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ESSAYS ON GEOGRAPHY AND FIRM DECISION ON EXPORTS AND INVESTMENT

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Abstract

The world is not flat, neither are countries. Geography, in terms of location and destination, plays a key role in firm activity. The thesis is composed of two chapters that are relevant to geography and firms' decisions on exporting and investment.

Previous research on export dynamics addresses a firm's tradeoff between generating a profit now or in the future, but it overlooks the importance of a firm's export decisions across markets. In the first chapter paper, I study a firm's dynamic export destination choice over two markets (the North and South) using a structural model in which I take into account of both the selection effect and the learning-by-exporting effect. Using data from the Chinese plastic industry, I distinguish and model two determinants that impact a firm's sales: a general component productivity that affects the firm's (entry) sales in all markets, and a market-specific component demand that influences sales only in that market to which the firm is exporting. I find that a firm's decision to export to the North promotes entry (sales) in other markets through productivity improvement. In contrast, a firm's decision to export to the South merely increases the sales in the South through a market-specific demand impact. Counterfactual analysis shows that omitting the benefits of exporting to the South deters 7% of all exporting firms that may have exported to the North; yet eliminating the benefits of exporting to the North deters 34% of all exporting firms that may have exported to the South.

In addition to research on export destinations, the location of the firm also determines the way they make decisions. In the second chapter, I study a panel dataset for firms in the equipment-making industry in China and observe that the investment rates in urban areas are consistently lower than in suburban areas by 6-7 percentage points. Three factors could explain this - the production technology, profit shocks and capital adjustment costs. I build a structural model and quantify the relative importance of three factors in determining the firms' investment rate. The results indicate that while the production technology is similar in urban and suburban areas, profit shocks tend to be more volatile and with higher means among firms in suburban areas. Moreover, urban firms face higher (even if more easily reversible) adjustment costs for capital. The counterfactual analysis reveals that profit shocks are responsible for 70-80% of the differential in investment rates whereas difference in adjustment costs explains only about 20-30%.

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Dedication

To my parents, Ping and Yasha, and my girlfriend, Ying

Chapter 1

A Structural Model of Export Destination Dynamics

1.1 Introduction

The massive entry of Chinese exporters into the global market can be characterized not only by the large export volume but also by the quick expansion to many new destinations. The distance and market size are the two key components that govern the export flow from the original country to the destination country. In contrast to the salient negative effect on trade flow, the distance has little effect on the extensive margin, which is exclusively determined by the GDP or GDP per capita of destination. In particular, more firms export to the countries with higher GDP/GDP per capita.

Table 1.1. Extensive Margin of Export

	log(export value) (1)	log(# of exporters) (2)(extensive margin)	log(export value) (1)	log(# of exporters) (2)(extensive margin)
log(dis)	-0.54**	-0.24	-0.48**	-0.22
	(0.19)	(0.14)	(0.18)	(0.14)
log(GDP)	0.97**	0.75**		
	(0.04)	(0.03)		
log(GDP per capita)			0.86**	0.73**
			(0.05)	(0.04)
log(pop)			yes	yes
year effect	yes	yes	yes	yes
# of obs.	1083	1083	1083	1083

log(dis) log(GDP) and log(pop) denote the distance from China to the destination country, the GDP of the destination country and the the population of destination country.

When we look at all exporting firms, 87.8% of the firms only choose to start exporting to the North[1], while 53.2% of the firms only start exporting to the South. 41% firms starts at both destinations. The destinations in the North seem to be more appealing to exporters than their counterparts in the South; this particularly holds for small exporters. What makes the North so popular? Two possible explanations may account for this pattern: (1) in cross-sectional analysis, the discrepancy in market size between the North and the South shows that firms' export decisions are determined by a demand that is proportional to the market size, or (2) in dynamics, beginning to export to the North indicates that the North is a more appealing destination for future exporting. While I do not disagree with the argument regarding market-size effect, here I pay particular attention to export dynamics.

Previous research on export dynamics typically focuses on firms' decision-making tradeoffs regarding current and future profits. However, the export destination is crucial to consider in assessing these tradeoffs. The export destination does not only determine current profits; it also determines whether and if so, where the firm can expect to generate a profit in the future. For example, a firm acquires experience through exporting to a certain market. This experience may be transferable to promote entry (sales) in other markets; such experience may be in efficient production methods or improvement in management or product quality. Alternatively, a firm acquires market-specific information through exporting that only improves the firm's future sales in the market to which it currently exports; in this case, such information may be about the customer base in a particular market.

Even though distinguishing among export destinations is crucial to investigating export dynamics, little research addresses the question in a unified framework in order to account for both the selection effect and learning by exporting with multiple foreign destinations. While research studying selection

[1]The term "the North" may refer to either developed countries or high-income countries. "The South" is typically used to refer to developing countries or low-income countries. Those terms are used interchangeably in the following context.

into exports identifies the equal importance of the general component, efficiency, and the market-specific component, demand (Eaton, Kortum and Kramarz, 2011; Roberts et al, 2012), it does not accommodate the learning-by-exporting effect in dynamics. Other literature studying export dynamics does not distinguish among destinations (Das Roberts and Tybout, 2007; Aw, Roberts and Xu, 2011; Rodriguez, 2014). Expanding on their work, in the paper, I study a firm's export decision-making across markets over time. In particular, I ask whether a firm's export experience in one destination affects its future entry (sales) in other destinations. To accomplish this, I consider a simple version of multiple destinations by dividing the destinations into the North (developed countries) and the South (developing countries). Using this categorization system allows me to account for the major differences in destination environments, such as financial institution efficiency (Chan and Manova, 2013), as well as market size and product market competition (Melitz and Ottaviano, 2008). [2]

In particular, I build a dynamic structural model with three unobservables: a general component, productivity, and two market-specific components, demand in the North and demand in the South. The goal is to study the way export experience affects their evolution. While I allow both export decisions to the North and to the South to jointly affect the general component, productivity, the market-specific component, demand, evolves only in relation to the export decisions regarding the particular market.

I estimate the model using Chinese customs data merged with manufacturing data for the plastic industry. I find that exporting to the North promotes a firm's entry (sales) in other markets through gains in productivity. In contrast, exporting to the South only increases the firm sales in that market through market-specific demand. This structural estimation allows me to evaluate the asymmetric importance of exporting to the North and the South, and in particular the extensive margin. While eliminating the benefits of exporting to the

[2]For example, efficient financial institutions encourage firms' entry through recovering a large proportion of the upfront costs(Chan and Manova, 2013) and large market sizes result in sharp competition (Melitz and Ottaviano, 2008)

North results in a 1.8 percentage point drop in the total number of firms that would have exported to the South (this accounts for 34% of the exporters that would have exported to the South), eliminating the benefits of exporting to the South only deters 0.5 percentage points of the total firms that would have been exported to the North (this accounts for 7% of the exporters that would have exported to the South). The counterfactual analysis further emphasizes the asymmetric importance of exporting through productivity channels to the North by lowering fixed costs in response to trade liberalization.

The paper contributes to current literature by modeling a firm's export decision-making process in the context of multiple destinations, taking into account into both destination selection and the learning by exporting effect. It reveals that the benefits acquired vary by export destination, and that these benefits may or may not spill over into other destinations. Even though no sequential assumption is imposed in considering a firm's destination choice, the different types of benefits that accrue to an exporting firm make the decision to export to the North more rewarding than the decision to export to the South. In addition, this study does not only generate the pecking order of export destinations in a cross-sectional pattern (Eaton, Kortum and Kramarz, 2011; Manova and Chan, 2013), but it also shapes the destination ranking in export dynamics.

The paper is organized as follows: Section 2 provides the foundation for the paper by presenting two facts regarding dynamics on export destinations and extensive and intensive margins. Based on empirical data, a structural model with two foreign destinations is formulated in Section 3. After introducing the data in Section 4, Section 5 discusses identification and estimation. Section 6 briefly discusses a possible mechanism. Section 7 highlights the role of productivity and demand as they relate to extensive margin. Section 8 includes a counterfactual analysis, and Section 9 offers our conclusions.

1.2 Dynamics on Export Destinations and Extensive and Intensive Margins

I group data regarding over 200 destinations to which Chinese firms export into the North (developed countries) and the South (developing countries)[3]. The North (developed countries) is comprised of the U.S, Japan, the E.U. countries, Korea, Canada, Australia, New Zealand, Taiwan,[4] and Singapore. The rest of the countries, mostly in Asia, Africa, and Latin America, comprise the South (developing countries). This twofold categorization captures the major differences among the countries, for example, the degree of market competition.

I look at firms that conduct ordinary trade via direct export using matched data. I control for processing trade from year 2000 to 2006[5]. The final sample includes 1,300,489 firm-year observations drawn from firms exporting to more than 200 countries. All firms fall into one of the following categories: (1) firms exporting to the North, (2) firms exporting to the South, (3) firms exporting to both the North and the South, (4) firms that are non-exporting.

I examine both the extensive margin, or entry into foreign markets, and the intensive margin, or export sales conditional on entry. Two facts about the dynamics of Chinese export destinations stand out: (1) firms are more likely to enter into other destinations upon exporting to the North, and (2) conditional on entry, firms' export sales in the South grow faster than firms' export sales in the North.

[3] This categorization is based on the U.N.'s Human Development Index, the World Bank's database of high-income countries, and the IMF's database regarding the World Economic Outlook. The rankings and classification systems significantly overlap.

[4] Most trade with Taiwan is conducted through processing trade, which is not included in the sample

[5] I aggregate all the firm exports up to the calendar year. Processing trade refers to export activity in which production has been contracted by a foreign party who is also responsible for selling the products. Ordinary trade refers to an export mode by which a firm penetrates a market independently. I do not consider the export-through-trading company, namely, a company that exports indirectly, because in this case, the company's exposure to the foreign market is quite limited.

1.2.1 The Extensive Margin

At first glance, the export destinations' transition pattern seems to defy the initial statement above. Among all firms that begin by exporting to the North, only 17.1% of them export to the South in the subsequent year. However, among all the firms start exporting to the South, 27.7% exporting to the North in the subsequent year.

Table 1.2. Export Destination Dynamics

		2nd Year Export				3rd Year Export				Firm Size		
		N	S	N&S	Total	N	S	N&S	Total	Capital ($1000)	Employment	Productivity
1st Year Export	N	51.9%	1.3%	15.8 %	7371	39.6%	1.4%	18.3%	7371	35	251	3.93
	S	4.6%	33.4%	23.1%	1913	4.8%	22.2%	23.8%	1913	55	300	3.98
	N&S	10.7%	4.1%	64.7 %	6437	10.4%	3.6%	55.0%	6437	38	269	4.03

N and *S* denote exports to the North and South, respectively.
N&S refers to combined exports to the North and South.

However, this is unsurprising given that the firms that export to the South have greater capital stock, employment ranks, and productivity[6]. In order to tease out the effects of other determinants, I apply the probit model to examine the importance of destination choice.

$$Pr(e_{it}^{f}) = \Phi(\gamma^{N} e_{it-1}^{N} + \gamma^{S} e_{it-1}^{S} + X_{it}' \beta + \eta_t + \eta_{ind} + \epsilon_{it})$$

where $f \in \{N, S\}$. e_{it}^{N} and e_{it}^{S} denote binary export decisions in relation to the North and the South, respectively. Following previous research (Aw, Roberts and Xu, 2011), X_{it} includes a series of characteristics: productivity ω_{it-1}, capital stock $\ln k_{it}$, employment $\ln l_{it}$ and ownership. η_t and η_{ind} denote sets of years and industry dummies. The results of (1) and (2) are very close. For simplicity, I approximate firm size using only capital stock $\ln k_{it}$ in my structural model.[7]

Unsurprisingly, a firm's export experience in the North (South) in $t-1$ has significant effects on its exports to the North (South) in t, thereby showing the persistence of export status. However, the coefficients imply a cross-destination

[6]Productivity is estimated according to industry using the LP method

[7]In the structural model, I control for only capital. Similar estimates are produced with and without controlling for a series of characteristics.

Table 1.3. Extensive Margin and Destinations (North vs. South)

	$Pr(e_{it}^N = 1)$		$Pr(e_{it}^S = 1)$	
	(1)	(2)	(1)	(2)
γ^N	2.23**	2.54**	1.18**	1.14**
	(0.021)	(0.013)	(0.016)	(0.015)
γ^S	0.73**	0.67**	1.69**	1.98**
	(0.018)	(0.016)	(0.026)	(0.018)
$\ln k_{it}$	Yes	Yes	Yes	Yes
$\ln l_{it}$/ownership	No	Yes	No	Yes
year/industry effect	No	Yes	No	Yes
obs	881269			

** and * denote 5% and 1% significance levels, respectively.
Std. are in parentheses.

effect. This occurs when the influence of exports to the North (South) in $t-1$ on the export decision to the South (North) in t is more significant if the firm exports to the North at $t-1$. It implies $\frac{\partial Pr(e_{it}^S)}{\partial e_{it-1}^N} > \frac{\partial Pr(e_{it}^N)}{\partial e_{it-1}^S}$, everything else being equal. This indicates that firms are more likely to enter into the South, conditional on exporting to the North.

Similar evidence regarding the extensive margin is also found when I examine the destinations by country rather than looking at the dichotomy between the North and the South[8]. Apart from on the evidence for the extensive margin, the second fact focuses on the intensive margin.

1.2.2 Intensive Margin

Unlike domestic sales that are always observed, foreign sales r_{it}^f are observed only if a firm exports to destination f. In particular, r_{it}^f denotes the sales for firm i at year t in destination f, where $f \in \{N, S, D\}$[9]. Let us compare the growth rate of sales in each destination between $t-1$ and t: $\triangle_{it}^f = lnr_{it}^f - lnr_{it-1}^f$.

Before I draw the conclusion that export sales grow faster in the South than in the North, two possible concerns arise: first, 26.7% of the firms that export through ordinary trade also conduct processing trade. Exports through

[8] See Appendix A.1

[9] $f \in \{N, S, D\}$ denotes the sales in the North, the South and the domestic market

Table 1.4. Intensive Margin and Destinations (North vs. South)

	$\triangle_{it}^{f}$			
	No Adj.		Adj.	
	(1)	(2)	(1)	(2)
North	0.25	0.22	0.20	0.12
South	0.30	0.25	0.25	0.15
Domestic	0.12	0.12	0.12	0.12
obs.	18040	34254	18040	34254

(1) and (2) denote samples of firms with and without processing trade, respectively.
No Adj. and Adj. denote samples with and without adjustments for the partial-year effect, respectively.

processing trade facilitate the exposure of firms to foreign markets, which in turn boosts foreign sales through ordinary trade. Column (2) documents a sample in which firms conduct processing trade alongside ordinary trade, while Column (1) summarizes a sample of firms that only conduct ordinary trade. Comparing (1) and (2), we can see that firms that conduct both processing trade and ordinary trade at the same time indeed have higher foreign-sales growth than their counterparts that only conduct ordinary trade. The second concern stems from an accounting issue in foreign sales associated with the partial-year effect (Bernard et al., 2014). Because exports are documented monthly, the partial-year effect suggests that foreign-sales growth may be overestimated. I therefore make an adjustment in the column "Adj"[10] so that the partial-year effect now reflects quarterly exports. The pattern of export sales growing faster in the South than in the North remains even after making these two adjustments.

The evidence above shows that firms' export sales in the South grow faster than their export sales in the North. Similar evidence regarding the intensive margin is also found when I examine the destinations by country rather than looking to the dichotomy between the North and the South[11].

[10]I adjust the column proportionally by multiplying 4,2,$\frac{4}{3}$ and 1 if the exporter enters at the first, second, third or fourth quarter of the year upon initial exporting.

[11]See Appendix A.2

Summary

In considering export destinations in terms of both the extensive margin and the intensive margin, I find that: (1) firms are more likely to enter into other destinations upon exporting to the North, and (2) conditional upon entry, firms' export sales in the South grow faster than their export sales in the North.

These empirical facts suggest two types of components that determine export sales: a general component that affects sales (entry) in all markets, and a market-specific component that only determines sales in a particular market. While (1) indicates that exporting to the North improves the general component by encouraging entry to the South, (2) emphasizes the rapid increase in the market-specific component of the South.

Guided by these two facts, I formulate a dynamic model in the next section.

1.3 Model

In this section, I develop a dynamic structural model of export destination choices. The model incorporates both a general component, productivity, and a market-specific component, demand in the North and the South. The goal of the empirical model is to estimate how destination choices affect the evolution of productivity and demand in the North and the South. Firms are heterogeneous in productivity and demand, and both of these are crucial to export decisions.

For each firm i, there are three markets: the domestic market D, the South S and the North N. The South and the North jointly comprise the foreign market f: $f \in \{N, S\}$. Serving the domestic market is the default option in the sense that domestic market entry/exit are excluded from consideration.

According to the model's setup, a firm can be categorized as one of four exclusive choices: (1) non-exporting (D), (2) only exporting to the North (D, N), (3) only exporting to the South (D, S), and (4) exporting to both the North and the South (D, N, S).

1.3.1 Timing

Each firm chooses one of the four exclusive choices to maximize the discounted value of its profit. The timing of information and decisions is as follows:

(1) At the beginning of each period, each firm observes its capital stock $\ln k_{it}$, productivity ω_{it} and demand in the foreign market: $(\lambda_{it}^N, \lambda_{it}^S)$. All the variables are summarized as a firm's state variables $s_{it} = (\omega_{it}, k_{it}, \lambda_{it}^N, \lambda_{it}^S)$.

(2) Each firm then observes the realization of fixed costs in the North and the South: κ_{it}^N and κ_{it}^S. If the firm exports to the foreign market f, it incurs fixed costs. Each firm knows the payoff of each market, which is the net profit of the fixed costs in that market.

(3) Each firm makes its export decisions by choosing among the four alternatives. It accordingly obtains the associated payoff of each market.

(4) After making its export decisions, the firm sees its state variables evolve accordingly for the next period.

1.3.2 Static Decision

To begin with the domestic market, I consider a representative consumer with CES preferences regarding the consumption of differentiated goods in t as:

$$U_t^D = [\int_{i \in \Omega_i^D} (h_i q_i)^{\frac{\sigma^D - 1}{\sigma^D}} di]^{\frac{\sigma^D}{\sigma^D - 1}}$$

where i indexes firm i, and q_i and h_i denote the quantity and quality of good i at time t. High-quality goods yield high-consumption utility per unit consumed. $\sigma^D > 1$ denotes the elasticity of substitution in domestic market D. Since utility follows the same functional form over time, it is easy to include subscript t, which makes the domestic demand:

$$q_{it}^D = h_{it}^{(\sigma^D - 1)} (\frac{p_{it}^D}{P_t^D})^{-\sigma^D} (\frac{E_t^D}{P_t^D}) = h_{it}^{(\sigma^D - 1)} (p_{it}^D)^{-\sigma^D} \Phi_t^D \tag{1.1}$$

where E_t^D and P_t^D denote the aggregate income and price index that are ultimately absorbed by the single term Φ_t^D.

Unlike in the domestic market in which a firm is incumbent, in the foreign market, a firm gradually penetrates the market f. $e^{\lambda_{it}^f}$ characterizes a market-specific shock, such as the customer base. It explains the gap between the foreign sales in market f and domestic sales over time. It rationalizes the situation as follows: a new exporting firm selling high-quality goods may have low sales because of its limited customer base. The quantity consumed in foreign market $f \in \{N, S\}$ is:

$$q_{it}^f = e^{\lambda_{it}^f} h_{it}^{(\sigma^f - 1)} (\frac{p_{it}^f}{P_t^f})^{-\sigma^f} (\frac{E_t^f}{P_t^f}) = e^{\lambda_{it}^f} h_{it}^{(\sigma^f - 1)} (p_{it}^f)^{-\sigma^f} \Phi_t^f \tag{1.2}$$

σ^f denotes the elasticity of substitution in market f. As one might expect, $\sigma^N > \sigma^S$. Under this specification, consumers in all markets exhibit the same quality preference for a single variety, which contradicts the common-sense understanding that consumers in the North prefer high-quality goods whereas those in the South do not. To account for this fact, it is reasonable to assume the set of varieties Ω_{it} is different across markets given firms' entry and exit. In particular, the set of varieties in the North Ω_{it}^N includes more high-quality goods compared to the set in the South Ω_{it}^S.

All markets are assumed to be monopolistic competitive. Firm i's marginal cost in t is:

$$\ln c_{it} = \ln c(k_{it}, h_{it}, \varphi_{it}) = \beta_0 + \beta_k lnk_{it} + \delta \ln h_{it} - \varphi_{it} \tag{1.3}$$

where k_{it} denotes the capital stock, and h_{it} and φ_{it} denote quality and efficiency. While a firm producing high-quality goods is associated with high marginal costs, a firm with high efficiency tends to have low costs. δ measures the extent to which the quality h_{it} determines the marginal cost relative to efficiency φ_{it}. The CES specification also implies constant markup over the marginal costs: $p_{it}^D = \frac{\sigma^D}{\sigma^D - 1} c_{it}$ and $p_{it}^f = \frac{\sigma^f}{\sigma^f - 1} c_{it}$ where $f \in \{N, S\}$. The log of domestic sales $r_{it}^D = p_{it}^D q_{it}^D$ is:

$$\ln r_{it}^D = (1 - \sigma^D) \ln(\frac{\sigma^D}{\sigma^D - 1}) + \ln \Phi_t^D + (1 - \sigma^D)(\beta_0 + \beta_k lnk_{it} + (\delta - 1) \ln h_{it} - \varphi_{it}) \quad (1.4)$$

Similarly, the log of foreign sales in markets f and $f \in \{N, S\}$:

$$\ln r_{it}^f = (1 - \sigma^f) \ln(\frac{\sigma^f}{\sigma^f - 1}) + \ln \Phi_t^f + (1 - \sigma^f)(\beta_0 + \beta_k lnk_{it} + (\delta - 1) \ln h_{it} - \varphi_{it}) + \lambda_{it}^f \quad (1.5)$$

The marginal effect of producing high-quality goods on the firm's total revenue is:

$$\frac{\partial \ln r_{it}^f}{\partial \ln h_{it}} = (1 - \sigma^f)(\delta - 1)$$

Since $(1 - \sigma^f) < 0$, the sufficient assumption $\delta < 1$ guarantees that producing high-quality goods is desirable. Rather than distinguishing efficiency φ_{it} from quality $\ln h_{it}$, revenue-based productivity ω_{it} absorbs the two components that drive up sales in all markets.

$$\underbrace{\omega_{it}}_{\text{productivity}} = \underbrace{\varphi_{it}}_{\text{efficiency}} + \underbrace{(1 - \delta) \ln h_{it}}_{\text{quality}}$$

$(1 - \delta) > 0$ implies that improvements in either efficiency or quality lead to revenue-based productivity increases. Under this setup, domestic and foreign sales become:

$$\ln r_{it}^D = (1 - \sigma^D) \ln(\frac{\sigma^D}{\sigma^D - 1}) + \ln \Phi_t^D + (1 - \sigma^D)(\beta_0 + \beta_k lnk_{it} - \omega_{it}) \quad (1.6)$$

$$\ln r_{it}^f = (1 - \sigma^f) \ln(\frac{\sigma^f}{\sigma^f - 1}) + \ln \Phi_t^f + (1 - \sigma^f)(\beta_0 + \beta_k lnk_{it} - \omega_{it}) + \lambda_{it}^f \quad (1.7)$$

Unlike domestic sales that only depend on the firm's capital stock and productivity, foreign sales also depend on a market-specific shock λ_{it}^f.

Alternatively, the setup implies that revenue-based productivity captures the common variation in all markets and that market-specific demand, which may include the customer base in each market, rationalizes market-specific heterogeneity[12].

The distinction between the two types of components is the major concern of this paper. I will examine how the destination choice affects the evolution of the two types of components. The profits for domestic market D and foreign market $f \in \{N, S\}$ are:

$$\pi_{it}^{D} = \frac{1}{\sigma^{D}} r_{it}(\Phi_t^{D}, k_{it}, \omega_{it}) \qquad \pi_{it}^{f} = \frac{1}{\sigma^{f}} r_{it}(\Phi_t^{f}, k_{it}, \omega_{it}, \lambda_{it}^{f}) \tag{1.8}$$

1.3.3 Transition of State Variables

As discussed before, both productivity ω_{it} and market-specific demand λ_{it}^{f} are unobserved for econometricians but known for each firm i. I assume both productivity and demand evolve over time in the Markov process and that this evolution depends on the firm's past export decisions $e_{it-1} = (e_{it-1}^{N}, e_{it-1}^{S})$. The first and second arguments denote firm i's export decisions regarding the North and South in year $t-1$, respectively. In particular, productivity evolves as follows:

$$\omega_{it} = g(\omega_{it-1}, e_{it-1}) + \epsilon_{it}^{\omega} = \alpha_0 + \alpha_1 \omega_{it-1} + \alpha_2^{N} e_{it-1}^{N} + \alpha_2^{S} e_{it-1}^{S} + \alpha_2^{NS} e_{it-1}^{N} e_{it-1}^{S} + \epsilon_{it}^{\omega} \tag{1.9}$$

where e_{it-1}^{f} denotes the export decisions to foreign market f in year $t-1$. ϵ_{it}^{ω} is i.i.d normal distribution: $\epsilon_{it}^{\omega} \sim N(0, \sigma_{\omega}^{2})$. $\{\alpha_2^{N}, \alpha_2^{S}\}$ capture learning by exporting in productivity to the North and the South, respectively. α_2^{NS} captures the gains in productivity if the firm exports to both the North and the South.

The specification of the productivity allows the export decisions to the North and the South to be dependent on each other. Since productivity affects sales in all markets, exporting to one destination might encourage exporting to an-

[12] The terminology of productivity and demand is discussed in Appendix A.3.

other destination. For example, exporting to the North may help improve management quality through φ_{it} or upgrade product quality through $\ln h_{it}$. Both improvements benefit the firm's exporting to the other destination. The possible mechanisms for this are discussed later.

In contrast to productivity, which is a general component since it affects sales in all markets, demand λ_{it}^{f}, $f \in \{N, S\}$ is market-specific, since it responds to a firm's particular geographic customer base. Specifically, the demand of destination f evolves independently at each destination as follows:

$$\lambda_{it}^{f} = f(\lambda_{it-1}^{f}, e_{it-1}^{f}) + \epsilon_{it}^{\lambda f} = \phi_0^f + \phi_1^f \lambda_{it-1}^{f} + \phi_2^f e_{it-1}^{f} + \epsilon_{it}^{\lambda f} \quad (1.10)$$

$\epsilon_{it}^{\lambda f} \sim N(0, \sigma_{\lambda_f}^2)$. Specifically, ϕ_1^f captures the persistence of λ_{it}^{f}. As long as a firm maintains its exposure within market f, it may build up market-specific demand. This specification precludes a situation in which a firm endogenously chooses to expand its customer base (Arkorlakis, 2010). If a firm does not export, the demand in the foreign market evolves in AR(1) as follows: $\lambda_{it}^{f} = \phi_0^f + \phi_1^f \lambda_{it-1}^{f} + \epsilon_{it}^{\lambda f}$.

1.3.4 Dynamic Decisions

Each firm makes its export decisions by choosing among the four exclusive alternatives:

$$e_{it} = (e_{it}^N, e_{it}^S) = \{(0,0), (0,1), (1,0), (1,1)\}$$

Even though much empirical evidence supports the export destinations hierarchy (Eaton et al. 2011; Chan and Manova, 2014), I allow each firm to choose export destinations simultaneously instead of imposing a decision sequence ad hoc. Each firm pays a fixed cost $\kappa_{it}^{f} \sim G^f(.)$ each time it exports; this cost may includes the cost to search for potential customers. κ_{it}^{N} and κ_{it}^{S} are independent of each other.

The setup does not distinguish between entry costs and fixed costs even though they are both important in export dynamics (Roberts and Tybout, 1997; Das et al. 2007). There are three reasons for this. First, entry costs justify firms' persistent export status regardless of destination. However, entry cost It becomes less important when I examine a firm's exports by destination since exporting status by market exhibits far less persistent patterns than exporting status does in general (Lawless, 2009). Second, either positive gains in both demand ϕ_2^f or entry costs determine the persistent export status in market f. Ideally, the inclusion of entry costs allows for the highly volatile demand process with low ϕ_1^f but does not change the parameters of interest, ϕ_2^f, which are identified from increases in export sales. Third, the average export durations to the North and the South are about 3.8 and 3.1 years, respectively, which are not long enough to separately identify both the fixed and sunk costs.

1.3.4.1 Dynamics

$V(s_{it})$ denotes the value of firm i in year t before it makes its export decisions. At the beginning of this period, a firm observes the realization of productivity ω_{it}, demand shock (λ_{it}^N, λ_{it}^S), and associated fixed costs (κ^N, κ^S):

$$V(s_{it}) = \max_{e_{it}}\{v^D(s_{it}), v^{DN}(s_{it}), v^{DS}(s_{it}), v^{DNS}(s_{it})\}$$

where $v(s_{it})$ denotes the choice-specific value. For example, $v^{DN}(s_{it})$ denotes the value when a firm chooses only to export to the North. Specifically, the choice-specific value functions are:

$$v^D(s_{it}) = \pi^D(s_{it}) + \beta\mathbb{E}V(s_{it+1}), \tag{1.11}$$

$$v^{DN}(s_{it}) = \pi^D(s_{it}) + \pi^N(s_{it}) - \kappa_{it}^N + \beta\mathbb{E}V(s_{it+1}), \tag{1.12}$$

$$v^{DS}(s_{it}) = \pi^D(s_{it}) + \pi^S(s_{it}) - \kappa_{it}^S + \beta\mathbb{E}V(s_{it+1}), \tag{1.13}$$

$$v^{DNS}(s_{it}) = \pi^D(s_{it}) + \pi^N(s_{it}) + \pi^S(s_{it}) - \kappa_{it}^S - \kappa_{it}^N + \beta\mathbb{E}V(s_{it+1}) \tag{1.14}$$

When the firm exports to the North, the firm gains associated profit $\pi^N(s_{it})$ by incurring fixed costs κ_{it}^N. This argument also applies to the South.

The expected future value becomes:

$$\mathbb{E}V(s_{it+1}) = \int_{(\lambda_{it+1}^N, \lambda_{it+1}^S)} \int_{\omega_{it+1}} V(s_{it+1}) dF(\omega_{it+1}|\omega_{it}, e_{it}) dF(\lambda_{it+1}^N|\lambda_{it}^N, e_{it}^N) dF(\lambda_{it+1}^S|\lambda_{it}^S, e_{it}^S)$$

On the one hand, this formulation recognizes the interaction between the decisions regarding different markets through productivity. On the other hand, the market-specific demand λ_{it}^f allows the export decisions to the North and the South to be independent of each other.

In dynamics, a firm does not only take the current payoff into account, but it also considers the evolution of both productivity and demand that determines future value. For example, MB^N denotes the marginal benefit of exporting only to the North ($e_{it}^N = 1, e_{it}^S = 0$) versus choosing not to export ($e_{it}^N = 0, e_{it}^S = 0$):

$$MB^N = \pi^N(s_{it}) + \beta \mathbb{E}V(s_{it+1}|e_{it}^N = 1, e_{it} = 0) - \beta \mathbb{E}V(s_{it+1}|e_{it}^N = 0, e_{it} = 0)$$

The marginal benefit of exporting only to the North consists of the current profit $\pi^N(s_{it})$ and the difference between future expected value $\beta \mathbb{E}V(s_{it+1}|e_{it}^N = 1, e_{it}^S = 0) - \beta \mathbb{E}V(s_{it+1}|e_{it}^N = 0, e_{it}^S = 0)$. We can similarly derive the marginal benefit of different export alternatives. Each firm makes export decisions among alternatives by weighing the marginal benefit and the associated fixed costs.

To summarize the model, each firm is heterogeneous not only in its general component, productivity, but also in its market-specific component, demand in the North and the South. While productivity is affected by export decisions to the North and the South, demand in a certain market is determined only by the firm's export decision to that market.

1.4 Data

Two datasets are used. The first dataset is the Annual Survey of Chinese Manufacturing Firm Data. It spans from 1999 to 2007 and includes all state-owned firms and private firms with total sales greater than 5 million RMB (equal to roughly $600,000). The firms' time-variant financial information such as sales, total variable cost, capital stock, total wages etc. are included. Other time-invariant information such as location, ownership etc. are also documented. Because there is no data on the quantity of goods sold in the domestic market, I estimate revenue-based productivity from the data that is available.

The second dataset is Chinese Customs Data, which is collected monthly. This dataset documents the import and export transactions for all firms in China from 2000 to 2006. The dataset includes the HS8 digit product categories, unit prices, destinations of export and import, quantities, types of transaction (ordinary trade versus processing trade), and firm information such as telephone and address. The destinations and the associated export sales are also reported.

Recognizing the different firm/industry coding systems used before and after 2002, I have manually adjusted the systems to make them consistent. In addition, all of the nominal variables have been deflated using the price index for each year and industry.

To echo the empirical facts, I investigate all firms in the plastic industry conducting ordinary exports. My rationale for this is as follows: (1) many firms in the industry export through ordinary trade rather than processing trade; (2) over 17 per cent of firms in the industry (1728 firms in total) stay within the domestic market from 2000 to 2006; (3) the products are mass-market products in the sense that there is foreign demand for them worldwide, in both the North and the South; and (4) the industry is representative in the sense that the empirical facts in the industry are similar to those overall sample[13].

Identification and estimation are discussed in detail in the following section.

[13]Sample statistics are shown in Appendix A.5.

1.5 Identification and Estimation

The key parameters of interest are: (1) the elasticity of substitution in three destinations $(\sigma^D, \sigma^N, \sigma^S)$; (2) the parameters of the production function β and the parameters that determine productivity, $(\alpha_0, \alpha_1, \alpha_2^N, \alpha_2^S, \alpha_2^{NS}, \sigma_\omega)$; (3) the parameters that determine demand, $(\phi_0^N, \phi_1^N, \phi_2^N, \sigma_{\lambda N}; \phi_0^S, \phi_1^S, \phi_2^S, \sigma_{\lambda S})$; and (4) the fixed costs (κ^N, κ^S). The 20 parameters are estimated in two steps: while parameters (1) and (2) are estimated before the dynamic estimation, parameters (3) and (4) are estimated during the dynamic estimation.

1.5.1 Elasticity of Substitution

The elasticity of substitution is estimated in a way that is similar to the method used by Aw, Roberts, and Xu (2011). The identification source is the variation in the total variable cost relative to the variations of sales in each market. By equalizing the marginal revenue and the marginal costs in each market, the total variable cost tvc_{it} is expressed as a sum of the domestic and foreign sales weighted by associated markups, proportional to the elasticity of substitution. The regression is:

$$tvc_{it} = r_{it}^D\left(\frac{\sigma^D - 1}{\sigma^D}\right) + \mathbb{I}(e_{it}^N = 1) r_{it}^N\left(\frac{\sigma^N - 1}{\sigma^N}\right) + \mathbb{I}(e_{it}^S = 1) r_{it}^S\left(\frac{\sigma^S - 1}{\sigma^S}\right) + \epsilon_{it} \quad (1.15)$$

where ϵ_{it} is the measurement error of costs that are not correlated with revenue. $\mathbb{I}(e_{it}^f = 1)$ denotes the index function of export decisions to f. Estimating the equation by OLS retrieves the estimates of σ^N, σ^S, and σ^D. One concern comes from the heteroskedasticity in the error term. For example, large firms that have high sales are more likely to have large variations in ϵ_{it}. I use the HAC robust standard error to address this heteroskedasticity.

The elasticity of substitution in foreign markets is lower than that in the domestic one, although the one in the North is very close to that in the domestic market. However, the elasticity of substitution in the South, $\sigma^S = 5.88$, is much

Table 1.5. Elasticity of Substitution

	σ^D	σ^N	σ^S
	12.5**	11.1**	5.88**
	(0.012)	(0.047)	(0.054)
# of obs.	12852	12852	12852

** and * denote 1% and 5% significance levels, respectively.
Std. are in parentheses.

lower than it is in the North $\sigma^N = 11.1$. The implied markup in the North is only 10%, half of what it is in the South, around 20%. Within this narrowly defined industry, the markup may indicate the degree of product market competition. I will discuss a possible mechanism through competition later.

1.5.2 Productivity

Now, I turn to the productivity estimation. Because the domestic price (quantity) is unavailable, I derive productivity from domestic revenue rather than domestic output quantity. Revenue-based productivity includes two components: production efficiency φ_{it} and product quality h_{it}.

$$\ln r_{it}^D = (1-\sigma^D)\ln(\frac{\sigma^D}{\sigma^D - 1}) + \ln \Phi_t^D + (1-\sigma^D)(\beta_0 + \beta_k lnk_{it} - \omega_{it}) + u_{it}$$

The unobserved error $-(1-\sigma^D)\omega_{it} + u_{it}$ includes both an *i.i.d* component, u_{it}, and firm-specific, time-varying productivity: ω_{it}.[14]. This method relies on the insight of Olley and Pakes (1996), which allows me to rewrite the unobserved productivity in terms of some observable variables that are correlated with it. The choice of the variable input levels for materials m_{it} and export decisions e_{it-1} are correlated with productivity:

$$\omega_{it} = \omega(k_{it}, m_{it}, e_{it-1})$$

[14]The specification assumes away the firm-specific effect of f_i on revenue, and in particular $u_{it} = f_i + \varepsilon_{it}$. I also estimate the case when $u_{it} = f_i + \varepsilon_{it}$. It generates close estimates of α_2^N and α_2^S. However, $\alpha_1 < 0$ underestimates the importance of productivity gain $\frac{\alpha_0 + \alpha_2^N \mathbb{I}(e_{it}^N=1) + \alpha_2^S \mathbb{I}(e_{it}^S=1) + \alpha_2^{NS} \mathbb{I}(e_{it}^N=1)\mathbb{I}(e_{it}^S=1)}{1-\alpha_1}$

The first stage produces an estimate of the predicted output as a non-parametric function of the components: $(k_{it}, m_{it}, e_{it-1})$.

$$\begin{aligned} \ln r_{it}^{D} &= \gamma_0 + \sum_{t=1}^{T} \gamma_t D_t + (1-\sigma^D)(\beta_k lnk_{it} - \omega_{it}) + u_{it} \\ &= \gamma_0 + \sum_{t=1}^{T} \gamma_t D_t + \chi(k_{it}, m_{it}, e_{it-1}) + u_{it} \end{aligned}$$

D_t is a set of "year" dummies that absorbs the aggregate effect. All of the productivity information is captured in k_{it}, m_{it}, and e_{it-1}. The function $\chi(k_{it}, m_{it}, e_{it-1})$ is used to substitute $(1-\sigma^D)(\beta_k lnk_{it} - \omega_{it})$. Specifically, I use the second-order polynomials of $(k_{it}, m_{it}, e_{it-1})$[15] to approximate $\chi(k_{it}, m_{it}, e_{it-1})$, where the fitted value of $\chi(.)$ is denoted by $\widehat{\chi_{it}}$. According to equation (9), the productivity parameters $\alpha_0, \alpha_1, \alpha_2^N, \alpha_2^S$ can be recovered by inserting $\widehat{\sigma^D}$, $\omega_{it} = \beta_k lnk_{it} + \frac{1}{\widehat{\sigma^D}-1}\widehat{\chi_{it}}$ and $\omega_{it-1} = \beta_k lnk_{it-1} + \frac{1}{\widehat{\sigma^D}-1}\widehat{\chi_{it-1}}$ into (9) and rearranged as such:

$$\begin{aligned} \widehat{\chi_{it}} =& \alpha_0(\widehat{\sigma^D}-1) + \alpha_1\beta(\widehat{\sigma^D}-1)lnk_{it-1} + \alpha_1\widehat{\chi_{it-1}} - \beta(\widehat{\sigma^D}-1)lnk_{it} \\ &+ \alpha_2^N(\widehat{\sigma^D}-1)e_{it-1}^N + \alpha_2^S(\widehat{\sigma^D}-1)e_{it-1}^S + \alpha_2^{NS}(\widehat{\sigma^D}-1)e_{it-1}^N e_{it-1}^S + \epsilon_{it}^{\omega} \end{aligned}$$

ϵ_{it}^{ω} is the shock in the productivity process, which is orthogonal to e_{it-1}. The productivity parameters are estimated using the non-linear least square method. The identification source of α_2^N and α_2^S is the increase in domestic sales upon exporting (as opposed to not exporting) to the North and South, respectively. A similar argument applies to the identification of α_2^{NS}.

While $\alpha_2^N = 0.01$ indicates that exporting to the North helps improve productivity, $\alpha_2^S = 0$ implies that exporting to the South does not benefit productivity at all. In addition, when a firm exports to both the North and the South, there is a slight decrease in productivity.

[15] I also attempt this with third-order polynomials and obtain a robust result.

Table 1.6. productivity parameters

	(1)
α_0	0.035**(0.002)
α_1	0.934**(0.005)
β	-0.013**(0.001)
α_2^N	0.013**(0.002)
α_2^S	-0.00(0.004)
α_2^{NS}	-0.011*(-0.006)
$SE(\epsilon^\omega)$	0.17
# of obs.	9180

** and * denote 1% and 5% significance levels.
Std. are in parentheses.

1.5.3 Market-specific Demand

In addition to the productivity levels that are identified by domestic sales, the market-specific foreign demand λ_{it}^f, $f \in \{N, S\}$ is identified by the variations in export sales among exporters to market f over time:

$$\lambda_{it}^f = f(\lambda_{it-1}^f, e_{it-1}^f) + \epsilon_{it}^{\lambda f} = \phi_0^f + \phi_1^f \lambda_{it-1}^f + \phi_2^f e_{it-1}^f + \epsilon_{it}^{\lambda f} \tag{1.16}$$

Because the demand within the domestic market is normalized to be 0, the identification source of demand parameters ϕ_0^f, ϕ_1^f and ϕ_2^f, $f \in \{N, S\}$ is the export sales relative to the domestic sales, as well as the entry/exit patterns.

Unlike productivity, which can be fully determined from domestic sales, export sales are only observed when a firm exports. Other than capital stock $\ln k_{it}$ and productivity ω_{it}, both of which determine export sales, the average demand for exporting and non-exporting firms is represented as:

$$\mathbb{E}(\lambda_{it}^f | e_{it}^f = 1) = \frac{\phi_0 + \phi_2^f}{1 - \phi_1^f} \qquad \mathbb{E}(\lambda_{it}^f | e_{it}^f = 0) = \frac{\phi_0}{1 - \phi_1^f} \tag{1.17}$$

Because a firm's export decision e_{it}^f depends on fixed costs κ^f. It is impossible to separate fixed costs and demand.

In particular, ϕ_2^f is identified by increments of average sales. $\phi_0 + \phi_2$ are identified by average sales, given ϕ_1 and κ^f. The other source of identification is entry/exit patterns. ϕ_1^f, coupled with σ_f^2, accounts for the volatility of export sales in market f. The low (high) persistence of export sales over time implies the low (high) value of ϕ_1^f and/or the high (low) value of σ_f^2. An increase in export sales in market f pins down ϕ_2^f, conditional on entry into f.

In the following subsection, I delineate the estimation of the demand and fixed-cost parameters.

1.5.4 Dynamic Estimation

Fixed costs follow a certain distribution: $\kappa_{it}^f \sim G(.)$. For simplicity, I assume they follow a degenerated distribution, a constant. The parameters Θ in the dynamic part are:

$$\Theta = [\underbrace{(\phi_0^N, \phi_1^N, \phi_2^N, \sigma_{\lambda_N}^2; \phi_0^S, \phi_1^S, \phi_2^S, \sigma_{\lambda_S}^2)}_{\text{demand}}, \underbrace{(\kappa^N, \kappa^S)}_{\text{fixed cost}}]$$

There are ten parameters, eight of which are relevant to demand. The state variables are $s_{it} = (k_{it}, \omega_{it}, \lambda_{it}^N, and \lambda_{it}^S)$. Information on discrete choice regarding entry/exit and information regarding continuous variables are both useful in pinning down the parameters. There is a burgeoning strand of literature on dynamic discrete choice. This literature proposes different two-step estimation methods by which to avoid the large state space problem (Hotz and Miller, 1994; Bajari, Benkard and Levin, 2007; Arcidiacono and Miller, 2011). However, the two-step methods are not applicable in this case, because the state variables, λ_{it}^f, are only partially observed and serially correlated.

Nevertheless, ignoring the partially observed export sales and making use only of entry/exit information causes us to miss part of the identification source for demand parameters. Das et al.(2007) construct the simulated demand jointly with firm entry/exit in order to fully utilize information. Given the large state space, the paperïijŇrather than utilizing individual information to construct maximum likelihood, adopts simulated methods of moments to capture both discrete-type entry/exit as well as continuous-type export sales information.

The following four sets of moments inform our estimations of the parameters of demand and fixed cost.

(1) The first set of moments contains cross-sectional discrete-type information: export destination choice. Specifically, it includes a proportion of non-exporting firms $Pr(e_{it} = (0,0))$, a proportion of firms exporting to the North $Pr(e_{it} = (1,0))$, a proportion of firms exporting to the South $Pr(e_{it} = (0,1))$, and a proportion of firms exporting to both the North and South $Pr(e_{it} = (1,1))$.

(2) The second set of moments carries information collected over time. The eight moments characterize firms' choices to start/continue/end exporting to foreign market f and the decision to stay non-exporting between t and $t+1$. They are the following:

$$\begin{aligned}
&Pr(e^N_{it-1} = 0, e^N_{it} = 1) \quad \text{and} \quad Pr(e^S_{it-1} = 0, e^S_{it} = 1)\\
&Pr(e^N_{it-1} = 1, e^N_{it} = 1) \quad \text{and} \quad Pr(e^S_{it-1} = 1, e^S_{it} = 1)\\
&Pr(e^N_{it-1} = 1, e^N_{it} = 0) \quad \text{and} \quad Pr(e^S_{it-1} = 1, e^S_{it} = 0)\\
&Pr(e^N_{it-1} = 0, e^N_{it} = 0) \quad \text{and} \quad Pr(e^S_{it-1} = 0, e^S_{it} = 0)
\end{aligned}$$

Since demand is market-specific, the switching pattern of each market, rather than the joint-switching decision $Pr(e_{it-1} = (0,0), e_{it} = (0,1))$, captures major variations.

(3) In addition to entry/exit discrete-type information, the third set of moments that includes continuous-type information is the average of domestic sales relative to export sales in f, conditional on exporting:

$$ln(\frac{r^D_{it}}{r^N_{it}}) \quad and \quad ln(\frac{r^D_{it}}{r^S_{it}})$$

(4) The last set of moments carries the overtime information of export sales,

conditional on exporting:

$$Cov(\ln r^N_{it}, \ln r^N_{it-1}) \quad and \quad Cov(\ln r^S_{it}, \ln r^S_{it-1})$$

$$ln(\frac{r^N_{it}}{r^N_{it-1}}) \quad and \quad ln(\frac{r^S_{it}}{r^S_{it-1}})$$

The four sets of moments contain 18 moments in total to match. Among those moments, $Cov(\ln r^f_{it}, \ln r^f_{it-1})$ and $ln(\frac{r^f_{it}}{r^f_{it-1}})$ provide identification source of ϕ^f_1 and ϕ^f_2, respectively. Given ϕ^f_1 and ϕ^f_2, ϕ^f_0 is mainly pinned down by $ln(\frac{r^f_{it}}{r^N_{it}})$ as shown in (17). Given ϕ^f_0, ϕ^f_1 and ϕ^f_2, the identification source of κ^f mainly comes from the first set of moments. In addition, σ_{λ_f}, which determines the volatility of demand, is identified from the second sets of moments. However, the identification sources for those parameters are not fully separable.

While the first and the second set of moments contain discrete-type information on entry/exit, the third and the fourth set of moments carry continuous-type information on sales. From another perspective, the first and the third sets of moments include cross-sectional information and the second and the fourth set of moments capture variation over time. Θ is derived from the minimization of distance between simulated moments $m(\Theta)$ and data moments M[16]:

$$\Theta = argmin \quad (m(\Theta) - M)'\mathbb{W}(m(\Theta) - M)$$

where $\mathbb{W}$ denotes the weighting matrix that is estimated using the inverse of the Variance-Covariance matrix of data moments. $m(\Theta)$ and M represent simulated moments and data moments. Standard errors are calculated as the square roots of the diagonal elements of the Variance-Covariance matrix $[\frac{\partial m(\Theta)}{\partial \Theta}'\mathbb{W}\frac{\partial m(\Theta)}{\partial \Theta}]^{-1}$. The model fits the data well. A comparison between simulated moments and data moments is in Appendix A.7.

[16]Since k_i is constant over time, the fixed point of value function is concurrently computed for each k_i. The parallel computing reduces one dimension in state space, which greatly saves computational time. The algorithm is listed in Appendix A.6

Table 1.7. Demand and Fixed-Cost Parameters

	North	South
	Demand	
ϕ_0	0.06* (0.03)	0.61** (0.05)
ϕ_1	0.83** (0.01)	0.81** (0.04)
η_2	0.01 (0.09)	0.36** (0.03)
σ_λ	0.67** (0.01)	0.79** (0.02)
	Fixed Cost	
κ	8.90** (0.29)	8.71** (0.57)
$	$1,041,000	$861,000

** and * denote 1% and 5% significance levels.
Std. are in parentheses.

Several points are noteworthy. Contrary to its effect on productivity, exporting to the North does not have a significant impact on the market-specific component, demand. However, exporting to the South increases the market-specific component of demand in the South. In addition, $\sigma_{\lambda N} < \sigma_{\lambda S}$ indicates that demand is more volatile in the South.

The fixed costs translate into $\kappa^N \approx \$1,041,000$ and $\kappa^S \approx \$861,000$, measured in U.S. dollars. The estimated fixed cost in both the North and the South are large. The fixed cost that a exporting firm incurs each period consists primarily of the cost to maintain exports and the search to build up the firm's customer base. If the market penetration cost is convex, as in Arkolakis (2010), the low fixed cost in the South, coupled with the quick expansion of the customer base in the South imply the North is a tougher market to penetrate than the South. Due to the nature of dynamics, it is the gains in productivity, instead of the low fixed cost, that makes the North the more popular export destination compared to the South. The estimates show that there is a high fixed cost in the North, which is consistent with the study's other finding that the North is a more difficult market than the South (Crino and Epifani, 2012). Even though the market in the North is tough, the North still enjoys popularity because of the future value that comes with exporting to there.

1.6 A Possible Mechanism: Competition

Why is the market in the North more appealing than the market in the South? In this paper's structural model, the mechanisms are not modeled explicitly. Here, I offer a possible mechanism to suggest why export destination choice affects productivity and demand: the degree of competition varies by destination.

A major concern stems from the missing variable that exists between the destination and productivity/demand. It is well-known that exporting to the North is associated with intensive R&D activity that also helps to improve productivity (Aw, Roberts and Xu, 2011). If the export destination choice is driven by R&D activity, the causality between export destination choice and productivity is undetermined. In order to tease out the impact of R&D decision-making on productivity gains, I include the R&D decision along with the export decision:

$$\omega_{it} = \alpha_0 + \alpha_1 \omega_{it-1} + \alpha_2^N e_{it-1}^N + \alpha_2^S e_{it-1}^S + \alpha^{rd} RD_{it-1} + \epsilon_{it}$$

where productivity ω_{it} is estimated by industry using LP methods. RD_{it-1} denotes the variable associated with R&D. Both discrete and continuous choices regarding R&D are controlled for in columns (2) and (3), respectively[17].

Although R&D does indeed improve productivity, the inclusion of R&D does not change the significant effect that exporting to the North has on productivity. It can be said that export destinations themselves, rather than R&D, lead to improvements in productivity.

There are huge discrepancies between the markets in the North and the South. Most research focuses on contract enforcement (Araujo, Mion and Ornelas, 2015) or the development of financial institutions (Chan and Manova, 2013). Alternatively, I seek to highlight the importance of market competition based on the parameters in the structural model. Of course, these areas of research

[17] A discrete variable is defined as 1 if the R&D expenditure is greater than 0; it is defined as 0 otherwise. A continuous variable is taken to be the log of the R&D expenditure.

Table 1.8. Productivity, R&D and Export Destinations

	ω_{it} (1)	(2)	(3)
α_1	0.88**	0.88**	0.88**
	(0.001)	(0.001)	(0.001)
α_2^N	0.03**	0.02**	0.02**
	(0.005)	(0.005)	(0.005)
α_2^S	0.01	0.01	0.01
	(0.01)	(0.006)	(0.006)
α^{rd}		0.01**	0.006**
		(0.004)	(0.001)
obs.	846536	846536	846536
R^2	0.83	0.83	0.83

The discrete and continuous R%D variables are controlled for in columns (2) and (3).
** and * denote 5% and 1% significance levels, respectively. Std. are in parentheses.

are not mutually exclusive. Instead, they go in hand in hand with one another. For example, developed financial institutions often emerge simultaneously with intense competition in the product market.

The elasticity of substitution in the model, under the CES setup, characterizes the markup that sheds light on market competitiveness. A high elasticity of substitution implies low markup (a high degree of competition): $\frac{\sigma^N}{\sigma^N-1} < \frac{\sigma^S}{\sigma^S-1}$.

I assume $\alpha_2^f = \theta_1 + \theta_2\sigma^f$[18], $f \in \{N, S\}$ to capture how competition affects gains in productivity and demand. While θ_2 measures the influence of competition on productivity, θ_1 pins down the overall magnitude of α_2^N and α_2^S. A similar setup applies to demand:

$$\text{productivity:} \quad \alpha_2^N = \theta_1 + \theta_2\sigma^N, \quad \alpha_2^S = \theta_1 + \theta_2\sigma^S \tag{1.18}$$

$$\text{demand:} \quad \phi_2^N = \eta_1 + \eta_2\sigma^N, \quad \phi_2^S = \eta_1 + \eta_2\sigma^S \tag{1.19}$$

Given $\sigma^N > \sigma^S$, $\alpha_2^N > \alpha_2^S$, and $\phi_2^N < \phi_2^S$, it is easy to derive $\theta_2 > 0$ and $\eta_2 < 0$. While $\theta_2 > 0$ is consistent with previous research indicating the positive impact of competition on productivity (Syverson, 2004; Backus, 2014), $\eta_2 < 0$

[18]Other indicators, such as the markup $\frac{\sigma^f}{\sigma^f-1}$, are isomorphic to the elasticity of substitution.

may suggest that intense competition limits a firm's capacity to build up its customer base quickly because the products are easily substituted. It thus sheds light on the manifold effects of competition on productivity and demand.

Since in the model, productivity includes both production efficiency and product quality, intense competition helps increase productivity through either improving production efficiency, management quality (Bloom et al. 2010), or product quality (Amiti and Khandelwal, 2011).

1.7 Counterfactural Analysis

Returning to this paper's examination of different gains associated with export destinations, I consider the magnitude of the general component, productivity, and the market-specific component, demand in each market, on both the intensive and extensive margins of exports. Because the extensive margin is the choice variable and much of the variation in trade volume is driven by firmsâĂŹ extensive margin decisions regarding whether to participate in export markets, I pay attention to the extensive margin.

When a firm chooses a discrete entry decision, the effect on the intensive margin is mechanical in the sense that the evolution of productivity and demand jointly determine the intensive margin.

Both productivity ω_{it} and demand λ_{it}^{f} determine foreign sales at destination f. The revenue function at market f is:

$$\ln r_{it}^{f} = (1-\sigma^{f})\ln(\frac{\sigma^{f}}{\sigma^{f}-1}) + \ln\Phi_{t}^{f} + (1-\sigma^{f})(\beta_0 + \beta_k lnk_{it} - \omega_{it}) + \lambda_{it}^{f}$$

While the gains in productivity upon exporting to the North $\alpha_2^N = 0.01$ translate into sales of $(\sigma^f - 1)\alpha_2^N$ at destination f, after an additional period of exporting, the gains in demand ϕ_2^f is directly attributed to the sales. However, the firm's entry/exit decision complicates this issue. In particular, I eliminate both the productivity gains α_2^N and demand gains ϕ_2^S by setting them to 0. The following table displays the extensive margin, namely, the percentage of exporting firms.

Table 1.9. Effect of Gains on Extensive Margin

	(1) Benchmark	(2) $\alpha_2^N = 0$	(3) $\phi_2^N = 0$
$\%(e_{it} = 1)$	8.2%	4.9%	6.8%
$\%(e_{it}^N = 1)$	7.2%	3.4%	6.7%
$\%(e_{it}^S = 1)$	4.4%	2.6%	1.2%

$\%(e_{it} = 1)$ denotes the percentage of exporting firms; $\%(e_{it}^N = 1)$ and $\%(e_{it}^S = 1)$ denote the total percentage of firms exporting to the North and South, respectively.

Eliminating the gains in the North and the South deter 3.8 and 3.2 percentage points of total firms, which account for 52.8% $(\frac{7.2\%-3.4\%}{7.2\%})$ and 72.7% $(\frac{4.4\%-2.6\%}{4.4\%})$ of all exporting firms to the North and the South, respectively. Even though the elimination of gains in both markets play equally important roles in deterring firms' entry into the current market, it generates asymmetric effect on cross-markets entry in the long run. In particular, only 2.6 percentage points of all firms export to the South if $\alpha_2^N = 0$. However, 6.7 percentage points of firms still export to the North if $\alpha_2^S = 0$. To better characterize the asymmetric importance of productivity and demand to the extensive margin, consider that eliminating the productivity gains deters 34% $(\frac{4.4\%-2.6\%}{4.4\%})$ of the all firms that would have exported to the South, whereas shutting down the demand gains deters only 7% $(\frac{7.2\%-6.7\%}{7.2\%})$ of firms that would have exported to the North.

These estimates highlight the asymmetric importance of productivity and demand in firms' export decisions. Given the type of gains in different destinations over time, the North, rather than the South, appears an appealing destination to which a firm might start exporting over time. From another perspective, the fixed-cost reduction in the North encourages more firms to export than does an equal fixed-cost reduction on firms in the South. The following counterfactual analysis validates the argument by lowering the export barrier, namely, the fixed cost. In particular, I lower the fixed costs in the North and the South by 20%. [19]

[19] 20% reduction of fixed cost in the North and the South are equal to $200,000 and $172,000 measured in dollars

Table 1.10. Effect of Fixed Cost Reduction on Extensive Margin

	(1) Benchmark	(2) $\kappa^N \downarrow 20\%$	(3) $\kappa^S \downarrow 20\%$
$\%(e_{it}=1)$	8.2%	9.4%	8.7%
$\%(e_{it}^N=1)$	7.2%	8.9%	7.2%
$\%(e_{it}^S=1)$	4.4%	4.6%	5.3%

Unsurprisingly, a reduction in κ^N does not only have a larger impact on export participation in the North than an equal reduction in κ^S does on firms' export participation in the South, but also induces export participation in the South, where such effect does not exist for a reduction in κ^S.

The counterfactual analysis carries some implications for trade-promotion policies. For example, it is preferable to reach a bilateral trade agreement to reduce the trade barrier to the North.

1.8 Conclusion

Ultimately, it is not only export activity, but also export destination choice, that determines a firm's future export sales. Spurred by data regarding Chinese firms' exporting relationships to the North and South over time, in this paper, I set up a dynamic structural model of firms' export destination choices. Using this model, I distinguish between two types of determinants that affect a firm's export sales: a general factor, productivity, and a market-specific factor, demand. I then quantify the extent to which the export destination choice affects the evolution of each of the two components.

I find that exporting the North increases productivity, and this productivity subsequently promotes a firm's entry (sales) to other markets. In contrast, exporting to the South enables a firm to build up a customer base in its chosen destination market rapidly, which serves only to increase the firm's export sales in that particular market. Even though the fixed cost in the North is higher than the fixed cost in the South, exporting to the North remains appealing.

Competition may be a possible mechanism accounting for the discrepancy between the North and South.

Counterfactual analysis indicates that eliminating the benefits of exporting to the North has a larger adverse effect on export participation to the South than the other way around. The paper highlights the asymmetric importance of exporting to different destinations when considering the benefits that determine future exports.

There are several limitations to this research. Due to lack of data regarding domestic quantities, it is impossible to separate the components of efficiency and quality. Even though productivity is assumed to be the same across markets, the product quality probably varies across markets (Manova and Zhang, 2012). In addition, the dichotomy of North and South fails to take into account the variations within each destination, and in particular, the multiple political and economic structures of each destination that may influence firms' decision-making processes.

Chapter 2
The Role of Investment Determinants: Profit Shocks vs. Adjustment Costs

2.1 Introduction

The goal of this paper is to understand why investment rates are systematically different in urban and suburban areas. It has been well documented that there is huge heterogeneity in firms' investment rates of different sizes and industry.[1] However, little has been written about the impact of spatial differences on investment behavior. Geographical difference is important since firms in different areas face different profit shocks, adjustment costs and may have different production technologies. I quantify the relative importance of these factors through a structural model. This work is important in understanding the investment behavior of firms in different areas. Moreover, it provides a useful framework to evaluate policies which affect the investment decision of firms in urban and suburban areas.

On one hand, geography matters for production technology and profit shocks. The demand shocks and supply shocks reflect a variety of inter-

[1]Doms and Dunne (1998), "Capital Adjustment Patterns in Manufacturing Plants", Review of Economic Dynamics

correlated factors that are difficult to measure directly or precisely and are expected to be different in urban areas than suburban areas in general. For instance, the intensity of technological spillovers might be different in urban and suburban areas that potentially cause different profit shocks. Different shock processes are expected to have different impact on investment. On the other hand, capital adjustment costs that arise from various factors may also vary by urban and suburban areas. For example, prominent among the many sources of capital adjustment cost is land assembly coupled with capital adjustment. It is difficult in some situations to increase capital without expanding land and it can be difficult to put parcels together in very dense environments. The associated problem of land use regulation can also be easier in the suburbs. Additionally, the degree of irreversibility is expected to be higher in suburban areas due to less active secondary markets in general than that in urban areas.

To figure out the relative importance of these three factors in determining the investment rates in urban and suburban areas, I group the firms by location into firms in urban areas and suburban areas and decompose the investment rate differential. I estimate a dynamic model of firm capital choice using the capital intensive equipment-making industry in China from year 2001 to 2007. The average investment rate in urban areas is consistently 6-7 percentage points lower than suburban areas although they follow the same trend. The results shows the production technology is the same across firms in urban and suburban areas but the profit shocks are different in that the shocks are more volatile and with higher mean in suburban areas than in urban areas. Using the estimated parameters in the dynamic estimation, I find that the firms in urban areas generally face higher adjustment cost. In counterfactual analysis, 70-80 percent of the investment rate differential is able to be explained by the profit shock process while the rest, around 20-30 percent of the differential, is justified by adjustment cost.

The paper is organized as follows: Section 2 includes the relevant literature review. In section 3, I introduce the facts on firm investment pattern summarized from the data. Section 4 and 5 contain the model specification and estimation. The last section is the conclusion.

2.2 Literature Review

The previous literature highlights the importance of adjustment cost in explaining firm-level investment patterns. Changing the level of capital generates disruption costs during installation of any new or replacement capital and costly learning must be incurred as the structure of production changes. It is difficult to separately identify the individual effect without enough information. Hamermesh and Pfann (1996) categorize adjustment cost into internal cost and external cost, where internal cost mainly includes the set-up cost for new machines and external cost comes from the legal and administrative cost. Cooper and Haltiwanger (2006) estimate the capital adjustment costs using a general micro level dataset of U.S manufacturing firms and conclude that there are both linear(non-convex) and quadratic(convex) parts to the adjustment cost function. While the non-convex adjustment cost associates with one-shot cost, the convex adjustment cost, usually coupled with scale diseconomy in adjustment. In the spirit of Bertola and Caballero (1994), they also incorporate an irreversibility in terms of "resale price" into the model. The irreversibility caused by lack of secondary market serves as another form of adjustment cost when the forward-looking firms take into account the resale price.

The other relevant literature for this paper documents the impact of uncertainty shocks on investment. Bloom et. al (2007) find evidence indicating that firms which face greater uncertainty are more cautious in their investment behavior. He also concludes that the investment behavior of large firms is consistent with a partial irreversibility model in which uncertainty dampens the short-run adjustment of investment to demand shocks. Bloom (2009) finds that an increase in macro shocks causes a drop in investment in the short-run but leads to overshooting in long-run. In addition, he concludes the ignorance of capital adjustment costs is shown to lead to substantial bias, while ignoring labor adjustment costs does not. However, only the variance of the shock, instead of the overall shock process that encompasses the trend, is considered in that literature. Bond et. al (2011) simulate the relationship between the shocks and capital stock under different specifications of adjustment cost. Through numerical simulations, they find the increase in volatility of shocks reduces the capital stock under quadratic adjustment cost while the relationship between capital stock and shocks is inverted-U shaped under irreversibility specification.

Even though the uncertainty and adjustment cost interacts with each other and jointly determines the investment decision, no literature has quantified the relative importance in investment determinants.

2.3 Data

I use two datasets. The first data is the Annual Survey of Chinese Manufacturing Firms from year 2001 to 2007, in which all manufacturing firms with sales above 5 million RMB are included. The dataset mainly contains firm-level variables including revenue, input materials, wage bills and the district where the firm is located. The second dataset contains the geography information in year 2005, in which district level information such as the population are also included. In China, a city contains several districts. Some of these are classified as “urban" while others are labeled as "suburban".

The equipment-making industry is chosen because the industry is typically capital intensive. It is two-digit classified industry including boiler furnance, valve, compressor and other similar products. Thus, capital adjustment costs may play a key role here. The firms in the industry face monopolistic competition which is in line with the model setup. In addition, the established firms in the industry are geographically dispersed in urban and suburban areas as a result of the planned economy[2]. All these characteristics in the industry

[2]The selection of location choice will be discussed later on.

help us identify the capital adjustment cost spatially using the model in this paper. The final sample consists of 1775 firms, in which 1163 firms are located in suburban areas and 612 in urban areas. The industry features frequent entry and exit, where three possibilities might happen: (1) a firm shuts down and it disappears from the dataset. (2) a firm disappears from the dataset because of merger and acquisition. (3) a firm disappears because of falling off the 5 million sales cutoff line. Based on the available information, it is hard to separate the three possibilities so that entry and exit are not addressed here. Only firms that survive during the whole period from 2001 to 2007 are kept. The final dataset is a balanced panel.

2.3.1 Facts on Firm Investment Pattern

The investment I_{it} is unobservable. I calculate the investment I_{it} from the difference of observable capital stock K_{it} and K_{it+1}, where δ denotes the depreciation rate. In the dataset, the investment is not directly observable, δ denotes the tax depreciation, which is around 10% of capital stock. Since the investment I is recovered from the capital stock, it is hard to distinguish the types of investments. Also, it is impossible to tell the increase in capial stock is the result of merger and acquisition or the investment.

$$I_{it} = K_{it+1} - (1 - \delta) K_{it}$$

The investment rate is defined: $i_{it} = \frac{I_{it}}{K_{it}}$. Figure 2.1 illustrates the distribution of investment rate.[3] The investment rate distribution is right-skewed and densely clustered within the interval $[0, 1]$. From the distribution of the investment rate, it is easy to see that few firms' investment rate exceed 0.5.

However, the pooled investment rates in urban and suburban areas conceal strong heterogenous pattern. As exibited in Figure 2.2, higher proportion of

[3] I drop all extreme investment rate $i > 5$ just in case that the lumpy investment is the result of merger and acquisition.

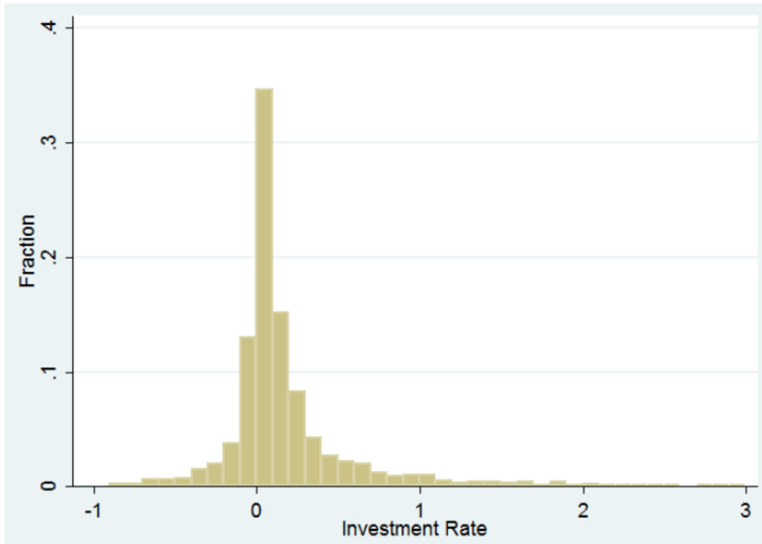

Figure 2.1. Investment Rate

firms in urban areas have investment rate around 0. Additionally, the fact that more right-skewed investment rate in suburban areas than in urban areas indicates more firms make higher investment rate in suburban areas.

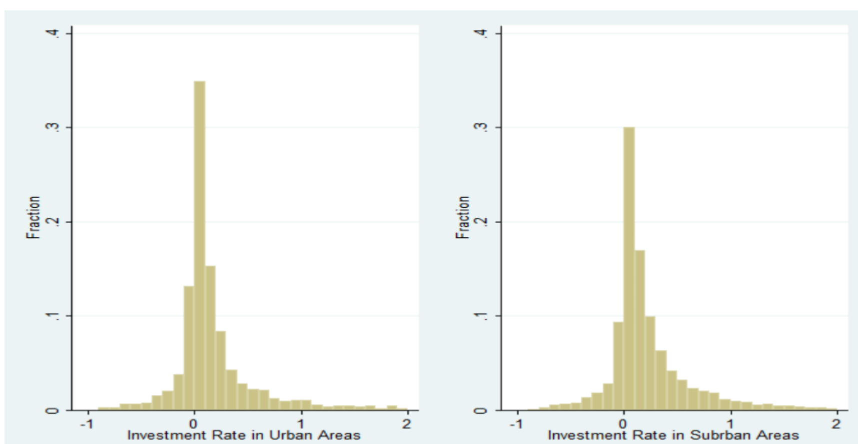

Figure 2.2. Investment Rate in Urban and Rural Area

The mean investment rate is $\bar{i} = 0.23$ with standard deviation $\sigma = 0.5$. However, there is a huge discrepancy in investment between firms in urban area and suburban area if we look at the data in detail. The statistics in Table 1 shed light on the evidence of spatial differences in the investment rate.

Both the mean and median of the investment rate in suburban area are

Table 2.1. Statistics on Investment Rate

	# of firms	median i	mean i	$\%(i > 0.3)$	$\%(i < 0.05)$
Urban	612	0.07	0.20	19.8%	31%
Suburban	1163	0.12	0.27	27.2%	23%

5-7 percentage points higher than those in urban areas. Additionally, the proportion of firms in suburban areas that makes the lumpy investment [4] is also 7 percentage points higher than those in urban areas. The proportion of inactive firms are also higher in urban areas than in suburban areas. If we look at the investment ratio each year, as shown in Figure 2.3, the investment rate differential is consistently around 5-7 percentage points across years even though they follow the same trends. This stable investment rate differential seems to be driven by systematic difference in urban and suburban areas.

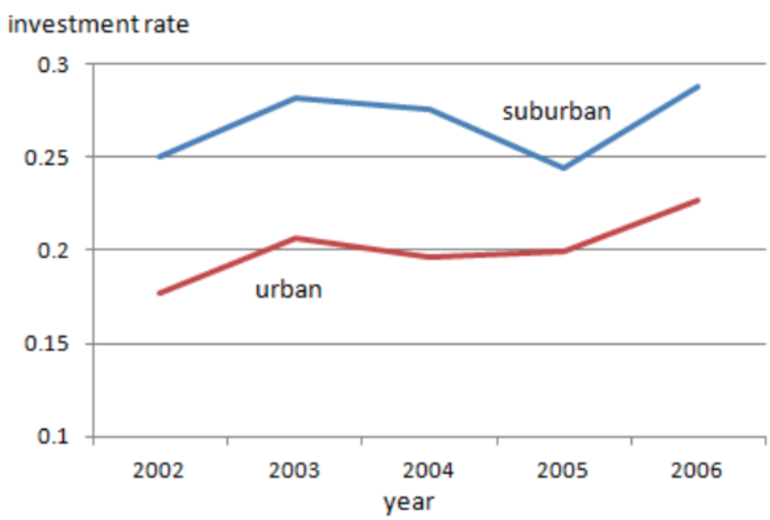

Figure 2.3. Investment Rate by Year

In addition to the aggregate statistics on investment pattern, individual firm investment behavior potentially sheds light on some competing explainations. Popular among the literature, individual firm makes investment following (S, s) rule so that lumpy investment pattern is informative. If we look at the

[4]The lumpy investment is defined as an investment such that the associated investment rate $i > 0.3$

frequency of individual firm's lumpy investment behavior, the more frequent lumpy investment could either be initiated by more volatile shocks or driven by higher non-convex adjustment cost. Table 2.2 highlights the statistics on lumpy investment:

Table 2.2. Proportion of Firms having # of lumpy investment

# of lumpy investment	0	1	2	≥ 3
Urban	40.5%	30.7%	20.1%	8.7%
Suburban	25.5%	33.8%	24.9%	15.8%

The table illustrates that lumpy investment is more frequent for firms in suburban areas. Column 1 shows that 40.5% firms in urban areas have no lumpy investment while only 25.5% of firms in suburban areas do not have lumpy investment.

All the statistics above lay out the systematic difference in investment between urban and suburban areas. However, the observable characteristics for firms are also different, as shown in Table 2.3. The capital/labor ratio is the almost the same in urban and suburban areas, which indicates the similarity in production technology. Two caveats potentially rises.

Table 2.3. Statistics on Firm Characteristics

	Urban	Suburban
% of state-owned firms	0.57	0.45
Capital	43.2	32.4
	(88.2)	(137.2)
Wage	8.7	6.4
	(17.1)	(19.8)
Worker	548.5	360.2
	(1059.2)	(778.0)

The first caveat comes from the ownership impact on investment. More state-owned firms are located in urban areas. On the one hand, the state-owned firms that are early established and have easy access to land, are more likely to be located in the urban areas. On the other hand, these state-owned firms, which potentially either face higher adjustment costs or lower payoff to investment, tend to invest less than non-state-owned firms. Alternatively, the investment rate difference might be driven by different types of firms rather than location.

Table 2.4. Ownership and Investment Rate

	state-owned firms	non-state-owned firms
Suburban areas	0.25	0.30
	(0.55)	(0.52)
Urban areas	0.17	0.23
	(0.46)	(0.52)

Eventhough Table 2.4 indeed sheds light on the systematic investment rate differential across ownership and investment rates conditional on ownership, the investment rate differential are not statistically significant. The std. error shows heterogeneity may exist among those firms if we do not consider other factors, say the firm size.

The second caveat stems from the correlation between firm size and investment rate. Table 2.3 illustrates that firms in urban areas are 30% larger in size. The larger firms that are more likely to have multiple plants, tend to allocate investment among plants to smooth firm level investment so that the firm level investment is less volatile (Matthias and Nicolas, 2012). However, the evidence of investment rate differential is robust to various specifications in regression after controlling for firm size, ownership and year effects.

From column (1) to (3), firms in urban areas are consistenly 4.1-6.7 percentage points lower in investment rate. The statistically insignificant interaction effect reveals there is no systematic size difference in investment rate within urban and suburban areas. If the dependent variable is changed into the investment amount as in column (4), the similar result that firms in urban areas have less investment still holds. The dependent variable in column (5) is the dummy variable that indicates whether the firm makes lumpy investment, the coefficient implies that the firms in urban areas are 6 percentage points less likely to make lumpy investment. All results boil down the systematic difference in investment behavior in urban and suburban areas.

Table 2.5. Regressions on Investment Difference

	(1)	(2)	(3)	(4)	(5)
Dep. Variables	i	i	i	I	$1\,(i > 0.3)$
urban	-0.067**	-0.044**	-0.041**	-2932.5*	-0.049**
	(0.012)	(0.012)	(0.012)	(1480.9)	(0.01)
ln(capital)		-0.054**	-0.062**	6144.6**	-0.045**
		(0.004)	(0.005)	(496.8)	(0.004)
state-owned			-0.042**	-1286.6	-0.044**
			(0.012)	(1091.5)	(0.01)
Year Effect	Yes	Yes	Yes	Yes	Yes
N	8875	8875	8875	8875	8875
R^2	0.005	0.021	0.024	0.37	0.016

** indicates 1% significance level; * indicates 5% significance level

In general, the investment pattern above is consistent with higher adjustment costs of investment or lower payoff to investment for firms in urban areas. However, the question whether the investment rate differentials are due to the difference in the production technology, profit shocks or adjustment cost are still ambiguous through the descriptive statistics and reduced form regressions. Now, we turn to the structural estimation of the firms' investment behavior to quantify the relative importance of each component in determining the firms' investment rates.

2.4 Model

Firm i in period t uses capital stock, labor and intermediate input, denoted by K_{it}, L_{it} and M_{it}, respectively, to produce Q_{it} units of product i. The production technology exhibits constant returns to scale and takes a Cobb-Douglas form:

$$Q_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{1-\alpha-\beta}$$

where A_{it} is the stochastic term, representing randomness in productivity. α and β are the same across firms in the industry such that $\alpha + \beta < 1$.

The demand for firm i in a monopolistically competitive product market is given by an iso-elastic downward-sloping demand curve:

$$Q_{it} = D_{it} P_{it}^{-\frac{1}{\eta}}$$

where η denotes the inverse demand elasticity and D_{it} is the stochastic firm-level demand shock. Denote w_{it} as the wage rate and m_{it} as the price for intermediate input for firm i in t. For a given K_{it}, the firm chooses variable input L_{it} and M_{it} to maximize the current profits Π_{it} :

$$\Pi_{it} = \max_{L_{it}, M_{it}} \left[P_{it} Q_{it} - w_{it} L_{it} - m_{it} M_{it} \right]$$

Denote $Y_{it} = P_{it} Q_{it}$ as the sales revenue. The first-order condition implies:

$$\frac{w_{it} L_{it}}{Y_{it}} = \beta \left(1 - \eta\right) \qquad \frac{m_{it} M_{it}}{Y_{it}} = \left(1 - \alpha - \beta\right)\left(1 - \eta\right)$$

Substituting the two maximized conditions above for variable inputs into the objective function:

$$\frac{\Pi_{it}}{Y_{it}} = \eta \left(1 - \alpha\right) + \alpha \tag{2.1}$$

The condition shows that the profit is proportional to revenue, which is jointly determined by α and η. The optimization also generates the profit function:

$$\Pi_{it} = Z_{it} K_{it}^{\theta} \tag{2.2}$$

where

$$\theta = \frac{\alpha \left(1 - \eta\right)}{\eta + \alpha \left(1 - \eta\right)}$$

and

$$Z_{it} = D_{it}^{\frac{\eta}{\eta + \alpha(1-\eta)}} \left(\eta + \alpha \left(1 - \eta\right)\right) \left[A_{it} \left(1 - \eta\right)^{1-\alpha} \left(\frac{\beta}{w_{it}}\right)^{\beta} \left(\frac{1 - \alpha - \beta}{m_{it}}\right)^{1-\alpha-\beta} \right]^{\frac{1-\eta}{\eta + \alpha(1-\eta)}}$$

Z_{it} is the profit shock that encompasses the productivity shock, demand shock and factor prices. Z_{it} denotes the statistics of "profitability" (Cooper and

Haltiwanger, 2006). θ is the production parameter that is composed of demand elasticity and production elasticity.

Following Cooper and Haltiwanger(2006), the capital adjustment cost $C\left(I_{it}, K_{it}\right)$ is specified:

$$C\left(I_{it}, K_{it}\right) = I_{it}\left(i_{it} > 0\right) - p_s I_{it}\left(i_{it} < 0\right) + \tau_1 K_{it} 1\left(\left|i_{it}\right| > 0\right) + \frac{\tau_2}{2}\left(i_{it}\right)^2 K_{it}$$

i_{it} denotes the investment rate $i_{it} = \frac{I_{it}}{K_{it}}$ where I_{it}, K_{it} denote investment and capital stock, respectively. p_s, which serves as the measure of irreversibility, denotes the price of disinvestment. p_s is expected to be less than 1: $p_s \in (0, 1)$. The degree of irreversibility also is treated as a kind of adjustment cost because rational expectation firms take into account the resale price when making investments. τ_1 measures the non-convex part of adjustment cost and τ_2 measures the convex[5] part of adjustment cost. The parameters of interests in the adjustment cost are: (p_s, τ_1, τ_2).

Given all the formulations above, a firm's dynamic problem is formulated recursively as:

$$V\left(K, Z\right) = \max_{I}\left\{\Pi\left(K, Z\right) - C\left(I, K\right) + \beta \mathbf{E}_{Z'|Z} V\left(K'|K, Z\right)\right\} \tag{2.3}$$

The policy function $I = g\left(K, Z\right)$ is a function of both capital stock and profit shock process. Individual firm, facing profit shock process, makes optimal investment(or disinvestment) I through tradeoff between the current profit, by incurring the adjustment cost, and future discounted payoff. Due to the existence of capital adjustment cost, the first order condition for the dynamic programming problem is not smooth and continuous so that estimation using Eular equation is not applicable. Instead, I use the simulated methods of moments to estimate the equation . In the following section, I will detail the estimation step.

[5]Most of the literature alternatively refer the "non-convex" and "convex" parts to the "linear" and "quadratic" parts in adjustment cost, respectively.

2.5 Estimation

The coefficients are estimated in two steps: I estimate the static parameters including the production parameter and profit shocks process in stage 1. Then I substitute those parameters into the second stage to estimate the dynamic parameters (p_s, τ_1, τ_2). In the following part, I conduct the estimation for firms in urban and suburban areas, separately.[6]. First, let us look at the timing assumption.

2.5.1 Timing

(1) At the beginning of period t, the capital K_{it} is realized for the firm.

(2) Upon receiving the profit shock Z_{it}, the firm makes the decision on variable input L_{it} and M_{it} so that the profit $\Pi_{it} = Z_{it} K_{it}^{\theta}$ is realized.

(3) After the profit is realized, the firm makes investment decision I_{it} with the capital adjustment cost $C(I_{it}, K_{it})$, the capital stock evolves: $K_{it+1} = (1-\delta_{it}) K_{it} + I_{it}$

(4) The time evolves to $t+1$.

2.5.2 Static Estimation

I measure profit Π_{it} as the result of revenue minus the variable cost (Das, Tybout and Roberts, 2007):

$$\Pi_{it} = R_{it} - MED_{it} - WAGE_{it}$$

where MED_{it} measures the intermediate input and $WAGE_{it}$ denotes the total wage bill.

For simplicity, the profit shock $\ln Z_{it}$ follows AR(1) process:

$$\ln Z_{it} = \mu + \rho \ln Z_{it-1} + \epsilon_{it} \qquad \epsilon_{it} \sim N\left(0, \sigma_{\epsilon}^2\right)$$

[6]All parameters are labeled with superscript $l \in [urban, suburban]$. For instance, $p_s^{suburban}$ and p_s^{urban} denote the p_s for firms in suburban and urban areas, respectively.

Taking logarithm of (2) and substituting the AR(1) process into the expression:

$$\ln \Pi_{it} = \mu + \rho \ln \Pi_{it-1} + \theta \ln K_{it} - \rho\theta \ln K_{it-1} + \epsilon_{it} \tag{2.4}$$

The timing assumption implies $\epsilon_{it} \perp (\Pi_{it-1}, K_{it}, K_{it-1})$ so that we directly apply constrained OLS to the above equation (4) to obtain $\left(\widehat{\theta}, \widehat{\rho}, \widehat{\mu}\right)$. Having estimated θ, the productivity shock is recovered by $\ln \widehat{Z_{it}} = \ln \Pi_{it} - \widehat{\theta} \ln K_{it}$. Under the assumption of AR(1) process, we use the maximum likelihood estimation to obtain $\widehat{\sigma_\epsilon}$. The static estimation results are summarized in Table 2.6.[7]

Table 2.6. Static Estimation

Parameter	Urban	Suburban
$\widehat{\theta}$	0.642**	0.680**
	(0.225)	(0.196)
$\widehat{\rho}$	0.585**	0.570**
	(0.114)	(0.101)
$\widehat{\mu}$	-0.102**	-0.061**
	(0.006)	(0.008)
$\widehat{\sigma_\epsilon}$	0.569**	0.650**
	(0.035)	(0.024)

** indicates 1% significance level; * indicates 5% significance level

θ denotes the production parameter and $(\mu, \rho, \sigma_\epsilon)$ jointly determines the profit shock process. I conduct the Wald Test[8] to test whether production parameter and profit shock process are significantly different for urban and suburban areas. The results indicate θ is not statistically different but reject the hypothesis of equal parameter for the profit shock process $(\rho, \mu, \sigma_\epsilon)$. Since

[7]Instead of using AR(1) process to estimate $\widehat{\sigma_\epsilon}$, the std errors of the regression are 0.52 and 0.69 for firms in urban and suburban areas, respectively. The result exibits the similar pattern of the more volatile shock in suburban areas. The results of other robust checks are listed in appendix.

[8]The Null hypothesis: $\widehat{\theta^{urban}} = \widehat{\theta^{subrban}}$; the alternative hypothesis: $\widehat{\theta^{urban}} \neq \widehat{\theta^{subrban}}$. $\left(\widehat{\theta^{urban}} - \widehat{\theta^{subrban}}\right)' \left[Var\left(\widehat{\theta^{urban}}\right) + Var\left(\widehat{\theta^{subrban}}\right)\right]^{-1} \left(\widehat{\theta^{urban}} - \widehat{\theta^{subrban}}\right) \sim \chi^2(1)$ denotes the statistics for θ, the similar construction applies for $(\mu, \rho, \sigma_\epsilon)$

the mean of the AR(1) process is $\frac{\mu}{1-\rho}$, which is -0.23 and -0.17 in urban and suburban areas. The shock process in suburban areas is more volatile but with a higher mean. How will the profit shock process affect firm investment? The overall effect is ambiguous in the sense that the volatility in terms of σ_ϵ reduces investment whereas the more positive shock boosts the investment.

2.5.3 Dynamic Estimation

Having estimated the static parameters $(\theta, (\mu, \rho, \sigma_\epsilon))$, I estimate the dynamic parameters (p_s, τ_1, τ_2) using Simulated Methods of Moments based on simulation of firms' investment choice using the policy function derived from equation (3). Intuitively, the identification of p_s partly comes from the the asymmetric investment and disinvestment conditional on τ_1 and τ_2 while the identification of τ_1 and τ_2, comes from the frequency of investment as well as the investment rate.

In order to capture the information, 4 types of moment conditions are employed, they are: (1) inaction rate: $\%(|i| < 0.05)$: the inaction rate mainly identify the non-convex part of adjustment cost. (2) The negative spikes and (3) The positve spikes jointly pin down the convex part of adjustment cost while the asymmetry between the two spikes pin down the irreversibility. (4) $corr(i_{-1}, i)$: the correlation between i_{-1} and i rationalizes the convex part of adjustment cost. The moments in (1) (2) and (3) capture the cross-sectional information while the moment in (4) capture the dynamic information.

Under the assumption that the firms' behavior are in partial equilibrium, the objective function $L(\Theta)$ is minimized over the parameter space Θ: [9]

$$L(\Theta) = (M(\Theta) - M(data))' W (M(\Theta) - M(data))$$

where $M(\Theta)$ and $M(data)$ denote the vector of moments from model sim-

[9] The algorithm of simulation details are in appendix. I simulate 200 periods and get rid of the first 190 periods in order to eliminate the starting value effect. I also simulate with firms' initial capital stock the same as the data in year 2001. The results turns out to be the same.

ulation and data, respectively. The optimal weighting matrix $W = \Omega^{-1}$, is calculated by bootstrapping for 10,000 times from data to obtain the variance-covariance matrix Ω. Intuitively, W puts more weight on moments that have smaller variance. Since there are 3 parameters of interest, I estimate the model using 3 moments and 4 moments, respectively. The 3 moments adopted in both models are: (1) $corr(i_{-1}, i)$ (2) $\%(i > 0.3)$ and (3) $\%(i < -0.2)$. The additional moment: $\%(|i| < 0.05)$ is added up in 4 moments estimation to capture the proportion of inactive firms[10]. The estimation results are listed:

Table 2.7. Dynamic Estimation

	3 Moments		*4 Moments*	
	Urban	*Suburban*	*Urban*	*Suburban*
p_s	0.49**	0.29**	0.57**	0.42**
	(0.012)	(0.001)	(0.01)	(0.004)
τ_1	0.09**	0.06**	0.10**	0.04**
	(0.001)	(0.01)	(0.002)	(0.007)
τ_2	0.09**	0.08**	0.09**	0.07**
	(0.02)	(0.02)	(0.01)	(0.02)

** indicates 1% significance level; * indicates 5% significance level

Several striking facts are worth pointing out.

First, $p_s^{suburban} < p_s^{urban}$ sheds light on the higher irreversibility in suburban areas, which potentially reflects the resale price in urban versus suburban markets when a firm decides to sell the assets. The resale price amounts to 49%-57% of purchase price in urban areas whereas it amounts to 29%-42% of purchase price in suburban areas. Note that both p_s^{urban} and $p_s^{subrban}$ are much lower than that in Cooper and Haltiwanger(2006), in which $p_s = 0.97$. The difference, possibly comes from the irreversibility of industry specific capital versus general capital since I single out the equipment-making industry where all manufacturing industries are employed in that paper.

Second, $\tau_1^{urban} > \tau_1^{suburban}$ and $\tau_2^{urban} > \tau_2^{suburban}$, which implies that urban firms face higher adjustment cost once they start to make investment. The non-convex part τ_1 is numerically equivalent to about 9% and 6% of capital for urban

[10]The computation algorithm is in Appendix B

and suburban firms, respectively. If the convex part τ_2 is taken into account, the adjustment costs for urban firms almost double the magnitudes of the adjustment costs for suburban firms. The results help explain the evidence that urban firms make less lumpy investment and investment rates are lower once they invest. (p_s, τ_1, τ_2) jointly reveal the internal and external cost as argued by Hamermesh and Pfann(1996), the internal cost mainly includes the set-up cost for new machines and the external cost comes from the legal and administrative cost by external agencies. In general, higher convex and non-convex part have a straightforward negative effect on investment but the irreversibility effect is ambiguous(Bond et. al, 2011). On one hand, higher irreversibility prevents the investment ex ante. On the other hand, the irreversibility reduces a firm's incentive to disinvest when it receives negative shocks, which in turn leads to higher capital accumulations. The model fits the data very well.[11]

2.6 Counterfactual Analysis

Having estimated the parameters in both the static and dynamic parts of the model, it is possible to quantitatively decompose the investment rate differential into three 3 components. From the previous statistics, the investment rate differential is constant around 6-7 percentage points across years in urban and suburban areas. The estimation reveals the production parameter θ is the same while the main difference come from the profit shock and adjustment cost. I conduct the counterfactual analysis by switching the profit shock process and adjustment cost. The column (1) and (2) are the benchmark case, in which investment rate is derived from the data and model prediction, respectively. The result in column (3) is the counterfactual analysis when both adjustment cost and profit shocks are switched. Actually, the urban firms become "suburban firms" and suburban firms become "urban firms". It also serves as the validity check in that the switch of both profit shock process and adjustment cost successfully

[11]The model fit is in Appendix B

replicates the counterparts' investment rate.

Table 2.8. Counterfactual Analysis

	Average Investment Rate				
	(1)	(2)	(3)	(4)	(5)
Urban	0.20	0.16	0.27	0.24	0.18
Suburban	0.27	0.26	0.16	0.17	0.23

Note (1)data statistics; (2)model prediction; (3)switching both; (4)switching profit shock processes; (5)switching adjustment costs

The interesting cases come into column (4) and (5). In column (4), firms in urban and suburban areas are imposed on the counterparts' profit shock process but kept their own adjustment cost. That is, urban firms are assumed to have the suburban profit shocks $(\mu, \rho, \sigma_\epsilon)^{suburban} = (-0.06, 0.57, 0.65)$ but keep the urban adjustment cost $(p_s, \tau_1, \tau_2)^{urban} = (0.57, 0.1, 0.09)$. Correspondingly, subrban firms are assumed to have urban profit shocks $(\mu, \rho, \sigma_\epsilon)^{urban} = (-0.102, 0.585, 0.57)$ but keep the suburban adjustment cost $(p_s, \tau_1, \tau_2)^{subrban} = (0.42, 0.04, 0.07)$. The result exibits 8-9 percentage point investment rate changes. In column (5), I conduct the other counterfactual analysis by switching the adjustment cost but keeping the profit shock process unchanged. The switching of adjustment cost contributes 2-3 percentage points difference in investment rate. From the relative percentage point changes, the profit shock changes explain 70-80% of the investment rate differential while the difference in adjustment cost accounts for 20-30% of the differential.

Table 2.9. Counterfactual Analysis

	Distribution of Investment Rates			
	(1)	(2)	(3)	(4)
$corr(i_{-1}, i)$	-0.07	-0.15	-0.09	-0.11
$\%(i > 0.3)$	0.11	0.31	0.13	0.26
$\%(\lvert i \rvert < 0.05)$	0.40	0.26	0.35	0.32
$\%(i < -0.2)$	0.10	0.11	0.11	0.09

(1): urban profit shocks + urban adjustment costs; (2): suburban profit shocks + suburban adjustment costs; (3): urban profit shocks + suburban adjustment costs; (4): suburban profit shocks + urban adjustment costs;

Moreover, the associated moments are listed in Table 2.9 in the counterfactural analysis. Column (1) and (2) denote the model predictions in urban and suburban areas, respectively. Column (3) denotes the case where firms are imposed on profit shocks in urban areas and adjustment costs in suburban areas. Not surprisingly, the lower adjustment cost in suburban areas slightly shifts the investment rates to positive, especially reduces the proportion of inactive firms from 40% to 35%. However, the effect is not that significant in lumpy investment tails because the deduction in adjustment cost only boosts proportions of lumpy investment from 11% to 13%. A potential explaination may lie in that the difference in adjustment costs mainly comes from the linear parts τ_1, rather than the quadratic parts τ_2. Column (4) denotes the situation where firms are imposed on profit shocks in suburban areas and adjustment cost in urban areas. The difference in profit shocks greatly shifts the investment rates to positive. To be noted, it significantly incentivizes more firms to make lumpy investment compared with column (1) and mildly decreases the proportion of inactive firms.

While the adjustment costs equally account for the proportion of inactive firms as the profit shocks, the profit shocks better justify higher proportion of lumpy investment. However, both the differences in profit shocks and the capital adjustment costs have no impact on the the proportion of disinvestment.

2.7 Conclusion

In this paper, we have presented evidence that firm investment rates are 6-7 percentage points systematically lower in urban areas than in suburban areas for the equipment making industry. Following previous literature that explores different factors' contribution to investment rate, I single out three prominent components that have been widely documented: the production technology, profit shocks and the capital adjustment cost and quantify their relative importance in determining the investment rate differential. The paper contributes to the literature by quantifying the relative importance of these factors explaining differences in firm investment behavior between urban and suburban areas.

The estimation shows that the firms use the same production technology in both urban and suburban areas. However, the profit shocks for firms in suburban areas are more volatile and with higher means than in urban areas. When it comes to capital adjustment costs, the firms in urban areas face higher adjustment costs in non-convex and convex parts but less degree of irreversibility. All those parts have potentially competing effects on investment so that the overall effect is ambiguous. In the counterfactual analysis, the profit shock process is found to contribute 70-80% to the systematic differential in investment rates while the adjustment cost difference explains only 20-30%. In addition, while adjustment costs equally explain the proportions of inactive firms as profit shocks, the profit shocks better rationalize the proportion of lumpy investment. As Bloom(2007) points out, firms' investment behavior on different types of capital during the volatile environment are different, the quantitative importance of profit shocks and capital adjustment costs are expected to be heterogeneous among types of capital. This topic is left for future research.

Appendix A

A.1 Extensive Margin and Destinations (By Country)

In order to see the extent to which exporting to the North(South) helps a firm enter into other markets, I examine a firms' expansion by countries.

$$E_{it}^{new} = \gamma^N e_{it-1}^N + \gamma^S e_{it-1}^S + X_{it}'\beta + \eta_t + \eta_{ind} + \epsilon_{it}$$

Table A.1. Extensive Margin (By Country)

	E_{it}^{new}		ne_{it}^{new}	
	(1)	(2)	(1)	(2)
γ^N	0.17**	0.18**	0.29**	0.28**
	(0.003)	(0.003)	(0.011)	(0.009)
γ^S	0.09**	0.10**	0.21**	0.19**
	(0.004)	(0.004)	(0.008)	(0.011)
$\ln k_{it}$	Yes	Yes	Yes	Yes
$\ln l_{it}$/ownership	No	Yes	No	Yes
year/industry effect	No	Yes	No	Yes
obs	881269			

** and * denote 5% and 1% significance level, respectively; std. are in parethsis.
The independent variable E_{it}^{new} denotes whether the firm enters into new market or not;
The independent variable ne_{it}^{new} denotes the number of new markets the firm enters.

$\gamma^N > \gamma^S$ indicates exporting to the North at $t-1$ indeed has larger impact on firms' expansion to other countries, compared with the impact imposed by the exporting to the South at $t-1$. Similarly, asymmetric effects are robust when the independent variables is the number of new countries: ne_{it}^{new}. The evidence of destinations by country carries the similar pattern as the dichotomy version of destinations, which supplements the previous findings.

A.2 Intensive Margin and Destinations (By country)

In similar vein, growth of foreign sales by each country(region) exhibits similar patterns in the following table. The left and right column document the Chinese major export destinations in the North and South, respectively. Even though there is a variation within each group, the growth of foreign sale in the North is systematically higher. The evidence by each country(region) consolidates with previous fact generated from dichotomy of destinations.

Table A.2. Intensive Margin and Destinations

North	(1)	(2)	South	(1)	(2)
Europe	0.32	0.31	India	0.38	0.38
U.S	0.26	0.25	Russian	0.26	0.26
Japan	0.13	0.12	Malaysia	0.17	0.17
Korea	0.19	0.18	Thailand	0.19	0.19
Canada	0.22	0.22	Mexico	0.24	0.25
Australia	0.19	0.18	Vietnam	0.23	0.22
New Zealand	0.15	0.15	Brazil	0.25	0.25

(1) and (2) denote the sample of firms with and without processing trade, respectively.

A.3 Productivity and Demand

In the appendix, I discuss the two critical terms in this paper: productivity and demand.

Productivity measures how efficiently production inputs, such as the capital and materials are used to produce output. Due to lack of price data, much literature measures productivity using revenue-based productivity, rather than the definition of quantity-based productivity (Syverson 2011). The revenue-based productivity measure is contaminated when goods are vertically differentiated and prices are heterogeneous across firms.

While productivity refers to the firm side, demand generally comprises two components on consumer side: the quality (Hallak and Sivadasan, 2013) and customer base (Arkolarkis, 2010). Given the same customer base, quality is measured as the residual of quantity conditional on price. However, customer base is embodied as the residual of quantity teasing out quality, conditional on price. The customer base is especially important in dynamic environment as a firm access new market gradually.

The following table clarifies the terminology and the associated meaning in this paper.

Table A.3. Terminology Comparison

		This Paper	Standard Definition
Productivity	Measure	revenue-based measure	quantity-based measure
	Component	efficiency + quality	efficiency
Demand	Measure	revenue teasing out both efficiency and quality	quantity teasing out price
	Component	customer base	quality + customer base

In contrast to standard definition, both production efficiency and product quality are merged into productivity.

A.4 Domestic Sales and Export Destinations

Even though the empirical facts rest on both the extensive margin and intensive margin of exports. The model also implies the relationship between the domestic sales and export destinations: only exporting to the North increases domestic sales. The following facts support the setup implied by domestic sales and export destination. I examine the relationship between domestic sales r_{it}^D and export destination choice:

$$\ln r_{it}^D = X_{it}'\beta + \theta_1 \ln r_{it-1}^D + \theta_2^N e_{it-1}^N + \theta_2^S e_{it-1}^S + \eta_t + \eta_{ind} + \epsilon_{it}$$

Table A.4. Domestic Sales and Export Destinations

	$ln(r_{it}^D)$	
θ_1	0.79**	0.60**
	(0.001)	(0.001)
θ_2^N	0.11**	0.04**
	(0.005)	(0.005)
θ_2^S	0.06**	0.01**
	(0.005)	(0.004)
X_{it}	NO	YES
year/industry effect	NO	YES
obs.	846536	846536
R^2	0.80	0.82

** and * denote 5% and 1% significance level, respectively;
std. are in parethsis.

Where X_{it}' include a set of characteristics, including the capital stock $\ln k_{it}$, $\ln lit$, productivity ω_{it-1} and ownership.

The estimates indicate that exporting to the North at $t-1$ is positively associated with increase in domestic sales at t. However, such correlation is much smaller when a firm exports to the South at $t-1$. The estimates justify the model setup of the general component that affect sales in all markets.

A.5 Empirical Regularties for the Plastic Industry

The plastic industry exhibits similar pattern to the whole sample in terms of preserving 3 empirical regularities. The plastic industry include 1675 firms are in total, 218 out of which has exported. It accounts for 13% of total firms, which is comparable to 14.6% of total sample. The following tables shows the similar 3 empirical facts in the plastic industry compared with the whole sample: (1) Export Destination Dynamics. (2) Domestic Sales and Export Destinations and (3) Foreign Sales and Export Destinations.

Table A.5. Export Destination Dynamics

		2nd year export				3rd year export				firm size		
		N	S	N&S	Total	N	S	N&S	Total	capital($1000)	labor	productivity
1st year export	N	44.3%	2.5%	17.7 %	79	34.6%	1.9%	28.8%	79	22.5	184	3.80
	S	5.6%	27.8%	22.2%	30	4.8%	22.2%	23.8%	30	29.1	187	3.83
	N&S	8.5%	2.4%	48.8 %	82	11.4%	4.9%	39.3%	82	41.1	189	3.84

Table A.6. Extensive Margin and Destinations (North vs. South)

	$Pr(e_{it}^N = 1)$		$Pr(e_{it}^S = 1)$	
	(1)	(2)	(1)	(2)
γ^N	2.62**	2.64*	1.27**	1.28**
	(0.16)	(0.17)	(0.19)	(0.12)
γ^S	0.48**	0.47**	1.65**	1.64**
	(0.13)	(0.13)	(0.19)	(0.19)
$\ln k_{it}$	Yes	Yes	Yes	Yes
$\ln l_{it}$/ownership/year effect	No	Yes	No	Yes

** and * denote 5% and 1% significance level, respectively;
std. are in parethsis.

Table A.7. Foreign Sales and Export Destinations

	$\triangle_{it} = lnr^f_{it} - lnr^f_{it-1}$			
	No Adj.		Adj.	
	(1)	(2)	(1)	(2)
N	0.20	0.27	0.11	0.23
S	0.24	0.28	0.16	0.20
D	0.06	0.05	0.06	0.05

(1) and (2) denote the sample of firms without processing trade and with processing trade, respectively.

Table A.8. Domestic Sales and Export Destinations

	$ln(r^D_{it})$	
θ_1	0.95**	0.82**
	(0.004)	(0.001)
θ^N	0.06*	0.04*
	(0.027)	(0.019)
θ^S	0.06	0.05
	(0.033)	(0.032)
X_{it}	NO	YES
R^2	0.86	0.88

** and * denote 1% and 5% significance level
std. are in parethsis.

A.6 Estimation Algorithm

It is computational intensive to solve the dynamic programming with 4 state variables. In addition to the 3 serially correlated state variables: $(\lambda_{it}^N, \lambda_{it}^S, \omega_{it})$. k_{it} is assumed constant over time k_i, which make it possible to parallel compute for each k_i. In practice, I take the average of capital stock for each firm as the k_i. By doing so, the computational time reduces into $\frac{1}{n}$, if k_i is discretized into n grids. Value function iteration is used to find the fixed point for each k_i. The detail steps are:

1. Discretized productivity ω, demand (λ^N, λ^S) and capital stock k_{it} into $\{\omega_p\}$, $\{\lambda_q^N\}$, $\{\lambda_r^S\}$ and $\{k_j\}$, where $p \in \{1, 2, ..., N_\omega\}$, $q \in \{1, 2, ..., N_{\lambda^N}\}$, $r \in \{1, 2, ..., N_{\lambda^S}\}$ and $j \in \{1, 2, ..., N_k\}$.

2. Because k_j is constant over time, parallel computed for each $k_j \in \{1, 2, ..., K\}$.

(2.1). For each k_j, constructed associated profit: $\pi^D(k_j)$, $\pi^N(k_j)$ and $\pi^S(k_j)$ according to (6) and (7) for each $s_{it} = (\omega_p, \lambda_q^N, \lambda_r^S)$ and calculated the choice-specific per-period payoff according to (11)-(14). The transition matrix for ω, λ^N and λ^S are also constructed.

(2.2). Constructed the value function $V^n(s_{it})$ for each state k_j and repeat (2.1) until the value function converges. Calculate the associated policy function for each state variable at k_j.

(2.3). Given the value function and policy function, simulate the N_j number of firms and calculate the associated moments $m(k_j, \Theta)$ for each k_j.

3. Weighing the moments $m(k_j, \Theta)$ by distribution of k_j to obtain the simulated moments $m(\Theta)$ and calculate the objective function, where M denotes the data moments.

In practice, all the moments are scaled up to the same magnitude and $\beta = 0.9$.

A.7 Model Fit

Table A.9. Model Fit: Data Moments and Simulated Moments

Moments				
	$\%((e^N_{it}, e^S_{it}) = (0,0))$	$\%((e^N_{it}, e^S_{it}) = (1,0))$	$\%((e^N_{it}, e^S_{it}) = (0,1))$	$\%((e^N_{it}, e^S_{it}) = (1,1))$
data	0.92	0.03	0.01	0.04
model	0.92	0.04	0.01	0.03
	$\%((e^N_{it-1}, e^N_{it}) = (0,0))$	$\%((e^S_{it-1}, e^S_{it}) = (0,0))$	$\%((e^N_{it-1}, e^N_{it}) = (0,1))$	$\%((e^S_{it-1}, e^S_{it}) = (0,1))$
data	0.91	0.93	0.02	0.06
model	0.91	0.94	0.02	0.01
	$\%((e^N_{it-1}, e^N_{it}) = (1,1))$	$\%((e^S_{it-1}, e^S_{it}) = (1,1))$	$\%((e^N_{it-1}, e^N_{it}) = (1,0))$	$\%((e^S_{it-1}, e^S_{it}) = (1,0))$
data	0.03	0.01	0.01	0.01
model	0.05	0.03	0.02	0.01
	$ln(r^D_{it}/r^N_{it})$		$ln(r^D_{it}/r^S_{it})$	
data	0.56		0.70	
model	0.72		0.84	
	$Cov(\ln r^N_{it}, \ln r^N_{it-1})$	$Cov(\ln r^S_{it}, \ln r^S_{it-1})$	$ln(\frac{r^N_{it}}{r^N_{it-1}})$	$ln(\frac{r^S_{it}}{r^S_{it-1}})$
data	0.8	0.79	0.2	0.25
model	0.9	0.89	0.42	0.61

Appendix B

B.1 Computation

All the static parameters $(\theta, (\mu, \rho, \sigma_\epsilon))$ have been estimated, therefore the parameters to be estimated in this stage are: (p_s, τ_1, τ_2). I conducted Simulated Method of Moments in dynamic estimation, where the algorithm contains an inner loop for each given parameters. In the inner loop, given parameters (p_s, τ_1, τ_2), value function iteration is used to find the fixed point and investment behavior is simulated from the associated policy function. Then I construct the simulated moments $M(\Theta)$ from the policy function to get the objective function $L(\Theta)$; In the outer loop, the parameter space Θ is searched over to minimize the objective function $L(\Theta)$. The detail implementation steps are as follows:

1. Discretize the two state variables: the capital K and the profit shock Z into N_K and N_Z grids, respectively. Given the static parameters $\left(\widehat{\theta}, (\widehat{\mu}, \widehat{\rho}, \widehat{\sigma_\epsilon})\right)$, use Tauchen method to calculate the stationary transition matrix $T_{(N_Z * N_Z)}$[1] and generate J firms whose capital stock are randomly drawn from the empirical distribution, with simulated profit shock sequences that follows AR(1) process: $\left(k_{j0}, \{z_{jt}\}_{t=1}^{T}\right)_{j=1}^{J}$. In addition, bootstrap 10,000 from data to construct W.

2. Pick the initial value (p_s, τ_1, τ_2)

    2.1. Given $\mathbf{V}^0_{(N_K * N_Z)}$ and $\mathbf{K}_{(N_K * N_Z)}$, use recursive formulation (3) to

[1] The subscript denotes the dimension of the matrix

optimally choose the $\mathbf{K}_i' = g(\mathbf{K}_i, \mathbf{Z})_{(1*N_Z)}$ for each $\mathbf{K}_i$ where $i = 1...N_K$. Update the value function $\mathbf{V}^1$.

2.2. Iterate until $\left\|\mathbf{V}^i - \mathbf{V}^{i+1}\right\| < \varepsilon$. Denote $\mathbf{V}^i = \mathbf{V}^*$.

2.3. Apply the policy function $\mathbf{g}_{(N_K*N_Z)}$ to simulated firms with $\left(k_{j0}, \{z_{jt}\}_{t=1}^T\right)_{j=1}^J$. Obtain the capital sequences $\left(\{k_{jt}\}_{t=1}^T\right)_{j=1}^J$ to calculate the investment: $inv_{jt} = \frac{k_{jt+1}-(1-\delta)k_{jt}}{k_{jt}}$ and associated investment rate: $i_{jt} = \frac{inv_{jt}}{k_{jt}}$.

2.4. Construct the associated moments $M(\Theta)$ and the objective function $L(\Theta)$, update the initial value function $\mathbf{V}^0 = \mathbf{V}^*$.[2]

3. Go back to step 2 and search over $(p_s, \tau_1, \tau_2) \in \Theta$ to minimize the objective function $L(\Theta)$.

[2]Instead of using $\mathbf{V}^0 = \mathbf{0}$ as the initial value function for each given parameter (p_s, τ_1, τ_2), use the last time value function $\mathbf{V}^*$ as the initial value function greatly reduces the computational time.

B.2 Model Fit

Table B.1. Moments Fit

Moments	*Urban*			*Suburban*		
	Data	3 *Moments*	4 *Moments*	*Data*	3 *Moments*	4 *Moments*
$corr(i_{-1}, i)$	-0.04	-0.10	-0.07	-0.06	-0.10	-0.15
$\%(i > 0.3)$	0.20	0.19	0.11	0.27	0.30	0.31
$\%(\|i\| < 0.05)$	0.31		0.40	0.23		0.26
$\%(i < -0.2)$	0.06	0.09	0.10	0.05	0.11	0.11
$L(\Theta)$		3.23	3.59		4.36	5.14

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- A Structural Model of Export Destination Dynamics, 2016
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