level data, performs a similar exercise and further decomposes the gains from importing into a static effect and a dynamic effect with the latter predominating. We contribute to this literature on the factors behind China's growth of exports by looking at a less well-understood, but important reform on which there is, to our knowledge, no formal work: namely the removal of restrictions on direct trading.

The rest of the paper is organized as follows. In the following section we describe the data and the background of the restrictions of direct trading. In Section 3 we explain how we incorporate intermediation as a technology of exporting. We also lay out the basis for firms' dynamic decisions over modes of exporting and provide intuition about the trade-offs between the two export modes. Section 4 describes the estimation method. Section 5 summarizes the parameter estimates and discusses the marginal returns to different modes of exports and the hidden costs of being constrained from direct trading. We conduct counterfactual exercises to examine the costs and benefits of the trading right liberalization and different trade policies in Section 6. We conclude in the last section.

2 Data and Background

This analysis utilizes two Chinese data sets. The first consists of firm-level data from the Annual Surveys of Industrial Production from 1998 through 2007 conducted by the Chinese government's National Bureau of Statistics. This survey includes all State-Owned Enterprises (henceforth SOEs) and non-SOEs with sales over 5 million Chinese Yuan (about $600,000$ US dollars). The data contains information on the firms' industry of production,

ownership type, age, employment, capital stocks, and revenues, as well as export values. The second data set is the Chinese Customs transaction-level data. It has been collected and made available by the Chinese Customs Office. We observe the universe of transactions by Chinese firms that participated in international trade over the 2000-2006 period. This data set includes basic firm information, the value of each transaction (in US dollars) by product and trade partner for 243 destination/origin countries and $7,526$ different products in the 8-digit Harmonized System.[4] We match the two data sets and use the matched data set in this paper.[5] We infer firms' exporting modes as follows. Firms from the Annual Survey are tagged as exporters if they report positive exports, and as direct exporters if they are also observed in the customs data set.[6] The fact that we observe the universe of transactions through Chinese customs allows us to tag the remaining exporting firms (those which are not observed in the customs data set) as indirect exporters. Firms that report exports larger than their exports in the customs data are exporting both directly and indirectly and are tagged as direct exporters in this paper. Firms that do not sell domestically are removed from the data. Only one percent never sell at home while another eight percent sometimes sell at home. We would like to emphasize that our classification of firms according to export mode is not based on a survey question as this question is rarely asked; export mode is inferred. We perform a number of checks to convince the reader and ourselves that we are not mis-classifying firms. For example, a concern might be that our definition is labeling unmatched firms as indirect exporters.[7] These results are provided in the Appendix. We also perform a number of robustness checks to reassure ourselves about our results in Section 5.

In recent work, Bernard et al. (2010, 2012) argue that carry-along trade is important in the data. This refers to firms who export for other firms, thereby acting as intermediaries. In this paper we do not distinguish between such firms and those that export only their own

[4]To check the consistency of the two data sets, we add up all reported exports in the 2004 Census data on manufacturing firms and compared it to the total exports in the customs data. The former is roughly 85 percent of the latter. Note that the former is at the factory gate and so does not include VAT or local transportation costs. The latter is at FOB prices.

[5]Details of this matching are given in Table A.2 and Table A.3 in the Appendix. We matched the data on the basis of firm name, region code, address, legal person, and so on. It is worth noting that about 15.3 percent of exports are unmatched among producing exporters. For example, in 2004, intermediary firms accounted for 25.6 percent of the universe of the export values and matched producers (producing exporters) accounted for 62.9 percent. Among the unmatched and unsurveyed firms' share, small manufacturing firms (with sales below 5 million Chinese Yuan) account for only 2 percent of exports, which leaves 9.5 percent accounted for by unmatched surveyed producers. See Brandt et al. (2012).

[6]According to the survey documentation, export value includes direct exports, indirect exports, and all kinds of processing and assembling exports.

[7]Here we show that indirect exporters who never exported directly (who are at the greatest risk of being unmatched direct exporters) look more like non-exporters than direct exporters.

products. We also drop pure producer intermediaries, those who show up in the customs data but do not report exporting in the survey data. Another issue that we are careful to deal with is that processing and/or assembly trade are very different from other types of trade. The value added in processing trade tends to be lower and the kinds of contracts are very different: in fact, for certain types of processing trade, the buyer pays for the intermediate inputs and the processor performs certain operations on the buyer's inputs. This could make the sunk cost and learning opportunities very different for processing trade. They account for about half of China's exports and we exclude these firms from our main sample. We experiment with including them in our analysis as a separate mode of exporting in the Appendix.

2.1 Were Restrictions on Direct Trading Binding?

One factor we make sure not to ignore is that direct trading was not an option for some firms before China's accession to WTO. These restrictions were eliminated over the period 2000-2004, at different rates for different regions, industries and types of firms, as part of the accession agreement for joining the WTO. The details of the rules governing the ability to trade directly in the period 1999-2004 are laid out in Table A.1 in the Appendix. 56.1 percent of the firms in the sample were not eligible for direct trading rights in 2000. This number dropped to 45.5 percent the next year, 6.2 percent in 2003, and all firms became eligible in 2004.

To study the choice of export modes (direct versus indirect) we distinguish between firms that were eligible to trade directly and the ones that were not eligible. We assume that firms are fully informed about policy changes now and in the future and incorporate this into their calculations. We restrict their export option sets when they are ineligible to account for the policy. Consequently, indirect exporting will be less attractive to a constrained non-exporter than to an unconstrained one since the former does not have the option of becoming a direct exporter in the future.

Before we examine the effects of the liberalization, it is worth ensuring that the restrictions were binding to begin with. We divide firms into three groups: domestic firms who were not eligible to trade directly in 1999, that were eligible to trade directly in 1999, and foreign invested enterprises (FIEs) who were not subject to such controls. We compare the evolution of the share of direct and indirect exporters in these three groups from 2000-2006. Table 1 shows that FIEs and domestic firms that were eligible for direct trading in 1999 had little change in their participation in indirect and direct exporting over this period. The share of direct exporters among the unconstrained domestic firms increased slightly from

14.6 percent to 18 percent. However, for the group of firms that were constrained in 1999, this share increased much more dramatically over the liberalization period. This is consistent with the constraint being binding.

We also focus on the constrained group and examine what happens to the direct exporting participation when the firm becomes eligible. Figure 1 shows how the direct exporting participation rate varies when the firm becomes unrestricted which occurs at T. The solid line depicts this for all firms on average. The dashed lines depict it for firms that became eligible in each year. Note that the line for the year 2000 literally jumps up upon eligibility.[8] The lines for 2001 and 2002 show a marked increase upon eligibility and in subsequent years, consistent with it taking time to start exporting directly. This increase is less pronounced in 2003, and almost non-existent in 2004. This makes sense as the restrictions were imposed on smaller and smaller firms in later years. Such firms would likely choose not to export directly anyway. This evidence also suggests that the restrictions were binding, and more so in early years.

2.2 Summary Statistics

This section provides some information on the sample we use as well as documents patterns in the data that drive our modeling choices. We focus on one industry [9]: Manufacture of Rubber and Plastic Products (2-digit ISIC Rev3 25).[10] We abstract from modeling firms' entry and exit decisions since the main focus of our study is firms' choice of export modes. Table 2 provides a summary of firms' export statuses and the modes of export over the sample years. On average, 81.2 percent of the firms were non-exporters, 8.4 percent were indirect exporters and 10.4 percent of them were direct exporters. This is in line with the export participation rates found in other data sets. The numbers are in line with what one would expect from such a large country. The share of non-exporting firms has dropped from 83.1 percent to 79.7 percent over the sample years. The percentage of firms that exported indirectly has decreased from 9.3 percent to 7.9 percent, and that of direct exporters has

[8] This makes sense as there were no reforms in 2000, so that the firms that became eligible chose to do so by raising their registered capital. These firms are likely to have been desperate to export directly.

[9] We have also estimated the evolution of productivity for a number of other industries with similar results. These results are given in Table 6 below.

[10] We choose this industry for two reasons. First, it was not subject to other restrictions on trading (like being restricted to state trading or designated trading only) before the accession to the WTO. Second, this industry has a fairly low R&D rate (on average 7.1 percent of the firms have positive R&D expenditure). The latter is important as our model does not incorporate R&D decisions. If R&D was important, and high R&D firms tended to export directly, our estimate on the evolution of productivity and demand shocks of direct exporters could be biased upwards. We have also done robustness checks by allowing R&D activities to affect productivity evolution, using a shorter panel that has R&D information. The results are in line with the patterns we find in our baseline estimation and are presented in the last section of the Appendix.

increased from 7.6 percent to 12.4 percent. Ahn et al. (2011) document a similar trend in all industries using customs data and show that the share of indirect exports in total Chinese exports decreased from 35 percent to 22 percent from 2000 to 2005, while the total value of Chinese exports tripled during that period.

Table 3 summarizes and compares firm size, measured in employment, capital stock, domestic sales and export sales among different types of exporters. The average indirect exporter is more than twice as large (in terms of employment) as the average non-exporter, while the average direct exporting firm is more than three times as large. This relationship also holds true for capital stocks, home sales and export sales, if not more so. Among exporting firms, the export sales of the average direct exporter are approximately twice that of an average indirect exporter. These facts provide some preliminary evidence of sorting of firms regarding their export modes. Large firms tend to export indirectly and even larger firms tend to choose to export directly. This makes sense as firms need to be large and/or productive enough to cover the sunk costs and fixed costs of direct exporting. While on average, firms that export directly are larger than those that export indirectly, which are larger than those that don't export, a strict hierarchy is not present in the data. The correlation between capital stock and export value is 0.674, and that of domestic sales and exports is 0.595. The latter implies that success in the domestic market does not necessarily translate into success in the foreign market. This suggests that there is multi-dimensional heterogeneity: productivity *and* some other persistent firm-level differences are needed to explain the data. We call this factor foreign demand shocks and they represent differences in product-specific appeal across destinations of all kinds. We see from Table 3 that the distributions of firm sizes and firm sales are highly skewed with a right tail for exporting firms (as the mean is significantly more than the median), and even more so among firms that export indirectly. In order to explain the existence of many small exporters, we assume that fixed and sunk costs are randomly drawn in each period.[11] Arkolakis (2010) chooses to account for small firms by allowing fixed/sunk costs to depend on the size of the market the firm chooses to reach.

2.3 Empirical Transition Patterns

In this section, we describe the dynamic patterns of exporting behavior in the sample. Since these patterns are what lie behind the estimated parameters, it is a good idea to look at these before estimating the model. Table 4 reports the average transition of export status

[11] These random costs of exporting are meant to capture situations such as a relative moving to country X which makes it cheaper to export there.

and export modes over the sample period among all eligible firms.[12] The patterns reported here highlight the importance of distinguishing between indirect and direct exporters in studying their cost structures. Column 1 shows the export status of a firm in year $t-1$, and columns 2–4 show the three possible statuses in year t. The first row of the table shows the transition rate from not exporting last period to not exporting, exporting indirectly, and exporting directly this period. On average, 96.1 percent of the firms that did not export last period remain non-exporters in this period. 3.0 percent of non-exporting firms transition into indirect exporting, while only 0.9 percent of them move into direct exporting. The high persistence of staying non exporting suggests the existence of significant sunk export costs that prevent firms from starting to export. The fact that more non-exporting firms start exporting indirectly than directly would suggest that starting to export directly requires a higher sunk entry cost that less productive firms may not wish to cover.

The second row shows the transition rates of indirect exporters. On average, 23.1 percent of the firms that exported indirectly last period stopped exporting this period, 65.5 percent of them remained indirect exporters, and 11.5 percent of them transited into exporting directly. The high entry into and exit from indirect exporting suggest that the sunk cost of entry may not be as quite high as those of direct exporting. The much higher rate of starting direct exporting as indirect exporters is consistent with firms self-selecting into different export modes based on their productivity levels. It is also possible that intermediaries help small firms learn about foreign markets, reducing the cost of market research, promoting matching with potential buyers, and facilitating their entry into foreign markets directly in later years at lower costs.

The last row shows quite different transition rates for firms that exported directly in the previous period. On average, 92.0 percent of these firms remain direct exporters in current period, 5.8 percent of them transit into indirect exporting, and only 2.2 percent of them exit the foreign market. Among exporting firms, the average exit rate of indirect exporters is ten times higher than that of direct exporters. The very different entry and exit rates of the two export modes reflect very different cost structures for these two modes. The high turnover of indirect exporting and the high persistence in direct exporting can also come from different long-run payoffs generated by different learning-by-exporting effects. High sunk costs of entry and learning-by-exporting provide a big incentive for exporting firms to stay in the export markets even if they are making short-run losses. Productivity differences between indirect and direct exporters can also explain the difference in exit rates into non-exporting of indirect exporters and direct exporters. The existing theoretical and empirical literature

[12]It is reasonable to exclude ineligible firms for this table because part of the ineligible firms were bound by the policy when export decisions were made and including them would complicate the patterns observed.

shows that indirect exporters on average tend to be less productive than direct exporters, and thus, more vulnerable to bad demand shocks.

3 The Model

The structural model of exporting modes developed here is based on the models developed by Das et al. (2007), Aw et al. (2011), and Ahn et al. (2011). It is a two-country model where firms engage in monopolistic competition in segmented domestic and foreign markets. When heterogeneous firms face decisions regarding exporting (in addition to always serving the domestic market), they have three options - not to export, export by themselves, and export through intermediaries ($d_{it}^m = \{0, 1\}$, m=Home, Indirect, Direct). Apart from different productivities and export demand curves, firms also face different entry costs and fixed costs of exporting. Based on its current and expected future value, a firm chooses whether or not to export, and the mode in which to export. These decisions in turn affect the future productivity and demand shocks impacting the firm and making the problem dynamic.

The advantage of exporting through intermediaries is that the manufacturers avoid much of the sunk start-up costs.[13] For example, the costs may include those generated from establishing their own foreign distribution networks, learning about bureaucratic procedures, and dealing with paperwork. In China for example, there are costs associated with applying for direct trading rights, which are a part of the sunk costs of direct exporting and avoided by indirect exporters. Indirect exporters also avoid some fixed costs, such as those generated from maintaining offices in foreign markets, renting warehouses, and monitoring foreign customs procedures. Firms need to possess higher levels of productivity and higher foreign market revenue to make it worth their while to export directly and incur such costs. On the other hand, firms exporting indirectly must pay for the services provided by intermediaries. Intermediary firms provide services such as matching with foreign clients, dictating quality specifications required in foreign markets, repackaging products for different buyers, consolidating shipments with products from other firms, acting as customs agents, etc., and are paid for these services by some sort of a commission. As a result, firms receive lower variable revenue from indirect exports than from direct exports. Ahn et al. (2011) document that

[13] In order to get a better idea of the export cost structure of manufacturing firms and trading intermediaries, we interviewed a small number of firms including both manufacturing exporters and trading intermediaries. From our survey we found that the major costs manufacturing firms face to export directly come from market research, searching for foreign clients, setting up and maintaining foreign currency accounts, hiring specialized accountants and custom declarants, and finding financing. Small manufacturers may find some of these activities cost more than what they wish to bear and choose to export through trading intermediaries. On the other hand, wages, warehouse rents, and marketing costs constitute some of the major costs of trading intermediaries.

intermediaries' unit values are higher than those of direct exporters and that this difference is not related to proxies for the extent of differentiation as it would be if intermediaries were acting as quality guarantors. This is consistent with less productive, higher cost firms using intermediaries and with intermediation resulting in *higher marginal costs* of foreign distribution for firms.

3.1 Static Decisions

We assume that domestic and export markets are segmented from each other and monopolistic competition prevails. Each firm supplies a single variety of the final consumption good at a constant marginal cost. Firms set their prices in each market by maximizing profits from that market, taking the price index as given, and do not compete "strategically" with other firms. We see that firms' domestic sales are not perfectly correlated with export sales. Firms may have different performances in the foreign market and the domestic market because of preference shocks. As in Aw et al. (2011), we allow for firm-market specific demand shocks to affect firms' performances in the foreign market.

3.1.1 Demand Side

We assume consumers in both domestic and foreign markets have CES preferences with elasticity of substitution σ^H and σ^X, respectively, and where σ^H and σ^Xexceed unity. The utility functions in the home and foreign markets are:

$$U_t^H = \left(U_t^{HH}\right)^a \left(U_t^{XH}\right)^{1-a}, \tag{1}$$

$$U_t^{HH} = \left[\int_{i\in\Omega^H} \left(q_{it}^H\right)^{\frac{\sigma^H-1}{\sigma^H}} di\right]^{\frac{\sigma^H}{\sigma^H-1}}, \tag{2}$$

$$U_t^X = \left(U_t^{XX}\right)^b \left(U_t^{HX}\right)^{1-b}, \tag{3}$$

and

$$U_t^{HX} = \left[\int_{i\in\Omega^X} \left(q_{it}^X\right)^{\frac{\sigma^X-1}{\sigma^X}} \exp\left(z_{it}\right)^{\frac{1}{\sigma^X}} di\right]^{\frac{\sigma^X}{\sigma^X-1}}, \tag{4}$$

where H denotes the home market and X the foreign market, i denotes the firm that provides variety i, and Ω^H $\left(\Omega^X\right)$ denotes the set of total available varieties in market H (X). Home utility has two components: the part that comes from consuming domestic goods (U_t^{HH}) and the part that comes from consuming foreign goods (U_t^{XH}). Consumers at home spend a given

share (α) of their income on domestic goods and the remainder on imports. Substitution between domestic goods is parametrized by σ^H which differs from that between foreign goods parametrized by σ^X. We assume that the demand in the foreign market for each firm from home (China) also depends on a firm-specific demand shock z_{it}. Foreign utility is analogously defined. Demand for Chinese goods comes from home consumers who substitute between Chinese goods according to σ^H and from foreign consumers who substitute between them according to σ^X as Chinese goods are exports for them.

The corresponding price indices in each market for Chinese goods are given by

$$P_t^H = \left[\int_{i \in \Omega^H} \left(p_{it}^H \right)^{1-\sigma^H} di \right]^{\frac{1}{1-\sigma^H}}, \tag{5}$$

and

$$P_t^X = \left[\int_{i \in \Omega^X} \left(p_{it}^X \right)^{1-\sigma^X} \exp\left(z_{it} \right) di \right]^{\frac{1}{1-\sigma^X}}, \tag{6}$$

where p_{it}^H (p_{it}^X) is the price firm i charges at time t in market H (X). Let the expenditure in market H (X) on Chinese goods be Y_t^H $\left(Y_t^X \right)$. The firm-level demand from these two markets are:

$$q_{it}^H = \left(\frac{p_{it}^H}{P_t^H} \right)^{-\sigma^H} \frac{Y_t^H}{P_t^H}, \tag{7}$$

and

$$q_{it}^{Xm} = \left(\frac{p_{it}^{Xm}}{P_t^X} \right)^{-\sigma^X} \frac{Y_t^X}{P_t^X} \exp(z_{it}),\ m = I, D, \tag{8}$$

where the demand for direct exports q_{it}^{XD} and demand for indirect exports q_{it}^{XI} depend on their prices p_{it}^{XD} and p_{it}^{XI} and a firm-market specific shock z_{it}, which captures firm-level heterogeneity other than productivity that affects a firm's revenue and profit. Persistence in this firm-market specific shock introduces a source of persistence in a firm's export status and mode in addition to that provided by firm-level productivity and the sunk costs of exporting.

3.1.2 The Intermediary Sector

As in Ahn et al. (2011), we assume the intermediary sector is perfectly competitive. In this paper, we do not focus on modeling the intermediation process in international trade. We treat the existence of intermediaries as one technology of exporting that is associated with potentially lower fixed costs and sunk costs but higher variable costs and possibly lower learning-by-exporting effects. Intermediaries purchase goods from manufacturers at p_{it}^I. By adding a commission to this, the intermediary sells the good at price $p_{it}^{XI} = \lambda p_{it}^I$. Thus, $(\lambda - 1)$ is the commission rate charged by the intermediary and the corresponding demand

is $q_{it}^{XI} = \left(\frac{p_{it}^{XI}}{P_t^X}\right)^{-\sigma^X} \frac{Y_t^X}{P_t^X} \exp(z_{it})$ from equation (8). The intermediary's cut can be thought of as a service fee or it can be any per-unit cost associated with re-packaging and re-labeling at the intermediary sector. Consequently, the price of indirectly exported goods is higher than that of the same good had it been directly exported. Each period, in order to access the intermediary sector, firms must pay a matching or search sunk cost to be matched with an intermediary and export indirectly as well as a fixed cost to use the services provided by the intermediary they are matched with. This fixed cost could be very low.

Manufacturing firms set the price they charge intermediaries, p_{it}^I, taking into account that intermediaries take their cut so that the price facing consumers is λp_{it}^I, $\lambda > 1$. Thus, they maximize

$$\max_{p_{it}^I} \pi_{it}^{XI} = \left(p_{it}^I - mc_{it}\right) \left(\frac{\lambda p_{it}^I}{P_t^X}\right)^{-\sigma^X} \frac{Y_t^X}{P_t^X} \exp(z_{it}), \tag{9}$$

where mc_{it} denotes the firm's marginal cost of production, which we assumed to be constant and the same for servicing local and foreign markets, and P_t^X is the aggregate price index in the export market. Thus, the price the manufacturer charges the intermediary is [14]

$$p_{it}^I = \frac{\sigma^X}{\sigma^X - 1} mc_{it}. \tag{10}$$

3.1.3 Supply Side

We assume as in Aw et al. (2011) that short-run marginal costs are given by the following reduced-form expression:

$$\ln mc_{it} = \ln\left(c(\boldsymbol{w}_{it})e^{-\omega_{it}}\right) = \beta_0 + \beta_k \ln k_{it} + \beta_t D_t - \omega_{it.} \tag{11}$$

A firm's marginal costs depend on the firm-time specific factor prices $\boldsymbol{w}_{it}$ and the firm-time specific productivity levels ω_{it}. Since we do not have data on firm-time specific factor prices, we use a time dummy D_t to capture the factor price differences that are the same for all firms but varying across time, and the capital stock $\ln k_{it}$ can be thought of as a firm-level cost shifter as only factor prices enter the cost function.[15] Short-run cost heterogeneity can also come from differences in the firms' scales of production, captured by the firm's capital

[14] As $\lambda^{-\sigma^X}$ multiplies the whole expression, the profit maximizing price is not affected by the intermediary's cut and the usual markup rule for pricing applies. Another way of seeing this is that as an indirect exporter's variable profit is a monotonic transformation of his profits had he chosen to be a direct exporter, the price charged by a firm is unaffected by his export mode.

[15] We could also replace capital with size dummies to capture the fact that firms with different scales of production may utilize different technology in their production processes or have access to different factor prices.

stock, and their efficiencies of production ω_{it}. Constant marginal cost of production allows firms to make their static decisions for the two markets separately.

Firms choose their prices for each market after observing their markets' demand shocks and their marginal costs. Their profit maximizing prices for the domestic market and for direct exporting take the form of constant mark-ups so that $p_{it}^H = \frac{\sigma^H}{\sigma^H - 1} mc_{it}$, $p_{it}^{XD} = \frac{\sigma^X}{\sigma^X - 1} mc_{it}$, while the price of indirectly exported goods is the product of the price charged to the intermediary and the intermediary's cut so that $p_{it}^{XI} = \lambda \frac{\sigma^X}{\sigma^X - 1} mc_{it}$.

Let $a^j = (1 - \sigma^j) \ln\left(\frac{\sigma^j}{\sigma^j - 1}\right)$ and $\Phi_t^j = \frac{Y_t^j}{\left(P_t^j\right)^{1-\sigma^j}}$, $j = H, X$. Then revenues for home markets, exporting indirectly, and exporting directly are as follows:

$$\ln r_{it}^H = a^H + \ln \Phi_t^H + \left(1 - \sigma^H\right)\left(\beta_0 + \beta_k k_{it} + \beta_t D_t - \omega_{it}\right), \tag{12}$$

$$\ln r_{it}^{Xm} = a^X + \ln \Phi_t^X + \left(1 - \sigma^X\right)\left(\beta_0 + \beta_k k_{it} + \beta_t D_t - \omega_{it}\right) + z_{it} - d_{it}^I \left(\sigma^X \ln \lambda\right), \tag{13}$$

where the last term $\left(\sigma^X \ln \lambda\right)$ is positive ($\lambda > 1$) when the firm is indirectly exporting ($d_{it}^I = 1$) and so shares the revenue from exports with the intermediary. Firms' revenues in each market depend on the aggregate market conditions[16] (captured by Φ_t^H and Φ_t^X), the firm-specific productivity, and capital stock, while the revenue in the foreign market also depends on firms' choices of export modes. The log-revenue from exporting indirectly is less than that from exporting directly by the amount of $\sigma^X \ln \lambda$.

Given the assumption on the Dixit-Stiglitz form of consumer preferences and monopolistic competition, firm's home market profits can be written as:

$$\pi_{it}^H = \frac{1}{\sigma^H} r_{it}^H \left(\Phi_t^H, \boldsymbol{w}_{it}, \omega_{it}\right), \tag{14}$$

and profits from the foreign market if the firm exports indirectly and directly are:

$$\pi_{it}^{XI} = \frac{1}{\sigma^X} r_{it}^{XI} \left(\Phi_t^X, \boldsymbol{w}_{it}, \omega_{it}, z_{it}, \lambda\right), \tag{15}$$

and

$$\pi_{it}^{XD} = \frac{1}{\sigma^X} r_{it}^{XD} \left(\Phi_t^X, \boldsymbol{w}_{it}, \omega_{it}, z_{it}\right). \tag{16}$$

The short-run profits together with firms' draws from the sunk costs and fixed costs distributions and the future evolution of productivity are going to determine firms' decisions to

[16]Market conditions could vary by period. However, in the estimation we assume that they are fixed at the average level.

export and their choices of export modes.

3.2 Transition of State Variables

In each period, firms observe their current productivity, foreign market demand shocks, and previous period mode of exporting [17] before they make their decisions. , This section describes the transitions of these state variables. We assume productivity ω_{it} evolves over time as a Markov process that depends on the previous period's productivity and the firm's export decision - export or not, and if yes, what mode of export to use. We use a cubic polynomial to approximate this evolution.

$$\begin{aligned} \omega_{it} &= g\left(\omega_{it-1}, d_{it-1}\right) + \xi_{it} \\ &= \alpha_0 + \sum_{k=1}^{3} \alpha_k \left(\omega_{it-1}\right)^k + \alpha_4 d_{it-1}^I + \alpha_5 d_{it-1}^D + \xi_{it} \end{aligned} \tag{17}$$

where $d_{it-1}^m = \{0,1\},\ m = I, D$, are dummy variables that indicate firm i's export status/modes at period $t-1$. We assume exporting firms either export directly or indirectly. If $\alpha_4 < \alpha_5$, then productivity will grow faster with direct exporting than with indirect exporting.

By allowing the choice of export modes to endogenously affect the evolution of productivity, we can separate (using the model) the role of learning-by-exporting and the sorting by productivity.[18] This is important because firms that expect their productivity to grow quickly with direct exporting may choose to export directly even though it is not profitable in the static sense. ξ_{it} is an i.i.d. shock with mean 0 and variance σ_ξ^2 that captures the stochastic nature of the evolution of productivity. ξ_{it} is assumed to be un-correlated with ω_{it-1} and d_{it-1}.

The firm's export demand shock is assumed to be a first-order Markov process with the constant terms dependent on the firm's previous export status and mode. This allows possible different mean values of the AR(1) process for demand shock evolutions of different export modes, which captures the different learning-by-exporting effects on the demand shocks.

$$z_{it} = \psi_1 d_{it-1}^I + \psi_2 d_{it-1}^D + \eta_z z_{it-1} + \mu_{it}, \quad \mu_{it} \sim N\left(0, \sigma_\mu^2\right). \tag{18}$$

[17] The assumption is that the firm does some test marketing to see how well its product would be received. As a result, it knows its demand shock.

[18] De Loecker (2013) points out that if the evolution of productivity is not allowed to depend on previous export experience, then the estimates obtained would be biased. Of course, this criticism does not apply to us!

This source of persistent firm-level heterogeneity allows firms to perform differently in local and export markets, and together with stochastic firm-level entry costs and fixed costs, allows for imperfect productivity sorting into export modes. For computational simplicity, we assume firms' sizes, captured by capital stocks k_{it}, do not change over time and we capture the market sizes Φ_t^H and Φ_t^X by time dummies, which we also treat as fixed over time in the estimation.

3.3 Dynamic Decisions

In this section, we model the firm's dynamic decision about export modes. At the beginning of each period, firm i observes the current state,

$$s_{it} = \left(\omega_{it}, z_{it}, \boldsymbol{d}_{it-1}, \Phi_t^H, \Phi_t^X, \boldsymbol{w}_{it}\right)$$

which includes its current productivity and demand shocks (ω_{it}, z_{it}) and its past decision regarding which markets to serve and its export mode $(\boldsymbol{d}_{it-1})$. It observes the price indices in the markets (Φ_t^H, Φ_t^X) as well as the firm- and time-specific factor prices it faces, $\boldsymbol{w}_{it}$. We will suppress $\boldsymbol{w}_{it}, \Phi_t^H, \Phi_t^X$, as these are not chosen by the firm and call the state space $s_{it} = (\omega_{it}, z_{it}, \boldsymbol{d}_{it-1})$ from now on. It then draws its fixed and sunk costs for all the relevant options open to it and then chooses whether to sell only domestically, export indirectly, or export directly. Ineligible firms can only choose whether to stay domestic or export indirectly, and their export dynamic problems are adjusted accordingly. We omit the detailed equations here since this is merely a special case. How these costs vary by firm is explained below.

We allow the *distributions* of the costs, both fixed and sunk, of exporting to differ depending on the firm's past exporting status and mode. We will allow these fixed and sunk costs to be drawn from separate independent distributions G^l.[19] This implies that a firm's past export modes are state variables in the firm's decision regarding current export modes. For example, firms must pay sunk start-up costs to initiate direct exports. We allow the distribution of the sunk start-up cost of a mode to differ depending on the previous mode. For example, firm i faces the sunk cost γ_{it}^{HDS} drawn from the distribution G^{HDS} if it did not export last period and is looking to export directly today, while it draws γ_{it}^{IDS} from the distribution G^{IDS}, if it was already exporting indirectly.[20] All this is summarized in Table

[19] l can take the value HDS when the draw is for the Sunk cost to be incurred by a Home firm looking to become a Direct exporter (hence the HDS label). Thus, the first letter defines the firm's past status (H, I, D) and the second defines where it might transition to (H, I, D) with the understanding that there are no sunk costs for staying put. Thus we have the labels HIS, IDS, DIS as other possibilities. We normalize the sunk costs of exiting exports, the IHS, DHS cases, to be zero.

[20] As intermediaries could help small firms lower their future entry cost into direct exporting (say by providing a match with foreign clients the firm can use to export directly later on) it could be that γ_{it}^{IDS}

5. We assume that all sunk costs are paid in the current period. It is worth explaining why we set the first column in this table to be zero. Since choices will involve comparing the difference in payoffs from pair-wise options as explained below, we will not be able to pin down all the elements of the table, only their relative sizes can be identified. We choose this particular normalization and assume the costs associated with exiting the export market are zero, though others could be chosen.

Exporters also have to pay a fixed cost to remain in the export market. We denote these costs by γ_{it}^{DF} drawn from G^{DF} for direct exporters and γ_{it}^{IF} for indirect exporters. Firms pay only the sunk costs (not the fixed costs) when switching and only the fixed costs (not the sunk costs) when not switching modes. For this reason, the fixed costs have only two letters in the superscript.

Knowing s_{it}, the firm's value function in year t, before it observes its fixed and sunk costs, can be written as the integral over these costs when the firm chooses the best option today (it maximizes over $\boldsymbol{d}_{it} \triangleq (d_{it}^H, d_{it}^I, d_{it}^D)$) and assuming it optimizes from the next period onwards:

$$V\left(s_{it}\right) = \int \max_{\boldsymbol{d}_{it}} \left[u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.) + \delta E_t V\left(s_{it+1} \left|\boldsymbol{d}_{it}\right.\right)\right] dG^{\gamma}, \tag{19}$$

where $u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.)$ is the current period payoff and depends on the choice of export status and mode, $\boldsymbol{d}_{it}$, the state s_{it} (which includes last period's demand and productivity draws as well as export status and mode of exporting) and the relevant sunk and fixed cost shocks drawn, $\boldsymbol{\gamma}_{it}$:

$$\begin{aligned} u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.) = \pi_{it}^H \quad &+ \quad d_{it}^I \left[\pi_{it}^{XI} - \left(d_{it-1}^H \gamma_{it}^{HIS} + d_{it-1}^I \gamma_{it}^{IF} + d_{it-1}^D \gamma_{it}^{DIS}\right)\right] \\ &+ \quad d_{it}^D \left[\pi_{it}^{XD} - \left(d_{it-1}^H \gamma_{it}^{HDS} + d_{it-1}^I \gamma_{it}^{IDS} + d_{it-1}^D \gamma_{it}^{DF}\right)\right]. \end{aligned} \tag{20}$$

For example, if firm i exported indirectly last period (so that $d_{it-1}^I = 1$) and decides to export directly this period (so that $d_{it}^D = 1$), then he gets π_{it}^H from the domestic market and π_{it}^{XD} from exporting directly and has to pay the sunk cost of direct exporting γ_{it}^{IDS} so that his current period payoff is $u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.) = \pi_{it}^H + \pi_{it}^{XD} - \gamma_{it}^{IDS}$.

The continuation value is

$$E_t V\left(s_{it+1} \left|\boldsymbol{d}_{it}\right.\right) = \int_{z'} \int_{\omega'} V\left(s'\right) dF\left(\omega' \left|\omega_{it}, \boldsymbol{d}_{it}\right.\right) dF\left(z' \left|z_{it}, \boldsymbol{d}_{it}\right.\right). \tag{21}$$

For any state vector, denote the choice-specific continuation value from choosing $d_{it}^m = \{0, 1\}$,

tends to be far smaller than γ_{it}^{HDS} so that the means of these distributions would differ. Intermediaries can also provide information on adjusting product characteristics or packaging style to meet foreign market standards which may also reduce sunk costs of exporting directly.

as $E_t V^m_{it+1} \triangleq E_t V\left(s_{it+1}\,|d^m_{it}=1\right),\ m=H,I,D.$ Firms' export decisions depend on the difference in the pair-wise marginal benefits between any two options. For example, the marginal benefits of being an indirect exporter versus being a non-exporter, the marginal benefits of being a direct exporter versus not exporting, and the marginal benefits of being a direct exporter versus being an indirect one, are defined in equations (22), (23) and (24) respectively.[21] Let

$$\Delta IH_{it} = \pi^{XI}_{it} + \delta\left(E_t V^I_{it+1} - E_t V^H_{it+1}\right), \tag{22}$$

$$\Delta DH_{it} = \pi^{XD}_{it} + \delta\left(E_t V^D_{it+1} - E_t V^H_{it+1}\right), \tag{23}$$

$$\Delta DI_{it} = \pi^{XD}_{it} - \pi^{XI}_{it} + \delta\left(E_t V^D_{it+1} - E_t V^I_{it+1}\right). \tag{24}$$

For example, if a firm was an indirect exporter last period, it will choose to become a direct exporter today if this is its best option. The options facing an indirect exporter are laid out pictorially in Figure 2. Thus, the probability of an indirect exporter becoming a direct exporter is the probability that becoming a direct exporter is more profitable than either staying an indirect exporter or becoming a non-exporter which is [22]

$$P^{ID}_{it} = \Pr[\gamma^{IDS}_{it} \leq \min\left\{\Delta DH_{it}, \gamma^{IF}_{it} + \Delta DI_{it}\right\}]. \tag{25}$$

Thus, these marginal benefits pin down the probability of switching given the distributions of costs.

The benefit an indirect exporter gains from choosing to export directly compared to exporting indirectly can be decomposed into the static and the dynamic benefit. The static part is the difference between the current period payoffs from these two modes of exporting, $(\pi^{XD}_{it} - \gamma^{IDS}_{it}) - (\pi^{XI}_{it} - \gamma^{IF}_{it})$. The difference between the discounted future payoff from these two modes of exporting, $\delta\left(E_t V^D_{it+1} - E_t V^I_{it+1}\right)$, captures the dynamic part. These values depend on profits and costs associated with different exporting modes as well as the impact of exporting modes on future productivity if firms learn from exporting.

[21] ΔHI_{it}, ΔHD_{it}, and ΔID_{it} could be similarly defined but simple calculations show that they are merely the negative of ΔIH_{it}, ΔDH_{it}, and ΔDI_{it}.

[22] The probability that becoming a direct exporter is the best option for a previous indirect exporter is

$$\begin{aligned} P^{ID}_{it} = Pr[(\pi^H_{it} + \pi^{XD}_{it} - \gamma^{IDS}_{it} + \delta E_t V^D_{it+1} &\geq \pi^H_{it} + \delta E_t V^H_{it+1}) \ \& \\ (\pi^H_{it} + \pi^{XD}_{it} - \gamma^{IDS}_{it} + \delta E_t V^D_{it+1} &\geq \pi^H_{it} + \pi^{XI}_{it} - \gamma^{IF}_{it} + \delta E_t V^I_{it+1})]. \end{aligned}$$

What lies behind these marginal benefits? Intuitively, higher fixed costs of exporting (directly or indirectly) will reduce the continuation value of being an exporter and thus decrease the marginal benefits of being an exporter versus not exporting, i.e., ΔIH_{it} or ΔDH_{it} fall. However, higher sunk costs will decrease the continuation value of being a non-exporter, and thereby increase ΔIH_{it} or ΔDH_{it}. Similarly, better learning-by-exporting effects increase ΔIH_{it} and ΔDH_{it}, and if firms learn more through direct exporting or the service fee λ rises, ΔDI_{it} will be larger, *ceteris paribus*. Firms make draws from the sunk and fixed costs distributions each period independently, but the marginal benefit of one option over another has some persistence due to the persistence in productivity and demand shocks.

4 Estimation

We estimate the model using a two-stage estimation method utilizing firm-level panel data on revenue from the domestic market, inputs of production, export market participation, the export modes firms used, and export market revenue. In the first stage of the estimation, we estimate the firms' static decisions regarding production to obtain estimates of the domestic revenue function and of the productivity evolution process. In the second stage, we exploit information on firms' discrete choices regarding export market participation modes, and the productivity estimates obtained in the first stage of the estimation procedure, to obtain the parameters on the sunk and fixed costs of two exporting modes.[23]

Our estimation strategy is based on that of Das et al. (2007) and Aw et al. (2011). We recover the following parameters in the first-stage estimation: the elasticities of substitution in the two markets, σ^H and σ^X, the home market size intercept Φ_t^H, the marginal cost parameter β_k, the productivity evolution function $g\left(\omega_{it-1}, d_{it-1}\right)$, and the variance of transient productivity shocks σ_ξ^2. Sunk and fixed costs parameters of G^γ, the parameters η_z, σ_μ, ψ_1, ψ_2 of Markov process z_{it}, and the foreign market size intercept Φ_t^X are recovered in the second-stage of the estimation.

4.1 Stage 1: Elasticities and Productivity Evolution

4.1.1 Elasticities

We need to estimate the elasticity of substitution in each market. We follow the method in Das et al. (2007) and use the fact that prices are a constant markup over marginal costs, $p_{it} = \frac{\sigma^X}{\sigma^X - 1} mc_{it}$ that comes from our assumptions of monopolistic competition with Dixit-Stiglitz preferences. Thus, $mc_{it} = \frac{\sigma^X - 1}{\sigma^X} p_{it}$. Each firm's total variable cost can be written

[23] Recall, we normalize these to be zero for non-exporters.

as

$$TVC_{it} = mc_{it}q_{it}^{H} + mc_{it}q_{it}^{Xm} \tag{26}$$

$$= \left(\frac{\sigma^{H}-1}{\sigma^{H}}\right)p_{it}^{H}q_{it}^{H} + \left(\frac{\sigma^{X}-1}{\sigma^{X}}\right)\left[d_{it}^{D}p_{it}^{XD}q_{it}^{XD} + d_{it}^{I}p_{it}^{I}q_{it}^{XI}\right].$$

We estimate equation (26) by OLS using data on domestic and export revenues and total variable costs (TVC_{it}) to recover the elasticities of substitution.

4.1.2 Productivity and Productivity Evolution

Recall that marginal costs and revenue in the domestic market are as described in Section 3.1.3. We can rewrite equation (12) as being made up of a part that does not vary over time, a part that does, and a part that varies by firm and time as follows:

$$\ln r_{it}^{H} = \phi_{0}^{H} + \sum_{t=1}^{T}\phi_{t}^{H}D_{t} + \left(1-\sigma^{H}\right)\left(\beta_{k}\ln k_{it} - \omega_{it}\right) + u_{it}, \tag{27}$$

where $\phi_{0}^{H} = \left(1-\sigma^{H}\right)\ln\left(\frac{\sigma^{H}}{\sigma^{H}-1}\right) + \left(1-\sigma^{H}\right)\beta_{0}$ and $\phi_{t}^{H} = \ln\Phi_{t}^{H} + (1-\sigma^{H})\beta_{t}$ which captures the time varying factor prices and the home market size. $\ln k_{it}$ captures firm-level cost shifters that arise from scale differences, ω_{it} is productivity, and u_{it} is an i.i.d. error term reflecting measurement error. Note that for the purposes of solving the model, we only need $\phi_{0}^{H} + \phi_{t}^{H}$, not the separate components. [24]

As in Levinsohn and Petrin (2003), we control for productivity using the fact that more productive firms will use more materials. Thus we can replace $\left(1-\sigma^{H}\right)\left(\beta_{k}\ln k_{it} - \omega_{it}\right)$ with $h\left(k_{it}, m_{it}\right)$. We estimate the function (27) using ordinary least squares and approximate $h\left(k_{it}, m_{it}\right)$ by a third-degree polynomial of its arguments. This gives us estimates of ϕ_{0}^{H}, ϕ_{t}^{H} and the values of $\hat{h}\left(k_{it}, m_{it}\right)$. Thus we can rewrite productivity as follows:

$$\omega_{it} = -\left(\frac{1}{1-\sigma^{H}}\right)\hat{h}(k_{it}, m_{it}) + \beta_{k}\ln k_{it}. \tag{28}$$

We know $-\left(\frac{1}{1-\sigma^{H}}\right)\hat{h}(k_{it}, m_{it})$ and $\ln k_{it}$, but still have to estimate β_{k} and the parameters for

[24] The Ψ^{H} reported in Table 6 is the average $\phi_{0}^{H} + \phi_{t}^{H}$ over all time periods. The same holds for Ψ^{X} reported in Table 7. These average variables are used in the second stage estimation.

the evolution of productivity. Recall that productivity evolves according to

$$\omega_{it} = \alpha_0 + \sum_{k=1}^{3} \alpha_k \omega_{it-1}^k + \alpha_4 d_{it-1}^I + \alpha_5 d_{it-1}^D + \xi_{it}.$$

Thus, if we substitute for ω_{it} and ω_{it-1} using equation (28) into the above equation, we can estimate the remaining parameters ($\alpha_i, i = 0, ..., 5$ and β_k), using non-linear least squares. The variance of ξ_{it} is pinned down by the sample variance of the residual.

So far we have estimates of ϕ_0^H and ϕ_t^H, which capture the home market condition, elasticities σ^H and σ^X, the marginal cost parameters β_k, the productivity evolution function $g(\omega_{it-1}, d_{it-1})$, and the variance of transient productivity shocks σ_ξ^2. What remains to be estimated are the parameters of the distributions of the sunk and fixed costs, i.e., of G^γ, for each mode, the demand shocks and their evolution, and the foreign market size intercept Φ_t^X.

One might think that we could take the same approach as above and estimate demand shocks from the export revenue data given our estimates of productivity and its evolution. But a different approach is needed here. Our previous approach will have difficulties as not all firms export in all years resulting in censored data. We will be able to estimate demand shocks jointly with the dynamic discrete choice component in the second stage.[25]

4.2 Stage 2: Dynamic Estimation

We exploit information on the transitions of export status and modes and export revenues of exporting firms to estimate a dynamic multinomial discrete choice model. Intuitively, sunk entry costs of an export mode are identified by persistence in the mode and the frequency of entry into the mode across firms, given their previous exporting status and mode. High sunk costs make a firm less willing to enter, and once it has entered, less willing to exit. Given sunk cost levels, the variable export profit levels at which firms choose to exit from being indirect or direct exporters help to identify the fixed costs of different export modes. Firms tend to stay in their current exporting status and mode if the sunk cost of exporting in that export mode is high and the fixed cost is relatively low. Ceteris paribus, we would observe frequent exits from a particular mode of exporting if the fixed cost was high.

We fix the intermediary margin parameter λ at 1.01, which means intermediaries obtain a 1% margin on their sales. [26] Given firms' productivity levels and capital stock, the level of

[25] We do not consider entry and exit or attempt to estimate their costs because this is not the focus of this paper. In addition, as we only have data for firms above a certain size, we cannot see exit from the industry, only from the data, though we do have information on a firm's age and hence on its entry date.

[26] This is consistent with the observed behavior of intermediaries.

export revenues of both types of exporters provides information on foreign market demand shocks when firms choose to export. We observe all firms' discrete choices of export modes and their export revenue *only* if they participate in the export market. Variable profits and revenues are tightly linked in the model so that once we have revenues and demand elasticities, we have variable profits. These profits play a key role in the dynamic estimation below. Given variable profits and the remaining parameters of the model, the value functions can be found as a solution to a fixed point problem.

We estimate the rest of the model (export demand shocks and their evolution by mode of exporting and the various levels of fixed and sunk costs) by maximizing the likelihood function for the observed participation and modes of exporting along with the observed export sales (which boils down to observing a particular demand shock). Since firm export revenue is determined by firm productivity, capital stock (a cost shifter), market size and the foreign market shocks, we can write firm i's contribution to the likelihood function as

$$P\left(\boldsymbol{d}_i, r_i^{Xm} \left| \omega_i, k_i, \Phi \right.\right) = P\left(\boldsymbol{d}_i \left| \omega_i, k_i, \Phi, z_i^{+} \right.\right) f\left(z_i^{+}\right) \tag{29}$$

where $f(\cdot)$ is the marginal distribution of z and z_i^+ is the series of foreign market demand shocks in the years when firm i exports. In the evaluation of the likelihood function, we followed Das et al. (2007) and Aw et al. (2011) to construct the density $f(\cdot)$ and simulate the unobserved export market shocks.

To provide some idea of how this works, consider an indirect exporter who becomes a direct one and sells a particular amount. The probability of an indirect exporter becoming a direct exporter is given in equation (25). This requires knowledge of the distribution of γ^{IDS} and γ^{IF} as well as ΔDH_{it} and ΔDI_{it}. We assume that the $\gamma's$ are drawn from exponential distributions. The values of ΔDH_{it} and ΔDI_{it} as defined in equations (23) and (24) depend on variable profits from exporting directly (which from equation (16) we know depend on parameters estimated in the first stage and the ones remaining to be estimated) and on the value functions for exporting directly, indirectly, and not exporting. For every guess of the parameters remaining to be estimated, we can calculate these value functions by essentially solving a fixed point problem, and then obtain the probability of an indirect exporter becoming a direct exporter.

For the exporter to sell the amount he has, the demand shock must have taken a particular value which we can back out from the data given our choice of parameters. This will then give the probability of seeing this shock. Such elements are what go into the likelihood function which we maximize to obtain our parameter estimates.

Thus, by assuming that the export sunk costs and fixed costs for each firm and year are

i.i.d. draws from separate independent exponential distributions, we can write the choice probabilities of each export status and mode in a closed form.[27] It is worth reiterating that these choice probabilities are conditional on the firm's state.

5 Estimation Results

We present our results as follows. First, we report the estimates of demand, marginal cost and productivity evolution in the Rubber and Plastic industry as well as a number of other industries. We then confirm the pattern of productivity sorting regarding different export modes. Following this, we report the results of the dynamic estimation, summarize the marginal returns to different modes of exporting and the hidden costs of being constrained from direct trading, and analyze the model fitness. Finally, we conduct some robustness checks.

5.1 Productivity Evolution

The revenue estimates as well as the productivity evolution are reported in Table 6. In the first column, we report our estimates for the Rubber and Plastic industry. We see that the home market elasticity of substitution is slightly higher than that of the foreign market, which implies a markup of price over marginal cost of 25 percent in home market and 28 percent in foreign market. Recall that capital proxies for scale effects on marginal costs. The estimate of the coefficient of log-capital is -0.036, which suggests that the marginal cost of production is lower for plants with larger scale of production. The coefficients α_1, α_2 and α_3 imply a non-linear and positive marginal effect of lagged productivity on current productivity. α_4 and α_5, the coefficients on previous export modes, imply significantly positive effects of exporting on productivity evolution.[28] Previous period indirect exporters have productivity that is 0.5 percent higher than previous period non-exporters, while previous period direct exporters have productivity that is 2.3 percent higher. The magnitude of α_5 is four times that of α_4 which implies that direct exporting has a higher impact on productivity than indirect exporting. This confirms the dynamic trade-off between direct and indirect exporting in terms of learning-by-exporting. Direct exporting has a larger learning effect in productivity evolution and would lead to a higher expected future payoff that comes from both domestic and foreign markets. This long-run benefit gives firms an incentive to stay in the direct exporting mode even if they are making short-run losses.

[27] Derivation of these choice probabilities is available upon request.

[28] Recall that ω is the natural log of productivity. Thus, α_4 and α_5 are the percentage change in productivity when exporting indirectly and directly.

In columns 2–6 of Table 6, we also report our estimates of the productivity evolution process in five other industries - Chemicals and Chemical Products (2-digit ISIC Rev3 24), Fabricated Metal Products (2-digit ISIC Rev3 28), Machinery and Equipment (2-digit ISIC Rev3 29), Electrical Machinery and Apparatus (2-digit ISIC Rev3 31) and Furniture (2-digit ISIC Rev3 36).[29] We see that different industries have different productivity evolution processes and magnitudes of learning-by-exporting effects. Direct exporting always has larger effects on firm productivity than indirect exporting in all these industries. For example, in the Furniture industry, previous indirect exporting status has no effect on productivity while firms that previously directly exported have a 1.2 percent increase in their productivity levels.

5.2 Productivity Sorting

We construct our measures of productivity based on the estimates in the first column in Table 6. The mean productivity is 1.477, and the (5th, 50th, 95th) percentiles are (1.174, 1.453, 1.867). When we look at the productivity distributions for non-exporters, indirect exporters and direct exporters separately, we have a clear pattern of productivity sorting. The (5th, 50th, 95th) percentiles of the three types of firms are (1.155, 1.431, 1.807), (1.253, 1.517, 2.005) and (1.280, 1.620, 2.091) respectively. We performed the t-test and the Kolmogorov-Smirnov test for the productivity distributions of the three groups and conclude that the productivity distributions of non-exporters, indirect exporters and direct exporters are significantly different from each other. Moreover, the distribution for direct exporters first order stochastically dominates that of indirect exporters which first order stochastically dominates that of non exporters. Figure 3 shows the kernel density and cumulative distribution function estimates of these three distributions. The randomness of sunk and fixed costs of different exporting modes and the persistence of the firm-level heterogeneous foreign demand shocks predict that the productivity sorting will not be a strict hierarchy just as observed here.

5.3 Dynamic Estimates

In this section we report the estimates of the dynamic discrete choice model. First, the estimate of Ψ^X (which proxies for average foreign market size) is smaller than that for the domestic market, Ψ^H, which we estimated in the first stage. This is in line with what we see in Table 3 that exporters on average sell 63 to 75 percent less in the foreign market than in the domestic market.

The coefficients $\gamma^{HIS}, \gamma^{HDS}, \gamma^{IDS}, \gamma^{DIS}$ reported in Table 7 are the mean parameters

[29] These industries are important in China's exports in terms of both export revenue and number of exporters

of the exponential distributions for, respectively, the sunk costs of a non-exporter to start indirect and direct exporting, the sunk cost of an indirect exporter to become a direct one and that of a direct exporter to start to export indirectly. First, the average sunk costs draws for non-exporters to start direct exporting (γ^{HDS}) is much higher than that for them to start exporting indirectly (γ^{HIS}). This is consistent with the observed transition patterns in the data and suggests that on average, it is much less costly to enter the indirect exporting market than the direct exporting market. The average sunk costs an indirect exporter faces to become a direct exporter (γ^{IDS}) is also much lower than what a non-exporter faces (γ^{HDS}). This indicates that using an intermediary to export in the previous period helps firms to start direct exporting in the current period by lowering their sunk costs. Moreover, we can see that on average, climbing the export ladder by starting off as an indirect exporter and then moving into direct exporting is cheaper than exporting directly to begin with. The relatively small average sunk costs of starting indirect exporting as a direct exporter (γ^{DIS}) indicates that it is much easier for a direct exporter to become an indirect exporter.

The coefficients γ^{IF} and γ^{DF} are the mean parameters of exponential distributions for the fixed costs of indirect and direct exporting. First, for both modes of exporting, the estimated fixed costs are relatively small compared to the sunk costs of starting such exporting. This indicates that regardless of exporting status and mode, a firm will always be more likely to remain in the export market than to exit and re-enter later. Second, the average fixed cost an indirect exporter could be drawing (γ^{IF}) is smaller than that for a direct exporter (γ^{DF}). This confirms the cost advantage of exporting through intermediaries.

These cost parameters are hard to interpret. For one, they say something about the distributions of the cost draws, not the costs actually incurred by firms. Firms with high cost draws do not avail of the option to export. Table 8 gives average costs *incurred* and the ratio of these costs to average export revenues earned (in brackets). These costs are measured as the truncated mean of the exponential distributions incorporating the fact that only favorable draws result in a firm exporting.[30] Table 8 present these numbers for firms at the mean productivity levels of a non-exporter, indirect exporter and direct exporter respectively. Thus, the average costs *incurred* by a firm with productivity 1.448, who was a non-exporter in the previous period is 0.827 and the ratio of costs to export revenues is 0.253.[31]

[30]For each combination of the state variables, the mean fixed and sunk costs of the firms that choose to export are the truncated means of the corresponding exponential distributions with truncation point given by the pairwise marginal benefits.

[31]It is worth noting that one of the main points made above, namely that it is "cheaper to climb the ladder than jump a rung" does not on first glance look like it holds in Table 8. For example, $0.827 + 1.338 > 1.500$ so that the actual costs incurred by a non-exporter to export directly after exporting indirectly are actually more than that of exporting directly to begin with. This is not surprising: though the mean of the sunk

The last four parameters describe the evolution of foreign market demand shocks, z_{it}. The parameters η_z and σ_μ characterize the serial correlation and standard deviation of z_{it} which is assumed to evolve as a first-order Markov process. The high serial correlation of 0.836 shows the persistence in firm-level demand shocks, which also induces persistence in firms' export status and export revenue. The parameter on the dummy of indirect exporting ψ_1 is positive but not significant, while the parameter on the dummy of direct exporting ψ_2 is significantly positive. These two parameters give the growth in the demand shocks if firms were indirectly or directly exporting last period, compared to non-exporters. A value of 0.008 for ψ_2 with the persistence parameter at 0.836 indicates that on average the demand shocks of continuing direct exporters are 5 percent higher than that of firms that never export.

To further understand how firms with different productivities sort into different export modes, we look at the values of being different in a mode and the pair-wise marginal benefits across modes at different productivity levels. Recall that these values depend on the sunk costs and fixed costs of each export mode and the impact of export modes on future productivity. Denote $V_{it}^m \triangleq V\left(s_{it}\,|d_{it}^m = 1\right),\ m = H, I, D$. In Table 9 we report the average values of being a non-exporter (V_{it}^H), an indirect exporter (V_{it}^I) and a direct exporter (V_{it}^D) and the pair-wise marginal benefits of each export mode at the 10th to 90th percentiles of the productivity distribution. In columns 1–3, we see that the values of being a non-exporter, an indirect exporter and a direct exporter are all increasing in the productivity level, reflecting the vital role of productivity in firm profits. For each value of productivity, $V_{it}^D > V_{it}^I > V_{it}^H$, suggesting a clear ranking of payoffs due to exporting and the learning-by-exporting effects. Second, in columns 4–6, the marginal benefits of exporting indirectly and exporting directly are both positive and increasing in productivity. The marginal benefits of exporting depend heavily on transition probabilities due to the existence of large start-up costs of entering the export market. At high productivity levels, current non-exporters have a high probability of starting to export and have to pay a large start-up cost, while exporters have a high probability of continuing to export and only having to pay relatively small fixed costs. The sixth column reports the marginal benefits of direct exporting to indirect exporting. This value is also positive and increasing in productivity, indicating that direct exporting is more favorable to indirect exporting for firms with higher productivity levels. This also suggests that firms with higher productivity will eventually select into direct exporting.

The last two columns show the average percentage loss in value of being a constrained non-exporter and indirect exporter in 2000, given the assumption that the policy changes

costs of exporting directly for a non-exporter is higher, costs actually incurred could be lower if the option is exercised only for low cost draws. In other words, the numbers in Table 8 come partly from selection and partly from the the distributions costs are drawn from and so cannot be interpreted in the same way as those in Table 7 in terms of climbing the ladder versus jumping a rung.

were fully anticipated.[32] We see that constrained firms lose 2 to 6 percent of their value because of the loss of an opportunity of being a direct exporter.

5.4 Model Fit

We see how well the estimated model is able to capture the features of the data by looking at the in-sample fitness of the model prediction. Using our estimates in Table 6 and Table 7 we simulate the model thirty times to assess its performance. Specifically, we use the actual data in the initial year of each firm observed in the sample and simulate their evolutions of productivity and decisions of export modes in the following years based on simulated draws of foreign market demand shocks and export costs. Table 10 compares the actual and simulated average productivity and the participation rates of each mode of exporting. Overall, the model predicts the average productivity and the participation rates of two export modes well. In Table 11, we report the actual and simulated transitions between each export status and mode. The simulated transitions for non-exporters which account for 81 percent of the sample are very close to the actual transition rates, indicating that our model performs well in estimating the sunk costs of starting two modes of exporting as non-exporter, specifically γ^{HDS} and γ^{HIS}. The model slightly overestimate the fixed costs of two modes of exporting and thus under predicts the persistence of indirect and direct exporters.

5.5 Robustness Checks

A question worth addressing at this point is the extent to which one can interpret our results as evidence that direct exporting results in better evolution of demand and productivity shocks as we do. There are several issues here. We check the robustness of our first stage results to these potential issues. As the second stage is very computationally intensive, we cannot do the same for it. The details are in the Appendix. Here we sketch what we found.

First, we address concerns about the definition of indirect and direct exporters. As discussed in Section 2, we infer export modes as firms are not directly asked about their mode of export. Mis-reporting in the survey and errors or mismatches in the process of merging the two data sets could create errors in our classification.[33] For example, some firms may say they did not export because they did not realize the intermediary they sold to was exporting their goods. Thus, we may have mis-classified indirect exporters as non-exporters. This is unlikely as exporting intermediaries have names that clearly differentiate them from

[32]The loss would be much higher if firms perceive the restrictive policy to be permanent.

[33]Evidence on match quality is discussed in the second section of the Appendix.

domestic ones as made clear in Ahn et al. (2011). In any case, this mis-classification would work in our favor as it would reduce growth of demand shocks and productivity of exporters relative to non-exporters. We also look at whether there is any evidence that non matched exporters are mistakenly classified as indirect ones. In the appendix, in section C, we show that this does not seem to be the case.

In addition, there might be producers who say they did not export in the survey data and show up in the customs data.[34] We interpret this to mean that such firms exported on someone else's behalf, making them "producer intermediaries". These firms are dropped in our baseline estimation. To check if this made a difference we ran the first stage of the estimation including them as a separate type of export mode. This did not affect the estimates of productivity evolution and these firms seemed to learn even faster than direct exporters. We performed the same exercise for processing firms whom we originally dropped. Processing firms' learning is in between that of indirect and direct exporters. These results are reported in Table A.4 of the Appendix.

We also checked the robustness of our results to alternative definitions of export modes. For example, if there is a delay in customs in recording export shipments at the end of a calendar year, a firm could report positive exports in year t while its shipment only show up in year $t+1$. In this case, we could have mis-classified direct exporters as indirect exporters. To deal with this we reclassify firms as described in the Appendix and find it makes no difference. We also estimate the evolution of productivity allowing it to differ by the share of direct exports and not just classify firms as one or the other. We find that the higher the share of direct exports, the greater the learning gains. These results are in Table A.4 of the Appendix.

Firms may also differ in other dimensions in terms of their exporting behavior and this could be what lies behind our results. For example, it is well understood (see Ahn et al. (2011)) that direct exporters access different markets and export different products than do indirect exporters. Direct exporters sell 10 to 15 percentage points more overall to the top ten destinations than do intermediaries, consistent with the idea that intermediaries are used to access smaller, less desirable destinations and sell differentiated goods (which are a greater share of expenditure in rich countries). However, when we control for destination and product in estimating the productivity evolution they do not seem to affect the evolution of productivity. Similarly, when we control for the propensity of a shipment to be sold by an intermediary, we find no significant change in the patterns of the coefficients of interest. These results are reported in Table A.5 of the Appendix.

Finally, omitting other firm decisions that could be affecting productivity may confound

[34] These comprise about 4% of the observations in the survey data.

our results. For example, if direct exporters tend to import intermediate inputs and due to this have a better productivity evolution, our results could be spurious. Other dimensions in which firms may differ include their behavior in investing in R&D or actively increasing their registered capital to obtain direct trading rights. Adjusting for such variations in our first-stage estimation does not change the learning-by-exporting patterns we have in our baseline estimation. Table A.6 in the Appendix reports these results.

6 Counterfactuals

In this section we use our estimated model to conduct some counterfactual experiments. These include liberalization of restrictions on direct exports and subsidy policies of different kinds.

6.1 Direct Trading Liberalization

Using our estimates, we compare firms' growth under different liberalization scenarios. As described above, the liberalization of direct trading rights that took place was gradual and expected. We simulate firms' growth in average productivity, export participation and export revenue under the following three scenarios. First, we assume that the liberalization was immediate and all firms were free to choose their export modes from the year 2000 onwards. Second, we look at banning indirect exports. This is similar to what would happen in the absence of a well-developed intermediary sector. Third, we look at what would happen if all domestic firms were forced to export through intermediaries, i.e., we eliminate direct exports for them. This scenario is a bit more extreme than what would have happened without the liberalization of direct trading rights that did occur. In addition, we also compare how firms react under these three scenarios when productivity evolution is completely exogenous and there are no learning-by-exporting effects. To compare the effects, we use the first year of the data as given and simulate firms' optimal export decisions for the next five, ten and fifteen years. In each of the three cases, firms perceive the changes made as being permanent when evaluating their options. We repeat the simulation thirty times and report the average effects in Table 12. The numbers reported here are the percentage changes relative to the current situation.

First look at columns 1–3 of the table where there are learning-by-exporting effects. As we can see from the first row of each horizontal panel, the first case, where the liberalization was immediate, is closest to the current trade regime. There is no effect on average productivity, though export participation and export revenue would have been slightly higher than under

the status quo. This is both because the liberalization process only took four years, and because it was perfectly expected by firms in the economy. In the second row of each panel, we report the relative effects when indirect trading was not an option. Restricting indirect exporting moves small firms who would have been indirect exporters into the non-exporter group. This reduces sales and productivity. However, it also moves larger indirect exporters into exporting directly which has the opposite effect. The net effect is close to zero for productivity which falls by 0.3 percent, but negative for sales and participation which fall by 11 and 13 percent respectively over 15 years. When direct exports are banned as in the third case average productivity falls by 1.2 percent. Export participation and export sales fall by 37 and 30 percent respectively. Had there been no learning-by-exporting effects, all these effects would be much smaller. This suggests that the effects via learning-by-exporting are critical. In sum, the counter-facutals show that liberalizing direct trading rights was important and exports would have been roughly a third lower had this not been done.

6.2 Subsidies

Evaluating the effects of different trade policies has always been a focus of research interests. A variety of trade policies have been used to encourage exports in developing countries. The most commonly used tools include direct subsidies based on firms' export performances, such as export revenue subsidies and duty-free access to imported inputs in export processing zones. Both of these tools have been used intensively by the Chinese government. This type of subsidy targets incumbent exporters and affects exports on the intensive margin. At the same time, it increases exporters' survival rates and encourages entry just like a fall in variable costs. Other subsidies, like those to fixed and sunk costs, directly focus on reducing the cost of exporting and encourage net entry.

In this section, we simulate the effects of such subsidies. First, we simulate the effect of a 5 and 10 percent subsidy on exports.[35] We also simulate the effect of a 25 and 50 percent reduction in fixed or sunk costs of exporting. In addition, we target the subsidies to different types of exporters. We take the first year of the data and simulate trajectories of firm performance for future years. We compare all the results to the case with no subsidies. In each of the three cases, firms perceive the policy to be permanent when evaluating their options.

Table 13 presents the results of this exercise ten years after the policy was introduced. We compare three measures of the effects of the subsidy: the increase in export participation,

[35]This can also be interpreted as the effect of a lower variable transportation cost or the development of transportation technologies or/and port facilities (as costs are of the iceberg variety) or VAT rebates. This is because revenues are multiplicatively related to productivity and costs in our setting.

export revenue and the ratio of increases in export revenue to the subsidy costs. The last is a sort of benefit to cost ratio and we focus on this.

First, we see that a 10 percent subsidy on exports increases the export participation rate by 2.9 percent and export revenue by 11.4 percent. The difference suggests that this type of subsidy mainly operates through the intensive margin of exports. In contrast, subsidizing the costs of exporting has a larger effect on increasing export participation than on export revenue. This is because subsidizing costs operates through the entry-exit of firms into exporting. It is worth noting that the benefit-cost ratio of the export subsidy is higher when targeting direct exporters. This makes sense as they tend to be more productive. However, the benefit-cost ratio of cost subsidies is higher for indirect exporters as their costs are lower.

7 Conclusion

This paper makes the case that a hitherto less studied policy, that of removing controls on direct exporting, had a significant effect on promoting Chinese export growth. Of course, all the other policies that changed also had an effect. In future work we hope to better understand the extent to which China's domestic reforms, tariff reforms, and tariffs it faced, as well as its selective encouragement of sectors by fine-tuning VAT rebate levels, contributed to its export growth.

References

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

Akerman, A., "A Theory on the Role of Wholesalers in International Trade Based on Economies of Scope," *Research Papers in Economics* 1 (2010).

Amiti, M. and J. Konings, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *The American Economic Review* 97 (2007), 1611–1638.

Antràs, P. and A. Costinot, "Intermediated Trade," *The Quarterly Journal of Economics* 126 (2011), 1319–1374.

Arkolakis, C., "Market Penetration Costs and the New Consumers Margin in International Trade," *Journal of Political Economy* 118 (2010), 1151–1199.

Aw, B. Y., M. J. Roberts and D. Y. Xu, "R&D Investment, Exporting, and Productivity Dynamics," *American Economic Review* 101 (2011), 1312–44.

Baldwin, R. and P. Krugman, "Persistent Trade Effects of Large Exchange Rate Shocks," *The Quarterly Journal of Economics* 104 (1989), 635–654.

Bernard, A. B., E. J. Blanchard, I. Van Beveren and H. Y. Vandenbussche, "Carry-Along Trade," *NBER Working Paper Series* 18246 (2012).

Bernard, A. B. and J. B. Jensen, "Exceptional Exporter Performance: Cause, Effect, or Both?," *Journal of International Economics* 47 (1999), 1–25.

———, "Why Some Firms Export," *Review of Economics and Statistics* 86 (2004), 561–569.

Bernard, A. B., J. B. Jensen, S. J. Redding and P. K. Schott, "Firms in International Trade," *The Journal of Economic Perspectives* 21 (2007), 105–130.

Bernard, A. B., I. Van Beveren and H. Vandenbussche, "Multi-Product Exporters, Carry-Along Trade and the Margins of Trade," *National Bank of Belgium Working Paper Series* 203 (2010).

Biglaiser, G., "Middlemen as Experts," *The RAND Journal of Economics* (1993), 212–223.

Blum, B. S., S. Claro and I. Horstmann, "Intermediation and the Nature of Trade Costs: Theory and Evidence," *University of Toronto, Mimeograph* (2009).

Brandt, L., J. Van Biesebroeck and Y. Zhang, "Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing," *Journal of Development Economic* 97 (2012), 339–351.

Clerides, S. K., S. Lach and J. R. Tybout, "Is Learning by Exporting Important? Micro-dynamic Evidence from Colombia, Mexico, and Morocco," *The Quarterly Journal of Economics* 113 (1998), 903–947.

Das, S., M. J. Roberts and J. R. Tybout, "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica* 75 (2007), 837–873.

De Loecker, J., "Do Exports Generate Higher Productivity? Evidence from Slovenia," *Journal of International Economics* 73 (2007), 69–98.

———, "Detecting Learning by Exporting," *American Economic Journal: Microeconomics* 5 (2013), 1–21.

Dixit, A., "Entry and Exit Decisions under Uncertainty," *Journal of Political Economy* (1989a), 620–638.

———, "Hysteresis, Import Penetration, and Exchange Rate Pass-through," *The Quarterly Journal of Economics* 104 (1989b), 205–228.

Ethier, W., "Internationally Decreasing Costs and World Trade," *Journal of International Economics* 9 (1979), 1–24.

Ethier, W. J., "National and International Returns to Scale in the Modern Theory of International Trade," *The American Economic Review* 72 (1982), 389–405.

Feenstra, R. C. and G. H. Hanson, "Intermediaries in Entrepôt Trade: Hong Kong Re-Exports of Chinese Goods," *Journal of Economics & Management Strategy* 13 (2004), 3–35.

Goldberg, P. K., A. K. Khandelwal, N. Pavcnik and P. Topalova, "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," *The Quarterly Journal of Economics* 125 (2010), 1727–1767.

Handley, K. and N. Limão, "Policy Uncertainty, Trade and Welfare: Theory and Evidence for China and the US," *NBER Working Paper Series* 19376 (2013).

Kasahara, H. and B. Lapham, "Productivity and the Decision to Import and Export: Theory and Evidence," *Journal of International Economics* 89 (2013), 297–316.

Kasahara, H. and J. Rodrigue, "Does the Use of Imported Intermediates Increase Productivity? Plant-level Evidence," *Journal of Development Economics* 87 (2008), 106–118.

Krishna, K. and L. H. Tan, *Rags and Riches: Implementing Apparel Quotas under the Multi-Fibre Arrangement* (University of Michigan Press, 1998).

Levinsohn, J. and A. Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables," *The Review of Economic Studies* 70 (2003), 317–341.

Melitz, M. J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71 (2003), 1695–1725.

Pierce, J. R. and P. K. Schott, "The Surprisingly Swift Decline of US Manufacturing Employment," *NBER Working Paper Series* 18655 (2012).

Roberts, M. J. and J. R. Tybout, "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs," *The American Economic Review* 87 (1997), 545–564.

Rossman, M. L., "Export Trading Company Legislation: US Response to Japanese Foreign Market Penetration," *Journal of Small Business Management* 22 (1984), 62–64.

Rubinstein, A. and A. Wolinsky, "Middlemen," *The Quarterly Journal of Economics* 102 (1987), 581–593.

Van Biesebroeck, J., "Exporting Raises Productivity in sub-Saharan African Manufacturing Firms," *Journal of International Economics* 67 (2005), 373–391.

Zhang, H., "Static and Dynamic Gains from Importing Intermediate Inputs: Theory and Evidence," *The Pennsylvania State University, Mimeograph* (2013).

Table 1: Export Participation Rates: Constrained and Unconstrained Firms

Group	Year	2000	2001	2002	2003	2004	2005	2006
Domestic	Indirect	16.2%	15.5%	15.2%	14.0%	12.4%	14.3%	13.5%
Constrained in 1999	Direct	1.4%	2.5%	4.0%	5.4%	7.2%	7.9%	7.6%
Domestic	Indirect	16.7%	15.1%	13.9%	13.8%	12.4%	14.4%	14.9%
Unconstrained in 1999	Direct	14.6%	15.6%	17.0%	17.0%	18.0%	18.1%	16.5%
FIE	Indirect	12.9%	12.4%	12.1%	12.6%	11.6%	12.1%	11.5%
Always Unconstrained	Direct	61.6%	62.2%	62.3%	62.0%	63.4%	62.6%	62.6%

Figure 1. Share of Direct Exporters Before and After Trading Rights

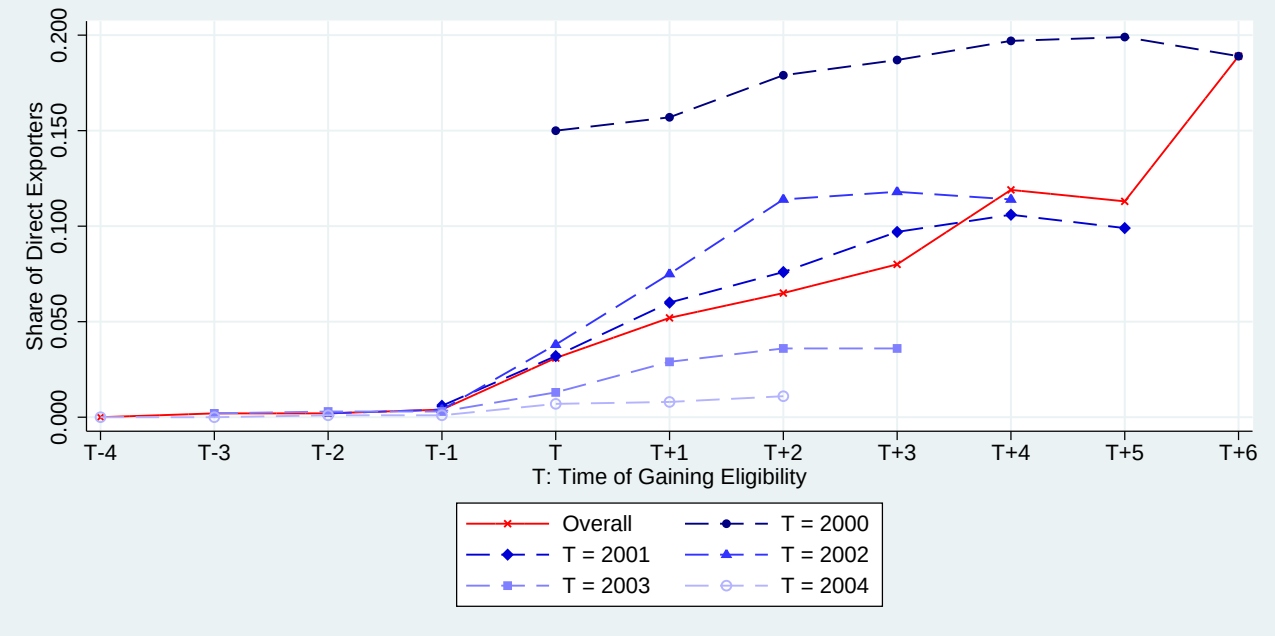


Table 2: Composition of Firms

	Non-Exporter		Indirect Exporter		Direct Exporter		Total
Year	Number	Percentage	Number	Percentage	Number	Percentage	Number
2000	3,244	83.1%	362	9.3%	299	7.6%	3,905
2001	4,599	83.5%	488	8.9%	419	7.6%	5,506
2002	5,046	82.5%	557	9.1%	514	8.4%	6,117
2003	5,415	81.9%	579	8.8%	615	9.3%	6,609
2004	7,697	80.9%	732	7.7%	1,085	11.4%	9,514
2005	8,509	79.8%	863	8.1%	1,292	12.1%	1,0664
2006	7,627	79.7%	758	7.9%	1,183	12.4%	9,568

Table 3: Summaries of Firm Size

Export Status		Employee	Capital	Domestic Sales	Export Sales
Non-Exporter	mean	119.787	0.796	2.660	0
	median	73	0.263	1.304	0
Indirect Exporter	mean	282.892	2.968	8.789	2.176
	median	120	0.400	2.089	0.482
Direct Exporter	mean	388.856	4.707	11.237	4.139
	median	180	1.070	3.806	1.270

Notes: Capital, domestic sales and exports are in 10 millions of Chinese Yuan.

Table 4: Transitions of Export Modes: All Eligible Firms

Export Status	Time t		
Time $t-1$	Non-Exporter	Indirect Exporter	Direct Exporter
Non-Exporter	0.961	0.030	0.009
Indirect Exporter	0.231	0.655	0.115
Direct Exporter	0.022	0.058	0.920

Table 5: Costs of Exporting

Export Status	Time t		
Time $t-1$	Non-Exporter	Indirect Exporter	Direct Exporter
Non-Exporter	0	γ_{it}^{HIS}	γ_{it}^{HDS}
Indirect Exporter	0	γ_{it}^{IF}	γ_{it}^{IDS}
Direct Exporter	0	γ_{it}^{DIS}	γ_{it}^{DF}

Figure 2. Example of a Firm's Dynamic Decisions

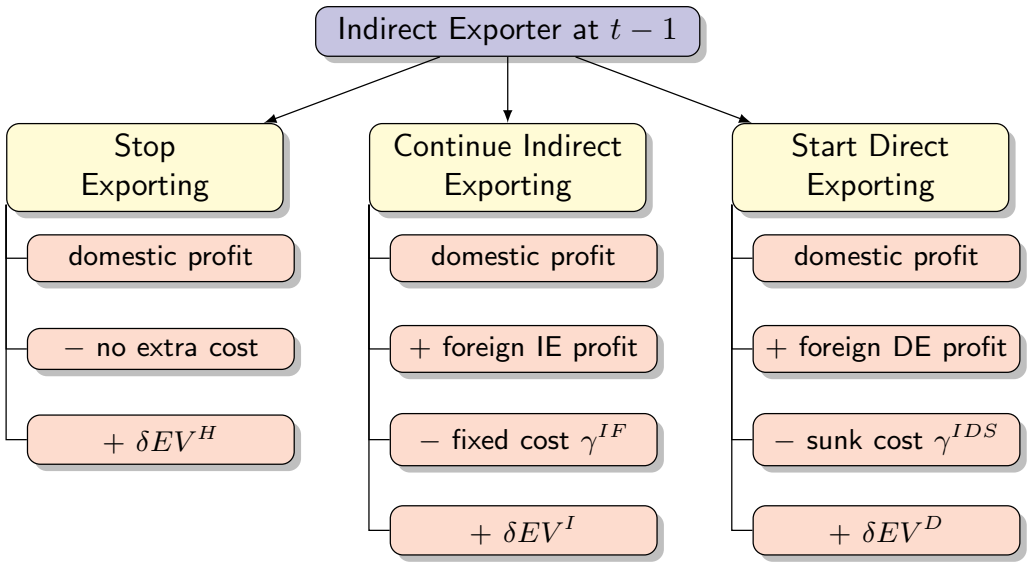
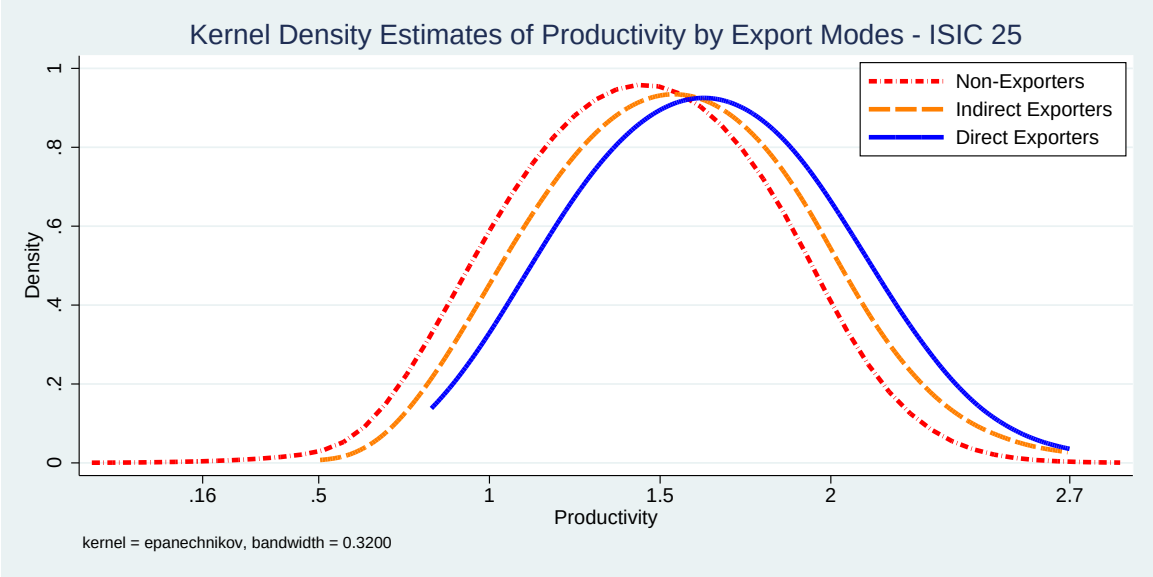


Table 6: Demand Elasticities, Marginal Cost, and Productivity Evolution

Parameters		Rubber & Plastic	Chemical	Metal Products	Machinery & Eqpt	Electrical Machinery	Furniture
Domestic Elasticity	σ^H	4.902***	5.818***	5.706***	5.740***	4.876***	5.844***
		(0.003)	(0.001)	(0.002)	(0.002)	(0.003)	(0.007)
Foreign Elasticity	σ^X	4.550***	3.776***	5.200***	4.357***	9.130***	5.930***
		(0.008)	(0.010)	(0.008)	(0.004)	(0.018)	(0.009)
Capital	β_k	-0.036***	-0.030***	-0.031***	-0.033***	-0.036***	-0.025***
		(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Constant	α_0	0.637***	0.559***	0.350***	0.338***	0.497***	-0.140*
		(0.036)	(0.017)	(0.036)	(0.014)	(0.024)	(0.081)
$\boldsymbol{\omega}_{it-1}$	α_1	0.194***	0.167***	0.789***	0.528***	0.249***	1.440***
		(0.071)	(0.039)	(0.079)	(0.034)	(0.055)	(0.151)
$\boldsymbol{\omega}^2_{it-1}$	α_2	0.309***	0.383***	-0.116**	0.200***	0.359***	-0.315***
		(0.046)	(0.030)	(0.057)	(0.026)	(0.041)	(0.094)
$\boldsymbol{\omega}^3_{it-1}$	α_3	-0.034***	-0.053***	0.066***	-0.026***	-0.054***	0.062***
		(0.010)	(0.007)	(0.013)	(0.006)	(0.010)	(0.019)
Indirect Export$_{t-1}$	α_4	0.005**	0.005***	0.003**	0.006***	0.007***	-0.000
		(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Direct Export$_{t-1}$	α_5	0.023***	0.016***	0.017***	0.017***	0.015***	0.012***
		(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Home Market Size	Ψ^H	2.627	2.382	1.584	2.146	3.483	-0.000
	$\boldsymbol{\sigma}_\omega$	0.123	0.111	0.102	0.108	0.133	0.095

***,** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Figure 3. Productivity Distributions by Export Modes



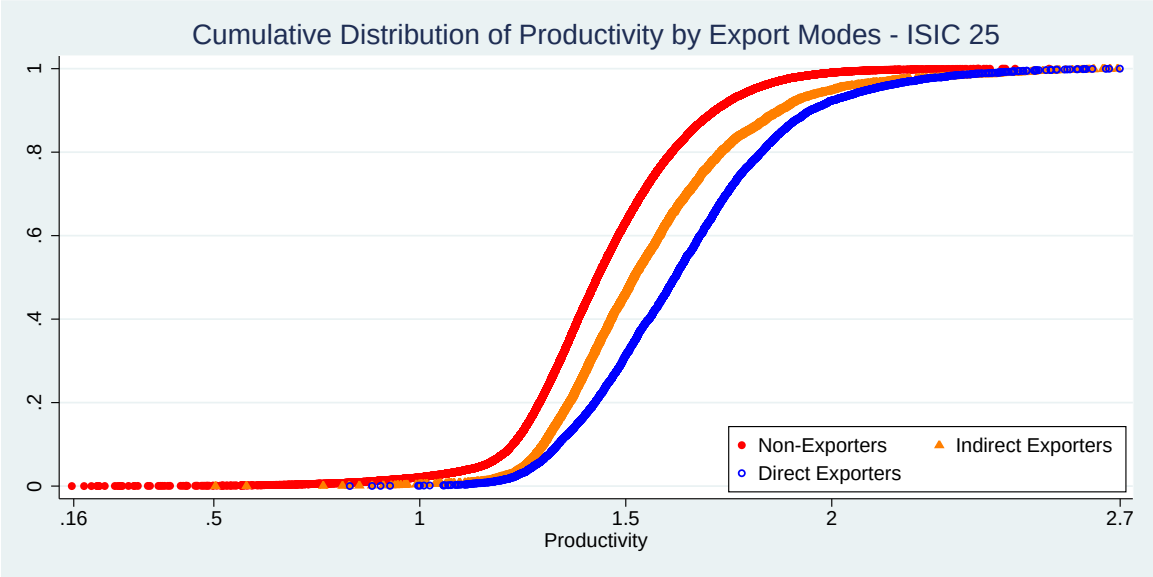


Table 7: Dynamic Parameter Estimates

Export Market Size	Ψ^X	1.574***	(0.018)
Sunk Export Costs			
Home → Indirect	γ^{HIS}	26.149***	(0.531)
Home → Direct	γ^{HDS}	123.079***	(3.634)
Indirect → Direct	γ^{IDS}	32.336***	(0.725)
Direct → Indirect	γ^{DIS}	1.116***	(0.031)
Fixed Export Costs			
Indirect	γ^{IF}	0.780***	(0.020)
Direct	γ^{DF}	1.544***	(0.035)
Demand Shock			
	η_z	0.836***	(0.007)
	$\log(\sigma_\mu)$	-0.200***	(0.003)
Indirect	ψ_1	0.003	(0.002)
Direct	ψ_2	0.008***	(0.001)

***,** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8: Average Costs of Exporting

Export Status		Time t			
Time t-1	ω_{it}	Indirect Exporter		Direct Exporter	
Non-Exporter	1.448	0.827	(0.253)	1.500	(0.438)
Indirect Exporter	1.558	0.385	(0.079)	1.338	(0.264)
Direct Exporter	1.638	0.052	(0.008)	1.111	(0.165)

Values of costs are in 10 millions of Chinese Yuan.

Numbers in brackets are the ratio of the costs to the gross export revenue.

Table 9: Pairwise Marginal Benefits of Exporting

Percentile	ω_{it}	V_{it}^H	V_{it}^I	V_{it}^D	ΔIH_{it}	ΔDH_{it}	ΔDI_{it}	$\frac{\Delta V_{it}^H}{V_{it}^H}$	$\frac{\Delta V_{it}^I}{V_{it}^I}$
10	1.239	7.101	7.703	8.051	0.937	1.605	0.667	0.016	0.020
20	1.304	7.885	8.644	9.082	1.156	1.986	0.830	0.020	0.023
30	1.356	8.634	9.528	10.061	1.348	2.341	0.992	0.022	0.026
40	1.403	9.461	10.498	11.154	1.554	2.740	1.185	0.025	0.028
50	1.453	10.519	11.736	12.569	1.814	3.257	1.443	0.028	0.031
60	1.508	11.991	13.460	14.550	2.178	3.977	1.799	0.033	0.035
70	1.571	14.180	16.023	17.506	2.728	5.047	2.318	0.039	0.041
80	1.650	18.031	20.521	22.698	3.685	6.879	3.194	0.047	0.048
90	1.763	26.302	29.990	33.268	5.485	10.031	4.547	0.057	0.057

Values in 10 millions of Chinese Yuan. $\Delta V_{it}^m / V_{it}^m \triangleq (V_{it,Eligible}^m - V_{it,Ineligible}^m)/V_{it,Eligible}^m,\ m = H, I$

Table 10: Model Prediction of Productivity and Participation Rates

		2001	2002	2003	2004	2005	2006
Productivity	Data	1.447	1.456	1.475	1.471	1.480	1.520
	Model	1.462	1.472	1.482	1.470	1.471	1.493
Indirect Exporter	Data	0.089	0.091	0.088	0.077	0.081	0.079
	Model	0.086	0.086	0.083	0.079	0.072	0.077
Direct Exporter	Data	0.076	0.084	0.093	0.114	0.121	0.124
	Model	0.079	0.088	0.101	0.114	0.115	0.123

Simulation reports average results from thirty simulations.

Table 11: Model Prediction of Transition Rates

Export Status	Time t			
Time $t-1$		Non-Exporter	Indirect Exporter	Direct Exporter
Non-Exporter	Data	0.963	0.029	0.008
	Model	0.951	0.031	0.017
Indirect Exporter	Data	0.234	0.660	0.107
	Model	0.271	0.619	0.110
Direct Exporter	Data	0.022	0.058	0.920
	Model	0.086	0.053	0.861

Simulation reports average results from thirty simulations.

Table 12: Firm Response Under Different Liberalization Scenarios

	Policy Regimes	Learning			No Learning		
	Year	5	10	15	5	10	15
Average Productivity	No Restriction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	No Intermediary	0.0%	-0.1%	-0.3%	0.0%	0.0%	0.0%
	No Liberalization	-0.2%	-0.6%	-1.2%	0.0%	0.0%	0.0%
Export Participation	No Restriction	0.9%	0.3%	0.2%	0.1%	0.0%	0.0%
	No Intermediary	-10.3%	-12.6%	-13.0%	-0.7%	-2.9%	-1.0%
	No Liberalization	-29.8%	-35.8%	-36.9%	-7.2%	-8.9%	-8.9%
Export Revenue	No Restriction	0.3%	0.2%	0.8%	0.0%	0.0%	0.0%
	No Intermediary	-9.3%	-9.8%	-10.8%	11.0%	3.4%	8.2%
	No Liberalization	-15.0%	-22.3%	-29.7%	-3.7%	-4.4%	-4.2%

Numbers in the table represent the percentage change compared to the current scenario.

Table 13: Firm Response to Alternative Subsidy Plans

		Indirect Exporter			Direct Exporter			Both Types		
Subsidy Plans	Rate	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Export Revenue	5%	0.5%	0.9%	1.222	0.9%	4.9%	1.128	1.3%	5.7%	1.124
	10%	1.0%	1.6%	0.643	2.0%	9.8%	1.112	2.9%	11.4%	1.126
Fixed Cost	25%	5.0%	1.3%	1.698	12.8%	4.2%	0.604	17.3%	5.4%	0.697
	50%	14.3%	3.2%	1.378	38.1%	9.5%	0.496	49.6%	11.5%	0.550
Sunk Cost	25%	4.6%	1.9%	2.216	5.1%	2.0%	0.800	9.6%	3.9%	1.167
	50%	11.2%	4.1%	1.556	13.3%	5.7%	0.706	23.9%	9.1%	0.924

(1) Percentage change in export participation rate compared to no subsidies.

(2) Percentage change in export revenue compared to no subsidies.

(3) Ratio of the gain in export revenue to the total subsidy costs.

Appendix

This appendix provides supplemental information on the restrictions on direct trading rights in China, the data sets used in this paper and robustness checks for the model.

A Restriction on Direct Trading Rights

China began to open up its economy in the late 1970s. Before a series of trade policy reforms, Chinese trade was dominated by a few Foreign Trade Corporations (FTC) with monopoly trading rights. By the end of 1978, there were less than 20 such FTCs and around 100 subsidiaries of these FTCs controlled by the central government. The Foreign Trade Law adopted in 1994 formalized the so called "approval system" of foreign trade rights. Restrictions on direct trading rights applied only to domestically-owned firms while foreign-invested firms automatically had direct trading rights. In 1998, the State Council approved the issuing of direct trading rights to private domestic entities whose registered capital, sales, net assets, and exports exceeded certain threshold levels. The thresholds were reduced and the restrictions eliminated over the period 2000 to 2004 as part of the accession agreement for joining the WTO. The details of the rules governing the ability to trade directly in the period 1999-2004 are laid out in Table A.1 below. Before 2001, private domestic firms faced multiple threshold requirements as explained above, but after 2001, they only needed to qualify in terms of their registered capital. Until 2001, they needed to formally apply for approval while after 2001, approval was automatically given.

Before 2001, State or Public-owned enterprises and firms in Special Economic Zones faced thresholds only on registered capital. In 2001, the requirements were made homogeneous across all types of firms, other than those in SEZs, whose requirements were less restrictive. In the middle of 2001 and then again later on, this common threshold for registered capital was lowered. By July 2004, the Chinese government removed all restrictions on direct trading rights.

Firms in Pudong were only treated differently from other firms (of the same type) in that the registered capital requirement was reduced for them in 2002, a year and a half before it was reduced for other firms.

B Data Matching

This section provides detailed information on the quality of the match between the firm-level survey data and the transaction-level customs data used in this paper. The difficulty

of matching these two data sets lies in the fact that the firm identification codes used in the two data sets are completely different. Thus we matched the data on the basis of firm name, region code, address, legal representative, and other information that identifies the firm. Firms were matched in multiple dimensions and a score was assigned which increased with the dimensions in which the records matched. All matches above a cutoff score were accepted. Below the cutoff, each case was manually examined.

Table A.2 and Table A.3 provide information on the percentage of the total number of exporters and total value of exports matched based on the customs data. In each of these two tables, the first horizontal panel shows the number of exporters or the value of exports accounted for by intermediaries. Below this is their share of the total. As in Ahn et al. (2011), we identify intermediaries in the customs data based on their names. For example, in 2004, intermediaries account for 18.1 percent of the total number of exporters. This means that in 2004, 81.9 percent of the total exporters are producing exporters, matched, unmatched, and unsurveyed.

The second horizontal panel of these two tables shows the number of exporters or the value of exports that have been matched. Below this is their share in the total. From the second panel of A.2, we can see that 46.8 percent of the total number of exporters observed in the customs data are matched with the firm-level data in 2004.

The third horizontal panel then shows the share of exporters that are unmatched or unsurveyed or the exports that are accounted for by these exporters. Below this is their share in the total. We can see that we have matched about 50 percent of the data in terms of the number of producing exporters and about 80 percent in terms of export values that belong to these producing exporters.

We can better understand the third panel by looking at the Census data. Based on the Census data from 2004, 39 percent of the producers who export are below the Census threshold and account for 2 percent of the total export value.

C Inferred Export Modes

This section examines the robustness of our definition of indirect and direct exporters by comparing the ever matched and never matched indirect exporters. Ever matched indirect exporters are the inferred indirect exporters who have been matched at least once with the customs data. Once these exporters are matched, we know their identification number in the customs data and are able to track their export modes over time. They are the ones who we can see switching between indirect and direct export modes. Never matched indirect exporters are the ones who could be wrongly labeled as indirect exporters, just because they

are not matched with the customs data in any sample year. Could these never matched indirect exporters actually be *unmatched* direct exporters? This is what we want to check.

We estimate the predicted probability of each firm-time observation being (observed as) a direct exporter using a Probit model.

$$e_{it} = \mathbb{1}\left[\beta e_{it-1} + \eta D_{omt} + X_{it}\phi + \nu_{it} > 0\right]$$

e_{it} equals one if exporter i is directly exporting (or being matched with the customs data) at time t. D_{omt} is a set of ownership, industry and time dummies and X_{it} includes other firm-time level covariates such as log capital, log employee, eligibility of direct trading rights, log revenue, previous export modes, etc. Figure A.1 compares the distribution of the predicted probability of being a direct exporter for firms we classify as direct exporters, ever matched indirect exporters, never matched indirect exporters and non-exporters.

From these histograms we can see that the distribution of the never matched looks like it lies between that of non-exporters and ever matched indirect exporters, which makes them closer to indirect exporters than to direct exporters. This gives us some confidence that we are not mis-classifying firms. We further examine the robustness of our model to alternative definitions of export modes in the next section.

D Robustness Checks

In this section, we re-estimate the first stage of our model with alternative definitions of export modes. For example, we treat processing and producer intermediaries as alternative modes. These are dropped in our baseline estimation. We also allow for differences in the evolution of productivity according to product exported and the destination of exports. We also control for other firm decisions, like importing intermediates and doing R&D that may affect productivity.

D.1 Definition of Export Modes

In Table A.4, we report the estimates of productivity evolution based on five variations. The baseline estimation is given in the first column. The second column shows the estimates reclassifying which firms are direct versus indirect exporters. An issue that could arise is that delays in the customs could make us wrongly classify firms. For example, a firm exporting at the end of a calendar year could report positive exports though its shipments only show up in the following year. Such firms would be wrongly classified as indirect exporters though they are really direct ones. To deal with this we redefine firms that report positive exports in year

t who do not show up in the customs data and have records of exporting in the customs data during the first two months in year $t+1$ as direct exporters in t.[36] Column 2 in Table A.4 shows that this reclassification does not change the estimates of the productivity evolution.

The third column shows the results when we include "producer intermediaries" as a separate type of export mode. "Producer intermediaries" are firms that do not report exports in the survey data and show up in the customs data. They comprise about 4 percent of the observations in the survey data. As we can see from column 3, producer intermediaries have a slightly better productivity evolution than do direct exporters. We also do the same exercise for processing firms and report the results in column 4. Processing firms are somewhere in between indirect and direct exporters in their productivity evolution. Also note that the coefficients on direct and indirect exporters are pretty stable across all the first four columns.

The last column shows the estimates when we use the ratio of direct exports to all exports (i.e., the exports in the customs data relative to the survey data) as a continuous measure of export mode instead of the dummy variables we used originally. The positive and significant coefficient on this variable confirms our results that the more the firm exports directly, the larger are the learning-by-exporting effects.

D.2 Other Dimensions and Firm Activities

Firms may also differ in other dimensions in their exporting behavior. Could this be what lies behind our results? For example, direct exporters tend to sell to easier (i.e., rich and close) markets. If sales grow faster in such markets, we could be spuriously obtaining our results. Direct exporters are differentiated by their exports to rich markets, and the goods they export. Firms that export more than 50 percent to rich and close countries are seen as selling to rich destinations. Goods that are handled primarily ($> 50\%$) by intermediaries are called intermediated products. Columns 2 and 3 in Table A.5 show that direct exporters who sell intermediated products or sell to easier markets have the same productivity evolution as others. Column 4 shows the estimates when we control for the propensity for a shipment to be sold by an intermediary, aggregated to the firm level. We find no significant change in the patterns of the coefficients of interest. Thus, though direct exporters do sell different products and to different countries than do indirect ones, this is not what lies behind their difference in productivity growth.

Finally, in the last table we examine the effects of other controls on productivity evolution. Firms can be actively increasing their registered capital to obtain direct trading rights and in turn affecting their productivity. Column 2 shows the estimates when we drop firms who

[36] Other possible cases of such types of mis-identifications are also checked and not discussed here.

are ineligible to export directly from the data. Columns 3 and 4 add controls for firms in investing in R&D or importing.[37] We see that R&D has positive effects on the evolution of productivity as in Aw et al. (2011). The smaller effects of learning-by-exporting are possibly due to the short time series of the data. Nonetheless, we still find that direct exporters experience better learning-by-exporting effects on productivity. Being an importer is not significant in the evolution of productivity. Column 5 controls for the propensity of being a direct exporter in the previous period. This is also irrelevant. Note also that the learning-by-exporting patterns we see in the baseline estimation are robust throughout.

[37]Column 3 uses a shorter panel of data given the unavailability of R&D information in the earlier years of the data set.

Table A.1: Policy and Changes 1999-2004

Time	1999 - 2000	1/2001 - 6/2001	7/2001 - 12/2001	1/2002 - 8/2003	9/2003 - 6/2004
SEZ	•Reg.K $\geq$ 2M •Register	•Reg.K $\geq$ 2M •Register	•Reg.K $\geq$2M Reg.K $\geq$1M if M&E •Register	•Reg.K $\geq$2M Reg.K $\geq$1M if M&E •Register	•Reg.K $\geq$0.5M •Register
Pudong New Area	No difference from the rest of China	No difference from the rest of China	No difference from the rest of China	•Reg.K$\geq$0.5M •Register	•Reg.K $\geq$0.5M •Register
State or Public Owned Domestic Firm	•Reg.K $\geq$5M Reg.K $\geq$3M if MW Reg.K $\geq$2M if M&E Reg.K $\geq$2M if Inst. •Register	•Reg.K $\geq$5M Reg.K $\geq$3M if MW Reg.K $\geq$2M if M&E Reg.K $\geq$2M if Inst. •Register	•Reg.K $\geq$3M Reg.K $\geq$2M if MW Reg.K $\geq$1M if M&E Reg.K $\geq$1M if Inst. •Register	•Reg.K $\geq$3M Reg.K $\geq$2M if MW Reg.K $\geq$1M if M&E Reg.K $\geq$1M if Inst. •Register	•Reg.K $\geq$0.5M •Register
Private Owned Domestic Firm	•Reg.K $\geq$8.5M Net Assets $\geq$8.5M Sales $\geq$50M for 2 yrs Export$\geq$1M USD Sales$\geq$30M if M&E •Apply for Approval	•Reg.K $\geq$5M Reg.K $\geq$3M if MW Reg.K $\geq$2M if M&E Reg.K $\geq$2M if Inst. •Apply for Approval	•Reg.K $\geq$3M Reg.K $\geq$2M if MW Reg.K $\geq$1M if M&E Reg.K $\geq$1M if Inst. • Register	•Reg.K $\geq$3M Reg.K $\geq$2M if MW Reg.K $\geq$1M if M&E Reg.K $\geq$1M if Inst. • Register	•Reg.K $\geq$0.5M •Register

Source: Ministry of Commerce of China;

M: Million Chinese Yuan; SEZ: Special Economic Zones; Reg. K: Registered Capital; M&E: Mechanical and Electrical products; MW: Midwest; Inst.: Research Institution;

Table A.2: Data Match: Number of Exporters

Match Status		2000	2001	2002	2003	2004	2005	2006	Total
(1)	Number	8,116	8,931	10,657	14,520	21,813	29,367	41,543	134,947
	Percentage	12.9	13.0	13.6	15.2	18.1	20.5	24.3	18.2
(2)	Number	23,708	27,704	32,383	38,425	56,313	58,537	63,209	300,279
	Percentage	37.8	40.5	41.2	40.2	46.8	40.8	37.0	40.6
(3)	Number	30,900	31,824	35,531	42,685	42,239	55,682	65,941	304,802
	Percentage	49.3	46.5	45.2	44.6	35.1	38.8	38.6	41.2
Total	Number	62,724	68,459	78,571	95,630	120,365	143,586	170,693	740,028

Source: Chinese Customs 2000-2006.

Match status: (1) Intermediaries; (2) Matched producers; (3) Unsurveyed and unmatched producers.

Table A.3: Data Match: Value of Exports

Match Status		2000	2001	2002	2003	2004	2005	2006	Total
(1)	Value	87.8	86.9	98.8	121.2	151.5	183.4	229.8	959.2
	Percentage	35.3	32.6	30.4	27.7	25.6	24.1	23.8	26.7
(2)	Value	111.6	130.9	168.5	243.5	372.9	469.7	589.4	2086.4
	Percentage	44.9	49.1	51.8	55.7	62.9	61.8	61.0	58.0
(3)	Value	49.4	48.7	57.7	72.8	68.1	107.0	147.3	551.1
	Percentage	19.9	18.3	17.8	16.6	11.5	14.1	15.2	15.3
Total	Value	248.8	266.5	325.0	437.5	592.5	760.1	966.5	3596.7

Source: Chinese Customs 2000-2006. Values in Billion US dollars.

Match status: (1) Intermediaries; (2) Matched producers; (3) Unsurveyed and unmatched producers.

Figure A.1. Matched and Never Matched Indirect Exporters

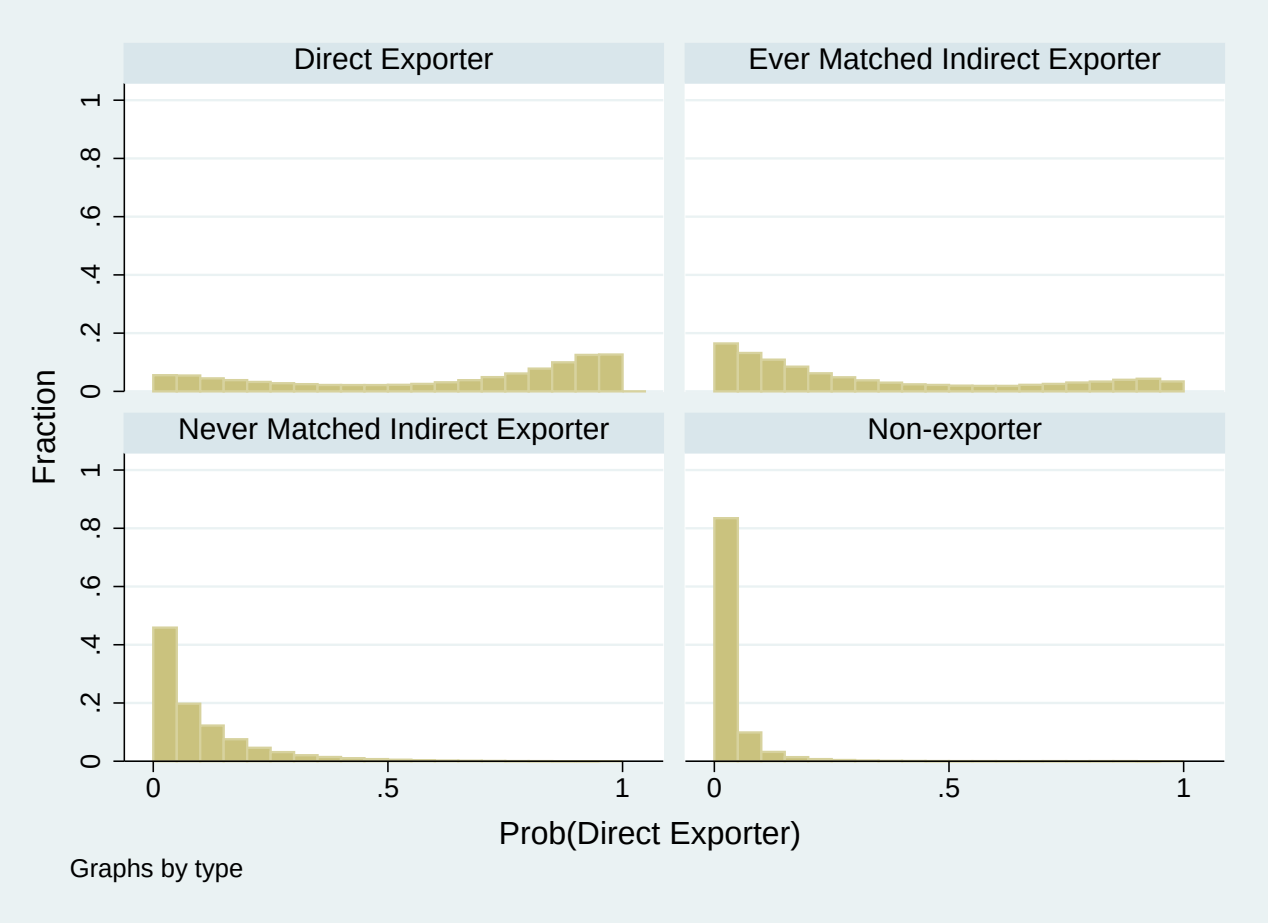


Table A.4: Productivity Evolution: Alternative Definitions of Export Modes

		(1)	(2)	(3)	(4)	(5)
			Customs			
		Benchmark	Delay	Intermediary	Processing	DE Ratio
Capital	β_k	-0.036***	-0.036***	-0.036***	-0.034***	-0.031***
		(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
Constant	α_0	0.637***	0.638***	0.591***	0.771***	0.573***
		(0.036)	(0.036)	(0.029)	(0.046)	(0.048)
$\boldsymbol{\omega}_{t-1}$	α_1	0.194***	0.191***	0.197***	0.108	0.203**
		(0.071)	(0.071)	(0.060)	(0.083)	(0.090)
$\boldsymbol{\omega}^2_{t-1}$	α_2	0.309***	0.310***	0.334***	0.313***	0.356***
		(0.046)	(0.046)	(0.042)	(0.049)	(0.056)
$\boldsymbol{\omega}^3_{t-1}$	α_3	-0.034***	-0.035***	-0.042***	-0.032***	-0.051***
		(0.010)	(0.010)	(0.009)	(0.009)	(0.011)
Indirect Export$_{t-1}$	α_4	0.005**	0.005**	0.006***	0.006***	
		(0.002)	(0.002)	(0.002)	(0.002)	
Direct Export$_{t-1}$	α_5	0.023***	0.022***	0.022***	0.022***	
		(0.002)	(0.002)	(0.002)	(0.002)	
Intermediary$_{t-1}$				0.028***		
				(0.003)		
Processing$_{t-1}$					0.016***	
					(0.003)	
DE Ratio$_{t-1}$						0.029***
						(0.004)

***,** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A.5: Productivity Evolution: Products and Destinations of Direct Exporting

		(1)	(2)	(3)	(4)
		Benchmark	HS4 Product	GDP p/c	Prob(IE_{t-1})
Capital	β_k	-0.035***	-0.031***	-0.031***	-0.031***
		(0.001)	(0.001)	(0.001)	(0.001)
Constant	α_0	0.616***	0.581***	0.581***	0.581***
		(0.033)	(0.043)	(0.043)	(0.043)
$\boldsymbol{\omega}_{t-1}$	α_1	0.121*	0.081	0.082	0.082
		(0.071)	(0.088)	(0.088)	(0.088)
$\boldsymbol{\omega}^2_{t-1}$	α_2	0.386***	0.471***	0.470***	0.470***
		(0.052)	(0.060)	(0.060)	(0.060)
$\boldsymbol{\omega}^3_{t-1}$	α_3	-0.052***	-0.079***	-0.079***	-0.079***
		(0.012)	(0.013)	(0.013)	(0.013)
Indirect Export_{t-1}	α_4	0.005**	0.006**	0.006**	0.006**
		(0.002)	(0.002)	(0.002)	(0.002)
Direct Export_{t-1}	α_5	0.023***	0.021***	0.020***	0.016***
		(0.002)	(0.003)	(0.005)	(0.003)
Intermediated Product *DE_{t-1}			-0.006		
			(0.005)		
Rich Destination*DE_{t-1}				-0.002	
				(0.005)	
Prob(IE_{t-1})*DE_{t-1}					0.009
					(0.008)

***,** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A.6: Productivity Evolution: Potential Unobserved Heterogeneity

		(1)	(2)	(3)	(4)	(5)
			Eligible			
		Benchmark	Firms	R&D	Import	Prob(DE_{t-1})
Capital	β_k	-0.035***	-0.032***	-0.033***	-0.031***	-0.031***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	α_0	0.616***	0.763***	0.805***	0.581***	0.293***
		(0.033)	(0.050)	(0.061)	(0.043)	(0.061)
$\boldsymbol{\omega}_{t-1}$	α_1	0.121*	-0.244**	0.040	0.082	0.596***
		(0.071)	(0.100)	(0.097)	(0.088)	(0.123)
$\boldsymbol{\omega}^2_{t-1}$	α_2	0.386***	0.661***	0.377***	0.471***	0.169**
		(0.052)	(0.067)	(0.051)	(0.060)	(0.082)
$\boldsymbol{\omega}^3_{t-1}$	α_3	-0.052***	-0.115***	-0.048***	-0.079***	-0.021
		(0.012)	(0.015)	(0.009)	(0.013)	(0.018)
Indirect Export_{t-1}	α_4	0.005**	0.005*	0.004	0.006**	0.001
		(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Direct Export_{t-1}	α_5	0.023***	0.017***	0.010***	0.016***	0.014**
		(0.002)	(0.002)	(0.002)	(0.003)	(0.007)
$\text{R\&D}_{t-1}$				0.007*		
				(0.004)		
$\text{R\&D}_{t-1}$*IE_{t-1}				-0.008		
				(0.011)		
$\text{R\&D}_{t-1}$*DE_{t-1}				0.003		
				(0.007)		
Import_{t-1}					0.000	
					(0.005)	
Import_{t-1}*IE_{t-1}					0.000	
					(0.013)	
Import_{t-1}*DE_{t-1}					0.004	
					(0.007)	
Prob(DE_{t-1})						0.007
						(0.008)

***,** and * indicate significance at the 1%, 5% and 10% level, respectively.