

How You Export Matters: Export Mode, Learning and Productivity in China¹

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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. These restrictions were eliminated over 2001-2004 as part of joining the WTO. 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.

Our counterfactual experiments suggest that this restriction of direct trading rights was very costly for China, suggesting that in the absence of such self inflicted wounds, China could have grown even faster than it did. We see this as a first step in a larger research agenda of examining the causes of China's remarkable export growth and the role of joining the WTO in this.

1 Introduction

Governments have a tendency to intervene in markets, often with what they see as the best of reasons. However, such intervention can have unexpected and often detrimental effects.¹ In this paper we look at restrictions on exporting that were in force in China before its ascension to the WTO in 2001. These restrictions prevented privately owned Chinese firms from exporting directly. They had to export only through intermediaries, unless their registered capital was quite large.

These restrictions were eliminated over the period 2001-2004, at different rates for different regions, industries and types of firms, as part of the ascension agreement for joining the WTO. In this period, Chinese exports took off and from 2000-2006, they roughly tripled. Were these restrictions binding? Could their removal, at least in part, be why Chinese exports grew so fast? These restrictions seem to have been quite binding. When the restrictions were lifted they affected the representation of direct exporters quite dramatically in early years, but less so in later years when they were constraining only for very small firms who would likely choose not to export anyway. This is shown in Figure 1. For each year in 2000-2003, and for each firm, we construct a measure of the restrictiveness of the policy on direct trading rights. We do this as follows. For firms that are ineligible, we construct the ratio of the required registered capital to become eligible relative to the registered capital of the firm. The higher this number, the further away the firm is from being eligible. However, we want increases in this number to make a firm closer to being eligible, not the opposite. To deal with this we put a negative sign before our ratio.² We divide ineligible firms (those with the ratio less than -1) into quintiles of this measure. We then construct the ratio of direct exporters to all exporters in each of these quintiles. For firms that are not constrained, we treat the required capital to be unity (rather than zero) and construct the quintiles and share of direct exporters in each quintile in the same manner as for constrained firms. If the policy is strictly

¹For example, the Multi Fibre Agreement which set bilateral and product specific quotas on Textile Yarn and Apparel exported by most 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 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.

²Using the inverse is not ideal as the required capita could be zero.

enforced, then our graph should take the value zero for the first five groups, and then should jump up for the sixth group, as it is just unconstrained. It should then rise monotonically as larger firms are more likely to be direct exporters. Moreover, as the requirement itself gets phased out, it will apply to smaller and smaller firms who would not have exported anyway. Thus, over the years we would expect a smaller and smaller jump up for the sixth group.

What do we see? To begin with, the first five groups do not have a zero or close to zero share of direct exporters. This suggests some leeway in the enforcement of the policy. We also see the share of direct exporters falling over the years in these first five groups but this is probably because the policy is becoming less restrictive over time, not because there is less leeway. Second, in 2000-2002, we see a distinct jump in the share of direct exporters in the sixth group as expected. This jump is smaller in 2003 and this is consistent with the liberalization of the policy over time.

Thus, the restrictions on direct exporting seem to have been binding. Could their elimination be a source of gains in exports for China? If direct trading results in more opportunities to learn, both about technology and preferences, and so creates greater learning from exporting on the cost and demand side, the elimination of these rules may well have a part in explaining the amazing growth of Chinese exports after it joined the WTO in 2001.

In this paper, we estimate a dynamic discrete choice model where firms choose their export status and mode. We recover the sunk and fixed costs of exporting that are allowed to vary by mode of export (direct or via an intermediary) and past choices on export mode (indirect exporter or non-exporter). We also estimate 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. This in turn suggests that had China not restricted the ability of firms to export directly it may well have grown even faster!

We also find that direct exporting requires significant start-up costs whereas starting indirect exporting is much cheaper to do. 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.

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).³

The literature on intermediaries has focused on their role in facilitating trade as 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.

Motivated by the patterns found in matched Chile-Colombia importer-exporter

³In 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 accounts, hiring specialized accountants and custom declarants 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. In contrast, wages, warehouse rents and marketing constitute the major costs of trading intermediaries.

data, Blum, Claro and Horstmann (2010) develop a model of distribution technologies where firms choose a distribution technology. They 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. Firms endogenously select their mode of export based on productivity. Using Chinese customs data, they provide evidence that firms sort into export modes based on productivity; that exports by intermediaries are more expensive; and that countries which are harder to access (higher trade costs or smaller market sizes) have relatively more intermediated trade. 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 causes productivity sorting among producers as regards export mode. Using Swedish cross-sectional data, he finds evidence to support a main prediction of his model that wholesalers export less per firm within a product category than do producers.

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. It also allows us to do counterfactual exercises. We utilize panel data on Chinese firms, by combining firm-level production data and transaction level data from the customs office. 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. Firms are distinguished by their history of exporting. We recover sunk costs of direct and indirect exporting conditional on their export history. The differences in the cost of exporting directly, with

and without a history of exporting indirectly, suggest that intermediaries have a role in helping indirect exporters becoming direct exporters. This makes sense as 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. The sunk costs of starting to export directly are also much higher than those of starting to export indirectly, or of exporting directly after exporting indirectly, i.e., of climbing the ladder of exporting.

In addition, we verify 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.

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. This in turn reinforces the productivity sorting by self-selection. We also find 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.

We also conduct counter-factual exercises to better understand the role of learning and restrictions on exporting on export growth. We find that without restrictions, learning results in roughly 50% greater export sales than without

learning over 10 years. Domestic sales and profits are also higher but by less. Restricting direct exports for all firms in the presence of learning is quite devastating: it takes ten years to achieve the exports that would have been obtained in five years without such restrictions. Restricting indirect exporting is far less costly in terms of exports as only six years, not ten, are needed. In the absence of learning, this is reversed: restricting indirect exports is more costly in terms of export growth than restricting direct exports (because indirect exporters just stop exporting while direct ones switch export mode) though both restrictions are less costly in terms of exports.

1.2 Other Related Work

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 hysteresis 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 example, 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.

A tangential but related literature in trade looks at the effects of trade liberalization on productivity via 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 by the time it joined the WTO. Joining the WTO just made it more certain. However, it did drop its import tariffs quite significantly as part of joining the WTO and this may also have 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, 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 also raises productivity but by half as much. Kasahara and Lapham (2008) 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 shows 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.

2 Data

This analysis utilizes two Chinese datasets. 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 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 the second dataset, the Chinese Custom transaction data to identify firms' exports modes. This data 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 2000-2007 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 data.⁴

By merging the custom data with firm production data, we can identify the exporting modes of a firm 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.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 as well as manufacturing firms who directly export. In this paper we do not distinguish between such firms and those that export their own products only and drop pure producer intermediaries from the data.

⁴Details of this matching are available on request. We matched the data on the basis of firm name, region code, address, legal person, and so on. It is worth noting that about 20% of exports are unmatched in manufacturing. 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, which leaves 13% accounted for by unmatched surveyed manufacturers.

⁵Firms that export directly and also do so indirectly are tagged as direct exporters. 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.

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 such licenses to engage in 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 these FTCs controlled by the central government. An important and fully anticipated aspect of trade reform was the assignment of trading rights to more firms: over time, the government 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 had direct trading rights. Restrictions on these rights applied 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 and western China) to be eligible to apply for direct trading rights after July 2001, and this threshold was dropped to .5 million by August 2003. In July 2004, Chinese government removed all restrictions on direct trading rights and firms no longer needed to apply for such rights. To study the choice of export modes (direct versus indirect) we distinguish between firms that were eligible to trade directly in each year, and the ones that were not eligible. We assume that firms exogenously become eligible or ineligible in our model and restrict their export option sets accordingly.⁶

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

⁶Firms 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.

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

Before estimating a structural model, it is always a good idea to look for reduced for evidence that shows that the data are in line with the model being imposed in the structural estimation. This is the purpose of this section.

We focus on one industry ⁷: Manufacture of Rubber and Plastic Products (2-digit ISIC Rev3 25)⁸. In this paper, we abstract 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 them were direct exporters. This is in line with the export participation rates found in other datasets, suggesting that the export costs might be quite high since 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, from around four thousand to around eleven thousand. 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

⁷We have also estimated the evolution of productivity for a number of other industries with similar results. These results are given in Table 6 below.

⁸We 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.

total value of Chinese export tripled during that period. These facts also suggest that 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.⁹

Table 2 provides some information on firm size, 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 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 a average indirect exporter. These facts provide some preliminary evidence of productivity sorting. 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 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. 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 2 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 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.

⁹76.6 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.

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. The patterns reported there 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, 96.6 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 persistence of non-exporting firms in non-exporting suggests the existence of significant sunk export costs that preventing 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 indirectly exporting firms. On average, 25.6 percent of the firms that 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. Note the much higher rate of exporting directly of indirect exporters. Higher rates of switching from being an indirect exporter to being a direct exporter is consistent with firms self-selecting into different export modes based on their productivity levels. It is also consistent with intermediaries 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 that 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 the foreign market. Among exporting firms, the average exit rate of indirect exporters is almost 13 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 entry into indirect exporting from not exporting and the extreme persistence in direct exporting are consistent with 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 into non exporting of indirect exporters and direct exporters. The existing theoretical and empirical literature shows that indirect exporters on average tend to be less productive than direct exporters, and thus more vulnerable to bad demand shocks.

2.3 Other Evidence

Besides the size rankings and differences in entry and exit rates, we document differences in the growth of sales, in the probability of exporting directly, and the growth of the ratio of export to domestic sales between exporters using different modes. In Table 5 we present results from three regressions. In the first column, we examine the dynamic effects of export modes on firms' revenue growth, 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 (direct exporter) has a positive (positive and significant) effect on firms' growth rate compared to non-exporters and being a direct exporter has higher positive effects. This result provides some initial evidence in support of learning-by-exporting and potentially different levels 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 the 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 importance of sunk costs of direct exporting on the decisions of direct exporting. This is consistent with the strong persistence of direct exporting seen in Table 3. The coefficient on indirect exporting status in period t is positive and significant indicating that exporting indirectly this period significantly increases the probability of exporting directly next period, compared to non-exporters. 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 tend to grow faster in the export market relative to the domestic market compared to indirect exporters. All this evidence pushes us to explore further the potentially different learning effects of different export modes on both productivity and demand.

3 The 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 ($d_{it}^m = \{0, 1\}, m = Home, Indirect, Direct$). Apart from different productivities and export demand curves, firms also face different entry cost and fixed cost of exporting. Based on its current and expected future value, a firm chooses whether or not to export, and the mode in which to exports. 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.¹⁰ For example, the costs generated from establishing their own foreign distribution networks, learning about bureaucratic procedures and dealing with paper work. In China for example, there are costs associated with applying for direct trading rights, which are part of the sunk costs of direct exporting and avoided by indirect exporters. Indirect exporters

¹⁰In 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 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 costs constitute some of the major costs of trading intermediaries.

also avoid some fixed costs, such as maintaining offices in foreign markets, warehouse rents, costs of monitoring foreign custom procedures, etc. Firms need to possess a 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, Khandelwal, and Wei (2011) document that 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.

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 pass-through of knowledge may be less effective than 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 that domestic and export markets are segmented from each other, that firms engage in monopolistic competition in each market, and that 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 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 the home and foreign market are given as below:

$$U_t^H = U_t^{HH}{}^a U_t^{XH}{}^{1-a} \quad (1)$$

$$U_t^{HH} = \left(\sum_{i \in \Omega^H} q_{it}^H \frac{\sigma^H - 1}{\sigma^H} di \right)^{\frac{\sigma^H}{\sigma^H - 1}} \quad (2)$$

$$U_t^X = U_t^{XX}{}^b U_t^{HX}{}^{1-b} \quad (3)$$

$$U_t^{HX} = \left(\sum_{i \in \Omega^X} q_{it}^X \frac{\sigma^X - 1}{\sigma^X} \exp(z_{it})^{\frac{1}{\sigma^X}} di \right)^{\frac{\sigma^X}{\sigma^X - 1}} \quad (4)$$

where H denotes the home market, and X the foreign market, i denotes the firm that provide variety i , and $\Omega^H \cup \Omega^X$ 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 also assume that each Chinese firm's demand in the export market in each period 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 are given by

$$P_t^H = \left(\sum_{i \in \Omega^H} p_{it}^H \frac{1 - \sigma^H}{\sigma^H} di \right)^{\frac{1}{1 - \sigma^H}} \quad (5)$$

$$P_t^X = \int_{i \in \Omega^X} p_{it}^X {}^{1-\sigma^X} \exp(z_{it}) di {}^{\frac{1}{1-\sigma^X}} \quad (6)$$

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 (Y_t^X). The firm level demand from these two markets are:

$$q_{it}^H = \frac{p_{it}^H}{P_t^H} {}^{-\sigma^H} \frac{Y_t^H}{P_t^H} \quad (7)$$

$$q_{it}^{Xm} = \frac{p_{it}^{Xm}}{P_t^X} {}^{-\sigma^F} \frac{Y_t^X}{P_t^X} \exp(z_{it}), m = \text{Indirect, Direct} \quad (8)$$

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} to capture firm-level heterogeneity other than productivity that affects firm's revenue and profit. Persistence in this firm-market specific shock introduces a source of persistence in firm's export status and mode in addition to that provided by 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 . The intermediary sells the good by adding a commission to this and sells 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 $q_{it}^{XI} = \frac{p_{it}^{XI}}{P_t^X} {}^{-\sigma^F} \frac{Y_t^X}{P_t^X} \exp(z_{it})$ from equation (8). The intermediary's cut can be thought of as a service fee, or it can be thought as any per-unit cost associated with re-packaging, 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

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

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 ¹¹

$$p_{it}^I = \frac{\sigma^X}{\sigma^X - 1} mc_{it} \quad (10)$$

3.1.3 Supply Side

We assume as in Aw, Roberts and Xu (2011) that short-run marginal cost are given by :

$$\begin{aligned} \ln mc_{it} &= c(\mathbf{w}_{it}) e^{-\omega_{it}} \\ &= \beta_0 + \beta_k \ln k_{it} + \beta_t D_t - \omega_{it} \end{aligned} \quad (11)$$

A firms' marginal costs depend on the firm-time specific factor prices \mathbf{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 cost shifter as only factor prices enter the cost function.¹² Short-run cost heterogeneity can also come from differences in the firms' scales of production, captured by the firm's capital stock, and their efficiencies of production ω_{it} . Constant marginal cost allows firms to make their static decisions for the two markets separately.

¹¹As $\lambda^{-\sigma^X}$ multiplies the whole expression, the profit maximizing price is not affected by the intermediaries cut and the usual markup rule for pricing applies. Another way of saying this is that as the indirect exporters variable profits are 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.

¹²We could also replace capital with size dummies.

Firms choose their prices for each market after observing their markets demand shock 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 product of the price charged to the intermediary plus the intermediary's cut so that $p_{it}^{XI} = \lambda \frac{\sigma^X}{\sigma^X-1} mc_{it}$.

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

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

$$\begin{aligned} \ln r_{it}^{Xm} &= a^X + \ln \Phi_t^X + (1 - \sigma^X) (\beta_0 + \beta_k k_{it} + \beta_t D_t - \omega_{it}) \\ &\quad + z_{it} - d_{it}^I \sigma^X \ln \lambda \end{aligned} \quad (13)$$

where the last term $\sigma^X \ln \lambda$ is positive ($\lambda > 1$) when the firm is indirectly exporting ($d_{it}^I = 1$) and so shares the revenue from exports with the intermediary. Firm's revenues in each market depend on the aggregate market conditions, the firm-specific productivity and capital stock, while 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:

$$\pi_{it}^H = \frac{1}{\sigma^H} r_{it}^H \Phi_t^H, \mathbf{w}_{it}, \omega_{it} \quad (14)$$

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

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

$$\pi_{it}^{XD} = \frac{1}{\sigma^X} r_{it}^{XD} \Phi_t^X, \mathbf{w}_{it}, \omega_{it}, z_{it} \quad (16)$$

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' decision to export and their choices of export modes.

3.2 Transition of State Variables

In 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. 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, and if yes, what mode of export to use. We use a cubic to approximate this evolution.

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

where $d_{it-1}^m = \{0, 1\}$, $m = Home, Indirect, Direct$, 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) between the role of learning-by-exporting and the sorting by productivity. This is relevant because firms that expect their productivity to grow fast 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 uncorrelated 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.

$$\begin{aligned}z_{it} &= \psi_1 d_{it-1}^I + \psi_2 d_{it-1}^D + \eta_z z_{it-1} + \mu_{it} \\ \mu_{it} &\sim N(0, \sigma_\mu^2)\end{aligned}\quad (18)$$

This source of persistent firm-level heterogeneity allows firms to perform differ-

ently 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} change exogenously over time and we capture the market sizes Φ_t^H and Φ_t^X by time dummies, which we also treated 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,

$$s_{it} = \omega_{it}, z_{it}, \mathbf{d}_{it-1}, \mathbf{w}_{it}, \Phi_t^H, \Phi_t^X$$

which includes its current productivity and demand shocks (ω_{it}, z_{it}) , its past decision regarding which markets to serve and export mode (\mathbf{d}_{it-1}) . It also 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 \mathbf{w}_{it} . We will suppress $\mathbf{w}_{it}, \Phi_t^H, \Phi_t^X$, as these are not chosen by the firm and call the state space $s_{it} = (\omega_{it}, z_{it}, \mathbf{d}_{it-1})$ from here on. It then draws its fixed and sunk costs for all relevant options open to it and then chooses whether to sell only domestically, export indirectly or export directly. How these costs vary by firm is explained below.

We allow the *distributions* of 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 .¹³ This implies that 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 sunk start-up cost of direct exporting to be differ depending on whether the firm was an indirect exporter or not in the previous period. Thus, firm i incurs the sunk cost γ_{it}^{HDS} drawn from

¹³ l can take the values HDS (when the draw is for the Sunk costs 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 (D,I,H), the second defines where it might transition to (D,I,H) 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.

the distribution G^{HDS} if it did not export last period and is looking to export directly, while it draws γ_{it}^{HIS} when looking to export indirectly. It incurs the sunk costs γ_{it}^{IDS} from the distribution G^{IDS} if it exported indirectly last period but is looking to export directly in this period and γ_{it}^{DIS} from the distribution G^{DIS} if it was exporting directly in the last period and is looking to export indirectly this period.¹⁴ All this is summarized in Table 4. We assume that all sunk cost 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 pairwise 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, though others could be chosen.

We allow for this flexibility to better match real world conditions. For example, intermediaries could help small firms lower future entry cost into direct exporting (say by providing a match with foreign clients the firm can use to export directly later on) so that γ_{it}^{IDS} tends to be far smaller than γ_{it}^{HDS} . We allow for this by letting the means of these distributions differ.

Exporters also have to pay a fixed cost to maintain their access to 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 \mathbf{d}_{it}) and assuming it optimizes from the next period onwards:

$$V(s_{it}) = \int \max_{\mathbf{d}_{it}} [u(\mathbf{d}_{it}, s_{it} | \gamma_{it}) + \delta E_t V(s_{it+1})] dG^\gamma \quad (19)$$

¹⁴As intermediaries could help small firms lower 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} 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.

where $u(\mathbf{d}_{it}, s_{it} | \gamma_{it})$ is the current period payoff and depends on the choice of export status and mode, \mathbf{d}_{it} , the state (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, γ_{it} .

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

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 $u(\mathbf{d}_{it}, s_{it} | \gamma_{it}) = \pi_{it}^H + \pi_{it}^{XD} - \gamma_{it}^{IDS}$.

The continuation value is

$$E_t V(s_{it+1}) = \int_{\omega_{it+1}} \int_{z_{it+1}} V(s_{it+1}) dF(\omega_{it+1} | \omega_{it}, d_{it}) dF(z_{it+1} | z_{it}) \quad (21)$$

For any state vector, denote the choice-specific continuation value from choosing $d_{it}^m = \{0, 1\}$, $m = H, I, D$, as $E_t V^m \equiv E_t V(s_{it+1} | d_{it}^m = 1)$. Firms' export decisions depend on the difference in the pairwise 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.¹⁵

Let

$$\Delta IH = \pi_{it}^{XI} + \delta E_t V^I - E_t V^H \quad (22)$$

$$\Delta DH = \pi_{it}^{XD} + \delta E_t V^D - E_t V^H \quad (23)$$

$$\Delta DI = \pi_{it}^{XD} - \pi_{it}^{XI} + \delta E_t V^D - E_t V^I \quad (24)$$

For example, if a firm is an indirect exporter, it will choose to become a direct

¹⁵ ΔHI , ΔHD , ΔID could be similarly defined but simple calculations show that they are merely the negative of ΔIH , ΔDH , ΔDI .

exporter tomorrow 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 as a non exporter or becoming an indirect exporter which is ¹⁶

$$P_{ID} = \Pr[\gamma_{it}^{IDS} < \min \Delta DH, \gamma_{it}^{IF} + \Delta DI] \quad (25)$$

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 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 $\delta E_t V^D - E_t V^I$, captures the dynamic part. These three values depend on the sunk costs and fixed costs of exporting modes as well as on the impact of exporting modes on future productivity if firms learn from exporting.

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 or ΔDH fall. However, higher sunk costs will decrease the continuation value of being a non exporter, and thereby increase ΔIH or ΔDH . Similarly, if firms learn more through direct exporting or the service fee λ rises, ΔDI will be larger, ceteris paribus. Firms make draws from the sunk and fixed costs distributions each period independently, but the marginal benefits of an option over another has some persistence due to the persistence in productivity and demand shocks. ¹⁷

¹⁶The probability that becoming a direct exporter is its best option is

$$P_{ID} = \Pr[\pi_{it}^H + \pi_{it}^{XD} - \gamma_{it}^{IDS} + \delta E_t V^D > \pi_{it}^H + \delta E_t V^H \ \& \ \pi_{it}^H + \pi_{it}^{XD} - \gamma_{it}^{IDS} + \delta E_t V^D > \pi_{it}^H + \pi_{it}^{ID} - \gamma_{it}^{IF} + \delta E_t V^I]$$

¹⁷For 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

4 Estimation

We estimate the model using a two-stage estimation method using firm-level panel data on revenue from the domestic market, 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 regarding production to obtain estimates of the domestic revenue function and of the productivity evolution process. In the second stage, we exploit the 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 modes¹⁸.

Our estimation strategy is based on that 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 , the home market size intercept Φ_t^H , the marginal cost parameters β_0 and β_k , the productivity evolution function $g(\omega_{it-1}, d_{it-1})$, and the variance of transient productivity shocks σ_ξ^2 . Sunk and fixed costs parameters of G^γ , the parameters $\eta_z, \mu_z, \psi_1, \psi_2$ of Markov process z_{it} , and the foreign market size intercept Φ_t^X will be recovered in the second-stage of the estimation.

4.1 Stage 1

4.1.1 Elasticities

We need to estimate the elasticity of substitution in each market. We follow the method in Das, Roberts and Tybout (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 preference. Thus, $mc_{it} = \frac{\sigma^X - 1}{\sigma^X} p_{it}$. Each firm's total variable cost can be written as

$$\begin{aligned} TVC_{it} &= mc_{it} q_{it}^H + mc_{it} q_{it}^{Xm} \\ &= \frac{\sigma^H - 1}{\sigma^H} p_{it}^H q_{it}^H + \frac{\sigma^X - 1}{\sigma^X} d_{it}^D p_{it}^{XD} q_{it}^{XD} + d_{it}^I p_{it}^I q_{it}^{XI} \end{aligned} \quad (26)$$

since it is merely a special case of the more general problem of eligible firms.

¹⁸Recall, we normalize these for non exporters to be zero.

We estimate equation (26) by OLS using data on home and export revenue and total variable cost (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 follows

$$\ln r_{it}^H = \phi_0 + \sum_{t=1}^T \phi_t D_t + \frac{1}{1 - \sigma^H} (\beta_k \ln k_{it} - \omega_{it}) + u_{it} \quad (27)$$

where $\phi_0 = \frac{1}{1 - \sigma^H} \ln \frac{\sigma^H}{\sigma^H - 1} + \frac{1}{1 - \sigma^H} \beta_0$, the time dummies capture the time varying factor prices and home market size $\ln \Phi_t^H$, $\ln k_{it}$ captures firm level cost shifters, ω_{it} is productivity, and u_{it} is an i.i.d. error term reflecting measurement error. Note that for purposes of solving the model, we only need ϕ_0 and not its separate components.¹⁹

As in Olley and Pakes (1996) and Levinsohn and Petrin (2003), we control for productivity using the fact that more productive firms will use more materials. Thus we can replace $\frac{1}{1 - \sigma^H} (\beta_k \ln k_{it} - \omega_{it})$ with $h(k_{it}, m_{it})$. We estimate the function (27) using ordinary least squares and approximating $h(k_{it}, m_{it})$ by a third-degree polynomial of its arguments. This gives us estimates of ϕ_0 and the values of $\hat{h}(k_{it}, m_{it})$. Thus we can rewrite productivity as follows

$$\omega_{it} = - \frac{1}{1 - \sigma^H} \hat{h}(k_{it}, m_{it}) + \beta_k \ln k_{it} \quad (28)$$

We know $-\frac{1}{1 - \sigma^H} \hat{h}(k_{it}, m_{it})$ and $\ln k_{it}$, but still have to estimate β_k and the parameters for the evolution of productivity. Recall that productivity evolves according to

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

¹⁹Note that we report in Table 6 Ψ^H which is ϕ_0 plus the mean time dummy ϕ_t . The same is true for Ψ^X reported in Table 7.

Thus, if we substitute for ω_{it} and ω_{it-1} as in equation (28) in the above equation, we can estimate the remaining parameters ($\alpha_i, i = 0, \dots, 5$, 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 β_k , ϕ_0 , σ^H , σ^X , the essential part of the home market size intercept Φ_t^H (in ϕ_0), the marginal cost parameters β_0 and 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 Stage 2.

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 a particular 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 1.02, which means interme-

diaries obtain a 2% margin on their sales.²⁰ Given firms' productivity levels and capital stock, the level of export revenues of both types of exporters provides information on foreign market demand shocks when firms choose to export. We observe 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 (cost shifter), market size and the foreign market shocks, we can write firm i 's contribution to the likelihood function as

$$P(\mathbf{d}_i, r_i^{Xm} | \omega_i, k_i, \Phi) = P(\mathbf{d}_i | \omega_i, k_i, \Phi, z_i^+) h(z_i^+) \quad (29)$$

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.

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 given in equation (25). This requires knowledge of the distribution of γ^{IDS} and γ^{IF} as well as ΔDH and ΔDI . We assume that the γ 's are drawn from exponential distributions. The values of ΔDH and ΔDI as defined in equations (23) and (24) depend on variable profits from exporting directly (which from equation (16) we know depend on parameters, some of which remain to be estimated) and on the value functions for exporting

ing 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.²¹ It is worth reiterating that these choice probabilities are conditioned on firms' state variables of the period, specifically on a firm's previous export status and mode.

5 Estimation Results

We present our results in three parts below. First, we report the estimates of demand, marginal cost and productivity evolution in the Rubber and Plastic industry along with that in 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 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 foreign market, which implies 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

²¹Derivation of these choice probabilities is given in the appendix.

that marginal cost of production is decreasing with the capital stock, which is a measure of the scale of production. The coefficients α_1, α_2 and α_3 gives our cubic approximation of the effect of ω_{t-1} , ω_{t-1}^2 and ω_{t-1}^3 on ω_t and implies a non-linear and positive marginal effect of lagged 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 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.²²

In columns 2 – 6 of Table 6, we also report our estimates of the productivity evolution process in 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 see that even though different industries give estimates for productivity evolution and magnitudes of learning-by-exporting effects, direct exporting always has larger effects on firm productivity than indirect exporting. For example, in the Paper Products industry, previous indirect exporting status has no effect on productivity while firms that previously directly exported have a

²²As 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 an 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 of 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.

2.2 percent increase in their productivity levels. Compared to other industries, the learning-by-exporting effect is larger for the Radio, TV and Communication equipment industry as being an exporter last period results in a 1 to 3.8 percent higher productivity relative to non-exporters.

5.2 Productivity Sorting

We construct our measures of productivity based on the estimates in the first column in Table 6. 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) 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 3 shows the kernel density 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. The estimate of Ψ^X (which proxies for average foreign market size) is smaller than that for domestic market, Ψ^H , which we estimated in the first-stage estimation. The coefficients $\gamma^{HIS}, \gamma^{HDS}, \gamma^{DIS}, \gamma^{IDS}$ reported in Table 7 are the mean parameters of the exponential distributions for, respectively, the sunk cost of starting indirect exporting being a non-exporter, starting direct exporting being a non-exporter, starting indirect exporting being a direct exporter, and starting direct exporting being an indirect exporter. First, the sunk cost parameter of starting direct exporting being a non-exporter, γ^{HDS} , is much higher than that of starting

indirect exporting while being a non-exporter, γ^{HIS} . This is consistent with the observed transition patterns in the data and suggests that it is much less costly to enter indirect exporting market than direct exporting market. γ^{IDS} , the sunk cost parameter of starting direct exporting while being an indirect exporter, is also much lower than γ^{HDS} , indicating that using an intermediary to export in the previous period helps firms to start direct exporting in current period by lowering their sunk costs. The relatively small sunk cost of starting indirect export while being 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 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 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 fixed cost parameters for direct exporting, γ^{DF} , is larger than that for indirect exporting, γ^{IF} , indicating that using an intermediary to export has some advantages.

The last four parameters describe the evolution 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 of 0.903 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 percentage increase in the demand shocks if firms were indirectly or directly exporting last period, compared to 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 firms that continuously do not export.

5.4 Alternative Interpretations

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. Most important is whether we are picking up what amounts to unobserved heterogeneity. If firms which know they are good, choose to become eligible and then export directly, we could be picking this up in our estimation rather than any effect of exporting directly. However, when we checked if productivity or sales jumps up once the eligibility threshold is crossed, we found no significant effect of crossing this threshold. It is also worth noting that the fraction that cross the threshold so as to become eligible²³ is quite small, only about 3-5%, limiting the extent of such an effect even had it been there.

In addition it is well understood (see Ahn, Khandelwal and Wei (2011)) that direct exporters access different markets (and export different products) than do intermediaries (indirect exporters). Could this could be responsible for the different evolution of productivity and demand shocks? When one compares the share of Chinese exports going to the top ten destinations, direct exporters and intermediaries look fairly similar. Direct exporters sell 10 to 15 percentage points more overall to these 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).

Another issue that we should address concerns the definition of indirect and direct exporters. We defined direct exporters as those that report exports in the survey data and show up in the customs data, while indirect exporters are those that report exports, but do not show up in the customs data. However, this may still leave considerable heterogeneity: for example, some firms may be doing carry along trade and be much bigger than other direct exporters. Such finer classification are left for future work.

In addition, there is the issue of producers who say they did not exports in the survey data and show up in the customs data. These comprise about 4% of the observations in the survey data. We interpret this to mean that such firms exported on someone elses behalf making them “producer intermediaries”. These firms are dropped in our baseline estimation. To check if this made a difference we ran stage 1 of the estimation including them as direct exporters. This did not

²³This is defined to be firms who would not have been eligible if they had not raised their registered capital level.

affect the estimates of productivity evolution.

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 be misclassifying indirect exporter as non exporters. This is unlikely as exporting intermediaries have names that clearly differentiate them from domestic ones as made clear in Ahn, Khandewal and Wei (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.

6 Model Fit

In this section we see how well the estimated model is able to capture the features of the data.

6.1 In-Sample Model Performance

We simulate the model using our estimates in Table 7 to assess its performance. We use the actual data in 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 8 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 9, 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

6.2 Productivity Sorting and Persistence

To further understand how firms with different productivities sort into different export modes, we look at the pairwise marginal benefits of being an indirect exporter or direct exporter relative to being a non-exporter (ΔIH , ΔDH), and the pairwise marginal benefit of being a direct exporter to being an 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 10 we report the expected continuation values of being a non-exporter ($E_t V^H$), an indirect exporter ($E_t V^I$) and a direct exporter ($E_t V^D$) 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 of 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 of being an indirect exporter, and the firm expects 181.53 million RMB on average as a direct exporter.

There are three distinct patterns to be noticed. In columns 1-3, the continuation 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, $E_t V^D > E_t V^I > E_t V^H$, suggesting a clear ranking of future payoffs due to the large start-up costs of exporting and learning-by-exporting effects. In 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 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 keeping on 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.²⁴

²⁴The choice-specific values and marginal benefits for ineligible firms have the same pattern

Table 11 reports the transition probabilities at different productivity levels. Together with Table 10, Table 11 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 while being a indirect exporter or direct exporter are always decreasing in productivity. Reported in column 5, the probabilities of indirect exporters staying as indirect exporters first increase in productivity for low levels of productivity, then decrease. This is due to the model's prediction that indirect exporters with high levels of productivity 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 which shows that the probabilities of indirect exporters transiting into direct exporting always increases with productivity. Similar patterns can be seen in column 8. The probability of direct exporters transiting into indirect exporting first increase and then decrease in productivity. 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 and are thus more likely to move into indirect exporting.

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. Table 12 report the means of sunk and fixed costs *actually* incurred by the firms that choose to export rather than the means of the distributions they draw from.

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

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.

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 a non-exporter γ^{HDS} are also higher than starting direct exporting as indirect exporter γ^{IDS} . 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 have 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 11. At very high productivity levels, direct exporting is more profitable even with higher levels of fixed and sunk costs.

7 Counterfactual Exercises

The centralized economy before China liberalized established and fostered a well developed intermediary sector and provided small firms the opportunity to engage in foreign trade with relatively low costs. However, at the same time, restricting direct trading rights may also have had a cost by depriving firms of better learning opportunities associated with direct trading, and thereby impeded firms' future growth in both domestic and foreign markets. In this section, we use the estimates from the model to perform some counterfactual exercises with a view to better understanding the benefits and costs of this policy. We use data from the initial year of our sample and simulate the next fifteen years for a number of counterfactual exercises.

7.1 Counterfactuals With and Without Learning

In the first set of exercises, we allow firms to learn from exporting as in our estimates for the evolution of productivity and demand shocks and compare the economy's ²⁵ performance to that under three counterfactuals. First, where there is no intermediary sector so that indirect exporting is not an option. Second, where foreign trade is completely centralized and firms can *only* export through intermediaries. Third, where there are no restrictions on the mode of exporting. In the second set of exercises we consider the same three cases, but where we shut down the learning channel.

Figure 4 - 8 plot total domestic sales, total export sales, total profits, export participation rates and average productivity in the economy under these three cases. Case 3 is probably closest to the status quo and while case 2 is close to the scenario before liberalization.

Case 3, where there are no restrictions, is the best case scenario, both with and without learning, and has the best performance of all for all of these five variables. Of course, the curves with learning lie above the analogous ones without learning.

Note however, with learning, that domestic sales as well as average productivity with no intermediation are very close to those without any restrictions. The reason for this is that there are two countervailing effects on sales and productivity. 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. These two roughly cancel out.

When it comes to export sales and total profits however, restricting indirect exporting has a cost: the loss in exports (profits) from small former indirect exporters who just stop exporting exceeds any gain from firms that would have preferred to be indirect exporters but who become direct exporters when indirect exporting is infeasible. Nevertheless, with learning, it is worse in terms of exports (profits) to restrict direct exporting than to restrict indirect exporting as depicted in Figure 5 and Figure 6. With no learning however, this is reversed. It is worse to restrict indirect exporting than direct exporting.

Looking at export participation is interesting: there is a difference in the short

²⁵We restrict ourselves to a partial equilibrium case.

run and in the long run. In the short run, restricting direct exporting reduces export participation by less than restricting indirect exporting. This is because those prevented from becoming direct exporters just export directly, while those prevented from becoming indirect exporters stop exporting. In the long run however, this is reversed because of the greater learning from direct exporting. In the absence of learning, no such reversal occurs.

8 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.

We see our work 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 well as the lower tariffs imposed by China on intermediate and final goods as part of the accession to the WTO.

It is well understood that China already had de-facto MFN treatment for its exports by the time it joined the WTO. Joining the WTO just made it more certain. However, it did drop its import tariffs quite significantly as part of joining the WTO and this may also have 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, 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 has a similar effect, though of half the size. importing intermediate goods improves plant performance. Kasahara and Rodrigue (2008) estimate a dynamic model that incorporates the choice of using imported intermediates using plant-level Chilean manufacturing panel data and shows that plant productivity improves by doing so.

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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 $t - 1$	Time t		
	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: 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 1. Restrictiveness of Limits on Trading Rights

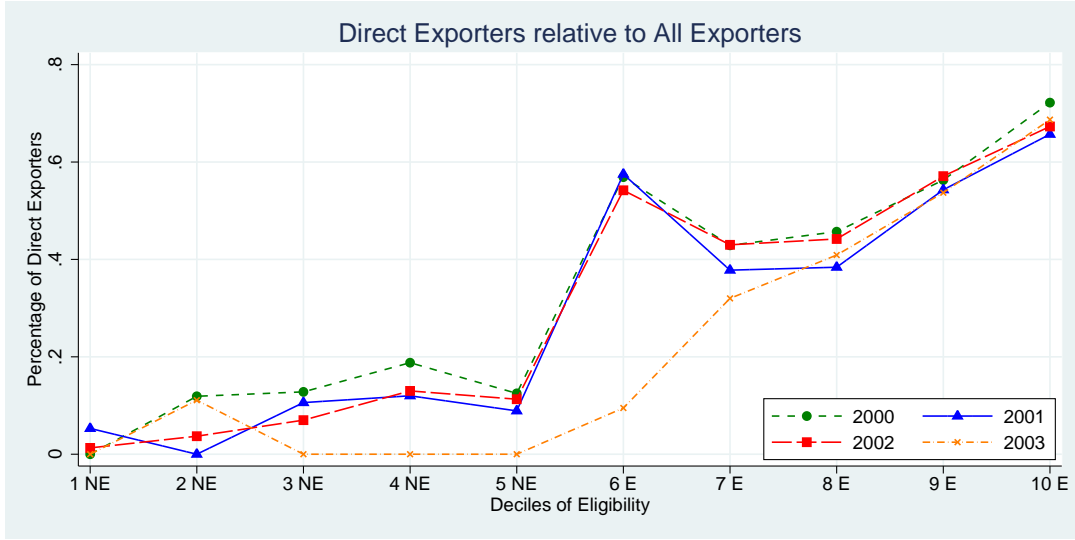


Figure 2. Example of Firm's Dynamic Decisions

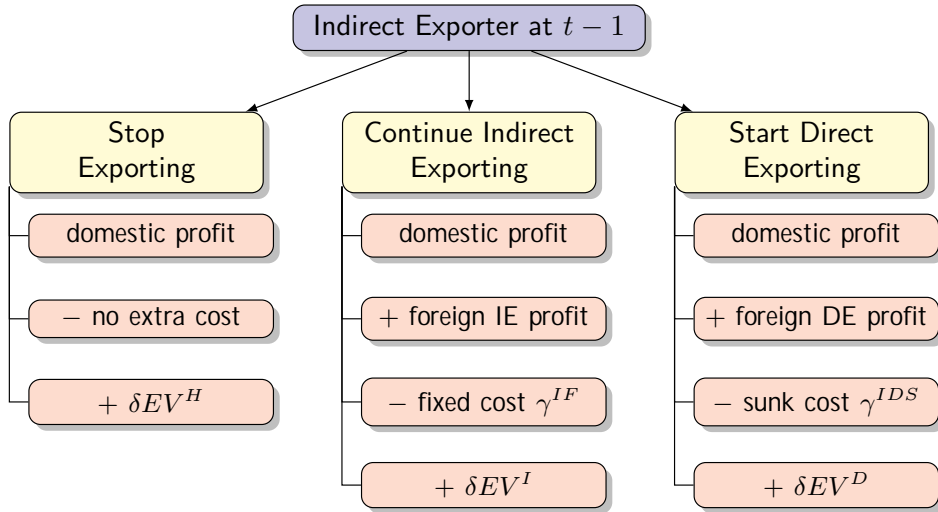


Table 5: Growth Rate, Export Participation and Relative Sale

	(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 (0.005)	1.189*** (0.035)	
$Direct_t$	0.018*** (0.005)	3.533*** (0.038)	0.137*** (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*** (0.014)	0.018 (0.015)
$\ln(Material)_t$		0.133** (0.053)	-0.024 (0.021)
$\ln(Employee)_t$		0.123*** (0.021)	-0.005 (0.023)
$\ln(Age)_t$	-0.012*** (0.002)	-0.107*** (0.019)	-0.053** (0.023)
Constant	0.087*** (0.016)	-3.558*** (0.177)	0.209 (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 6: Demand Elasticities, Marginal Cost, and Productivity Evolution

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

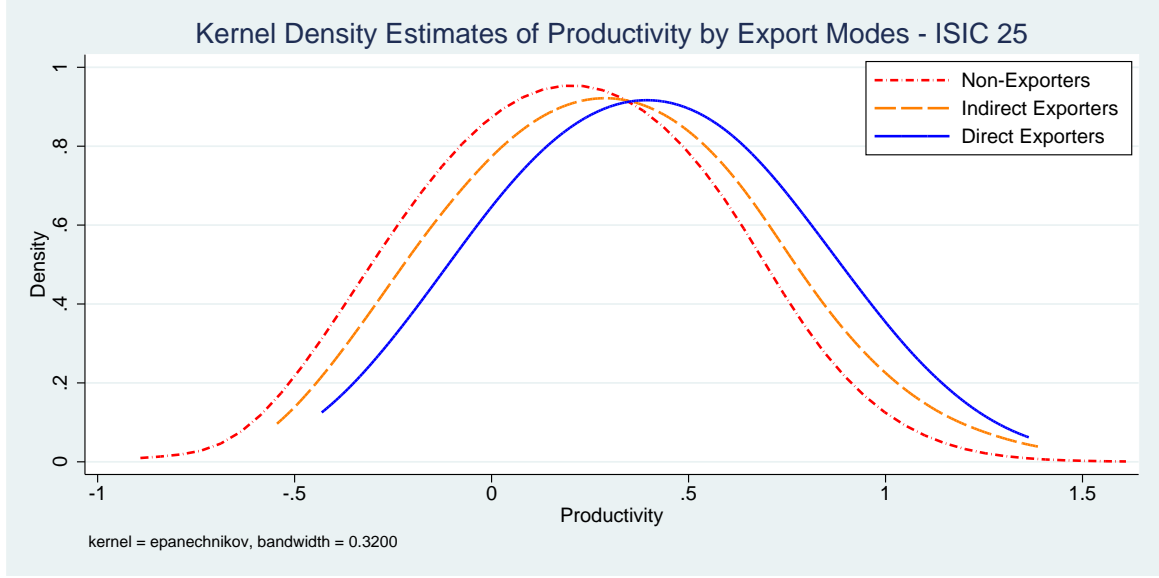


Table 7: Dynamic Parameter Estimates

Export Market Size	Ψ^X	5.666***	(0.018)
Sunk Export Costs			
Home \rightarrow Indirect	γ^{HIS}	18.406***	(0.419)
Home \rightarrow Direct	γ^{HDS}	122.098***	(5.634)
Direct \rightarrow Indirect	γ^{DIS}	0.781***	(0.029)
Indirect \rightarrow 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 8: 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 9: 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
	Model	0.962	0.026
Indirect Exporter	Data	0.256	0.628
	Model	0.337	0.546
Direct Exporter	Data	0.020	0.063
	Model	0.081	0.114

Table 10: Pairwise Marginal Benefits of Exporting

Percentile	ω_t	$E_t V^H$	$E_t V^I$	$E_t V^D$	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 11: 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 12: 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*

Figure 4. Domestic Sales

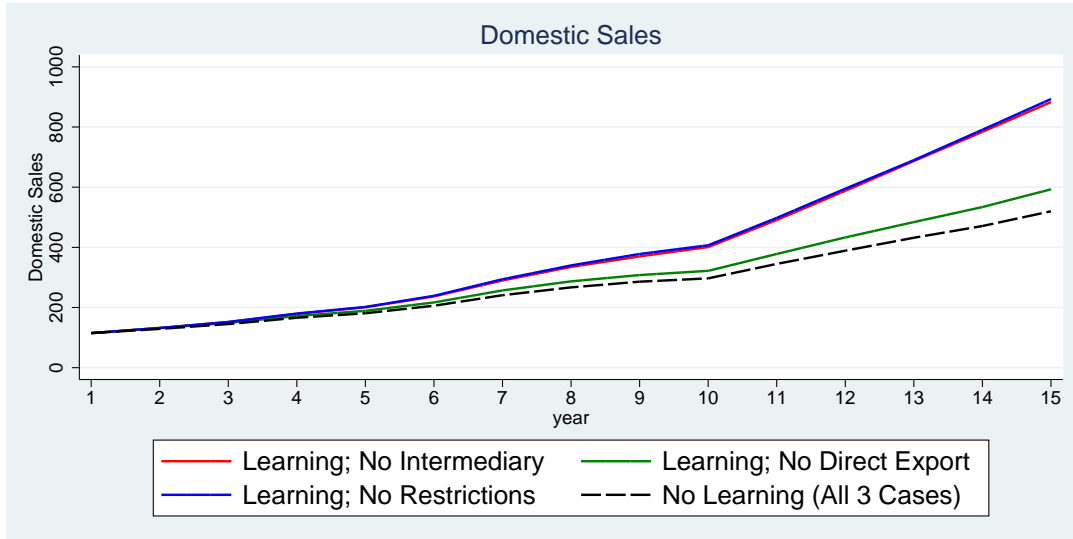


Figure 5. Export Sales

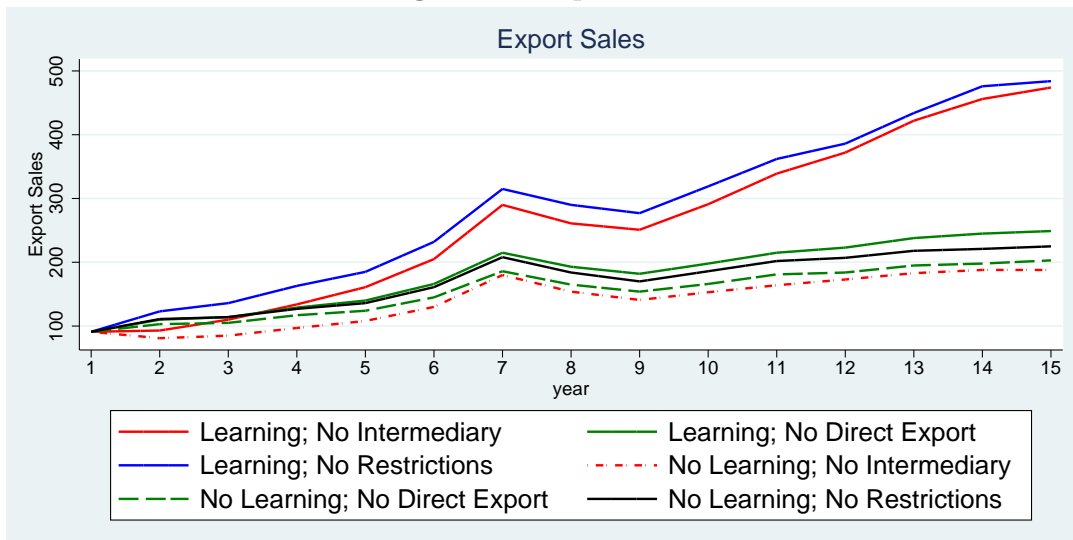


Figure 6. Total Profits

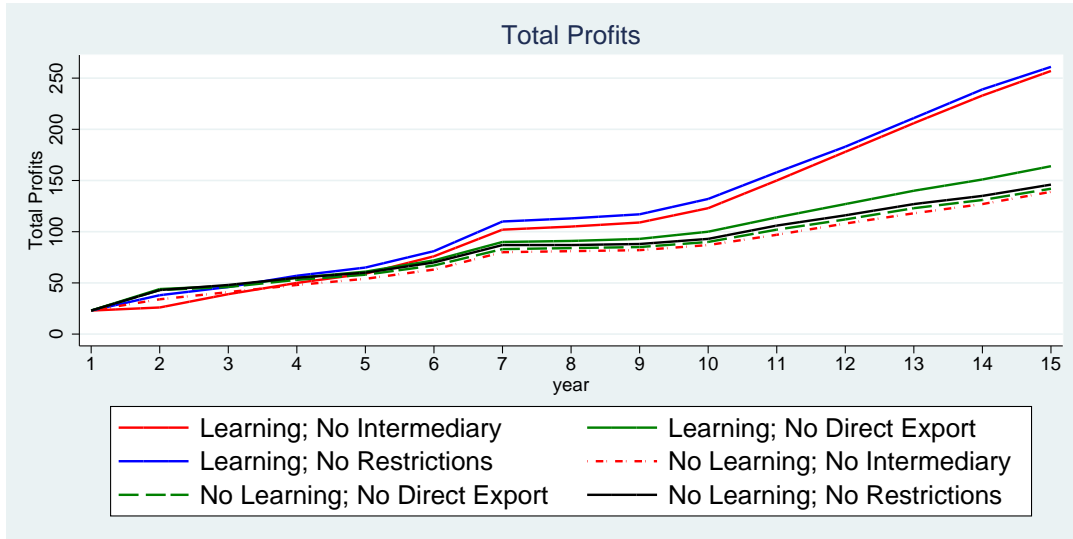


Figure 7. Export Participation

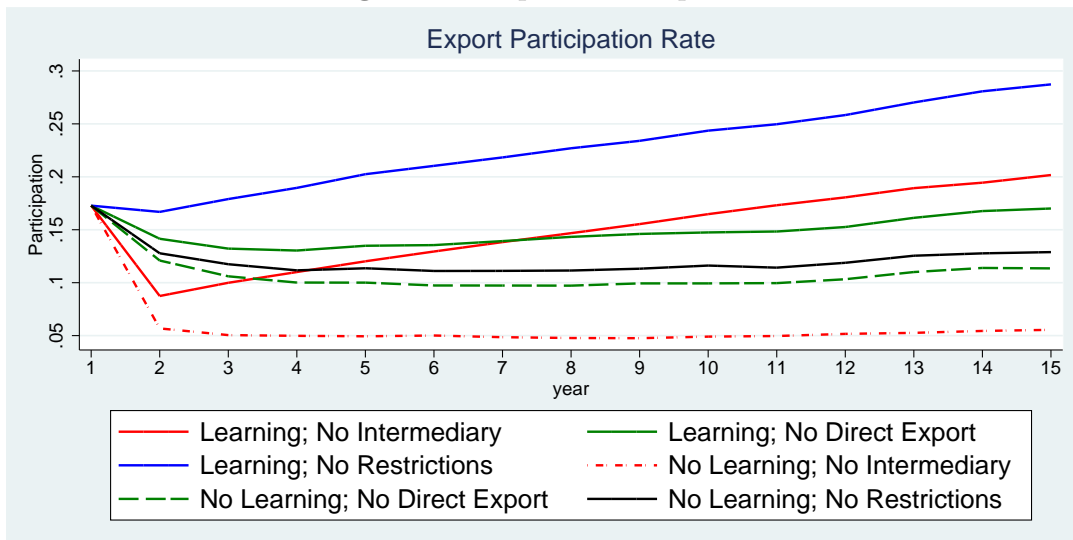


Figure 8. Productivity

