

The Mutable Geography of Firms' International Trade: Evidence and Macroeconomic Implications

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November 1, 2024

Abstract

Using customs data from China (2000-2006) and the UK (2010-2016), this paper documents that international trade is characterized by a mutable geography – firms frequently adjust their set of export markets, even for established large exporters. To understand the underlying micro shocks that drive these market changes, this paper proposes new empirical measures and exploits the information on firms' price and quantity changes in their continuing markets. I find consistent results in both China and the UK that most of these market changes are largely driven by demand-related shocks with a nontrivial proportion being correlated across markets. Introducing calibrated micro demand shocks into the a multi-country general equilibrium model implies a 3.5% increase in welfare due to endogenous market participation, but has a negligible impact on the welfare *changes* following a reduction in trade cost.

*I am deeply indebted to Giancarlo Corsetti and Meredith Crowley for their invaluable guidance and constant support. I thank Vasco Carvalho, Tiago Cavalcanti, Arpita Chatterjee, Doireann Fitzgerald, Scott French, Pete Klenow, Jozef Konings, Kim Ruhl, Lucas Macedoni, Balázs Muraközy, Rui Zhang and Weilong Zhang, and seminar and conference participants at the University of Cambridge, UNSW Sydney, the University of Liverpool Management School, the Research Centre for Firms and INdustry Dynamics (FIND) at the University of Aarhus, the 2019 ETSG Annual Conference, the 2020 ESCoE Conference on Economic Measurement, the 2020 EEA Annual Conference, the 2021 Asian Meeting of the Econometric Society, and the 2021 Royal Economic Society Annual Conference for their comments and advice. The views expressed in this paper are those of the author and not necessarily the views of the Bank of Canada.

1 Introduction

Firms engaged in the global economy face a complex and ever-changing landscape in which demand for a firm’s output rises or falls across different countries around the world. In part, country-specific fluctuations in demand for a firm’s product can be explained by country-specific aggregate fluctuations such as movements in bilateral exchange rates or CPIs. However, they also contain a significant idiosyncratic component—e.g., competition by exporters from third countries systematically impinges on the demand for a firm’s product. Overall, many things can shift the residual demand facing a firm in each of its foreign markets, motivating active re-optimization of pricing and market decisions. These decisions include whether to continue selling in an existing market, and whether to begin selling in a new market.

A key challenge in understanding what drives the firms’ market changes is that we do not observe the firms’ prices and quantities in markets that they have already exited or have not yet entered. Therefore, it is impossible to conduct direct estimation on changes in prices and quantities and infer the underlying shocks that drive the firms’ market changes. This paper proposes a novel identification strategy to overcome this challenge by looking at the firm’s price and quantity adjustments in its continuing markets. In particular, this paper provides new empirical measures to link firms’ intensive margin adjustments in continuing markets and extensive margin adjustments in market participation, and builds a conceptual framework to quantify the contribution of firm and firm-market specific demand and supply shocks in driving the firms’ market changes. It then uses a multi-country general equilibrium model with endogenous market participation to quantify the micro shocks faced by firms and assess the aggregate welfare implications of these shocks.

Empirically, using detailed information on country-specific product sales by firms from the universe of customs transactions from China (2000-2006) and the UK (2010-2016),¹ I document three novel facts on within firm (and product) market changes.² First, I find that the set of markets an exporter serves is highly variable, and that the value of these market changes is quantitatively significant at both the firm level and within the product level for each firm. I provide evidence that the geography of trade is highly mutable not only for growing firms but also for established ones, and that this mutability is especially pronounced

¹The two time periods were selected based on data availability and to study entry dynamics both before and after the Great Trade Collapse.

²The empirical analysis is conducted separately at firm, firm-sector (2-digit HS) level and firm-product (8 digit HS) level. While the exact quantitative estimates may differ, the main qualitative findings of this paper hold at different disaggregation levels.

among “the happy few,” large multi-product, multi-destination exporters.³ At the firm-product level, a typical established exporter changes *two-thirds* of its markets on a year-to-year basis, with about 30-40% of these extensive margin adjustments involve simultaneously adding and dropping markets.⁴

Second, for the same product, firms that drop more markets also see a significant decline in the quantity sold in the markets they continue to export to, with prices remaining largely unchanged. For a 1 percentage point change in the drop-to-change ratio, defined as the proportion of markets being dropped relative to the total number of markets that have been changed in the same period, the average quantity in the continuing markets drops by 0.65% while the average price only increases by 0.01%. These estimates suggest that these market changes could be largely driven by demand-related shocks that not only contain destination-market-specific changes but also correlated changes across markets.

Third, in a variance decomposition, I estimate that 20% of the variation in the firm’s choice of markets is associated with changes in bilateral exchange rates and local CPI. I document that firms are less likely to discontinue sales in countries whose currency has appreciated vis-a-vis its own currency. Moreover, my measure of market changes yields evidence consistent with a gravity model. The average geographical distance between all of a firm’s destinations and the firm’s origin declines in the proportion of markets being dropped. Firms are more likely to drop markets that are far away: everything else equal, there is ‘gravity’ not only in the cross section but also in the time variation of a firm’s trade pattern.

Theoretically, I build a tractable analytical framework to map the new empirical measures to fundamental model parameters and quantify the contribution of the underlying shocks that drive firms’ market changes. In particular, I show the relationship between the drop-to-change ratio and the price and quantity adjustments in the continuing markets provide important insights on the underlying shocks that drive the within-firm market changes. For example, firms dropping markets due to supply shocks should also see price rises in its continuing markets, resulting in a positive relationship between price changes in the continuing markets and the drop-to-change ratio. Similarly, firms dropping markets because of global demand shocks should see large quantity drops in their continuing markets but

³International trade is dominated by a relatively small number of large multi-product, multi-destination firms; see [Mayer and Ottaviano \(2008\)](#).

⁴I focus on the selection of export markets by established exporters over time rather than entry and exit decisions by new exporters. See [Alessandria, Arkolakis and Ruhl \(2021\)](#) for a recent review of the existing findings in the literature.

limited price changes⁵. In contrast, if the market changes are purely driven by destination-specific shocks, then the drop-to-change ratio is uncorrelated with the price and quantity adjustments in the continuing markets. Applying the framework to the data suggest that the within-firm market changes are largely driven by residual demand rather than supply shocks. In addition, a nontrivial fraction (30-50%) of these residual demand shocks are correlated across markets.

I then study the welfare implication of the micro-firm and firm-market specific demand shocks that drive firms' market changes after calibrating a multi-country general equilibrium model to match the newly documented empirical facts. Relative to a standard trade model without micro demand shocks, introducing micro shocks can (1) change the sales distribution of exporters, by giving small firms a chance of receiving positive micro shocks to enter the market, and (2) widen the set of firms influenced by a trade cost shock. Relative to the standard model where a trade cost reduction mainly affects firms around the productivity cutoff, small firms below the productivity cutoff can also be directly affected by the trade cost change in the model with micro demand shocks.

At the aggregate level, I show the total welfare is increasing in the size of micro shocks when firms are allowed to re-optimize their market participation decisions after receiving the micro shocks. At the size of micro shocks that match the data, the increase in welfare is sizable, at around 3.5%. All of this increase is driven by endogenous market participation { adding micro shocks in the absence of re-optimization of market participation has no impact on the aggregate welfare. Despite a higher level of welfare under micro demand shocks and endogenous market participation, the difference in the percentage change in welfare as a result of a trade cost change is only very weakly influenced by the size of the micro shocks. With the calibrated micro shocks, the difference in the percentage change in welfare in the model with and without micro shocks is negligible.

Literature: My empirical findings offer new insights to the literature on the export dynamics of firms [Chaney (2008), Alborno, Calvo Pardo, Corcos and Ornelas (2012, 2023), Timoshenko (2015), Araujo, Mion and Ornelas (2016), Fitzgerald, Haller and Yedid-Levi (2016), Ruhl and Willis (2017), Fitzgerald and Haller (2018), Geishecker, Schröder and Sørensen (2019), Alessandria, Choi and Ruhl (2021)]. It is most closely related to contributions from Alborno, Calvo Pardo, Corcos and Ornelas (2012) and Fitzgerald, Haller and Yedid-Levi (2016) both of which study the determinants of the formulation of a firm's trade

⁵In standard trade models with constant markups, demand shocks do not influence the prices set by firms. Even in variable markup models, such as Atkeson and Burstein (2008), a negative demand shock typically leads to a reduced markup, causing the firm's price to move in the opposite direction compared to the response to supply shocks.

pattern over time. Using firm-level data on Argentina, [Albornoz, Calvo Pardo, Corcos and Ornelas \(2012\)](#) document that many new exporters give up exporting immediately after entry while firms that can survive in the initial market expand to new destinations. [Fitzgerald, Haller and Yedid-Levi \(2016\)](#) focus on the growth of trade volumes and prices for successful exporters and find that, conditional on survival, there is an economically significant growth of trade volume within each of a firm's markets, but price growth is flat.⁶ My work contributes to this literature by creating new measures which focus on those foreign markets that have been added or dropped and linking these market changes to the price and quantity adjustments in those continuing markets, and fluctuations in local market conditions. In particular, I propose a novel method to investigate the underlying shocks behind the firms' market changes by linking a firm's extensive margin adjustments to its intensive margin adjustments in its continuing markets.

My theoretical finding is related to existing works around the aggregate implications of export participation on the transmission of international shocks and welfare [[Alessandria and Choi \(2007, 2014\)](#), [Ruhl \(2008\)](#), [Kehoe and Ruhl \(2013\)](#)]. My paper revisits this classical question focusing on the underlying micro shocks that drive the large within-firm market changes and their aggregate implication on output and welfare. I find that while micro shocks increase the aggregate welfare under endogenous market participation, they have negligible impact on the percentage change in welfare under trade cost shocks.

A group of works have emphasized the importance of large firms on aggregate fluctuations [[Gabaix \(2011\)](#) and [Carvalho and Grassi \(2019\)](#)]. This paper focuses on established exporters and analyses micro foundations of aggregate fluctuations through the lens of within-firm market changes. I show that mean zero micro shocks can have non-negligible aggregate and welfare impacts in the presence of endogenous market participation. My empirical and theoretical results together highlight the need to take into account the demand and entry aspects of firm heterogeneity along the lines of recent research by [Di Comite, Thisse and Vandebussche \(2014\)](#), [Hottman, Redding and Weinstein \(2016\)](#) and [Roberts, Xu, Fan and](#)

⁶Other important contributions include: [Ruhl and Willis \(2017\)](#) who find that new exporters sell small quantities and are highly likely to exit in the first few years; [Timoshenko \(2015\)](#) who finds new exporters add and drop products with much greater frequency than established exporters; and [Araujo, Mion and Ornelas \(2016\)](#) who finds that exporters start with higher volumes and sell for longer periods in countries with better contracting institutions. In addition, several recent papers suggest understanding the seller-buyer relationship plays an important role in explaining the growth path of destination choices of firms [[Aeberhardt, Buono and Fadinger \(2014\)](#) [Albornoz, Fanelli and Hallak \(2016\)](#) and [Araujo, Mion and Ornelas \(2016\)](#)].

⁷Recent works integrate the aspects of adjustments in products, inputs, markets and markups [[Bernard, Redding and Schott \(2011\)](#), [Bilbiie, Ghironi and Melitz \(2012\)](#), [Gopinath and Neiman \(2014\)](#), [Impullitti and Licandro \(2017\)](#), [Alessandria, Choi and Ruhl \(2021\)](#) and [Crowley, Han and Prayer \(2024\)](#)].

Zhang (2017)⁸

The rest of the paper is organized as follows. Section 2 explains the new empirical measures and the key results from applying the measures in the Chinese and British customs dataset. Section 3 introduces a tractable analytical framework and discusses the channels that can generate the observed pattern of within- firm market changes. Section 4 discusses the aggregate welfare implications of the calibrated micro shocks in a multi-country general equilibrium model with endogenous market participation. Section 5 concludes.

2 Within- firm Market Changes: Measurement and Evidence

Firms engaged in international trade have a "frothy" extensive margin characterized by simultaneous entry and exit. I develop a new set of measures for this froth, which can be used to quantify how market expansion/contraction by firms relates to local market conditions. This section discusses the main empirical findings on changes in the set of export markets served by a firm over time.

Due to the richness of the customs data, the market changes within a firm can happen along different product dimensions. I conduct the analysis separately on changes in trade patterns measured at the firm-product (8-digit HS), firm-sector (2-digit HS) and firm levels. In the following discussions, I focus on the statistics of market changes at the most disaggregated level, i.e., the firm-product level. Online appendices report measures and results at the firm-sector and firm levels, which largely confirm the main results discussed in the text.

2.1 Measuring Changes in Trade Patterns

How can we measure changes in trade patterns? I develop a set of simple measures to capture changes in the set of export markets served by a firm with a particular product over time. To illustrate the properties of the custom datasets and how trade pattern measures are defined and calculated, it is useful to go through the following example. The example, constructed to reflect the actual structure of trading patterns of many firm and product level transactions, conveys the highly unbalanced nature of data.

⁸Using Nielsen HomeScan data, Hottman, Redding and Weinstein (2016) find 50-70% of the variance in firm sales can be attributed to differences in taste or quality. By analysing the footwear industry of Chinese manufacturing firms during 2002-2006, Roberts, Xu, Fan and Zhang (2017) find that firm-specific demand factors account for 30% of sales and price variations among exporters.

Consider a firm that sells a product to four countries, A, B, C, D over 4 time periods. The left panel of Figure 1 shows the trading records of this firm-product pair. An empty cell means no trade. The right panel shows the construction of relevant statistics.

					Trade Pattern	Activity	M. Changes/ Markets	Drops/ Changes
t = 1	A	B			A-B			
t = 2	A		C		A-C	Churn	2=2	1=2
t = 3	A		C	D	A-C-D	Add	1=3	0=1
t = 4	A		C		A-C	Drop	1=2	1=1

Figure 1: An Example of Market Switching Measures

A trade pattern is defined as the set of destination markets that a firm-product pair exports to in a given period. The first column in the right hand side panel shows the identified trade patterns. In this example, 3 trade patterns are identified, i.e., A-B, A-C, and A-C-D. The second column in the right hand side panel classifies the activity of market changes into different categories. Market churn happens if the firm-product pair simultaneously adds and drops markets in a given period. In this example, market churn only occurs in period 2. The last two columns of Figure 1 show that changes to the extensive margin can be decomposed into two components: (a) the proportion of markets changed among all active markets and (b) the proportion of markets being dropped/added among the changed markets.

Specifically, I construct 5 measures meant to capture the magnitude, quantitative importance, direction and frequency of changes in the trade patterns of a firm (or firm-product):

Market Changes / Number of Markets: This variable captures the magnitude of market changes.

Count Measure: the number of markets that have changed from s to t divided by the total number of markets operating in period t , where s is the lag between two observed periods.

Value Measure: the total trade value of those markets that have changed from s to t divided by the total export value at period t , where s is the lag between two observed periods.

Market Drop / Market Changes (DC Ratio): This variable captures the proportion of markets being dropped among the total number of markets changed.

Count Measure: the number of markets being dropped from $t-s$ to t divided by the number of market changes from $t-s$ to t , where s is the lag between two observed periods.

Value Measure: the total trade value of markets being dropped from $t-s$ to t divided by the total trade value of markets being added and dropped from $t-s$ to t , where s is the lag between two observed periods.

Note that the drop-to-change ratio is a directional measure. If a firm only adds markets, the drop-to-change ratio will be zero; if a firm only drops markets, the drop-to-change ratio will be 1; If a firm simultaneously adds and drops markets, the drop-to-change ratio will be in between 0 and 1.

Probability of Churn: The number of market churn activities over the total number of trading periods, i.e., the probability that the drop-to-change ratio is neither one nor zero.

2.2 Data

I carry out my analysis on two custom databases: (1) the Chinese Customs Database, i.e., the universe of annual import and export records for China from 2000 to 2006 and (2) administrative data from Her Majesty's Customs and Revenue (HMRC) in the UK from 2010 to 2016.

The Chinese Customs Database reports detailed trade flows (quantities and values) at the firm-product-destination level. In addition to standard variables, such as the firm ID, an 8-digit HS code, the destination country and month, the database contains the Chinese measure word in which quantity is reported, an indicator of the form of commerce for tax and tariff purposes, and a categorization based on the registration type of the exporting firm.⁹ The database is available at the monthly frequency during the period 2000-2006.

⁹The form of commerce indicator records the commercial purpose of each trade transaction including "general trade," "processing imported materials," and "assembling supplied materials," etc. The registration type variable contains information on the capital formation of the firm by 8 categories: namely state-owned enterprise, Sino-foreign contractual joint venture, Sino-foreign equity joint venture, wholly foreign owned enterprise, collective enterprise, private enterprise, individual business, and other enterprise. In my later analysis, I group three types of foreign-invested firms, namely wholly-foreign-owned enterprise, Sino-foreign contractual joint venture and Sino-foreign equity joint venture, into one category and dub it as "foreign invested enterprises." I group minority categories such collective enterprise, individual business and other enterprise into one category and refer to them as "other enterprises."

I aggregate trade flows into the annual level in this study. Like other firm-level studies using customs databases, I use unit values as a proxy for prices. A product is defined as a 8-digit Harmonized System (HS) code. An industry is defined as a 2-digit HS code. The database reports transactions denominated in US dollars. I calculate the price in the exporter's currency (renminbi) by multiplying the unit value of dollar transactions with the annual renminbi-dollar rate.

The HMRC administrative datasets include transaction level trade flows for non-EU exports and monthly records for EU exports.¹⁰ HMRC reports the value of transactions denominated in sterling and two quantity measures (net mass and quantity). I aggregate trade flows at the firm-product-destination-year level by summing over quantity and value of transactions. The unit value is calculated as the total sterling value divided by the quantity with reported quantities (net mass in kilos, units, pairs, etc) and as the total sterling value divided by the net mass (in kilos) for products for which there is no specific quantity units reported. Firms are identified by a firm-specific anonymised identifier.¹¹ Products are defined by an 8-digit Combined Nomenclature (CN) code.¹² To create the same time span of Chinese firms, I focus on time period 2010-2016, where 2016 is the latest year of data available at the time when the analysis was performed.

Aggregate time series such as bilateral exchange rates and local CPI rates are taken from International Financial Statistics, International Monetary Fund. Data on geographical distance between countries is taken from the organised dataset of [Feenstra, Li and Yu \(2014\)](#).

In this draft of my paper, I only report the main empirical results on Chinese exporters in the following subsections. Statistics and estimates of UK exporters are reported in [Online Appendix: UK Results](#).¹³ The following statistics and estimates are based on exports to the destinations with non-missing bilateral exchange rates and CPI series during the sampling period.¹⁴ Statistics for the full sample including all destinations are similar and available

¹⁰EU records only contain UK firms whose exports to the EU exceed £250,000 in a given calendar year. The requirement to report exports at the detailed product level applies to firms whose total value of exports exceeds the reporting threshold. A comparison with official statistics indicates that these companies account for around 96-98% of the total value of UK exports to the EU. Details on the data statistics can be found in [Online Appendix: UK Results](#).

¹¹The raw data also contains a plant indicator on a firm has multiple production bases. In index of plant numbers are self-reported and may not consistent over time. I aggregate all trade flows into the firm level.

¹²There has been a major revision in the product classification during the year 2012 and many small revisions in other years during my sampling period 2010-2016. I wrote an algorithm to convert all product classifications into the base year (2012) while keeping the maximum number of consistent product definitions based on the [official concordance tables](#).

¹³HMRC requires two months of advance notice before it will permit any changes to documents that report results from its micro data. For expediency, I have placed all UK-based results in a separate document.

¹⁴In practice, this means I drop 51 (217-166) destinations whose total share of world trade is small.

upon request.

2.3 Stylized Facts on Within- firm Market Changes

Statistics on market changes at the most refined disaggregation level of my dataset, i.e., firm-product level, are reported below. Results on changes in trade patterns at the firm-sector and firm level are reported in my online appendices.

Table 1 presents the median of market change measures for Chinese exporters during 2000-2006. As shown in the table, around two-thirds of markets have changed between two observed trading years at the firm-product level (row 1). To clarify the economic importance of these market changes, I use the value measure of market changes (row 2). The question is whether market changes are mainly due to frequent changes of fringe markets with small trade values. As shown in the table, the value measure of market changes is actually substantially larger than the count measure, suggesting that market changes involve shifts in trade reflecting more than, say, trial and error with small markets.¹⁵

With a median value measure of market changes around 2.21, large firms seem to have more stable trade patterns. However, as large firms tend to trade with more markets, the total trade value involved in these changes is still bigger than that of small firms.

Table 1: Statistics on Firm-product Level Trade Patterns (Median)

	All Firms	Large Firms
Markets Changes/ Markets	0.67	0.64
Markets Changes/ Markets (Value Measure)	3.27	2.21
Markets Drop/ Market Changes	0.50	0.50
Markets Drop/ Market Changes (Value Measure)	0.41	0.35
Probability of Churn	0.26	0.33

Note: This table presents the statistics on changes in trade patterns at the firm-product (8-digit HS) level. Statistics are calculated based on year-to-year changes of Chinese exporters during 2000-2006. The median of each measure is presented in the table. Details regarding the distribution of relevant statistics are reported in Appendix A.2.

A key question is whether these market changes are mainly due to product switches/replacement within a firm|a possibility consistent with the empirical evidence documented by Bernard,

¹⁵It is worth stressing these large changes of trade value measures cannot be explained by the partial year effects as in Bernard et al. (2017) as this effect tend to lower the relative importance of the first year trade values.

Redding and Schott (2010). To clarify that the margins of market changes are actually substantially more general, I aggregate trade flows to the firm-destination-year level and repeat all empirical estimates discussed in this section. The degree of market changes are quantitatively smaller at the firm level, but the qualitative pattern remains the same.

In view of the large scale of market changes found in the data, a natural question is whether these changes mainly consists of dropping existing markets or adding new markets. The median value of market drops over market changes (drop-to-change ratio afterwards) is around 0.5. This suggests that firms simultaneously add and drop markets at the same time—a pattern that is difficult to rationalize using trade models that focus exclusively on supply side (productivity) determinants of trade. Note that the drop-to-change ratio is not very sensitive to the size of firms. The value measure of the drop-to-change ratio is slightly smaller for larger firms, suggesting that large firms are more likely to add markets. In terms of frequency, market churn accounts for around one-third of the trading periods.

Relying on the rich information included in the Chinese Customs Database, I uncover substantial heterogeneity in the degree of the value measure of market changes depending on the capital structure of the firm, the nature of the business and the degree of product differentiation. Table 2 shows results by firm and product types. Market changes are considerable for both private and state-owned enterprises. In contrast, trading patterns seem more stable for foreign invested enterprises, with only very small market changes.

The information on the form of commerce allows me to group transactions into three categories according to the purpose of trade: (a) those firm-product pairs conducting general trade, i.e., those manufacturers selling their own products in the foreign market; (b) firm-product pairs with contracts to process other foreign firms products/materials; and (c) firm-product pairs conducting businesses in both general trade and processing trade. There is a striking difference across these categories: large market changes are only observed in relation to general trade, but not for firms with contracts to process other firms products. Finally, I breakdown trade transactions by product differentiation according to Rauch (1999) classification. As shown in the bottom panel of Table 2, firms selling less differentiated products (such as vegetable animal products, and foodstuffs) rarely change their destination markets. In contrast, firms selling more differentiated products, such as machinery and mechanical appliances and optical and photographic products, demonstrate a significantly larger degree of market changes. A breakdown by two-digit industries is presented in Table A3 in the appendix.

The last two columns show the count and value measures of drop-to-change ratio. These statistics are calculated based on those time periods involving market changes. Although

Table 2: Breakdown by Firm and Product Types

	Market Changes / Markets		Market Drops / Market Changes	
		Value Measure		Value Measure
By Firm Ownership				
Private Enterprises	0.75	4.10	0.50	0.36
State-owned Enterprises	0.88	5.98	0.50	0.47
Foreign Invested Enterprises	0.33	0.18	0.33	0.12
By Form of Commerce				
General Trade	0.79	4.84	0.50	0.42
Processing Trade	0.40	0.22	0.50	0.37
Mixture	0.00	0.00	0.50	0.32
By Rauch Classification				
Differentiated Products	0.71	3.98	0.50	0.41
Reference Priced	0.50	1.01	0.50	0.42
Organised Exchange	0.40	0.19	0.50	0.48

Note: This table presents the statistics of firm-product level market change measures. The median of each measure is presented in the table. Source: Chinese Customs Database, 2000-2006.

the degree of market change differ among firm and product types, drop-to-change ratios are very similar across types.

These three dimensions of heterogeneity all together suggest within-firm-product market changes are far from random and unlikely due to transportation concerns such as infrequent shipments.¹⁶

2.4 Price and Quantity Adjustments in Continuing Markets

What drives these market changes? Do these market changes reflect large and frequent demand shocks facing the firms? Or are these changes driven by supply-side factors? For example, a firm receiving a common positive cost shock will need to increase its prices and thus may no longer get enough demand in some destinations to cover its fixed costs of exporting to those destination.

A known problem in addressing these questions is measurement. We do not observe the price that would have been set or the quantity that would have been sold before the firm

¹⁶All statistics are calculated based on year-to-year changes. This is another reason that the infrequent shipments would not play an important role in generating these results.

enters (or after the firm exited) the market. A key innovation of this paper is to exploit the price and quantity adjustments in the firm's continuing markets (i.e., those markets that the firm continues to sell to from $t - 1$ to t) to gauge the possible shocks facing the firms when they add or drop markets.

Figure 2 illustrates the estimation strategy, where I regress the changes in unit value or mean quantity sold in the continuing markets on the drop-to-change ratio, which measures the direction of the market changes, i.e., proportion of markets being dropped.¹⁷ The estimates from this specification captures whether firms dropping more markets also charge a higher price and a lower quantity in those continuing markets.

				Outcome in Continuing Markets	Drops/Changes
t = 1	A	B			
t = 2	A		C	$y_{A;2}$ $y_{A;1}$	1=2
t = 3	A		C D	$y_{AC;3}$ $y_{AC;2}$	0=1
t = 4	A		C	$y_{AC;4}$ $y_{AC;3}$	1=1

Figure 2: Illustration of the Estimation Strategy

Note: The first subscript in y denotes the set of markets in which the variable is calculated. The outcome variable is unit value or mean quantity calculated based on the set of markets indicated by the first subscript of y .

Table 3 presents a summary of the estimation results for the continuing markets. The estimates suggest the quantity in the continuing markets is significantly lower if more markets are dropped conditional on a market change. However, the changes in unit value of these markets is only weakly related to the proportion of the markets being dropped. The magnitude of unit value changes is small and the statistical significance of unit value coefficients is sensitive to the estimation sample.

While the market-specific demand changes can be important in driving the market changes, the estimates highlight that global, common demand changes are also important in driving the market changes. More specifically, the large quantity changes in the continuing markets suggest that a non-trivial proportion of the market changes are driven by changes in demand that are correlated across markets. If the market changes were purely driven

¹⁷Note that the drop-to-change ratio is already a change measure and therefore no further time differences need to be taken.

Table 3: Elasticity of Prices and Quantities to Drop-to-Change Ratio
(Continuing Markets, Summary of Key Estimates)

	(1) Unit Value	(2) Mean Quantity	Observations
Firm-product (8-digit) level	0.01*** y	-0.65***	1,244,580
Firm-sector (2-digit) level	0.03*** y	-0.73***	731,199
Firm level	0.05*** y	-0.73***	281,564

Note: This table presents a summary of estimates regressing price or quantity measures on the drop-change ratio. Each cell presents a parameter estimate from a separate estimation. The header of each column indicates the dependent variable of the corresponding estimation equation. Each row indicates the level of disaggregation at which the trade pattern measures are constructed. Firm-product and year xed effects are added for firm-product and firm-sector specifications. Firm and year xed effects are added for firm level specifications. The statistical significance is calculated based on robust standard errors with ***, **, * representing statistical significance at 1%, 5%, 10% level respectively. y indicates the magnitude and statistical significance of the estimates are sensitive to alternative samples and measures. Source: Chinese Customs Database, 2000-2006.

by idiosyncratic market-specific demand changes, then we would not have observed any big change in the quantity sold in the continuing markets.¹⁸

2.5 Market Changes and Local Market Conditions

Finally, as a way to quantify the importance of market-specific demand changes, I investigate the relationship between changes in local market conditions and within-firm market changes. In particular, I use fluctuations of bilateral exchange rates and changes in local CPI as proxies for changes in destination-specific demand. Intuitively, an appreciation of the currency of the destination country makes the product of foreign exporters relatively cheaper and thus makes it more profitable to sell to the destination country. All else equal, the firm is less likely to drop (more likely to add) a market whose currency has appreciated. Similarly, a rise in the average price of the consumption basket in a destination makes the price of the exporter relatively cheap and the exporter is less likely to drop (more likely to add) a market.

I estimate the following equation:

$$DC_{fit} = \beta_1 e_{fit} + \beta_2 p_{fit} + \beta_3 f_i + \beta_4 t + \beta_5 fit ; \quad (1)$$

¹⁸Note that, if the firm faces capacity constraints and makes a joint decision for all of its markets, then the exit of one market should lead to an increase in the quantity sold in (one of the) other markets.

Table 4: Regressing Drop-to-Change Ratio on Changes in Relative Market Conditions

	Exchange Rate	Destination CPI	Within R ²	Observations
<u>Count Measure</u>				
Firm-product (8-digit) level	-0.22***	-0.81***	0.23	1,791,353
Firm-sector (2-digit) level	-0.14***	-0.59***	0.21	875,096
Firm level	-0.12***	-0.45***	0.20	301,455
<u>Value Measure</u>				
Firm-product (8-digit) level	-0.21***	-0.83***	0.17	1,791,353
Firm-sector (2-digit) level	-0.14***	-0.61***	0.16	875,095
Firm level	-0.11***	-0.46***	0.16	301,455

Note: This table shows estimates from regressing drop-change ratio on relative exchange rates and destination CPI measures. The upper and bottom panel present results using the count and value measures of drop-change ratio respectively. Each row represents a separate regression with the different levels of disaggregation at which the trade pattern measures are constructed. Firm-product and year fixed effects are added for firm-product and firm-sector specifications. Firm and year fixed effects are added for firm level specifications. The statistical significance is calculated based on robust standard errors with ***, **, * representing statistical significance at 1%, 5%, 10% respectively. Source: Chinese Customs Database, 2000-2006.

where DC_{fit} is the drop-to-change ratio; e_{fit} is a measure of relative exchange rates; p_{fit} is the relative local CPI rate; and α_{fi} and β_t are firm-product and time fixed effects, respectively. $f; i; t$ represent firm, product, and time respectively. Details on construction of the relevant measures are discussed in Appendix A.1.

As shown in Table 4, a 1% increase in the relative exchange rate lowers the drop-to-change ratio by 0.2%, suggesting that those markets whose exchange rates have appreciated are more likely to be dropped conditional on a market change. Similarly, a 1% increase in local market CPI lowers the drop-to-change ratio by 45-83%. The magnitude of the estimates differs slightly between estimates of Chinese and British exporters. British exporters are less sensitive to changes in bilateral exchange rates and more sensitive to changes in destination CPI. Analysis of variance suggests that around 20% of the variation of the drop-to-change rate is explained by changes in the relative exchange rate and local market CPI measures.

In addition to changes in measures of local market conditions, I find the probability of market being dropped is negatively correlated with the geographical distance between the origin of the exporter and the destination country, suggesting that markets with longer distance are more likely to be dropped. The relevant results are presented in Appendix A.4 and discussed in more detail in the online appendix of UK results.

3 Conceptual Framework

In this section, I develop a tractable partial equilibrium model to highlight the key implications of the empirical facts documented in the previous section. Section 3.1 introduces the model setup. Section 3.2 derives a closed-form mapping between the model parameters and the proposed empirical measures, using a simplified version of the model with two types of firms and two markets. Section 3.3 then generalizes the results from Section 3.2 to include multiple firm types and markets, discussing how the contributions of various shocks can be identified from the measured statistics and estimated elasticities.

3.1 Model Setup

In each period t , a firm f decides whether to export to market d based on its operating profit $\pi_{f,dt}$ relative to the fixed cost of exporting f_{fd} . The firm's market participation indicator $\mathbb{1}_{f,dt}$ is:

$$\mathbb{1}_{f,dt} = \begin{cases} 1 & \text{if } \pi_{f,dt} > f_{fd} \\ 0 & \text{if } \pi_{f,dt} \leq f_{fd} \end{cases} \quad (2)$$

If $\pi_{f,dt}$ is greater than f_{fd} , the firm f will export to market d in period t and the market participation indicator $\mathbb{1}_{f,dt}$ equals one, while $\mathbb{1}_{f,dt}$ equals zero if otherwise.

The probability of a market d being added from $t - 1$ to t is the joint probability that the firm did not export to market d in $t - 1$ and decides to export to market d in t :

$$\Pr(\pi_{f,dt} > f_{fd} \mid \pi_{f,d,t-1} \leq f_{fd}); \quad (3)$$

which equals the probability of not exporting to market d in period $t - 1$, $\Pr(\pi_{f,d,t-1} \leq f_{fd})$, multiplied by the conditional probability of exporting to market d in period t , $\Pr(\pi_{f,dt} > f_{fd} \mid \pi_{f,d,t-1} \leq f_{fd})$. Similarly, the probability of exiting a market d in period t is the joint probability that the firm exported to market d in $t - 1$ and decides not to export to market d in t , $\Pr(\pi_{f,dt} \leq f_{fd} \mid \pi_{f,d,t-1} > f_{fd})$.

Assuming there is a unit mass of firms, the fraction of firms exported to market d in $t - 1$ is $\Pr(\pi_{f,d,t-1} > f_{fd})$ and the fraction $\Pr(\pi_{f,d,t-1} \leq f_{fd})$ of firms did not export to market d in $t - 1$. Then the probability of a market change is the sum of the probability of those that exported in $t - 1$ dropping the market in t and the probability of those that did not export

in $t - 1$ adding the market in t :

$$\Pr\left(\frac{f_{dt} > f_d}{\underbrace{\{Z_{f_{dt-1}, f_d}\}}_{\text{Entrants}}}\right) + \Pr\left(\frac{f_{dt} < f_d}{\underbrace{\{Z_{f_{dt-1}, f_d}\}}_{\text{Exiters}}}\right); \quad (4)$$

where $\Pr(f_{dt} > f_d | Z_{f_{dt-1}, f_d}) = \Pr(f_{dt} > f_d | f_{dt-1}, f_d) \Pr(f_{dt-1}, f_d)$ is the probability of those that did not export to d starting to export to d in t .

As shown in (4), the key to understand how and why the market participation of firms has changed over time is to understand how the firm's destination-specific profits f_{dt} are changing from one period to the next. Denote the percentage change in profits from $t - 1$ to t as $b_{f_{dt}} = \frac{f_{dt} - f_{dt-1}}{f_{dt-1}}$ and the percentage difference between the fixed cost of entry and the period- $(t - 1)$ profit as $z_{f_{dt-1}, f_d} = \frac{f_{dt-1} - f_d}{f_{dt-1}}$. Substitute $b_{f_{dt}}$ and z_{f_{dt-1}, f_d} into (4) to rewrite (4) as:

$$\Pr\left(\frac{b_{f_{dt}} > z_{f_{dt-1}, f_d}}{\underbrace{\{Z_{f_{dt-1}, f_d}\}}_{\text{Entrants}}}\right) + \Pr\left(\frac{b_{f_{dt}} < z_{f_{dt-1}, f_d}}{\underbrace{\{Z_{f_{dt-1}, f_d}\}}_{\text{Exiters}}}\right); \quad (5)$$

An observation from (5) is that firms' market changes depend on the distributions of two key statistics: (a) $b_{f_{dt}}$, capturing how operating profits have changed from $t - 1$ to t , and (b) z_{f_{dt-1}, f_d} , capturing the percentage difference between the fixed entry cost and the initial profit in period $t - 1$.

To show the mechanisms behind the market changes, we need to specify the firm's profit maximization problem and study $b_{f_{dt}}$. Specifically, I assume firms compete via monopolistic competition and each firm f faces the following residual demand function:

$$q_{dt} = a_{f_{dt}} b_{ft} (p_{ft})^{-\epsilon}; \quad (6)$$

where ϵ is the elasticity of substitution and $a_{f_{dt}}$ and b_{ft} denote the firm-destination-specific and firm-specific demand shifters, respectively. Facing the residual demand function, the firm f chooses its price p_{ft} to maximize the profit:

$$f_{dt} = q_{dt} (p_{ft} - mc_{ft});$$

where mc_{ft} denotes the firm's marginal cost. Taking the first order condition with respect

to p_{ft} gives the optimal price as a constant markup over the marginal cost:

$$p_{ft} = \frac{1}{1 - \alpha_{fdt}} mc_{ft} \quad (7)$$

Substituting (7) and (6) into the profit function, it can be shown that the firm's profit at the optimal price is:

$$\pi_{f,t} = \frac{1}{1 - \alpha_{fdt}} b_{ft} \left(\frac{1}{1 - \alpha_{fdt}} mc_{ft} \right)^{1 - \alpha_{fdt}} \quad (8)$$

Let $\Delta_{ft} = \frac{X_t - X_{t-1}}{X_{t-1}}$ denote the percentage change of X from $t-1$ to t . Taking the first-order linear approximation of (8) gives the following percentage change in profit:

$$\Delta \pi_{f,t} = \alpha_{fdt} \Delta b_{ft} + (1 - \alpha_{fdt}) \Delta mc_{ft} \quad (9)$$

As can be seen, the change in profits is driven by the changes in the firm's residual demand and its marginal cost on the supply side. In addition, the change in profits can be due to the changes in firm-destination-specific conditions or firm-specific conditions.

To quantify the relative importance between (1) residual demand changes vs. marginal cost (supply-side) changes, and between (2) firm-destination-specific changes vs. firm-specific changes, I introduce two weight parameters, $\beta \in [0, 1]$ and $\gamma \in [0, 1]$, to capture the relative importance between different types of changes¹⁹, and rewrite (9) as:

$$\Delta \pi_{f,t} = (1 - \beta) \Delta A_{fdt} + \beta [\Delta B_{ft} + (1 - \gamma) \Delta C_{ft}]; \quad (10)$$

where $(1 - \beta) \Delta A_{fdt} = \alpha_{fdt} \Delta b_{ft}$, $\Delta B_{ft} = \Delta b_{ft}$, and $(1 - \gamma) \Delta C_{ft} = (1 - \alpha_{fdt}) \Delta mc_{ft}$. I assume ΔA_{fdt} , ΔB_{ft} and ΔC_{ft} are drawn from mean zero normal distributions with variances $\sigma_A^2 = \frac{\sigma_b^2}{(1 - \alpha_{fdt})^2 + \alpha_{fdt}^2}$ and $\frac{\sigma_B}{\sigma_C} = \frac{\sigma_b}{\sigma_{mc}} = \frac{\sigma_b}{\sigma_{mc}}$, so that Δb_{ft} is normally distributed with $N(0; \sigma_b^2)$.

Most importantly, parameter β reflects the contribution of the firm-destination-specific changes and parameter γ captures the relative contribution of the firm's supply-side changes. The observed changes in prices and quantities in those continuing markets can inform the underlying shocks that drive those market change decisions. For example, if $\Delta \pi_{f,t}$ is mainly driven by firm-specific rather than destination-specific changes (i.e., β is close to one), then

¹⁹An alternative way is to specify the shock processes for Δb_{ft} , Δb_{ft} , and Δmc_{ft} directly, e.g., $\Delta b_{ft} \sim N(0; \frac{\sigma_b^2}{a})$, $\Delta b_{ft} \sim N(0; \frac{\sigma_b^2}{b})$, $\Delta mc_{ft} \sim N(0; \frac{\sigma_{mc}^2}{c})$. The volatility of the profit change and the relative contribution parameters, β and γ , can be backed out from a , b , and c : This approach is identical to my specification (10). The main advantage of specification (10) is that it allows for direct control of the contribution parameters, β and γ , which facilitates interpretation in later analysis.

the changes in profits would be correlated across destination markets within a firm. Therefore, for firms dropping more markets, we should also see a drop in quantity sold or an increase in its price in those markets it continues to sell to. In section 3.3, I will show that in a simple partial equilibrium model, the two contribution parameters, α and β , as well as the volatility of the profit change σ , can be pinned down using the observed quantity and price changes in the continuing markets.

3.2 Mapping Empirical Measures to Model Parameters: A First Look with Two Firm Types and Two Markets

In this section, I demonstrate how the constructed empirical measures map to the model parameters, using a simplified version with two firm types and two markets. To derive closed-form solutions, I make two simplifying assumptions. First, the entry cost for firms to enter market 1 is sufficiently low, ensuring that firms always export to market 1 in both periods $t-1$ and t . Consequently, market 1 represents the continuing markets. Second, only two types of firms sell to market 2, where $\epsilon_{f,t-1}$ is randomly drawn from f^+ ; f^- with equal probability, where $0 < \bar{\epsilon} < 1$. Both assumptions will be relaxed in the quantitative exercises in Section 3.3, where all results remain consistent.

Under these assumptions, half of the firms that draw $\epsilon_{f,t-1} = \bar{\epsilon} < 0$ would export to market 2 in $t-1$. Following (5), the probability of a change in participation in market 2 is:

$$\underbrace{\Pr(b_{f,2t} > \bar{\epsilon} \mid \epsilon_{f,2t-1} = \bar{\epsilon})}_{\text{Entrants in market 2}} + \underbrace{\Pr(b_{f,2t} < \bar{\epsilon} \mid \epsilon_{f,2t-1} = \bar{\epsilon})}_{\text{Exiters in market 2}}; \quad (11)$$

where the first term captures the probability of those firms that did not export to market 2 in $t-1$ and decide to enter market 2 in t due to the higher operating profit relative to the entry cost. Similarly, the second term captures the probability of those that exported to market 2 in $t-1$ but not in t due to a drop in profit.

Recall that the market change to markets ratio (MCM) is defined as the number of market changes from $t-1$ to t divided by the number of active markets in period t . Since firms always export to market 1, for those firms that decide to export to market 2 in t , they would have two active markets and for those firms that decide to drop market 2 in t , but they only

have one active market int. Therefore, using (11), the mean MCM across all firms is:

$$\begin{aligned} \text{MCM} &= \frac{1}{2} \Pr(b_{f,2t} > -\lambda_{f,2t-1} | \lambda_{f,2t-1} = \bar{\lambda}) + \Pr(b_{f,2t} < -\lambda_{f,2t-1} | \lambda_{f,2t-1} = \bar{\lambda}) \\ &= \frac{3}{4} \Phi\left(\frac{\bar{\lambda}}{\sigma}\right); \end{aligned} \quad (12)$$

where the fraction $\frac{1}{2}$ in front of the first term is because there are two active markets int for those firms entering market 2 int. Given that $b_{f,2t} \sim N(0; \sigma^2)$ and $\lambda_{f,2t-1}$ is drawn from $f(\cdot; \bar{\lambda})$ with an equal probability, it can be shown that the MCM ratio in this case equals $\frac{3}{4} \Phi\left(\frac{\bar{\lambda}}{\sigma}\right)$, where $\Phi(\cdot)$ is the cumulative density function of a standard normal distribution. For a given $\bar{\lambda}$, the measured MCM is increasing in the volatility of firms' profits, σ .

In this simple setup with two markets, the firm-level drop-to-change ratio can only take a value of zero (when the firm adds market 2 int) or one (when the firm drops market 2 int). Therefore, regressing the change in quantity in the continuing market (i.e. market 1) on the drop-to-change ratio gives the following estimator:²⁰

$$\frac{E(b_{f,1t} | b_{f,2t} < -\lambda_{f,2t-1} | \lambda_{f,2t-1} = \bar{\lambda})}{\text{Those dropping market 2 in } t} = \frac{E(b_{f,1t} | b_{f,2t} > -\lambda_{f,2t-1} | \lambda_{f,2t-1} = \bar{\lambda})}{\text{Those adding market 2 in } t}; \quad (13)$$

When the changes in profits are purely driven firm-destination-specific changes (i.e., $\lambda_{f,2t-1} = 0$), the profit and thus market changes in market 2 do not provide any information in market 1, in which case the estimated elasticity in (13) will be exactly zero. To see this, I use the residual demand function (6) and the decomposition (10) to rewrite (13) as:

$$\begin{aligned} & \frac{E\left[\left(1 - \frac{1}{\lambda}\right) A_{f,1t} + B_{f,t} + \frac{1}{\lambda} \left(1 - \frac{1}{\lambda}\right) C_{f,t} \mid \left(1 - \frac{1}{\lambda}\right) A_{f,2t} + B_{f,t} + \left(1 - \frac{1}{\lambda}\right) C_{f,t} < \bar{\lambda}\right]}{\text{Those dropping market 2 in } t} \\ & \frac{E\left[\left(1 - \frac{1}{\lambda}\right) A_{f,1t} + B_{f,t} + \frac{1}{\lambda} \left(1 - \frac{1}{\lambda}\right) C_{f,t} \mid \left(1 - \frac{1}{\lambda}\right) A_{f,2t} + B_{f,t} + \left(1 - \frac{1}{\lambda}\right) C_{f,t} > \bar{\lambda}\right]}{\text{Those adding market 2 in } t} \\ & = \frac{2\sigma^2}{\left(\frac{\bar{\lambda}}{\sigma}\right)^2 + (1 - \frac{1}{\lambda})^2} \frac{1}{\lambda} < 0; \end{aligned} \quad (14)$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ denote the probability density function and cumulative distribution function of a standard normal distribution, respectively. Three main insights arise from (14). First, for a given profit volatility σ and demand contribution $\frac{1}{\lambda}$, the magnitude of the

²⁰A similar expression can be defined for the impact of the drop-to-change ratio on the change in price in the continuing market.

elasticity of the quantity change in the continuing market with respect to the drop-to-change ratio increases with the contribution of firm-specific changes relative to firm-destination-specific changes, captured by α . Second, for a given α and β , the magnitude of the elasticity rises with the profit volatility σ . Intuitively, larger profit volatility implies larger underlying demand or supply shocks, which result in bigger changes in quantity. Finally, for a given α and β , the magnitude of the elasticity weakly decreases with the demand contribution, as indicated by the term $\frac{2+(1-\alpha)^2-1}{2+(1-\alpha)^2}$, which reflects the unequal contribution of cost changes on quantity and profit. A similar expression can be obtained for the elasticity of the price change in the continuing markets to the drop-to-change ratio.

3.3 Mapping Empirical Measures to Model Parameters: Many Firm Types and Many Markets

In this section, I extend the simple model to allow for an arbitrary number of exporting markets and relax the two restrictive assumptions in Section 3.2. First, I remove the assumption of a stable market with sufficiently low entry costs that firms always export to. Second, instead of limiting the model to two types of firms with two distinct initial profit values, I adopt a more realistic distribution of initial profits. Following [Head, Mayer and Thoenig \(2014\)](#), I assume the initial profit distribution is log-normal.²¹ In this more general case, there are no closed-form solutions.²² Therefore, numerical simulations are used in this section instead. Nevertheless, all the key insights of the previous discussions will carry through.

Specifically, I simulate data for 10,000 firms potentially exporting to 20 markets according to the model setup in Section 3.1. I begin by calibrating $\alpha = 1:5$, $\beta = 0:3$, and $\sigma = 1:0$, which roughly aligns with my empirical estimates of the market changes-to-markets ratio (MCM) and the elasticities of quantity and price changes in continuing markets with respect to the drop-to-change ratio (DC). This calibration indicates that all the within-firm market changes are driven by demand rather than supply shocks, with approximately 30% of demand shocks correlated across markets. To further explore these mechanisms, I adjust these parameter values to illustrate how the three empirical measures vary in response to changes in each parameter.

Figure 3 shows the simulation results. The blue line in Figure 3(a) shows that the MCM

²¹Due to the CES preference assumption, a firm's operating profit is a fraction of its sales: $\pi_{f,dt} = \frac{1}{\sigma} p_{f,t} q_{f,dt}$. Therefore, the profit distribution is a scaled version of the sales distribution.

²²This is because there is no closed-form solution for the conditional expectation of a multivariate truncated normal distribution.

(a) Market Changes to Markets (MCM)

(b) Elasticity of Quantity w.r.t. DC

(c) Elasticity of Price w.r.t. DC

Figure 3: Relationship Between Empirical Measures and Model Parameters

Note: This figure plots how the three statistics (i.e., market changes to markets ratio, elasticity of quantity changes in continuing markets with respect to the drop-to-change DC ratio, and the elasticity of the price changes in continuing markets with respect to the DC ratio) calculated using the model simulated data vary with each of the key model parameters β ; γ ; δ . Each line shows the change in a given parameter, while keeping the other two parameters unchanged at their initial calibrated values and x-axis shows the value of the parameter being changed.

ratio in the model is monotonically increasing in the volatility of the operating profit measured by σ , while keeping ρ and β at the calibrated values. Varying ρ while keeping σ and β unchanged, or varying β while keeping the other two parameters unchanged has no impact on the MCM, as seen from the pink and the green line, respectively. This can also be seen from (12), where the MCM ratio does not depend on ρ or β . Intuitively, the size of the profit change matters for the frequency of the market changes, while given a profit change, the composition of the profit change affected by ρ or β does not matter.

Figure 3(b) shows the model predicted elasticity of the quantity changes in continuing markets with respect to the DC ratio is monotonically decreasing in σ and β , which is consistent with equation (14). It is worth noting that, when $\rho = 0$ and thus there are no correlated changes across markets, the estimated elasticity with respect to the DC ratio is always zero regardless of the volatility of profit σ , as shown by the pink line. This is because when the changes to profits are not correlated across destination markets, the market changes are purely caused by firm-destination-specific changes and thus do not provide information about the quantity changes in the firms' continuing markets.

Finally, the green line in figure 3(c) shows that as β increases, indicating that the changes in firms' residual demand changes contribute more to the profit changes, compared to the contribution of the marginal cost changes, the elasticity of the price changes in continuing markets with respect to the DC ratio is falling. Therefore, to match the very low price elasticity to DC ratio observed in the data (0.01, as shown in row 1, column (1) of Table 3), a value of β close to one is required.

To sum up, these three statistics shown in figure 3 provide a joint system to pin down the three key model parameters, σ ; ρ ; β . g. MCM ratio pins down the volatility of the firm profits σ . The elasticity of the price changes in continuing markets with respect to the DC ratio pins down the contribution of the marginal cost changes to profit changes (12). Given σ and ρ , the elasticity of the quantity changes in continuing markets with respect to the DC ratio pins down the contribution of the firm-specific changes that are correlated across destination markets within a firm.

4 Aggregate Implications of Variable Markets

The key finding from the previous sections is that the set of active exporting markets for firms is highly volatile, driven largely by demand-related rather than supply-related shocks. In this section, I explore the aggregate implications of this finding by incorporating variable markets and micro shocks into a multi-country general equilibrium model.

I begin by highlighting two key features introduced by variable markets and micro shocks through a partial equilibrium model in Section 4.1. I then calibrate the multi-country general equilibrium model to align with the empirical moments and assess the welfare implications of the estimated micro shocks in Section 4.2.

4.1 The Changing Distribution of Exporters

Incorporating the micro shocks estimated in the data into a standard trade model brings two major changes. First, it changes the sales distribution of exporters, allowing small firms that receive positive micro shocks to export. Second, in the presence of micro shocks, the set of exporters influenced by an aggregate shock (e.g. a reduction in trade cost) will be much larger. Since the mechanism applies to all destinations, I will focus on one destination here.

Specifically, I assume the initial distribution of the potential sales is log-normal or Pareto distributed. Firms need to pay a fixed cost f_d to export to the market. Therefore, if the initial sales is below of cutoff value for entry, the firm will not export to a given market and the realized sales would be zero. Figure 4 plots the realized sales distribution after accounting for firms' market participation decisions. The x-axis shows the percentile of the potential sales and the y-axis shows the realized sales after taking into account the market entry decisions. As can be seen in Figure 4(a1) and 4(b1), without the micro shocks, the realized sales distribution has a clear cutoff point. That is, the firms whose potential sales are high enough would enter the market and have positive sales values, while the firms with potential sales below the cutoff will not enter the market and the realized sales are zero, as can be seen from the y-axis.

In the presence of micro shocks, the sales distribution no longer has a clear cutoff point, as shown in the red lines in Figure 4(a1) and 4(b1). The micro shocks make it possible for some small firms with potential sales below the entry cutoff point to have a chance of receiving a positive shock and thus become able to enter the market. Therefore the realized sales averaged across these small firms can be positive under micro shocks. The probability of exporting to a market is increasing as the percentile of potential sales increases, indicating that the potential sales is closer to the entry cutoff value and small positive shocks would be sufficient to allow firms to enter the market. Similarly, with micro shocks, larger firms with potential sales above the entry cutoff value now have a chance of receiving a negative shock, resulting in lower sales than in the model without micro shocks. This explains why the red line is below the blue line when the percentile of potential sales is above the cutoff point.

Figure 4(a2) and 4(b2) show how the sales distribution changes after a reduction in

a1: Sales (Log-normal)

b1: Sales (Pareto)

a2: Effect of trade cost change
(Log-normal)

b2: Effect of trade cost change
(Pareto)

Figure 4: Illustrating the Impact of Micro Shocks on the Sales Distribution of Exporters

Note: The x-axis shows the potential sales by percentiles and the potential sales are drawn from a log-normal distribution in (a1) and from a Pareto distribution in (b1). The y-axis shows the realized sales after taking into account firms' market entry decisions. When y equals zero, it indicates that firms in that percentile do not enter the market and thus the realized sales are zero. The upper panel compares the sales distributions conditional on firms' participation in a given market with and without micro shocks to sales. The lower panel compares the effect of a trade cost reduction on sales distribution with and without micro shocks.

trade cost, with and without the micro shocks. The green line shows the change in sales distribution in standard trade models that do not have micro shocks. In this case, the trade cost reduction has two effects on the sales distribution. First, it shifts the sales distribution to the left by lowering the entry cutoff point and thus allowing more firms to export. Second, it shifts the sales distribution upward for the incumbents. As can be seen, the reduction in trade cost will not directly influence those small firms below the cutoff point, which differs from the micro shock. The black line shows that in the presence of micro shocks, small firms can also benefit from the trade cost reduction while large firms may benefit relatively less, as a fraction of big firms will stop exporting upon receiving large negative shocks. Compared with the pink line without the trade cost reduction, it can be seen that in the presence of micro shocks, the main effect of trade cost reduction is to shift the sales distribution upward.

To see whether this change in sales distribution has aggregate implications, we need to sum over each individual firm's sales or equivalently, export value. The total exports to this market are given by the area below the lines in Figure 4(a2) and 4(b2). Theoretically, as discussed in Appendix B.1, with micro shocks, the total exports and the change in exports as a result of a trade cost reduction can be larger or smaller depending on the (1) initial distribution of π_{fdt-1} (which depend on the distribution of initial sales or profits π_{fdt-1} and the fixed cost of export f_d), and (2) the distribution of shocks to profits π_{fdt} or equivalently, sales. In the next section, I calibrate a multi-country general equilibrium model to match the key empirical moments to quantify the aggregate implications of variable markets and micro shocks.

4.2 Quantifying Welfare Implications

In what follows, I use a multi-country general equilibrium model to quantify (1) how micro shocks to firm residual demand and endogenous market participation jointly influence the aggregate welfare (i.e. the real aggregate consumption), and (2) how they impact the welfare after a change in trade cost.

Relative to the partial equilibrium model discussed in the earlier sections, the general equilibrium model allows the micro shocks to residual demand to arise endogenously from other firms' demand or supply shocks. In addition, entry and exits of firms will have general equilibrium effects on the production cost (by influencing wage) and total output (by influencing the allocation of resources).

4.2.1 Model Setting

The world consists of N countries, where countries are indexed by destination d . The national consumption Q_{dt} and the price of the national consumption good P_{dt} in each country d in period t are aggregated over firms f from different origins o :

$$Q_{dt} = \left(\sum_f \sum_o \left(\frac{a_{fodt}}{b_{fot}} \right)^{\frac{1}{\sigma}} \left(q_{fodt} \right)^{\frac{1}{\sigma}} \right)^{\sigma}; \quad P_{dt} = \left(\sum_f \sum_o \left(\frac{a_{fodt}}{b_{fot}} \right)^{\frac{1}{\sigma}} \left(p_{fodt} \right)^{\frac{1}{\sigma}} \right)^{\sigma};$$

where $\sigma > 1$ is the constant elasticity of substitution across industries. $\frac{a_{fodt}}{b_{fot}}$ is a demand shifter and $\mathbb{1}_{fodt} \in \{0, 1\}$ is a binary indicator for whether the firm f from origin o chooses to sell in destination d at time t .

Export Decision. The optimal operating profit, quantity and price of firm f from origin o in destination d are given by

$$p_{fodt} = \frac{1}{\sigma} P_{dt} q_{fodt}; \quad q_{fodt} = \frac{p_{fodt}}{P_{dt}} Q_{dt} \quad \text{and} \quad p_{fodt} = \frac{W_{ot}}{1 - \sigma} \frac{1}{b_{fot}}; \quad (15)$$

where W_{ot} is the nominal wage in origin o at time t ; τ_{odt} is the bilateral trade cost and $\frac{1}{b_{fot}}$ is the productivity from firm f from origin o . The firm chooses to sell to destination d at t if its operating profit π_{fodt} is higher than the a per-period fixed cost of exporting W_{ot} . I assume there is no cost of operating in domestic markets.

Equilibrium Conditions. I assume labor is supplied inelastically. The competitive equilibrium is characterized as follows. Firms in each country make decisions on whether to sell in each country and set prices to optimize their profits as (15) such that goods market clear: $\sum_d q_{fodt} = \sum_o L_{fot}$; labor market clear: $\sum_f L_{fot} + \sum_o \sum_f \tau_{odt} q_{fodt} = L_{ot} = 1$; and trade is balanced: $\sum_o \sum_f \tau_{odt} p_{fodt} q_{fodt} = \sum_o \sum_f \tau_{o0t} p_{fo0t} q_{fo0t}$. The nominal wage W_{ot} in country 1 is set as the numeraire. The bilateral nominal exchange rate is calculated as $e_{odt} = W_{ot} = W_{dt}$.

Calibration and Moments. I simulate a general equilibrium model with 20 countries and 10,000 potential firms in each country and calibrate the parameters that govern the shock distributions using simulated method of moments, as shown in Table 5.

Specifically, I draw initial productivity $\frac{1}{b_{fo0}}$ from a Pareto distribution with dispersion parameter β . I allow the initial preferences $\frac{a_{fod0}}$ to be heterogeneous across countries, which

are assumed to have a log-normal distribution $\ln N(0; \sigma_0^2)$. In each year, firms receive three types of shocks: (1) firm-destination specific preference shocks $\epsilon_{fodt} \sim N(0; \sigma_a)$; (2) firm-specific preference shocks $\epsilon_{fot} \sim N(0; \sigma_b)$; and (3) productivity shocks $\epsilon_{fot} \sim N(0; \sigma_c)$. I simulate the model for 7 years (same length as the empirical data) and I conduct estimation separately for each of the 20 countries simulated in the same ways as in the empirical section. Finally, in all simulations, I calibrate the elasticity of substitution to $\sigma = 4$ and set the fixed cost of entry such that about 20% of firms export to at least one of the foreign markets.

The top panel of Table 5 shows the parameters that are calibrated by matching the model simulated moments with the data moments shown in the lower panel. The magnitude of shock sizes, σ_a , σ_b , σ_c , suggests that preference (demand) shocks account for most of the market changes. In addition, the magnitude of σ_b shows that about half of these preference or demand changes are correlated across destination markets within a firm.

Parameter	Value	
Size of firm-destination specific preference shock, σ_a	0.507	
Size of firm-specific preference shock, σ_b	0.459	
Size of firm-specific productivity shock, σ_c	0.01	
Dispersion of initial preference, σ_0	0.618	
Dispersion of initial productivity, σ_0	4.75	
Moment	Data	Model
Market change to markets ratio	0.67	0.67
Drop-to-change (DC) ratio	0.5	0.497
Elasticity of quantity changes to DC ratio	-0.65	-0.65
Elasticity of price changes to DC ratio	0.01	0.01
Within R^2 in specification (1)	0.23	0.26

Table 5: Calibration of Key Parameters and Matching of Moments

4.2.2 Aggregate Welfare Implications

With the calibrated model, I conduct two counterfactual exercises to quantify (1) how micro shocks and endogenous market participation jointly impact the aggregate welfare and (2) how this impact on welfare would change after a trade cost change.

To quantify the importance of the micro shocks, I look at micro shocks of different sizes by multiplying each of the calibrated micro shock sizes ϵ_{fodt} (ϵ_{fot}) by a factor m .

As a result, when $m = 0$, the model has no micro shock, and when $m = 1$, the model is calibrated to match the empirical moments. To quantify the importance of endogenous market participation, I simulate a "fixed markets" version of the model where the set of market choices remains unchanged from those selected prior to the micro shocks.

Figure 5 shows the results from the first counterfactual exercise where I investigate the implications of these micro shocks and variable markets on aggregate welfare (measured by the real consumption Q_d).²³ Figure 5(a) plots the percentage change in Q_d against different values of m , ranging from zero when there are no micro shocks to two when the micro shocks are twice the size of the calibrated values. In addition, Figure 5(a) shows the differences between the baseline model with variable markets and a "fixed markets" version of the model.

a: Real consumption, Q_d

b: Real exports, Q_{od}

Figure 5: Welfare Implications of Micro Shocks and Variable Markets

Note: The x-axis shows the scale factor of the micro shocks. When $m = 0$, the size of the micro shocks ($a; b; mc$) are zero or equivalently, the model has no micro shocks. When $m = 1$ on the x-axis, ($a; b; mc$) are at their calibrated values. For a given m , the y-axis shows the percentage change in real consumption in figure (a) and real exports in figure (b) relative to the model without micro shocks. For example, figure (a) plots $[Q_d(m) - Q_d(0)] / Q_d(0) \cdot 100$. In each figure, the red line shows the baseline model with variable markets (endogenous market participation) and the blue line shows the model with fixed markets, where each firm's set of markets is not adjusted in response to the micro shocks.

The blue line in Figure 5(a) shows that, without endogenous market participation (extensive margin adjustments), the mean zero micro shocks have no impact on the aggregate welfare Q_d . In this case, positive micro shocks cancel out with negative ones, leaving the aggregate conditions unchanged. In contrast, in the presence of endogenous market participation, the aggregate real consumption expands with the size of the micro shocks. At

²³I take the mean of Q_d of all countries. With large micro shocks, the exact solution of the model differs depending on the exact realization of the micro shocks. I thus take the average over 30 simulations to obtain a smooth relationship.

the level of calibrated micro shocks (i.e. $m = 1$ on the x-axis), the increase in welfare is significant, at around 3.5%.

With endogenous market participation, firms receiving negative shocks stop exporting, resulting in a larger reduction in sales and outputs. At the same time, firms receiving positive shocks not only sell more in their existing markets but also expand by exporting to more markets, enlarging the gain from the positive shocks. In general, these two forces do not exactly offset each other and which effect dominates depends on the initial distribution of profits and sales and how micro shocks shift the distribution of profits and sales. In the calibrated model, micro shocks shift unconditional distribution of potential profit and sales (i.e., the profit and sales distribution without conditioning on entry) of exporters, making it more fat tailed. When the fixed cost of exporting is high and only a small fraction of firms export, the more fat tailed distribution implies the firms receiving positive shocks benefit more compared to those receiving negative shocks, leading to a larger value of exports (as shown in Figure 5(b)) and aggregate output.²⁴

In the second counterfactual exercise, I evaluate the impact of a trade cost change on the welfare implications in the presence of micro shocks and endogenous market participation. Specifically, for each model, I calculate the percentage change Θ_d due to the trade cost change:

$$\Theta_d(m) = \frac{Q_d^{\text{with trade cost change}}(m)}{Q_d^{\text{without trade cost change}}(m)} - 1 \quad (16)$$

Since adding micro shocks increases aggregate output and welfare in levels in our baseline model with endogenous market participation, the baseline model cannot be directly compared with the counterfactual model with fixed markets. Therefore, the red line in Figure 6 compares the change in welfare in the baseline model relative to that in the alternative fixed markets model, i.e., $\Theta_d^{\text{baseline}}(m) = \Theta_d^{\text{fixed market}}(m)$. The red line shows that the impact of a trade cost change is increasing in the size of micro shocks. However, the overall difference between these two models is small (around 1%) at the calibrated size of micro shocks (with $m = 1$ on the x-axis).

To study the underlying drivers of this small difference, I perform a second-order approx-

²⁴See Appendix B.1 for further discussion on conditions under which output expands in response to micro shocks.

Figure 6: Change in Welfare in Response to Trade Cost Change

Note: The x-axis shows the scale factor of the micro shocks. When $m = 0$, the size of the micro shocks (a ; b ; m_c) are zero or equivalently, the model has no micro shocks. When $m = 1$ on the x-axis, (a ; b ; m_c) are at their calibrated values. For a given m , each line shows the percentage change in real consumption Q_d due to the trade cost change based on the given model $Q_d(m)$, divided by the outcome in the model with x ed markets $Q_d(m)^{x\text{ed markets}}$.

imation of the change in welfare:

$$Q_d(m) = \sum_o s_{od}(m) Q_{od}(m) + \frac{1}{2} \sum_o s_{od}(m) (1 - s_{od}(m)) \frac{Q_{od}(m)^2}{s_{od}(m)} + \sum_o \frac{s_{od}(m) s_{od}(m)}{s_{od}(m)} Q_{od}(m) Q_{od}(m); \quad (17)$$

where $s_{od}(m)$ is country o 's market share in country d after the realization of micro shocks and before the realization of the trade cost shock and $Q_{od}(m)$ is the change in consumption of country's o good in country d due to the trade cost change.

Based on this decomposition, I conduct two additional counterfactual experiments. In the first experiment (shown in green line), I calculate the change in welfare keeping change in consumption the same as in the xed market case $Q_{od}(m) = Q_{od}^{xed\ market}(m)$ while changing the starting market share of firms to the baseline model $s_{od}(m) = s_{od}^{baseline}(m)$. This experiment tells us to what extent, the difference in welfare is driven by a different starting steady state of the baseline variable market vs the alternative xed market model. In the second experiment (shown in black line), I calculate the change in welfare keeping market shares the same as in the same market case $s_{od}(m) = s_{od}^{xed\ market}(m)$ while having change in consumption the same as the benchmark case $Q_{od}(m) = Q_{od}^{baseline}(m)$. This experiment is informative about the extent that is driven by the differential change in real consumption.

The opposite direction of the green and black lines explains the overall small difference in the welfare change between the baseline and the xed market models. On the one hand, the green line reflects that firms in the baseline model enjoy a larger initial market share in the foreign market and thus the same magnitude of change in consumption $Q_{od}^{xed\ market}(m)$ brought by the trade cost change has larger impact on real consumption, resulting in bigger welfare adjustments. On the other hand, the black line indicates that the percentage change in real consumption is relatively smaller in the baseline model, resulting in smaller welfare impact evaluated at the starting market share of the xed market model. Overall, these two effects largely cancel out, resulting in a negligible change in the welfare impact of a trade cost change.²⁵

²⁵Note that despite the difference in the percentage change in welfare between these two models, $Q_d^{baseline}(m) - Q_d^{xed\ market}(m)$, is small, the level difference in the change in welfare in the baseline model compared to the alternative xed market model (i.e., $Q_d^{baseline\ with\ trade\ cost\ change}(m) - Q_d^{baseline\ without\ trade\ cost\ change}(m)$ relative to $Q_d^{xed\ market\ with\ trade\ cost\ change}(m) - Q_d^{xed\ market\ without\ trade\ cost\ change}(m)$) remains sizable and is increasing in the size of micro shocks.

5 Conclusions

Firms frequently change the set of destinations to which they export their products|their international trade is characterized by what I call a `mutable geography.' This dynamism in market changes observed is not merely an artifact of the early stages of a firm's growth in global markets. It is actually detectable among established exporters. This paper proposes new empirical measures to understand the underlying shocks behind these market changes { exploiting the information on the price and quantity changes in the firm's continuing markets. Applying the empirical measures to the customs data from Chinese and UK exporters, I find consistent results in both countries that most of these market changes are largely driven by firm residual demand shocks. In addition, the residual demand shocks facing the firms are not just driven by destination-market-specific changes, as a non-trivial proportion of firms drop markets as a result of correlated global demand shocks. These micro demand shocks shift the distribution of exporters, enabling smaller and less productive firms to enter export markets.

At the aggregate level, micro demand shocks increase total output and welfare levels by reallocating demand toward firms that experience favorable shocks, thanks to endogenous market participation. However, these micro shocks have a negligible impact on the percentage changes in welfare in response to changes in trade costs.

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A Empirical Measures and Additional Results

A.1 Constructing Measures of Relative Changes in Local Market Conditions

To understand whether market changes are related to changes in relative market conditions, I construct the following relative market condition measures focusing on the markets that has changed as illustrated in Figure A1.

Figure A1: Constructing rm-product level measures of changes in local market conditions (focusing on those markets changed)

			Continuing Markets	Markets Changed	Changes in Relative Exchange Rates
t = 1	A	(B) (C)			
t = 2	A	{B} (C) {D}	A	B; C	$\log(e_{C;2}=e_{C;1})$ $\log(e_{B;2}=e_{B;1})$
t = 3	A	C (D)	A; C	D	$\log(e_{D;3}=e_{D;2})$
t = 4	A	C {D}	A; C	D	$\log(e_{D;4}=e_{D;3})$

Note: Circled cells mark the variation used to construct the augmented exchange rate variable. Dashed circles indicate auxiliary cells with no transaction observed. The same method is used to construct relative changes in destination CPI.

The relative change in bilateral exchange rates are constructed by taking the relative changes in exchange rates for those markets have been added relative to those markets have been dropped. Specifically, to construct a compatible measure that can be used for both market entry and exit, I multiply +1 for exchange rate changes associated with those market being added and -1 for exchange rate changes associated with those markets being dropped. Relative local CPI changes are constructed in the same way as the relative bilateral exchange rates.

A.2 Distribution of Constructed Measures

The following tables give details on the distribution of constructed statistics of Chinese exporters.

Table A1: All Sectors - All Firms
Trade patterns are calculated at the firm-product(8-digit HS)-year level

	Mean	Median	Distribution (Percentile)				Observations
			1st	25th	75th	99th	
Number of Destination Markets	2.79	1.00	1.00	1.00	3.00	21.00	6,042,767
Number of Market Changes/ Number of Markets	0.95	0.67	0.00	0.00	1.50	5.00	3,662,453
Market Changes/ Markets (Value Measure)	8092.44	0.65	0.00	0.00	13.33	12465.22	3,658,615
Market Drop/ Market Changes	0.47	0.50	0.00	0.20	0.67	1.00	2,469,771
Market Drop/ Market Changes (Value Measure)	0.48	0.38	0.00	0.00	1.00	1.00	2,189,105
Probability of Churn	0.26	0.26	0.00	0.04	0.43	0.69	6,042,767

Source: Chinese Customs Database, 2000-2006.

Table A2: All Sectors - Large Firms
Trade patterns are calculated at the firm-product(8-digit HS)-year level

	Mean	Median	Distribution (Percentile)				Observations
			1st	25th	75th	99th	
Number of Destination Markets	4.67	2.00	1.00	1.00	5.00	31.00	1,795,746
Number of Market Changes/ Number of Markets	0.84	0.64	0.00	0.00	1.00	5.00	1,319,763
Market Changes/ Markets (Value Measure)	22119.43	2.21	0.00	0.00	18.13	32511.96	1,319,403
Market Drop/ Market Changes	0.45	0.50	0.00	0.13	0.70	1.00	974,393
Market Drop/ Market Changes (Value Measure)	0.44	0.35	0.00	0.01	0.90	1.00	974,393
Probability of Churn	0.33	0.33	0.00	0.04	0.54	0.83	1,795,746

This table represents calculations based on trading patterns of a restricted sample of large firms by trade values. Specifically, I restrict the sample to firms with trade values above the 50th percentile measured at 8-digit HS level across all years (2000-2006).
Source: Chinese Customs Database, 2000-2006.

Table A3: By Industries (Median)
Trade patterns are calculated at the rm-product(8-digit HS)-year level

	Market Changes / Markets	Value Measure	Market Drops / Market Changes	Value Measure	Probability of Churn	Observations
1-5 Live animals; animal products	0.00	0.00	0.50	0.51	0.06	44,882
6-14 Vegetable products	0.00	0.00	0.50	0.46	0.06	134,952
15 Animal/vegetable fats	0.33	0.40	0.50	0.45	0.00	2,282
16-24 Prepared foodstuffs	0.00	0.00	0.50	0.41	0.03	85,874
25-27 Mineral products	0.25	0.00	0.50	0.45	0.09	32,180
28-38 Products of chemical and allied industries	0.61	3.33	0.50	0.44	0.25	379,742
39-40 Plastics/rubber articles	0.83	5.36	0.50	0.41	0.31	401,840
41-43 Rawhides/leather articles, furs	0.90	4.39	0.50	0.45	0.33	179,972
44-46 Wood and articles of wood	0.59	2.12	0.50	0.44	0.22	126,662
47-49 Pulp of wood/other fibrous cellulosic material	0.80	3.77	0.50	0.38	0.27	154,438
50-63 Textile and textile articles	0.67	3.65	0.50	0.42	0.25	1,620,660
64-67 Footwear, headgear, etc.	0.86	3.94	0.50	0.45	0.33	200,537
68-70 Misc. manufactured articles	0.75	2.21	0.50	0.42	0.27	230,100
71 Precious or semiprec. stones	0.80	4.55	0.50	0.39	0.20	25,929
72-83 Base metals and articles of base metals	0.71	3.96	0.50	0.40	0.29	652,357
84-85 Machinery and mechanical appliances, etc.	0.67	5.17	0.50	0.38	0.28	922,058
86-89 Vehicles, aircraft, etc.	0.73	7.56	0.50	0.37	0.29	118,649
90-92 Optical, photographic, etc.	0.67	2.62	0.50	0.42	0.29	180,550
93 Arms and ammunition	0.93	21.14	0.50	0.45	0.40	697
94-96 Articles of stone, plaster, etc.	0.86	3.40	0.50	0.43	0.33	542,511
97+ Others	0.50	3.91	0.50	0.47	0.00	8,633

Source: Chinese Customs Database, 2000-2006.

A.3 Deviation from Common Trade Pattern

In studying these changes, a relevant question concerns the extent to which market changes are synchronized or correlated across firms. Empirically, it has been documented firms tend to learn from the market choices of other firms.²⁶ The firms’ decisions captured by my measures may result in common changes in trade patterns. To get a measure for the degree of heterogeneity in firms’ market choices, I calculate deviations from the common trade pattern among firms, where the “Common Trade Pattern” is defined as the set of markets that occur most often across firms selling the same product in any given period. In most cases, the common trade pattern is the most popular market or a combination of two most popular markets of a product. Specifically, I construct an entropy measure based on the deviations from the common trade pattern. In each time period, I count the number of deviations from the common trade pattern for each firm-product pair. To obtain a compatible measure across firms, I divide the calculated deviation counts by the number of trading markets in period t . Figure A2 illustrates how this measure is calculated.

Trade Pattern	Common Trade Pattern	Deviation / Markets
A	A	0=1
A	A C	1=1
A B	A	1=2
A B	A C	2=2
C	A	2=1
C	A C	1=1

Figure A2: Examples of How the Entropy Measure Is Calculated

All my measures on market changes can be redefined in terms of deviations from the common trade pattern—as illustrated in the last two columns of Figure A3. I should also stress that there are different ways to identify the common trade pattern. For instance, instead of studying the deviation from the common trade pattern among firms, one may be interested in how a firm’s trading markets deviate from the firm’s own most frequently

²⁶Using data on Chinese exporters, [Fernandes and Tang \(2014\)](#) show neighbors’ exporting activity affects new exporters’ performance as exporters update beliefs about foreign demand, after observing neighbors’ exports. [Kamal and Sundaram \(2016\)](#) show the presence of neighboring exporters that previously transacted with a U.S. importer is associated with a greater likelihood of matching with the same U.S. importer for the first time. Moreover, recent findings by [Crowley, Meng and Song \(2018\)](#) suggest that firms learn about foreign trade policy from geographically proximate firms.

exported set of destinations. Figure A4 illustrates such a measure. These constructed deviation measures provide alternative perspectives in clarifying cross-firm as well as within-firm market choices. Results using these measures are available upon request.

				Common Trade Pattern	Deviation	M. Changes/ Markets	Drops/ Changes
$t = 1$	<i>A</i>	<i>B</i>		<i>A</i>	<i>B</i>		
$t = 2$	<i>A</i>		<i>C</i>	<i>A-C</i>		1=0	1=0
$t = 3$	<i>A</i>	<i>C</i>	<i>D</i>	<i>A-C</i>	<i>D</i>	1=1	0=1
$t = 4$	<i>A</i>	<i>C</i>		<i>A</i>	<i>C</i>	2=1	1=2

Figure A3: Measures Based on Deviation from the Common Trade Pattern across Firms

				Common Trade Pattern	Deviation	M. Changes/ Markets	Drops/ Changes
$t = 1$	<i>A</i>	<i>B</i>		<i>A-C</i>	<i>B</i> <i>C</i>		
$t = 2$	<i>A</i>		<i>C</i>	<i>A-C</i>		2=0	1=0
$t = 3$	<i>A</i>	<i>C</i>	<i>D</i>	<i>A-C</i>	<i>D</i>	1=1	0=1
$t = 4$	<i>A</i>	<i>C</i>		<i>A-C</i>		1=0	1=0

Figure A4: Measures Based on Deviation from the Common Trade Pattern over Time

Table A4 shows statistics of the entropy measure designed to capture the degree of heterogeneity of trade patterns across and within firms.²⁷ The deviation from the product-time common trade patterns captures the degree of heterogeneity in the set of destinations across firms, whereas the deviation from the firm-product common trade pattern captures the degree of heterogeneity of trading countries within a firm over time. Combining these two measures provide useful information to disentangle the change of trade patterns due

²⁷Examples on construction of this measure are given by Figure A2 in the previous subsection and Figures A3 and A4 in the appendix.

to global, local and firm idiosyncratic shocks by examining the synchronization of trade patterns across firms (and products).

Table A4: Deviation from the Common Trade Pattern (CTP)

	Mean	Median	Distribution (Percentile)				Observations
			1st	25th	75th	99th	
<u>8-digit level deviation from</u>							
product-time CTP	1.28	1.50	0.00	0.75	2.00	2.00	6,042,761
firm-product CTP	0.64	0.00	0.00	0.00	1.00	5.00	6,042,761
<u>2-digit level deviation from</u>							
product-time CTP	1.23	1.25	0.00	0.83	2.00	2.00	1,927,599
firm-product CTP	0.71	0.00	0.00	0.00	1.00	7.00	1,927,599

Note: This table presents statistics on two entropy measures: the deviation from the product-time common trade pattern and the deviation from the firm-product common trade pattern. For each measure, the deviation is normalized by the number of markets traded to facilitate the comparison across firms. Source: Chinese Customs Database, 2000-2006.

There are two key findings. First, the level of disaggregation does not exert any significant influence on these measures. This suggests that differences in trade patterns, both across firms and within a firm and product, are not due to differences in product allocations. Second, deviations are substantially larger across firms than within firm (and product) deviations. The mean deviation from the product-time common trade pattern is around 1.25, suggesting substantial heterogeneity in trade patterns across firms. The fact that the deviation statistic is larger than 1 suggests that differences in trade patterns across firms are not primarily driven by large firms selling to more destinations. By way of example, suppose the common trade pattern consists of two destinations $fA; Bg$. Both small and large firms export to these two destinations. In addition, large firms also export to two additional destinations, C and D. In this case, the deviation measure for small firms will be zero and the deviation measure for large firms is $2/4 = 0.5$, which is smaller than 1. Comparing to deviations across firms, the time deviation from the common trade pattern within firm-product is much smaller, with a mean value of 0.64 for the 8-digit measure and of 0.71 for the 2-digit measure.

A.4 Market Changes and Distance

Table A5 shows that the drop-to-change ratio is negatively correlated to the mean distance of trading markets, suggesting longer distance markets are more likely to be dropped.

Mean distance refers to the geographical distance between China and its trade partners. It is calculated as the total distance of all trade partners divided by the total number of markets at the firm-product level in period t .

Table A5: Regressing Mean Distance on DC Ratio

	Mean Distance	Within R^2	Observations
<u>Count Measure</u>			
Firm-product (8-digit) level	-0.16***	0.01	1,791,353
Firm-sector (2-digit) level	-0.13***	0.01	875,096
Firm level	-0.20***	0.04	301,455
<u>Value Measure</u>			
Firm-product (8-digit) level	-0.13***	0.01	1,791,353
Firm-sector (2-digit) level	-0.13***	0.01	875,095
Firm level	-0.15***	0.03	301,455

Note: This table shows estimates from regressing changes in average distance of trading markets on the drop-to-change ratio. The upper panel shows results using non-weighted drop-change ratio as the dependent variable and the bottom panels shows results using trade weighted drop-change ratio as the dependent variable. The subsections of the first column indicate the level of disaggregation at which the trade pattern measures are constructed. Firm-product and year fixed effects are added for firm-product and firm-sector specifications. Firm and year fixed effects are added for firm level specifications. The statistical significance is calculated based on robust standard errors with ***, **, * representing statistical significance at 1%, 5%, 10% respectively. Source: Chinese Customs Database, 2000-2006.

B Model Appendix

B.1 Distributional Implications

The key takeaway from Section 4.1 is that micro demand shocks shift the distribution of sales in the export market. In this section, I investigate the implications of this shift on the total exports of firms. In what follows, I will discuss the change in sales and profit distribution when the initial profit distribution is log-normally distributed, where analytical solution is available. The results carry through if the initial sales distribution is Pareto distributed, but numerical solution would be needed.

Assume the initial log sales are normally distributed $\mathcal{N}(0; \sigma_1^2)$. The sales (in level) are thus log-normally distributed with mean $\exp(\frac{\sigma_1^2}{2})$. In the presence of micro demand shocks, firms receive log-normal shocks to their sales $\mathcal{N}(\mu_2; \sigma_2^2)$. To facilitate a fair comparison, I set $\mu_2 = \frac{\sigma_2^2}{2}$ such that the mean of the level sales does not change. In a partial equilibrium model, adding additional mean zero log-normal shocks also change the mean of sales distribution. For example, adding mean zero log-normal shock to the existing sales distribution would lead to a new sales distribution with mean being $\exp(\frac{\sigma_1^2}{2} + \frac{\sigma_2^2}{2}) > \exp(\frac{\sigma_1^2}{2})$. This would have a direct positive impact on the total sales of firms. However, this mean shift does not occur in a general equilibrium model. Intuitively, due to the aggregate resource constraint, the mean change in aggregate demand is largely restricted by the total resources available for production.

Figure B1 plots the unconditional percentile distribution of sales with and without micro shocks. As shown in the figure, after adjusting the mean of the shocks (e.g., setting $\mu_2 = \frac{\sigma_2^2}{2}$ for the log-normal distribution), the average sales plotted against the percentile of the initial distribution of sales are identical with and without micro shocks. Had we set $\mu_2 = 0$, the red line would have shifted upward, indicating a higher mean and total sales in the raw unconditional sales distribution.

Let x_c be the profit cutoff point below which the firm no longer exports, the difference in the total sales of exporters with and without the micro demand shocks is given by:²⁸

$$\text{Total sales}_2 - \text{Total sales}_1 = \int_{x_c}^{\infty} x \left[f(x; \mu_2, \sigma_2^2) - f(x; \mu_1, \sigma_1^2) \right] dx; \quad (\text{B.1})$$

where $f(x; \mu; \sigma^2)$ is the probability density function of a log-normal distribution, given by

²⁸Recall that profit is a fraction of sales $\pi_{fdt} = \frac{1}{\sigma} p_{fdt} q_{fdt}$. Given the profit cutoff is equal to the fix cost of export π_c , the sales cutoff is $x_c = \frac{\sigma \pi_c}{p_{fdt} q_{fdt}}$.

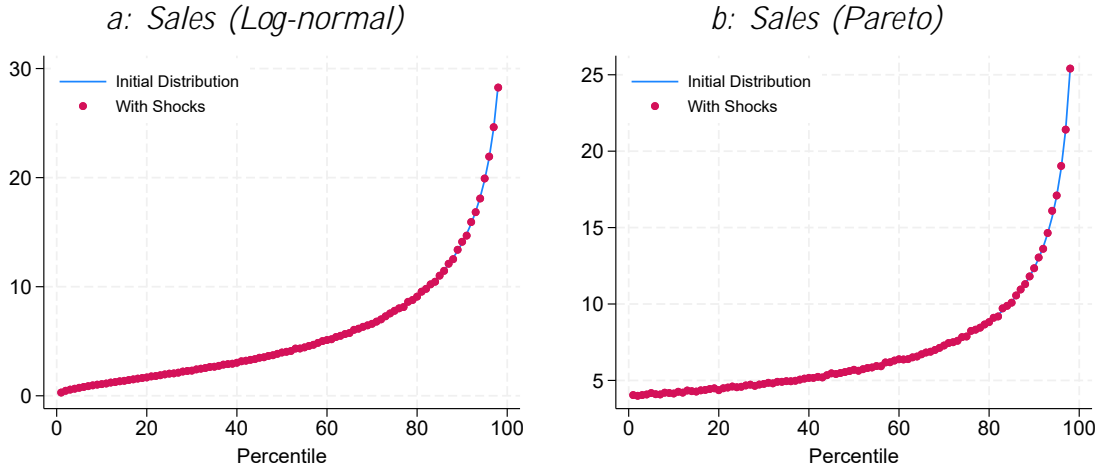


Figure B1: Distribution match

Figure B2 (a1) plots $x'(x; \tau_2; \frac{\rho}{\tau_1 + \tau_2})$ in red and $x'(x; \tau_1; \tau_1)$ in blue against x for $\tau_1 = 0$ and $\tau_1 = \tau_2 = 1$. As we can see from the figures, adding micro shocks makes the unconditional sales distribution more fat tailed. The total sales in each case is calculated by integrating over the area with sales $> \underline{x}$ under each curve. Comparing the blue and red lines in figure (a1), the effect of adding additional shocks on the total sales depends on the cutoff point \underline{x} . For example, when $\underline{x} = 40$, the area with sales > 40 under the red curve is larger than that under the blue curve, indicating a larger total sales under additional micro shocks. In contrast, when the cutoff point is low (e.g., $\underline{x} = 15$), the difference in total sales is less clear cut as the positive difference between the red and blue curve after sales > 23 is partly offset the negative difference for the area in between $[\underline{x}; 23]$. Further reducing the cutoff point may lead the total sales to reduce with additional micro shocks. Finally, in the special case when all firms export ($\tau_2 = 0$), the total sales is the same with and without micro shocks and the expression in (B.1) equals zero.

Now, moving to the impact of the change in trade cost. Define the change in total sales due to a reduction in trade cost as

$$\Delta \text{Total sales}(\underline{x}; \tau_2; \Delta \tau_2) = \int_{\underline{x}}^{\infty} x [x'(x; \tau_2 + \Delta \tau_2; \frac{\rho}{\tau_1 + \tau_2}) - x'(x; \tau_2; \frac{\rho}{\tau_1 + \tau_2})] dx \quad (\text{B.2})$$

Figure B2 (a2) plots the change in total sales in the model without micro shocks $\Delta \text{Total sales}(\underline{x}; \tau_1; \Delta \tau_1)$ in blue and the change in total sales in the model with micro shocks $\Delta \text{Total sales}(\underline{x}; \tau_2; \Delta \tau_2; \frac{\rho}{\tau_1 + \tau_2})$ in red against the sales cutoff \underline{x} for $\tau_1 = 0$, $\tau_1 = \tau_2 = 1$ and $\Delta \tau = 0.1$. We see that the change in total sales due to the trade cost reduction can be larger or smaller depending on

