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How you export matters: Export mode, learning and productivity in China☆

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ABSTRACT

This paper shows that *how* firms export (directly or indirectly via intermediaries) matters. We develop and estimate a dynamic discrete choice model that allows learning-by-exporting on the cost and demand side as well as sunk/fixed costs to differ by export mode. We find that demand and productivity evolve more favorably under direct exporting, though the fixed/sunk costs of this option are higher. Our results suggest that had China not liberalized its direct trading rights when it joined the WTO, its exports and export participation would have been 26 and 33% lower respectively.

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1. Introduction

Firms can choose how they export: directly or indirectly through intermediaries. What are the costs and benefits of such choices? On the one hand, intermediaries provide smaller firms the opportunity to engage in foreign trade without incurring the many costs associated with direct exporting. On the other hand, indirect exporters face lower variable profits because intermediaries take a cut. The existing literature on heterogeneous firms focuses on this static trade-off between exporting directly and indirectly. However it neglects the dynamic trade-offs that might exist if there were different learning-by-exporting effects for direct versus indirect exporters.

Learning-by-exporting refers to the mechanism whereby firms improve their performance (on the productivity and/or demand side) after entering export markets. Case study evidence points to the importance of learning about cost-cutting technologies and profit-boosting product designs through buyer–seller relationships.[1] Since firms who export through intermediaries usually do not engage in direct contact with their foreign buyers and do not maintain employees in foreign markets, the pass-through of knowledge may be less effective than that of direct exporters. Hence, firms who export directly may have more opportunities to improve than indirect ones. Consequently, firms' current export mode choices can affect their future profits. These dynamic considerations can be vital in shaping the effects of policy.

Before 2004, smaller domestically owned Chinese firms with registered capital below a specified level were prohibited from exporting directly.[2] They had to export through others. These restrictions on direct trading were removed by 2004 as part of China's joining the WTO.[3] If direct exporters learn more than indirect ones, then limiting the ability to export directly could have had significant adverse effects. We use this reform as a natural experiment and estimate a structural dynamic model that allows us to quantify the static and dynamic trade-offs and evaluate the cost of the restrictions on direct trading. We recover not only the sunk and fixed costs of exporting according to mode, but also the evolution of productivity and demand under different export modes. We find that the evolution of both demand and productivity is more favorable under direct exporting. Our counterfactuals suggest that China's restrictions on direct exporting reduced Chinese export growth considerably. Exports would have been 26% lower and the export participation rate would have been 33% lower after 15 years had there been no liberalization of trading rights.

We build on the literature on firm export decisions and learning by exporting. Dixit (1989a,b) and Baldwin and Krugman (1989), among others, drew attention to the hysteresis created by the sunk costs of entering the export market. Das et al. (2007) develop and estimate a dynamic structural model of export decisions incorporating uncertainty, firm heterogeneity and sunk entry costs. Most studies find little or no evidence of improved productivity as a result of beginning to export, see Clerides et al. (1998), but rather find that more productive firms select into exporting, see for example Bernard and Jensen (1999). More recently, there is some evidence of productivity improvement after entry, see Van Biesebroeck (2005) and De Loecker (2007). Also, there may be linkages between the export decision, R&D investment and endogenous productivity growth as in Aw et al. (2011). This paper is most closely related to their work.

Our work is also related to a recent literature on intermediation which has become a topic of growing interest. There is substantial evidence suggesting that intermediaries facilitate international trade (see, for example, Rossman (1984) for Japan, Akerman (2010) for Sweden, Bernard et al. (2007) for the US, and Ahn et al. (2011) for China.). 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). Intermediaries help match firms with potential trade partners and reduce information asymmetries (Rubinstein and Wolinsky, 1987; Biglaiser, 1993), or play a role in quality control (Feenstra and Hanson, 2004). More recent work has either focused on the network and matching process between buyers and sellers (Antràs and Costinot, 2011) or has extended the model of Melitz (2003) and modeled intermediation as involving lower fixed costs than exporting directly, but lower variable profits as the intermediary takes his cut (Ahn et al., 2011; Akerman, 2010). An insight that emerges is sorting in the cross-sectional distribution of firms across the modes of exporting: the most productive firms choose to export directly, less productive firms export through intermediaries, and the least productive firms sell only to the domestic market. Blum et al. (2009, 2010) show that the data is consistent with a model of heterogeneous importers and exporters and that most importer exporter pairs involve at least one large firm, which is often an intermediary, and this is particularly so in smaller markets. Ahn et al. (2011) use a standard static heterogeneous firm setting with costs of exporting that vary by mode. They show that for China at least, less productive firms use intermediaries, especially to export to less accessible markets. As in their work, we treat intermediation as just one technology of exporting with associated costs.

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

In theory, learning effects could be bigger for indirect exporters than for direct ones. This may be particularly relevant in terms of learning to deal with customs procedures and learning the ins and outs of how to get things done in settings where procedures are less transparent.[4] Thus, the question is an empirical one and one of the contributions of the paper is to see what seems to hold in the data, at least for China. We treat intermediaries as agents who help export to rather than distribute in the destination market. Blum et al. (2009, 2010) show that distributors in the destination market also play a role in accessing them. In the current paper, such exporters would be labeled as direct exporters, even though they are using the services of intermediaries. As argued in Section 2 in more detail, this misclassification would if anything, work against us.

Other policy reforms in China have also been important in driving export growth. Handley and Limão (2013) argue that 22–30% of the growth in exports after China joined the WTO could be due to China getting permanent MFN status and Pierce and Schott (forthcoming) confirm that this feature also drives job losses in the US. This firm level evidence confirms the chilling effect of uncertainty. China also

[1] See Egan and Mody (1992) (pages 324–328) for some examples of how direct engagement with buyers enhances learning.

[2] Registered capital is also known as the authorized capital. It is the maximum value of securities that a company can legally issue. This number is specified in the memorandum of association when a company is incorporated.

[3] These restrictions were part and parcel of China's being a planned economy. Part of the concern was that unrestricted exporting would result in unrestricted importing as exports earn foreign exchange. In planned economies, access to foreign exchange is usually restricted as the exchange rate is not market driven. Mr. Long Yongtu, head of the Chinese delegation, described the removal of such restrictions as "revolutionary" at the third working party meeting on China's accession to the WTO.

[4] Also, intermediaries like Costco and Walmart may also provide significant input into what sorts of products to produce. These large intermediaries have vast experience about what sells and often conduct a lot of market research that others could not.

dropped its import tariffs quite significantly as part of joining the WTO which may have also had beneficial effects. Ethier (1979, 1982), suggests greater input variety reduces unit costs of production. Recent work, see Goldberg et al. (2010), shows that this seems to be the case for India, while Amiti and Konings (2007) and Feng et al. (2016) have similar results for Indonesia and for China respectively. A more structural approach is to be found in Kasahara and Lapham (2013), Kasahara and Rodrigue (2008) and Zhang (2013). We contribute to this literature on the factors behind China's growth of exports by looking at a less well-understood, but important reform on which there is, to our knowledge, no formal work: namely the removal of restrictions on direct trading.

The rest of the paper is organized as follows. In the following section we describe the data and the background of the restrictions of direct trading. In Section 3 we lay out the basis for firms' dynamic decisions over modes of exporting. Section 4 describes the estimation method. Section 5 summarizes the parameter estimates. We conduct counterfactual exercises to examine the costs and benefits of the trading right liberalization and different trade policies in Section 6. We conclude in the last section.

2. Data and background

This analysis utilizes two Chinese data sets that we have matched. 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 revenue over 5 million Chinese Yuan (about 600,000 US dollars). The data contains information on the firms' industry of production, ownership type, age, employment, capital stocks, and revenues, as well as export values. The second data set is the Chinese Customs transaction-level data. We observe the universe of transactions by Chinese firms that participated in international trade over the 2000–2006 period. This data set includes basic firm information, the value of each transaction (in US dollars) by product and trade partner for 243 destination/origin countries and 7526 different products in the 8-digit Harmonized System.[5]

We infer firms' exporting modes as follows. Firms from the Annual Survey are tagged as exporters if they report positive exports, and as direct exporters if they are also observed in the customs data set.[6] The fact that we observe the universe of transactions through Chinese customs allows us to tag the remaining exporting firms (those which are not observed in the customs data set) as indirect exporters. Firms that report exports larger than their exports in the customs data are taken to be exporting both directly and indirectly and are tagged as direct exporters in this paper. We would like to emphasize that our classification of firms according to export mode is not based on a survey question as this question is rarely asked; export mode is inferred.[7] Had we done a poor job matching the customs and survey data, then we would be at risk of classifying unmatched direct exporters as indirect ones. We perform a number of checks to convince the reader and ourselves that this is not the case.[8]

Moreover, intermediaries can operate in China or outside China. For example, intermediaries in China could buy from Chinese producers and sell to foreign buyers. In this case, the producers would be labeled as indirect exporters. Alternatively, Chinese producers could sell to intermediaries outside China who serve as importing intermediaries in the destination country, as suggested by Blum et al. (2009, 2010). Here the intermediary abroad would buy directly from Chinese producers. In our paper such exporters would be labeled as direct exporters even though they are also working through intermediaries. This could bias our results.

However, if intermediaries in China operated in the same way as those operating abroad, this mis-classification would bias our estimates of productivity and demand shock evolution for direct exporters *downward* as we would be mis-classifying indirect exporters as direct ones, and work against finding direct exporters having a more favorable evolution of productivity and demand shocks. Of course, if intermediaries in China differed from those outside in terms of their learning effects, this could work against the results we find. Head et al. (2014) examine the role of procurement centers set up by western multinationals. They find that current retailer presence is associated with enhanced city export capability. They take this as an indication that such procurement centers may serve the same role as intermediaries in the promotion of exports. Unfortunately, we do not have information on the importing country side, so we cannot directly test the learning effects from exporting via foreign intermediaries.

In recent work, Bernard et al. (2012) argue that carry-along trade is important in the data. This refers to firms who export for other firms, thereby acting as intermediaries. In this paper we do not distinguish between such firms and those that export only their own products. We also drop pure producer intermediaries, those who show up in the customs data but do not report exporting in the survey data. As processing trade is very different from ordinary trade,[9] sunk cost and learning opportunities could be very different for processing trade. For this reason we exclude processing firms from our main sample.[10]

2.1. The restrictions on direct trading

The restrictions on direct trading were eliminated over the period 2000–2004, at different rates for different regions, industries and types of firms, as part of the accession agreement for joining the WTO. The details of the rules governing the ability to trade directly in the period 1999–2004 are laid out in Table A.1 in the Appendix. 56.1% of the firms in the sample were not eligible for direct trading rights in 2000. This number dropped to 45.5% the next year, 6.2% in 2003, and all firms became eligible in 2004.

We leverage the institutional features that are present, namely eligibility variations, and look at firms below and above the threshold of eligibility. We find these are indeed different in terms of their probability of exporting, export and revenue growth. We also find that there is evidence that the restrictions were binding to begin with, and became less so as they were relaxed, see Bai and Krishna (2014).

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

[5] Details of this matching are given in Section C of the Appendix, particularly in Tables A.2 and A.3.

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

[7] The Ghana Manufacturing Enterprise Survey Dataset used by Ahn et al. (2011) does ask firms to identify themselves as direct or indirect exporters and has a panel, but this seems to be the only such example.

[8] The basic idea is to predict the probability of each firm at each time of being classified as a direct exporter. If our classification is accurate, this predicted probability should be higher for firms we do classify as direct exporters relative to other groups. This is exactly what we see. Details are provided in the Appendix.

[9] See Feenstra and Hanson (2005) for details.

[10] See the Appendix for robustness checks when including processing firms.

Table 1
Composition of firms.

Year	Non-exporter		Indirect exporter		Direct exporter		Total
2000	3270	82.1%	387	9.7%	326	8.2%	3983
2001	4617	82.5%	524	9.4%	454	8.1%	5595
2002	5054	81.5%	599	9.7%	551	8.8%	6204
2003	5410	81.1%	604	9.1%	657	9.8%	6671
2004	7703	80.1%	763	7.9%	1149	12.0%	9615
2005	8544	79.1%	886	8.2%	1369	12.7%	10,799
2006	7660	79.0%	781	8.1%	1254	12.9%	9695

Table 2
Summaries of firm size.

	Employee	Capital	Home revenue	Export revenue
Non-exporter				
Mean	120.177	0.792	2.667	0.000
Median	73	0.262	1.306	0.000
Indirect exporter				
Mean	280.316	2.858	8.539	2.138
Median	120	0.375	1.989	0.538
Direct exporter				
Mean	379.454	4.506	10.857	4.038
Median	178	1.016	3.719	1.270

Notes: Capital, domestic revenue and exports are in 10 million Chinese Yuan.

2.2. Summary statistics

In this section, we document patterns in the data that drive our modeling choices. We focus on one industry: Manufacture of rubber and plastic products (2-digit ISIC Rev3 25).[11] 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 their modes of export over the sample years. Note that the share of direct exporters has risen over time and that the numbers are in line with those for other large countries.

Table 2 summarizes and compares firm size, measured in employment, capital stock, domestic revenue and export revenue among different types of exporters. On average, direct exporters are larger in all these dimensions than indirect exporters who are larger than non-exporters. This makes sense as firms need to be large and/or productive enough to cover the sunk costs and fixed costs of direct exporting.

The correlation between capital stock and export value is 0.674, and that of domestic revenue and exports is 0.595. Thus, success in the domestic market does not necessarily translate into success in the foreign market. This suggests multi-dimensional heterogeneity: productivity *and* 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 revenue are highly skewed with a right tail for exporting firms (as the mean is significantly more than the median), and even more s among firms that export indirectly. In order to explain the existence of many small exporters, we assume that fixed and sunk costs are randomly drawn in each period.[12]

2.3. Empirical transition patterns

Before estimating the model, we first describe the dynamic exporting patterns which motivated our choice of model and help in identification of key structural parameters. Table 3 reports the average transition of export status and export modes over the sample period among all eligible firms.[13] The patterns reported here highlight the importance of distinguishing between indirect and direct exporters in studying their cost structures. Column 1 shows the export mode of a firm in year $t-1$, and Columns 2–4 show the three possible export modes in year t. The high persistence of non-exporting (96.2%) suggests the existence of significant sunk export costs that prevent firms from starting to export. The fact that more non-exporting firms start exporting indirectly than directly suggests that starting to export directly requires a higher sunk entry cost that less productive firms may not wish to cover.

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

The last row shows quite different transition rates for firms that exported directly in the previous period. Among exporting firms, the average exit rate of indirect exporters is ten times higher than that of direct exporters. The high turnover in indirect exporting and the high persistence in direct exporting reflect very different sunk/fixed costs for the two modes. This churning may also come from different long-run payoffs generated by different learning-by-exporting effects. High sunk costs of entry and large learning-by-exporting in direct exporting would provide a substantial incentive for direct exporters to remain as such even if they are making short-run losses. 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. This higher productivity of direct exporters would also help explain their lower exit from exporting.[14]

3. The model

Our model is based on Das et al. (2007), Aw et al. (2011), and Ahn et al. (2011). Heterogeneous firms (who differ in costs and demand shocks) engage in monopolistic competition in segmented domestic and foreign markets. In addition to always serving the domestic market, they can choose — not to export, export through intermediaries, and export by themselves ($d_{it}^m = \{0,1\}$, $m = H$ome, Indirect, Direct). Firms also face different entry costs and fixed costs of exporting. Based on its current and expected future value, a firm chooses whether or not to export, and the mode in which to export.

[11] We choose this industry for two reasons. First, it was not subject to other restrictions on trading (for example, 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 are in line with the patterns we find in our baseline estimation and are presented in the Appendix.

We have also estimated the evolution of productivity for a number of other industries. These results are given in Table 5.

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

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

[14] The Ghanian data has similar patterns in terms of order, though persistence as a direct or indirect exporter is much lower. See Ahn et al. (2011).

Table 3
Transitions of export modes: all eligible firms.

Export status	Time t		
Time $t-1$	Non-exporter	Indirect exporter	Direct exporter
Non-exporter	0.962	0.029	0.009
Indirect exporter	0.227	0.662	0.111
Direct exporter	0.020	0.062	0.918

These decisions in turn affect the future productivity and demand shocks making the problem dynamic.

An advantage of exporting through intermediaries could be to avoid some of the sunk start-up costs and fixed costs of exporting.[15] Such costs may include those generated by establishing and maintaining a foreign distribution network, learning about and dealing with bureaucratic procedures, and so on. Firms need to be large to make it worth their while to export directly. On the other hand, firms exporting indirectly must pay for the services provided by intermediaries.[16] As a result, firms receive lower variable revenue from indirect exports than from direct exports.[17]

3.1. Static decisions

Each firm supplies a single variety of the final consumption good at a constant marginal cost. Firms set their prices in each market by maximizing profits from that market, taking the price index as given, and do not compete "strategically" with other firms. Firms' domestic revenue are not perfectly correlated with export revenue as there are firm and market specific demand shocks.

3.1.1. Demand side

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

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

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

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

and

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

where H denotes the home market and X the foreign market, i denotes the firm that provides variety i, and $\Omega^H(\Omega^X)$ 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 assume that the demand in the foreign market for each firm is also subject to a firm-specific demand shock z_{it}.[18] Foreign utility is analogously defined. Demand for Chinese goods comes from home consumers who substitute between Chinese goods according to σ^H and from foreign consumers who substitute between them according to σ^X as Chinese goods are exports for them.

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

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

and

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

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

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

and

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

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

3.1.2. The intermediary sector

As in Ahn et al. (2011), we assume the intermediary sector is perfectly competitive. We do not focus on modeling the intermediation process in international trade but treat the intermediation as one technology of exporting. Intermediaries purchase goods from manufacturers at p_{it}^I and sell them at price $p_{it}^{XI} = \lambda p_{it}^I$. Thus, $(\lambda - 1)$ is the commission rate charged by the intermediary and the corresponding demand is $q_{it}^{XI} = \left(\frac{p_{it}^{XI}}{P_t^X}\right)^{-\sigma^X} \frac{Y_t^X}{P_t^X} e^{z_{it}}$ from Eq. (8). The intermediary's cut can be thought of as a service fee. Consequently, the price of indirectly exported goods is higher than that of the same good had it been directly exported. In order to start to export indirectly, firms must pay a sunk cost. They also need to pay an ongoing fixed cost which could be very low.

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

[16] 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, and acting as customs agents, and are paid for these services by some sort of a commission.

[17] Ahn et al. (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.

[18] Note that the demand shocks should be interpreted as something that affect exports differently from the domestic market, or as a shock to foreign demand relative to that in the domestic market.

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

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

where mc_{it} denotes the firm's marginal cost of production, which we assumed to be constant and the same for servicing local and foreign markets, and P_t^X is the aggregate price index in the export market. Thus, the price the manufacturer charges the intermediary is[19]

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

3.1.3. Supply side

We assume as in Aw et al. (2011) that short-run marginal costs are given by

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

Since we do not have data on firm-time specific factor prices, $\boldsymbol{w}_{it}$, these are proxied for by the time, industry and location dummies D_t, D_s, and D_l. D_t is a year dummy and D_s denotes the dummy at the 4-digit industry level. D_l is a dummy for location (inland v.s. coastal provinces).[20]

Firm-time specific productivity levels are given by ω_{it}. The capital stock, $\ln k_{it}$, should be thought of as a firm-level cost shifter as only factor prices enter the cost function.[21] Short-run cost heterogeneity can come from differences in scale of production, and this is captured by the firm's capital stock. Constant marginal costs of production allow firms to make their static decisions separately for the two markets.

Firms choose their prices for each market after observing their demand shocks and marginal costs. They charge 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 $p_{it}^{XI} = \lambda \frac{\sigma^X}{\sigma^X - 1} mc_{it}$.

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

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

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

where $m = I, D$. The last term of Eq. (13)($\sigma^X ln\lambda$) is positive ($\lambda > 1$) when the firm is indirectly exporting ($d_{it}^I = 1$). Firms' revenues in each market depend on the aggregate market conditions[22] (captured by Φ_t^H and Φ_t^X), the firm-specific productivity, and capital stock, while the revenue in the foreign market also depends on firms' choices of export modes. The log-revenue from exporting indirectly is less than that from exporting directly by the amount of $\sigma^X ln\lambda$.

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

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

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

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

and

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

The short-run profits together with firms' draws from the sunk costs and fixed costs distributions and the future evolution of productivity determine firms' decisions to export and their choices of export modes.

Note that productivity enters both domestic and export revenue while demand shocks enter only export revenue. In interpreting the demand and productivity shocks, it is important to realize that we call all shocks that affect both the domestic and foreign revenue as productivity shocks because in our model, productivity shocks affect costs and impact both domestic and foreign revenues. Shocks that operate in the foreign market alone are called demand shocks. We also assume these shocks are independent. To the extent that foreign and domestic demand shocks are positively correlated, we would be picking up part of the demand shocks in what we call productivity shocks.

3.2. Transition of state variables

In each period, firms observe their current productivity, foreign market demand shocks, and previous period mode of exporting[23] before they make their decisions. This section describes the transitions of these state variables. We assume productivity ω_{it} evolves over time as a Markov process that depends on the previous period's productivity and the firm's export decision — export or not, and if yes, what mode of export to use. We use a cubic polynomial to approximate this evolution.

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

where $d_{it-1}^m = \{0, 1\}$, $m = I, D$, are dummy variables that indicate firm i's export mode 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.

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

[20] We could have included dummies at a more detailed level, for example, for provinces as the results were similar. However, they increase the state space and make second stage estimation much more complicated.

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

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

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

By allowing the choice of export modes to endogenously affect the evolution of productivity, we can separate the role of learning-by-exporting and the sorting by productivity.[24] Note that if firms expect their productivity to grow quickly with direct exporting, they may choose to export directly even though it is not profitable in the static sense. ξ_{it} is an i.i.d. shock with mean 0 and variance σ_ξ^2 that captures the stochastic nature of the evolution of productivity. ξ_{it} is assumed to be un-correlated with ω_{it-1} and d_{it-1}. It is well known that more-productive firms self-select into export markets. When estimating productivity with learning-by-exporting, the concern is that when we compare an exporter to a non-exporter, we would attribute the future productivity differences to the act of exporting, although they merely reflect selection. Under the model's structure, productivity differences that might have existed prior to the entry into export markets are controlled for through the inclusion of lagged productivity in the productivity evolution. Thus, potential self-selection into export markets is controlled for.[25]

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

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

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

3.3. Dynamic decisions

At the beginning of each period, firm i observes the current state,

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

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

We allow the *distributions* of the costs, both fixed and sunk, of exporting to differ depending on the firm's past exporting status and mode. We assume firms draw from distributions of fixed and sunk costs rather than having common values of these. Without this assumption, firms that look alike in terms of mode, productivity and demand shocks would make the same decisions in entering/exiting markets and changing modes. These fixed and sunk costs are drawn from separate independent distributions G^r.[26] For example, firm i faces the sunk cost γ_{it}^{HDS} drawn from the distribution G^{HDS} if it did not export last period and is looking to export directly today, while it draws γ_{it}^{IDS} from the distribution G^{IDS}, if it was already exporting indirectly.[27] All this is summarized in Table 4. We assume that all sunk costs are paid in the current period. Since choices will involve comparing the difference in payoffs from pair-wise options as explained below, we will not be able to pin down all the elements of the table. We can only identify their relative sizes and so assume zero sunk costs associated with exiting exporting.

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}

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

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

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

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

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

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

The continuation value is

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

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

[25] Of course, if firms differ not just in their productivity, but also in terms of the growth of productivity, there could still be bias. We check for this later on in Section 5.5.

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

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

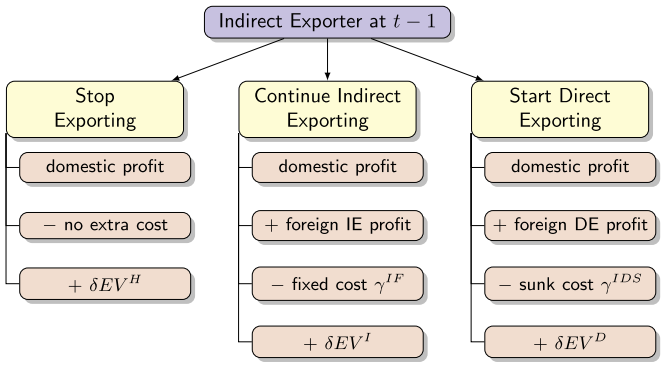

Fig. 1. Example of a firm's dynamic decisions.

where $dF(\omega'|\omega_{it}, \boldsymbol{d}_{it})$ and $dF(z'|z_{it}, \boldsymbol{d}_{it})$ are the evolutions of productivity and demand shocks as defined in Eqs. (17) and (18).

For any state vector, denote the choice-specific continuation value from choosing $d^m_{it} = \{0,1\}$, as $E_t V^m_{it+1} = E_t V\left(s_{it+1}\,|d^m_{it}=1\right)$, $m = H, I, D$. Firms' export decisions depend on the difference in the pair-wise *marginal benefits* between any two options and the associated sunk/fixed costs. 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 Eqs. (22), (23) and (24) respectively.[28]

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

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

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

For example, if a firm was an indirect exporter last period, it will choose to become a direct exporter today if this is its best option. The options facing an indirect exporter are laid out pictorially in Fig. 1. An indirect exporter will become a direct exporter if it is more profitable than either staying an indirect exporter or becoming a non-exporter.[29] The probability of this event is

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

Thus, these marginal benefits are useful in defining the probability of switching given the distributions of costs.[30]

The benefit an indirect exporter gains from choosing to export directly compared to exporting indirectly can be decomposed into the static and the dynamic parts. The static part is the difference between the current period payoffs from these two modes of exporting, $(\pi^{XD}_{it} - \gamma^{IDS}_{it}) - (\pi^{XI}_{it} - \gamma^{IF}_{it})$. The difference between the discounted future payoff from these two modes of exporting, $\delta\left(E_t V^D_{it+1} - E_t V^I_{it+1}\right)$, captures the dynamic part.

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

4. Estimation

Following Das et al. (2007) and Aw et al. (2011), we estimate the model using a two-stage approach. 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. The following parameters are recovered: the elasticities of substitution in the two markets, σ^H and σ^X, the home market size intercept Φ^H_t, the marginal cost parameter β_k, the productivity evolution function $g(\omega_{it-1}, d_{it-1})$, and the variance of transient productivity shocks σ^2_ξ. In the second stage, we exploit information on firms' discrete choices regarding export market participation modes, and the productivity estimates obtained in the first stage of the estimation procedure, to obtain the parameters on the sunk and fixed costs of two exporting modes.[31] Parameters of G^γ (the distribution of sunk and fixed costs), the parameters η_z, σ_μ, ψ_1, ψ_2 of the Markov process, z_{it}, followed by the demand shock, and the foreign market size intercept, Φ^X_t, are also recovered in the second stage.

4.1. Stage 1: elasticities and productivity evolution

4.1.1. Elasticities

To estimate the elasticity of substitution in each market we use the approach in Das et al. (2007). Each firm's total variable cost can be written as

$$\begin{aligned} TVC_{it} &= mc_{it} q^H_{it} + mc_{it} q^{Xm}_{it} \\ &= \left(\frac{\sigma^H - 1}{\sigma^H}\right) p^H_{it} q^H_{it} + \left(\frac{\sigma^X - 1}{\sigma^X}\right)\left[d^D_{it} p^{XD}_{it} q^{XD}_{it} + d^I_{it} p^I_{it} q^{XI}_{it}\right] + \epsilon_{it}. \end{aligned} \tag{26}$$

The first line in Eq. (26) is an identity. The second comes from using the model to substitute for marginal costs in terms of price. In the estimating equation, we add an error term which reflects measurement error in variable costs. As total variable costs and revenues are data, we can estimate Eq. (26) by OLS to recover the elasticities of substitution.

4.1.2. Productivity and productivity evolution

We can rewrite Eq. (12) as being made up of a part that does not vary over time, a part that does, and a part that varies by firm and time as follows:

$$\begin{aligned} \ln r^H_{it} &= \phi^H_0 + \sum_{t=1}^{T} \phi^H_t D_t + \sum_{s=1}^{S} \phi^H_s D_s + \sum_{l=1}^{L} \phi^H_l D_l \\ &\quad + \left(1 - \sigma^H\right)\left(\beta_k \ln k_{it} - \omega_{it}\right) + u_{it}, \end{aligned} \tag{27}$$

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

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

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

[30] More details on constructing unconditional and conditional choice probabilities are provided in the Appendix.

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

where $\phi_0^H = (1-\sigma^H)\ln\left(\frac{\sigma^H}{\sigma^H-1}\right) + (1-\sigma^H)\beta_0$, $\phi_t^H = \ln\Phi_t^H + (1-\sigma^H)\beta_t$ which captures the time varying factor prices and the home market size, $\phi_s^H = (1-\sigma^H)\beta_s$ and $\phi_l^H = (1-\sigma^H)\beta_l$. k_{it} denotes the firm's capital,[32] ω_{it} is productivity, and u_{it} is an i.i.d. error term reflecting measurement error.[33]

As in Levinsohn and Petrin (2003), we proxy for unobserved productivity using the fact that more productive firms will use more materials. Thus we can replace $(1-\sigma^H)(\beta_k ln k_{it} - \omega_{it})$ with $h(k_{it}, m_{it})$.[34] We estimate the function (Eq. (27)) using ordinary least squares and approximate $h(k_{it}, m_{it})$ by a third-degree polynomial of its arguments. This gives us estimates of ϕ_0^H, Φ_t^H and the values of $\hat{h}(k_{it}, m_{it})$.[35] Thus we can rewrite productivity as follows:

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

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

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

Thus, if we substitute for ω_{it} and ω_{it-1} using Eq. (28) into the above equation, we can estimate the remaining parameters ($\alpha_i, i = 0, \ldots, 5$ and β_k), using non-linear least squares. The variance of ξ_{it} is pinned down by the sample variance of the residual.[36]

So far we have estimates of ϕ_0^H and ϕ_t^H, which capture the home market condition, ϕ_s^H and ϕ_l^H for 4-digit industry and location specific effects on factor prices, elasticities σ^H and σ^X, the marginal cost parameters β_k, the productivity evolution function $g(\omega_{it-1}, d_{it-1})$, and the variance of transient productivity shocks σ_ξ^2. What remains to be estimated are the parameters of the distributions of the sunk and fixed costs, i.e., of G^γ, for each mode, the demand shocks and their evolution, and the foreign market size intercept Φ_t^X.

One might think that we could take the same approach as above and estimate demand shocks from the export revenue data given our estimates of productivity and its evolution. However, not all firms export in all years, resulting in censored data. Thus a different approach is needed here: we will be able to estimate demand shocks jointly with the dynamic discrete choice component in the second stage.[37]

4.2. Stage 2: dynamic estimation

We exploit information on the transitions of export 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 the persistence in the mode and the frequency of entry into the mode across firms, given their previous exporting 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 mode if the sunk cost of exporting in that export mode is high and the fixed cost is relatively low. Ceteris paribus, we would observe frequent exits from a particular mode of exporting if the fixed cost was high.

Without additional data we have no way to pin down intermediation cost. For this reason we assume the intermediary market is relatively competitive and set the commission rate obtained by the intermediary at 1% of the export revenue. Thus, $\lambda = 1.01$.[38] Given productivity and capital stock, the export revenues of both types of exporters provide information on foreign market demand shocks when firms choose to export. We observe a firm's choice of export modes and its export revenue *only* if it exports. Note that the level and evolution of demand shocks is reflected in the level and behavior of export revenue for firms in a given export mode. The sunk and fixed costs are identified by the patterns in transitions in export modes. 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 revenue. The level of each firm's export revenue provides information on the demand shocks once we know the firm's industry and location, productivity, capital stock (a cost shifter) and market sizes. For the exporter to sell the amount he has, the demand shocks must have taken a particular value. We can back out this value from the data given the estimated parameters from the first-stage estimation and the foreign market condition which is to be estimated in the second stage. This information goes into the likelihood function which we maximize to obtain our parameter estimates. This information is only observable conditioning on exporting. Hence the demand shock distribution is censored so that we do not observe the demand shocks of non-exporters. We follow Das et al. (2007) and Aw et al. (2011) to infer the unconditional distribution for the demand shocks based on the conditional distribution given the functional form assumptions. Based on the first-stage parameter estimates and productivity estimates, we can write firm i's contribution to the likelihood function as

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

[32] We convert book values of capital stock into real capital stock following the perpetual inventory method used in Brandt et al. (2012).

[33] We could have estimated the model separately for different kinds of firms. However, given that we estimate the model industry by industry, this would reduce the size of our sample a lot.

[34] Note that the LP method crucially requires the invertibility of productivity with respect to material inputs. In our model, this is further complicated by other factors like demand shocks. For this reason we use an alternative approach to verify our results. In particular, we run a nonparametric measure of productivity using the Tornqvist index. See Section 5.5 for more discussion.

[35] Note that for the purposes of solving the model, we only need $\phi_0^H + \phi_t^H$, not the separate components. Like Aw et al. (2011), our estimation does not allow for aggregate shocks. Instead, the Ψ^H reported in Table 5 is the average $\phi_0^H + \phi_t^H$ over all time periods. The same holds for Ψ^X reported in Table 6. These average variables are used in the second stage estimation. We could allow them to change over time and to reach steady state at the end of the period for which we have data so that we could solve for the dynamic problem. As we have a short panel, after controlling for 4-digit industry and location dummies, it does not make much difference if we do this or do what we have done as a shortcut, namely just set them to be constant. The estimates on 4-digit industry and location dummies (β_s and β_l) are not reported in the tables to conserve space.

[36] We also experimented with incorporating additional firm specific factors in marginal costs such as the wage bill, location by province, and ownership (domestic, foreign or SOE). This did not change the patterns in the evolution of productivity we focus on below.

[37] We do not consider entry and exit or attempt to estimate their costs. This is not the focus of this paper. In addition, since the survey data covers all SOEs and all non-state firms above a certain size (5 million Yuan in annual revenue), we cannot distinguish exit from the industry and exit from the data, though we do observe firm's age and hence its entry date.

[38] Intermediaries tend to have thin margins and make up for them in terms of volume. A 1% cut is not out of line with observed contracts.

where $f(\cdot)$ is the marginal distribution of z and z_i^+ is the series of foreign market demand shocks in the years when firm i exports.[39] In the evaluation of the likelihood function, we followed Das et al. (2007) and Aw et al. (2011) to construct the density $f(\cdot)$ and simulate the unobserved export market shocks. The technical details are in the Appendix.

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

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.[40] It is worth reiterating that these choice probabilities are conditional on the firm's state.

5. Estimation results

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

5.1. Productivity evolution

The elasticity of substitution estimates, estimates from the revenue function as well as those for productivity evolution are reported in Table 5. In the first column, we report our estimates for the Rubber and Plastic industry. The elasticities of substitution imply markups of 27% in home market and 29% in foreign market. The negative coefficient on log capital implies that the marginal costs are lower for larger scale. The coefficients α_1, α_2 and α_3 imply a non-linear and positive marginal effect of lagged productivity on current productivity. α_4 and α_5, the coefficients on previous export modes, are critical parameters.[41] Previous indirect exporters have a 0.7% higher productivity relative to previous non-exporters, while previous direct exporters have productivity that is 2.5% higher. This confirms the dynamic trade-off between direct and indirect exporting in terms of learning-by-exporting. This long-run benefit gives firms an incentive to stay in the direct exporting mode even if they are making short-run losses.

In Columns 2–4 of Table 5, we also report our estimates of the productivity evolution process in three other industries — Chemicals and chemical products (2-digit ISIC Rev3 24), Machinery and equipment (2-digit ISIC Rev3 29), and Furniture (2-digit ISIC Rev3 36).[42] Direct exporting always has larger effects on firm productivity than indirect exporting in all these industries.

Table 5
Demand elasticities, marginal cost, and productivity evolution.

Parameters		Rubber & plastic	Chemical	Machinery & eqpt	Furniture
Domestic elasticity	σ^H	4.679***	5.506***	5.401***	5.539***
		(0.003)	(0.002)	(0.002)	(0.006)
Foreign elasticity	σ_X	4.405***	3.530***	4.581***	7.059***
		(0.008)	(0.009)	(0.004)	(0.010)
Capital	β_k	−0.070***	−0.057***	−0.057***	−0.043***
		(0.002)	(0.001)	(0.001)	(0.002)
Constant	α_0	0.542***	0.515***	0.323***	−0.273***
		(0.032)	(0.017)	(0.014)	(0.093)
$\boldsymbol{\omega}_{t-1}$	α_1	0.303***	0.188***	0.549***	1.730***
		(0.068)	(0.041)	(0.034)	(0.172)
$\boldsymbol{\omega}^2_{t-1}$	α_2	0.264***	0.398***	0.206***	−0.488***
		(0.050)	(0.034)	(0.027)	(0.104)
$\boldsymbol{\omega}^3_{t-1}$	α_3	−0.028**	−0.061***	−0.032***	0.096***
		(0.012)	(0.008)	(0.007)	(0.020)
Indirect export$_{t-1}$	α_4	0.007***	0.004***	0.006***	−0.001
		(0.002)	(0.001)	(0.001)	(0.002)
Direct export$_{t-1}$	α_5	0.025***	0.017***	0.019***	0.014***
		(0.002)	(0.001)	(0.001)	(0.002)
Ψ^H		2.392	2.161	1.799	0.072
σ_ω		0.129	0.115	0.116	0.104

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

5.2. Productivity sorting

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 Kolmogorov–Smirnov test affirms that non-exporters, indirect exporters and direct exporters are significantly different from each other. Moreover, the distribution for direct exporters first order stochastically dominates that of indirect exporters which first order stochastically dominates that of non-exporters. Fig. 2 shows the kernel density and cumulative 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.

In addition, if direct exporters have an advantage in terms of productivity evolution, we should observe that direct exporters have actually experienced a larger improvement in productivity than that of indirect exporters and non-exporters. To check if this is indeed present in the data, in Fig. 3 we look at firms who were present in the period 2001–2006 and never switched export mode. In the top panel we depict the productivity distributions of non-exporters in these two years, in the middle and lower panels we do the same for indirect and direct exporters respectively. The vertical lines give the means of the distributions. It is clear to the naked eye that the distributions move to the right over time in each panel. The increase in the mean for direct exporters is significantly higher than that for indirect exporters and non-exporters. However, there is no significant difference in the increase in the means of indirect exporters and non-exporters.

[39] Note that the independence of z makes the conditional density function the same as the marginal density function.
[40] Derivation of these choice probabilities is available upon request.
[41] Recall that ω is the natural log of productivity. Thus, α_4 and α_5 are the percentage changes in productivity when exporting indirectly and directly.
[42] These industries are important in China's exports in terms of both export revenue and number of exporters. Other industries are presented in the working paper version of the paper.

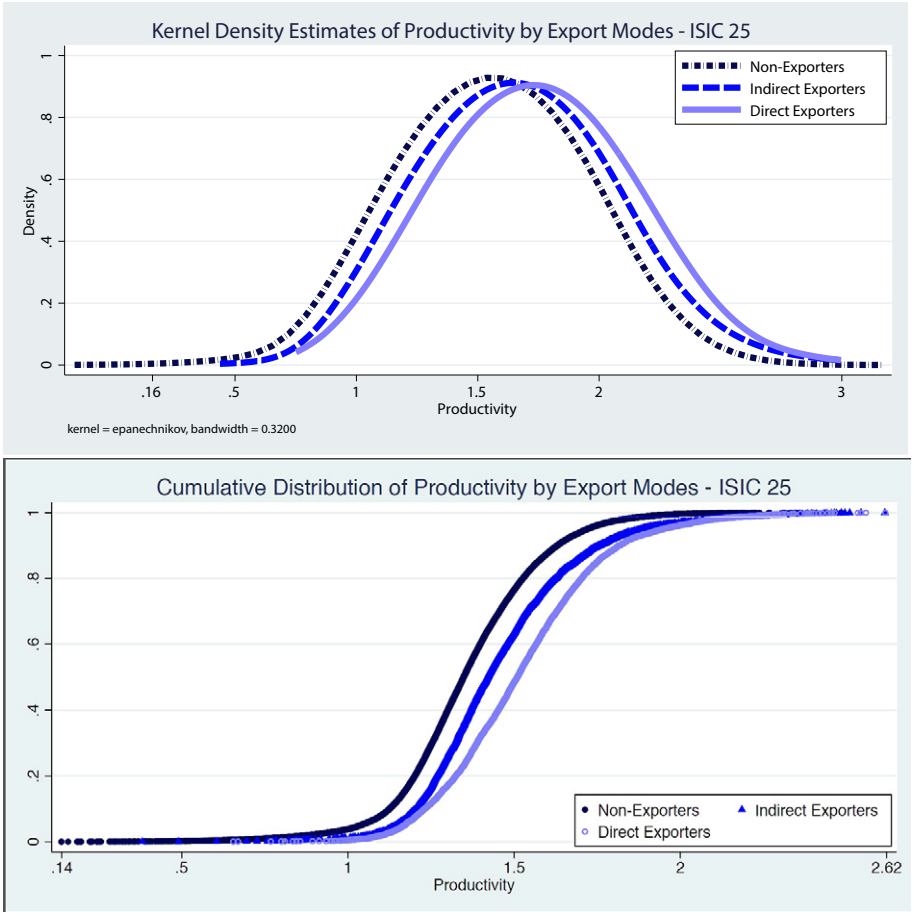

Fig. 2. Productivity distributions by export modes.

5.3. Dynamic estimates

First, the estimate of Ψ^X in Table 6 (which proxies for average foreign market size) is smaller than that for the domestic market, Ψ^H, which we estimated in the first stage. This is in line with what we see in Table 2 that exporters on average sell 63 to 75% less in the foreign market than in the domestic market.

The coefficients $\gamma^{HIS}, \gamma^{HDS}, \gamma^{IDS}, \gamma^{DIS}$ reported in Table 6 are the mean parameters of the exponential distributions for, respectively, the sunk costs of a non-exporter to start indirect and direct exporting, the sunk cost of an indirect exporter to become a direct one and that of a direct exporter to start to export indirectly. Note that γ^{HDS} is much higher than γ^{HIS}. This is consistent with the observed transition patterns in the data and suggests that on average, it is much less costly to enter the indirect exporting market than the direct exporting market. γ^{IDS} is also much lower than what γ^{HDS}. This indicates that using an intermediary to export in the previous period helps firms to start direct exporting in the current period by lowering their sunk costs. Moreover, we can see that on average, climbing the export ladder by starting off as an indirect exporter and then moving into direct exporting is cheaper than exporting directly to begin with. The relatively small average sunk costs of starting indirect exporting as a direct exporter (γ^{DIS}) indicates that it is much easier for a direct exporter to become an indirect exporter.

The coefficients γ^{IF} and γ^{DF} are relatively small compared to the sunk costs of starting such exporting. This is what creates hysteresis. γ^{IF} is also smaller than γ^{DF} confirming the cost advantage of exporting through intermediaries.

What do firms actually pay? Firms with high cost draws do not avail of the option to export. Table 7 gives average costs *incurred* and the ratio of these costs to average export revenues earned (in brackets). These costs are measured as the truncated mean of the exponential distributions incorporating the fact that only favorable draws result in a firm exporting.[43] Table 7 presents these numbers for firms at the mean productivity levels of a non-exporter, indirect exporter and direct exporter respectively.[44]

The last four parameters describe the evolution of foreign market demand shocks, z_{it}. The parameters η_z and σ_μ characterize the serial correlation and standard deviation of z_{it} which is assumed to evolve as a first-order Markov process. The high serial correlation shows the persistence in firm-level demand shocks, which also induces persistence in firms' export status and export revenue. The parameter

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

[44] It is worth noting that one of the main points made above, namely that it is "cheaper to climb the ladder than jump a rung" does not on first glance look like it holds in Table 7. For example, $1.393 + 1.492 > 2.228$ so that the actual costs incurred by a non-exporter to export directly after exporting indirectly are actually more than that of exporting directly to begin with. This is not surprising: though the mean of the sunk costs of exporting directly for a non-exporter is higher, costs actually incurred could be lower if the option is exercised only for low cost draws. In other words, the numbers in Table 7 come partly from selection and partly from the distribution costs are drawn from and so cannot be interpreted in the same way as those in Table 6 in terms of climbing the ladder versus jumping a rung.

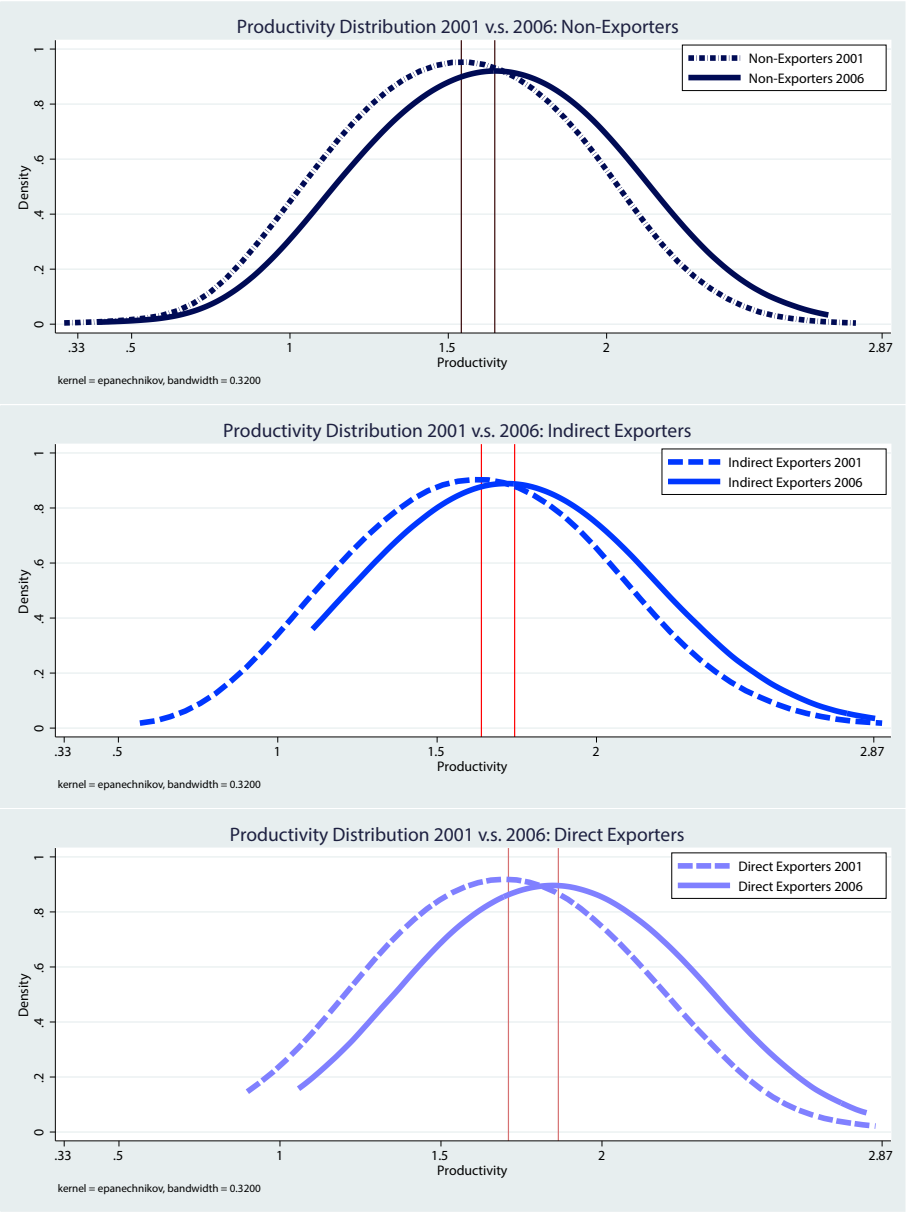

Fig. 3. Evolution of productivity distributions: 2001 & 2006.

on the dummy of indirect exporting ψ_1 is positive but not significant, while the parameter on the dummy of direct exporting ψ_2 is significantly positive. These two parameters give the growth in the demand shocks if firms were indirectly or directly exporting last period, compared to non-exporters.

5.4. Model fit

Using our estimates in Tables 5 and 6 we simulate the model thirty times to assess its performance. Specifically, we use the actual data in the initial year of each firm observed in the sample and simulate their evolutions of productivity and decisions of export modes in the following years based on simulated draws of foreign market demand shocks and export costs. Table 8 compares the actual and simulated average productivity and the participation rates of each mode of exporting. Overall, the model predicts the average productivity and the participation rates of two export modes well. In Table 9, we report the actual and simulated transitions between each export status and mode. The simulated transitions for non-exporters which account for 81% of the sample are very close to the actual transition rates, indicating that our model performs well in estimating the sunk costs of starting two modes of exporting as non-exporter, specifically γ^{HDS} and γ^{HIS}. The model slightly under predicts the persistence of indirect and direct exporters.

5.5. Robustness checks

We check on the robustness of our first stage estimates. As the second stage is very computationally intensive, we cannot do the same for it. The complete set of robustness checks are in the Appendix. We present them in four tables. In Table A.4, we look at the evolution of productivity estimated in a variety of ways. Column 1 is our benchmark. Most important is Column 2 which follows Brandt et al. (2012) which uses the same data set as ours. We match the technology parameters to input shares, thereby backing out productivity firm by firm and estimating its evolution allowing learning by exporting. Other variations are described in the the remaining columns, but the thing to note is that in each case, the evolution of

Table 6
Dynamic parameter estimates.

Export market size	Ψ^X	1.663***	(0.019)
Sunk export costs			
Home → indirect	γ^{HIS}	32.555***	(0.542)
Home → direct	γ^{HDS}	140.544***	(6.055)
Indirect → direct	γ^{IDS}	25.886***	(0.719)
Direct → indirect	γ^{DIS}	0.979***	(0.031)
Fixed export costs			
Indirect	γ^{IF}	0.830***	(0.015)
Direct	γ^{DF}	1.527***	(0.023)
Demand shock			
	η_z	0.825***	(0.004)
	$\log(\sigma_\mu)$	−0.176***	(0.007)
Indirect	ψ_1	0.003***	(0.002)
Direct	ψ_2	0.007***	(0.001)

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

Table 7
Average costs of exporting.

Export etatus		Time t			
Time $t-1$	ω_{it}	Indirect exporter		Direct exporter	
Non-exporter	1.359	1.393	(0.265)	2.228	(0.406)
Indirect exporter	1.455	0.441	(0.060)	1.492	(0.195)
Direct exporter	1.523	0.063	(0.060)	1.061	(0.111)

Values of costs are in 10 million Chinese Yuan.
Numbers in brackets are the ratio of the costs to the gross export revenue.

productivity is more favorable for direct exporters than for indirect ones.

Table A.5 in the Appendix looks at productivity evolution when alternative definitions of export modes are considered. This alleviates concerns about out definitions and enriches the results in a number of dimensions. First, if there is a delay in customs in recording export shipments at the end of a calendar year, a firm could report positive exports in year t while its shipment only show up in year $t+1$. In this case, we could have mis-classified direct exporters as indirect exporters. To deal with this we reclassify firms allowing for such delays and find this makes no difference, see Column 2. Second, there may also be producers who say they did not export in the survey data and show up in the customs data.[45] We interpret this to mean that such firms exported on someone else's behalf, making them "producer intermediaries". These firms were dropped in our baseline estimation. To check if this made a difference we ran the first stage of the estimation including them as a separate type of export mode. This did not affect the estimates of productivity evolution and these firms seemed to learn even faster than direct exporters, see Column 3. Third, we performed the same exercise in Column 4 for processing firms whom we originally dropped. Processing firms' learning is in between that of indirect and direct exporters which makes sense as they have less control over their product. Finally, in Column 5, we also estimate the evolution of productivity allowing it to differ by the share of direct exports and not just classify firms as one or the other. We find that the higher the share of direct exports, the greater the learning gains.

Next we focus on whether productivity evolution differs according to destination and product type. One might expect there is more to learn from exporting to rich countries than poor ones as they are likely to be ahead in technology and have more sophisticated consumers. There is also a concern that exports to Hong Kong may actually be mis-classified as direct since Hong Kong often acts like an intermediary and re-exports to the final destination, see Feenstra and Hanson (2004). Neither of these seem to matter once export mode is controlled for. The results are in Columns 2 and 3 of Table A.6 in the Appendix.

One might also suspect that direct exporters export different products than do indirect exporters. For example, it is well understood (see Ahn et al., 2011) that intermediaries are used to sell differentiated goods. By classifying firms as being in differentiated goods sectors, or not, using the Rauch classification, we can explore this idea. However, we find that controlling for type of product (differentiated or not) in estimating productivity evolution does not seem to have an effect. Similarly, when we control for the propensity of a shipment to be sold by an intermediary, we find no significant change in the patterns of the coefficients of interest. These results are reported in Columns 4 and 5 of Table A.6 in the Appendix.

It is also natural to ask if we could use eligibility as an instrument in the choice of export mode. This is not as easy as it seems. If firms choose to become indirect exporters on the way to exporting directly, eligibility would both make firms more likely export indirectly as well as directly. This would make eligibility a poor instrument and this is exactly why we are unable to exploit this institutional feature. However, we could run our productivity evolution regression on eligible firms only to see if the results differ. As is evident in Column 2 of Table A.7, the pattern is unchanged. It could also be that firms that know they are on a good productivity evolution path self select into exporting so that the usual problem of causation reappears. To deal with this, we restrict our attention to firms that exported through out and never switched export mode in Column 3. Note that the patterns are unchanged. Omitting other firm decisions that could be affecting productivity may also confound our results. For example, if direct exporters tend to import intermediate inputs and due to this have a better productivity evolution, our results could be spurious. Other dimensions in which firms may differ include their behavior in investing in R&D or actively increasing their registered capital to obtain direct trading rights. Adjusting for such variations in our first-stage estimation does not change the learning-by-exporting patterns we have in our baseline estimation as is evident in Columns 4 and 5 in Table A.7 in the Appendix. Direct exporters have a more favorable evolution of productivity in each of the columns of Table A.7, and what is more, this is so year by year as shown in Column 6.

6. Counterfactuals

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

6.1. Direct trading liberalization

Using our estimates, we compare firms' growth under different liberalization scenarios. As described above, the liberalization of direct trading rights that took place was gradual and expected. We simulate firms' growth in average productivity, export participation and export revenue under the following three scenarios. First, we assume that the liberalization was immediate and all firms were free to choose their export modes from the year 2000 onwards. Second, we look at banning indirect exports. This is similar to what would happen in the absence of a well-developed intermediary sector. Third, we look at what would happen if all domestic firms were forced to export through intermediaries, i.e., we eliminate direct exports for them. This scenario is a bit more extreme than what would have happened without the liberalization of direct trading rights that did occur. In addition, we also compare how firms react under these three scenarios when productivity evolution is completely exogenous and there are no learning-by-exporting effects. To compare the effects, we use the first year of the data as given and

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

Table 8
Model prediction of productivity and participation rates.

		2001	2002	2003	2004	2005	2006
Productivity	Data	1.336	1.354	1.381	1.379	1.397	1.445
	Model	1.363	1.378	1.392	1.385	1.390	1.412
Indirect exporter	Data	0.094	0.097	0.091	0.079	0.082	0.081
	Model	0.093	0.096	0.093	0.088	0.082	0.091
Direct exporter	Data	0.081	0.088	0.098	0.120	0.127	0.129
	Model	0.088	0.102	0.115	0.125	0.127	0.139

Simulation reports average results from thirty simulations.

Table 9
Model prediction of transition rates.

Export status	Time t			
Time $t-1$		Non-exporter	Indirect exporter	Direct exporter
Non-exporter	Data	0.962	0.029	0.009
	Model	0.942	0.038	0.020
Indirect exporter	Data	0.227	0.662	0.111
	Model	0.247	0.616	0.137
Direct exporter	Data	0.020	0.062	0.918
	Model	0.065	0.066	0.869

Simulation reports average results from thirty simulations.

simulate firms' optimal export decisions for the next five, ten and fifteen years. In each of the three cases, firms perceive the changes made as being permanent when evaluating their options. We repeat the simulation thirty times and report the average effects in Table 10. The numbers reported here are the percentage changes relative to the current situation.

First look at Columns 1–3 of the table where there are learning-by-exporting effects. As we can see from the first row of each horizontal panel, the first case, where the liberalization was immediate, is closest to the current trade regime. There is no effect on average productivity, though export participation and export revenue would have been slightly higher than under the status quo. This is both because the liberalization process only took four years, and because it was perfectly expected by firms in the economy. In the second row of each panel, we report the effects when indirect trading was not an option relative to the status quo. Restricting indirect exporting moves small firms who would have been indirect exporters into the non-exporter group. This reduces revenue and productivity. However, it also moves larger indirect exporters into exporting directly which has the opposite effect. The net effect is close to zero for productivity which falls by 0.1%, but negative for export participation and revenue which fall by 36 and 10% respectively over 15 years. This comes from the weaker firms dropping out of exporting market and the stronger ones becoming direct exporters so that the effect on export revenue is smaller than that on participation. This also confirms the important role of intermediaries in facilitating trade, especially for China. When direct exports are banned as in the third case average productivity falls by 0.6% over the 15 years. Export participation and export revenue fall by 33 and 26% respectively.

In the last three columns of Table 10 we look at the same experiments but without learning. The outcomes are again all relative to the existing policies with no learning. Average productivity in the economy is unaffected by definition. Export participation and revenue fall by more than with learning when intermediation is banned (53 and 21% respectively). This is because potential indirect exporters are less willing to switch to direct exporting since they cannot look forward to learning gains. However, export participation and revenue fall by less than with learning when direct exporting is banned (7 and 4% respectively). This is because potential direct exporters can export indirectly and in the absence of learning effects, exporting indirectly is not much less profitable. This suggests that the effects via learning-by-exporting are critical. It is worth pointing out that this liberalization of direct trading rights was "revolutionary" (see footnote 2) given where China was coming from. In sum, the counterfactuals show that liberalizing direct trading rights was important and exports would have been roughly a third lower had

Table 10
Firm response under different liberalization scenarios.

Policy regimes	Learning			No learning		
Years since 2000	5	10	15	5	10	15
Average productivity						
No restriction	0.0	0.0	0.0	0.0	0.0	0.0
No intermediary	0.0	−0.1	−0.1	0.0	0.0	0.0
No liberalization	−0.1	−0.4	−0.6	0.0	0.0	0.0
Export participation						
No restriction	0.3	0.0	0.0	0.1	0.0	0.0
No intermediary	−34.6	−35.2	−35.8	−51.0	−53.7	−53.3
No liberalization	−21.3	−30.6	−33.4	−5.8	−6.8	−6.7
Export revenue						
No restriction	0.2	0.1	0.0	0.0	0.0	0.0
No intermediary	−21.1	−17.6	−9.7	−23.1	−23.3	−21.0
No liberalization	−13.5	−21.6	−25.7	−3.4	−3.6	−3.7

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

Table 11
Firm response to alternative subsidy plans.

	Indirect exporter			Direct exporter			Both types		
Rates	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Export revenue subsidy									
5%	0.5	1.0	3.865	1.9	5.1	5.175	2.4	5.8	4.849
10%	1.0	1.4	1.872	3.9	10.4	4.951	4.7	12.1	4.742
Fixed cost subsidy									
25%	6.6	1.1	2.053	10.1	2.7	1.246	13.7	2.9	2.355
50%	21.3	2.7	3.123	27.5	6.4	2.047	33.3	6.4	4.287
Sunk cost subsidy									
25%	4.6	2.1	2.547	2.3	1.4	1.240	8.1	3.1	1.389
50%	20.4	8.9	4.756	9.1	5.6	2.109	30.4	10.8	2.585

(1) Percentage change in export participation rate compared to no subsidies.
(2) Percentage change in export revenue compared to no subsidies.
(3) Ratio of the gain in export revenue to the total subsidy costs.

this not been done. Our estimates show that direct exporters have productivity growing at 2.5% compared to 0.7% for indirect exporters, see Table 5. De Loecker (2013) shows that across all sectors, exporting and investing raises future productivity per annum from 1 to 8% and our estimates fall in this range.

6.2. Subsidies

A variety of trade policies have been used to encourage exports in developing countries. The most commonly used tools include direct subsidies based on firms' export performances, such as export revenue subsidies and duty-free access to imported inputs in export processing zones. Both of these tools have been used intensively by the Chinese government.

In this section, we simulate the effects of such subsidies. First, we simulate the effect of a 5 and 10% subsidy on exports.[46] We also simulate the effect of a 25 and 50% reduction in fixed or sunk costs of exporting. In addition, we target the subsidies to different types of exporters. We take the first year of the data and simulate trajectories of firm performance for future years. We compare all the results to the case with no subsidies. In each of the three cases, firms perceive the policy to be permanent when evaluating their options.

Table 11 presents the results of this exercise ten years after the policy was introduced. We compare three measures of the effects of the subsidy: the increase in export participation, export revenue and the ratio of increases in export revenue to the subsidy costs. At last, we look at the increase in exports relative to the increase in subsidies to better understand the leverage obtained by them.

First, we see that a 10% subsidy on exports increases the export participation rate by 4.7% and export revenue by 12.1%. The difference suggests that this type of subsidy mainly operates through the intensive margin of exports. In contrast, subsidizing the costs of exporting has a larger effect on increasing export participation than on export revenue. This is because subsidizing costs operates through the entry–exit of firms into exporting. It is worth noting that the increase in export revenues per dollar spent on subsidies is higher when targeting direct exporters. This makes sense as they tend to be more productive. However, the benefit–cost ratio of cost subsidies is higher for indirect exporters as the costs of indirect exporting are lower.

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

7. Conclusion

A massive amounts of money has been allocated to "Aid for Trade" initiatives in developing countries. The aim is to help developing countries overcome "trade-related constraints" and to bring growth and reduce poverty. Yet, little is known about where the constraints are. Our paper suggests that policies that help firms export directly could be useful in this regard.

The policy conclusions we wish to highlight from our results are straightforward. First, learning-by-exporting is important and is dramatically different across export mode. Direct exporters seem to learn more about how to produce and what to produce than indirect ones. For this reason alone, policies that encourage direct exporting might be worth considering. We make the case that a hitherto less studied policy, that of removing controls on direct exporting, had a significant effect on promoting Chinese export growth. Of course, all the other policies that changed also had an effect. In future work we hope to better understand the extent to which China's domestic reforms, tariff reforms, and tariffs it faced, as well as its selective encouragement of sectors by fine-tuning VAT rebate levels, contributed to its export growth.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jinteco.2016.10.009.

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