FDI, Exports & Aggregate Productivity*

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Abstract

Empirical evidence confirms that trade exposure can shift resources towards the most efficient firms in an industry and induce substantial increases in aggregate productivity. Although recent studies document that much of world trade is controlled by multinational firms, few examine the effect of foreign direct investment decisions on resource allocation and aggregate productivity. This paper presents an open economy model where producers make simultaneous production and export decisions across different countries. In particular, the model highlights the interaction between firms' location and export decisions and their effect on aggregate productivity. The theoretical model is estimated using detailed plant-level Indonesian manufacturing data. The results are broadly consistent with the pattern of productivity, exports and foreign investment across firms. I use the model to perform a number of counterfactual experiments to assess the effects of barriers to international trade and investment on aggregate productivity. The experiments suggest that there are substantial productivity gains due to international trade and investment. Moreover, they highlight that evaluating the substitutability and complementarity of trade and investment is crucial to determining the aggregate effects of trade and investment policy.

KEYWORDS: exports, foreign direct investment, firm heterogeneity, aggregate productivity, resource allocation

JEL: C23, E23, F21, O40

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1 Introduction

This paper builds an open economy model of international trade and foreign direct investment with heterogeneous firms. The model extends Melitz (2003) to capture heterogeneity across foreign and domestic firms and highlights how these differences affect the structure of international trade. The theoretical model is estimated using Indonesian plant-level manufacturing data. The estimated model is then used to perform a variety of counterfactual experiments to assess the positive and normative effects of international barriers to trade and investment.

Empirical evidence suggests that the current volume and direction of trade are intimately related to multinational production decisions. It is estimated that total sales from multinational firms represented 60% of world GDP and over 35% of world trade in 2001.[1] At the same time, empirical studies have repeatedly confirmed that trade can substantially impact resource allocation across firms and aggregate productivity within an industry. Yet, few studies have examined the role of foreign direct investment decisions (FDI) on trade flows, resource allocation and their effect on aggregate productivity.

Recent studies confirm that understanding firm-level decisions is vital for evaluating the effects of policy on aggregate productivity (c.f. Baily, Hulten and David (1992), for example). Several papers have specifically documented substantial productivity gains from resource reallocation across countries caused by trade liberalization. In particular, both Pavcnik (2002) and Trefler (2004) find increasing openness induces productivity gains among exporters, while the former also finds increases in aggregate productivity.[2]

A separate but related set of empirical evidence suggests that among firms producing in a given country, multinational firms are the most productive. Domestic exporters are reportedly less productive than multinationals, but significantly more productive than domestic non-exporters.[3] In this paper, I confirm these productivity differences across foreign and domestic firms and provide new evidence emphasizing important differences within foreign firms. My data

[1] Ramondo (2006).

[2] Pavcnik (2002) finds substantial productivity gains due to resource reallocation from less to more productive after trade liberalization in Chile. Similarly, Trefler (2004) finds productivity improvements among both exporters and importers after the Canada-U.S. free trade agreement.

[3] See Helpman, Melitz and Yeaple (2004) for a comparison of multinationals, domestic exporters and domestic non-exporters. Arnold and Javocik (2005) provide evidence that foreign owned firms are more productive than domestic firms. Similarly, Aw, Chung, and Roberts (2000), Bernard and Jensen (1999), Bernard et. al. (2003), Clerides, Lack and Tybout (1998), and Eaton, Kortum, and Kramarz (2004) find that more productive firms are more likely to export.

suggests that firms who invest abroad to serve the foreign country's market are substantially more productive than those who invest in a foreign country as a platform for exports.

Economists have traditionally separated FDI into horizontal and vertical components. Horizontal FDI, the largest of the two components, usually refers to firms which set up affiliate plants in multiple countries to serve the domestic market in each of those countries. By investing in a foreign country, a firm saves the export transportation costs, but incurs additional fixed production costs by operating multiple plants (c.f. Brainard (1997), for example). Helpman, Melitz and Yeaple (2004) extend the traditional proximity-concentration framework to examine the choice between exports and horizontal FDI in an economy where firms are characterized by heterogeneous productivity. They demonstrate that only the most productive firms will produce in multiple countries. Most importantly, they show that allowing productivity to vary across firms generates richer trade patterns and provides an explanation for the co-existence of exports and multinational production across developed countries.

In contrast, vertical FDI usually represents the production of goods in foreign countries for re-export back to the domestic parent. Though smaller in aggregate than horizontal FDI, vertical FDI is often reported to be growing quickly and is a highly important source of world trade, particularly for developing countries.[4] Typically, vertical FDI is driven by a desire to take advantage of low foreign production costs in an environment where contracting with local producers is either impossible or sub-optimal. For example, Antras and Helpman (2004) combine the insight of Melitz's (2003) heterogeneous firms framework with the vertical integration model of Antras (2003) to explore the effects of incomplete contracts and multiple stage production.

Several studies include both types of foreign investment. However, models encompassing the multistage nature of vertical FDI, along with the proximity-concentration trade-off of horizontal FDI are inherently complex. Ekholm et al. (2003), Yeaple (2003) and Grossman, Helpman and Szeidl (2006) construct increasingly complex models to elucidate the interplay between FDI and the structure of international trade flows.[5] In particular, these models illustrate that as

[4]Yeats (2001) argues that trade in intermediate inputs has grown much faster than trade in final goods. Moreover, he estimates that trade in intermediates accounts for 30% of world trade in manufactures. Similarly, Hummels, Ishii and Yi (2001) assert that within firm transfers of goods across national borders accounted for one-third of world export growth between 1970 and 1990.

[5]The Grossman, Helpman and Szeidl (2006) model is particularly appealing because it includes firm level heterogeneity and captures a wide variety of firm structures and trade flows across countries. Moreover, it can generate predictions for firm behavior in relation to the determinants of trade and investment. Unfortunately, while it is possible to test the model's aggregate implications across countries, it is would be practically impossible

determinants of international trade or investment[6] change, it is possible to generate a myriad of different equilibria. Unfortunately, none of these models are well suited to empirically examine the plant-level decisions to export and/or invest abroad.[7]

One objective of this paper is to provide a framework that is rich enough to describe the principal channels for international capital and trade flows, while remaining suitable for estimation using plant-level data. The advantage of this approach is that all of the model's predictions are readily testable. Moreover, the model is used to empirically assess the influence of policy on plant-level decisions, and thus provides a framework for evaluating economic policy and predicting changes in aggregate productivity, exports and foreign investment.[8]

I begin by extending the international trade and investment framework of Helpman, Melitz and Yeaple (2004) by allowing firms to offshore production in a foreign country. In this environment, exports and FDI can either substitute or complement each other. When foreign marginal production costs are relatively high, exports and FDI are substitutes for each other because foreign direct investment occurs to save the transport costs of serving the foreign market. In this case, trade (foreign investment) liberalization will have a positive effect on exports (FDI), but a negative effect on FDI (exports). In contrast, when foreign marginal production costs are relatively low, exports and FDI are complements. Firms invest abroad to capitalize on low production costs and use the foreign country as a platform for exports worldwide. In this context, trade or foreign investment liberalization will encourage both aggregate FDI and exports to grow. In either case, liberalized investment or trade will cause an increase in aggregate productivity as resources are reallocated towards more productive firms.

Using a panel of Indonesian manufacturing plants, I develop and estimate a structural empirical model of exports and FDI. These estimates capture the pattern of productivity, exports and market share across firms with different ownership and export status. I find that the mean of productivity at the steady state is over significantly higher than the estimated mean at entry, indicating that endogenous exit decisions play an important role in determining aggregate pro-

to evaluate the plant level predictions using even the most detailed modern data sets.

[6]Such as transport costs, set up costs, country size, wages, etc.

[7]As noted by Grossman, Helpman and Szeidl (2006), the distinction between horizontal and vertical FDI is increasingly blurred. As reported by Feinberg and Keane (2003) 69% of all multinational firms in the US have elements of both horizontal and vertical FDI. A similar pattern is found here for Indonesia.

[8]It is important to note, however, that a disadvantage of this approach is that it requires abstracting from the details of contractual arrangements that cannot be observed. To the extent that incomplete information is important in determining the types the structure of FDI, the estimates may be biased.

ductivity. To examine the effects of trade and foreign investment policies, I perform a number of counterfactual policy experiments which demonstrate that restrictions on investment and trade can potentially have widely different effects on aggregate productivity.

The next section outlines the differences across and within foreign and domestic producers. The third section presents a theoretical model of exports and FDI with heterogeneous firms and countries, while the fourth describes the model's empirical analog. The fifth section presents empirical results and the sixth concludes.

2 Empirical Motivation

In this section I briefly describe the Indonesian manufacturing data and provide summary statistics to characterize patterns across plants with varying degrees of international integration.

2.1 Data

I use the Indonesian manufacturing census for 1993-1996. The data set reports the total value of domestic and export sales, the percentage of foreign ownership and the number of workers. I determine the export status of each firm by checking whether the value of export sales is positive or zero. Likewise, I determine the ownership status of each firm by checking whether foreign investors hold a positive amount of equity in the plant.[9] Nominal values are converted to real values using the industry output price deflators. I identify the entry/exit decisions by observing the number of workers across years. After cleaning the data, I use an unbalanced panel of 24,519 plants. Each plant is observed for at least one year between 1993 and 1996.[10]

2.2 Exports and Foreign Ownership

It is well known that multinational and/or foreign-owned firms are typically the largest firms in a country. Table 1 documents this fact for Indonesian manufacturing plants between 1993-1996. Although only six percent of all firms have any foreign ownership, foreign firms account for more than one quarter of total output and over one third of all exports in manufacturing. Moreover, foreign firms are not solely export oriented but also capture one quarter of the Indonesian

[9] Using other threshold values (e.g. 10% or 50% of equity) yielded similar results.

[10] I omit 729 plants which are wholly owned by the government.

domestic market for manufactured goods. This suggests that the Indonesian market may also be an important market for foreign plants.

Table 1: Foreign Plants Over Time

	1993	1994	1995	1996	1993-1996 avg.
Exports	0.30	0.38	0.35	0.38	0.36
Output	0.23	0.27	0.29	0.34	0.28
Domestic Market Share	0.20	0.22	0.27	0.31	0.25
% of Firms	0.06	0.06	0.06	0.06	0.06

Notes: The top three rows document the percentage of the total manufacturing sales attributed to foreign firms. The bottom row documents the percentage of foreign manufacturing plants.

A common explanation for these findings is that multinational or foreign firms are substantially larger and more productive than their domestic counterparts.[11] Comparing the top two rows with the bottom two rows of Table 2 it is evident that foreign plants are not only much larger than domestic firms but they also appear to be more capital-intensive, use a higher fraction of skilled employees and produce more output per worker than their domestic counterparts.

It is often cited that domestic exporters are relatively large, capital and skill-intensive, and more productive relative to domestic non-exporters.[12] The bottom two rows of Table 2 are consistent with this result for the Indonesian manufacturing sector. Although the Indonesian data confirms that foreign plants are always larger and more productive than their domestic counterparts with the same export status, the disparity in differences across export groups is striking. For instance, while foreign exporters are approximately twice as large and productive as domestic exporters, foreign non-exporters are ten to fifteen times larger than domestic non-exporters and produce eight times the output per worker.

The differences between foreign exporters and non-exporters are less obvious. Several studies have previously examined the differences across a variety of attributes for domestic exporters and non-exporters (e.g. Bernard and Jensen, 1999 or Kasahara and Lapham, 2007), but few have examined differences across ownership status,[13] and even fewer have examined differences

[11]See Helpman, Melitz and Yeaple (2004) or Arnold and Javorcik (2005) for an example
[12]See Kasahara and Lapham (2006) for an example.
[13]A notable study examining the differences across ownership status using the Indonesian manufacturing census is Arnold and Javorcik, 2005.

Table 2: Descriptive Statistics

	Total Sales[a]	Export Intensity[a,b]	Labor	Skill Ratio[c]	Capital	K/L Ratio[a]	Output/ Worker	No. of Obs.
All	35.47	0.70	185.57	0.14	6.00	0.02	0.12	72,732
Plants	(261.88)	(0.33)	(613.13)	(0.15)	(22.00)	(0.03)	(0.59)	—
Foreign	166.38	0.71	700.14	0.18	30.13	0.06	0.35	2,563
Exporters	(381.88)	(0.34)	(1,047.91)	(0.17)	(47.30)	(0.05)	(0.58)	—
Foreign	167.76	—	411.23	0.28	29.09	0.09	0.48	1,803
Non-Exporters	(361.14)	—	(649.24)	(0.20)	(49.08)	(0.06)	(1.08)	—
Domestic	81.14	0.70	445.81	0.15	14.53	0.03	0.16	10,784
Exporters	(495.38)	(0.33)	(1,192.23)	(0.14)	(37.84)	(0.03)	(0.37)	—
Domestic	11.77	—	74.25	0.10	1.81	0.01	0.06	57,582
Non-Exporters	(139.75)	—	(286.21)	(0.14)	(8.43)	(0.02)	(0.50)	—

Notes: Reported number are sample means with standard deviations in parentheses. (*a*) In millions of Indonesian Rupiahs. (*b*) Computed using the sample of exporting plants. (*c*) The of skilled workers to total workers.

across foreign firms. Although foreign exporting plants employ almost twice as many workers, they earn little more revenue, employ a smaller percentage of skilled workers, are less capital-intensive and produce less output per worker. The difficulty in comparing foreign exporters and non-exporters arises from the fact that exporters serve multiple markets from one plant while non-exporters only serve the Indonesian market. On average foreign exporting plants sold 63.5 million rupiahs worth of goods to the Indonesian market per year.[14] Thus, foreign non-exporters sold approximately 2.5 times more on average than foreign exporters sold to the Indonesian market.[15]

While the mean differences between firms with different export and ownership status are striking it is not clear that they are statistically significant. In fact, the standard deviations are often large, particularly for foreign firms where there are fewer observations. Following Bernard and Jensen (1999) and Kasahara and Lapham (2007) I estimate the export and ownership premia

[14]See table 11 in the appendix for documentation of domestic performance across all types of plants and all variables. A similar calculation can be made for domestic exporters and non-exporters, but it does not change any of the above implications.

[15]Table 13 in the appendix documents further differences in productivity across ownership and export states.

using a pooled ordinary least sqruares regression over the 1993-1996 period:

$$lnX_{it} = \beta_0 + \alpha_1 d_{it}^x(1 - d_{it}^f) + \alpha_2 d_{it}^x d_{it}^f + \alpha_3(1 - d_i t^x)d_{it}^f + Z_{it}\beta + \epsilon_{it}, \quad (1)$$

where $X_I t$ is a vector of plant attributes such as total employment, domestic sales, output per worker, average wages, the percentage of non-production workers and capital per worker. A firm's export status is captured by the dummy variable d_{it}^x, while d_{it}^f is a dummy variable capturing whether any of the plant's equity is held by foreign investors. Last, $Z_i t$ is matrix of control variables including industry dummies at the 5-digit ISIC level, year dummies, province dummies, municipality dummies and total employment to control for size. The export premium α_1 is the average percentage difference between exporters and non-exporters among domestic plants. The foreign exporter premium α_2 is the average percentage difference between domestic non-exporters and foreign exporters, while the foreign non-exporter premium α_3 is the average percentage difference between domestic and foreign plants who do not export.

The results in Table 3 show that there are not only substantial differences between domestic exporters and non-exporters but also between foreign exporters and non-exporters. Column 3 indicates that foreign non-exporters tend to demonstate the highest premia across all measures other than those related directly to size. In particular, foreign non-exporting plants tend to demonstrate higher productivity foreign exporters or domestic plants. Similar results are found at the industry level with one exception. The chemicals industry in Indonesia tends to display a distinctly different pattern where foreign exporters are the most productive firms. This is not surprising since the chemicals industry is dominated by fuel and natural gas related products for which there are large export markets.[16]

Although the estimates between foreign exporters and non-exporters in Table 3 are statistically significant, these differences could be driven by unobserved plant-specific differences.[17]

[16] Results for the chemicals industry are reported in the Appendix. All further exclude all plants in the chemicals industry.

[17] Another possiblity is that differences in prices across countries causes spurious correlation in our measurement of productivity across firms. In particular, if mark-ups are higher in domestic markets than exports markets the productivity measurement of foreign exporters would be biased downwards. In contrast, it is likely that the mark-up in export markets is higher than in domestic markets due to income differences across countries. This would imply that Tables 2 and 3 underestimate the differences between foreign exporters and non-exporters. A last possibilty is that foreign firms use transfer pricing to earn profits abroad due to high corporate tax rates. However, the World Tax Database reports that over 1993 to 1996 the top Indonesian corporate tax rates were slightly lower than those in Japan, the United Kingdom and the United States on average.

Table 3: Export & Ownership Premia

	Pooled OLS: 1993-1996		
Export/Ownership Status	Domestic Exporters	Foreign Exporters	Foreign Non-Exporters
Output per Worker	0.217	0.710	0.871
	(0.012)	(0.021)	(0.024)
Average Wage	0.114	0.443	0.604
	(0.007)	(0.013)	(0.015)
Non-Production/Total Workers	0.086	0.006	0.246
	(0.010)	(0.018)	(0.021)
Capital per Worker	0.351	0.712	0.932
	(0.011)	(0.019)	(0.022)
Domestic Sales	-0.789	-0.043	0.848
	(0.016)	(0.030)	(0.029)
Total Sales	0.250	0.737	0.883
	(0.014)	(0.024)	(0.027)
Total Employment	1.062	1.528	1.045
	(0.010)	(0.019)	(0.022)
No. of Observations	72732		

Notes: Standared errors are in parentheses.

Fixed effects panel estimation is the most common regression used to control for plant-specific effects. However, there are two difficulties with implementing a fixed effects regression here. First, ownership and export status are very persistent over the short panel. Since the source of identification in a fixed effects regression comes from variation in ownership and export status within each firm, there is little variation from which to identify the coefficients. Second, because the identification is coming from plants which switch the export status and ownership status, the method used to identify these variables is particularly important. In general, the results are robust to changes in the percentage of equity held by foriegn investors, but sensitive to the definition of an exporter.

I observe in the data that plants that receive a relatively small percentage of total revenues from export sales can be broadly characterized much more like foreign non-exporters. If we define an exporter as one that has positive export sales then the plants that switch export status most often are going to plants that are in fact foreign non-exporters in some years and receive only a small amount of revenue from export sales. If most of the identification comes from these plants we would expect to observe very little difference between foreign non-exporters and exporters in a fixed effects regression. Suppose one changes the definition of an exporter so that exporters must receive at least a 25 percent of total revenues from export sales. In that case, most of the identification will come from exporting firms that cross the 25 percent threshold. A natural reason for arbitrarily increasing the percentage of export revenues required for export status is that export intensive firms are more likely to export to developed countries, while firms that export only a small percentage of revenues are more likely to emerging market countries near Indonesia. In fact, in Table 6 I show that industries where firms export intensively have a higher percentage of exports destined for Japan, the US and Western Europe. As such, I estimate equation (1) by both pooled OLS and fixed effects and report the results for the measure of output per worker as I vary percentage of export sales required for a foreign firm to have export status.[18]

Table 4: Export & Ownership Premia: Output per Worker 1993-1996

	Pooled OLS			Fixed Effects		
Export Threshold	Domestic Exporters	Foreign Exporters	Foreign Non-Exporters	Domestic Exporters	Foreign Exporters	Foreign Non-Exporters
0	0.141	0.534	0.800	0.007	0.294	0.306
	(0.012)	(0.023)	(0.027)	(0.011)	(0.031)	(0.030)
25	0.176	0.490	0.869	0.028	0.253	0.288
	(0.014)	(0.028)	(0.028)	(0.012)	(0.037)	(0.035)
50	0.174	0.435	0.869	0.027	0.209	0.309
	(0.014)	(0.029)	(0.027)	(0.012)	(0.038)	(0.034)
No. of Obs.	64254			63649		

Notes: Standared errors are in parentheses. Plants in the chemicals industry are excluded from the estimation and results for the chemicals industry are reported in the Appendix.

Table 4 reports the results of the pooled OLS and fixed effects regressions. It shows that as we vary the defintion of a foreign non-exporter the differences in the output per worker premia grow.[19] Moreover, the differences are increasingly significant even when using a fixed effects estimator.[20] It is natural to ask why the larger, more productive foreign non-exporters do not

[18] Results are similar for other measures of export premia.
[19] Similar results are found for other measures of premia.
[20] A potential concern is that foreign exporters and foreign non-exporters produce very different products. While

export while the smaller, less productive foreign exporters do? A likely reason is that foreign non-exporters are part of a larger multinational corporations that serve multiple markets though multiple plants located in different countries. I will further develop this hypothesis to explain the effects of foreign barriers to trade and investment across different plants in Indonesia.

3 A Model of FDI and Exports

The model begins from the environment outlined by Helpman, Melitz and Yeaple (2004) and extends to include FDI and exports to capture most channels of vertical FDI.[21]

3.1 Environment

Consider two countries, Home and Foreign, which are endowed with non-depreciating stocks of labour, L.[22] In each country there are two sectors: a homogeneous good sector (agriculture) and a differentiated good sector (manufacturing).

3.2 Consumers

Consumers supply capital and labour inelastically. Their preferences are defined by a Cobb-Douglas utility function over the agriculture product z and a continuum of manufactured goods indexed by v:

$$U = z^{1-\delta} \left[\int_{v \in V} q(v)^{\alpha} dv \right]^{\delta/\alpha}.$$

all pooled OLS regressions include 5-digit ISIC industry level dummies, it is possible that these dummies are not capturing fixed industry level differences for the foreign firms alone. Suppose that the foreign technology in one 5-digit industry is more productive that the foreign technology in another. If foreign non-exporters are more likely to be in the most highly productive industries then the output per worker premia will be biased upwards. Fortunately, using plant-level fixed effects will control for this possibility. Since the significance is much lower on the fixed effects regressions than it is on the pooled OLS regressions I also report the empirical distributions of foreign exporters and foreign non-exporters in the Appendix. As shown in the empirical distributions the mass of each type of plant in each 5-digit industry is highly correlated.

[21] Specifically, I exclude strict vertical integration here. I do not consider the case where foreign firms set up a subsidiary or subcontract with a domestic firm solely to supply the parent firm further up the supply chain. The reason for this choice is two-fold. First, strict vertical integration represents at most 2% of domestic firms and 7-9% of foreign firms. Second, strict vertical integration likely involves more complex contractual arrangements where incomplete information between plants may play a larger role in determining the direction of FDI and trade. See Antras and Helpman (2004) for an example.

[22] All foreign country variables are starred.

The elasticity of substitution between different varieties of manufactured goods is given by $\varepsilon = 1/(1-\alpha) > 1$.[23]

3.3 Producers

3.3.1 Agriculture

There is a continuum of potential firms that can freely enter the agricultural sector and produce a homogeneous agricultural product, z, with linear technology, $z = \phi_l l$. Producers hire labour on perfectly competitive markets which pins down wages in each country. I assume that the foreign agricultural technology is more productive than the technology employed in the home country, $\phi_l^* > \phi_l$, so that wages in the foreign country are greater than those in the home country. Factor prices differences are an important determinant of the flow of exports and FDI across countries.

3.3.2 Manufacturing

The model allows for a wide variety of potential outcomes across countries. To keep the model as transparent as possible, I focus on the case in which both foreign and domestic exporters and non-exporters are present. Specifically, I allow each country to have 4 types of firms: non-exporters, exporters, multinational non-exporters and multinational exporters who are owned by either domestic residents or those of the other country.[24]

I denote variables for non-exporting plants by D and exporting plants by X. Following the nomenclature in the literature I will refer to multinational exporters as "vertical multinationals" and will denote their variables by V while I refer to multinational non-exporters as "horizontal multinationals" and will denote their variables by H.[25]

To enter the market each firm must pay a fixed cost, f_E. Once the entry cost is paid, each firm receives a productivity draw a from the distribution, $G_a(a)$, and an extreme cost shock with constant probability ξ. A firm's productivity draw is constant over the life of the firm. If the firm suffers the extreme cost shock it is forced to exit the industry regardlessly of its productivity.

[23]The set of available goods is denoted by V and all goods are substitutes, $0 < \alpha < 1$.

[24]I exclude the possibility of joint ownership.

[25]I exclude the possibility that a firm owned by foreign investors will produce in the home country solely for the home market without producing in the home market. While it is possible to extend the model to allow for this to occur, I omit it here for tractability. See the Appendix for conditions under which no firm will optimally choose to only operate abroad for the foreign market.

Conditional on survival, each firm can decide to exit immediately or to produce according to the linear production function

$$q = \frac{l}{a} \tag{2}$$

where l is labour hired on competitive markets.

It is well known that the Dixit-Stiglitz (1977) framework generates a demand function $\gamma R P^{1-\varepsilon}/p^{\varepsilon}$ for each variety where R is the total revenue earned in each country, P is an index of manufacturing prices and p is the price chosen by each individual producer.[26] Since demand is exogenous to each individual producer the optimal pricing rule for each firm depends only the firm-specific productivity level

$$p(a) = \frac{aw}{\alpha}$$

where w is the wage in the home country.

To produce domestically each firm must pay a fixed overhead cost f_D each period. If the firm also decides to export abroad it bears additional fixed cost f_X and iceberg transport costs $\tau > 1$ per unit shipped to the foreign country. As in Helpman, Melitz and Yeaple (2004) the firm may choose to set up production in the foreign country rather than export to that market. While the firm saves on the fixed export costs, f_X, and on the transport costs, τ, by choosing to produce abroad, it incurs the additional fixed overhead cost, f_I.[27] Firms may choose not to produce domestically at all. In this case, each firm sets up a plant abroad and exports back to its country of origin.[28] In this case, the firms incurs the fixed costs f_D, f_X and f_I and the transport cost τ. If $f_I > 0$, any firm that produces abroad to export back home incurs higher fixed costs and the same transport costs of a home exporter. Thus, to give firms an incentive to produce abroad and export there must be some difference in factor prices across countries.

I interpret f_X as the cost of forming and maintaining distribution and service networks in export markets. It is important to note that firms must pay this cost even if they are exporting back to their home market.[29] Similarly, f_I includes the distribution, servicing, overhead and set up costs of operating a subsidiary abroad. The relative size of the fixed costs plays an important

[26] $R = wL$ where L is the total amount of labour and w is the wage in the home country. The price index is $P = [\int_V p(v)^{1-\varepsilon} dv]^{1/(1-\varepsilon)}$

[27] In the multi-country setting each firm would pay f_X or f_I for each export/production destination.

[28] This can be thought of as "offshoring". However, as described below, no firm will ever choose to produce domestically and solely export back to its country of origin. Although it is possible to extend the model to include this possibility, for simplicity I omit it here.

[29] The empirical model allows for differences in fixed export costs across firms.

role in determining each firm's optimal production and export decisions.

3.4 Profits, FDI & Exports

I assume that each firm that chooses not to exit will always serve the domestic market. It accomplishes this through domestic production or exports from the foreign country. Similarly, firms will never choose to produce solely for export. As argued below, casual empiricism suggests that a small number of firms produce solely for export markets.[30] In equilibrium, I rule out the possibility that multinational firms produce solely for the foreign market or that any firm will serve the same market by both exports and FDI.[31]

The operating profits for any firm with productivity level a producing in the home country solely for domestic consumption are

$$\pi_D = (awB)^{1-\varepsilon} - f_D, \tag{3}$$

where $B = [(1-\alpha)\gamma wL]^{1/(1-\varepsilon)}/(\alpha P)$. Since market size, B, is positively related to country size L, larger countries will have a larger market, for a given price level. Exporters earn both profits from selling abroad, in addition to those earned at home. Thus, the operating profits for an exporter are

$$\pi_X = \pi_D(a) + (\tau awB^*)^{1-\varepsilon} - f_X. \tag{4}$$

Similarly, firms that produce in both countries for each domestic market earn the additional operating profits from their plants abroad. The operating profits for a *horizontal* multinational are

$$\pi_H = \pi_D(a) + (aw^*B^*)^{1-\varepsilon} - (f_D + f_I). \tag{5}$$

Lastly, *vertical* multinationals do not produce at home for the home market, but instead produce abroad for both home and foreign markets. The profits these firms earn in either country will depend upon the factor prices in the foreign country. The operating profits for a vertical multinational are

$$\pi_V = (aw^*B^*)^{1-\varepsilon} + (\tau aw^*B)^{1-\varepsilon} - (f_D + f_X + f_I) = \pi_X^* - f_I. \tag{6}$$

[30] It would be possible to generate production solely for export by allowing fixed costs to vary across countries.
[31] Rob and Vettas (2001) use uncertainty in a dynamic setting to explain this phenomenon.

Equations (3)-(6) indicate that export and investment decisions will depend primarily on both firm-specific characteristics (productivity) and the differences across countries (wages, fixed costs, size). Suppose that the foreign country is a large, high-wage country, while the home country is relatively small and characterized by low-wages. Consider the export and investment decisions facing foreign country firms. The first decision is whether to produce domestically and export abroad versus producing abroad and exporting back to the country of origin. This decision will clearly depend on the cost of exporting in either direction. However, even if transport costs are equal there will be substantial differences in these two production and export decisions. When transport costs are equal, the advantage to exporting from the foreign country is that the foreign firm incurs lower fixed overhead costs. The disadvantage is that labour costs are high.[32] Thus, foreign firms that produce in the home country must be productive enough to afford the higher fixed costs.

Similarly, consider the firm deciding to produce all units abroad and export back to the foreign country versus opening a plant in each country. By producing all units abroad the firm incurs the lowest marginal costs on each unit of output and saves the extra fixed costs from operating multiple plants. However, by producing all units abroad the firm incurs the transport cost on each unit exported. This is particularly costly when the foreign country is large.

The model has several intuitive implications. First, since exporting is costly, firms that export must be productive enough to afford these extra costs. Second, higher fixed costs associated with investing abroad suggests that multinational firms will be more productive than their domestic counterparts. Finally, if country size is equal across countries, only firms from the foreign (high wage) country will invest in the home (low wage) country and export back to the foreign country. In other words, the model predicts that vertical multinationals will originate in the high wage country and produce in the low wage country. This does not mean that FDI only flows from the foreign country to the home country. Highly productive home firms may still want to invest in the foreign country in order to save the transport costs from exporting. It will never, however, be profit maximizing for home firms to use the foreign country as an export platform for home country sales.

It is well known that multinational firms are more productive than domestic exporters and

[32] Country size also plays an important role here. Firms will be more likely to enter larger markets by FDI, *ceteris paribus*. However, to focus on the effect of factor prices I abstract from country size differences here.

that domestic exporters are more productive than domestic non-exporters.[33] The evidence presented in section 2 demonstrates that we can further divide multinational firms into more productive horizontal multinationals and less productive vertical multinationals.[34] Similar to Helpman, Melitz and Yeaple (2004), I must place restrictions on the size of fixed and transport costs to ensure that firms can be partitioned into four groups. These conditions are as follows:

$$f_D \left(\frac{\tau B}{B^*}\right)^{1-\varepsilon} < f_X \tag{C1}$$

$$(f_D + f_X)\left(\frac{w}{w^*}\right)^{1-\varepsilon}\left(\frac{B^{1-\varepsilon} + (\tau B^*)^{1-\varepsilon}}{B^{*1-\varepsilon} + (\tau B)^{1-\varepsilon}}\right) < f_D + f_I + f_X \tag{C2}$$

$$f_X \left(\frac{w}{\tau w}\right)^{1-\varepsilon} < f_D \tag{C3}$$

$$w^* < \tau w \tag{C4}$$

The first condition is identical to that of Melitz (2003) except that it allows for differences in country size. It ensures that the continuum of domestic firms is partitioned between domestic non-exporters and exporters. In essence, the fixed cost to exporting must be large enough that not all domestic firms are willing to export if they produce. The second condition implies that the fixed costs of production abroad must be large enough to ensure that not all exporting firms are more profitable by offshoring production. The third condition implies that the fixed cost to domestic production cannot be so low that no firm would ever want to offshore production. Finally, the last condition states that the marginal production cost in the home country must be lower than joint production and transport costs in the foreign country. If (C4) did not hold, production in the foreign country would be so inexpensive that no multinational firm would ever choose to produce in the home country.

Condition (C1) and condition (C3) also simultaneously imply that if they both hold then it must be that $w^*B^* > wB$. Thus, for all four types of firms to exist from the country of origin it must be that the wage-size combination in that country is greater than the wage-size combination of the receiving country. For any pair of countries, this inequality can only hold for one country. Its implication is that for the country for which the inequality holds, the model

[33] See Helpman, Melitz and Yeaple (2004), for example.

[34] Since the evidence in Section 2 is not conclusive, I consider the possibility of vertical multinationals as the most productive firms in the appendix.

predicts positive flows of vertical FDI originating from that country. Thus, unlike horizontal FDI, vertical FDI flows only in one direction.

This also allows us to refine the model's prediction about the direction of vertical FDI. It is consistent with vertical FDI flows from large, high wage countries to small, low wage countries. However, it also suggests that vertical FDI may flow from small, high wage countries to large, low wage countries if the wage gap is large enough. [35]

There are a variety of other production and export possibilities that I have purposely omitted here. For instance, it is possible that foreign investors may open plant in the home country exclusively for sales to the home country consumers without operating a plant in any other country. I exclude this possibility for two reasons. First, I cannot empirically separate plants which are multinationals and those which stand-alone but have foreign ownership. Second, Indonesia is a small country relative to its major sources of FDI.[36] If foreign investors are able to profitably operate a plant which sells exclusively to Indonesian consumers, it is likely they are also able to the same in their home countries.

Table 5 documents the other production and sales combinations that I have purposely restricted from the set possibilities by placing bounds on the fixed and transport costs. The first row of Table 5 shows that firms can locate in the home country and produce only for the home country or both markets, but not just the foreign market. As in Melitz (2003) I exclude this possibility since less than two percent of all Indonesian plants receive all revenues from export sales. Similarly, in the second row I exclude all foreign plants that receive all revenues from export sales. Although seven percent of foreign firms strictly export all output, it is likely that these plants do so to protect technological advantages, patents or product features from local rivals.[37] I exclude this possibility since it is not observable in the Indonesian manufacturing data.[38] The last row simply indicates that if a firm produces in both countries, then it must sell in both countries. Since firms must pay all of the fixed costs to produce in a given country and the Dixit-Stiglitz framework implies some residual demand for each variety, selling to local

[35]Similarly, the inequality $w^*B^* > wB$ also suggests vertical FDI to flow from large, low wage countries to small, high wage countries if the difference in country size is large enough. However, in this case, condition (C4) would be violated.

[36]Japan, the United States and Europe.

[37]Since the large majority of plants (93%) have positive amounts of domestic sales it is not likely that these firms are subject to the same restrictions.

[38]See Antras and Helpman (2004) for a model with incomplete contracts and vertical integration.

consumers can always increase profits.[39]

Table 5: Production and Sales Combinations

Production Location	Sales Location: Home	Foreign	Both
Home	Yes*	No	Yes
Foreign	No	Yes*	Yes
Both	No	No	Yes

Only if the ownership is the same as the country where production is located.

3.5 Exit & Entry Decisions

Upon drawing their firm-specific productivity level each firm must decide whether or not to enter each market. For convenience, first consider the decisions of foreign country firms. The least productive firms expect negative profits and choose not to produce. Marginal firms earn just enough profits to cover the fixed cost f_D:

$$(aw^*B^*)^{1-\varepsilon} = f_D \tag{7}$$

since $\varepsilon > 1$ and all of the profit functions are monotonically increasing in $1/a$. For convenience, I denote productivity by the index $a^{1-\varepsilon}$ and let the productivity of the marginal foreign firm be $a_D^{*1-\varepsilon}$. Figure 1 graphs the profit functions for all firms originating in the foreign (high wage) country under the assumption that the demand level is the same in both countries. Any firm with a productivity level below $a_D^{*1-\varepsilon}$ will earn negative profits and choose to exit the market altogether. Similarly, as shown in Figure 2, the same is true for all home country firms with productivity below $a_D^{1-\varepsilon}$.

Two important features of the model are highlighted in Figure 1. First, the profit functions for foreign country firms are increasingly steep across non-exporters, exporters, vertical multinationals and horizontal multinationals. Second, the fixed costs are increasingly high across the same four groups of firms.[40] The slope of the profit function is determined by factor prices,

[39] Over 98% of Indonesian producers and 93% of foreign producers sell to the local Indonesian market.

[40] As demonstrated in conditions (C1)-(C4) the fixed costs do not have to have this strict of a ranking. I assume such a ranking here to improve the exposition of the cutoff values.

transport costs and country size. Increases in factor prices reduce the profitability of every unit sold and thereby reduce the slope of profit function. Similarly, increases in transport costs reduce the profitability of every unit sold in the export market which will flatten the slope of exporters' profit functions. For example, vertical multinationals have the lowest marginal cost of production for every unit sold, while horizontal multinationals only benefit from low marginal costs of production in the foreign plant. However, horizontal multinationals do not suffer the transport costs in the home country. Conditional on productivity, both firms are equally profitable in the foreign country. However, which firm is more profitable in the home country will depend on the relative size of marginal costs across countries and the transport cost. If the total marginal cost of producing a unit for sale abroad by a vertical multinational τw is greater than the marginal cost of the horizontal multinational w^*, the latter will earn higher profits in the home country. On the other hand, if $w^* > \tau w$ and fixed costs are higher for the horizontal multinational[41] then no firm will ever choose to be a horizontal multinational.

The last effect on the slope of the production function is country size. Although figure 1 abstracts from differences in country size, it will always increase the profitability of any firm producing for that market. Thus, the greater the country size, the greater the amount of entry from any type of firm. This is particularly true for home country firms, which would otherwise suffer substantial transport costs by exporting to the large country.

Figure 1 demonstrates that the differences in the slopes and intercepts create four distinct cutoff levels between foreign country firms. The first cutoff $a_D^{*1-\varepsilon}$ partitions the active from the non-active firms. Between cutoffs $a_D^{*1-\varepsilon}$ and $a_X^{*1-\varepsilon}$ all firms have positive profits in the domestic market, but are not productive enough to engage in exports or FDI. Likewise, all firms with productivity levels between $a_X^{*1-\varepsilon}$ and $a_V^{*1-\varepsilon}$ are productive enough to export abroad, but not productive enough to establish home plants and capture lower foreign wages. Any firm with productivity above $a_V^{*1-\varepsilon}$ establish plants abroad, but only those with productivity above $a_H^{*1-\varepsilon}$ establish them in both countries. Thus, given a firm's productivity index $a^{*1-\varepsilon}$ its optimal production strategy can be read off the highest of all four profit functions at that point.

Figure 2 demonstrates a similar pattern for home country firms except for the fact that the profit function for a vertical multinational always lies below at least one of the other profit functions. This implies that home firms who produce abroad and export back home are not

[41]Technically, condition (C3) holds.

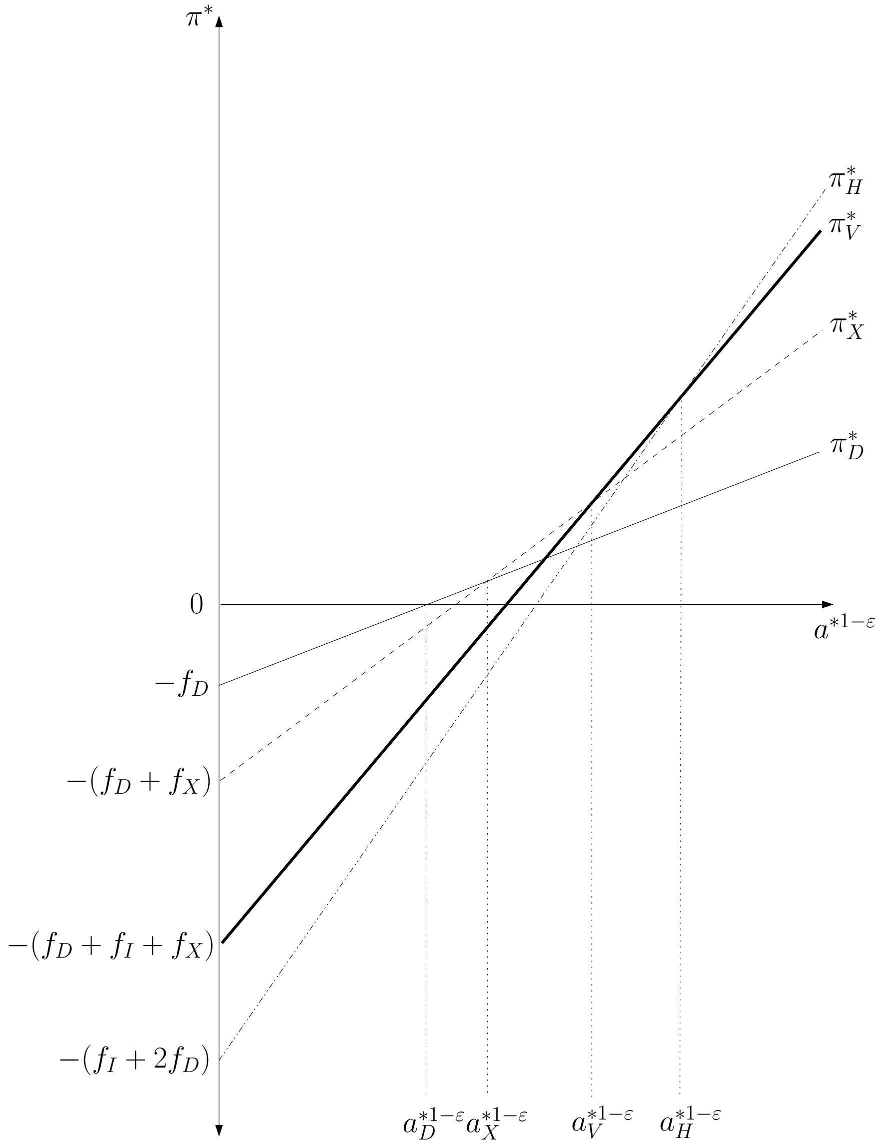

Figure 1: Foreign Country Productivity Cut-off Levels

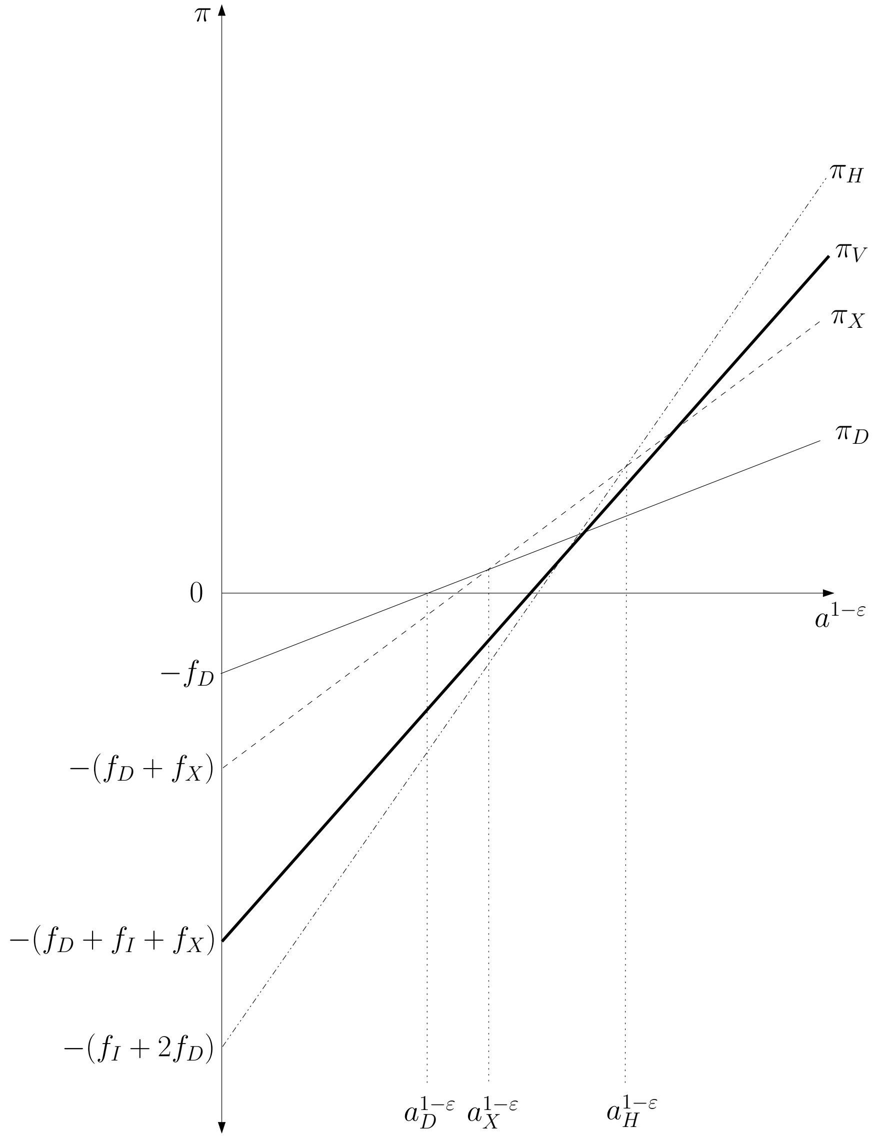

Figure 2: Home Country Productivity Cut-off Levels

maximizing profits.[42] This is intuitive since foreign producers are already located in the country with lower marginal costs. However, as long as $w\tau > w^*$, the most productive home country firms will still want to invest in the foreign country in order to avoid paying the transport costs.

3.6 Equilibrium

I focus on a stationary equilibrium in which aggregate variables are constant over time. The value of a potential entrant is given by the maximum of its exiting value, which is assumed to be zero, and the discounted sum of expected profits

$$V(a) = \max\left\{0, \sum_{t=1}^{\infty}(1-\xi)^t E\left(\max_{S\in\{D,X,V,H\}} \pi_S(a)\right)\right\} = \max\left\{0, \max_{S\in\{D,X,V,H\}} \frac{\pi_S(a)}{\xi}\right\} \quad (8)$$

where unstarred functions are replaced with starred functions for foreign firms. Following Melitz (2003) I can write the revenue of any firm as a function of the productivity of the marginal firm with productivity a_D

$$r_S(a) = \lambda_S \left(\frac{a}{a_D}\right)^{1-\varepsilon} f_D \quad (9)$$

where I can solve for

$$\lambda_X = 1 + (\tau B/B^*)^{1-\varepsilon},\ \lambda_V = (w^*/w)(\tau^{1-\varepsilon} + (B^*/B)^{1-\varepsilon}) \text{ and } \lambda_H = 1 + ((w^*B^*)/(wB))^{1-\varepsilon}$$

by multiplying and dividing each revenue function by $r_D(a_D) = (a_D wB)^{1-\varepsilon} = f_D$.[43]

Let average profits within each group of firms be denoted by $\tilde{\pi}_S(a_D)$ and the fraction of firms within each group as $\nu_S(a_D)$. Average overall profit, $\bar{\pi}(a_D)$, is then

$$\bar{\pi}(a_D) = \sum_S \nu_S(a_D)\tilde{\pi}_S(a_D). \quad (10)$$

Equation (10) relates average profits to the marginal productivity level in equilibrium. For foreign firms average profits can be expressed as

$$\bar{\pi}^*(a_D^*) = \sum_S \nu_S^*(a_D^*)\tilde{\pi}_S^*(a_D^*) \quad (11)$$

[42] Thus, for home country firms I use an economy very similar to that in Helpman, Melitz and Yeaple (2003).

[43] For the foreign country the same three multipliers exist, λ_X^*, λ_V^*, and λ_H^*, the only difference being that the starred and unstarred variables are switched.

where $a_D = a_D^* \left(\frac{w^* B^*}{wB}\right)$.

A second equilibrium relation is provided by the free entry condition. The free entry conditions imply that the ex-ante expected value of a potential entrant in either country must be zero

$$(1 - G(a_D)) \left(\frac{\bar{\pi}(a_D)}{\xi}\right) = f_E \qquad \text{and} \qquad (1 - G^*(a_D^*)) \left(\frac{\bar{\pi}(a_D^*)}{\xi}\right) = f_E^*. \tag{12}$$

I solve equations (10)-(12) to determine the equilibrium values of a_D and $\bar{\pi}(a_D)$ (and hence a_D^* and $\bar{\pi}^*(a_D^*)$). Unlike Melitz (2003) the lack of symmetry across countries does not allow me to ensure the existence or uniqueness of equilibrium, however, it can be demonstrated numerically that such an equilibrium exists for reasonable parameter values.[44]

4 Empirical Model

4.1 Environment

In this section I construct an empirical analog to the theoretical model presented in the previous section. I extend the theoretical model to incorporate stochastic fixed cost shocks to the exit, export and foreign investment decisions captured in the theoretical model.[45]

I extend Rust's (1987) framework to examine the nature of exit, export and foreign investment decisions in the presence of stochastic fixed costs. Specifically, I reframe the model as a *nested logit* dynamic programming problem in which the set of alternatives facing each producer are partitioned into different subsets. At the beginning of every period, an incumbent firm with value first draws an idiosyncratic cost shock $\epsilon_t^\chi \equiv (\epsilon_t^\chi(0), \epsilon_t^\chi(1))$ associated with its exiting decision $\chi \in \{0, 1\}$. If the firm decides to exit, $\chi = 0$, it receives the terminal value $\epsilon_t^\chi(0)$. If the firm decides to produce, $\chi = 1$ it receives $\epsilon_t^\chi(1)$ along with the value of continued operation. I assume that ϵ_t^χ is independent of alternatives and is randomly drawn from the extreme-value distribution with scale parameter ϱ_χ.

If the firm decides to produce, it then draws cost shocks ϵ_t^d associated with its export/investment decision and decides whether to export or invest abroad. The firm's export decision is cap-

[44] A numerical example in Matlab is available from the author upon request. See Helpman, Melitz and Yeaple (2004) or Kasahara and Lapham (2006) for other examples of similar models that exploit symmetry to prove the existence and uniqueness of equilibrium.

[45] The cost shocks are necessary to capture certain patterns in the data. For instance, the theoretical model predicts that all firms below a certain cutoff will exit the market. However, the data confirms the existence of many small firms.

tured by the binary variable $d^X \in \{0,1\}$ where $d^X = 1$ if a firm chooses to export. Similarly, $d^I \in \{0,1\}$ denotes the firm's foreign investment decision and $d^I = 1$ when a firm chooses to invest in a foreign country. Thus, I capture the firm's export and investment decisions by $d = (d^X, d^I)$ and denote the stochastic fixed export and investment cost shocks as $\epsilon_t^d \equiv (\epsilon_t^d(0,0), \epsilon_t^d(0,1), \epsilon_t^d(1,0), \epsilon_t^d(1,1))$. Again, I assume that ϵ_t^d is independent of alternatives and is randomly drawn from an extreme-value distribution with the scale parameter ϱ_d.

Using the structure of the cost shocks I can characterize the optimization problem for an incumbent firm with productivity level a by the following set of Bellman equations:

$$V(a) = \int \max\{\epsilon^\chi(0), W(a) + \epsilon^\chi(1)\} dH^\chi(\epsilon^\chi), \tag{13}$$

$$W(a) = \int \left(\max_d \pi(a, d') + \beta V(a) + \epsilon^d(d') \right) dH^d(\epsilon^d) \tag{14}$$

where β is the discount factor and H^χ and H^d are the cumulative distribution functions of ϵ^χ and ϵ^d, respectively.

Using the properties of extreme-value distributed random variables[46] along with the solution to the function equations (13)-(14), the conditional choice probabilities follow the familiar nested logit formula (c.f. McFadden, 1978).[47] The probability of producing this period ($\chi = 1$) and the probability of exiting this period ($\chi = 0$) are calculated as:

$$P(\chi = 1|a) = (1-\xi)\frac{\exp(W(a)/\varrho^\chi)}{\exp(0) + \exp(W(a)/\varrho^\chi)} \tag{15}$$

and $P(\chi = 0|a) = 1 - P(\chi = 1|a)$ where ξ is the exogenous probability of exit. Conditional on continuously operating, the probability of being a type $d \in \{0,1\}^2$ producer is calculated as

$$P(d|a, \chi = 1) = \frac{\exp([\pi(a, d) + \beta V(a)]/\varrho^d)}{\sum_{d' \in D_1} \exp([\pi(a, d') + \beta V(a)]/\varrho^d)} \tag{16}$$

[46]See Ben-Akiva and Lerman (1985) for an example.

[47]As described in Rust (1994) there are important differences between the static nested logit models and dynamic nested logit models, like the one described here. First, in static models the *independence from irrelevant alternatives* (IIA) property holds within each nest. However, in a dynamic setting the IIA property typically cannot hold even within a nest because the continuation value depends on alternatives outside the nest. Second, a static model usually has a closed-form specification in parameters, such as linear-in-parameters specification. Dynamic models, such as the one here, do not have a closed-form expression in parameters and instead require the solution to the functional equations (13)-(14). Evaluating the conditional choice probabilities in a dynamic setting is a computationally intensive task. Fortunately, the extreme-value specification adopted here substantially simplifies the computation by avoiding the need for multi-dimensional numerical integration in (13)-(14).

I focus on a stationary equilibrium where the distribution of a is constant over time. I assume that the logarithm of plant-specific productivity, $\ln a$, is drawn from the $N(\mu_{ah}, \sigma_a)$ distribution for Indonesian plants and the $N(\mu_{af}, \sigma_a)$ distribution for foreign plants.[48] As in the theoretical model I further assume that these draws are independent of each other and are constant over the life of the firm. Let $g_a(a)$ denote the density function of a for Indonesian plants.

The above assumptions imply that we can write down the expected value of the firm, which, under free entry, must be equal to the fixed entry cost f_E:

$$\int V(a) g_a(a) da = f_E. \tag{17}$$

Denote the stationary distribution of a among incumbents as $g_a^s(a)$. A stationary equilibrium requires that the number of exiting firms with productivity a must equal the number of successful entrants with the same productivity level. Specifically,

$$MP(\chi = 0|a) g_a^s(a) = M_e P(\chi = 1|a) g_a(a) \qquad \text{for all } a, b$$

where M is the mass of incumbents and M_e is the total mass of entrants that attempt to enter the market. Rearranging terms, the stationary distribution of productivity $g_a^s(a)$ can be computed as

$$g_a^s(a) = \frac{M_e}{M} \frac{P(\chi = 1|a)}{P(\chi = 0|a)} g_a(a) \tag{18}$$

where

$$\frac{M_e}{M} = \frac{1}{\int \frac{P(\chi=1|a)}{P(\chi=0|a)} g_a(a) da}$$

since $\int g_a^s(a) da = 1$. A similar procedure is followed for foreign plants.

4.2 The Likelihood Function

I define the following function of iceberg shipping costs[49]

$$\varphi_\tau \equiv (1 - \varepsilon) \ln \tau. \tag{19}$$

[48] I assume that the variance of the distribution of initial productivity draws is the same across foreign and domestic plants. It is difficult to identify the standard deviation of initial for foreign plants since the data only captures a subset of all foreign plants.

[49] Allowing transport costs to vary across foreign and domestic plants makes little difference to the final results.

I assume that total revenue is measured with error for foreign and domestic plants and that exogenous technological change occurs at rate ρ. Modifying the profit functions to include measurement error and a time trend I use equations (3)-(6) to write the logarithm of *observed* revenue for any domestic plant h as

$$\ln r_{ht} = \rho t + \ln \varphi_B (1 - d_{ht}^X) + \ln[\varphi_B + \varphi_W \exp(\varphi_\tau)] d_{ht}^X - \ln a_h + \nu_{ht} \tag{20}$$

where r_{ht} is the observed revenue, φ_W measures the ratio of wages $(w^*/w)^{1-\varepsilon}$, φ_B is a function of the country sizes $(B^*/B)^{1-\varepsilon}$ and ν_{ht} is the associated measurement error. Similarly, the logarithm of observed revenue for any foreign plant f is written as

$$\ln r_{ft} = \rho + \ln \varphi_B (1 - d_{ft}^X) + \ln[\varphi_B + \varphi_W \exp(\varphi_\tau)] d_{ft}^X - \ln a_f + \nu_{ft} \tag{21}$$

Equations (20)-(21) highlight an important limitation of the data: I only observe the revenue, exports and ownership from plants located in Indonesia. I do not observe any variables for plant parents or subsidiaries abroad. Estimating the model requires imposing some consistency across plants located in different countries. In particular, I assume that every foreign non-exporting plant also produces in a separate plant located in the foreign country with the same firm-specific productivity level as the plant located in Indonesia.

Using the empirical specification, a firm's detrended profit may be expressed in terms of reduced-form parameters as:[50]

$$\pi_h(a_h, d_{ht}) = r_h(a_h, d_{ht}) - F_h(d_{ht}) \qquad \text{for Indonesian Firms} \tag{22}$$

$$\pi_f(a_f, d_{ft}) = r_f(a_f, d_{ft}) - F_f(d_{ft}) \qquad \text{for Foreign Firms} \tag{23}$$

[50]The detrended firm's problem uses a trend-adjusted discount factor $\beta \exp(\rho)$ when solving the Bellman's equation.

where

$$r_h(a_h, d_{ht}) = \exp\Big(\ln\varphi_B(1-d_{ht}^X) + \ln[\varphi_B + \varphi_W \exp(\varphi_\tau)]d_{ht}^X - \ln a_h\Big) \quad (24)$$

$$r_f(a_f, d_{ft}) = \exp\Big(\ln(1+\varphi_B/\varphi_W \exp(\varphi_\tau))(1-d_{ft}^I)d_{ft}^X + \ln(\varphi_B + \varphi_W \exp(\varphi_\tau))d_{ft}^I d_{ft}^X + \ln(1+\varphi_B)d_{ft}^I(1-d_{ft}^X) - \ln a_f\Big) \quad (25)$$

$$F_h(d_{ht}) = f_{Dh} + f_{Xh} d_{ht}^X \quad (26)$$

$$F_f(d_{ft}) = f_{Df}(1-d_{ft}^X) + (f_{Df} + f_{Xf})d_{ft}^X(1-d_{ft}^I) + (f_{Dh} + f_{Ih})d_{ft}^I + \zeta f_{Xh} d_{ft}^X d_{ft}^I \quad (27)$$

where F_h and F_f are the fixed cost functions for Indonesian and foreign firms, respectively, and ζ captures any reduction in fixed export costs enjoyed by foreign exporters. The choice probabilities (15)-(16) may then be evaluated using the solution to the Bellman equations with the profit functions (22)-(23).

Estimating the model requires that I make assumptions on the distribution of the measurement errors. I assume that, conditional on a, ν_{ht} is independently and randomly drawn from $N(0, \Sigma_{\nu_h})$ and ν_{ft} is independently and randomly drawn from $N(0, \Sigma_{\nu_f})$. Denote the density functions of ν_{ht} and ν_{ft} by $g_{\nu_h}(\cdot)$ and $g_{\nu_f}(\cdot)$, respectively.

Due to limitations of the data it is not possible to identify all of the coefficients. Specifically, it is not possible to identify the parameters φ_W, f_{Df}, and f_{Xf}. The first parameter represents differences in wages across countries. I calibrate this parameters using data on manufacturing wages in different countries.[51] The last two parameters are fixed cost parameters in the foreign country. To calibrate the fixed cost of operating in a foreign country, f_{Df} I use information from the World Bank's Doing Business Report to estimate that $f_{Df} = 0.51 f_{Dh}$. In particular, I use an index of labour rigidity. I posit that the fixed cost of exporting from the foreign country is $f_{Xf} = \omega f_{Xh}$ and I calibrate ω to match the ratio manufacturing imports to Indonesia to the total output of domestic firms. To test for possible misspecification around the fixed cost parameters, I check the robustness of the results with regards to this calibration by estimating the model under various alternative fixed cost assumptions.[52]

[51] The wage data is taken from the International Labour Organization Bureau of Statistics. The ratio is constructed using the manufacturing wage in Japan as the foreign wage since Japan has the largest foreign investment in Indonesia.

[52] In particular, I re-estimate the model assuming that the fixed operation costs are equal across countries and that fixed costs are much more extreme in Indonesia.

The vector of remaining parameters θ is estimated by the method of maximum likelihood where[53]

$$\theta = (\rho, \varphi_B, \varphi_\tau, f_D, f_X, f_I, \zeta, \xi, \varrho^\chi, \varrho^D, \mu_{ah}, \mu_{af}, \sigma_a).$$

Denote $T_{i,0}$ as the first year the firm appears in the data. Then, the likelihood contribution of plant i in year $t > T_{i,0}$ is

$$L_{it}(\theta|a_i) = \begin{cases} P(\chi_{it} = 0|a_i) & \text{for } \chi_{it} = 0 \\ \underbrace{P(\chi_{it} = 1|a_i)}_{\text{Stay/Exit}} \underbrace{P(d_{it}|a_i, \chi_{it} = 1)}_{\text{FDI/Export}} \underbrace{g_\mu(\tilde{\mu}_{it}(a_i))}_{\text{Revenue}} & \text{for } \chi_{it} = 1 \end{cases}$$

In the first year of the sample, T_{i0}, I only observe plants that chose to produce. Thus, to calculate the likelihood contribution of these plants in the initial year, I condition the likelihood on $\chi_{it} = 1$:

$$L_{it}(\theta|a_i) = P(d_{it}|a_i, \chi_{it} = 1) g_{\mu_1}(\tilde{\mu}_{it}(a_i)) \tag{28}$$

Let $T_{i,1}$ denote the last year plant i appears in the data. Then, conditioning the likelihood on productivity level a_i, I calculate the likelihood contribution from each plant as

$$L_i(\theta|a_i) = \prod_{t=T_{i,0}}^{T_{i,1}} L_{it}(\theta|a_i).$$

Unfortunately, I do not observe the inherent productivity level a_i. Thus, to compute the likelihood I must integrate out the a_i for each plant's observation. For domestic plants that enter after the initial sample year, I need to use the distribution of initial draws of home firms upon successful entry into the home country. Define the probability that a successful entrant chooses to set up a plant in the home country as

$$P^h_{in}(a) = P(d = (0,0)|a, \chi = 1) + P(d = (1,0)|a, \chi = 1).$$

Then the distribution of initial draws of home firms upon successful entry into the home country

[53] The discount factor is not estimated and is set to 0.95. It is difficult to identify the discount factor β in dynamic discrete choice models.

is given by

$$g_a^e(a) = \frac{P(\chi = 1|a) P_{in}^h(a)}{\int P(\chi = 1|a') P_{in}^h(a') da'} g_a(a). \tag{29}$$

Similarly, for foreign plants, I use the distribution of initial draws upon successful entry of foreign firms into the home country given by

$$g_a^{e*}(a) = \frac{P(\chi = 1|a) P_{in}^f(a)}{\int P(\chi = 1|a') P_{in}^f(a') da'} g_a^*(a). \tag{30}$$

where $P_{in}^f(a) = P(d = (0,1)|a, \chi = 1) + P(d = (1,1)|a, \chi = 1)$. However, in the initial period I cannot use the initial distributions of successful entrants since I only observe that all plants chose to produce. Thus, in the initial year I use P_{in}^h, P_{in}^f and (18) to calculate the stationary distributions for both home and foreign firms in the home country, $g_a^s(a)$ and $g_a^{s*}(a)$, respectively. The likelihood contribution from each individual plant is then

$$L_i(\theta) = \begin{cases} \int L_i(\theta|a') g_a^s(a) da' & \text{for } T_{i,0} = 1993, \\ \int L_i(\theta|a') g_a^e(a) da' & \text{for } T_{i,0} > 1993, \end{cases}$$

where the starred distributions are used in place of the unstarred distributions for foreign firms. The parameters vector θ can then be estimated by maximizing the logarithm of the likelihood function

$$\mathcal{L}(\theta) = \sum_{i=1}^{N} \ln L_i(\theta). \tag{31}$$

The evaluation of the log-likelihood function involves solving the dynamic programming problem that approximates the Bellman equations (13)-(14) by discretization of the state space.[54] I first fix ω which determines the fixed export cost in the foreign country. Then for each candidate choice of parameter vector, I solve the discretized dynamic programming problem (13)-(14), calculate the conditional choice probabilities (15)-(16) and the stationary distributions. Using the conditional choice probabilities and the stationary distributions, I evaluate the log-likelihood function (31). Searching over the parameter space of θ, I maximize (31) to find the estimates. Taking the estimates, I check that the initial guess of ω implies that aggregate manufacturing trade flows to Indonesian match those predicted by the model. If not, I update ω and repeat this procedure until ω converges. It is important to note that throughout this process the

[54]I use the Gauss-Quadrature method with twenty-five grid points to approximate the state space of a.

endogeneity of the export, investment and exiting decisions are controlled for by simultaneously considering the likelihood contribution from each decision.

4.3 Reduced-Form & Structural Parameters

As noted above, it is not possible to identify all of the parameters of the model. As such, equations (20)-(27) are reduced-form specifications where the reduced-form parameters represent the structural parameters as follows.

$$\begin{aligned}\varphi_B &= \left(\frac{wB}{w^*B^*}\right)^{1-\varepsilon}, \\ \varphi_W &= \left(\frac{w}{w^*}\right)^{1-\varepsilon}.\end{aligned}$$

Since I cannot estimate φ_W, the coefficient is calibrated using data on wages across countries.

It is important to note that policy changes may affect the value of reduced-form parameters if the underlying structural parameters change. In particular, any change to the aggregate price level P will lead to a change in $B = [(1-\alpha)\gamma E]^{1/(1-\varepsilon)}/(\alpha P)$ and φ_B. As described below, it is important to take into account any changes in P when conducting policy experiments.

4.4 Identification

I consider the identification of the empirical model's parameters in two steps. First, the identification of the revenue functions' (20)-(21) parameters follows from the within-plant variation in export status along with the moment restrictions $E[\nu_{it} - \nu_{i(t-1)}|d_{it}] = 0$ where $i \in \{h, f\}$. The latter condition is obtained by first-differencing the plant-level revenue functions (20)-(21).

Second, I assume that the panel is long enough that given the parameters identified in the revenue function, I can identify the value of plant-specific productivity a for each plant.[55] Since the exiting probabilities are strictly increasing in the fixed cost, f_{Dh}, I can identify f_{Dh} by relating the probability of exit to the variation in a. At the same time, the elasticities of the exiting probabilities tend to decrease as the variance of the exiting shocks increases. The variation in the differences between different a's across firms and the difference in exiting probabilities

[55] Even though I only use four years of data, the distributional assumptions on a allow me to identify each plant's likelihood of having a particular value of a.

identify the scale parameter ϱ_χ separately from f_D.[56] We may similarly identify the fixed cost and scale parameters by relating the variation in a to the variation in export and investment probabilities.

Lastly, the scale of the profit function cannot be identified because multiplying the profit function by a constant leads to the same optimal choice. Thus, for identification I normalize the profit functions (22)-(23) by $\kappa = \varepsilon/(w^* B^*)^{1-\varepsilon}$.[57]

4.5 Data

I employ data from the Indonesian manufacturing census for 1993-1996.[58] The census enumerates all plants with at least 20 employees.[59] I focus on Indonesian food, textile and manufactured metals industries since they are among Indonesia's largest industries and receive substantial foreign direct investment.[60] I omit all plants that are owned entirely by the Indonesian government.[61] The food, textile and manufactured metals industry data consists of unbalanced panels of 6,042, 4,491 and 2,497 plants, respectively, where each plant is observed for at least one year between 1993 and 1996.[62]

The advantage of this data set relative to many other plant-level data sets is that I am able to observe the percentage of foreign ownership for each individual plant. This will allow me to examine the behaviour of foreign plants relative to their domestic counterparts. I identify a foreign plant as any plant that has positive foreign ownership as a foreign plant. It is possible that if foreign investors own a small minority of plant equity the plant may not be foreign controlled. However, in over 66% of the foreign firms in the sample, foreign investors own at least 50% of the equity, while foreign investors own at least 25% of foreign firms in 95% of the sample.[63] Similarly, I identify exporters as plants that receives any positive revenues from

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[56] The variance of the exit decision cost shocks is calculated as $Var(\epsilon^\chi(\chi)) = \frac{(\varrho_\chi \pi)^2}{6}$.

[57] Specifically, by multiplying the profit function by ε, I estimate the parameters κf_{Dh}, κf_{Xh}, κf_{Ih}, $\kappa \varrho_\chi$ and $\kappa \varrho_d$ instead of f_{Dh}, f_{Xh}, f_{Ih}, ϱ_χ and ϱ_d.

[58] Two-digit ISIC classification.

[59] It is believed that over this period the coverage was close to complete since regional offices had financial incentives to enumerate plants (Blalock and Gertler, 2005).

[60] Approximately 58% of all foreign plants in the Indonesian manufacturing census are in the food, textile and manufactured metals industries.

[61] Overall, I eliminate 669 plants over the 1993-1996 period.

[62] A description of the Indonesian manufacturing industry over this period can be found in Blalock and Gertler, 2005.

[63] Blalock and Gertler (2005) argue that firms with significant foreign ownership are likely to be foreign controlled even if they are not majority owned. Moreover, this variable correlates very well with a government status variable

export sales. As discussed in the second section this definition is the most conservative of all possible thresholds.

The unit of observation is that of the individual plant, not the firm. This is particularly important to this empirical exercise because I do not observe if the plant is a parent or a subsidiary, but only if it is foreign or domestically owned. To estimate the model I will have to make an assumption that all foreign plants are part of a multinational firm and that all domestic plants are strictly national firms.[64] While this assumption may appear extreme, Indonesia received over 14,352 million US dollars of foreign investment from 1993-1996, while it only supplied just over 40 millions US dollars worth of FDI to the world economy.[65]

Since I only observe plants located in Indonesia, I calibrate the foreign country parameters using data the International Labour Organization Bureau of Statistics, the World Bank's Doing Business Report and the United Nations Commodity Trade Statistics. Specifically, I use the wage data from the International Labour Organization Bureau of Statistics for manufacturing wages, the World Bank's Doing Business Report to estimate the relative size of fixed operation costs across countries and the Commodity Trade Statistics to determine the approximate level of manufacturing imports in Indonesia.

Another limitation of the data is that I do not observe the export destinations of each firm. Thus, I cannot identify plants that export to developed markets versus those who use Indonesia as an export platform for nearby regional markets. However, Table 6 suggests that Indonesian industries that earn a higher percentage of revenues from exports are more likely to export to developed countries. Along with the discussion in Section 2, this would suggest that vertical multinationals are more likely to export-intensive foreign firms. In order to be conservative I assume that all foreign exporters are vertical multinationals and all foreign non-exporters are horizontal multinationals.[66]

I focus on the following five variables for each plant i in year t: χ_{it}, r_{it}, l_{it}, d_{it}^X and d_{it}^I. I

that indicates whether a firm if a plant has official foreign status by the Indonesian government.

[64]Several other empirical papers use data that directly connects parents and subsidiary plants (see Helpman, Melitz and Yeaple (2004), for example). Unfortunately, these data sets are inadequate to estimate the model presented here, since it requires observing all plants in the industry. Baily, Hulten and Campbell (1992) accounting for productivity differences across is particularly important when evaluating policy. Thus, in order to perform the policy experiments in this paper I must observe all plants in the industry.

[65]OECD International Direct Investment Statistics (2006).

[66]The results would not change if I included firms that only receive a small percentage of revenues from export sales in the "non-exporting" group.

Table 6: Indonesian Export Destinations

Industry	Export Intensity[a]	% of Industry Exports to Developed Nations	No. of Obs.
Wood	0.67	58%	1,860
Textiles	0.55	75%	1,816
Food	0.46	64%	956
Manufactured Metals	0.41	49%	892
Minerals	0.41	47%	275
Chemicals[b]	0.35	47%	1,065
Basic Metals	0.33	32%	144
Paper	0.27	19%	147

Notes: Data compiled from the United Nations Commodity Trade Statistics 1994. (a) Export Intensity is the mean export intensity of all exporting firms in the industry. (b) I have omitted firms in the petroleum industry as they were large outliers. This resulted in the removal of twelve plant-year observations.

convert the nominal value of total sales by the manufacturing output price deflator to calculate the real value of total sales, r_{it}. Labour is the total number of workers employed by each plant, while the binary variables d_{it}^X and d_{it}^I are constructed by checking the value of export sales and foreign ownership in each year. The entry/exit decision, χ_{it} is identified by checking whether plants employed a positive number of workers in each year.

Table 7 provides descriptive statistics for all five variables over the sample period. The large standard deviations indicate substantial variation across plants in terms of total sales, export sales and labour. Both revenues and labour are both growing over the sample, particularly in the metals industry. The percentage of foreign plants is highest in the metals industry and lowest in the food industry. However, the food industry demonstrates a substantial growth in foreign presence, while the food and textiles industries display a slight decline. Table 7 also demonstrates high exit and entry rates which are important for identifying the parameters that affect the choice probabilities as well as the initial distribution of productivity shocks. On average 906, 674 and 400 new plants enter the Indonesian food, textiles and metals industries each year, respectively, while 544, 359, 150 incumbents exit, creating a substantial amount of turnover.

Table 7: Descriptive Statistics - Food, Textiles & Metals Industries

	Food		Metals		Textiles	
	1993-96 avg.	1993-96 %Δ	1993-96 avg.	1993-96 %Δ	1993-96 avg.	1993-96 %Δ
Total Sales[a]	25.51	1.18	45.77	5.28	38.35	6.28
	(410.97)	(39.16)	(210.26)	(78.57)	(198.91)	(117.36)
Export Sales[a,b]	44.67	0.64	45.70	0.64	56.76	0.42
	(312.42)	(4.05)	(102.67)	(2.81)	(144.16)	(4.82)
Labour	106.64	0.17	168.87	0.32	245.09	0.15
	(703.44)	(1.84)	(325.05)	(1.60)	(730.25)	(1.23)
% of Foreign Plants[c]	0.02	0.18	0.10	-0.01	0.04	-0.02
	—	—	—	—	—	—
Entry Rates[d]	0.15	0.57	0.16	0.23	0.15	0.48
	—	—	—	—	—	—
Exit Rates[e]	0.09	-0.02	0.06	0.08	0.08	0.29
	—	—	—	—		
No. of Plants[f]	6,042	3,212	2,497	1,387	4,491	2,394

Notes: Reported numbers are sample means with standard deviations in parentheses. (a) In millions of Indonesian Rupiahs. The percentage change is calculated as the mean percentage change across plants. (b) Computed using the sample of exporting plants. (c) The average is computed as the percentage of plants with some foreign ownership. (d) The number of new entrants divided by the total number of plants in 1993. (e) The number of exiting plants divided by the total number of plants. (f) The first number is the total number of plants observed during the period, while the second is the number of plants present in all four years.

5 Results

5.1 Parameter Estimates

Table 8 presents the maximum likelihood parameter estimates of the empirical model along with the associated asymptotic standard errors.[67] The parameters are evaluated in millions of Indonesian rupiahs in 1983.

The estimate of φ_τ ranges between a low of -4.994 for the food industry and a high of -4.983 for the metals industry. The estimates imply that the value of the transport cost τ is approximately 6.8 if $\varepsilon = 3.6$.[68] While these estimates seem high, Blonigen and Wilson (2006)

[67] The standard errors are computed using the outer product of gradients estimator.

[68] Eaton and Kortum (2002) estimate an elasticity of substitution of 3.6 using information from wages. This

note that Indonesia's ports are quite inefficient relative to the rest of the region. In fact, in 2006 the Jakarta Post noted that poor port management has previously caused excessively high transport costs, particularly for international shipments.[69] Together the estimates of φ_B and $\varphi_t au$ imply that in the steady state 43% of a domestic exporter's revenues are from export sales in the food and metals industries, while 47% of total revenues are from export sales in the textiles industry. The model overpredicts the percentage of revenues earned from exports in the food and metals industries by 7 and 2 percent, respectively, while it underpredicts the percentage of revenues earned from exports in the textiles industry by 4 percent.

The estimates of the fixed costs vary substantially across industries. In the food industry, the estimated fixed cost of operating in the Indonesian market is $\hat{f}_{Dh} = 1.078/\kappa$ which is just over 88 percent of the average domestic firms revenue. The implication is that without cost shocks, very few domestic non-exporters would be able to produce profitably. In dollar terms, the fixed operating cost is 5,462.65 US dollars (or approximately 12.1 million Indonesian Rupiahs) in the food industry. The estimated parameters on the fixed export cost and investment cost in Indonesia are also large and significant, $\hat{f}_{Xh} = 0.856/\kappa$ and $\hat{f}_{Ih} = 3.613/\kappa$, which are approximately 4,337.34 and 18,303.59 US dollars, respectively. For the metals and textiles industries, the fixed cost of operating are approximately 7,171.13 and 8,975.33 US dollars, while the fixed export costs are 7,099.42 and 10,501.14 US dollars, respectively.[70] The fixed investment costs are again estimated to be much higher. In the textiles industry it is estimated that foreign plants must pay an additional 59,961.51 US dollars annually in fixed costs, while foreign plants in the metals industry must pay an average of 85,193.04 US dollars. While the fixed investment costs appear to be somewhat high, they are potentially biased upwards if there are substantial sunk costs associated with FDI which are not accounted for in the model.

In contrast, the parameter capturing the fraction of fixed export costs paid by foreign exporters ζ is very low indicating that foreign plants only pay a small fraction fixed export costs relative to their domestic counterparts. In fact, the estimates suggest that the fixed export cost is 62%, 90% and 97% lower for foreign exporters in the food, textiles and metals industries.

number is appropriate since the elasticity of substitution inflates wage differences between countries in the model. The sensitivity of the estimates with respect to this parameter are reported in the appendix.

[69]Moreover, in 2002 the Jakarta Post noted that poor port maintenance was a potential deterrent to Japanese FDI.

[70]Most of the fixed export cost estimates are in line with those found in Eaton, Kortum and Kramarz (2004) where they estimate that the fixed export cost is approximately 7,000 US dollars in 1986.

The estimates imply that foreign ownership allows plants to access foreign export markets at a substantial discount.

The magnitude of exiting cost shocks can be moderately large. The estimate of the scale parameter on the exit cost shocks in the food industry is $\varrho_{\chi} = 0.028/\kappa$ which implies a standard error of $\frac{\pi}{\sqrt{6}} \times 0.028/\kappa = 0.036/\kappa$. This is approximately 3.3 percent of the average non-exporting domestic firm's revenue. In the textiles and metals industries the standard errors of exit cost shocks are just over 4 and 12 percent of a domestic non-exporter's revenue. The scale parameter on the export/investment decisions are usually quite modest. The standard errors of export/investment cost shocks are 2 percent or less of a domestic non-exporter's revenue in all three industries.

The model predicts that higher productivity firms are more likely to survive than lower productivity firms. As shown in Table 9 the mean productivity level among successful Indonesian entrants is predicted to be 95 percent higher than the mean of Indonesian productivity distribution in the food industry, while it is 42 and 48 percent higher in the textiles and metals industries, respectively. The model also predicts that selection is important for foreign firms, however, it is important to interpret these results cautiously since I only observe a subset of foreign firms.[71]

Table 10 compares the distribution of firms in the data with that predicted by the model. The distribution of plants predicted by the model matches the general pattern of plants across different export and ownership status in each industry very well. However, it is noteworthy that the model underpredicts the percentage of domestic exporters in the metals and textiles industry. This will affect the overall aggregate productivity predictions because the model predicts a fewer number of domestic firms will be affected by changes in trade policy.[72]

The model also predicts the same pattern of productivity across export and ownership status as found in the data. The top panel of Table 11 reports revenue per worker where I have used revenue shares as weights among each group of firms, while the bottom panel reports the same calculation for the model's prediction. Table 11 demonstrates that in all three industries the

[71] The empirical results suggest that at the steady state foreign firms' average productivity is 84, 11 and 21 percent higher than the mean of the initial foreign distribution in the food, metals and textiles. As noted in the text, since the data set only captures a subset of the most productive firms it is impossible to evaluate how well the model captures the entire distribution of foreign productivity.

[72] The estimated model does not provide a prediction in terms of the total number of foreign firms relative to the total number of domestic firms. As such, I take the percentage of foreign in the data as given.

Table 8: Structural Estimates

Industry	Food	Metals	Textiles
ϱ_X	0.028	0.101	0.051
	(0.012)	(0.010)	(0.002)
ϱ_d	0.010	0.005	0.006
	(0.030)	(0.0002)	(0.0002)
ρ	0.0002	0.0002	0.0012
	(0.006)	(0.007)	(0.006)
φ_B	1.236	1.279	1.083
	(0.264)	(0.049)	(0.022)
φ_τ	-4.994	-4.983	-4.988
	(0.211)	(0.001)	(0.001)
f_{Dh}	1.078	0.284	0.502
	(0.456)	(0.023)	(0.021)
f_{Xh}	0.856	0.280	0.587
	(0.246)	(0.011)	(0.012)
f_{Ih}	3.613	3.360	3.353
	(1.493)	(0.242)	(0.122)
ζ	0.383	0.028	0.099
	(0.975)	(0.026)	(0.014)
μ_{ah}	1.665	1.780	1.287
	(0.224)	(0.043)	(0.027)
μ_{af}	-0.007	0.005	-0.00001
	(0.222)	(0.043)	(0.033)
σ_a	0.293	0.176	0.211
	(0.007)	(0.003)	(0.004)
ξ	0.011	0.006	0.008
	(0.001)	(0.001)	(0.004)
ω	0.009	0.175	0.122
log-likelihood	-54983.13	-33842.80	-59504.92
No. of Obs.	17,786	7,549	13,287

Notes: Standard errors are in parentheses. The parameters are evaluated in units of millions of Indonesian Rupiahs in 1983.

model predicts that foreign non-exporters are the most productive plants, followed by foreign exporters, domestic exporters and, lastly, domestic non-exporters.

Tables 12 and 13 compare the percentage of total exports and the domestic market share across export and ownership status. The model matches the fact that foreign plants account

Table 9: Average Productivity

	Food		Metals		Textiles	
	Indonesian	Foreign	Indonesian	Foreign	Indonesian	Foreign
Mean at entry trial	0.535	1.019	0.507	1.004	0.615	1.009
Mean at successful entry in Indonesia	0.949	1.692	0.519	1.497	0.689	1.663
Mean at steady state in Indonesia	0.958	1.692	0.576	1.497	0.765	1.663

Table 10: Distribution of Plants by Ownership/Export Status

Actual	Domestic Non-Exporters	Domestic Exporters	Foreign Non-Exporters	Foreign Exporters
Food	0.931	0.046	0.016	0.008
Metals	0.824	0.071	0.058	0.047
Textiles	0.839	0.114	0.025	0.023
Predicted				
Food	0.858	0.118	0.015	0.009
Metals	0.857	0.038	0.062	0.043
Textiles	0.929	0.024	0.024	0.023

for a higher percentage of exports in the metals industry relative to either the food or textiles industries. However, it overpredicts the export share of foreign plants by 4 percent in the food industry, 37 percent in the metals industry and 64 percent in the textiles industry. Table 13 indicates that the model captures the pattern of domestic market share differences across industries relatively well, but typically underpredicts the market share of domestic exporters.

Table 14 documents the actual and predicted transition probabilities of investment, export and exit in the textiles industry.[73] It is noteworthy that despite the model's restriction that no domestic plant can become a foreign plant, the model captures many of the transition probabilities between investment and export status relatively well. A surprising result in Table 14 is the large degree of persistence captured by the model despite the fact that there are no sunk costs. The persistence in export status is due to the fact that I assume that the firm-level productivity level is constant over the life of the firm and the relatively small size of the export/investment shocks.[74]

[73]Similar tables can be found in the appendix for the food and metals industries.

[74]An interesting extension of this model would be allow productivity to follow a Markov process and incorporate

Table 11: Relative Average Productivity of Plants by Ownership/Export Status

Actual	Domestic Non-Exporters	Domestic Exporters	Foreign Non-Exporters	Foreign Exporters
Food	1.000	2.415	5.053	3.799
Metals	1.000	1.537	3.280	3.073
Textiles	1.000	1.237	2.532	1.590
Predicted				
Food	1.000	1.070	1.796	1.757
Metals	1.000	1.098	2.617	2.609
Textiles	1.000	1.100	2.229	2.131

Notes: The top panel reports revenue per worker weighted by revenue shares. The average productivity of Domestic Non-Exporters is normalized to 1.

Table 12: Export Share by Ownership

Actual	Domestic	Foreign
Food	0.837	0.163
Metals	0.458	0.542
Textiles	0.717	0.283
Predicted		
Food	0.791	0.209
Metals	0.086	0.912
Textiles	0.153	0.847

Table 13: Domestic Market Share by Ownership/Export Ownership

Actual	Domestic Non-Exporters	Domestic Exporters	Foreign Non-Exporters	Foreign Exporters
Food	0.551	0.289	0.126	0.032
Metals	0.462	0.099	0.300	0.138
Textiles	0.602	0.238	0.097	0.062
Predicted				
Food	0.776	0.127	0.063	0.033
Metals	0.394	0.022	0.347	0.237
Textiles	0.704	0.023	0.146	0.127

Table 14: Distribution of Ownership/Export Status - Textiles

Actual	Dom. Non-Exporters	Dom. Exporters	For. Non-Exporters	For. Exporters	Exit
Dom. Non-Exporters at t	0.945	0.051	0.003	0.001	0.088
Dom. Exporters at t	0.309	0.679	0.001	0.011	0.068
For. Non-Exporters at t	0.138	0.031	0.581	0.256	0.030
For. Exporters at t	0.027	0.066	0.178	0.732	0.016
Predicted					
Dom. Non-Exporters at t	0.987	0.013	—	—	0.108
Dom. Exporters at t	0.455	0.545	—	—	0.008
For. Non-Exporters at t	—	—	0.990	0.010	0.008
For. Exporters at t	—	—	0.430	0.570	0.008

5.2 Counterfactual Experiments

I present the results from a series of counterfactual experiments intended to examine the effect of trade and investment barriers for the textiles industry.[75] In particular, to determine the quantitative implications of barriers to trade and investment I conduct the following three counterfactual experiments by manipulating four counterfactual parameters:

1. Autarky: $f_{Xh}, f_{Xf}, f_{Ih} \rightarrow \infty$,
2. No Trade: $f_{Xh}, f_{Xf} \rightarrow \infty$,
3. No Investment in Indonesia: $f_{Ih} \rightarrow \infty$,

To determine the full impact of trade or investment barriers on the Indonesian economy it is important to consider the effect policy changes have on the aggregate price level. To do this I employ the free entry conditions (17). I solve for the new price levels in Indonesia and the rest of the world which satisfies (17) under the policy change.

Table 15 presents the results from the counterfactual experiments in the textiles industry.[76] The effect of trade and investment on average productivity can be best understood by comparing the steady state level of average productivity between the estimated (base) model and that of the

sunk costs into the estimation to determine whether to what extent the persistence generated by the model is robust to model specification.

[75]The results for the food and metals industries are presented in the appendix.

[76]Results for the metals and food industries are presented in the Appendix.

Table 15: Counterfactual Experiments - Textiles

	Base	Autarky	No Trade	No FDI	Rise in ζ
Avg. Productivity[a]	1.136	0.755	1.046	0.765	1.034
$-(\varepsilon-1)\delta\Delta\ln P$	—	$-\delta 0.025$	$-\delta 0.001$	$-\delta 0.0002$	$-\delta 0.00004$
Exit/Entry Rate	—	-1	-0.421	-1	-0.482
of Foreign Firms					
% of For. Non-Exporters	0.024	0	0.028	0	0.025
% of For. Exporters	0.023	0	0	0	≈ 0
% of Dom. Exporters	0.024	0	0	0.025	0.024
%Δ in Dom. Exports	—	-1	-1	≈ 0	≈ 0
%Δ in For. Exports	—	-1	-1	-1	≈ -1
Mkt. Shr. of Dom. Non-Exporters	0.704	1	0.817	0.969	0.803
Mkt. Shr. of Dom. Exporters	0.023	0	0	0.031	0.026
Mkt. Shr. of For. Non-Exporters	0.146	0	0.183	0	0.171
Mkt. Shr. of For. Exporters	0.127	0	0	0	≈ 0

Notes: a) Average productivity of all plants located in Indonesia in the steady state. Calculated using plant-level revenue shares as weights.

counterfactual experiments in the first row. The second compares welfare across the experiments and will be left to the end.

Eliminating trade and investment reduces average productivity by 33.5 percent. As I discuss below, much of the fall in productivity can be attributed to the removal of foreign firms from the economy. I also find a fall in average productivity across trade barriers and investment barriers alone, but the overall effect of these barriers varies widely. In particular, examining the third and fourth columns of Table 15 it is clear that trade barriers cause a substantially smaller reduction in average productivity than investment barriers. The explanation behind this phenomenon lies in the substitutability and complementarity of trade and FDI.

In the third column I examine the case where there is no trade between Indonesia and the rest of the world. To the extent that trade restrictions would reduce the incentive to invest in Indonesia and use it as an export platform, foreign firms are less likely to invest in Indonesia. On the other hand, due to the trade restrictions firms that previously exported to Indonesia may be interested in investing in Indonesia to access the domestic market. In fact, the column 3 suggests that the number of foreign firms falls by 42 percent. In this sense, one can think of FDI as a complement for exports. However, because many foreign firms remain in Inodnesia despite the trade restriction average productivity falls by only 7.9 percent which is substantially smaller than the fall under autarky.

The fourth column presents the results from a counterfactual experiment where trade is allowed but foreign investment is not permitted. Average productivity drops by 32.6 percent without FDI. Although the fall in productivity is almost as large as that under autarky it can be attributed to 3 features of the model. First, the fall is partly due the removal of the top 5% of the most productive firms, the foreign firms, in the industry.[77] Second, I construct average productivity by weighting firm level productivity my revenue shares. Thus, while foreign plants might only account for less than 5% of all plants, their productivity levels receive almost one quarter of the total weight in the average productivity calculation. Last, the increase in the price level encourages more small, domestic firms to enter the industry which in turn causes average productivity to fall. Most importantly, the counterfactual experiment indicates that the impact of FDI on average productivity is more than 4 times greater than trade.

[77]Note that when firms leave they take all of their knowledge and technology with them so their are no spillovers to the domestic industry.

The welfare results are reported in the second row of Table 15. Welfare is measured as the change in the inverse price level since increases in prices reduce the purchasing power of consumers. The parameter δ captures the size of the textiles sector in the Indonesian economy. Blalock and Gertler (2005) estimate that manufacturing composes approximately one quarter of the Indonesian and I find that the textiles industry accounts for almost one quarter of manufacturing which implies $\delta \approx 0.055$. Although this will greatly reduce the size of the welfare impact it is clear from Table 15 that if similar changes occur across all Indonesian manufacturing sectors there would be significant drop in overall welfare.

Table 15 documents a relatively large fall in welfare due to autarky, but smaller changes for restrictions to trade and FDI. The intuition behind this result is that trade and FDI flows "insure" restrictions to each other. Thus, a restriction to trade (FDI) is partially insured by the capital (trade) flows into Indonesia so that Indonesian consumers can continue to access foreign goods through FDI (trade). An insurance feature of the model is emphasized here again since estimates of the welfare change that do not account for capital (trade) flows resulting from trade (capital) restrictions will tend to overestimate the fall in welfare due to trade restrictions.

6 Conclusions

This paper presents and estimates a model of foreign direct investment and exports with heterogeneous firms. I find that the impact of FDI on aggregate productivity may be as high as 4 times that of trade in Indonesia. Recently the *Economist* magazine stated that "the fate of the [Indonesian] economy rests on attracting foreign investment."[78] To the extent that economists believe that aggregate productivity is important for economic growth, these results tend to echo the *Economist*'s prediction.

The model emphasizes that accounting for financial capital flows is essential to recovering accurate estimates of the impact of trade on aggregate productivity. In particular, the counterfactual experiments imply that the impact of trade on productivity is greatly mitigated by FDI flows. Similar results are obtained for welfare calculations.

Last, the estimated model emphasizes that international trade in Indonesia is a complement to foreign direct investment on aggregate. As such, the model highlights the effect of foreign

[78] "Time to deliver: A survey of Indonesia." December 11, 2004, pg. 4.

investment policy on exports and the effect of trade policy on foreign direct investment. These results are particularly important for policymakers designing development strategies.

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A Counterfactual Experiments

Denote the Indonesian aggregate price under the parameter vector θ by $P(\theta)$ and the foreign aggregate price by $P^*(\theta)$. Suppose that I am interested in a counterfactual Indonesian policy experiment with the parameter vector $\tilde{\theta}$ which is different from the estimated parameter vector $\hat{\theta}$. First, recall that the reduced form parameter φ_B is a function of the Indonesian price level and the foreign price level:

$$\hat{\varphi}_B = \frac{E}{E^*}\left(\frac{P(\hat{\theta})}{P^*(\hat{\theta})}\right)^{\varepsilon-1}$$

where the aggregate price levels are written as a function of the estimated parameter vector $\hat{\theta}$. Writing the revenue functions in this fashion is equivalent to normalizing $E^*P^*(\hat{\theta}) = 1$ in the estimation routine. Denoting ϕ_B^* as

$$\varphi_B^* = \frac{E^*}{E^*}\left(\frac{P^*(\hat{\theta})}{P^*(\hat{\theta})}\right)^{\varepsilon-1} = 1$$

I can rewrite the firm level revenue functions as follows:

$$\begin{aligned} r_h(a_h, d_{ht}) &= \exp\Big(\ln\varphi_B(1-d_{ht}^X) + \ln[\varphi_B + \varphi_W\exp(\varphi_\tau)\varphi_B^*]d_{ht}^X - \ln a_h\Big) \\ r_f(a_f, d_{ft}) &= \exp\Big(\ln(\varphi_B^*)(1-d_{ft}^X)(1-d_{ft}^I) + \ln(\varphi_B^* + \varphi_B/\varphi_W\exp(\varphi_\tau))(1-d_{ft}^I)d_{ft}^X \\ &\quad + \ln(\varphi_B + \varphi_W\varphi_B^*\exp(\varphi_\tau))d_{ft}^I d_{ft}^X + \ln(\varphi_B^* + \varphi_B)d_{ft}^I(1-d_{ft}^X) - \ln a_f\Big) \end{aligned}$$

where $\bar{\varphi}_W$ is the calibrated level of intercountry wages and $\hat{\varphi}_\tau$ is the estimated transport cost.

At the counterfactual price $P(\tilde{\theta})$ and $P^*(\tilde{\theta})$, the reduced form coefficients φ_B and φ_B^* take the values

$$\begin{aligned} \tilde{\varphi}_B &= \frac{E}{E^*}\left(\frac{P(\tilde{\theta})}{P^*(\hat{\theta})}\right)^{\varepsilon-1} = \hat{\varphi}_B k(\tilde{\theta},\hat{\theta}) \\ \tilde{\varphi}_B^* &= \frac{E^*}{E^*}\left(\frac{P^*(\tilde{\theta})}{P^*(\hat{\theta})}\right)^{\varepsilon-1} = \hat{\varphi}_B^* k^*(\tilde{\theta},\hat{\theta}) \end{aligned} \tag{32}$$

where $k(\tilde{\theta},\hat{\theta}) = (P(\tilde{\theta})/P(\hat{\theta}))^{\varepsilon-1}$ and $k^*(\tilde{\theta},\hat{\theta}) = (P^*(\tilde{\theta})/P^*(\hat{\theta}))^{\varepsilon-1}$ represent the equilibrium price changes.

We can then evaluate the revenue functions using the counterfactual coefficients $\tilde{\varphi}_B$ and $\tilde{\varphi}^*_B$ which have been adjusted for the change in the counterfactual prices levels $P(\tilde{\theta})$ and $P^*(\tilde{\theta})$:

$$\begin{aligned} r_h(a_h, d_{ht}) &= \exp\Big(\ln\tilde{\varphi}_B(1-d^X_{ht}) + \ln[\tilde{\varphi}_B + \varphi_W \exp(\varphi_\tau)\tilde{\varphi}^*_B]d^X_{ht} - \ln a_h\Big) \\ r_f(a_f, d_{ft}) &= \exp\Big(\ln(\tilde{\varphi}^*_B)(1-d^X_{ft})(1-d^I_{ft}) + \ln(\tilde{\varphi}^*_B + \tilde{\varphi}_B/\varphi_W \exp(\varphi_\tau))(1-d^I_{ft})d^X_{ft} \\ &\quad + \ln(\tilde{\varphi}_B + \varphi_W\tilde{\varphi}^*_B\exp(\varphi_\tau))d^I_{ft}d^X_{ft} + \ln(\tilde{\varphi}^*_B + \tilde{\varphi}_B)d^I_{ft}(1-d^X_{ft}) - \ln a_f\Big) \end{aligned}$$

The equilibrium price change is determined so that the free entry conditions hold

$$\int V(a;\tilde{\theta}, k(\tilde{\theta},\hat{\theta}))g_a(a)da = f_E$$
$$\int V^*(a^*;\tilde{\theta}, k(\tilde{\theta},\hat{\theta}))g_{a^*}(a^*)da^* = f^*_E$$

where $V(a;\tilde{\theta}, k(\tilde{\theta},\hat{\theta}))$ is the solution to the Bellman equations (13)-(14) using the counterfactual adjusted revenue function and $g_a(a)$ and $g_{a^*}(a^*)$ are the normal probability density functions from which the initial productivity level are drawn.

B Fixed Cost Bounds

If exporting multinationals to be more productive than non-exporting multinationals than the following bounds on fixed costs must hold

$$f_D\left(\frac{\tau B}{B^*}\right)^{1-\varepsilon} < f_X \tag{C1a}$$

$$\left(\frac{w}{w^*\tau}\right)^{1-\varepsilon} < \frac{f_D + f_I}{f_X} \tag{C2a}$$

$$\frac{f_D + f_I - f_X}{f_X - f_D} < \left(\frac{w^{1-\varepsilon} - (w^*\tau)^{1-\varepsilon}}{(w\tau)^{1-\varepsilon} - w^{*1-\varepsilon}}\right)\frac{B}{B^*} \tag{C3a}$$

$$\tau w < w^* \tag{C4a}$$

C 5-Digit Industry Differences Across Export Status

Here I report the empirical distributions foreign exporters and foreign non-exporters across 5-digit industries (for selected 2-digit industries).

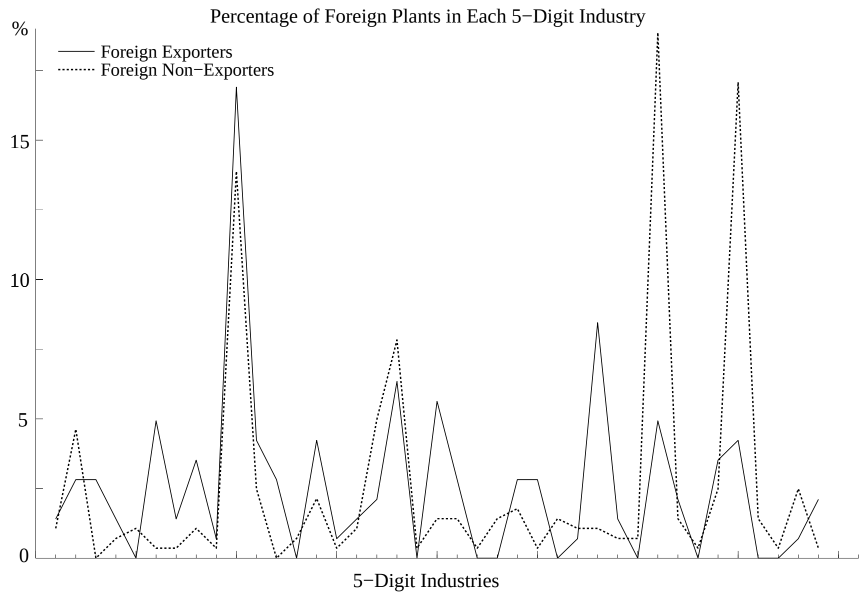

Figure 3: Food

Note: Each small tick along the x-axis represents a different 5-digit industry (ISIC codes).

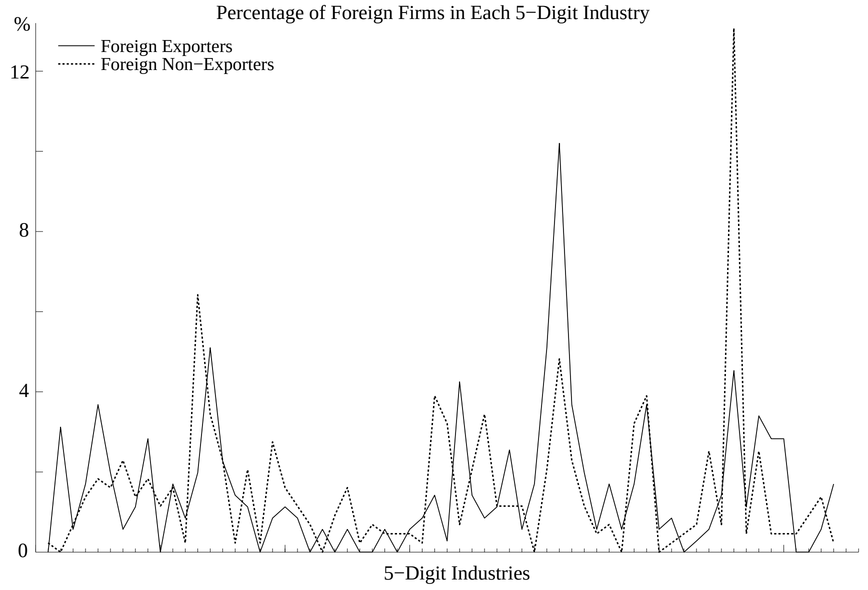

Figure 4: Metals

Note: Each small tick along the x-axis represents a different 5-digit industry (ISIC codes).

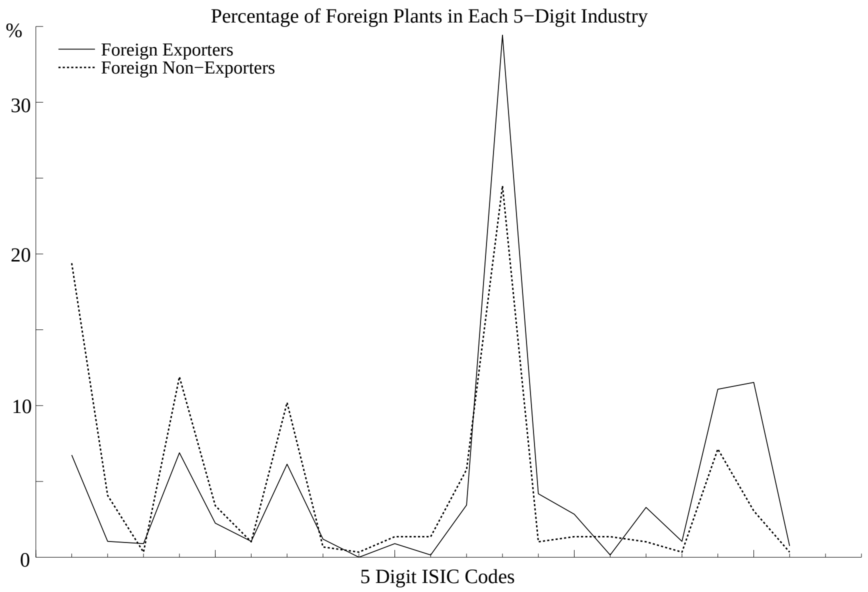

Figure 5: Textiles

Note: Each small tick along the x-axis represents a different 5-digit industry (ISIC codes).

D Tables

Table 16: Indonesian Market Statistics

	Total Sales[a]	Labor	Skill Ratio[b]	Capital	K/L Ratio[a]	Output/ Worker	No. of Obs.
All	25.20	122.98	0.14	3.86	0.02	0.12	72,732
Plants	(225.72)	(460.27)	(0.15)	(15.48)	(0.03)	(0.59)	—
Foreign	63.85	161.89	0.18	9.14	0.06	0.35	2,563
Exporters	(208.77)	(374.41)	(0.17)	(22.06)	(0.05)	(0.58)	—
Foreign	167.76	411.23	0.28	29.09	0.09	0.48	1,803
Non-Exporters	(361.14)	(649.24)	(0.20)	(49.08)	(0.06)	(1.08)	—
Domestic	36.29	151.83	0.15	5.12	0.03	0.16	10,784
Exporters	(396.91)	(835.09)	(0.14)	(20.95)	(0.03)	(0.37)	—
Domestic	11.77	74.25	0.10	1.81	0.01	0.06	57,582
Non-Exporters	(139.75)	(286.21)	(0.14)	(8.43)	(0.02)	(0.50)	—

Notes: Reported number are sample means with standard deviations in parentheses. (*a*) In millions of Indonesian Rupiahs. (*b*) The of skilled workers to total workers.

Table 17: Capital, Labour, Productivity & Foreign Firms

Foreign Firm[a] Export Intensity:	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Output per Worker	0.48	0.66	0.54	0.53	0.61	0.45	0.35	0.32	0.29	0.25	0.25
Solow Residual[b]	2.64	3.18	3.05	2.82	2.84	2.74	2.62	2.63	2.47	2.37	2.51
Capital-Labour Ratio[c]	0.09	0.08	0.08	0.07	0.08	0.08	0.07	0.06	0.06	0.05	0.04
Skill Ratio[d]	0.28	0.31	0.29	0.23	0.27	0.25	0.20	0.18	0.16	0.13	0.13
No. of Obs.	1,803	226	146	253	106	108	129	125	199	242	1140

Notes: (*a*) Percentage of total revenues from export sales. (*b*) The naive Solow Residual is calculated as $a = \ln q - 0.67 \ln k - 0.33 \ln l$. (*c*) Reported in millions of Indonesian Rupiahs. (*d*) Calculated as the ratio of skilled workers to total workers.

Table 18: Capital, Labour, Productivity & Domestic Firms

Domestic Firm[a] Export Intensity:	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Output per Worker	0.09	0.224	0.18	0.18	0.20	0.14	0.17	0.15	0.13	0.13	0.14
Solow Residual[b]	1.89	2.48	2.28	2.21	2.29	2.05	2.28	2.23	2.11	2.09	2.09
Capital-Labour Ratio[c]	0.02	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Skill Ratio[d]	0.14	0.20	0.18	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.13
No. of Obs.	57,582	974	597	598	509	524	536	562	1,055	1,089	4,340

Notes: (*a*) Percentage of total revenues from export sales. (*b*) The naive Solow Residual is calculated as $a = \ln q - 0.67 \ln k - 0.33 \ln l$. (*c*) Reported in millions of Indonesian Rupiahs. (*d*) Calculated as the ratio of skilled workers to total workers.

Table 19: Export & Ownership Premia: Chemicals

	Pooled OLS: 1993-1996		
Export/Ownership Status	Domestic Exporters	Foreign Exporters	Foreign Non-Exporters
Output per Worker	0.702	1.493	1.122
	(0.038)	(0.056)	(0.053)
Average Wage	0.122	0.776	0.900
	(0.022)	(0.033)	(0.031)
Non-Production/Total Workers	0.012	0.099	0.392
	(0.029)	(0.042)	(0.041)
Capital per Worker	0.381	0.814	1.055
	(0.034)	(0.049)	(0.047)
Domestic Sales	-0.462	0.521	1.060
	(0.045)	(0.068)	(0.060)
Total Sales	0.694	1.476	1.100
	(0.040)	(0.059)	(0.056)
Total Employment	1.034	1.000	0.717
	(0.031)	(0.047)	(0.046)
No. of Observations	8,478		

Notes: Standared errors are in parentheses.

Table 20: Distribution of Ownership/Export Status - Food

Actual	Dom. Non-Exporters	Dom. Exporters	For. Non-Exporters	For. Exporters	Exit
Dom. Non-Exporters at t	0.979	0.018	0.003	0.0005	0.094
Dom. Exporters at t	0.292	0.694	0.003	0.010	0.071
For. Non-Exporters at t	0.087	0	0.734	0.179	0.024
For. Exporters at t	0.022	0.034	0.225	0.719	0.033
Predicted					
Dom. Non-Exporters at t	0.970	0.030	—	—	0.067
Dom. Exporters at t	0.206	0.794	—	—	0.023
For. Non-Exporters at t	—	—	0.853	0.147	0.011
For. Exporters at t	—	—	0.572	0.428	0.011

Table 21: Distribution of Ownership/Export Status - Metals

Actual	Dom. Non-Exporters	Dom. Exporters	For. Non-Exporters	For. Exporters	Exit
Dom. Non-Exporters at t	0.956	0.033	0.007	0.005	0.062
Dom. Exporters at t	0.272	0.699	0.014	0.014	0.037
For. Non-Exporters at t	0.071	0.009	0.750	0.170	0.040
For. Exporters at t	0.022	0.017	0.191	0.774	0.041
Predicted					
Dom. Non-Exporters at t	0.978	0.022	—	—	0.121
Dom. Exporters at t	0.433	0.567	—	—	0.006
For. Non-Exporters at t	—	—	0.677	0.333	0.006
For. Exporters at t	—	—	0.581	0.419	0.006

Table 22: Counterfactual Experiments - Food

	Base	Autarky	No Trade	No FDI	Rise in ζ
Avg. Productivity[a]	1.070	0.952	1.056	0.958	1.037
$-(\varepsilon-1)\delta\Delta\ln P$	—	$-\delta 0.009$	$-\delta 0.004$	$-\delta 0.001$	$-\delta 0.004$
Exit/Entry Rate	—	-1	1.819	-1	1.395
of Foreign Firms					
% of For. Non-Exporters	0.015	0	0.023	0	0.018
% of For. Exporters	0.009	0	0	0	≈ 0
% of Dom. Exporters	0.118	0	0	0.1028	0.057
%Δ in Dom. Exports	—	-1	-1	0.050	0.457
%Δ in For. Exports	—	-1	-1	-1	≈ -1
Mkt. Shr. of Dom. Non-Exporters	0.776	1	0.908	0.881	0.867
Mkt. Shr. of Dom. Exporters	0.127	0	0	0.119	0.060
Mkt. Shr. of For. Non-Exporters	0.063	0	0.092	0	0.073
Mkt. Shr. of For. Exporters	0.034	0	0	0	0

Notes: a) Average productivity of all plants located in Indonesia in the steady state. Calculated using plant-level revenue shares as weights.

Table 23: Counterfactual Experiments - Metals

	Base	Autarky	No Trade	No FDI	Rise in ζ
Avg. Productivity[a]	1.245	0.574	1.222	0.576	1.165
$-(\varepsilon-1)\delta\Delta\ln P$	—	$-\delta 0.029$	$-\delta 0.001$	$-\delta 0.0002$	$-\delta 0.00001$
Exit/Entry Rate	—	-1	-0.120	-1	-0.355
of Foreign Firms					
% of For. Non-Exporters	0.062	0	0.093	0	0.070
% of For. Exporters	0.043	0	0	0	≈ 0
% of Dom. Exporters	0.038	0	0	0.043	0.040
%Δ in Dom. Exports	—	-1	-1	0.0001	0.00001
%Δ in For. Exports	—	-1	-1	-1	≈ -1
Mkt. Shr. of Dom. Non-Exporters	0.394	1	0.449	0.946	0.496
Mkt. Shr. of Dom. Exporters	0.022	0	0	0.054	0.028
Mkt. Shr. of For. Non-Exporters	0.347	0	0	0	0.476
Mkt. Shr. of For. Exporters	0.237	0	0.551	0	≈ 0

Notes: a) Average productivity of all plants located in Indonesia in the steady state. Calculated using plant-level revenue shares as weights.