How You Export Matters: Export Mode, Learning and Productivity in China[1]

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Abstract

Before 2004, private Chinese firms were not allowed to export directly, only through intermediaries, unless their registered capital was quite large. As part of joining the WTO, these restrictions were eliminated by 2004. While intermediaries can facilitate exports, especially by smaller firms, restricting the choice of export mode may well have unforeseen costs. If direct trading results in more opportunities to learn, both about technology and preferences, and so creates greater learning from exporting, such rules may end up slowing down export growth.

In this paper, we estimate a dynamic discrete choice model (using matched production and customs data for China) where firms choose their export status and 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.

Our results suggest that firms learn more from direct exporting than from indirect exporting. We also find that starting direct exporting requires significant start-up costs whereas starting indirect exporting is much cheaper. 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.

Policy experiments suggest that with learning-by-exporting, restricting direct trading rights is very costly comparing to the benefits from an established intermediary sector. However, if firms do not learn from exporting at all, the case is reversed due to the high costs associated with direct trading.

We see this as a first step in a larger research agenda of examining causes of China's remarkable export growth and the role of joining the WTO in explaining this.

1 Introduction

Before 2004, private Chinese firms were not allowed to export directly, only through intermediaries, unless their registered capital was quite large. These restrictions were eliminated as part of China's joining the WTO in 2001. While intermediaries can facilitate exports, especially by smaller firms, restricting the choice of export mode may well have unforeseen costs. If direct trading results in more opportunities to learn, both about technology and preferences, and so creates greater learning from exporting, such rules may end up slowing down export growth.

In this paper, we estimate a dynamic discrete choice model where firms choose their export status and mode, and recover not only the sunk and fixed costs of exporting that can vary by mode of export (direct or via an intermediary) and past choices on export mode (indirect exporter or non-exporter), but also differences in the evolution of productivity and demand, and hence long run profits, according to export mode. Our results suggest that firms learn more from direct exporting than from indirect exporting which in turn suggests that had China not restricted the ability of firms to export directly, it may have grown even faster!

We also find that starting direct exporting requires significant start-up costs whereas starting indirect exporting is much cheaper. 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. We see this as a first step in a larger research agenda of examining causes of China's remarkable export growth and the role of joining the WTO in this. In future work we hope to build on our work here to better understand the extent to which China's domestic reforms as a part of accession agreements for joining the WTO, contributed to its export growth and what part was due to more favorable tariff (MFN) treatment given to China as a member oft he WTO.

1.1 Understanding Intermediation

In recent years, the role played by intermediaries in international trade has become a topic of growing interest. There is substantial evidence that suggests

intermediaries facilitate international trade. About 80% 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. wholesaler and retailers account for approximately 11% and 24% of exports and imports (Bernard et al., 2007). In China, at least 35% of exports in 2000 and 22% in 2005 went through intermediaries (Ahn, Khandelwal, and Wei 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: they help firms match with potential trade partners and reduce information asymmetries (Rubinstein and Wolinsky, 1987; Biglaiser, 1993). Feenstra and Hanson (2004) have found 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 (Antras and Costinot 2009; Blum, Carlo, and Horstmann 2009), or has extended the model of Melitz (2003) and modelled intermediation as involving lower fixed costs than exporting directly, but lower variable profits as the intermediary takes his cut (Ahn, Khandelwal, and Wei 2011; Akerman 2010; Felbermayr and Jung 2009). These studies predict 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.

Based on the characteristics of a matched Chile-Colombia importer-exporter dataset, Blum, Claro and Horstmann (2010) develop a model of distribution technologies where firms choose a distribution technology, and predict that in equilibrium, more productive firms choose to distribute directly and less productive firms use the intermediation technology to reach foreign markets. Ahn, Khandelwal, and Wei (2011) set up a heterogeneous firm model to allow for an intermediary sector. Firm endogenously select their mode of export based on productivity. By looking at Chinese customs data, they provide evidence that firms sort into export modes based on productivity; exports by intermediaries are more expensive; and countries that are more difficult to access (higher trade

costs or smaller market sizes) have relatively more intermediated trade. Akerman (2010) models wholesalers as having economies of scope. They can spread the fixed cost of exporting over more than one good. In order to cover their fixed cost, wholesalers charge a markup between the manufacturer's price and foreign market final price. This markup causes productivity sorting among producers as regards export mode. Using Swedish cross-sectional data, he finds evidence to support the main predictions of his model that wholesalers export less per firm within a product category than do producers. However, it is worth noting that all of the above papers look for correlations between variables as predicted by theory, i.e., do reduced form analysis, rather than structural estimation.

In contrast, in this paper 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 verifying that the patterns in the data are consistent with their existence. We utilize panel data on Chinese firms, by combining firm-level production data and custom transaction level data. We examine the learning-by-exporting effect from different export modes. Firms choose their export status and mode (direct, indirect exporter or non exporter). Their decision depends on their expected future profits from each choice and current fixed or sunk costs. Using an intermediary (exporting indirectly) may help a firm to establish its own distribution network, learn about their potential in foreign markets, match with potential clients, invest in tailoring their products for foreign markets, and so reduce the sunk cost of entering as a direct exporter in the future. Firms are distinguished by their history of exporting. We recover sunk costs of direct exporting with and without a history of intermediated exporting. The differences in these costs confirms the intermediaries' role in helping indirect exporters becoming direct exporters.

We confirm the standard predictions of productivity sorting as regards export modes. We allow the choice of export mode to affect the evolution of productivity *and* of demand shocks. We can distinguish between the two through the lens of the model by looking at the evolution of prices and quantity. Prices track productivity given the modeling setup. Given the evolution of productivity, the evolution of quantity is then related to the evolution of demand shocks. We can

only estimate the evolution of foreign demand shocks *relative* to domestic ones, as the evolution of exports *relative* to domestic sales identifies the evolution of foreign demand shocks relative to domestic ones.

We find that engaging in direct exporting leads to higher learning-by-exporting effects than exporting through intermediaries in terms of the evolution of both productivity and relative demand shocks, which in turn reinforces the productivity sorting by self-selection. We also find evidence that less productive firms who have exported through intermediaries are more likely than non-exporters to become direct exporters in the future. This pattern is partly what makes the estimated sunk costs of starting to export directly, on average, be lower for firms that are already exporting indirectly. The data also shows that firms which export indirectly have a higher exit rate (from the export market) than firms who engage in direct exports. This is also consistent with differences in the fixed-sunk entry costs associated with the two exporting modes, as well as with productivity differences between the firms that select into the two export modes.

Our paper is closely related to the literature on firm export decisions and learning by exporting. The work of Dixit 1989a, 1989b, and Baldwin 1989, among others, drew attention to hysterisis created by sunk costs of entering the export market. Under the same dynamic framework, Bernard and Jensen (2004) examine the factors that increase the possibility of exporting in U.S. manufacturing plants, but find no effect of spillovers from the export activity of other plants, possibly due to significant entry costs. Das, Roberts and Tybout (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, Lach, and Tybout (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 causation of the correlation between firm productivity and export status runs from the former to the latter: more productive firms self-select into the export market. However, recent research on low income countries finds productivity improvement after entry. Van Biesebroeck (2005), for exam-

ple, reports evidence that exporting raises productivity for sub-Saharan African manufacturing firms. Aw, Roberts and Xu (2011) estimate a dynamic structural model of producers' decision rule for R&D investment and export, allowing for an endogenous productivity evolution path. They quantify the linkages between the export decision, R&D investment and endogenous productivity growth, and find that firms that select into exporting and/or R&D investments tend to already be more productive than their domestic counterparts, and the decision to export and R&D investments raise exporters' productivity levels further in turn. This paper builds on their work.[1]

One qualification needs to be made. 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 as well as manufacturing firms who directly export. In this paper we do not make this distinction.

2 Data

This analysis utilizes two Chinese datasets. The main dataset is firm-level data from Annual Surveys of Industrial Production from 1998 through 2007 conducted by the Chinese government's National Bureau of Statistics. This survey includes all of the State-Owned Enterprise (henceforth SOE) and non-SOEs with sales over 5 million RMB (about $600,000$ US dollars). The data contain information on the firms' ownership type, age, employment, capital stocks, revenues, profits, exports as well as the firm's industry, employment, capital stock, input values, output values, and export values. We use a second dataset, the Chinese Custom transaction data to identify firms' exports modes. This data have 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 2000-2007 period. This dataset includes basic firm information, the value of each transaction (in US dollars) by product and trade partner for 243 destination/source countries and $7,526$ different products in the 8-digit Harmonized System. We also match the firm level data with the customs transaction level

[1]We are grateful to Mark Roberts for sharing his code with us.

data.[2]

By merging the custom data with firm production data, we can identify the trade modes of the firms over 2000-2007. 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 custom dataset. According to the survey documentation, export value includes direct exports, indirect exports, and all kinds of processing and assembling exports. Even though not all of the firms in two datasets are perfectly merged due to different coverages, 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 custom dataset, as indirect exporters.[3]

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. The Chinese government issued trading licenses for certain products prior China's accession to the WTO and all domestic firms needed to apply for direct trading rights to do direct trading. 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 the FTCs controlled by the central government. An important and fully anticipated aspect of trade reform was the delegation of trading rights to more firms: over time, the government slowly granted more enterprises the ability to trade both directly and indirectly. To begin with in 1983, State-owned enterprises were allowed to trade. The Foreign Trade Law adopted on 1994 formalized the approval system of foreign trade rights. Foreign-invested firms automatically have direct trading rights. The restrictions on these rights apply only to domestically-owned firms. In Oct. 1998, the State Council approved the issuing of direct trading rights to private-domestic entities (producers, intermediaries, and research institutes) over a certain size in terms of registered capital. Specifically, firms that were domestically owned needed to have registered capital exceeding 3 million RMB (2 million for firms from central

[2]Details of this matching are available on request. We matched the data on the basis of firm name, region code, address, legal person, etc. For example, in 2004, intermediary firms accounted for no less than 26.0% of the universe of the export values. Matched manufacturers accounted for 58.5%, small manufacturing firms (with sales below 5 million RMB) account for only 2% of exports, and left the 13% accounted by unmatched surveyed manufacturers.

[3]Firms that export directly and also do so indirectly are tagged as direct exporters.

and western China) to be eligible to apply for direct trading rights after July 2001, and this threshold was been dropped to .5 million in Aug 2003. In July 2004, Chinese government removed all restrictions on direct trading rights and firms no longer needed to apply for direct trading rights. To study firms' choice on export modes of both direct exporting and indirect exporting, we distinguish firms that were eligible to trade directly in each year, and the ones that were once not eligible. We assume that firms exogenously become eligible or ineligible in our model and restrict their export option sets accordingly.[4]

Another issue that we are careful to deal with is that processing and/or assembly trade are very different from other trade. The value added in processing trade tends to be lower and the kinds of contracts 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 from processing trade. As they account for about half of China's exports, we exclude these firms from our sample.

2.1 Summary Statistics

The main results of the paper focus on one industry: Manufacture of Rubber and Plastic Products (2-digit ISIC Rev3 25)[5]. In this paper, we abstract ourselves from modeling firms' entry and exit decisions, since the main focus of our study is firms' choice of export modes. Table 1 provides a summary of firms' export status and the modes of export over the sample years. On average, 82.9 percent of the firms were non-exporters, 7.7 percent were indirect exporters and 9.4 percent of

[4]Specifically, firms that were eligible are allowed to freely choose among direct exporting and indirect exporting while ineligible ones can only choose indirect exporting if they decide to export.

[5]We choose this industry based on two observations. First, this industry was not subject to other restrictions in 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% 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 confirm that our estimates are not biased by omitting R&D in the productivity evolution.

them were direct exporters. This is in line with the export participation rates found in other datasets suggesting that the export costs might be high enough so that more than 80 percent of the firms are non-exporters. The share of non-exporting firms has remained stable over time even though the number of firms increased a lot. However, the percentage of firms that exported indirectly has decreased from 9.7 percent to 5.3 percent, and that of direct exporters have increased from 7.6 percent to 11.3 percent. Ahn, Khandelwal, and Wei (2011) document a similar trend in all industries using customs data, and show that the share of indirect exports of total Chinese exports decreased from 35 percent to 22 percent from 2000 to 2005, while the total value of Chinese export tripled during that period. This decline in indirect exporting could be due to the removal of restrictions on exporting directly as a result of China's accession to the WTO and its removal of restrictions on direct trading (on both manufacturing firms and intermediaries) over the sample period.[6]

Table 2 provides some summary on the measures of firms sizes, measured in employment, capital stock, domestic sales and export sales. The average indirect exporter is more than twice as large, in terms of employment, as the 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 two times that of a average indirect exporter. These facts provide some preliminary evidence of productivity sorting. Larger firms tend to export and even larger firms choose to export directly. Firms need to be large and productive enough to cover the sunk costs and fixed costs of direct exporting. While on average, firms which export directly are larger than those export indirectly, which are larger than those who don't export, a strict hierarchy is not present in the data. The correlation between capital stock and export value is 0.697, and that of domestic sales and exports is 0.622, which 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

[6] 76.6 percent of the firms in the sample were not eligible for direct trading rights in 2000. This number dropped to 48.3 percent the next year, 7.4 percent in 2003, and all firms became eligible in 2004.

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 2 that the distribution of firm sizes and firm sales are highly skewed for exporting firms, and even more so among firms that export indirectly. In order to explain the existence of small exporters, we assume that fixed costs are randomly drawn in each period. 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.

2.2 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 3 reports the average transition of export status and export modes over the sample period. 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 no-exporting last period to no-exporting, export indirectly and export directly this period. On average, 96.6 percent of the firms that did not export last period remain non-exporters in this period. 2.6 percent of non-exporting firms transit into indirect exporting, while 0.8 percent of them transit into direct exporting. The high persistent rate of non-exporting firms staying as non-exporting firms suggests significant levels of sunk export costs that preventing firms to start exporting. The fact that it is on average easier for non-exporting firms to start indirect exporting rather than direct exporting would suggest that start direct exporting requires a higher sunk entry cost that less productive firms may not wish to cover.

The second row shows the transition rates of previously indirectly exporting firms. On average, 25.6 percent of the firms who exported indirectly last period stopped exporting this period, 62.8 percent of them remained indirect exporters, and 11.6 percent of them transited into exporting directly. Higher rates of switching from indirect exporter to direct exporter shows evidence that firms self-select into different export modes based on their productivity levels. It also suggests intermediaries' role in helping small firms to learn about foreign markets and

enabling them to enter foreign markets directly in later years.

The last row shows quite different transition rates for firms who exported directly in last period. On average, 91.7 percent of these firms remain direct exporters in current period, 6.3 percent of them transit into indirect exporting, and only 2.0 percent of them exit foreign market. Among exporting firms, the average exit rate of indirect exporters is almost 13 times higher than that of direct exporters. These very different entry and exit rates of the two export modes reflect very different cost structures for these two modes. The high entry rate of indirect exporters and high persistence in direct exporters may indicate a much lower sunk cost of indirect exporting than that of direct exporting. Productivity differences between indirect exporters and direct exporters can also explain the difference in exit rates of indirect exporters and direct exporters. Existing theoretical and empirical literature show that indirect exporters on average tend to be less productive than direct exporters, and thus more vulnerable to bad demand shocks. The patterns reported in Table 3 show the importance of distinguishing between indirect and direct exporters in studying their cost structures.

2.3 More Data Evidence

Besides the size rankings and different entry and exit rates, we show other potential differences between different modes of exporters in Table 4 in which we present results from three regressions. In the first column, we examine the dynamic effects of export modes on firms' revenue growth rate, while controlling for firms' size (proxied by lagged log revenue), growth rates of capital, material use, employee, log age and a sets of time and ownership dummies. From the estimated coefficients, we can see that being an indirect exporter (or a direct exporter) has positive (or positive and significant) effect on firms' growth rate comparing to non-exporters and being a direct exporter has higher positive effects. This result suggest initial evidence of learning-by-exporting and potentially different level of learning from different modes of exporting. In the second column, we report estimates of a probit regression of directly exporting in period $t+1$. The explanatory variables are firms' period t export status, log revenue, log capital stock, log material use, log employee, log age, and a set of time and ownership dummies. The estimated coefficient on direct exporting status in period t shows the impor-

tance of sunk costs of direct exporting on the decisions of direct exporting. This is consistent with the high persistent levels of direct exporting firms continuing direct exporting we have seen in Table 3. The coefficient on indirect exporting status in period t is positive and significant indicating that exporting indirectly this period significantly increase the possibility of exporting directly next period, comparing the non-exporting firms. Again, this is consistent with the last column in Table 3 that it is much easier for indirect exporters than non-exporters to start direct exporting. The third column in this table reports estimates of regression of firms' growth rate of relative sales (export sales relative to domestic sales) on export mode and other firm characteristics. The positive and significant estimates on direct exporting status in period t indicates that direct exporters may growth faster in export market relative to domestic market comparing to indirect exporters. All these evidences motivate us to explore further the potentially different learning effects of different export modes on both productivity and demand.

3 Model

The structural model of exporting modes developed here is based on the models developed by Roberts and Tybout (2007), Aw, Roberts and Xu (2011) and Ahn, Khandelwal, and Wei (2011). When heterogeneous firms face decisions regarding exporting (in addition to always serving domestic market), they have three options - not to export, export by themselves and export through intermediaries ($d_{it}^m = \{0, 1\}, m = H\text{ome}, I\text{ndirect}, D\text{irect}$). Apart from different productivities and export demand curves, firms also face different entry cost and fixed cost of exporting. Based on firms current and expected future value, firms select into different export status and modes. In turn, these decisions can affect the future productivity and demand shocks of the firm.

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 exporter and trading intermediaries. The major costs manufacturing firms face to export directly come from market research, searching for foreign clients, setting up and maintaining foreign currency account, hiring

specialized accountant and custom declarant and 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, wage, warehouse rents and marketing constitutes of the major costs of trading intermediaries.

The advantage of exporting through intermediaries is that the manufacturers avoid much of the sunk start-up costs. For example, the costs generated from establishing their own foreign distribution networks, learning about bureaucratic procedures and dealing with paper works. Specifically in China, there are costs associated with applying for direct trading rights, which are part of the sunk costs of direct exporting. Also, firms avoid some fixed costs such as maintaining offices in the foreign market, warehouse rents, costs of monitoring foreign custom procedures, etc. Firms need to possess higher levels of productivity and higher foreign market revenue to overcome these costs to export directly. However, firms exporting indirectly will 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. As a result, for a given good, the indirect exporting price therefore exceeds that of direct exporting. Firms in turn receive a lower revenue from indirect exports compared to direct exports (Ahn, Khandelwal, and Wei 2011). If there is learning-by-exporting, the extent and process of learning may be different for these two 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 knowledge pass-through may not be as effective as that of directly exporting.

3.1 Static Decisions

We see that firms' domestic sales are not perfectly correlated with export sales. Firms may have different performances in foreign market and domestic market because of preference shocks. As in Aw, Roberts and Xu (2011), we allow for firm-market specific demand shocks to affect firms' performances in the foreign market. We assume domestic and export markets to be segmented from each

other, and firms engage in monopolistic competition in each market, such that each firm supplies a single variety of the final consumption good. Firms set their prices for each market by maximizing profit from that market, taking the price index as given, and do not compete strategically with other firms.

3.1.1 Demand Side

We assume consumers in domestic and foreign markets have CES preferences with elasticity of substitution σ^H and σ^X where $\sigma^H > 1$ and $\sigma^X > 1$. The utility functions in home and foreign market are given as below:

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

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

where H denotes the home market, and X the foreign market, i denotes the firm that provide variety i, and Ω^H $\left(\Omega^X \right)$ denotes the set of total available varieties in market H (X). We also assume that each firm's demand in export market in each period also depends on a firm-specific demand shock z_{it}. The corresponding price indexes in each market are given by

$$P_t^H = \left[\int_{i \in \Omega^H} \left(p_{it}^H \right)^{1 - \sigma^H} di \right]^{\frac{1}{1 - \sigma^H}} \tag{3}$$

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

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

$$q_{it}^H = \left(\frac{p_{it}^H}{P_t^H} \right)^{-\sigma^H} \frac{Y_t^H}{P_t^H} \tag{5}$$

$$q_{it}^{Xm} = \left(\frac{p_{it}^{Xm}}{P_t^X}\right)^{-\sigma^F} \frac{Y_t^X}{P_t^X} \exp(z_{it}), m = I\text{ndirect}, D\text{irect} \tag{6}$$

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} to capture possible firm-level heterogeneity other than productivity that affects firm's revenue and profit. Persistence in this firm-market specific shock introduces another source of persistence in firm's export status and mode, other than the sunk costs of exporting.

3.1.2 The Intermediary Sector

As in Ahn, Khandelwal, Wei (2011), we assume the intermediary sector is perfectly competitive. Intermediaries purchase goods from manufacturers at p_{it}^I, and incur an additional marginal cost to sell these goods abroad, which we assumed it to be a percentage $(\lambda - 1)$ of the original price. Thus the intermediary sells the good at price $p_{it}^{XI} = \lambda p_{it}^I$, and the corresponding demand is $q_{it}^{XI} = \left(\frac{p_{it}^{XI}}{P_t^X}\right)^{-\sigma^F} \frac{Y_t^X}{P_t^X} \exp(z_{it})$ from equation (6). This intermediary's cut can be thought of the commission or service fee, or it can be thought as any per-unit cost associated with re-packaging, re-labeling at the intermediary sector. So the price of indirectly exported goods is higher than that of directly exported goods.

Each period, in order to access the intermediary sector, firms must pay a matching or searching sunk cost to be matched with an intermediary firm to export indirectly, and a fixed cost to use the service provided by the intermediary firm that has been matched with them. This fixed cost can 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

$$\max_{p_{it}^I} \pi_{it}^{XI} = \left(p_{it}^I - mc_{it}\right) \left(\frac{\lambda p_{it}^I}{P_t^X}\right)^{-\sigma^X} \frac{Y_t^X}{P_t^X} \exp(z_{it}) \tag{7}$$

where mc_{it} denotes the firm's marginal cost of production, which we assumed to be same for local and foreign market, and P_t^X is the aggregate price index in the

export market. Thus the price the manufacturer charges the intermediary is [7]

$$p_{it}^{I} = \frac{\sigma^{X}}{\sigma^{X}-1} mc_{it} \tag{8}$$

3.1.3 Supply Side

We assume the following form of firms' short-run marginal cost, similar to Aw, Roberts and Xu (2011):

$$\ln mc_{it} = \ln\left[\frac{c(\boldsymbol{w}_{it})}{exp(\omega_{it})}\right] = \beta_0 + \beta_1\ D_i + \beta_2\ D_t - \omega_{it} \tag{9}$$

Firms' 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 a firm dummy to capture all the firm specific but time-invariant factor prices. Specifically, we allow firms with different sizes to have access to different factor prices. The short-run cost heterogeneity comes from the heterogeneity of firms' scales of production, captured by firm's capital stock, and their efficiencies of production ω_{it}. Constant marginal cost implies that firms make their static decisions for two markets separately.

Firms choose their optimal prices for the two markets after observing the markets demands and their marginal costs. Their profit maximizing prices for the domestic markets and direct exporting are in the form of constant mark-up $p_{it}^{H} = \frac{\sigma^{H}}{\sigma^{H}-1} mc_{it}$, $p_{it}^{XD} = \frac{\sigma^{X}}{\sigma^{X}-1} mc_{it}$, and the price of indirect exported goods is the price sold to intermediary plus the intermediary's cut $p_{it}^{XI} = \lambda \frac{\sigma^{X}}{\sigma^{X}-1} mc_{it}$.

Denote $a^{j} = (1-\sigma^{j}) \ln\left(\frac{\sigma^{j}}{\sigma^{j}-1}\right)$ and $\Phi_{t}^{j} = \frac{Y_{t}^{j}}{\left(P_{t}^{j}\right)^{1-\sigma^{j}}} j = H, X$. The revenues for

[7] As $\lambda^{-\sigma^{X}}$ multiplies the whole expression, price is not affected by the intermediaries cut and the usual markup rule applies.

home markets, exporting indirectly and exporting directly are as follows:

$$\begin{aligned} \ln r_{it}^{H} &= a^{H} + \ln \Phi_{t}^{H} + \left(1-\sigma^{H}\right)\left(\beta_0 + \beta_1\ D_i + \beta_2\ D_t - \omega_{it}\right) && (10) \\ \ln r_{it}^{Xm} &= a^{X} + \ln \Phi_{t}^{X} + \left(1-\sigma^{X}\right)\left(\beta_0 + \beta_1\ D_i + \beta_2\ D_t - \omega_{it}\right) && (11) \\ & \quad + z_{it} - d_{it}^{I}\left(\sigma^{X} \ln \lambda\right) \end{aligned}$$

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 has to forgo some of his revenue to the intermediary sector. Firm's revenue in each market depends on the aggregate market conditions, firm-specific productivity and capital stock, and the revenue in the foreign market also depends on firm's choice 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 Dixit-Stiglitz form of consumer preference and monopolistic competition, firm's home market profits can be written as:

$$\pi_{it}^{H} = \frac{1}{\sigma^{H}} r_{it}^{H}\left(\Phi_{t}^{H}, \boldsymbol{w}_{it}, \omega_{it}\right) \tag{12}$$

and profits from foreign market if firm export indirectly and directly are:

$$\begin{aligned} \pi_{it}^{XI} &= \frac{1}{\sigma^{X}} r_{it}^{XI}\left(\Phi_{t}^{X}, \boldsymbol{w}_{it}, \omega_{it}, z_{it}, \lambda\right) && (13) \\ \pi_{it}^{XD} &= \frac{1}{\sigma^{X}} r_{it}^{XD}\left(\Phi_{t}^{X}, \boldsymbol{w}_{it}, \omega_{it}, z_{it}\right) && (14) \end{aligned}$$

The short-run profits together with firms' draws from the sunk costs and fixed costs distributions are going to determine firms' decision to export and their choices of export modes.

3.2 Transition of State Variables

Each period, firms observe their current productivity, capital stock, demands from the two markets, foreign market demand shocks and make their decisions regarding exporting. This section describes the transitions of these state variables. To begin with, we assume productivity ω_{it} evolves overtime as a Markov process that depends on last period's productivity and firm's export decision - export or not, if yes, what mode of export. We use a cubic functional form to

approximate this evolution.

$$\begin{aligned} \omega_{it} &= g\left(\omega_{it-1}, d_{it-1}\right) + \xi_{it} \\ &= \alpha_0 + \sum_{k=1}^{3} \alpha_k \left(\omega_{it-1}\right)^k + \alpha_4 d^I_{it-1} + \alpha_5 d^D_{it-1} + \xi_{it} \end{aligned} \tag{15}$$

where $d^m_{it-1} = \{0,1\}, m = H\text{ome}, I\text{ndirect}, D\text{irect}$, are dummy variables that indicate firm i's export status/modes at period $t-1$. We assume exporting firm either export directly or indirectly.

Aside from allowing for the possibility of learning-by-exporting, we distinguish direct and indirect exporting in this process. Intuitively, less productive firms learn by indirect exporting and improve their productivities so that in the future they can export directly. Direct exporting may lead to faster and better learning. Direct exporters contact and communicate with foreign clients closely and the knowledge and/or expertise from overseas clients may pass through more efficiently. By allowing choice of export modes to endogenously affect the evolution of productivity, we can distinguish the role of learning-by-exporting from the observed productivity-sorting pattern. ξ_{it} is an $i.i.d.$ shock with mean 0 and variance σ^2_ξ that captures the stochastic nature of evolution of productivity, ξ_{it} is assumed to be not correlated with ω_{it-1}, d_{it-1}.

The firm's export demand shock is assumed to be a first-order Markov process with the constant term dependent on firms' previous export status and modes. 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.

$$\begin{aligned} z_{it} &= \psi_1 d^I_{it-1} + \psi_2 d^D_{it-1} + \eta_z z_{it-1} + \mu_{it} \\ & \quad \mu_{it} \sim N\left(0, \sigma^2_\mu\right) \end{aligned} \tag{16}$$

This source of persistent firm-level heterogeneity allows firms to have different performances in local and export markets, and together with stochastic firm-level entry costs, allows for imperfect productivity sorting into export modes. For computational simplicity, we assume firms' sizes, captured by capital stocks k_{it} changes exogenously over time and also we capture the market sizes Φ^H_t and

Φ_t^X by time dummies, which we also treated as fixed over time in the estimation.

3.3 Firm Dynamic Decisions

In this section, we model the firm's dynamic decision about export modes. Each period, firm i observes it's current states and chooses to stay domestic, export indirectly or export directly. Firms must pay sunk start-up costs to initiate direct exports. We allow the sunk start-up cost of direct exporting to be dependent on firms' histories of indirect exporting status. Firm i incurs sunk cost γ_{it}^{HDS} if he did not export last period and γ_{it}^{IDS} if he exported through the intermediary sector last period. This allow us to incorporate the mechanism that the intermediaries might help small firms lowering future entry cost into direct exporting. For example, intermediaries can provide a match with foreign clients so that firms save on searching cost in subsequent periods when they start direct exporting. Intermediaries can also provide information on adjusting product characteristics or packaging style to fit in foreign market standards which may require purchases of special equipment. A history of exporting through intermediaries can help firms to decrease the sunk costs once they start export directly. Direct exporters also have to pay a fixed cost to maintain its access to the export market, γ_{it}^{DF}.

Firms must pay a sunk cost to be matched with an intermediary firm to export indirectly. This cost could also be state dependent in so much as it is γ_{it}^{HIS} if the firm was previously not exporting, and γ_{it}^{DIS} if he was exporting directly. There is also a fixed cost required to access the intermediary sector γ_{it}^{IF}. We assume that firms who export indirectly have to pay the sunk cost in the current period if they were not using intermediary services the previous period.

Assume each of these costs are drawn from separate independent distributions G^{γ}.This implies that firm's past export modes are state variables in the firm's decision regarding current export modes. The state variables at time t for firm i are $s_{it} = \left(\omega_{it}, z_{it}, \boldsymbol{w}_{it}, \Phi_t^H, \Phi_t^X, \boldsymbol{d}_{it-1}\right)$. A firm's value function in year t, before he observes its fixed and sunk costs, can be written as:

$$V\left(s_{it}\right) = \int \max_{\boldsymbol{d}_{it}} \left[u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.) + \delta E_t V\left(s_{it+1}\right)\right] dG^{\gamma} \tag{17}$$

where $u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.)$ is the current period payoff. $u(\boldsymbol{d}_{it}, s_{it} \left|\boldsymbol{\gamma}_{it}\right.)$ depends on last

period's status and mode of exporting and also the current period's decision regarding exporting status and mode.

$$\begin{aligned} u(\boldsymbol{d}_{it}, s_{it} \,|\boldsymbol{\gamma}_{it}) &= \pi_{it}^{H} + d_{it}^{I}\left[\pi_{it}^{XI} - \left(d_{it-1}^{H}\gamma_{it}^{HIS} + d_{it-1}^{I}\gamma_{it}^{IF} + d_{it-1}^{D}\gamma_{it}^{DIS}\right)\right] \\ &\quad + d_{it}^{D}\left[\pi_{it}^{XD} - \left(d_{it-1}^{H}\gamma_{it}^{HDS} + d_{it-1}^{I}\gamma_{it}^{IDS} + d_{it-1}^{D}\gamma_{it}^{DF}\right)\right] \end{aligned} \tag{18}$$

For example, if firm i exported indirectly last period and decides to export directly this period, then he has to pay the sunk cost of direct exporting γ_{it}^{IDS} and his current period payoff is $u(\boldsymbol{d}_{it}, s_{it} \,|\boldsymbol{\gamma}_{it}) = \pi_{it}^{H} + \pi_{it}^{XD} - \gamma_{it}^{IDS}$ and the continuation value depends on the evolution of productivity, demand shock and the market size of foreign market.

$$E_t V\left(s_{it+1}\right) = \int_{\Phi'}\int_{z'}\int_{\omega'} V\left(s'\right) dF\left(\omega' \,|\omega_{it}, d_{it}\right) dF(z' \,|z_{it}) dF\left(\Phi' \,|\Phi_t\right) \tag{19}$$

For any state vector, denote the choice-specific continuation value from choosing $d_{it}^{m} = \{0,1\}, m = H, I, D$, as $E_t V^{m} \equiv E_t V\left(s_{it+1} \,|d_{it}^{m} = 1\right)$. Firms' export decisions depend on the difference in the expected future returns comparing any two pair of the three options: do not export, export indirectly and export directly. The pairwise marginal benefits between any two options, specifically the marginal benefits from being an indirect exporter to staying domestic, the marginal benefits from being a direct exporter to no exporting, and the marginal benefits from being a direct exporter to being an indirect one are defined in equations (20), (21) and (22) respectively.

$$\Delta IH = \pi_{it}^{XI} + \delta\left(E_t V^{I} - E_t V^{H}\right) \tag{20}$$

$$\Delta DH = \pi_{it}^{XD} + \delta\left(E_t V^{D} - E_t V^{H}\right) \tag{21}$$

$$\Delta DI = \pi_{it}^{XD} - \pi_{it}^{XI} + \delta\left(E_t V^{D} - E_t V^{I}\right) \tag{22}$$

For example, the benefits firm gains from choosing to export directly comparing to export indirectly can be decomposed into static benefit and dynamic benefit. The static gain is the difference between the current-period payoff from these two modes of exporting $\pi_{it}^{XD} - \pi_{it}^{XI}$. The latter part, the difference between the

discounted future payoff from these two modes of exporting $\delta\left(E_tV^D - E_tV^I\right)$ captures the dynamic part of the pairwise benefit. These three values depend on the sunk costs and fixed costs of exporting modes and impact of exporting modes on future productivity if firms learn from exporting. Intuitively, higher fixed costs of exporting will decrease the marginal benefits as being an exporter and higher sunk costs will increase it. If firms learn more through direct exporting, ΔDI will be positive if everything else is the same. It also depends on the service fee λ that the intermediary sector would charge for its services. As a result, firm's choice of each option depends on the relationships between the sunk or fixed costs that would incur given the current state, and the differences in the expected future returns. For example, firm i who is currently not exporting will choose to export directly if the sunk costs of starting direct exporting as a non-exporter γ_{it}^{HDS} is smaller than the marginal benefits of being a direct exporter to staying domestic (ΔDH), and at the same time, the difference between sunk costs of starting direct exporting and indirect exporting as non-exporter $\left(\gamma_{it}^{HDS} - \gamma_{it}^{HIS}\right)$ is smaller than the marginal benefits from these two modes (ΔDI). Firms make draws from the sunk and fixed costs distributions each period independently, but the marginal benefits of each options over the other has some persistence due to the persistence in firms' productivity levels and the firm-level demand shocks z_{it} in the foreign market. [8]

4 Estimation

We estimate the model using a two-stage estimation method using firm-level panel data on domestic market revenue, inputs of production, export market participation, the modes they used, and export market revenue. In the first stage of the estimation, we estimate the firms static decisions of production to recover the estimates of domestic revenue function and the estimates of productivity evolution process. In the second stage, we exploit the information on firms' discrete choice regarding export market participation modes and the productivity measure recovered from the first-stage estimation to estimate the parameters on

[8]For the ineligible firms, they can only choose to stay domestic or export indirectly, and their export dynamic problems are adjusted accordingly. We omit the detailed equations here since it is merely a special case of the more general problem of eligible firms.

the sunk and fixed costs of two exporting modes. Our estimation strategy is based on the model of Das, Roberts and Tybout (2007) and Aw, Roberts and Xu (2011). We recover the following parameters in the first-stage estimation: the elasticities of substitution in two markets, σ^H and σ^X and home market size intercept Φ_t^H, the marginal cost parameters β_0 and β_1, 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, μ_z, ψ_1, ψ_2 of Markov process z_{it}, foreign market size intercept Φ_t^X and the intermediary service fee λ will be recovered from second-stage estimation.

4.1 Productivity Evolution

Following the methods in Aw, Roberts and Xu (2011), we estimate the productivity evolution function by rewriting the domestic revenue function (**??**) as a function of firm capital stock, productivity level, time dummies, a time-invariant dummy and an *i.i.d.* error term. As in Olley and Pakes (1996) and Levinsohn and Petrin (2003), we rewrite the productivity conditioning on the capital stock as function of firm's choice of material levels m_{it}. Then the domestic revenue function can be written as the second equation in (23), where function $h(k_{it}, m_{it})$ comes from $\omega_{it} = \omega_{it}\left(k_{it}, m_{it}\right)$.

$$\begin{aligned} \ln r_{it}^H &= \phi_0 + \sum_{t=1}^{T} \phi_t D_t + \left(1 - \sigma^H\right)\left(\beta_k \ln k_{it} - \omega_{it}\right) + u_{it} \\ &= \phi_0 + \sum_{t=1}^{T} \phi_t D_t + h\left(k_{it}, m_{it}\right) + v_{it} \end{aligned} \tag{23}$$

We estimate function (23) using ordinary least squares and approximating $h\left(k_{it}, m_{it}\right)$ by a third-degree polynomial of its arguments. After we have recovered the value of $h\left(k_{it}, m_{it}\right)$, we estimate the parameters of productivity evolution function in (15) using non-linear least squares by substituting $\omega_{it} = -\left(\frac{1}{1-\sigma^H}\right)\hat{h}(k_{it}, m_{it}) + \beta_k \ln k_{it}$ into equation (15).

Given our estimates from last step, in order to construct our final measurement of productivity ω_{it}, we need the estimates of the elasticity of substitution. We follow the method in Das, Roberts and Tybout (2007) and utilize the constant

markup from our assumptions of monopolistic competition with Dixit-Stiglitz preference. Since the prices each firm charges has a constant markup over the constant marginal costs, each firm's total variable cost (tvc) can be represented by its revenue and elasticities of each market. We estimate the third equation of (24) using data on home and export revenue and total variable cost (tvc_{it}) to recover the elasticities of substitution.

$$\begin{aligned} TVC_{it} &= mc_{it}q_{it}^{H} + mc_{it}q_{it}^{Xm} \\ &= \left(\frac{\sigma^{H}-1}{\sigma^{H}}\right) p_{it}^{H}q_{it}^{H} + \left(\frac{\sigma^{X}-1}{\sigma^{X}}\right)\left[d_{it}^{D}p_{it}^{XD}q_{it}^{XD} + d_{it}^{I}p_{it}^{I}q_{it}^{XI}\right] \end{aligned} \tag{24}$$

4.2 Dynamic Estimation

Based on the estimated parameters of productivity evolution in the first-stage estimation and the constructed productivity measure, we estimate the parameters of export costs and process of foreign market demand shocks. We exploit information on the transitions of export status and modes and export revenues of exporting firms to estimate this dynamic multinomial discrete choice model. Intuitively, sunk entry costs of each export mode are identified by the entry frequencies into this mode across plants given their previous exporting status and mode. Exit frequencies among indirect and direct exporters and their export revenues help to identify the fixed costs of different export modes. Firms tend to stay in their current exporting status and mode if sunk cost of entering foreign market in particular export mode is high and fixed costs is relatively low. We would have observed frequent exits from exporting market if fixed cost of maintaining foreign presence or access to intermediary sector is high. Specifically, sunk entry costs of starting indirect exporting and direct exporting as non-exporters can be identified by the transition frequencies of non-exporters; indirect exporting fixed cost and sunk cost of starting direct exporting as indirect exporters can be identified by the transition frequencies of indirect exporters; finally the transition frequencies of direct exporters help to identify the direct exporting fixed cost and sunk cost of starting indirect exporting as direct exporters. Given firms' productivity levels and capital stock, the level of export revenues of both types of exporters provide information on the foreign market demand shocks and the extra margin

that intermediary sector charges for indirect exporting. In this version of the paper, we fix the intermediary margin parameter λ at 1.02, which means a 2% of extra margin on the price of indirect exported goods.

We estimate the model by maximizing the likelihood function for the observed participation and modes of exporting and export revenue. We observe firms' discrete choices of export modes and their export revenue only if they participate in export market. Since firm export revenue is determined by firm productivity, capital stock, market size and the foreign market shocks, we can write firm i's contribution to the likelihood function as

$$P\left(\boldsymbol{d}_i, r_i^{Xm} \left| \omega_i, k_i, \Phi \right.\right) = P\left(\boldsymbol{d}_i \left| \omega_i, k_i, \Phi, z_i^+ \right.\right) h\left(z_i^+\right) \tag{25}$$

where $h(\cdot)$ 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 likelihood function, we followed Das, Roberts and Tybout (2007) and Aw, Roberts, Xu (2011) to construct the density $h(\cdot)$ and simulate the export market shocks.

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.[9] These choice probabilities are conditioned on firms' state variables of the period and specifically firms previous export status and mode. Recall that a firm's choice of exporting status and its mode depends on the relationships between the sunk or fixed costs that would incur given its previous status and mode, and the differences in the expected future returns. Previous export status and mode determine whether the firm pays the sunk cost to enter or the fixed cost to remain in current period, and which kind of sunk cost or fixed cost. Specifically, the probability of exporting indirectly is:

$$\begin{aligned} P_{I\left|\boldsymbol{d_{it-1}}\right.} &= \Pr[d_{it-1}^H \gamma_{it}^{HIS} + d_{it-1}^I \gamma_{it}^{IF} + d_{it-1}^D \gamma_{it}^{DIS} \\ &< \min\left\{\Delta IH, d_{it-1}^H \gamma_{it}^{HDS} + d_{it-1}^I \gamma_{it}^{IDS} + d_{it-1}^D \gamma^{DF} - \Delta DI\right\}] \end{aligned} \tag{26}$$

[9]Derivation of these choice probabilities is given in the appendix.

The probability of exporting directly can be written as:

$$\begin{aligned} P_{D|\boldsymbol{d_{it-1}}} &= \Pr[d^H_{it-1}\gamma^{HDS}_{it} + d^I_{it-1}\gamma^{IDS}_{it} + d^D_{it-1}\gamma^{DF} \\ &< \min\left\{\Delta DH, d^H_{it-1}\gamma^{HIS}_{it} + d^I_{it-1}\gamma^{IF}_{it} + d^D_{it-1}\gamma^{DIS} + \Delta DI\right\}] \end{aligned} \tag{27}$$

5 Estimation Results

We present our results in three parts below. First, we report the estimates of demand, marginal cost and productivity evolution of the interested industry Rubber and Plastic along with some other industries. We then confirm the pattern of productivity sorting regarding different export modes. In the end, we report the results of the dynamic estimation which includes different types of export costs and the evolution of foreign demand shocks.

5.1 Productivity Evolution

The estimates of the revenue function as well as the productivity evolution are reported in Table 5. In the first column, we report our estimates of the Rubber and Plastic industry. We see that the home market elasticity of substitution is slightly higher than that of foreign market, which implied a markup of price over marginal cost of 25 percent in home market and 27 percent in foreign market. The estimate of the coefficient of log-capital is -0.029, which is consistent with our intuition that marginal cost of production is decreasing with the capital stock, which is a measure of scale of production. The coefficients α_1, α_2 and α_3 gives our cubic approximation of the effect of ω_{t-1}, ω^2_{t-1} and ω^3_{t-1} on ω_t and implies a non-linear and positive marginal effect of lag productivity on current productivity. The coefficient on last period's indirect exporting status α_4 and last period's direct exporting status α_5 implies significantly positive effects of exporting on productivity. Past indirect exporters have productivity that is 0.5 percent higher than non-exporters while past direct exporters have productivity that is 2.0 percent higher. The magnitude of α_5 is four times as that of α_4 and implies that direct exporting has a higher impact on productivity than indirect exporting. This result confirms the trade-off between direct and indirect exporting in terms

of learning, where direct exporting has a larger learning-by-doing effect in productivity evolution and would lead to a higher expected future payoff that comes from both local market returns and foreign market returns. [10]

In columns $2-6$ of Table 5, we also report our estimates of the productivity evolution process on five other industries - Paper Products (2-digit ISIC Rev3 21), Chemical and Chemical Products (2-digit ISIC Rev3 24), Machinery and Equipment (2-digit ISIC Rev3 29), Electrical Machinery and Apparatus (2-digit ISIC Rev3 31) and Radio, TV and Communication equipment (2-digit ISIC Rev3 32). We can see that even though different industries have different functional form of the productivity evolution and magnitudes of learning-by-exporting effects, direct exporting always has larger effects on firm productivity than indirect exporting. For example, in Paper Products industry, previous indirect exporting status has no effect on productivity while firms that previously directly exported has 2.2 percent increase in their productivity levels. Comparing to other industryies, the learning-by-exporting effect is relatively larger for Radio, TV and Communication equipment industry that being exporters last period will have 1 percent to 3.8 percent higher productivity than non-exporters.

5.2 Productivity Sorting

We construct our measures of productivity based on the estimates in the first column in Table 5. The mean of our productivity measure is 0.166, and the $(5th,\ 50th,\ 95th)$ percentiles are (-0.070, 0.201, 0.642). 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 $(5th,\ 50th,\ 95th)$

[10] For robustness checks, we examine our specification of the productivity evolution by adding two more dummy variables in addition to the export modes terms. A number of Chinese firms have changed their ownership during the sample years, especially State-owned enterprises and Collectively-owned enterprises, and this may have impact on their productivity levels. We add the dummy variable to capture the change of ownership between previous period and current period into the productivity evolution process. We found a non-significant negative effect of changing ownerships. This may be due to the negative impact from short-term shocks to human resource structure, change of production process of certain products, and change of managing style. We also found no significant effect of long-term investments on productivity. However, since this long-term investment variable lumps all kinds of investments and we cannot tell the specific form of this investment from the dataset we have, we cannot say that there is no effect on productivity evolution from all kinds of investments.

percentiles of the three types of firms are (-0.084, 0.180, 0.585), (-0.011, 0.260, 0.650) and (0.024, 0.385, 0.851) respectively. We also performed t-tests to compare the means of any two groups of firms and the corresponding two-tailed p-values are all less than 0.001. We can conclude that the means of the productivity distributions of non-exporters, indirect exporters and direct exporters are significantly different from each other. Figure 1 shows the kernel density estimates of these three distributions. The red dash-dot curve at the left is the kernel density of non-exporters, the orange dash curve in the middle is the kernel density of indirect-exporters and the blue solid curve is the density of direct exporters. 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 we observe here.

5.3 Dynamic Estimates

In this section we report the estimates of the dynamic discrete choice model. The first estimates describes the the foreign market size which is smaller than that of domestic market which we estimated in the first-stage estimation. The coefficients $\gamma^{HIS}, \gamma^{HDS}, \gamma^{DIS}, \gamma^{IDS}$ reported in Table 6 are the mean parameters of exponential distributions for, respectively, the sunk cost of starting indirect exporting as non-exporter, starting direct exporting as non-exporter, starting indirect exporting as direct exporter, and starting direct exporting as indirect exporter. First, the sunk cost parameter of starting direct exporting as non-exporter γ^{HDS} is much higher that that of starting indirect exporting as non-exporter γ^{HIS}. This result is consistent with the observed transition pattern in the data and suggests that it is much less costly to enter indirect exporting market than direct exporting market. Comparing to start direct exporting as non-exporter, the sunk cost parameter of starting direct exporting as indirect exporter γ^{IDS} is also much lower, indicating that using intermediary to export in previous period helps firms to start direct exporting in current period by lowering its sunk costs. The relatively small entry cost parameter of starting indirecting export as direct exporter γ^{DIS} indicates that it is much easier for direct exporter than non-exporter to enter indirect exporting market. It is possibly because that most of the sunk entry cost of starting indirect exporting is related to activities

like adjusting production process or product quality to foreign market rather than searching or matching cost in intermediary sector.

The coefficients γ^{IF} and γ^{DF} are the parameters of exponential distributions for the fixed cost of indirect exporting and the fixed cost of direct exporting. First, for both modes of export, the estimated fixed cost is relatively small comparing to the sunk costs of starting such mode of exporting. This indicates that regardless of exporting status and mode, a plant will always be more likely to remain in export market than to enter the market. Second, the fixed cost parameters for direct exporting γ^{DF} is larger than that for indirect exporting γ^{IF}, indicating the advantage of using intermediary to export. The intermediaries are able to lower the average fixed cost per good exported as having economies of scope and spread the fixed cost of exporting over more than one good.

The last four parameters describe the stochastic process of foreign market demand shocks z. The parameters η_z and σ_μ characterize the serial correlation and standard deviation of z which is assumed to evolve as a first-order Markov process. The high serial correlation 0.903 shows the persistence in firm-level demand shocks and induce the 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 indicate the percentage increase in the demand shocks if firms were indirectly or directly exporting last period, comparing to the non-exporters. A value of 0.012 of ψ_2 with the persistence parameter at 0.903 indicates that on average the demand shocks of continuously direct-exporting firms are 12 percent higher than that of continuously non-exporters.

5.3.1 In-Sample Model Performance

We simulated the model using our estimates in Table 6 to assess the performance of the model. Specifically, we use the actual data of the initial year of the sample (2000) and simulate the next seven years' discrete choices of export modes and evolution of productivity based on simulated draws of foreign market demand shocks and export costs. Table 7 compares the actual and simulated mean productivity evolution over four years and the participation rates in each mode of export. Overall, the model predicts the evolution of productivity reasonably well

and slightly under predicts the participations of two export modes.

In Table 8, we report the actual and simulated transitions between each export status and mode. The simulated transitions for non-exporters which account for 83 percent of the sample are pretty 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 seems to slightly over estimate the fixed costs of two modes of exporting and thus under predict the persistent rates of indirect and direct exporters.

5.3.2 Pairwise Marginal Benefits of Different Export Modes

To further see the model prediction of the productivity sorting into different export modes, in this section we look at the pairwise marginal benefits of being indirect exporter and direct exporter comparing to being non-exporter (ΔIH ΔDH), and the pairwise marginal benefit of being direct exporter to being indirect exporter (ΔDI) at different productivity levels. Recall that these three values depend on the sunk costs and fixed costs of each export mode and impact of export modes on future productivity. In Table 9 we report the expected continuation values of being non-exporter (E_tV^H), indirect exporter (E_tV^I) and direct exporter (E_tV^D) and the pairwise marginal benefits of each export modes at the $5th$ to $95th$ percentiles of the productivity distribution. For example, for the firm with the $55th$ percentile productivity level 0.230, the future payoff of staying domestic is 159.52 million RMB on average, the future payoff is 172.46 million RMB on average as indirect exporter, and the firm expects 181.53 million RMB on average as direct exporter.

There are three distinct patterns to be noticed. In columns 1-3, the continuation values of being non-exporter, indirect exporter and direct exporter are all increasing in the productivity level, reflecting the vital role of productivity in firm profits. For each value of productivity, $E_tV^D > E_tV^I > E_tV^H$, suggesting a clear ranking of future payoffs due to the large start-up costs of exporting and learning-by-exporting effects. In the columns 4-5, 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 with 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 export and have to pay a large start-up cost, while exporters have a high probability of staying exporting and only have to pay relatively small fixed costs. The last 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. [11]

Table 10 reports the transition probabilities at different productivity levels. Together with Table 9, Table 10 shows, for example, 87.7 percent of non-exporters with productivity level 0.230 will have direct-export start-up cost γ^{HDS} higher than the marginal benefit ΔDH 36.73 million RMB and indirect-export start-up cost γ^{HIS} higher than marginal benefit ΔIH 27.07 million RMB, and stay in domestic market. In the first three columns, the probabilities of staying domestic are always decreasing in productivity and the probabilities of starting export (direct and indirect) as non-exporter are always increasing in productivity. Second, in the columns 4 and 7, the probabilities of exiting exporting as indirect exporter and direct exporter are always decreasing in productivity. Reported in column 5, the probabilities of indirect exporters staying as indirect exporters first increase in productivities among lower levels of productivities, then decrease as productivity rises. This is due to the model's prediction that indirect exporters with high levels of productivities will be able to cover the sunk cost of starting direct exporting and eventually self-select into direct exporting. This pattern is accompanied by column 6 that the probabilities of indirect exporters transiting into direct exporting always increase with productivity. Similar patterns can be seen in column 8. The probabilities of direct exporters transit into indirect exporting first increase and then decrease in productivities. This is due to the fact that direct exporters with lower productivities are more vulnerable to bad demand shocks and bad draws of fixed costs thus more likely to exit to indirect exporting.

[11] The choice-specific values and marginal benefits for ineligible firms have the same pattern as those for eligible firms. We omit the comparisons here for the sake of clean presentation. However, we do observe smaller continuation values of both staying non-exporting and indirect exporting comparing to those of eligible firms. This is coming from the less of options in their choice set and indicates the welfare cost of the restrictive government policy.

Given a firm's current productivity level, previous export status and mode, capital stock and the demand shock, the firm's draws of export costs will determine this firm's current decision of exporting. A previous direct exporter will stay direct exporting only if his draw of direct exporting fixed cost is smaller than both the marginal benefit to staying domestic and the sum of his draw of indirect sunk cost plus the marginal benefit to indirect exporting. Table 11 report the truncated mean of sunk and fixed costs of the firms that choose to export. These values are the means of the exponential distributions with our estimated parameters conditioning on that they are smaller than corresponding cut-off values so that firms would choose to stay in export market or enter export market. In other words, these are the "real" export costs that have actually incurred.

The columns 1 and 5 report the per period profits of indirect exporting and direct exporting. First, direct exporting always generate a higher per period profit than indirect exporting since the intermediary would charge a 2 percent fee for its service. Second, we compare the per period payoffs and fixed costs of indirect exporting and direct exporting in columns 1-2 and columns 5-6. The average per period payoff of indirect exporting and direct exporting can always cover the average indirect fixed cost at all levels of productivities. At all productivity levels, costs of starting direct exporting as non-exporter γ^{HDS} are always higher than the costs of starting indirect exporting as non-exporter γ^{HIS}. This is consistent with the transition patterns we observe in the data that non-exporters start indirect exporting at a higher rate than starting direct exporting, regardless of their productivity levels. The costs of starting direct exporting as non-exporter γ^{HDS} are also higher than starting direct exporting as indirect exporter γ^{IDS}, which implies that starting direct exporting becomes easier with the experience of exporting through intermediary. Except for the fixed cost of indirect exporting and the sunk cost of starting indirect exporting as direct exporter, the fixed cost of direct exporting and all other sunk costs are increasing in productivity. Firms with higher productivity levels can survive higher export costs and still make positive profits. The fact that the fixed cost of indirect exporting γ^{IF} and sunk cost of starting indirect exporting as direct exporter γ^{DIS} first increase with productivity and then decrease at higher levels of productivity coincides with the patterns in columns 5 and 8 we saw in Table 10. At very high productivity levels,

direct exporting is more profitable even with higher levels of fixed and sunk costs.

6 Direct Trading Rights Liberalization

The centralized economy before the reform in China has established and fostered a well developed intermediary sector and provided firms opportunity to engage in foreign trade with relatively low costs. Especially, it has facilitated smaller firms in international trade in a way that they may have not experienced if there is no or poor intermediary sector. However, at the same time, restricting direct trading rights have deprived firms with better learning opportunity and may have impeded firms' future growth in both domestic and foreign markets. In this section, we use the estimates from the model to evaluate the benefits and costs of this policy. Specifically, we use the actual data of the initial year of the sample and simulate the next fifteen years in three cases of two scenarios.

We allow firms to learn from exporting as we have estimated in the first scenario and compare the economy's [12] performances under three cases where there is no intermediary sector, or foreign trade is completely centralized and firms can only export through intermediaries, or there is a established intermediary sector and direct trading rights have been completely liberalized so that firms can freely choose between two export modes. Table 12 compares total domestic sales, total export sales, total profits, export participation rates and average productivity in the economy under these three cases. Clearly case 3 is the best case scenario and has the best performance of all. Case 1 where firms can only engage in direct exporting is better in all five measures than case 2 where firms can only export through intermediaries even if firms have to endure high sunk entry cost and fixed costs. This suggests that when firms can learn in productivity and demand, restricting direct trading rights is very costly, since improving productivity and demand shocks benefits firms significantly in both domestic and foreign market in the long run. Table 13 compares the same three cases in a scenario where we assume that firms cannot learn at all from exporting. In this scenario, since there is no long-run benefits of engaging in direct trading, firms can only be better-off if they can export with lower costs, even if they have to sacrifice part of their

[12] We restrict ourselves to a partial equilibrium case.

profits to the intermediary sector.

7 Conclusion

In this paper, we estimated a dynamic discrete choice model where firms choose their export status and mode, and recover different forms of sunk and fixed costs of exporting with the presence of intermediary trading. We also assume learning-by-exporting, and allow previous export status and modes to affect the evolution of firm-level productivity and foreign market demand shocks. Given their productivity levels, firms face the trade-offs between indirect exporting and direct exporting in terms of the per-unit revenue, sunk and fixed costs, and learning-by-doing from exporting. We showed that firms with the highest productivity levels self-select themselves into direct exporting, while firms with the intermediate productivities participate in indirect exporting, and firms with lowest levels of productivities stay in domestic market. We find that in industries where the export decision affects productivity growth and evolution of demand shocks, engaging in direct exporting leads to higher learning-by-exporting effects than exporting through intermediaries, which in turn reinforces the productivity sorting by self-selection. We also find that starting direct exporting requires significant start-up costs and starting indirect exporting is relatively cheaper. With better learning-by-exporting and higher sunk costs, direct exporting also leads to higher expected future payoff than indirect exporting and both leading that of being non-exporting. It is easier for firms with lower productivities to engage in indirect exporting first and then transit into direct exporting, given the lower start-up costs to start direct exporting as indirect exporter.

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Table 1: Composition of Firms

Year	Non-Exporter		Indirect Exporter		Direct Exporter		Total
2000	3500	82.7%	409	9.7%	322	7.6%	4231
2001	4686	84.0%	499	8.9%	392	7.1%	5577
2002	5104	83.7%	531	8.7%	460	7.6%	6095
2003	5537	83.2%	548	8.2%	571	8.6%	6656
2004	7653	82.6%	698	7.5%	919	9.9%	9270
2005	8359	81.8%	803	7.9%	1051	10.3%	10213
2006	9631	82.5%	876	7.5%	1172	10.0%	11679
2007	9094	83.4%	577	5.3%	1228	11.3%	10899

Table 2: Summaries of Firm Size

Export Status		Employee	Capital	Domestic Sales	Export Sales
Non-Exporter	mean	112.566	0.727	27.999	0.000
	median	70	0.256	13.428	0.000
Indirect Exporter	mean	276.544	2.636	90.138	2.161
	median	118	0.378	20.203	0.512
Direct Exporter	mean	382.604	4.588	118.939	4.414
	median	180	1.003	38.460	1.337
All	mean	150.657	1.238	41.356	0.583
	median	78	0.290	15.000	0.000

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

Table 3: Transitions of Export Modes

Export Status	Time t		
Time $t-1$	Non-Exporter	Indirect Exporter	Direct Exporter
Non-Exporter	0.966	0.026	0.008
Indirect Exporter	0.256	0.628	0.116
Direct Exporter	0.020	0.063	0.917

Table 4: Growth Rate, Export Participation and Relative Sale

	(1) Growth Rate $\Delta ln(R)$[1]	(2) Direct Export D_{t+1}^{Direct} [2]	(3) Relative Sale $\Delta ln(\frac{R_X}{R_H})$[3]
$Indirect_t$	0.008	1.189***	
	(0.005)	(0.035)	
$Direct_t$	0.018***	3.533***	0.137***
	(0.005)	(0.038)	(0.035)
$ln(Revenue)_{t-1}$	-0.007***		
	(0.001)		
$\Delta ln(Capital)$	0.023***		
	(0.002)		
$\Delta ln(Material)$	0.695***		
	(0.003)		
$\Delta ln(Employee)$	0.102***		
	(0.004)		
$ln(Revenue)_t$		-0.180***	
		(0.055)	
$ln(Capital)_t$		0.067***	0.018
		(0.014)	(0.015)
$ln(Material)_t$		0.133**	-0.024
		(0.053)	(0.021)
$ln(Employee)_t$		0.123***	-0.005
		(0.021)	(0.023)
$ln(Age)_t$	-0.012***	-0.107***	-0.053**
	(0.002)	(0.019)	(0.023)
Constant	0.087***	-3.558***	0.209
	(0.016)	(0.177)	(0.177)
Year	Yes	Yes	Yes
Ownership	Yes	Yes	Yes
R^2	0.6980	0.7273	0.0069

Note 1: $\Delta ln(R) \equiv ln(R)_{t+1} - ln(R)_t$

Note 2: $D_{t+1}^{Direct} \equiv \mathbb{1}\{\text{Being a direct exporter at t}\}$

Note 3: $\Delta ln(\frac{R_X}{R_H}) \equiv ln(\frac{R_X}{R_H})_{t+1} - ln(\frac{R_X}{R_H})_t$

Table 5: Demand, Marginal Cost, and Productivity Evolution

		Rubber & Plastic	Paper	Chemicals	Machinery & Equipment	Electrical Machinery	Radio, TV & Communication
Domestic Elasticity	σ^H	4.937***	4.449***	5.446***	5.978***	6.299***	3.890***
		(0.003)	(0.013)	(0.002)	(0.002)	(0.008)	(0.008)
Foreign Elasticity	σ^X	4.671***	3.082***	4.106***	4.570***	4.451***	10.487***
		(0.007)	(0.034)	(0.010)	(0.004)	(0.005)	(0.018)
Capital	β_k	-0.029***	-0.040***	-0.025***	-0.025***	-0.022***	-0.038***
		(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Constant	α_0	0.054***	0.117***	0.120***	0.084***	0.054***	0.085
		(0.001)	(0.003)	(0.002)	(0.001)	(0.004)	
$\boldsymbol{\omega}_{t-1}$	α_1	0.768***	0.649***	0.630***	0.735***	0.739***	0.785***
		(0.005)	(0.011)	(0.009)	(0.007)	(0.008)	(0.011)
$\boldsymbol{\omega}_{t-1}^2$	α_2	0.246***	0.349***	0.348***	0.239***	0.385***	0.156***
		(0.014)	(0.019)	(0.017)	(0.015)	(0.023)	(0.015)
$\boldsymbol{\omega}_{t-1}^3$	α_3	-0.075***	-0.114***	-0.103***	-0.067***	-0.173***	-0.045***
		(0.013)	(0.011)	(0.010)	(0.010)	(0.022)	(0.006)
Indirect Export	α_4	0.005***	0.000	0.006**	0.003***	0.003**	0.010**
		(0.002)	(0.004)	(0.002)	(0.001)	(0.002)	(0.004)
Direct Export	α_5	0.020***	0.022***	0.018***	0.017***	0.013***	0.038***
		(0.002)	(0.005)	(0.002)	(0.001)	(0.002)	(0.004)
	$\boldsymbol{\sigma}_\omega$	0.124	0.145	0.121	0.104	0.096	0.178
Home Market Size	Φ^H	7.757	7.046	6.857	6.627	7.489	7.573

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

Figure 1. Productivity Distributions by Export Modes

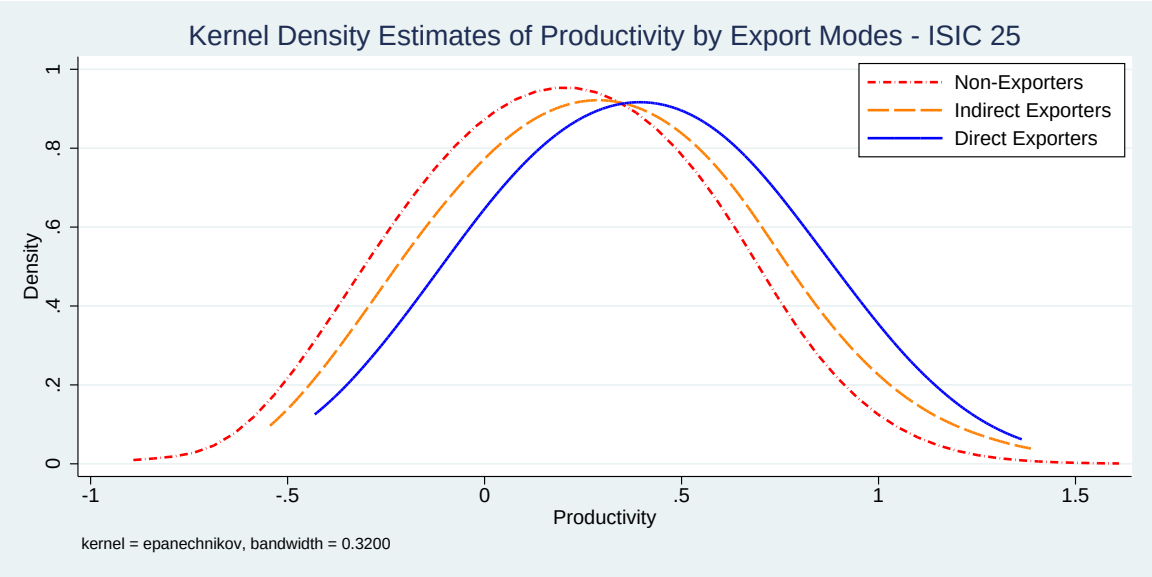

Table 6: Dynamic Parameter Estimates

Export Market Size	Φ_x	5.6663*	(0.018)
Sunk Export Costs			
Home → Indirect	γ^{HIS}	18.406*	(0.419)
Home → Direct	γ^{HDS}	122.098*	(5.634)
Direct → Indirect	γ^{DIS}	0.781*	(0.029)
Indirect → Direct	γ^{IDS}	36.051*	(0.684)
Fixed Export Costs			
Indirect	γ^{IF}	1.446*	(0.220)
Direct	γ^{DF}	2.539*	(0.035)
Demand Shock			
	η_z	0.903*	(0.001)
	$\log(\sigma_\mu)$	-0.175*	(0.001)
Indirect	ψ_1	0.003	(0.002)
Direct	ψ_2	0.012*	(0.001)

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

Table 7: Model Prediction of Productivity and Participation Rates

		2001	2002	2003	2004	2005	2006	2007
Productivity	Data	0.195	0.204	0.226	0.211	0.224	0.239	0.290
	Model	0.214	0.227	0.239	0.222	0.226	0.227	0.254
Indirect Exporter	Data	0.090	0.087	0.082	0.075	0.079	0.075	0.053
	Model	0.080	0.077	0.074	0.073	0.065	0.064	0.069
Direct Exporter	Data	0.070	0.076	0.086	0.099	0.103	0.100	0.113
	Model	0.067	0.068	0.077	0.085	0.080	0.081	0.085

Table 8: Model Prediction of Transition Rates

Export Status		Time t		
Time $t-1$		Non-Exporter	Indirect Exporter	Direct Exporter
Non-Exporter	Data	0.966	0.026	0.008
	Model	0.962	0.026	0.011
Indirect Exporter	Data	0.256	0.628	0.116
	Model	0.337	0.546	0.116
Direct Exporter	Data	0.020	0.063	0.917
	Model	0.081	0.114	0.803

Table 9: Pairwise Marginal Benefits of Exporting

Percentile	ω_t	E_tV^H	E_tV^I	E_tV^D	ΔIH	ΔDH	ΔDI
5%	-0.070	10.024	10.619	11.081	1.048	1.513	0.465
15%	0.017	11.180	11.942	12.502	1.393	1.965	0.572
25%	0.074	12.118	12.997	13.627	1.662	2.313	0.652
35%	0.123	13.080	14.069	14.768	1.932	2.662	0.730
45%	0.174	14.280	15.400	16.185	2.263	3.091	0.827
55%	0.230	15.952	17.246	18.153	2.707	3.673	0.966
65%	0.293	18.363	19.880	20.973	3.309	4.481	1.172
75%	0.367	21.982	23.766	25.141	4.158	5.642	1.484
85%	0.466	28.514	30.650	32.494	5.593	7.608	2.015
95%	0.642	46.621	49.681	52.754	9.746	13.190	3.443

Values in 10 millions of RMB

Table 10: Transition Probabilities

Percentile	ω_t	P_{HH}	P_{HI}	P_{HD}	P_{IH}	P_{II}	P_{ID}	P_{DH}	P_{DI}	P_{DD}
5%	-0.070	0.942	0.047	0.011	0.769	0.210	0.021	0.699	0.131	0.170
15%	0.017	0.926	0.060	0.014	0.744	0.231	0.025	0.673	0.134	0.193
25%	0.074	0.915	0.069	0.016	0.728	0.245	0.027	0.655	0.135	0.209
35%	0.123	0.905	0.078	0.018	0.713	0.257	0.030	0.639	0.137	0.225
45%	0.174	0.893	0.087	0.020	0.696	0.271	0.033	0.619	0.138	0.243
55%	0.230	0.877	0.100	0.023	0.675	0.288	0.037	0.593	0.138	0.269
65%	0.293	0.858	0.115	0.027	0.648	0.309	0.043	0.557	0.138	0.306
75%	0.367	0.835	0.133	0.032	0.613	0.335	0.052	0.508	0.136	0.356
85%	0.466	0.804	0.156	0.040	0.563	0.370	0.067	0.433	0.136	0.431
95%	0.642	0.738	0.204	0.058	0.455	0.441	0.104	0.281	0.132	0.588

Values in 10 millions of RMB

Table 11: Profits and Costs of Exporting

Percentile	ω_t	π^{XI}	γ^{IF}	γ^{HIS}	γ^{DIS}	π^{XD}	γ^{DF}	γ^{HDS}	γ^{IDS}
5%	-0.070	0.512	0.242	0.477	0.074	0.562	0.280	0.677	0.390
15%	0.017	0.707	0.274	0.619	0.076	0.775	0.324	0.853	0.459
25%	0.074	0.871	0.294	0.725	0.077	0.955	0.356	0.982	0.510
35%	0.123	1.042	0.311	0.828	0.078	1.143	0.387	1.105	0.558
45%	0.174	1.255	0.330	0.949	0.078	1.377	0.423	1.251	0.617
55%	0.230	1.543	0.353	1.105	0.078	1.692	0.474	1.442	0.698
65%	0.293	1.944	0.381	1.303	0.077	2.132	0.547	1.696	0.817
75%	0.367	2.552	0.414	1.554	0.076	2.799	0.651	2.037	0.991
85%	0.466	3.671	0.455	1.905	0.074	4.026	0.808	2.546	1.277
95%	0.642	6.993	0.539	2.636	0.070	7.671	1.155	3.757	2.022

Values in 10 millions of RMB

Table 12: Growth in Fifteen Years with Learning-by-Exporting

	Case 1 No Intermediary	Case 2 No Direct Export	Case 3 No Restrictions
Total Domestic Sales	88,310	59,264	89,258
(Ratio to Case 3)	(0.989)	(0.664)	(1)
Total Export Sales	47,413	24,892	48,386
(Ratio to Case 3)	(0.980)	(0.514)	(1)
Total Profits	25,664	16,392	26,123
(Ratio to Case 3)	(0.982)	(0.627)	(1)
Export Participation	0.202	0.170	0.287
(Ratio to Case 3)	(0.702)	(0.592)	(1)
Average Productivity	0.449	0.424	0.451
(Ratio to Case 3)	(0.997)	(0.940)	(1)

Table 13: Growth in Fifteen Years with No Learning-by-Exporting

	Case 1 No Intermediary	Case 2 No Direct Export	Case 3 No Restrictions
Total Domestic Sales	52,026	52,026	52,026
(Ratio to Case 3)	(1)	(1)	(1)
Total Export Sales	18,767	20,277	22,461
(Ratio to Case 3)	(0.836)	(0.903)	(1)
Total Profits	13,885	14,202	14,573
(Ratio to Case 3)	(0.953)	(0.975)	(1)
Export Participation	0.055	0.114	0.129
(Ratio to Case 3)	(0.430)	(0.881)	(1)
Average Productivity	0.416	0.416	0.416
(Ratio to Case 3)	(1)	(1)	(1)