Static and Dynamic Gains from Importing

1 Introduction

Empirical literature has documented a strong and positive correlation between productivity and importing. For example, using cross-country macro data, Coe and Helpman (1995) and Coe, Helpman, and Hoffmaister (1997) found that countries more actively participating in importing have higher productivity levels and productivity growth rates. Recent firm/plant-level evidence, for example Halpern, Miklos, and Szeidl (2005) (Hungarian data), Blalock and Veloso (2007) (Indonesian data), Amiti and Konings (2007) (Indonesian data), Kasahara and Rodrigue (2008) (Chilean data), and Vogel and Wagner (2010) (German data), all found a positive correlation between importing and productivity.

A natural question to ask is: how do we explain this observed positive correlation theoretically? In general, there are two possible answers. First, the productivity two sources: (1) an input quality effect–the imported inputs may have better quality, which can immediately increase the firm's productivity; (2) an input variety effect–the imported inputs increase the variety of inputs, which may immediately help increase productivity.

The dynamic effect represents the dynamic impact of current importing experience on firms' future productivity and profit. This could happen even when the firm discontinues importing in the future. The dynamic effect can be caused by several different channels. For example, importing firms usually receive technical support from their foreign suppliers, which directly increases their productivity. Importing firms also have more exposure to foreign knowledge and technology. This exposure can directly increase firm productivity, or help the firm to reduce the cost of innovation and/or increase its chances of succeeding in R&D, leading to more R&D investment and a higher productivity growth rate. Another possible channel for the dynamic effect is through an indirect network effect of importing. Importing helps importers to establish a larger foreign business network, which in turn helps them to increase export. The expansion of the market increases the return to R&D and thus enhances the productivity growth rate[2].

To achieve these objectives, this paper constructs a dynamic structural model to characterize firms' decisions to import intermediate inputs or to rely exclusively on domestically-supplied inputs, and to quantify both the static and dynamic effects of importing on firm-level productivity. In the model, firm productivity evolves endogenously. The productivity, along with other factors, determines firms' importing decisions, which in turn has a dynamic effect on the future productivity of the importing firms. The model provides an approach to simulating the long-term impact of import expansion on firm productivity. As part of the model I estimate the dynamic decision rule for the plant's optimal importing decisions which depends on the expected future profits and the current fixed or sunk costs of importing.

I estimate the dynamic model structurally using a plant-level data set from Colombia. I find that more productive firms are more likely to import and that the gains from importing are large. The counterfactual analysis shows that the total gains from importing are mainly due to the dynamic effect, which increases firm value by enhancing future productivity. This means that importing is important mostly because it generates higher productivity growth in the long run. Meanwhile, the static effect has a positive and significant effect on firm value. As the static effect mainly consititutes the quality and variety effects, this finding provides some evidence on the "Quality and

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[2] To study the indirect network effect of importing, a complete model including import, export and R&D decisions is called for.

Variety Assumption" mentioned above, which are commonly assumed in the literature. The parameterization of the model futher allows me to compute the quality effect and the (potential) variety effect separately. The empirical results show that the static effect is mainly due to the variety effect in all industries examined. These findings have important policy implications. For example, they imply that, when evaluating considers firms' optimal importing decision, which affects the estimated total gains from importing. Second, my paper incorporates both the static "quality and varieity effeccts" and the dynamic productivity effect of importing in one unified framework, so I can evaluate the relative importance of different sources of gains from importing in terms of increased firm profit. Moreover, the structural model in my paper allows me to use counterfactual analysis to evalutate the effects of different policy changes on firms' profitability and importing dynamics.

The remainder of this paper is organized as follows. Section 2 describes some basic facts in the Colombian data, which forms the basis for the theoretical model. Section 3 establishes a simple theoretical model to characterize firms' dynamic importing decisions. Section 4 describes the empirical model and estimation strategy. Section 5 reports the estimation results, and section 6 performs robustness checks for the esti-

934 to 11,316 for each industry.

I start with a brief description of several stylized facts observed in the data, which are the basis for the theoretical model in the following section.

Fact one: within each industry some plants purchase imported inputs while others do not. When looking at the plant-level importing status, we can see that, within each industry, some plants purchase imported inputs while others do not. Table 1 shows the number and percentage of plants for each industry which ever imported inputs during the years 1977-1989. I report the total number of plants ever observed in the data in column 3, the number of plants importing at least once during the data period in column 4, and the percentage of importers in column 5. Note that each plant is counted only once, even if it is observed or imported in multiple years. About 18.9% of all the plants had importing experience in the six industries during the sample years, while the percentage varies significantly across industries, from 4.6% in clothing industry to as high as 77.2% in pharmaceuticals industry. Moreover, the last column reports the value share of the imported material in total material used. On average, about 28% of materials used in the six industries are imported. This indicates that import should not be ignored in analyzing firm behavior. This observation raises the question: why do some plants purchase imported inputs while others in the same industry do not? This cannot be explained by the classic comparative advantage. Instead, plant-level heterogeneity must be introduced to account for the within-industry importing diversity.

Table 1: Number and Percentage of Importers: 1977-1989

SIC	Industry Name	#Plants	#Importers	%Importers	Share imported
3511	Basic Ind Chemicals	164	80	0.4878	0.1804
3522	Pharmaceuticals	232	179	0.7716	0.6216
3560	Plastics	747	291	0.3896	0.2788
3240	Leather Shoes	769	81	0.1053	0.0631
3420	Printing&Publishing	933	278	0.2980	0.3739
3220	Clothing	2613	121	0.0463	0.0410
	All six Industries	5458	1030	0.1887	0.2842

Notes: "Share imported" is defined as the value share of the imported material in the total value of material used.

Fact two: turnover in importing status. If we look further into the data, we can see that each year some plants begin and some plants stop importing intermediate inputs. Table 2 shows the turnover of importing status for all six industries in question. In this table, I do not count the firms that import at year t, but exit (stop operation) at year t + 1. The second to the last columns show the number of importers, the number of incumbent importers, the number of new importers, and the number of importers which quit importing at the end of the year, respectively. In 1978, for example, among the 324 importers, 297 were incumbent importers and 27 were new importers. At the end of 1978, 39 importers stopped importing. In the whole sample, about 9.86% of the importers annually were new to importing intermediate inputs, while about 12.63% stopped importing intermediate inputs at the end of the year. The significant turnover raises the second question: what are the determinants of the switch in the importing status? Again, plant-level heterogeneity within one industry must be introduced to

	Import	Not Import
Import	0.8737	

Kasahara and Lapham (2008) emphasize that in the presence of fixed costs of importing, only inherently highly productive plants import intermediate inputs. Andersson, Loof and Johansson (2008) point out that importing is associated with fixed costs that are sunk, as the import agreement is preceded by a search process for potential foreign suppliers, inspection of goods, negotiation, contract formulation etc. Castellani, Serti and Tomasi (2010) argue in a similar way, adding that there are sunk costs of importing due to the learning and acquisition of customs procedures. All of these papers emphasize the importance of a sunk startup cost of importing. With the existence of sunk startup costs, the importing status yesterday will affect the plant's choice today because it determines whether the plant needs to pay sunk startup coss5945(p)128qI1(s)-3

Table 4: Mean of Value Added Per Worker: Importers and Non-importers
(1,000 Colombia Peso, 1977)

SIC	Industry Name	Non-importers	Importers	All Firms
3511	Basic Ind Chemicals	333.47	442.22	380.29
3522	Pharmaceuticals	86.25	210.10	174.46
3560	Plastics	88.81	142.21	107.55
3240	Leather Shoes	84.41	113.07	86.65
3420	Printing&Publishing	77.87	126.03	89.57
3220	Clothing	91.67	99.61	91.87
	All six Industries	115.37	177.30	126.01

needed to tackle the cause and effect of importing.

The model is directly based on the stylized facts observed in the data. The bottom line is that the model needs to be able to explain these facts well. In particular, I model the turnover and persistence of importing status by fixed and sunk costs of importing randomly drawn from two different distributions. A current importer needs to pay a fixed cost to continue importing and a current non-importer needs to pay a sunk cost to start importing. The draw of sunk and fixed costs governs the turnover and persistence of importing status. The model also constructs a productivity measure for each plant. This allows us to compare the productivity of importers with that of non-importers and to characterize the endogenous productivity evolution path.

3 The Model

In this section, I introduce a dynamic model to characterize plants' decisions to import intermediate inputs or rely solely on domestically-supplied inputs[4], following the model developed by Aw, Roberts and Xu (2011), which was initially used to analyze firms' dynamic exporting decisions. An important feature of this model is that it considers both the determinants and effects of importing simultaneously. A new feature of the model in this paper is that it explicitly disentangles the static effect and the dynamic productivity effect of importing within one unified framework. The static effect can be further explained by an input quality effect and an input variety effect. These features allow us to investigate and quantify different sources of gains from importing.

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[4] The data do not link plants common to a firm, so we treat the plant as the decision-making unit. This is potentially problematic because, among multiplant firms, plant-level imports may partly respond to characteristics of other production units. However, the vast majority of Colombian firms operate a single plant.

3.1 Timing Story

Plants face monopolistic competition from other plants in the same industry, and the objective of each plant is to maximize its discounted value of lifetime profits. The timing of the information flow and decisions is as follows:

1. At the beginning of each date, each plant observes its own capital stock (K_{jt}), productivity shock (ω_{jt}) and its importing status for the current date (d_{jt}), as well as the aggregate demand and production shifter, $_{t}$. These variables are summarized in $s_{jt} = K_{jt}; \omega_{jt}; d_{jt}; {}_{t}$ which represents plant j's state at date t:

2. Each plant chooses the amount of labor, domestic input, and imported input to maximize its period profit. Then production and sales occur.

3. Each plant then observes the realization of its own sunk cost and fixed cost.

intermediate input M_{jt}: is the corresponding elasticity of substitution of domestic and imported inputs used to produce M_{jt}. In some sense, represents the input variety effect of imported products because it governs how easily the two inputs can be substituted in production. When is big, the two inputs are more substitutable, meaning that the input variety effect of the imported inputs is small. A represents the input quality effect of the imported inputs relative to domestic inputs, whose quality coefficient is normalized to one. When $A = 1$, imported inputs have no quality advantage over domestic inputs; when $A > 1$, imported inputs have relative quality advantage over domestic inputs; when $A < 1$, imported inputs have relative quality disadvantage.[5]

If plant j is an importer of intermediate inputs, then the logarithm production function is

$$\ln Q_{jt} = {}_{l} \ln L_{jt} + {}_{m} \frac{}{\quad 1} \ln \Big[M^{\frac{-1}{}}$$

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static variables and they depend on the beginning-of-date state $s_{jt} = K_{jt}; \omega_{jt}; d_{jt}; \ _{t}$. A plant's static optimization problem is to choose these static inputs to maximize its own period profit.

When $d_{jt} = 1$, plant j has access to the import market in the current period with no additional cost. Observing the input prices and the demand status, plant j's static problem is to choose the static inputs ($L_{jt}; M_{jtd}$ and M_{jtf}) and output price to maximize its period profit. Specifically, plant needs to choose static inputs ($L_{jt}; M_{jtd}$ and M_{jtf}) to minimize the cost of producing any amount of output; then, facing the plant level demand, the plant sets output price to maximize its period profit. Similarly, when $d_{jt} = 0$, the plant has no access to the import market at date t; it chooses labor and domestic inputs to minimize the cost of producing any amount of output, and then chooses output price to maximize its period profit.

investment associated with its importing status. d_{jt} is a discrete 0/1 variable identifying firm j's importing status at date t. If the firm imported at date t, then it will pay a fixed cost C^f_{jt} to continue importing at date $t + 1$. If the firm did not import at date t, then it will pay a sunk cost C^s_{jt} (very likely higher than fixed cost) to start importing.

Note that the value of investment is subsumed in the choice-specific value functions $V^1(s_{jt})$ and $V^0(s_{jt})$. To be more precise the choice specific value functions could be written as

$$\begin{aligned} V^1(s_{jt}) &= E_t V(s_{jt+1} \quad s_{it}; d_{jt+1} = 1) \\ V^0(s_{jt}) &= E_t V(s_{jt+1} \quad s_{it}; d_{jt+1} = 0) \end{aligned}$$

The expectation is taken over the stochastic evolution process of ω_{jt}, and the uncertainty of the demand shifter and input prices $(\;_t)$. More specifically, by expressing expectation in integral form, the choice-specific value functions are written as:

$$V^1(s_{jt}) = \max_{I_{jt}} \int\int V(s_{jt+1}; d_{jt+1} = 1) dF$$

exclusively using domestic inputs can help identify the share parameters $_l; \ _m; \ _k$ in the production function and the parameters associated with $!_{jt-1}$ in the productivity evolution process $g(\,;\,)$. On the other hand, usage of imported and domestic materials from importing plants provides additional information to help identify the quality parameter A, the elasticity of substitution , and the parameters associated with d_{jt-1} in the productivity evolution process $g(\,;\,)$. Usage of imported and domestic materials from importing plants also provides information about the share parameters $_l; \ _m; \ _k$ and $g(\,;\,)$, which can be used to improve the estimation efficiency.

Given the estimates for $_l$ and $_m$, the demand elasticity can be identified from the cost and revenue information. Finally, the distributions of sunk cost and fixed cost can be identified from plants' dynamic decisions on whether or not to import intermediate inputs. Specifically, the entry decisions of current non-importers provides direct information to identify the sunk cost distribution, and the exit decisions of current importers provides direct information to identify the fixed cost distribution.

The estimation algorithm is a three-stage procedure, combining the insights of Olley and Pakes (1996) and Das, Roberts and Tybout (2007).

Stage one: estimate production parameters $_l; \ _m; \ _k; A; \ $, using data on labor, capital, domestic and imported inputs and investment.

Stage two: given the estimates of $_l$ and $_m$, the demand elasticity is estimated from equation (4), using variable cost and revenue data. Then the profit functions can be derived from the estimate of the revenue function from equations (3) and (5).

Stage three: the sunk and fixed costs parameters are estimated from plants' decisions on whether to import intermediate inputs. More precisely, the cost parameters can be identified from the conditional choice probabilities (CCP) of that plants begin or stop importing intermediate inputs.

4.1 Stage One: Production Parameters: $_l; \ _m; \ _k; A; \ ; g; \ ^2_\varepsilon$

In order to increase estimator efficiency, I make use of the data on all plants (both importers and non-importers) to estimate the production parameters, although the identification of $_l; \ _m; \ _k$ does not rely on information about importers. Assuming $x = \ln X$ and making use of the importing status dummy d_{jt} for firm j at date t, equation (1) and (2) can be rewritten in one equation as:

$$q_{jt} = \ _l l_{jt} + \ _m \frac{}{\ -1} \ln \left[M_{jdt}^{\frac{-1}{}} + (AM_{jft})^{\frac{-1}{}} d_{jt} \right] + \ _k k_{jt} + !_{jt} + \ _{jt} \qquad (10)$$

This equation allows us to use data for all plants to estimate the production parameters. $!_{jt} + {}_{jt}$ constitutes the plant-level productivity, where only $!_{jt}$ is observed by the plant (but not by researchers), and ${}_{jt}$ is not observed by the plant or researchers. Under the timing assumption above, d_{jt} is uncorrelated with ${}_{jt}$ because the i.i.d productivity shock ${}_{jt}$ happens after the choice of d_{jt}: However, it is a well known fact that the direct OLS estimator from the above equation is subject to an endogeneity problem because the labor and material inputs choices are dependent on $!_{jt}$. In addition, the importing status d_{jt} is also correlated with $!_{jt}$ because productivity is a Markov process. This correlation further aggravates the endogeneity problem.

To ensure a consistent estimator, the above endogeneity problem must first be resolved. In general, plants' investment contains information about the unobserved productivity $!_{jt}$. Under the timing assumption in this paper, investment is a function of current capital stock, productivity, and the chosen importing status for the future, i.e. $i_{jt} = i_t(!_{jt}; k_{jt}; d_{jt+1})$. We can utilize the insights of Olley and Pakes (1996) to recover the unobserved productivity $!_{jt}$ from investment, $!_{jt} = !_t(i_{jt}; k_{jt}; d_{jt+1})$; under the usual monotonicity assumption.[7]

$$
\begin{aligned}
q_{jt} &= {}_l l_{jt} + \frac{m}{1} \ln \left[M_{jdt}^{\frac{-1}{}} + (AM_{jft})^{\frac{-1}{}} d_{jt} \right] + {}_k k_{jt} \\
&\quad + !_t(i_{jt}; k_{jt}; d_{jt+1}) + {}_{jt} \\
&= {}_l l_{jt} + {}_m \frac{}{1} \ln \left[M_{jdt}^{\frac{-1}{}} + (AM_{jft})^{\frac{-1}{}} d_{jt} \right] + (i_{jt}; k_{jt}; d_{jt+1}) + {}_{jt}
\end{aligned}
\qquad (11)
$$

where $(i_{jt}; k_{jt}; d_{jt+1})$ captures the combined effect of capital and observed productivity on production. The static input shares $\widehat{}_l$ and $\widehat{}_m$, the quality parameter $\widehat{A}$;the variety parameter $\widehat{}$; and the $(\,)$ function can be estimated from equation (11) semiparametrically. This estimation is consistent since $l_{jt}; M_{jdt}; M_{jft}; i_{jt}; k_{jt}$ and d_{jft}

$g(\ ;\ )$ function can be retrieved from data on $\widehat{\ }_{jt}; \widehat{\ }_{jt-1}; k_{jt-1};$ and d_{jt-1}. In this paper, the $g(\ ;\ )$ function is parameterized simply by $g(!_{jt-1}; d_{jt-1}) = g_0 + g_! !_{jt-1} + g_d d_{jt-1}$. $g_!$ represents the marginal effect of current productivity on future productivity, and g_d represents the dynamic effect of importing on productivity associated with importing. We are especially interested in g_d and we expect it to be positive based on our model.

Based on the estimate of $\ _k$, we can construct a pseudo sample of productivity for each plant each year

$$\widehat{!}_{jt} = \widehat{\ }_{jt} \quad \widehat{\ }_k k_{jt} \tag{13}$$

4.2 Stage Two: Demand Elasticity and Profit Function

Under the structural assumptions of the production function and the demand function, we can characterize plants' revenue function and profit function using the structural parameters. Plants' static decisions lead to a simple relationship between the total variable cost and the revenue, as shown in equation (4). The total variable cost is defined as the total expenditure on domestic inputs, imported inputs and labor and is observed in the data. By introducing the usual optimization error and measurement error, equation (4) can be written in the following estimable form:

$$C_{jt} = \frac{1+}{\ }(\ _l + \ _m) R_{jt} + \ _{jt} \tag{14}$$

The error term $\ _{jt}$ is assumed to be i.i.d across plants and across time. As in Das, Roberts and Tybout (2007) and Aw, Roberts and Xu (2010), we can estimate the demand elasticity from equation (14), given that $\ _l$ and $\ _m$ have been estimated above.

Construct the profit function. With all the production parameters and demand parameters on hand, we can compute $r_k; r_w;$ and r_d in equation (3). To derive the revenue function, we still need to estimate the coefficients of the time dummies.

Denote $\tilde{r}_{jt} = \log(R_{jt}) \quad (r_w \widehat{!}_{jt} + r_k k_{jt} + r_d d_{jt})$: The coefficients of time dummies can be estimated from the following equation:

$$\tilde{r}_{jt} = \underset{t}{\text{[redacted]}}\, e_{jt} \tag{15}$$

where the error term e_{jt} comes from an i.i.d measurement error or any form of optimization error which affects plant revenue.

The revenue function is then $R_{jt} = \exp(\;_t\; r_k k_{jt} + r_w !_{jt} + r_d d_{jt})$: The profit, as a fixed share of the revenue function from equation (5), is a function of $(\;_t; w_{jt}; k_{jt}; d_{jt})$;

$$_{jt} = \left[1 \quad \frac{1+}{\quad}(\;_1 + \;_2)\right] \exp\left(\begin{array}{l} \;_t\; r_k k_{jt} \\ + r_w !_{jt} + r_d d_{jt} \end{array}\right) \qquad (16)$$

where all unknown parameters are replaced with their estimates. This profit function is useful when computing the value functions of plants in the next subsection.

4.3 Stage Three: Sunk/Fixed Cost Parameters

The distributions of sunk cost and fixed cost, in principle, can be identified from plants' dynamic discrete decisions of importing status. A Maximum Likelihood Estimator

A()$8(1)8()oe2323(p)11(r)) ax35389117(354o)11(n)11()s4[(e)228(be)317()6()11(119558(23)5()1235661()A

The probability of observing the importing status of all plants in the data set is

$$L = \prod_{j=1:N} L_j = \prod_{j=1:N} \prod_{t=1:T} L_{jt} \tag{19}$$

Given the shape of the sunk and fixed cost distributions, parameters in F^s and F^f could be estimated by MLE. In this paper, I assume that sunk costs and fixed costs are i.i.d drawn from two different exponential distributions, $C^s_{jt} \sim \exp(cs)$ and $C^f_{jt} \sim \exp(cf)$[8]. Then the distribution parameters $(cs; cf)$ can be estimated by MLE. The major problem associated with this estimation is that $V^1(s_{jt})$ and $V^0(s_{jt})$ need to be constructed for each parameter evaluated from the plants' dynamic optimization problem. The computational algorithm to solve for $V^1(s_{jt})$ and $V^0(s_{jt})$ is in the Appendix 1.

5 Estimation Results

In this section, I will first report and briefly discuss the estimation results of the V_{jt}

and ownership is a dummy variable which equals 1 if the plant is a public corporation and 0 otherwise.

Industry	B.I.Chemicals	Pharmaceuticals	Plastics	L.Shoes	Print&Pub	Clothing
α_l	0.4260 (0.0024)	0.3466 (0.0026)	0.3034 (0.0013)	0.4736 (0.0012)	0.4956 (0.0006)	0.5510 (0.0003)
α_m	0.3420 (0.0011)	0.5774 (0.0019)	0.6253 (0.0006)	0.4015 (0.0006)	0.4283 (0.0003)	0.3666 (0.0001)
A	1.0006 (0.4611)	0.9255 (0.0828)	1.0903 (0.0233)	1.0001 (0.5430)	0.9317 (0.0359)	0.9995 (0.1013)
θ	5.0069 (0.1287)	9.6690 (0.0897)	21.5337 (0.0577)	2.7108 (0.3821)	22.3194 (0.0479)	9.2140 (0.5232)
age	0.0469 (0.0031)	0.0361 (0.0018)	0.0294 (0.0010)	0.0077 (0.0010)	-0.0415 (0.0003)	0.0129 (0.0003)
ownership49	02.653.492 2.393 TD[	owner22155(492 2.6530 TD	[261)]TJ7.807 0 TD	[0.)4713283)]TJ7.80		
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In Table 5, $_l$ and $_m$ represent the labor share and material share in the production function, respectively. The magnitude for all parameters are reasonable. We are particularly interested in the quality parameter (A) and elasticity of substitution ( ). It is interesting that the estimated input quality parameter A is very close to 1. In four out of the six industries, the input quality parameter A is not statistically different from 1; in printing and publishing industry, A is statistically smaller than 1. This means that the imported intermediate inputs have a very small quality advantage or even a quality disadvantage over domestic inputs in these five industries. In the plastics industry, A is larger than 1 statistically, indicating that imported intermediate inputs have quality advantage in this industry. However, we must be cautious about interpreting this result. As we estimate the model using the value of imported and domestic inputs, the estimated quality parameter (A) contains both the real input quality effect and the price difference between domestic and imported inputs. Because the prices for imported inputs are usually higher than those of domestic inputs for developing countries like Colombia, $A < 1$ implies that the imported inputs have a quality disadvantage over domestic inputs after taking the price difference into consideration. $A = 1$ implies that imported inputs have no quality advantage over domestic inputs after considering the price difference[10]. To separate the real input quality effect

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[10] This probably suggests that price, in some sense, is a good proxy for inestn

from the price difference, we need additional information on prices of both imported and domestic inputs. Unfortunately, these data are not available in the Colombian data; therefore, in the paper, the parameter A is interpreted as containing both the input input quality effect and the price difference between imported and domestic inputs.

Another interesting finding is that the elasticity of substitution between the imported and domestic inputs is significantly higher than one, but still not very large. This implies that the input variety effect of imported inputs does exist, which is consistent with the argument in Goldberg, Khandelwal, Pavcnik and Topalova (2009; 2010). The estimates of A and together imply that when the input quality effect is small or even negative, plants may still want to import inputs in order to take advantage of the the input variety effect, along with other possible gains. I will elaborate on this point in more detail in the subsequent sections.

Table 6: Parameters in Productivity Evolution and Capital Share (NLLS)

Industry	Chemicals	Pharmaceuticals	Plastics	L.Shoes	Print&Pub	Clothing
Panel A: Basic Model						
$_k$	0.1111	0.0992	0.0586	0.0917	0.1083	0.0580
	(0.0065)	(0.0027)	(0.0013)	(0.0023)	(0.0002)	(0.0005)
g_0	0.3954	0.1282	0.2527	0.4600	0.6003	0.3501
	(0.5068)	(0.4933)	(0.4217)	(1.0083)	(0.0302)	(0.2000)
g	0.9032	0.9224	0.8421	0.7259	0.3906	0.7753
	(0.0324)	(0.1773)	(0.1754)	(0.2895)	(0.0153)	(0.0719)
g_d	0.0148	0.0092	0.0122	0.0213	0.0568	0.0050
	(0.0061)	(0.0067)	(0.0036)	(0.0141)	(0.0012)	(0.0047)
	0.0762	0.0310	0.0329	0.0397	0.0682	0.0329
Panel B: Control for Export						
$_k$	0.1247	0.0723	0.0537	0.0854	0.0911	0.0545
	(0.0096)	(0.0036)	(0.0014)	(0.0020)	(0.0002)	(0.0007)
g_0	0.5583	0.2743	0.3085	0.5481	0.6390	0.4593
	(0.9385)	(0.9876)	(0.5828)	(0.9686)	(0.0320)	(0.3650)
g	0.8240	0.7719	0.7919	0.6954	0.3154	0.7202
	(0.1169)	(0.5460)	(0.2666)	(0.2548)	(0.0128)	(0.1111)
g_d	0.0150	0.0213	0.0115	0.0205	0.0277	0.0026
	(0.0072)	(0.0128)	(0.0035)	(0.0157)	(0.0012)	(0.0070)
g_e	0.0172	-0.0005	0.0066	0.0262	0.0036	0.0012
	(0.0085)	(0.0001)	(0.0040)	(0.0115)	(0.0000)	(0.0000)
	0.0994	0.0621	0.0402	0.0588	0.1307	0.0472

Notes: Standard errors in parentheses.

The estimates of capital elasticity and the productivity evolution process are recorded in Table 6. The estimation is based on equation (12). I estimate both the base model and an extension in which I control for exporting in the productivity evolution process. The results are reported respectively in panels A and B in Table 6. $_k$ is the capital elasticity and the g parameters characterize the productivity evolution process. g_w is the effect of today's productivity (w_{jt}) on tomorrow's productivity (w_{jt+1}

the model section that importing has a positive dynamic effect on productivity. We will compute the gains of firm value from this dynamic effect in section 8.

5.2 Demand and Revenue Function

Under the structural assumptions of production and demand, plants' revenue and profit functions can be constructed structurally. The revenue function parameters calculated from equation (3) and the demand parameters estimated from equation (14) are reported in panel A and panel C, respectively, in Table 7.[11] I also compute the implied revenue elasticities with respect to productivity, capital and importing participation, as reported in panel B in Table 7.

Table 7: Demand Elasticity and Constructed Revenue Function

Industry	B.I.Chemicals	Pharmaceuticals	Plastics	L.Shoes	Print&Pub	Clothing
Panel A: Revenue Function						
r_ω	0.7920	1.7661	2.0021	1.8300	1.6968	1.8764
r_k	0.1286	0.1382	0.1157	0.1785	0.1673	0.1113
r_d	0.0611	0.0526	0.1268	0.3402	0.0074	0.0630
r_0	12.9609	12.9649	12.1032	10.0024	11.7837	11.1879
Panel B: Implied Revenue Elasticity						
productivity	2.5328	2.2258	3.2128	3.6272	1.8669	3.4363
capital	0.1286	0.1382	0.1157	0.1785	0.1673	0.1113
importing	0.0630	0.0540	0.1352	0.4052	0.0074	0.0651
Panel C: Demand Elasticity						
η	-2.3554	-3.2365	-3.5475	-3.8308	-3.1350	-3.4588
	(0.0127)	(0.0064)	(0.0024)	(0.0033)	(0.0029)	(0.0022)

Notes: (1) the revenue parameters are constructed from parameters estimated in stage 1. Therefore I do not report the standard deviations for revenue parameters in this table. (2) The standard deviation for demand elascitity is reported in parentheses. (3) Revenue elasticity of productivity = (exp(0.01*productivity*r_ω)-1)*100. Productivity is the chosen industry mean. (4) Revenue elasticity of capital = r_k. (5) The third row in Panel B represents the percentage gain of revenue when a plant imports. It is defined as = exp(rd)-1. Strictly speaking, it is not a concept of elasticity. (6) Standard deviations for demand elasticity are in parentheses.

The estimated demand elasticity is significantly larger than 1. This is reasonable because the market power in the monopolistic competition market allows plants to

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[11] The constant r_0 is the average of time dummies estimated in equation (15). I do this in order to simplify the dynamic estimation.

charge a markup price. $r_!$ measures the effect of productivity on revenue and is positive. In the basic industrial chemicals industry, for example, $r_! = 0:7920$ means that a 1% increase in productivity increases revenue by about 2:53%. r_k is the revenue elasticity of capital stock. Other things equal, $r_k = 0:1286$ in the basic industrial chemicals industry means that a 1% increase in capital stock increases revenue by about 0:1286%. The most interesting finding here is the positive effect of importing on revenue, $r_d > 0$. The use of imported inputs immediately increases current period revenue. Because the quality and input variety effects are static, this finding implies that the total quality and input variety effect is positive. We will further explore this point using a counterfactual analysis in the subsequent section. The estimates for r_d imply that importing can increase revenue by about 0:74% to 40:52%[12] for the six industries under investigation.

5.3 Fixed and Sunk Cost

As noted above, the distribution parameters of the fixed and sunk costs can be estimated with Maximum Likelihood, using plants' dynamic decisions on whether or not to import inputs.

5.3.1 Distribution of the Sunk and Fixed Costs

In the estimation, to limit the range of the parameters more efficiently, we redefine $_s = \log(cs)$; $_f = \log(cf)$ and estimate the parameters $_s$ and $_s$ in the program. The sunk and fixed cost distributional parameters, cs and cf, can be retrieved from $_s$ and $_s$ in a straightforward way.

The estimation results for $_s$ and $_f$ are reported in Table 8. The estimates are all statistically significant. I also report the mean of the fixed cost and sunk cost in the second half of Table 8. Two observations are worthy of specific discussion. First, the estimated sunk cost is always larger than the fixed cost in all of the industries estimated. In all six industries, the estimated mean of sunk cost is over 15 times as large as that of the fixed cost. The second interesting result is that both the fixed cost and the sunk cost are very large. The mean of the sunk cost goes from about 15 to over 350 million Colombian Pesos. This accounts for about 8:78%-63:70% of the annual average profits in these industries. At the same time, the mean fixed cost ranges from 0.3616 to 4.1853 million Colombian Pesos, accounting for a low 5:30% of

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[12] Current importing status d_{jt} increases revenue by $\exp(r_d)\ \ 1$.

plants' annual profits in the pharmaceuticals industry to as high as 21:73% of annual profits in the plastics industry. The significant magnitude means that sunk and fixed costs are not negligible in terms of plants' import participation decisions.

The fact that the sunk cost is much larger than the fixed cost is consistent with our model conjecture that sunk cost is a critical factor that generates the observed persistence of plants' importing status. If a firm is importing today, to continue importing it only needs to pay a fixed cost, which is on average much smaller than the sunk cost. This explains why compared to non-importers, importers today are more likely to import tomorrow. Also, the large sunk costs prevent non-importers from starting to import. Only those non-importers who have a very small draw of the sunk cost start importing. This explains that why only a few non-importers start importing at each period.

There are several possible reasons for the high estimated sunk costs. As Andersson et al. (2008) point out, importing is associated with fixed costs that are sunk, because import agreement is preceded by a search process for potential foreign suppliers, inspection of goods, testing whether the good matches current production streamline, negotiation, contract formulation etc. These costs may be very high. Also, first time importers need to spend both human and monetary resources to learn customs procedures. This again increases the sunk cost.

As for the fixed cost, continuing importers do not need to pay costs to master the customs procedures, and they have more experience in importing. So we can expect that fixed cost will be much lower than sunk cost. However, fixed costs could still be very high due to several reasons. First, plants need to maintain the business relationship via different forms, which may be costly. Second, although first-time importers have inspected the goods, they still need to inspect goods each time they continue importing to make sure that the international exporters deliver the appropriate materials. Third, because shipping is more costly and risky in international trade, plants need to spend extra money to buy shipping and delivery insurance. Moreover, trade friction is common and frequent in international trade and importers are usually the side that suffers to losses. In these cases, they need to spend time and resources on, for example, filing lawsuits in order to fight for their rights. These costs may be very high.

In addition, there were substantial trade barriers that significantly affected importing during the data period in Colombia, which drove up the sunk and fixed importing costs. As documented by Roberts and Tybout (1996), although Colombia had quite an open trade policy in the 1970s, it totally reversed its trade policy to slow import liberalization starting in 1981. In 1981, only 36% of commodities could be freely imported, compared to 69% in 1980 before the policy change. The number of commodities subject to quantitative restrictions continued to rise through 1984. By that time, only 0.5% of all products were classified in the free import category, 83% required licenses, and 16.5% were completely prohibited. As a result of these import restrictions, plants who wanted to import needed to spend extra time and resources (both monetary and non-monetary) to lobby importing licenses. Because of the quota, bribery was very common, which may have greatly increased both the sunk and fixed costs of importing. All of the quota-induced costs related to importing are picked up by the fixed/sunk costs estimated in the model and can contribute to the large estimated sunk/fixed costs.

6 Robustness Check

Our goal is to accurately measure the effects of importing intermediate materials on productivity and firm value. As such, it is important to have confidence that the estimation results from the model are robust and not sensitive to particular underlying assumptions in the model. In particular, we need to make sure that the estimated effect of importing is not actually the effect of exporting, considering the possible correlation between the two activities. To remove the impact of exporting on the estimation results, I estimate the model for non-exporters only and compare the results with those from the whole sample. As the firm value is defined as the discounted present value of the future profit flow, in order to check the effect of importing on firm value, it is enough to check the effect of importing on revenue and productivity.

Tables A2 to A4 in Appendix 3 show that the non-exporter subsample yields qual-

give a parametric form of the threshold costs which can be used to analyze plants' importing decisions.[13]

Figure 1 and Figure 2 report the threshold costs and productivity of importing for the basic industrial chemical industry as an example.[14] The threshold costs are determined by equations (20) and (21). Figure 1 shows the thresholds of productivity and sunk cost involved in current non-importers' decision of whether or not to start importing, for three different capr nal levels. The hor28(nz)9(o)11(n)38(t)9(a)10(l)-377(a)10(productivity and the vertical ax28(ns)-315(r)11(e)9(p)11(r)11(e)9(s)8(e)9(n)38(t)9ns the sunk cost i bian Pesos. The solid line, the dashed line and the dot-dashed line each represent the thresholds when capitalns chosen to be the median, the 75th quantile and the 25th quantile in the industry respectively. For a given capital level, firm below the associated threshold line have higher productivity/lower draw of sunk cost and will start importing. Firms above the threshold have lower productivity/higher draw of sunk cost and will not start importing. Take the solid line for example, firm in the shaded area do not importing and firms in the unshaded area start importing. The positive slope of the threshold implie that, all other things equal, as non-importers become more productive, they are more likely to start importing intermediate inputs. It clearly shows the self-selection of firms to importing inputs: firm that are more productive and that draws lower sunk costs are more likely to starting importing.

Figure 1 also shows that, given productivity, larger firms are more likely to import intermdiate inputs. Ans capital increases from the 25th quantile to the median to the 75th quantle, the threshold involved in the decision to start importing shifts up in figure 1. Th28(ns)-301(m)17neans plants are mre likely to start importing when they are larger in terms of capital level.

Similarly, Figure 2 shows the thresholds of productivity and fixed cost of stopring importing oo7(t)9(h)11(e)o7(t)9(h)11(e6(r)11(m)17ns)-401q94hm(m)17(0)6(m(m)17(0)6(m(m)17(0)

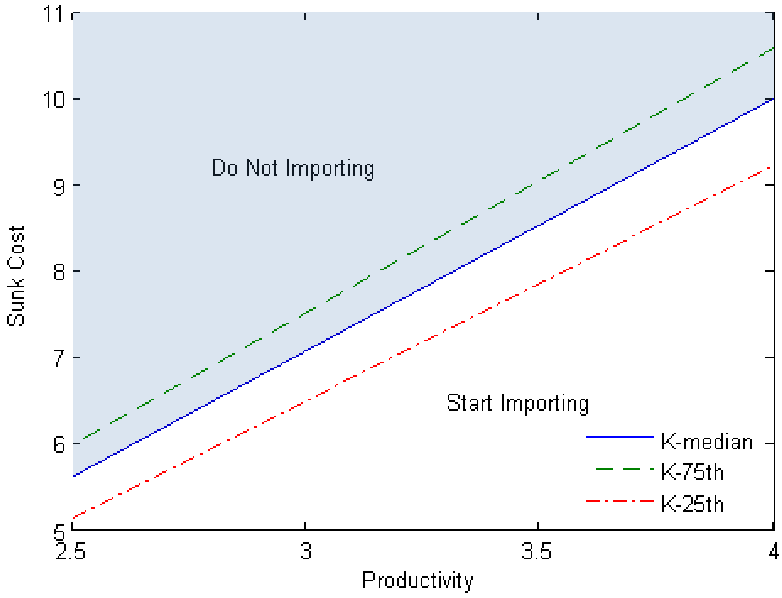

Figure 1: Thresholds for Current Non-Importing Firms to Start Importing: Sunk Costs, Productivity, and Firm Size.

Notes: The solid line represents the threshold of starting importing for a current non-importing firm, which has a median industry capital. Given the capital, firms with a combination of productivity and sunk costs above this line (in the shaded area) do not start importing and firms below this line (in the unshaded area) start importing. The upward slope of the threshold line suggests that as productivity goes up, firms are more likely to start importing. The dashed line and the dot-dashed line represent the thresholds of starting importing for two hypothetical firms, which are assumed to have the 75th and the 25th quantile of industry capital stock, respectively. The comparison of the three thresholds implies that larger firms (measured by capital stock) are more likely to start importing, all other things equal.

to continue importing shifts up. This implies that, all other things equal, larger importers (measured by capital level) are more likely to continue importing. The finding in figure to clearly shows that firms that are larger and more productive are more likely to continue importing.

The same results are also found in the other industries in our investigation. I omit the results in the interest of space. In general, self selection of plants into the importing market is clear: current non-importers are more likely to start importing if they are larger, more productive, and/or have drawn a low sunk costs of importing; current importers are also more likely to continue importing if they are larger, more productive and/or have drawn a low fixed cost.

8 Gains from Importing Intermediate Inputs

In this section, I will quantify the gains to plants from importing intermediate inputs and decompose them into a static effect and a dynamic effect.

8.1 Gains from Importing

The total gain to plants from importing inputs is defined as the net gain of plant value from importing, which equals the plant's value when it has access to the foreign import market minus the value of the same plant in an autarky economy. An autarky refers to an economy in which none of the plants have access to a foreign market. The autarky plant value can be easily derived by solving the following standard investment model

$$\begin{aligned} V(\omega_{jt};K_{jt}) &= {}^{0}_{(s_{jt})} + \max_{i_{jt}} E_{\omega_{jt+1}} V(\omega_{jt+1};K_{jt+1}) \\ s.t.\ \ K_{jt+1} &= i_{jt} + (1 \quad {}_{k})K_{jt-1} \\ \omega_{jt} &= E(\omega_{jt} \quad \omega_{jt-1};d_{jt-1} = 0) + \varepsilon_{jt} \end{aligned} \tag{22}$$

It is straightforward that the solution to the autarky model is equivalent to our full model with infinite fixed and sunk costs for importing. Using this idea, we can easily calculate the autarky plant value from our full model by letting the sunk and fixed costs be infinite. Total gains from importing intermediate inputs can be calculated as

$$\text{Total gain} = V(s_{jt}) \quad V(\omega_{jt};K_{jt}) \tag{23}$$

To illustrate the gains from importing, I compute the plant values in the autarky economy and the full model for an average plant. The average plant is defined as a hypothetical plant whose capital and productivity level equals the mean of the industry's. Table 9 reports the gain to plants from importing inputs for all six industries, with the state variables (ω_{jt}, k_{jt}) chosen to be the industry means for each industry. I compute the loss of firm value if a firm is prohibited from importing. Table 9 shows that the total gains from importing inputs to the plant are substantial, accounting for $0.87\% - 22.28\%$ of plant value. The result also shows that gains from importing in more technologically advanced industries, the pharmaceuticals industry for example, are relatively larger. At the same time, in traditional industries like the clothing industry, the gains from importing inputs are very small. This is reasonable since, intuitively, firms in traditional industries cannot learn much from abroad, while firms the autarky economy ($V(\omega_{jt}; K_{jt})$):

$$\text{Static Effect} = V(s_{jt} \mid g_d = 0) - V(\omega_{jt}; K_{jt}) \tag{25}$$

I compute the value of $V(s_{jt} \mid g_d = 0)$ by computing the full model under the restriction $V(s_{jt} \mid g_d = 0)$.[15] Then I compute the dynamic effect and static effect using equations (24) and (25). By definition, the sum of dynamic effect and static effect equals the total gains from importing.

Table 10 reports the static gains and dynamic gains from importing for average plants of each industry, which are defined as a hypothetical plant whose capital and productivity level equals the mean of the industry's. I find that the dynamic effect is large, accounting for over 86% of the total gains in all six industries. This implies that importing is important mostly because it generates higher productivity growth in the long run. This is consistent with the findings in Table 6. In the productivity evolution process, importing experience has a positive and significant impact on future productivity. This result indicates that when considering gains from importing, we have to pay special attention to the associated dynamic effect.

The the static effect is always positive in all industries, accounting for 0.74% - 13.96% of the total gains from importing in the six industries. This positive static effect, which mainly consitutes the input quality and variety effects, provides some evidence for the popularly used "Quality and Variety Effects Assumption" of importing in the literature. However, the comparison of the magnitudes of the dynamic effect and static effect suggests that the quality and variety effects of importing, although positive, are not the major sources of gains from importing; it is the dynamic productivity effect which makes importing so profitable.

The static effect contains the input quality effect and input variety effect. A nice feature of the model parameterization is that it provides a way to evaluate the input quality effect. I define the input quality effect as the difference between $V(s_{jt})$ in the full model and $V(s_{jt} \mid A = 1)$, which is the firm value when the quality effect is shut down. I compute $V(s_{jt} \mid A = 1)$ by solving the full model with under the restriction $A = 1$. Then the input quality effect of importing is computed as:

$$\text{Input Quality Effect} = V(s_{jt}) - V(s_{jt} \mid A = 1) \tag{26}$$

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[15] Note that the autarky value $V(\omega_{jt}, K_{jt})$ is already derived when calculating the total gains from importing in the previous subsection.

Table 10: Dynamic and Static Effects from Importing (in millions of 1977 Pesos)

Industry Name	Dynamic Effect		Static Effect		Total E.
	Value	Pctg.	Value	Pctg.	
Basic Ind Chemicals	58.9987	96.37%	61.2299	3.63%	61.2206
Pharmaceuticals	102.8105	97.91%	2.1996	2.09%	105.0101
Plastics	51.6595	97.00%	1.5993	3.00%	53.2589
Leather Shoes	5.0599	86.66%	0.7789	13.34%	5.8388
Printing&Publishing	4.2915	99.26%	0.0322	0.74%	4.3237
Clothing	0.6800	86.07%	0.1101	13.93%	0.7900

Notes: "Pctg." refers to percentage, and defined as the share of gain from each effect in the total gain from importing.

The residual, defined as:

$$\text{Residual} = \text{Static Effect} - \text{Input Quality Effect} \tag{27}$$

contains the input variety effect, along with the computational errors. I call this residual, although not very rigorously, input variety effect in the rest of this paper.

Table 11 reports the components of static effect for average plants, which are similarly defined as hypothetical plants with their capital and productivity equal their industry median. The first column of results reprents the static effect measured by firm value, and the third and fifth columns represent the that of quality effect and variety effect. The second, fourth, and sixth columns represent the corresponding share of each effect in the total gains from importing. Two interesting results are worth noting. First, the input quality effect, in general, is small or even negative. In the basic industrial chemicals industry, the plastics industry and the the leather shoes industry, input

Table 11: Components of Static Effect (in millions of 1977 Pesos)

Industry Name	Static Effect (total)		Quality Effect		Variety Effect	
	Value	Pctg.	Value	Pctg.	Value	Pctg.
Basic Ind Chemicals	61.2299	3.63%	0.0093	0.02%	61.2205	3.61%
Pharmaceuticals	2.1996	2.09%	-3.2854	-3.13%	5.4849	5.22%
Plastics	1.5993	3.00%	0.7149	1.34%	0.8844	1.66%
Leather Shoes	0.7789	13.34%	0.0003	0.10%	0.7785	13.33%
Printing&Publishing	0.0322	0.74%	-0.6404	-14.81%	0.6726	15.56%
Clothing	0.1101	13.93%	-0.0008	-0.10%	0.1108	14.03%

Notes: "Pctg." refers to percentage, and is defined as the share of gain from each effect in the total gain from importing.

inputs.[17] Second, the input variety effect is substantial in all six industries, ranging from 1.66% in the plastics industry to 15.56% in the printing and publishing industry. This finding implies that importing firms do benefit substantially from more variety of inputs due to importing.

Our estimation results have important implications for trade policy, especially for developing countries. As we know, the technology used in developing countries is relatively old and inefficient. However, they usually halt participation in international trade activity. The large gain from importing intermediate inputs suggests that the developing countries may benefit from opening their markets to more active importing.

Also, as the cost/risk of a policy change is usually short-term, the government faces an intertemporal trade-off between the long-term gain and short-term risk/cost of a trade policy change. The decomposition results show that the static gain from importing is small but the dynamic gain is large. This suggests that even when the static gain from importing (through input quality effect and input variety effect) is smaller than the risk/cost of trade, the government may still find it beneficial to encourage importing if the dynamic gain is large enough because importing can improve future productivity in the long run.

9 Conclusion

This paper constructs a dynamic structural model to characterize firms' decisions on whether to import intermediate inputs or rely exclusively on domestically-supplied

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[17] If indeed there is significant real quality difference between domestic and imported inputs, our result of a "close-to-one" parameter A potentially supports the assumption in Kugler, Maurice and Verhoogen (2009, 2012) that price is a good proxy for quality.

inputs and to quantify the gains from importing on firm level profit and productivity. The model allows me to decompose the gains from importing into two components: a static effect and a dynamic effect.

Empirical results from Colombian plant-level data show that self selection into importing intermediate inputs is important. That is, more productive and larger plants tend to import intermediate inputs from abroad. The empirical results also show that gains to plants from importing inputs is substantial, accounting for about 0:87% 22:28% of plants' continuation value in the six industries in examination.

A more interesting finding is that the dynamic effect is the most important source of gain from importing intermediate inputs. It accounts for about 90% of the total gains from importing. This implies that importing intermediate inputs is important mainly because it can endogenously improve the importers' future productivity in the long term endogenously. According to the estimates, the dynamic effect increases the importers' annual productivity growth by 1:47% on average. These findings have important policy implications. For example, they imply that when evaluating an import policy, the government should carefully evaluate the long-term gain from importing against the short-term cost.

As the static effect mainly constitutes the input quality and variety effect of importing, the positve static effect of importing is consistent with the popularly accepted "Quality and Input Variety Effect Assumption". However, the static effect is fairly small and is mainly due to the input variety effect. The input quality effect combined with the price difference, on the other hand, is trivial or even negative.

There are also some interesting topics for future research. First, in this paper, I consider the endogenous choice of importing but keep the export counterpart as an exogenous control, in order to focus on the import side. Considering the correlation between export (demand side) and import (production side), it is a good idea to incorporate both of them in the model and study their endogenous interaction with one another and their effect on productivity dynamics and industrial structure. This will give a more complete description of the dynamics of plants' importing and exporting decisions. Another interesting topic is the relationship between importing (and exporting) and R&D. With R&D data, we can explicitly investigate the channels through which imports and exports improve productivity. I leave these topics for future research.

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Appendix

Appendix 1: Algorithm to Evaluate $V^1(s_{jt})$ and $V^0(s_{jt})$

All the static parameters have been estimated from stage 1 and stage 2. Therefore the only parameters to be estimated in this stage are the parameters in the distribution of fixed and sunk costs.

1. Pick a parameter set ^{1} ; where is the parameter space. In this paper, $^1 = (_s; _f)$.

2. Discretize the state space S into S' with N grid points, pick one grid state s S';

3. Given ^{1} and s, compute the value function $V(s)$ defined in equation (7);

The algorithm to compute $V(s)$ for given ^{1} and s:

3.1: Pick an starting value function $V_0(s)$; for all s S';

3.2: Compute the choice-specific value function $V^1(s_{jt})$ and $V^0(s_{jt})$ from equations (8), and (9); where $F(w_{jt+1} \; w_{jt;}d_{jt})$ is derived from the productivity evolution process, and $_{jt}$ is assumed to be constant over time since the panel is short;

3.3: Use $_{(s_{jt})}$; $V^1(s_{jt})$ and $V^0(s_{jt})$ to update the value function to $V_0(s)$;

Iterate until $V_{i+1}(s) \quad V_i(s)$ is small enough. This finishes computing the value function at state s. Other states could be derived similarly via loop, or vectorization.

4. With the value function and the assumption on the distribution of C^f_{jt} and C^s_{jt} in hand, we can write the likelihood functions: $L_{jt}(^1); L_j(^1); L(^1)$

5. Search over all the points in the parameter space (or use other optimization algorithms), and pick $^* = \arg\max_{\in} L( )$ as the estimates of the dynamic parameters.

Appendix 2: Self Selection to Import: A Numerical Example

In this appendix, I perform a numerical example to illustrate firms' self selection into importing intermediate inputs. In particular, I want to answer the question:

are more or less productive firms more likely to import? I simplify the analysis by parameterizing the value function.

Assume $V(s_{jt}; d_{jt+1})$ takes the following flexible form,

$$\begin{aligned} V(s_{jt}; d_{jt+1}) \;&=\; a_0 + a_{w1} !_{jt} + a^2_{!2} !^2_{jt} + a_{w3} !^3_{jt} + a_{k1} k_{jt} + a_{k2} k^2_{jt} + a_{k3} k^3_{jt} \\ &\quad + a_d d_{jt} + a_{!kdd'} !_{jt} k_{jt} d_{jt} + a_{d'} d_{jt+1} + a_{!kd'} !_{jt} k_{jt} d_{jt+1} \\ &\quad + a_{!kdd'} !_{jt} k_{jt} d_{jt} d_{jt+1} \end{aligned} \tag{28}$$

Then the difference in the firm value for the firm to import and not to import is

$$V \;=\; V^1(s_{jt}) \quad V^0(s_{jt}) = a_{d'} + a_{!kd'} !_{jt} k_{jt} + a_{!kdd'} !_{jt} k_{jt} d_{jt} \tag{29}$$

The linearity of V in $!_{jt} k_{jt}$ in this example depends on the functional form of $V(s \; d')$, but the main results remain valid if I use other more flexible functional forms.

Running a regression using equation (28) gives the summary statistics of $V(s_{jt}; d_{jt+1})$, which are reported in Table A1. The estimates of the choice specific value function gives the value difference of the importer and non-importer in next period. In the basic industrial chemicals industry, for example, the difference of the choice-specific value function is

$$V \;=\; V^1(s_{jt}) \quad V^0(s_{jt}) = (\quad 1{:}6707 + 0{:}1837 !_{jt} k_{jt} \quad 0{:}0055 !_{jt} k_{jt} d_{jt}) \quad 10^6$$

It is clear that for this specific industry, current importing experience tends to decrease the potential gain of importing (coefficient on $!_{jt} k_{jt} d_{jt}$ is negative). This is because the first-time importers can sometimes acquire one-time benefits, which

Besides the point made above, I am particularly interested in the effect of current productivity on plants' choice of importing status. To see this, take the derivative of V with respect to productivity $(!_{jt})$

$$\frac{d \quad V}{d(!_{jt})} = (0{:}1837 \quad 0{:}0055 k_{jt} d_{jt}) \quad 10^6 > 0$$

So the value of importing relative to non-importing is always increasing in productivity. This result justifies the significant self selection of plants into the importing market: more productive plants and more capital-abundant plants are more likely to import inputs. I elaborate on this point in a bit more detail in figure 1 and figure 2.

In Figure 1, the thresholds of plants' decisions to starting importing inputs are determined by the function $CS = \quad 1{:}6707 + 0{:}1837 !_{jt} k_{jt}$: Plants (current non-importers) with sunk cost and productivity below the solid line would like to start importing, while plants above the curve would not. The positive slope of the solid line implies that more productive plants are more likely to start importing inputs, showing a clear self selection pattern into importing market.

Similarly, Figure 2 shows plants' exit decisions from the importing market. The thresholds of plants' decisions to stop importing inputs are defined by the function $CF = \quad 1{:}6707 + 0{:}1782 !_{jt} k_{jt}$. Importers with productivity and fixed cost below the red curve would continue importing, while those above the solid line would stop importing. The positive slope of the solid line implies that more productive importers are more likely to continue importing inputs, clearly showing a self selection for firms to continue importing. That is, more productive importers tend into continued importing.

Industry B.I.Chemicals Pharmaceutical

Appendix 3: Robustness Check

This appendix contains the estimation results for the robustness check in Section 6. They are estimated from a subsample of the data set which only contains non-exporting firms.

Table A2: Robustness Check: Parameters of Static Inputs in Production Function (Non-Exporters)

Industry	B.I.Chemicals	Pharmaceuticals	Plastics	L.Shoes	Print&Pub	Clothing
α_l	0.3508	0.3414	0.2913	0.4973	0.4801	0.5635
	(0.0032)	(0.0030)	(0.0013)	(0.0011)	(0.0006)	(0.0002)
α_m	0.3846	0.5839	0.6235	0.3567	0.4374	0.3569
	(0.0014)	(0.0021)	(0.0006)	(0.0006)	(0.0003)	(0.0001)
A	0.9696	0.9706	0.9828	0.9964	0.9997	0.9994
	(0.4694)	(0.0911)	(0.0270)	(0.2164)	(0.0406)	(6.2074)
θ	4.4014	24.9377	18.5874	1.7724	35.7143	5.9312
	(0.0811)	(0.0856)	(0.0384)	(0.1674)	(0.0482)	(0.6933)
age	0.0606	0.0113	0.0330	-0.0002	-0.0267	0.0055
	(0.0032)	(0.0018)	(0.0010)	(0.0009)	(0.0003)	(0.0002)
ownership	0.1926	0.0487	0.0479	0.1081	0.1248	0.1340
	(0.0103)	(0.0098)	(0.0066)	(0.0587)	(0.0029)	(0.0092)

Notes: The standard errors in parentheses.

Table A3: Robustness Check: Parameters in Productivity Evolution and Capital Share for Non-Exporters

Industry	B.I.Chemicals	Pharmaceu.	Plastics	L.Shoes	Print&Pub	Clothing
$_k$	0.1424	0.0662	0.0444	0.0933	0.0928	0.0540
	(0.0097)	(0.0031)	(0.0015)	(0.0016)	(0.0002)	(0.0006)
g_0	0.2452	0.2115	0.3137	0.7894	0.6763	0.3520
	(1.2080)	(0.7623)	(0.7764)	(1.1252)	(0.0451)	(0.2156)
g	0.9355	0.8772	0.8075	0.6348	0.4224	0.7889
	(0.0857)	(0.2622)	(0.3062)	(0.2023)	(0.0192)	(0.0670)
g_d	0.0052	0.0097	0.0042	0.0262	0.0322	0.0042
	(0.0101)	(0.0099)	(0.0025)	(0.0152)	(0.0013)	(0.0080)
	0.0052	0.0410	0.0225	0.0425	0.0664	0.0349

Notes: The standard errors in parentheses.

Industry	B.I.Chemicals	Pharmaceuticals	Plastics	L.Shoes	Print&Pub	Clothing
Revenue Function						
r_ω	0.8389	1.7225	3.2131	3.8280	1.1466	2.4272
r_k	0.1290	0.0454	0.1246	2.0700	0.0157	0.1908
r_d	0.1406	0.1236	0.1558	0.4012	0.1146	0.1274