



2017

GEOGRAPHY, TRADE, AND MACROECONOMICS

Hao Guo

University of Kentucky, hao.guo@uky.edu

Author ORCID Identifier:

 <https://orcid.org/0000-0001-5963-9579>

Digital Object Identifier: <https://doi.org/10.13023/ETD.2017.328>

[Click here to let us know how access to this document benefits you.](#)

Recommended Citation

Guo, Hao, "GEOGRAPHY, TRADE, AND MACROECONOMICS" (2017). *Theses and Dissertations--Economics*. 31.
https://uknowledge.uky.edu/economics_etds/31

This Doctoral Dissertation is brought to you for free and open access by the Economics at UKnowledge. It has been accepted for inclusion in Theses and Dissertations--Economics by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

STUDENT AGREEMENT:

I represent that my thesis or dissertation and abstract are my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained needed written permission statement(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine) which will be submitted to UKnowledge as Additional File.

I hereby grant to The University of Kentucky and its agents the irrevocable, non-exclusive, and royalty-free license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless an embargo applies.

I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Director of Graduate Studies (DGS), on behalf of the program; we verify that this is the final, approved version of the student's thesis including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Hao Guo, Student

Dr. Josh Ederington, Major Professor

Dr. Jenny Minier, Director of Graduate Studies

GEOGRAPHY, TRADE, AND MACROECONOMICS

DISSERTATION

A dissertation submitted in partial
fulfillment of the requirements for
the degree of Doctor of Philosophy
in the College of Business and
Economics at the University of
Kentucky

By
Hao Guo
Lexington, Kentucky

Co-Director: Dr. Josh Ederington, Professor of Economics
and Dr. Jenny Minier, Professor of Economics
Lexington, Kentucky 2017

Copyright© Hao Guo 2017

ABSTRACT OF DISSERTATION

GEOGRAPHY, TRADE, AND MACROECONOMICS

This dissertation studies the effects of external integration and internal liberalization on the economic geography within a country, when regions within the country have different access to the world market.

The first paper introduces internal geography into the Melitz (2003) model to examine how external and internal liberalizations affect the economic geography within a country. By dividing a country into a coastal region and an inland region, the model shows that trade leads the coastal region to have more than proportional share of industry, and causes firms in the coastal region to be larger and more productive than firms in the inland region. Both external and internal liberalizations encourage industry agglomeration in the coastal region. However, external trade liberalization leads to firm divergence, and internal liberalization leads to firm convergence, between coastal and inland regions. This allows me to test the relative importance of internal and external liberalization. Using Chinese data from 1998 to 2007, I find that the manufacturing sector grew faster in the coastal region than in the inland region after the WTO accession in 2001. Firms also converged between coastal and inland regions, indicating that internal liberalization had stronger effects during this period.

In the second paper, I document large economic discontinuities across the east/non-east provincial borders in China and argue that the border effects are largely due to preferential policies that give the east advantages in international trade and economic development. Using counties contiguous to the borders of 4 plain provinces, I find that manufacturing activities (output, employment, and export) increase abruptly from the west to the east of the borders. The counties in the east also have a lower share of agricultural population and a higher share of output by foreign firms. The economic discontinuities are larger for non-state sectors than for the state sector, and are stronger in non-mountain regions than in mountain regions. The large economic discontinuities are unlikely to be explained by geographic and cultural differences across the borders, and can be accounted for by the policy differences between east and non-east provinces. I find that the openness level and the index of market liberalization can account for a large part of the east/non-east divide.

In the third paper, I use the ending of the Multi-fiber Arrangement (MFA) to study the effects of an external trade liberalization on Chinese textile and clothing industry. After the Multi-fiber Arrangement ended in 2005, Chinese textile and clothing exports in products that faced quotas before experienced significant boom. The effects are stronger in the coastal region than in the inland region. Using distance to the seaport as a measure of world-market access, I show that the external trade liberalization (the quota removal) had larger effects on regions with better access to the world market. A further analysis of firm entry shows that the large adjustment of export after the

expiration of the MFA was largely due to destination and product expansions by existing firms.

KEYWORDS: external integration; internal liberalization; coastal agglomeration; the border effect; the Multi-fiber Arrangement (MFA)

Author's signature: _____ Hao Guo

Date: _____ July 29, 2017

GEOGRAPHY, TRADE, AND MACROECONOMICS

By
Hao Guo

Co-Director of Dissertation: Dr. Josh Ederington

Co-Director of Dissertation: Dr. Jenny Minier

Director of Graduate Studies: Dr. Jenny Minier

Date: July 29, 2017

To my parents and my sister.

ACKNOWLEDGMENTS

This dissertation would not have been completed without the help and support from so many people. First and foremost, I want to thank my advisors, Dr. Jenny Minier and Dr. Josh Ederington, for their guidance, support, and encouragement along the way. They have shown me how to do good research and helped me to become a better researcher. I thank my dissertation committee members, Dr. Felipe Benguria and Dr. Andrew Wood for their help. I would also like to thank the outside examiner Dr. Dan Brass. I thank the seminar participants at the University of Kentucky Brown Bag, the 2015 Southern Economic Meeting, and the Macro Reading Group, for their comments and suggestions. In addition, the economics department has been very supportive. I especially want to thank Dr. William Hoyt for his help and support during the past five years.

I have benefited a lot from the support of my fellow graduate classmates. I thank Dr. Anna Maximova, Dr. Gary Hunter, Dr. Tim Harris and Dr. Rob Hartley for their friendship. I thank Chenxu Hu, for being a perfect officemate, an ideal roommate, and a great coauthor.

Last but not least, I want to thank my parents, Gang Guo and Yali Fan, for their unconditional love and support. They have always believed in me and encourage me to pursue a higher aim.

TABLE OF CONTENTS

Acknowledgments	iii
Table of Contents	iv
List of Tables	vii
List of Figures	viii
Chapter 1 Introduction	1
Chapter 2 External Integration, Internal Liberalization, and Coastal Agglomeration	5
2.1 Introduction	5
2.2 Model	8
2.2.1 Model Structure	8
2.2.2 Closed Economy Equilibrium	10
2.2.3 Opening Up to International Trade	11
2.2.4 Welfare Analysis	15
2.3 External and Internal Trade Liberalization	16
2.3.1 Decreasing the International Trade Cost τ_x	16
2.3.2 Decreasing the Fixed Export Cost f_x	17
2.3.3 Decreasing the Domestic Trade Cost τ	18
2.4 Empirical Evidence From China	21
2.4.1 Background	21
2.4.2 Empirical Strategy	23
2.4.3 Data Description and China's Economic Geography	24
2.4.4 Regression Results	25
2.4.5 Robustness	27
2.5 Conclusion	30
Chapter 3 The Border Effect of China's East/Non-east Divide	34
3.1 Introduction	34
3.2 Geography and Culture	36
3.3 Economic Discontinuities Across the Provincial Border	39
3.3.1 Population and Agriculture Production	39
3.3.2 Economic Discontinuity	40
3.3.3 Economic Geography in the Plains Provinces	41
3.3.4 The Border Effect	46
3.4 Heterogeneity in the Border Effect	48
3.4.1 State and Non-state sectors	48
3.4.2 Borders in the Plain and Borders in the Mountain	50

3.5	The Border Effects Explained	53
3.5.1	Opening-up Policy	53
3.5.2	Market Liberalization	54
3.6	Robustness	55
3.6.1	Human Capital and Local Public Goods	55
3.6.2	The “False” Border Effect	56
3.7	Conclusion	58
Chapter 4	The Ending of the Multi-fiber Arrangement and Its Impacts on Textiles and Clothing Industry in China	59
4.1	Introduction	59
4.2	The Multi-fiber Arrangement and Chinese Textile and Clothing Exports	60
4.2.1	The Evolution of the Multi-fiber Arrangement	60
4.2.2	Distribution of the T&C Industry in China	61
4.3	The Effects of the MFA Removal	62
4.3.1	Data	62
4.3.2	The Overall Effects of the MFA Removal	64
4.3.3	The Heterogeneous Effects of the Trade Liberalization on Coastal and Inland Regions	65
4.4	Market Access, Agglomeration, and Comparative Advantage	66
4.4.1	Market Access to International Markets	66
4.4.2	Agglomeration	68
4.4.3	The Comparative Advantage in Labor-intensive Industries	69
4.4.4	Market Access, Agglomeration, and the Comparative advantage	69
4.5	Margins of Adjustment	70
4.5.1	Incumbents and Entrants	70
4.5.2	Decomposing the Effects of the MFA removal by Different Margins	72
4.5.3	Entry Rate	73
4.5.4	Effects of the MFA Removal on Firm Entry	75
4.6	Conclusion	77
Appendix A	Chapter 2 Appendix	78
A.1	Solve the Open Equilibrium	78
A.2	External and Internal Trade Liberalizations	82
A.2.1	Trade Liberalizations On the Coastal Region	82
A.2.2	Trade Liberalizations On the Inland Region	83
A.2.3	Trade Liberalizations and the Welfare of Coastal and Inland Regions	84
A.2.4	Trade Liberalizations and Firm Convergence (Divergence)	87
A.2.5	Model Parameters In the Simulation	88
A.3	Appendix Figures	88
Appendix B	Chapter 3 Appendix	93
B.1	Data Sources	93
B.2	Regression Discontinuity at the Border	93

B.3	An Alternative Method to Construct Comparison Counties	96
B.4	The Border effect as a Share of Provincial Gap (Excluding Border Counties)	97
Appendix C	Chapter 4 Appendix	98
C.1	The Effect of the MFA on Firm Exit	98
Bibliography	100
Vita	103

LIST OF TABLES

2.1	The Coastal Region v.s. the Inland Region	26
2.2	The Heterogeneous effects of the WTO Accession	27
2.3	The Heterogeneous Effects of the WTO Accession (industry level)	28
2.4	The Heterogeneous Effects of the WTO Accession (with tariff control)	30
3.1	Comparison between Counties in the East and the Non-east	45
3.2	The Border Effect of Economic Development	46
3.3	The Border Effect as a Share of the Provincial Gap	47
3.4	Border Effect of Economic Development (by Ownership)	49
3.5	The Border Effect of Manufacturing Development	52
3.6	Openness and the Border Effect	54
3.7	Market Liberalization and the Border Effect	55
3.8	The East/Non-east Border Effect (with controls)	56
3.9	The Effects of False Borders	57
4.1	Geographic Distribution of the T&C Exports	63
4.2	The Effects of the MFA removal	65
4.3	The Effects of the MFA removal: Inland v.s. Coast	65
4.4	World Market Access and the Effects of the MFA Removal	67
4.5	Production Linkage and the Effects of the MFA Removal	68
4.6	Factor Proportion and the Effects of the MFA Removal	69
4.7	Market Access, Agglomeration, and the Comparative Advantage	70
4.8	Share of Export by Margins (%)	71
4.9	Different Margins of Adjustment	73
4.10	Firm Entry Rates	74
4.11	Growth Rate of Adders at Different Margins	75
4.12	Quotas and Firm Entry	75
4.13	Quotas and Margins of Adders	76

LIST OF FIGURES

1.1	The World Map of Night Light in 2010	1
1.2	A Global Map of Accessibility	2
2.1	The Effects of Decreasing τ_x on Firm Inequalities	17
2.2	The Effects of Decreasing τ_x on Industry Agglomeration and Regional Inequality	18
2.3	The Effects of Decreasing f_x on Firm Inequalities	19
2.4	The Effects of Decreasing f_x on Industry Agglomeration and Regional Inequality	19
2.5	The Effects of Decreasing τ on Firm Inequalities	20
2.6	The Effects of Decreasing τ on Industry Agglomeration and Regional Inequality	21
2.7	Trends before and after the WTO accession	32
2.8	Trends of the Difference between Coastal and Inland Regions	33
3.1	Counties in the Plains Provinces and the Border Counties	37
3.2	Elevations of the Plain Counties	38
3.3	Dialects in the Plains Provinces	39
3.4	(Dis)continuities Across the Border	41
3.5	Economic Discontinuities Across the Border	42
3.6	Manufacturing Output in 2007	43
3.7	Manufacturing Export in 2007	44
3.8	Number of Manufacturing Firms in 2007	44
3.9	Counties Contiguous to the East/non-east Borders	51
3.10	Border Counties and Comparison Counties	57
4.1	The Share of MFA Exports in the Coastal and Inland Regions (%)	64

Chapter 1 Introduction

Economic activity, in its nature, is spatial. The economic theory emphasizes the importance of proximity to larger markets in shaping the economic geography in the world (Krugman (1991)). In a time of globalization, it is evident that economic activities are concentrated in coastal regions. Now, 44% of the world population lives within 150 kilometers of the sea. In the US, 51% of the population lives within 80 km of the sea or the Great Lakes. These regions account for only 13% of the US land area, but they account for 57% of GDP in 2000 (Rappaport and Sachs (2003)). In China, 44% of the population lives in coastal provinces. Those provinces account for 13.3% of the land area in mainland China, but they account for 58.6% of GDP in 2004. Many other countries show a similar pattern. Perhaps a more visual way to see this is to look at night light from outer space. As we can see from Figure 1.1, most points that glitter at night are in the coastal regions.

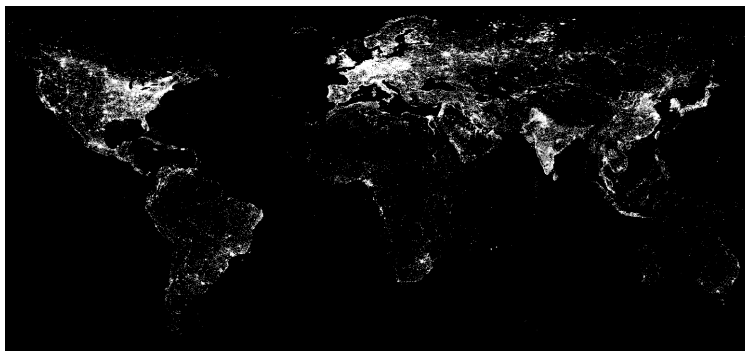


Figure 1.1: The World Map of Night Light in 2010

Source: National Oceanic and Atmospheric Administration (NOAA) earth observation group.

Accompanying the “coastal economy” is a surge of international trade. According to the World Trade Organization (WTO), world trade volume has increased 27 fold from \$296 billion in 1950 to \$8 trillion in 2005. Since the 1950s, international trade has grown twice as fast as world GDP. Maritime transport plays an important role in international trade. The international shipping industry is responsible for 90% of world trade.

With both the agglomeration of economic activities in the coastal regions and the connections between countries by international trade, it is natural to ask, can globalization help explain the agglomeration of economic activities in the coastal regions? A more formal question is: Can international trade shape the economic geography of a country?

To explore the question, we need to look at the internal geography within a country. If all regions within a country are equal and they have equal access to the world market, then international trade would have the same effects on all regions. However,

intra-national trade costs are still sizable in many countries, especially in developing countries. For example, Atkin and Donaldson (2015) find that intra-national trade costs in Ethiopia and Nigeria are 7-15 times larger than that in the US. The global map of accessibility (Figure 1.2) also shows that different regions have quite different access to larger markets.

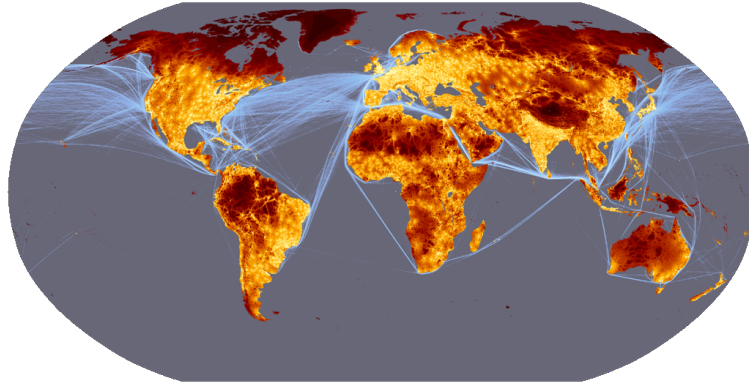


Figure 1.2: A Global Map of Accessibility

Source: European Commission. The map shows travel time to major cities. Darker color means longer travel time.

When different regions have different access to the world market and domestic trade costs are substantial, international trade will have heterogeneous effects on different regions. Regions with better access to the world market face more competition, but also have better opportunities to export. Regions less connected to the world market find them more difficult to engage in international trade, but are also protected from international competition. The interaction between domestic trade costs and international trade could cause firms in different regions to have different productivities and also lead to the agglomeration of economic activities in coastal regions.

My first paper builds up a theoretical model to formalize this idea. To model that different regions have different access to the world market, I assume a country is divided into a coastal region and an inland region, and the inland region has to trade through the coastal region with the rest of the world. Firms in the inland region have to pay extra domestic trade costs to export and import. Thus, when the country opens to trade, firms would want to locate near the larger market (the world market) to save trade costs. Since domestic trade costs are sizable, firms would prefer to produce in the coastal region to reduce trade costs. This hub effect (Krugman (1993)) could generate industrial agglomeration in the coastal region. I also assume that firms have different productivities and have to pay for a sunk cost when entering a new market, as in Melitz (2003). Since firms are heterogeneous and entering a foreign market is expensive, only the most productive firms choose to export. Less efficient firms only serve the domestic market, because the profit (for these firms) from exporting is less than the cost of entering foreign markets. The least productive firms exit the market due to foreign competition. This selection mechanism could increase

the average industry productivity and lead the exporters to be more productive than non-exporters. When domestic trade costs are high, the coastal region faces more foreign competition, and the selection effect is stronger. By combining the selection mechanism with the hub effect, my model generates the following predictions: 1. the coastal region has a higher average productivity than the inland region; 2. the coastal region has more than a proportional share of manufacturing firms. 3. Both internal and external liberalizations lead to coastal agglomeration. However, internal liberalizations lead to firm convergence, and external liberalizations lead to firm divergence, between the coastal and the inland region.

The model implications are tested by using Chinese manufacturing data. I choose China because it has high domestic trade costs and different regions in China have different access to the world market. The eastern part of China faces the Pacific Ocean and is close to the world market. The western part is surrounded by mountains and deserts, and it is difficult to trade with other countries directly. I use the manufacturing data from 1999 to 2007 to look at the economic geography in China. I also study how China's WTO accession affected the industry distribution, firm productivity, and regional inequalities in the coastal and inland regions. The data shows that there are more manufacturing activities in the coastal regions, and firms in the coastal region are more productive, which are consistent with the model implications. A further regression analysis shows that after the WTO accession, firm agglomerated in the coastal region. The difference in firm size and firm productivity (measured by valued added per labor) also narrowed between the coastal and the inland region, indicating that internal liberalizations are more significant during the study period.

Since it is the internal geography that caused the heterogeneous effects of trade liberalizations, I further explore what determines the market access of a region. Geography plays a role, but policies could also cause regions to have different world-market access. In the second paper, I look at the policy differences between the eastern and non-eastern provinces of China, and argue that the policy differences between provinces can account for the large economic discontinuities across the east/non-east of China.

In the paper, I first document that there are large economic discontinuities across the east/non-east provincial borders. Using counties contiguous to the borders of 4 plain provinces, I find that manufacturing activities (output, employment, and export) increase abruptly from the west to the east of the borders. The counties in the east also have a lower share of agricultural population and a higher share of output by foreign firms. The economic discontinuities are larger for non-state sectors than for the state sector, and are stronger in non-mountain regions than in mountain regions. Since the border counties in the east and in the west are similar in geographic conditions and culture, the large economic discontinuities across the border are unlikely to be explained by geography and culture. Meanwhile, China is an economically decentralized country and different provinces have different development strategies. Since the reform and opening-up of China, the eastern provinces have been given preferential policies in international trade and economic development. Thus, there are policy differences between provinces and the effects are most evident at the borders. I find that differences in the openness level and the index of market

liberalization between provinces can account for a large part of the east/non-east divide.

In the third paper, I examine how the removal of the Multi-fiber Arrangement (MFA) affected the textile and clothing industries in China. The MFA was a quota system that restricted the textile and clothing exports from developing countries to developed countries. It ended on January 1, 2005. China is an important player in the world textile and clothing market, and its exports to developed countries were highly constrained by the MFA. Thus, the expiration of MFA provides an opportunity to study the effects of trade liberalization on the distribution of textile and clothing exports. After the Multi-fiber Arrangement ended in 2005, Chinese textile and clothing exports in products that faced quotas before experienced significant boom. The effects are stronger in the coastal region than in the inland region. Using distance to the seaport as a measure of world-market access, I show that the external trade liberalization (the quota removal) had larger effects on regions with better access to the world market. A further analysis of firm entry shows that the large adjustment of export after the expiration of the MFA was largely due to destination and product expansions by existing firms.

Chapter 2 External Integration, Internal Liberalization, and Coastal Agglomeration

2.1 Introduction

Trade costs are central in determining the location of firms in economic geography literature (Krugman (1980), Krugman (1991), Baldwin et al. (2003)). For large countries with internal geography, trade costs can be divided into external trade costs and internal trade costs. External trade costs include international transportation cost and international trade barriers imposed by both domestic and foreign countries. Internal trade costs include internal trade barriers caused by physical geography, as well as market segregation and other man-made trade barriers. The interactions of external and internal trade costs determine the location of firms within a country.

Recent research studying the effects of economic integration on economic geography within a country have been focusing on external trade liberalizations (Coşar and Fajgelbaum (2016), Fajgelbaum and Redding (2014)), although internal trade costs are sizable (Atkin and Donaldson (2015)) in many countries and internal trade cost reductions are equally significant. Indeed, for many developing countries, external integration is often accompanied by internal liberalization. Effects of internal liberalization and external integration are often intertwined and are hard to distinguish. Thus, there is a need to study external and internal liberalization simultaneously and to distinguish their effects on the economic geography within a country.

In this paper, I introduce internal geography into the Melitz (2003) model to study the effects of external and internal trade liberalization on the economic geography within a country. By dividing a country into two regions (the coastal region and the inland region) with different access to the world market, the model generates rich implications on firm productivity and location. When a country participates in international trade, firms in the coastal region are on average more productive than firms in the inland region, as competitions from abroad push up the surviving productivity threshold in the coastal region more than that in the inland region. However, exporting firms in the inland region are on average more productive than those in the coastal region, as firms in the inland region need to be more productive to overcome the higher trade costs of exporting aboard. Thus, the exporting productivity threshold is higher in the inland region. Average firm size and profit are both higher in the coastal region. Exposure to international trade gives the coastal region a location advantage, and leads the coastal region to have more than proportional share of industry (the increasing returns to scale sector). The inland region, on the other hand, sees a decline in its industry sector. If internal migration is restricted, real wage will also be higher in the coastal region.

The effects of external and internal trade liberalizations are also discussed. External trade liberalization magnifies the location advantage of the coastal region and leads firms in the industry sector to agglomerate in the coastal region. This relocation of firms tends to decrease the real wage in the inland region and enlarge the real wage

gap between coastal and inland regions. External trade liberalization also increases the difference between firms in the coastal and inland regions. On the other hand, internal trade liberalization decreases the location advantage of the coastal region. The difference between firms in the coastal and inland region also decreases when internal trade costs are reduced. But as the coastal region is always better connected to the world market than the inland region, reducing internal trade costs still encourages agglomeration in the coastal region. A decrease of internal trade costs increases the real wage in both regions, but also increases the real wage gap before all firms have agglomerated in the coastal region. After that, a further internal trade liberalization reduces the real wage gap between the coastal and the inland region.

The model is then brought to the data by using Chinese prefecture level data during a period of both internal and external liberalizations. I test the main implications of the model: both internal and external trade liberalizations lead to agglomeration of firms in the coastal region; external trade liberalization leads to firm divergence and internal liberalization leads to firm convergence between coastal and inland regions. I find that after China joined the World Trade Organization (WTO), a prefecture 250 km closer to the seaport experienced a 5.47% increase in manufacturing output compared with a prefecture with average distance (396 km) to the seaport. Manufacturing employment increased by 16.1%; number of firms increased by 14.4%; Manufacturing export increased by 7.27%. I also find that after China's WTO accession, average firm size (firm revenue) increased 11.5% more in the inland region than in the coastal region. Exporting probability in the inland region increased more by 0.5 percentage. Firm productivity also grew faster in the inland region. Value added per labor increased 9.27% more and annual wage increased 5.1% more in the inland region after the WTO accession.

The results are consistent with the model implication that economic integration (both internal and external) leads to industry agglomeration in the coastal region. Contrary to the conventional wisdom that external trade liberalization leads to agglomeration in the coastal region, the results suggest that internal trade liberalization is the primary force behind the coastal agglomeration during the study period, as we see firm convergence between the coastal and the inland region. Indeed, compared with tariff and non-tariff reduction, domestic reforms and market liberalizations that significantly reduced the disadvantages of inland regions in international trade are more important during the study period.

Since Krugman (1991), the new economic geography (NEG) literature has been focusing on the home market effect (HME) to explain economic agglomeration. Larger markets tend to have more than proportional share of industry. In this model, the agglomeration force is similar to the home market effect extensively discussed in the previous literature (Baldwin et al. (2003)), but it emphasizes the importance of being close to the larger market, not just being the larger market. The agglomeration mechanism is the hub effect discussed by Krugman (1993). In this paper, it is the location (how easy it is to access the international market) that determines the economic geography within a country, not just how large the coastal and the inland region is.

The model brings firm heterogeneity to the NEG model. Adding firm hetero-

geneity does not change the results about industry agglomeration, but it enriches the model implications about firm productivity and exporting behavior. The model could be used to explain why the coastal region is more productive, and has a higher share of firms participating in international trade. The different implications of internal and external trade liberalizations on firm convergence also give us a way to determine which liberalization dominates when both internal and external trade liberalizations happen during the same period.

The model is related to the literature studying the economic geography under heterogeneous firm framework. Baldwin and Okubo (2006) add firm heterogeneity into a footloose capital (FC) model to study the location of firms when two regions are not symmetric. By assuming a relocation cost, they show that the most productive firms move to the larger region first, causing the larger region to be more productive. While my model in the closed economy case is very similar to their model, I do not have this sorting effect in my model. In this model, firm dies in the inland region and grows in the coastal region, there is no relocation of firms. It should be noted that in their model, firm productivity difference between the two regions relies on the *ad hoc* assumption of firm relocation cost; in this model, the productivity difference between the coastal and the inland region originates from the different levels of exposure to the world market.

The paper is also related to a growing literature studying the effects of external integration on internal economic geography. Coşar and Fajgelbaum (2016) build up a Ricardian type model to show that external trade liberalization in China leads labor intensive and export oriented industries to agglomerate in the coastal region. Fajgelbaum and Redding (2014) use Argentina's entry into the world market to show that locations with better access to the world market have a higher economic density. While both their papers and mine predict agglomeration in the coastal region, the mechanism is different. Their papers focus on comparative advantages and *inter-industry* relocation while my paper concentrates on increasing returns to scale and *intra-industry* relocation.

The model distinguishes between internal and external trade liberalization and shows they have different implications on firm convergence between coastal and inland regions. Previous literature studying the effect of trade liberalization has focused on external trade liberalizations, especially tariff and non-tariff reductions. But for many developing countries, external trade liberalization is often accompanied by internal liberalizations. Tang and Wei (2009) document that joining the WTO usually comes with the commitment of domestic market liberalizations for developing countries. Effects of external and internal trade liberalizations are often intertwined. Meanwhile, internal liberalization is hard to measure and data on internal trade costs are difficult to obtain. Thus, measuring and comparing the effects of internal and external trade liberalizations is an empirical challenge. Because my model makes different predictions about the effects of internal and external trade liberalization, I am able to test their relative importance without measuring their magnitudes. The empirical results suggest that internal trade liberalization is the primary driver behind the coastal agglomeration during the study period. This also supports the idea that for many developing countries, the gains from trade liberalizations go beyond

the usual external trade costs reduction. The effects of internal reform and market liberalization appear to be at least as important¹.

The paper proceeds as follows. Section 2 specifies the model and solve the closed and open equilibrium. Section 3 discusses the effects of external and internal trade liberalizations. Section 4 tests the model implications using Chinese data during a period of trade liberalizations. Section 5 concludes. A more comprehensive discussion about labor allocation in the open economy is delegated to the appendix.

2.2 Model

The model introduces firm heterogeneity and internal geography into a new economic geography model. It emphasizes the importance of being close to the world market in shaping the economic geography within a country. Specifically, I assume that the coastal region is equal in size to the inland region, so the traditional home market effect does not function. The agglomeration force in the model thus comes solely from the location advantage of the coastal region, or “the hub effect”. I also introduce the “selection” mechanism of the Melitz (2003) model to show that as the coastal region face more competitions from abroad, the selection effect is stronger and firms in the coastal region are larger and more productive.

The way I introduce internal geography is to let the inland region trade through the coastal region with foreign countries. The aim is to let the coastal region have location advantages in international trade compared with the inland region. The assumption also guarantees that the coastal region always has a location advantage as long as internal geography exists.

2.2.1 Model Structure

The model is comprised of $n + 1$ symmetric countries, i.e. a home country and n foreign countries. There is only one production factor, labor (L). Each country has two sectors, a homogeneous sector (A) and a differentiated sector (M).²

Each country is divided into two regions; a coastal region with population L_C and an inland region with population L_I . I assume that $L_I = L_C$, so that the coastal region will be identical with the inland region in autarky.

Trade of the homogeneous good is free. Trade of differentiated products incurs *iceberg* trade costs. The coastal region can trade with the rest of the world directly with a trade cost τ_x , but the inland region has to trade with foreign countries through the coastal region. The domestic trade cost between two regions also take the iceberg form, and is set to be τ .

¹For example, Khandelwal et al. (2013) find that the ending of Multi-fiber Agreement also removed the inefficient quota allocation system and led to a higher welfare gain from trade liberalization.

²In the economic geography literature, the agriculture sector is often consider as the homogeneous sector, and the industry sector is often considered as the differentiated sector. I use the same assumption in this paper.

The labor market is segregated across regions. Migration is not allowed across regions/countries, but labor is free to move between A and M sector in each region. There is no moving cost between A sector and M sector.

Preference

The preference is a two-tier demand system. The upper tier is a C-D utility function and the lower tier is of Dixit-Stiglitz (CES) preference,

$$U = A^{1-\beta} \left[\int_{j \in M} c(j)^\rho dj \right]^{\beta/\rho}$$

The demand for and revenue of a firm from region j in region i are:

$$q_{ij} = \frac{R_i}{P_i} \left(\frac{p_{ij}}{P_i} \right)^{-\sigma}$$

$$r_{ij} = R_i \left(\frac{p_{ij}}{P_i} \right)^{1-\sigma}$$

where $i \in \{C, I, f\}$ is the region and j is the variety of differentiated products. R_i is total expenditure of region i on differentiated products, and is equal to βL_i . The price level P_i is defined as:

$$P_i = \left[\int_{j \in M_i} p_{ij}^{1-\sigma} dj \right]^{1/(1-\sigma)}$$

Production

Production of the homogeneous good (A) uses constant returns to scale technology. Without losing generality, I assume that one unit of labor produces one unit of A product. Since trade of the homogeneous good is free, prices of the homogeneous good are equalized among different countries/regions. If the homogeneous product is produced in both regions, wages are also equalized. In this model, I assume the homogeneous good is always produced in both regions. I normalize the wage to be one.

Production of differentiated products (M) uses increasing returns to scale technology. Firms are heterogeneous and each has a productivity φ drawn from the distribution $G(\varphi)$. The production function is:

$$l(q|\varphi) = f + q/\varphi$$

Since the elasticity of demand is constant, the price mark-up is also constant, so

$$p(\varphi) = \frac{1}{\rho\varphi} = \frac{\sigma}{\sigma-1} \frac{1}{\varphi}$$

Thus, firm profit is:

$$\pi(\varphi) = \frac{r(\varphi)}{\sigma} - f = \frac{R}{\sigma}(P\rho\varphi)^{\sigma-1} - f$$

Firm entry and exit behaviors are assumed to be the same as in Melitz (2003). Firms pay a *sunk cost* f_e to draw a productivity from $G(\varphi)$. There is a fixed cost of production, so firms only produce when their productivities are above some threshold φ^* .

The *average* productivity of all firms in the market (or the productivity of a representative firm) is defined as:

$$\tilde{\varphi}(\varphi^*) = \left[\frac{1}{1 - G(\varphi^*)} \int_{\varphi^*}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{1/(\sigma-1)}$$

The price level, aggregate revenue, aggregate production, and aggregate profits of differentiated products are as follows:

$$P = \left[\int_0^{\infty} p(\varphi)^{1-\sigma} M u(\varphi) d\varphi \right]^{1/(1-\sigma)} = M^{1/(1-\sigma)} p(\tilde{\varphi})$$

$$R = \int_0^{\infty} r(\varphi) M u(\varphi) d\varphi = M r(\tilde{\varphi})$$

$$Q = \frac{R}{P} = M^{1/\rho} q(\tilde{\varphi})$$

$$\Pi = \int_0^{\infty} \pi(\varphi) M u(\varphi) d\varphi = M \pi(\tilde{\varphi})$$

2.2.2 Closed Economy Equilibrium

When there is no international trade, the two regions can only trade with each other. Since trade between the two regions does not incur fixed cost, all products produced in one region will also be traded to the other region. There is no sorting effect of trading with the other region.

The free entry (FE) conditions requires that

$$\bar{\pi}_i = \frac{\delta f_e}{1 - G(\varphi_i^*)} \quad (2.1)$$

The average profit of a firm in region i is:

$$\bar{\pi}_i = \frac{1}{\sigma} (r_i(\tilde{\varphi}) + \tau^{1-\sigma} r_j(\tilde{\varphi})) - f \quad (2.2)$$

where $r_i(\tilde{\varphi}) = R_i(P_i\rho\tilde{\varphi})^{\sigma-1}$. Since the productivity threshold satisfies:

$$\frac{1}{\sigma} (r_i(\varphi^*) + \tau^{1-\sigma} r_j(\varphi^*)) - f = 0$$

The average profit (the zero cutoff profit (ZCP) condition) is:

$$\bar{\pi}_i = \left(\left[\frac{\tilde{\varphi}_i^*}{\varphi_i^*} \right]^{\sigma-1} - 1 \right) f = k(\varphi_i^*) f \quad (2.3)$$

Combining (1) and (3) solves cutoff threshold and average profit in each region. It is easy to show that both regions have the same average productivity and profit. Since the two regions are equal in size, the number of firms is also equal between the coastal and the inland regions. In the closed equilibrium, the coastal region and the inland region are identical.

2.2.3 Opening Up to International Trade

The Equilibrium

When opening up to international trade, firms can sell in both home country and abroad (with some probability). Since there is no fixed cost of trading between the coastal region (C) and the inland region (I), foreign firms trade with the inland region through the coastal region without paying additional fixed exporting cost. Thus, in the open equilibrium, the inland and the coastal region have the same varieties of products. It is only the price of each product, and thus price level, will be different.

The average profits of firms in region C and region I are:

$$\bar{\pi}_C = \frac{R_t}{\sigma} (P_{Ct} \rho \tilde{\varphi}_C)^{\sigma-1} + n p_{Cx} \frac{R_f}{\sigma} (P_f \rho \tilde{\varphi}_{Cx})^{\sigma-1} \tau_x^{1-\sigma} - f - n p_{Cx} f_x \quad (2.4)$$

$$\bar{\pi}_I = \frac{R_t}{\sigma} (P_{It} \rho \tilde{\varphi}_I)^{\sigma-1} + n p_{Ix} \frac{R_f}{\sigma} (P_f \rho \tilde{\varphi}_{Ix})^{\sigma-1} (\tau_x \tau)^{1-\sigma} - f - n p_{Ix} f_x \quad (2.5)$$

where $p_{ix} = \frac{1-G(\varphi_{ix}^*)}{1-G(\varphi_i^*)}$ is the probability that firms in region $i \in \{C, I\}$ export to foreign markets. $R_t P_{it}$ is the index of market demand accounting for transportation costs for a firm in region i (Melitz and Redding (2012)), and

$$R_t = R_C + R_I$$

$$P_{Ct}^{\sigma-1} = \frac{R_C}{R_t} P_C^{\sigma-1} + \frac{R_I}{R_t} P_I^{\sigma-1} \tau^{1-\sigma}$$

$$P_{It}^{\sigma-1} = \frac{R_C}{R_t} P_C^{\sigma-1} \tau^{1-\sigma} + \frac{R_I}{R_t} P_I^{\sigma-1}$$

Since all countries are symmetric, $R_f = R_t$ and $P_f = P_{Ct}$. In equilibrium, the cutoff thresholds in coastal and inland regions must satisfy:

$$\frac{R_t}{\sigma} (P_{Ct} \rho \varphi_C^*)^{\sigma-1} = f \quad (2.6)$$

$$\frac{R_t}{\sigma} (P_{It} \rho \varphi_I^*)^{\sigma-1} = f \quad (2.7)$$

And exporting thresholds in both regions satisfy:

$$\frac{R_f}{\sigma}(P_f \rho \varphi_{C_x}^*)^{\sigma-1} \tau_x^{1-\sigma} = f_x \quad (2.8)$$

$$\frac{R_f}{\sigma}(P_f \rho \varphi_{I_x}^*)^{\sigma-1} (\tau \tau_x)^{1-\sigma} = f_x \quad (2.9)$$

The ZCP curve of the coastal and the inland region can be got by substituting equation (2.6)-(2.9) into (2.4) and (2.5):

$$\bar{\pi}_C = f k(\varphi_C^*) + n p_{C_x} f_x k(\varphi_{C_x}^*) \quad (2.10)$$

$$\bar{\pi}_I = f k(\varphi_I^*) + n p_{I_x} f_x k(\varphi_{I_x}^*) \quad (2.11)$$

where $k(\varphi) = (\frac{\varphi}{\varphi^*})^{\sigma-1} - 1$ is a non-increasing function of φ under some extreme value distributions.³ The cutoff threshold and exporting threshold, as well as average profit, can be solved by combining the ZCP and FE curve with equation (2.6)-(2.9).

Proposition 1. *In the open equilibrium, the coastal region has a higher cutoff threshold, but a lower exporting threshold, compared with the inland region. The coastal region has a higher percentage of firms participating in international trade. $\varphi_I^* < \varphi_C^* < \varphi_{C_x}^* < \varphi_{I_x}^*$; $p_{C_x} > p_{I_x}$.*

Proof. Compare the two cutoff equations (2.6) (2.7) with the two exporting threshold equations (2.8) (2.9),

$$\frac{\varphi_{C_x}^*}{\varphi_C^*} = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}} \frac{P_{Ct}}{P_f} \tau_x \quad (2.12)$$

$$\frac{\varphi_{I_x}^*}{\varphi_I^*} = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}} \frac{P_{It}}{P_f} \tau \tau_x \quad (2.13)$$

Since $P_{It}^{\sigma-1} \tau^{\sigma-1} - P_{Ct} = \frac{R_C}{R_t} P_C^{\sigma-1} + \frac{R_I}{R_t} P_I^{\sigma-1} \tau^{\sigma-1} - (\frac{R_C}{R_t} P_C^{\sigma-1} + \frac{R_I}{R_t} P_I^{\sigma-1} \tau^{1-\sigma}) = \frac{R_I}{R_t} P_I^{\sigma-1} (\tau^{\sigma-1} - \tau^{1-\sigma}) > 0$ for $\tau > 1$, then $P_{Ct} < P_{It} \tau$ and $\frac{\varphi_{C_x}^*}{\varphi_C^*} < \frac{\varphi_{I_x}^*}{\varphi_I^*}$. Because $k(\varphi)$ decreases with φ , the ZCP curve of the inland region lies below the ZCP curve of the coastal region. Thus, $\varphi_C^* > \varphi_I^*$.

The relationship between φ_{I_x} and φ_{C_x} is derived by comparing equation (2.8) and (2.9):

$$\varphi_{I_x}^* = \tau \varphi_{C_x}^* \quad (2.14)$$

Thus, $\varphi_I^* < \varphi_C^* < \varphi_{C_x}^* < \varphi_{I_x}^*$, and $p_{C_x} > p_{I_x}$. \square

After opening up to international trade, the coastal region has a higher cutoff threshold, but a lower exporting threshold compared with the inland region. The two

³For Pareto distribution with shape parameter θ , it can be shown that $k(\varphi) = \frac{\sigma-1}{\theta-\sigma+1}$.

regions are no longer symmetric even if they have the same endowment of labor. In the open equilibrium, firms in the coastal region are more exposed to international trade. On the one hand, easier access to the world market increases the profit from exporting abroad (if they were to export), so the exporting threshold in the coastal region is lower; on the other hand, firms in the coastal region face more competition from abroad, so the cutoff threshold in the coastal region is higher. Overall, firms in the coastal regions are on average larger and more profitable than those in the inland region.

Proposition 2. *In the open equilibrium, firms in the coastal region are on average more profitable and larger than firms in the inland region. $\bar{\pi}_C > \bar{\pi}_I$, $\bar{r}_C > \bar{r}_I$.*

Proof. The free entry condition implies $\bar{\pi}_i = \frac{\delta f_e}{1-G(\varphi_i^*)}$; average profit is positively correlated with the cutoff threshold. Since the cutoff threshold in the coastal region is higher, so is the average firm profit.

From the ZCP curve, the average revenue of a firm in region i is

$$\bar{r}_i = \sigma(\bar{\pi}_i + f + np_{ix}f_x) \quad (2.15)$$

Since $\bar{\pi}_C > \bar{\pi}_I$ and $p_{Cx} > p_{Ix}$, it follows immediately that the average firm revenue in the coastal region is higher than that in the inland region. \square

In the open equilibrium, the coastal region trades more with the rest of the world. Since all countries are symmetric, trade of M products has to be balanced for each country. The coastal region will be the net exporter and the inland region will be the net importer of M goods. In the model, total expenditure on the differentiated products are fixed to be βL_t , so total labor allocated to the M sector is also fixed. Since migration is not allowed, the better exporting opportunity in the coastal region will draw labor from A sector to M sector. In the inland region, labor migrates from M sector to A sector.

Exposure to international trade, as well as “relocation” of firms in the M sector⁴, affects the price level and the average productivity in both regions. Since the inland region has to import through the coastal region, the prices of foreign products are always higher in the inland region. Moreover, the relocation of firms to the coastal region means that the inland region has to import more from the coastal region. This also drives up the price level. Overall, the price level in the inland region will be higher than that in the coastal region.

Proposition 3. *Opening up to international trade leads the coastal region to have more than proportional share of industry. In the open equilibrium, the coastal region has a higher average productivity and a lower price level compared with the inland region. $\tilde{\varphi}_{Ct} > \tilde{\varphi}_{It}$; $P_C < P_I$.*

⁴Firms cannot move between regions in this model. The relocation of firms is through the growth in the number of firms in one region and the death of firms in the other region.

Proof. Since $\varphi_C^* > \varphi_I^*$, the cutoff threshold conditions (6) and (7) imply $P_{Ct} < P_{It}$. Using the definition of P_{Ct} and P_{It} , we get:

$$\frac{R_C}{R_t} P_C^{\sigma-1} + \frac{R_I}{R_t} P_I^{\sigma-1} \tau^{1-\sigma} < \frac{R_C}{R_t} P_C^{\sigma-1} \tau^{1-\sigma} + \frac{R_I}{R_t} P_I^{\sigma-1}$$

It simplifies to:

$$P_C^{\sigma-1} < \frac{R_I}{R_C} P_I^{\sigma-1}$$

Since the coastal region and the inland region are equal in market size ($R_C = R_I$), it follows immediately that $P_C < P_I$.

Average market productivity in a region is defined as the average productivity of firms selling in that market, weighted by its share of revenue in this region:

$$\tilde{\varphi}_{Ct}^{\sigma-1} = \frac{1}{M_t} [M_C \tilde{\varphi}_C^{\sigma-1} + M_I \left(\frac{\tilde{\varphi}_I}{\tau}\right)^{\sigma-1} + n \tau_x^{1-\sigma} (M_C p_{Cx} \tilde{\varphi}_{Cx}^{\sigma-1} + M_I p_{Ix} \tilde{\varphi}_{Ix}^{\sigma-1} \tau^{1-\sigma})]$$

$$\tilde{\varphi}_{It}^{\sigma-1} = \frac{1}{M_t} [M_C \left(\frac{\tilde{\varphi}_C}{\tau}\right)^{\sigma-1} + M_I \tilde{\varphi}_I^{\sigma-1} + n (\tau_x \tau)^{1-\sigma} (M_C p_{Cx} \tilde{\varphi}_{Cx}^{\sigma-1} + M_I p_{Ix} \tilde{\varphi}_{Ix}^{\sigma-1} \tau^{1-\sigma})]$$

where $M_t = M_C + M_I + n(M_C p_{Cx} + M_I p_{Ix})$ is the total number of M products in each region. Note that firms selling in the coastal region also sells in the inland region, and *vice versa*.

The price levels of M products in the coastal and the inland region are defined as:

$$P_C^{1-\sigma} = M_C (\rho \tilde{\varphi}_C)^{\sigma-1} + M_I (\rho \tilde{\varphi}_I)^{\sigma-1} \tau^{1-\sigma} + n \tau_x^{1-\sigma} (M_C p_{Cx} (\rho \tilde{\varphi}_{Cx})^{\sigma-1} + M_I p_{Ix} (\rho \tilde{\varphi}_{Ix})^{\sigma-1} \tau^{1-\sigma}) \quad (2.16)$$

$$P_I^{1-\sigma} = M_C (\rho \tilde{\varphi}_C)^{\sigma-1} \tau^{1-\sigma} + M_I (\rho \tilde{\varphi}_I)^{\sigma-1} + n (\tau_x \tau)^{1-\sigma} (M_C p_{Cx} (\rho \tilde{\varphi}_{Cx})^{\sigma-1} + M_I p_{Ix} (\rho \tilde{\varphi}_{Ix})^{\sigma-1} \tau^{1-\sigma}) \quad (2.17)$$

Using the definition of $\tilde{\varphi}_{Ct}$ and $\tilde{\varphi}_{It}$, the price level of M products in both regions can be rewritten as:

$$P_C = (M_t)^{\frac{1}{1-\sigma}} \frac{1}{\rho \tilde{\varphi}_{Ct}} \quad (2.18)$$

$$P_I = (M_t)^{\frac{1}{1-\sigma}} \frac{1}{\rho \tilde{\varphi}_{It}} \quad (2.19)$$

$P_C < P_I$ implies $\tilde{\varphi}_{Ct} > \tilde{\varphi}_{It}$. The average market productivity in the coastal region is higher than that in the inland region. \square

When opening up to international trade, firms face competitions from abroad. This competition effect drives out the least productive firms. Meanwhile, the market access effect from international trade increase the revenue of the most productive firms. Overall, opening up to international trade increases the average market produc-

tivity. In this model, since the coastal region is more exposed to foreign competitions, the average productivity is also higher in the coastal region.

The opening up breaks up the symmetry between the coastal and the inland region. Firms in the coastal region have better opportunities to export and are more productive. To produce more and export more, they have to pay a higher real wage to pull labor from the A sector (constant returns to scale sector) to the M sector (the increasing returns to scale sector). To balance the trade, labor moves from the M sector to the A sector in the inland region. Thus, the M sector agglomerates in the coastal region. To get the labor allocation in each sector, as well as the number of firms, in each region, we need to fully solve the model. This part is delegated into the appendix. Numerical results show that opening up leads the M sector to agglomerate into the coastal region, even if the coastal regional and the inland region are symmetric in closed economy.

2.2.4 Welfare Analysis

The price level and the real wage in region i are defined as:

$$\Lambda_i = P_A^{1-\beta} P_i^\beta = P_i^\beta$$

$$\omega_i = \frac{w_i}{\Lambda} = w_i P_i^{-\beta}$$

Thus, real wage is inversely related with the price level of the differentiated products. When free trade in A sector equalizes the nominal wage in both regions, real wage is inversely related to the price level of differentiated products. Solving P_C and P_I using the cutoff threshold conditions (2.7) and (2.8), I get:

$$P_C^{\sigma-1} = \frac{\sigma f}{(1-\phi^2)R_C \rho^{\sigma-1}} (\varphi_C^{*1-\sigma} - \phi \varphi_I^{*1-\sigma}) \quad (2.20)$$

$$P_I^{\sigma-1} = \frac{\sigma f}{(1-\phi^2)R_I \rho^{\sigma-1}} (\varphi_I^{*1-\sigma} - \phi \varphi_C^{*1-\sigma}) \quad (2.21)$$

Now the cutoff threshold of region i is not a sufficient statistic of welfare in region i as in the Melitz model (Melitz and Redding (2012)). The welfare of region i depends not only on the cutoff threshold of region i , but also on the cutoff threshold of the other region. In the appendix, I prove that the price level of the coastal region decreases with the cutoff threshold, and the price level of the inland region increases with the cutoff threshold. Since the cutoff threshold in both regions increases after opening up to international trade, real wage increases in the coastal region and decreases in the inland region. In this model, trade actually hurts the inland region⁵.

Opening up to international trade increases the average productivity in both re-

⁵Regions with “location disadvantages” could lose from trade. For example, Faber (2014) studies the effects of the construction of China’s National Trunk Highway System (NTHS) and finds that counties connected to NTHS grew slower than those not connected.

regions. Meanwhile, both regions may have more varieties of M products⁶. These are the channels discussed in heterogeneous firm literature through which trade can benefit. However, there is also industry relocation to the coastal region after trade. The “relocation effect” increases the share of product imported and incurs more trade costs for the inland region. It tends to increase the price level in the inland region. In this model, the effect of industry relocation overweighs the effect of productivity and variety change in the inland region. Thus, the inland region see an increase of price level and a decrease of real wage.

Proposition 4. *In the open equilibrium, the real wage in the coastal region is higher than the real wage in the inland region. $\omega_C > \omega_I$.*

2.3 External and Internal Trade Liberalization

In this section, I consider how external trade liberalizations (decrease of τ_x, f_x) and the internal trade liberalization (decrease of τ) affect firm size, productivity, firm location and regional inequality. While both external and internal trade liberalizations lead to agglomeration in the coastal region, they have different implications on regional inequality, as well as firm inequalities. External trade liberalization increases regional real wage gap and difference in firms between the coastal and the inland region. Internal trade liberalization, on the other hand, first increases and eventually decreases the regional inequality. It also decreases the difference in firms between the coastal and the inland region.

The effects of decreasing international trade cost τ_x , fixed export cost f_x and domestic trade cost τ are discussed. Simulation results are shown in Figure 2.1- Figure 2.6. Formal proofs of the effects of trade liberalizations are delegated into the appendix.

2.3.1 Decreasing the International Trade Cost τ_x

When international trade cost τ_x decreases, both regions have better access to the world market. Meanwhile, both regions face more competitions from abroad. Thus, the cutoff threshold increases and the exporting threshold decreases in both regions. Since a decrease of international trade cost have a larger “selection effect” on the coastal region, the relative cutoff threshold $\frac{\varphi_C^*}{\varphi_I^*}$ increases. Relative firm productivity $\frac{\bar{\varphi}_C^*}{\bar{\varphi}_I^*}$ and relative firm size $\frac{\bar{r}_C}{\bar{r}_I}$ also increases. The reduction of international trade cost also increases the relative exporting probability $\frac{p_{Cx}}{p_{Ix}}$. To summarize, difference in firms between the coastal and the inland region enlarges when international trade cost τ_x is reduced.

The decrease of international trade cost also magnifies the location advantage of the coastal region, thus causing firms to agglomerate in the coastal region. The pro-

⁶The number of variety consumed by each region does not necessarily increase. For example, if firm productivity follows Pareto distribution and $f = f_x$, the number of variety of goods in each region does not change from trade liberalization.

ductivity increase and the (possible) increase in the number of variety of M products benefit both regions, but the industry relocation hurts the inland region and benefits the coastal region. The coastal region experiences an increase of real wage but the inland region suffers from real wage decrease. The regional inequality (in terms of relative real wage) increases as international trade cost goes down. After all firms in the M sector have agglomerated in the coastal region, a further decrease of international trade cost will not affect firm location. Thus, the further reduction of international trade cost will benefit both region equally, and the relative real wage will stay constant.

Simulation results when international trade cost τ_x is reduced from nearly prohibitive level ($\tau_x = 3$) to free ($\tau_x = 1$) are shown in Figure 2.1 and Figure 2.2.

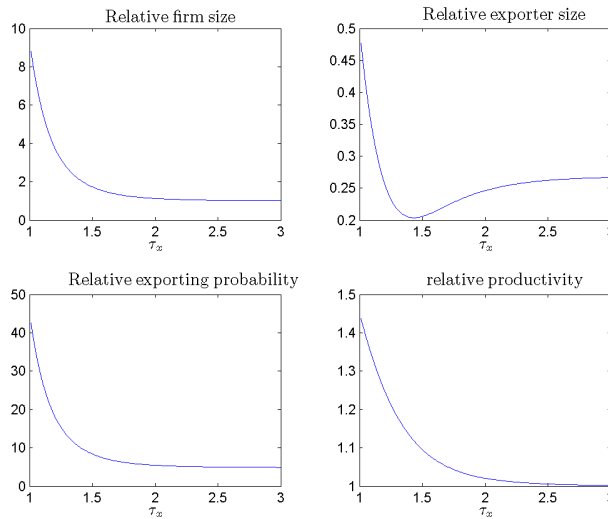


Figure 2.1: The Effects of Decreasing τ_x on Firm Inequalities

2.3.2 Decreasing the Fixed Export Cost f_x

Decreasing fixed export cost has similar effects with decreasing international trade cost. It decrease the costs of exporting and introduces more competitions from abroad. Thus, cutoff threshold increases and exporting threshold decreases in both regions. Since the “selection effect” is stronger in the coastal region, a decrease of fixed export cost will increase the difference in firms between the coastal and the inland region.

The decrease of fixed export cost encourages agglomeration of firms in the coastal region. The relocation of firms benefits the coastal region but hurts the inland region. After all firms in the M sector have agglomerated in the coastal region, a further reduction of fixed exporting cost will benefit both region equally and the relative real wage will stay constant.

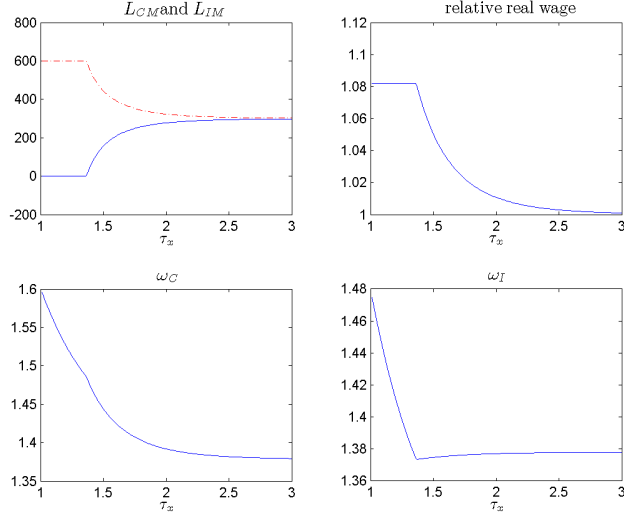


Figure 2.2: The Effects of Decreasing τ_x on Industry Agglomeration and Regional Inequality

Assume fixed export cost is decreased from 3 to 0.16.⁷, the effects are shown in Figure 2.3 and Figure 2.4.⁸

Effects of external trade liberalizations (decrease of τ_x , f_x) can be summarized in the following proposition:

Proposition 5. *External trade liberalizations (decrease of τ_x or f_x) encourage industry agglomeration in the coastal region and increase the difference in firms between coastal and inland regions. The coastal region benefits more from external trade liberalizations than the inland region. Regional inequality first increase, then stay constant during the external trade liberalization.*

2.3.3 Decreasing the Domestic Trade Cost τ

For simplicity, I consider the case when all countries decrease domestic trade costs symmetrically. For the coastal region, substitute equation (2.12) into the ZCP curve of the coastal region (2.10), it is easy to find that cutoff threshold does not change with

⁷To ensure that the exporting threshold is larger than the cutoff threshold, it must satisfy that $f_x \geq f(\frac{1}{\tau_x})^{\sigma-1}$

⁸Here we do not see a complete specialization of production as fixed exporting cost decreases. This is purely due to the choice of model parameters. If we choose $\tau = 1.2$ and $\tau_x = 1.5$, with all other parameters stay the same, we will get the part where industry agglomerates in the coastal region.

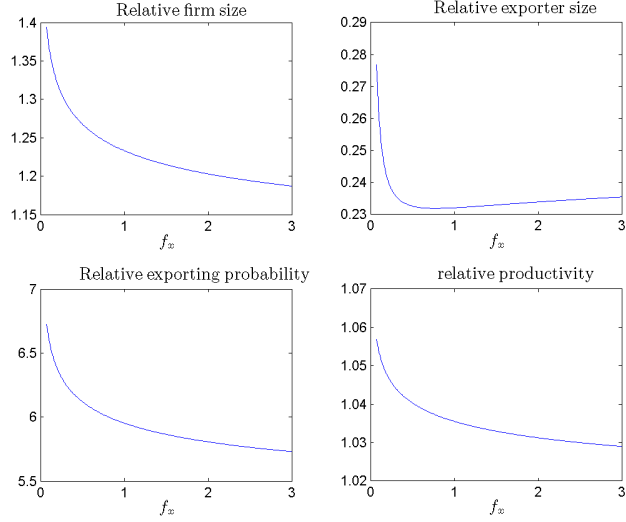


Figure 2.3: The Effects of Decreasing f_x on Firm Inequalities

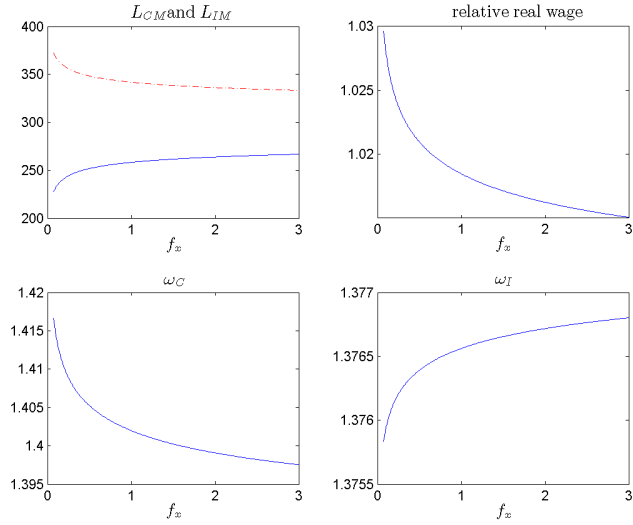


Figure 2.4: The Effects of Decreasing f_x on Industry Agglomeration and Regional Inequality

domestic trade cost. The exporting threshold also stays constant⁹. For the inland

⁹If the home country is a small country, and when only the home country decrease internal trade cost, firms in the coastal region will not face more competition from abroad. Thus, exporting threshold stays constant in the coastal region. Combine the FE condition with ZCP equation, $\delta f_e = [1 - G(\varphi_C^*)]fk(\varphi_C^*) + nf_x[1 - G(\varphi_{Cx}^*)]k(\varphi_{Cx}^*)$. It means that cutoff threshold φ_C^* also do not change. Therefore, when home country is a small country, unilateral internal trade liberalization will not affect firm productivity in the coastal region.

region, decreasing the domestic trade cost introduces more foreign competition. The cutoff threshold increases, and the exporting threshold decreases as the domestic trade cost decreases.

Decreasing the domestic trade cost creates a stronger “competitive effect” on the inland region than the coastal region, thus decreasing relative firm productivity $\frac{\bar{\varphi}_C^*}{\bar{\varphi}_I^*}$ and relative firm size $\frac{\bar{r}_C}{\bar{r}_I}$. Relative exporting probability $\frac{p_{Cx}}{p_{Ix}}$ also decreases. In the extreme case of zero domestic trade cost, there is no difference in firms between coastal and inland regions.

Decreasing the domestic trade cost increases the real wage in both regions. It also causes relocation of firms to the coastal region, and enlarges the real wage difference between the coastal and the inland region. However, after all firms in the industry sector have agglomerated in the coastal region, a further decrease of domestic trade cost does not affect the real wage in the coastal region, but still increase the real wage in the inland region. Thus, a large enough internal trade liberalization can reduce regional inequality.

Simulation results when the domestic trade cost is reduced from prohibitive level ($\tau = 3$) to free ($\tau = 1$) are shown in Figure 2.5 and Figure 2.6.

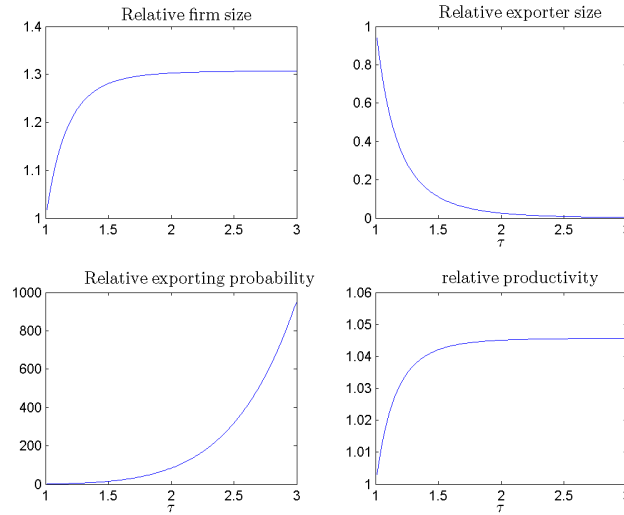


Figure 2.5: The Effects of Decreasing τ on Firm Inequalities

Proposition 6. *Symmetric internal trade liberalizations (decrease of τ) in all countries encourage agglomeration of firms in the coastal region, and decrease the differences in firms between the coastal and the inland region. Both regions benefit from internal trade liberalizations. Internal trade liberalization will first increase, but eventually decrease regional inequality.*

The implications of internal and external trade liberalizations are different. Both external and internal trade liberalizations lead to industry agglomeration in the coastal region. However, external trade liberalizations lead to firm divergence, and

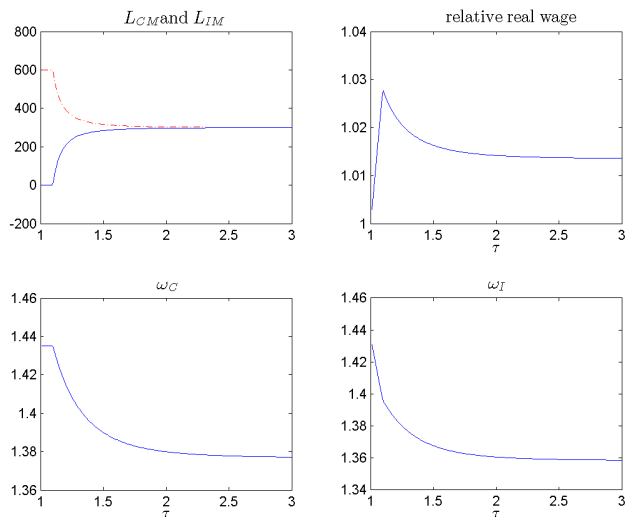


Figure 2.6: The Effects of Decreasing τ on Industry Agglomeration and Regional Inequality

internal trade liberalizations lead to firm convergence between coastal and inland regions.

2.4 Empirical Evidence From China

2.4.1 Background

Why China

China is an ideal country to test the model implications, as it can be clearly divided into the coastal region and the inland region. The east part of the country faces the Pacific Ocean and has easy access to the world market. China has 7 of the 10 largest ports in the world, and they are all in the east coast. The west part of the country, however, is not so easily connected with the rest of the world. Natural barriers (mountains and deserts) separate China from the rest of the Asia, making it difficult to import and export through the west border. The internal geography of China varies a lot from the east to the west. The east is mainly plains and the altitude is low. The vast lands of the west are mountains and plateaus, and the altitude is high. This makes transportation between the east and the west expensive. Thus, in China, distance to the seaport (or distance to the coast) acts as a good measure of access to the world market.

During the past 30 years, China experienced one of the largest liberalizations in history. Before the reform, China was basically a closed country. Its share of trade in GDP was only 8.5% in 1977. The opening up policy launched in 1978 and subsequent reforms made China the largest trading nation in the world. In 2007, its share of

trade in GDP has increased to 62.3%.¹⁰ The “reform and opening up” transformed China from a closed economy to the world’s largest trading nation. Thus, there is sufficient variation to allow us to study the effects of trade liberalization.

From Partial Opening up to Comprehensive Opening Up

Trade liberalizations, like many other economic reforms of China, are incremental. In 1978, China set up four special economic zones (SEZs) to begin its opening up plan¹¹. The success of the SEZs led to the opening up of 14 coastal cities in 1984. Hainan province was set up as a new special economic zone in 1988 and Pudong New Area in Shanghai was established in 1990 and was given more favorable opening up policies. Eventually, the opening up policy was extended to all coastal regions¹². China’s accession to the World Trade Organization (WTO) in December 2001 marked a new era with all regions actively involved in international trade.

In China, opening up and economic reform are intertwined. For a planned economy like China before reform, opening up means that it has to change the way that the economy functions. To avoid reform failures, the earliest reforms were tested in the Special Economic Zones (SEZ) in Guangdong and Fujian provinces. The SEZs were set up to attract foreign direct investment (FDI) and to trade with other countries, but also to “learn” about the market economy. SEZs were given considerable economic freedom to trade and conduct economic reforms. Foreign firms were given preferential policies¹³ to set up factories in SEZs and the private sector was allowed to grow in the SEZs. The establishment of SEZs allowed the central government to experiment in the market economy without bearing the political risk of undermining the socialist economy. But a “side effect” is that it also gave SEZs the “one step ahead” advantage (Vogel (1989)). The preferential policies in SEZs, and later in other coastal regions, created the “opening up gradient” between the coastal and the inland region, where the coastal regions had a high level of openness while the inland region was still shut off from international trade.

Figure A.3 in the appendix shows an opening up map in 1998 based on preferential policy index from Demurger et al. (2002). The coastal region has a higher level of openness. All 5 special economic zones are in the coastal region. By 1998, there were 32 national Economic and Technology Development Zones (ETDZ)¹⁴, of which 26 were in the coastal provinces. The inland provinces had only 6 ETDZs.

¹⁰The data are from World Development Indicators. Trade share is the sum of exports and imports of goods and services measured as a share of gross domestic product

¹¹The four SEZs are Shenzhen, Zhuhai, Shantou and Xiamen. They are in southeast China, and are both geographically and culturally close to Hong Kong and Taiwan.

¹²China launched the “coastal development strategy” in 1988 to encourage coastal provinces to fully participate in the international economy (Yang (1991)). A map of coastal and inland region in China is shown in Appendix C.1.

¹³Preferential policies include (but are not limited to) tax and tariff reductions, lower rental cost of land and factories, and access to the domestic market.

¹⁴National ETDZs are small regions (often within a prefecture) that enjoy many policies of the SEZs.

By late 1990s, China had decided to build a market economy. The partial opening up policy had been proved successful and a more comprehensive opening up had become consensus. Meanwhile, the preferential policies were believed to have caused regional inequalities between the east and the west (Demurger et al. (2002), Démurger et al. (2002)). The West Development Project was launched in 2000 to decrease regional inequalities. Western provinces were given better policies to attract FDI and develop industry. Large infrastructure projects aiming to decrease the geographic disadvantages of the west were also launched.

To build a market economy, China finally decided to privatize the bulk of its state owned sector, which was already losing profits and had become a burden of the government. The privatization and restructuring of state owned firms went from 1998 to 2002. Fewsmith (2001) documents the political struggle before China joined the WTO: the reformers (especially the then premier Rongji Zhu) wanted to use the WTO accession as an external commitment to push forward economic reform. Bajona and Chu (2003) argue that since state owned enterprises (SOE) reform is a prerequisite of WTO accession, the welfare gain from SOE reform should also be counted as the benefit of WTO accession¹⁵.

The WTO accession in December 2001 marked the final step of China's comprehensive opening up. China promised to open up its domestic market and reduce its trade barriers. By 2001, China's tariff had been decreased to 13.4%, and was further reduced to 4.9% by 2005¹⁶. China also liberalized its trading regime and extended the trading right to all firms. The reforms further liberalized China's export potential and it's now world's largest exporter and second largest importer.

The WTO accession should be seen as both external and internal trade liberalizations. The WTO accession decreased tariffs and non-tariff barriers (e.g. quota) faced by Chinese exporting firms. This can be seen as external trade liberalizations and is often seen as the main gains from trade. Meanwhile, the WTO accession required China to open its domestic market (not just the coastal region, but the whole country) to foreign companies, thus decreased the policy advantages of the coastal region. The WTO accession and subsequent economic reforms allow firms in the inland region to better participate in international trade. This amounts to an internal trade liberalization in my model. Since China joined the WTO, the policy gradient between the east and the west have been greatly reduced. Preferential policies were extended to more cities in the inland region. By 2015, the number of national ETDZs has increased to 219, of which about half (108) are in the inland provinces.

2.4.2 Empirical Strategy

In the following analysis, I test the main model implications that trade liberalizations leads to agglomeration of firms in the coastal region, and test whether internal

¹⁵SOE reforms also decreased local protectionism and facilitated domestic market integration.

¹⁶The tariff rate is the average tariff rate weighted by import value. Data are from United Nations Conference on Trade and Development (UNCTAD). The change of tariff rate between 1998 to 2007 are shown in Appendix figure A.4.

or external liberalization is the primary force behind the coastal agglomeration. The study period is from 1998 to 2007, a period when China experienced rapid liberalizations and joined the WTO in December 2001. I use prefectures in China as observations. A prefecture is an administration unit above the county and below the province. A prefecture usually has a central city and several surrounding counties. It is large enough to form a local economy, but the geographic variation within the prefecture is small, so we can treat it as a homogeneous region.

During the study period (1998-2007), there are both external and internal trade liberalizations. The model predicts that they both lead to agglomeration of firms in the coastal region. However, external trade liberalizations increase the difference in firms between the coastal and the inland region; internal trade liberalizations decrease the difference in firms between coastal and inland regions. To examine the effects of trade liberalizations, I use the following basic specification:

$$y_{rt} = \alpha_r + \eta_t + \beta \ln(\text{Distance}_r) \times \text{WTO}_t + \epsilon_{rt} \quad (2.22)$$

where Distance_r is the great-circle distance of a prefecture to the nearest seaport, WTO_t is a dummy variable that equal one after 2001. y is the outcome variables. I include both prefecture and year fixed effect. While both coastal and inland regions are affected by China's WTO accession, the effects are different. The coefficient β measure the heterogeneous effect of WTO accession on coastal and inland regions.

I divide my outcome variables into two groups. I use manufacturing output, manufacturing employment, number of manufacturing firms and manufacturing exports to see whether industry sector agglomerates in the coastal region. A negative and significant β indicates that industry agglomerates in the coastal region after WTO accession, as it means that prefectures closer to the seaport grew faster. I use average firm revenue, exporting probability, value added per labor and annual wage to determine whether firms converge or diverge between coastal and inland regions after the WTO accession. A positive and significant β shows firm convergence, since it means that firms further away from the seaport grew faster after the WTO accession.

2.4.3 Data Description and China's Economic Geography

I use the Annual Survey of Industrial Firms of China from 1998 to 2007. The data set consists of all state owned firms and private firms with annual sales over 5 million yuan (about \$600,000) and includes information about employment, production, exports and other financial variables. The majority of firms included in the survey are manufacturing firms, but the survey also contains some large mining and utility firms. I only use the manufacturing firms in my analysis, because they are tradable and their locations are affected by trade liberalizations. I aggregate the data into prefecture level. In the sample, there are 338 prefectures, including four central administrated cities.¹⁷

¹⁷The four central administrated cities are Beijing, Shanghai, Tianjin and Chongqing. They have the same political rank as provinces, but have similar size with prefectures.

I use distance from the center of a prefecture to the nearest seaport as a measure of closeness to the world market. The average distance of a prefecture to the seaport is 682 km. A map of access to the seaport is shown in the appendix C.1. To compare the difference between the coastal region and the inland region, I define the coastal region as all prefectures in coastal provinces. There are 115 prefectures in the coastal region, and 223 prefectures in the inland region.

Table 2.1 gives the summary statistics of coastal and inland prefectures. It shows the economic geography of China. The coastal region has a much higher economic density. Manufacturing production and employment are much higher in coastal prefectures. Exports are predominately concentrated in the coastal region. Coastal prefectures export more and have a higher share of exporting firms. In coastal prefectures, 26.3% of manufacturing output is exported, and 38.7% of firms participates in export. In inland prefectures, only 5.7% of manufacturing output is exported, and only 11.5% of firms exports. The economic structure is also different between the coastal and inland regions. In inland prefectures, over 20% of manufacturing firms is state owned. In coastal prefectures, only 8% of the manufacturing firms is state owned. Foreign firms and private firms, on the other hand, account for a larger share in coastal prefectures.

There are also considerable variations in firm size and productivity between the coastal region and the inland region. Average firm revenue is higher in coastal prefectures, but average exporter revenue is higher in inland prefectures. This suggests that in general it is more difficult for a firm to survive in the coastal region, but it is easier for it to export to the world market. On average, firms in the coastal region are more productive than those in the inland region. Both annual wage and value added per worker are higher in coastal prefectures than in inland prefectures.

Overall, Table 2.1 suggests what would happen in the model when a closed country opens up: being closer to the larger world market leads to agglomeration of firms in the coastal region and causes firms in the coastal region to be larger and more productive.

2.4.4 Regression Results

Before turning to the regression results, it is useful to look at the trends of outcome variables during the study period (Figure 3.7). There are two things to notice. First, the trends do not change abruptly in 2002 for either region, suggesting that WTO was not a sudden shock to the economy. Second, we do see some changes of the trends during this period. The top 4 figures show industry agglomeration in the coastal region. For example, we see similar trends of employment between the coastal and the inland region before 2000. After that, employment in the coastal region grew much faster than the inland region. The number of firms in the coastal region also grew faster than number of firms in the inland region, especially after 2003. The last four figures show firm convergence between coastal and inland regions.

Table 2.2 shows the regression results. Panel A shows agglomeration of manufacturing activities in the coastal region after the WTO accession. Compared with a prefecture with mean distance (396 km, such as Fuyang) to the seaport, a prefecture one log distance closer to the seaport (146km, such as Yangzhou) experienced a 5.57%

Table 2.1: The Coastal Region v.s. the Inland Region

	Inland Prefecture		Coastal Prefecture	
	mean	sd	mean	sd
Industry employment	74,803	96,497	313,332	406,028
Industry Production (millian yuan)	16,327	29,122	98,394	182,537
Export (millian yuan)	931	1,953	25,905	68,789
Num. of firms	243	295	1,299	1,830
Num. of state owned firm	53	69	104	215
Num. of private firms	174	239	859	1,211
Num. of foreign firm	16	29	336	664
Num. of exporter	28	67	425	709
Average firm revenue(1000 yuan)	60,872	91,822	66,608	45,460
Average exporter revenue(1000 yuan)	298,595	837,624	168,564	222,610
Annual wage (1000 yuan)	11.6	6.7	14.5	33.8
Value added per labor (1000 yuan)	65.0	59.3	73.7	111.7
Exporter VAL (1000 yuan)	78.4	132.0	84.1	264.7
Distance to the seaport(k.m.)	959	707	131	93
Observations	2215		1142	

^a Data are from Annual Survey of Industrial Firms of China (1998-2007). The firm level data are aggregated into the prefecture-year cell.

higher increase in manufacturing output after China joined the WTO. Employment increased by 16.3% more, and the number of firms increased by 17.2% more. Exports and the number of exporting firms also grew faster in the coastal region. Since the model predicts that both external and internal trade liberalizations lead to industry agglomeration in the coastal region, it is not surprising to see industry agglomeration in the coastal region from the data.

Panel B shows firm convergence between coastal and inland regions. After the WTO accession, average firm revenue in a prefecture with mean distance to the seaport increased 11.5% more than average firm revenue in a prefecture one log distance closer to the seaport. Exporting probability also increased 0.52 percent more in the prefecture further away from the seaport. Average firm productivity in terms of value added per labor and annual wage also increased by 9.27% and 5.1% more, respectively. The results show that after the WTO accession, firms grew faster and average productivity increased faster in the coastal region than in the inland region. The exporting probability also increased more for firms in the inland region. We see firm convergence between coastal and inland regions.

The results in panel B are consistent with the story of internal trade liberalizations. It suggests that the decrease of internal trade costs is more significant than the decrease of external trade barriers. Indeed, China's tariffs had already been decreased to a low level before its WTO accession, and the tariffs that Chinese exporters faced did not change much after China joined the WTO. Many countries, including the US and the EU, had already given China most favored nation (MFN) status before

Table 2.2: The Heterogeneous effects of the WTO Accession

	(1)	(2)	(3)	(4)
Panel A: Industry agglomeration				
	ln(Output)	ln(L)	log(num. firm)	ln(export)
<i>Distance</i> × <i>WTO</i>	-0.0549*** (0.0205)	-0.156*** (0.0171)	-0.166*** (0.0204)	-0.0686** (0.0299)
Observations	3357	3329	3357	3099
R^2	0.980	0.977	0.963	0.941
Panel B: Firm response				
	ln(firm revenue)	Prob. export	ln(VAL)	ln(wage)
<i>Distance</i> × <i>WTO</i>	0.111*** (0.0201)	0.00523** (0.00251)	0.0876*** (0.0170)	0.0481*** (0.00864)
Observations	3357	3357	3323	3329
R^2	0.896	0.834	0.853	0.837

^a Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

^b Standard errors clustered at prefecture level.

China joined the WTO, so external trade cost reduction brought about by the WTO accession is limited. During this period, however, economic reforms and market liberalizations greatly reduced internal barriers of trade. A transition from partial opening up to comprehensive opening up decreased the policy advantage of the coastal region and encouraged the inland region to participate more in international trade. Large infrastructure projects were launched to connect the geographically disadvantaged regions to the world market. Further domestic market integration also decreased internal trade costs¹⁸. These internal liberalizations are more important than tariff and non-tariff reductions, new market access and other external trade costs reductions after the WTO accession.

2.4.5 Robustness

Industry Level Evidence

Like other Melitz (2003) type models, the model emphasizes reallocation within the industry during the trade liberalization. In reality, there are many industries and the difference between coastal and inland regions could arise from the difference of economic structure. When different regions have different industry compositions and different industries have different growth trends, we can see agglomeration in the coastal region even if trade liberalization has same effects on the coastal and the inland region within an industry. To check if the above results are driven by industry

¹⁸Lu and Tao (2009) find that local protectionism obstructed the industry agglomeration in China.

composition of different regions, I run the following regression:

$$y_{rit} = \alpha_{ri} + \eta_{it} + \beta \ln(\text{Distance}_r) \times \text{WTO}_t + \varepsilon_{rit} \quad (2.23)$$

where r is prefecture, i is industry, and t is year. I use prefecture-industry fixed effect to control for the difference in industry composition between coastal and inland regions, and use industry-year fixed effect to control for different growth trends of different industries. Again, I run two sets of regressions: one with industry outcome variables; the other with firm outcome variables. The results are shown in Table 2.3.

Table 2.3: The Heterogeneous Effects of the WTO Accession (industry level)

	(1)	(2)	(3)	(4)
Panel A: Industry agglomeration				
	ln(Output)	ln(L)	log(num. firm)	ln(export)
<i>Distance</i> × <i>WTO</i>	-0.0280* (0.0146)	-0.105*** (0.0198)	-0.0728*** (0.0139)	-0.0510*** (0.0198)
Observations	369554	370756	375987	131601
R^2	0.852	0.832	0.859	0.810
Panel B: Firm response				
	ln(firm revenue)	Prob. export	ln(VAL)	ln(wage)
<i>Distance</i> × <i>WTO</i>	0.0445*** (0.00865)	0.00906*** (0.00338)	0.0749*** (0.0161)	0.0361*** (0.00639)
Observations	369554	375987	359712	367297
R^2	0.799	0.685	0.695	0.682

^a Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

^b Standard errors clustered at prefecture level.

The industry level results are consistent with the model implications. Even after controlling for industry composition and different industry trends, the results still show agglomeration in the coastal region. The coefficient estimates are almost the same as in the basic specification. This means that the results are indeed driven by the heterogeneous effects of WTO accession on coastal and inland regions within the industry. Table 2.3 also shows firm convergence between coastal and inland regions, and the coefficient estimates are very similar to the results in the basic specification. This supports the inference that the coastal agglomeration is driven mostly by internal trade liberalization.

Controlling For Tariff Change

Tariffs have been used extensively as a measure for external trade costs. In this section, I control for the average export tariff faced by each prefecture. If we still see agglomeration in the coastal region and firm convergence, we can be more confident that the results are not driven by external trade liberalization, at least not by tariff

reduction. The export tariff each prefecture faces is defined as average tariff of all industries weighted by production.

$$Tariff_{rt} = \frac{\sum_i Tariff_{it} \times Production_{rit}}{Production_{rt}}$$

where i denotes industry. Since the production structure of each prefecture is affected by the tariff faced, the variable $Tariff_{rt}$ is endogenous. To reduce the endogeneity problem, I construct an instrumental variable (IV) using the production of the base year:

$$TariffIV_{rt} = \frac{\sum_i Tariff_{it} \times Production_{ri1998}}{Production_{r1998}}$$

I add the constructed tariff variable into equation (2.22) to control for the effects of tariff reductions. The coefficients on tariffs and the interaction of WTO and distance are shown in Table 2.4. From the table, we still see industry agglomeration in the coastal region and firm convergence between coastal and inland regions. Compared with the base results in Table 2, the magnitude of $Distance \times WTO$ is almost the same. The results show that the industry agglomeration and firm convergence we have found are not due to tariff reductions.

Although there may be other kinds of external trade liberalizations not discussed here, such as quota removal, new market access, etc., the analysis in this section suggests that external trade liberalization, even if it has an effect, may not be the primary driver behind the coastal agglomeration.

More General Specification

If the external trade liberalization brought about by WTO accession is not the main driver behind the coastal agglomeration, and if the coastal agglomeration is mostly pushed forward by internal reforms and market liberalizations, we should see gradual industry agglomeration and firm convergence. To capture the effects of the market liberalization in different years, I run a more flexible specification:

$$y_{rt} = \alpha_r + \gamma_t + \sum_{t=1998}^{2007} \beta_t Distance_r \times Year_t + \varepsilon_{rt} \quad (2.24)$$

where $Year_t$ is the dummy for year t . The coefficient can be interpreted as the difference between the coastal and the inland region in year t compared with the base year, year 1998.

The change in β s over time are shown in Figure 3.8. The solid lines show the time trend of the coefficient β , and the dashed lines show the 95% confidence intervals. From the figure, we see gradual industry agglomeration in the coastal region. Manufacturing output, manufacturing employment and number of firms grew faster in the coastal region than in the inland region during the whole period. Export grew faster in the coastal region between 1998 to 2001. The trend reversed between 2002 to 2004, but the coastal region regained momentum since 2005.

The lower 4 figures show firm responses during this period. Firm revenue grew

Table 2.4: The Heterogeneous Effects of the WTO Accession (with tariff control)

	(1)	(2)	(3)	(4)
Panel A: Industrial agglomeration				
	ln(Output)	ln(L)	log(num. firm)	ln(export)
Export Tariff	-0.00950 (0.0106)	-0.0107 (0.00803)	-0.0325*** (0.00836)	-0.0286 (0.0196)
<i>Distance</i> × <i>WTO</i>	-0.0595*** (0.0190)	-0.155*** (0.0161)	-0.158*** (0.0190)	-0.0709** (0.0282)
Observations	3290	3262	3290	3045
R^2	0.980	0.976	0.962	0.942
F	146.309	145.374	146.309	154.164
Panel B: Firm response				
	ln(firm revenue)	Prob. export	ln(VAL)	ln(wage)
Export Tariff	0.0230*** (0.00847)	0.000838 (0.00105)	0.0138* (0.00830)	-0.00249 (0.00436)
<i>Distance</i> × <i>WTO</i>	0.0984*** (0.0177)	0.00516** (0.00243)	0.0831*** (0.0164)	0.0477*** (0.00819)
Observations	3290	3290	3259	3262
R^2	0.900	0.832	0.851	0.836
F	146.309	146.309	145.322	145.374

^a Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

^b Standard errors clustered at prefecture level.

^c F is the first-stage F statistic.

faster in the coastal region than in the inland region, and the trend became more significant after 2002. Before 2002, exporting probability in the inland region decreased compared to the coastal region, but the trend reversed after 2003. Valued added per worker and annual wage increased faster in the inland region than in the coastal region during the whole period.

Overall, the figure shows industry agglomeration and firm convergence over the entire period. However, there does not seem to be an abrupt change of trends after China joined the WTO. The results are more consistent with the story that gradual internal reforms and market liberalizations, rather than external trade liberalizations, are the primary drivers behind the coastal agglomeration.

2.5 Conclusion

This paper introduced internal geography into the heterogeneous firm model to study the effects of trade and trade liberalization on coastal and inland regions. I show that opening up to international trade leads to industry agglomeration in the coastal region and causes firms in the coastal region to have a higher productivity.

Both internal and external trade liberalizations lead to industry agglomeration in the coastal region. External trade liberalizations leads to firm divergence, and internal trade liberalizations leads to firm convergence between coastal and inland regions.

Using Chinese data from 1998 to 2007, I find that manufacturing firms agglomerated in the coastal region, and that firms converged between the coastal and inland regions. The results suggest that internal trade liberalization had a more significant effect during the study period. For many developing countries, external integration is accompanied by internal liberalizations. The model suggests a way to weigh the relative importance of external and internal trade liberalization, and also to help explain why the benefits of opening up go beyond the usual external trade cost reduction.

It should be noted that the agglomeration force in my model is the hub effect, not the home market effect. The location advantage is the driving force for the industry agglomeration and higher productivity in the coastal region. In reality, both the home market effect and the hub effect exist. If the coastal region has a larger market than the inland region, the home market effect could also induce industry to agglomerate in the coastal region, but it would not caused the coastal region to have a higher productivity. The higher average productivity in the coastal region also suggest that the hub effect is the primary force at work.

Since we do not assume migration between the coastal and the inland region, industry relocation occurs through free migration between agriculture and industry sectors. When migration is allowed, there will be another channel of agglomeration, and we would expect a faster agglomeration process when trade costs decrease. In the empirical section, we do see that industry employment agglomerated faster than industry output. Since the household registration system discourages migrants from living permanently where they work (Chan and Zhang (1999)) , it could cause a separation of employment and consumption and reduce the agglomeration of production. How to model the household registration system and how it affects China's industrial agglomeration is an interesting topic for future research.

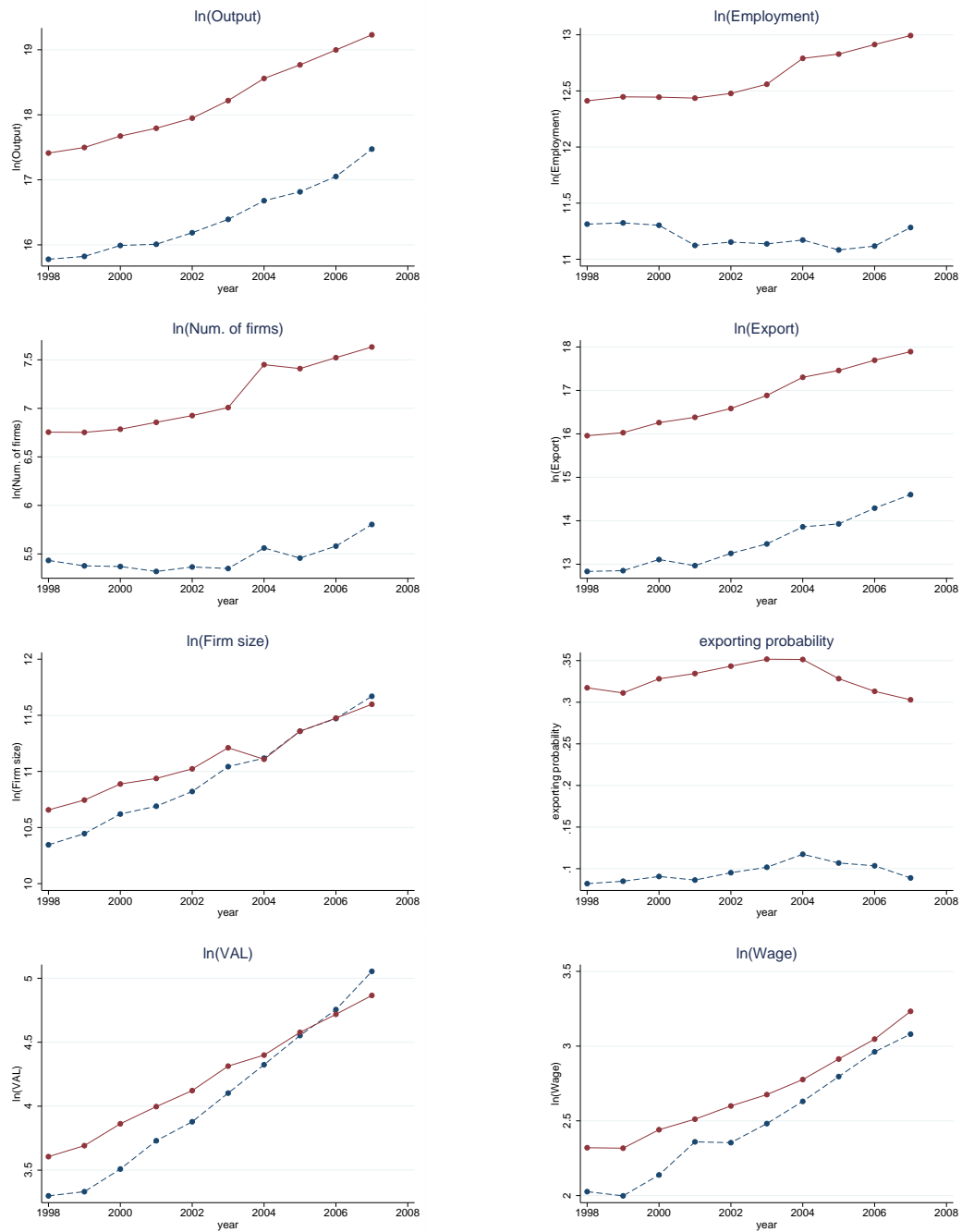


Figure 2.7: Trends before and after the WTO accession

Notes: The solid line shows the trend of the coastal region, and the dashed line shows the trend of the inland region. I exclude Henan province in 2005 and 2006 because the number of exporters is too large in these two years and they are not consistent with the data before 2005 or after 2006.

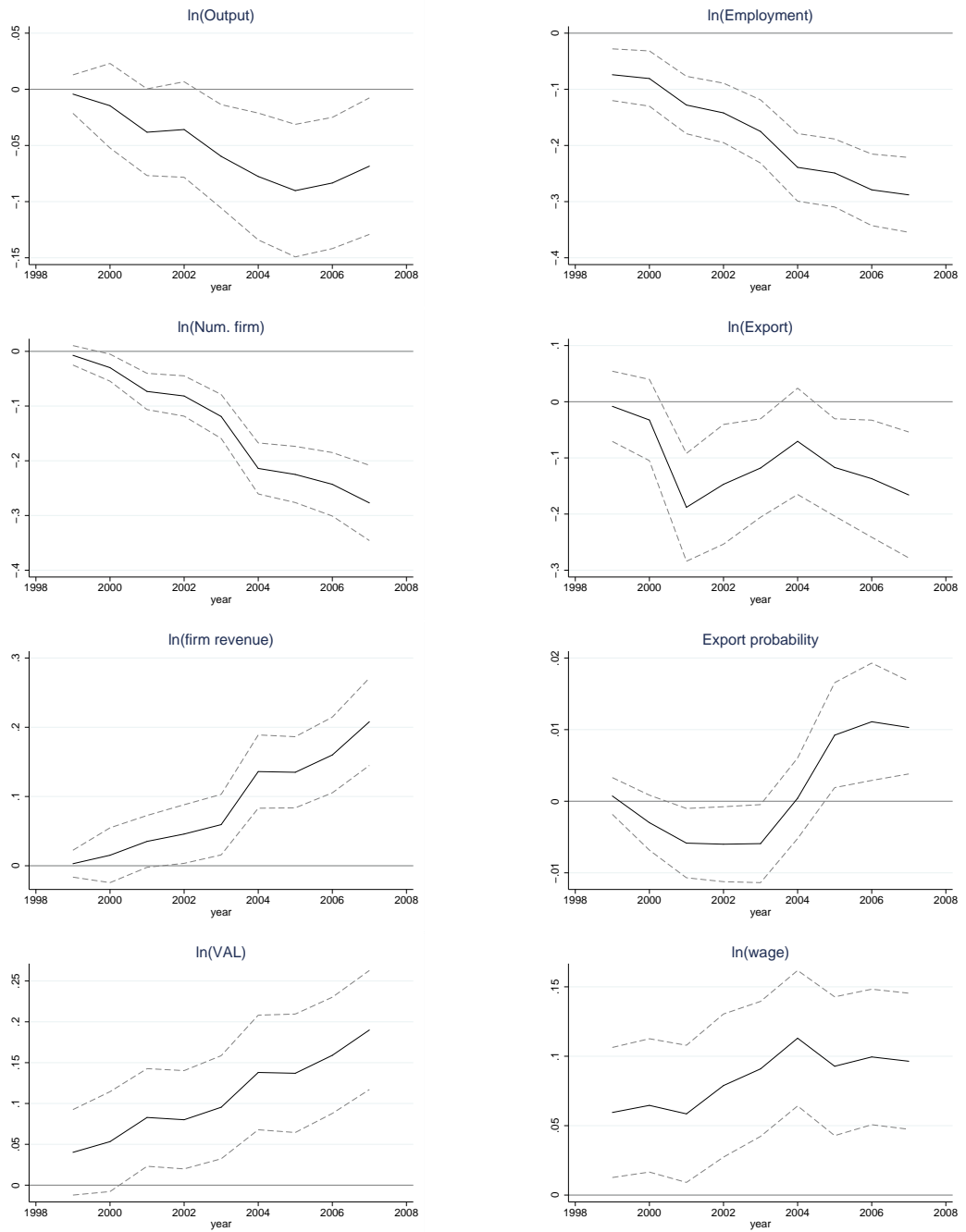


Figure 2.8: Trends of the Difference between Coastal and Inland Regions

Notes: The figure show the trend of $Distance_r \times Year_t$. The base year is 1998. The solid line depicts β from regression (2.24), and the dashed lines show 95% confidence interval.

Chapter 3 The Border Effect of China's East/Non-east Divide

3.1 Introduction

It is not new that country borders could cause large economic discontinuities (Pinkovskiy (2017)). At the beginning of *Why nations fail*, Acemoglu and Robinson (2013) use the stark contrast between two towns at the US-Mexico border to motivate the theme of their book that institution rules. The satellite night light map of Korean Peninsula is also often used to show the effect of country borders on economic development. However, within-country economic discontinuities have received less attention. In this paper, I document the large economic discontinuities across the east/non-east provincial borders in China, and shows that the economic discontinuities are correlated with openness level and index of market liberalization at the provincial level.

The reasons to choose China are twofold. First, China is a diverse country with substantial variations in local government policies. China's economy is highly decentralized, and subnational governments actively participate in economic development (Xu (2011)). Thus, subnational policies could have large effects on the local economy, and the effects of different policies are most evident on the borders. Second, China's economic reform began from east (coastal) provinces, and coastal provinces have received preferential policies in international trade and economic development. Since the economic reform, east provinces have been growing faster than non-east provinces. The large variation of government policies provides an opportunity to examine the effects of subnational policies on China's east/non-east divide.

I took 4 plains provinces in China, among which two are coastal provinces in the east and the other two are in the non-east. There is no geographic barrier between the 4 provinces. I show that there are significant discontinuities of manufacturing activities across the east/non-east provincial borders. The east has significantly higher manufacturing employment, production, and export. By using only counties that are contiguous to the east/non-east provincial borders, I find that the eastern counties have 87% higher manufacturing production, 80% higher manufacturing employment, and 106% higher manufacturing export than the western counties. Meanwhile, the eastern counties have a lower share of the rural population, a higher exporting share, and a higher share of manufacturing output by foreign firms. I also find the border discontinuities account for a large proportion of the gaps between east and non-east provinces.

Next, I show that the border effects are larger for non-state sectors than for the state sector, and are stronger in non-mountain regions than in mountain regions. Since the state sector is under the direct control of the government and China's industrial policies had long favored inland over coastal regions before its economic reform, the distribution of state-owned firms is less affected by provincial reform and openness levels. Thus, we see smaller economic discontinuities in the state sector. The place-based preferential policies, although good for export and industry development, only

works if the regions have good access to the world market. Thus, for counties in plain regions, the eastern counties have a higher level of manufacturing density than the western counties because of the better policies; in mountain regions, preferential policies do not work well and counties on both sides of provincial borders have a low level of manufacturing activities.

At last, I provide some direct evidence that openness level and index of market liberalization at the provincial level can account for a large part of the east/non-east divide. I use the number of national economic and technological development zones (ETDZs) within a province as a measure of openness level and show that the higher openness level is associated with higher manufacturing densities. I also use Gang Fan's market index as a measure of market liberalization and show that counties with a higher level of market liberalization is also associated with higher level of manufacturing activities.

This paper documents economic discontinuities across the east/non-east provincial borders in China, and points to the importance of provincial policies, or "local institutions". Acemoglu and Dell (2010) document substantial within-country (and cross-municipality) difference in output and standards of living for countries in Latin America. They argue that the large within-country income difference can be explained by local institutions that influence how local and regional collective decisions are made, how the lower level of government interact with the national government, and how political power is distributed at the local level. For countries as diverse as China, it seems that local policies are important to explain regional differences. Xu (2011) and many others have emphasized the regional decentralization of economic affairs in understanding China's economic growth and regional inequalities. Since many economic affairs are delegated to subnational governments, different provinces could adopt different development strategies. Conditional on that local protectionism is severe and inter-provincial trade and migration barriers are substantial, provincial-level policy differences could cause economic discontinuities at the borders.

One significant policy difference between the coastal and the inland region is that the coastal region received many preferential policies in international trade and economic development. Démurger et al. (2002) and many earlier works have shown that preferential policies received by coastal provinces are important to explain the higher growth of the coastal region. Recent research such as Wang (2013) and Alder et al. (2015) have examined directly the effects of the "place-based policy" on local economic development. This paper takes a different approach by comparing counties contiguous to the east/non-east borders, where the east have preferential policies of openness and trade. The regression discontinuity design identifies the border effect caused by policy differences.

The paper is also related to the literature studying China's coastal/inland divide (or east/non-east divide), and how the regional inequality is related to China's economic reform and openness. China's opening-up policy has been proved successful. However, the incremental opening-up policy has also been criticized for increasing regional inequalities between the coast and the inland.(Demurger et al. (2002)) Studies examining the relationship between preferential policies and regional inequalities have to control for geographic factors, since the coastal provinces have better geographic

conditions (infrastructure, location, etc) than inland provinces. One major difficulty is to find good measures of geographic factors that contribute to local development. This paper avoids this difficulty by comparing counties with similar (if not the same) geographic conditions (and also culture), so the difference across the border has to be mainly explained by policy differences.

The idea of using border approach to identify policy effects is not new, and it has been particularly popular since the pioneering work of Holmes (1998). However, when applying the border approach to study the regional inequalities between the east and the non-east of China, it is important to note that we are not identifying the effect of a specific policy, but a general political border effect. The border effect is not explained by geographical or cultural factors. The abrupt change of manufacturing activities across the east/non-east provincial borders can be attributed to the difference in openness level and market liberalization at the provincial level.

The paper proceeds as follows. In section 2, I explain why I choose the 4 plains provinces in my main analysis, and argue that there is no geographic or cultural discontinuity across the borders. Section 3 documents the economic discontinuities across the borders. Section 4 discusses the heterogeneities of the border effect. Section 5 examines the possible explanations for the border effect. Section 6 does some robustness checks. Section 7 concludes.

3.2 Geography and Culture

In the main analysis, I choose 4 adjacent provinces in plain regions of China, Anhui, Henan, Jiangsu and Shandong (shown in Figure 4.1). Jiangsu and Shandong are coastal provinces in the east; Anhui and Henan are neighboring provinces in the non-east (I thus call them the western provinces). The 4 provinces are mainly plains. There is no mountain standing between Anhui-Henan and Jiangsu-Shandong.

Three big rivers run through these provinces. All of them flow from the west to the east. The Yellow River runs through Henan and Shandong Province. The Huai River runs through the south of Henan, and the north of Anhui and Jiangsu province. The Yangtze River runs through the south of Anhui and Jiangsu province. Although a small part of the Henan-Shandong border is along the Yellow River, in general, the border between Anhui-Henan and Jiangsu-Shandong is not along the rivers.

Figure 3.2 shows elevations of the counties in these four plains provinces. Most of the counties have an average elevation below 100 meters. The western counties have relatively high elevations, and the eastern counties have relatively low elevations. Although the western provinces have a higher elevation, counties contiguous to the provincial borders are all in plains and their elevations are below 100m. There is no abrupt change in elevation across the provincial border. Figure 3.1 and Figure 3.2 show that geographic conditions do not change discontinuously across the border.

The province as the first-level administration unit under the central government came into shape in China in the Yuan Dynasty (13th century). Anhui and Jiangsu

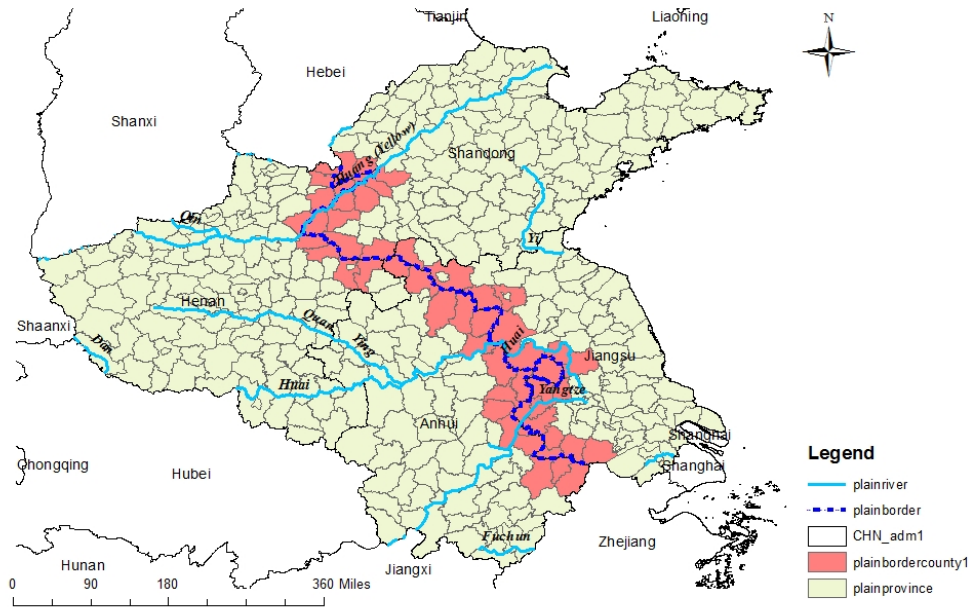


Figure 3.1: Counties in the Plains Provinces and the Border Counties

used to belong to the same province¹ in the Ming and Qing dynasty (14-17th century), and its size is equivalent to today's Jiangsu and Anhui combined. In 1666, Emperor Kangxi divided the Jiangnan province into Anhui and Jiangsu province, and the boundaries of them were very similar to today's boundaries. (Tan (1987)) However, the Qing dynasty did not divide Jiangnan province according to geographic or cultural similarities, but instead divided it out of concern for maintaining political stability. At that time, China's economic center had already moved to the Yangtze river valley from the Yellow river valley, and the south of Jiangnan province was more prosperous than the north. The economic and cultural differences between the north and the south are much greater than the differences between the east and the west. Yet, Jiangnan province was divided into a east province and a west province, so that both provinces have a rich south and a poor north part. A side effect relevant to this study is that counties contiguous to the provincial border between Jiangsu and Anhui are similar in cultural and economic conditions.

Henan and Shandong province were established in the Ming dynasty, and their boundaries have been relatively stable. Although the borders between the two provinces have changed, most of the times it is for the convenience of harnessing the Yellow

¹It was called Nan Zhili in Ming dynasty and Jiangnan in Qing dynasty.

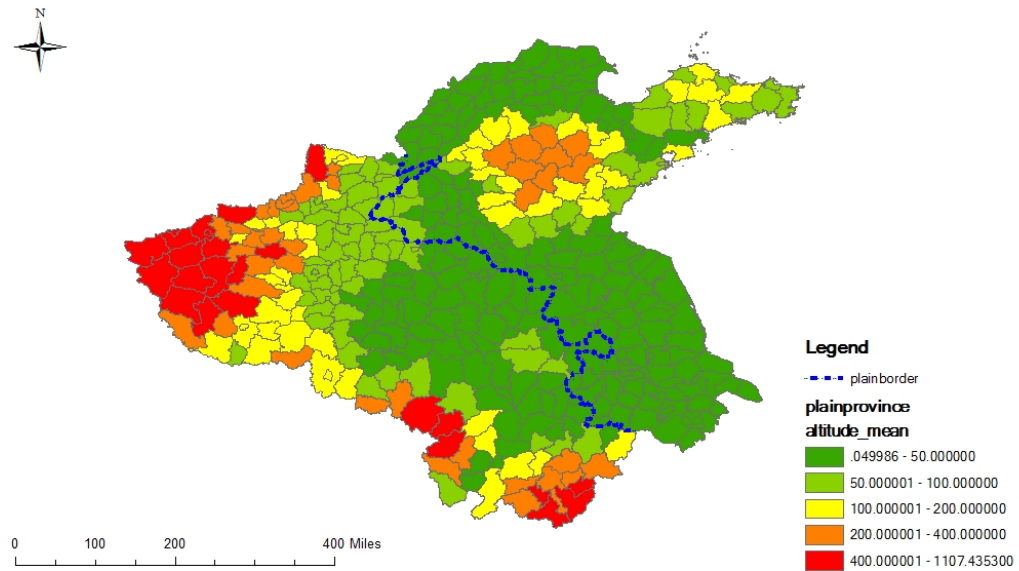


Figure 3.2: Elevations of the Plain Counties

River, a much-troubled river that has caused floods constantly.

Since the boundaries of the four provinces are set long before China's industrial development, there is no reason to worry that the borders are set to separate regions with different levels of industrial development. However, there is also a concern that culture might be different among those provinces, and cultural difference can also lead to economic discontinuities at the border.² While I do not have a direct measure of culture, there are several reasons to believe that cultural differences across provincial borders are small. First, culture tends to develop and transmit along the river. All the three big rivers run from the west to the east. So culture in north of Henan is similar to the culture in Shandong; culture in the north of Anhui is similar to that in the north of Jiangsu; culture in the south of Anhui and Jiangsu province are also similar. Second, provincial borders were not set according to economic or cultural similarities, especially in the case of Anhui-Jiangsu border. There is no reason to believe that culture changes suddenly across the border. Figure 3.3 shows the dialect map of the plains provinces. A dialect is spoken by a group of people with similar culture. Thus, it can be used to measure culture similarities. Looking at the dialect map in these four provinces, people in most places north of the Yangtze River speak Mandarin; people in the south of the Yangtze River speak other dialects. The cultural

²For example, Ma (2017) finds that regions that are in the same dialect area with Hong Kong receive more foreign direct investment than regions that are outside the same dialect area.

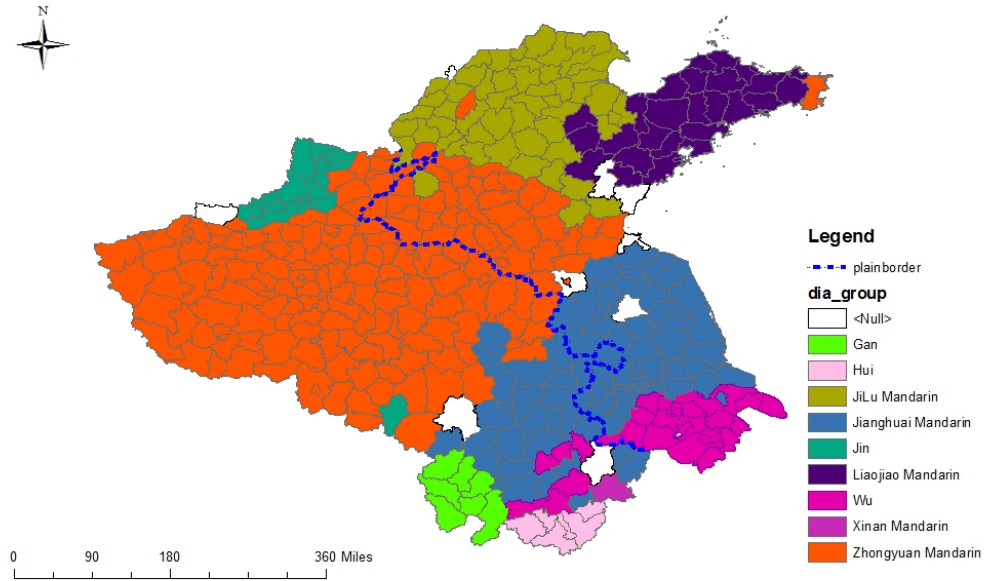


Figure 3.3: Dialects in the Plains Provinces

difference between the north and the south is greater than the cultural difference between the east and the west. The Mandarin speaking region can be further divided into several sub-dialect regions (Zhongyuan, Jianghuai, LiaoJiao, and Jilu Mandarin region). Even the borders of these subgroup dialects do not overlap with provincial borders. This gives us more confidence that even if there is a culture discontinuity between provinces, it does not appear at the provincial borders.

The above analysis shows that the east/non-east provincial borders are not determined by geographic barriers, were set long before China’s industrial development, and culture does not change across the border. Thus, if we see a significant discontinuity of manufacturing activities across the provincial border, it must not be due to geographic or cultural differences.

3.3 Economic Discontinuities Across the Provincial Border

3.3.1 Population and Agriculture Production

The four plains provinces are important agricultural provinces. Henan and Shandong province mainly produce wheat, while the South of Jiangsu and Anhui plant rice. The plains provinces are also the most populated regions in China. Shandong has the 2nd largest population in China. Henan ranks 3rd, Jiangsu ranks 5th, and Anhui ranks 8th in population. (2010 population census)

In the agricultural economy, grain production is the most important economic ac-

tivity and counties tend to be self-sufficient. Thus, political border would not cause discontinuity of economic activities if it were not along geographic barriers (such as mountains). In graph 1 and 2 of Figure 3.4, it shows that there is no discontinuity in both elevation and ruggedness (measured by standard deviation of elevation) across the east/non-east border. The geographic conditions are not significantly different across the border. Thus, we should not expect agriculture productivity to be different. The third graph shows no discontinuity in grain production across provincial borders.

The last graph in Figure 3.4 shows the distribution of population. Although the east counties have more population, the difference is not statistically significant.³ Part of the reason is that most of the population in the counties are agricultural population. Since geographic conditions do not change abruptly, so do agricultural production and agricultural population. The household registration system further restricts migration across regions. Thus, the population distribution today (to some extent) still resembles the distribution of agricultural population.

3.3.2 Economic Discontinuity

Although agricultural production and population show little evidence of discontinuity across the border, manufacturing activities and export are statistically different once crossing the border from the non-east to the east.

Under China's current political system, economic affairs are largely decentralized to sub-national governments.⁴ Different provinces may have different policies on international trade and economic development, and political borders can cause domestic market segregation⁵. Since China's economic reform began from the coastal region, coastal provinces were given preferential policies in trade and industry development. Border counties in the east provinces have better policies in trade and industry development than border counties in the west, even if they have similar geographic conditions and the same culture. Border counties in the eastern provinces also benefit more from technology and production spillover from port regions. Thus, there is a reason to conjecture that there is a discontinuity of industry activities across the borders between east (coastal) provinces and non-east provinces.

Figure 3.5 shows the discontinuity of industry activities across the border. The share of rural population is lower in eastern provinces and there is an abrupt decrease across provincial borders. This means that the level of industrialization is immediately different across the border. The second and the third graph show that manufacturing output and manufacturing employment are higher on the east side than on the west

³It is not significant at 10% significance level when running both parametric and non-parametric estimation.

⁴Subnational governments spend about 70% of all fiscal expenditure.(Wong et al. (2008))

⁵There has been intensive research on the relationship between China's economic reform and domestic market segregation. Young (2000) argues that economic reform increase market segregation, while Holz (2009) did not find that. Nonetheless, there is a consensus that the local protection is significant and inter-regional trade costs are high in China (Bai et al. (2004)).

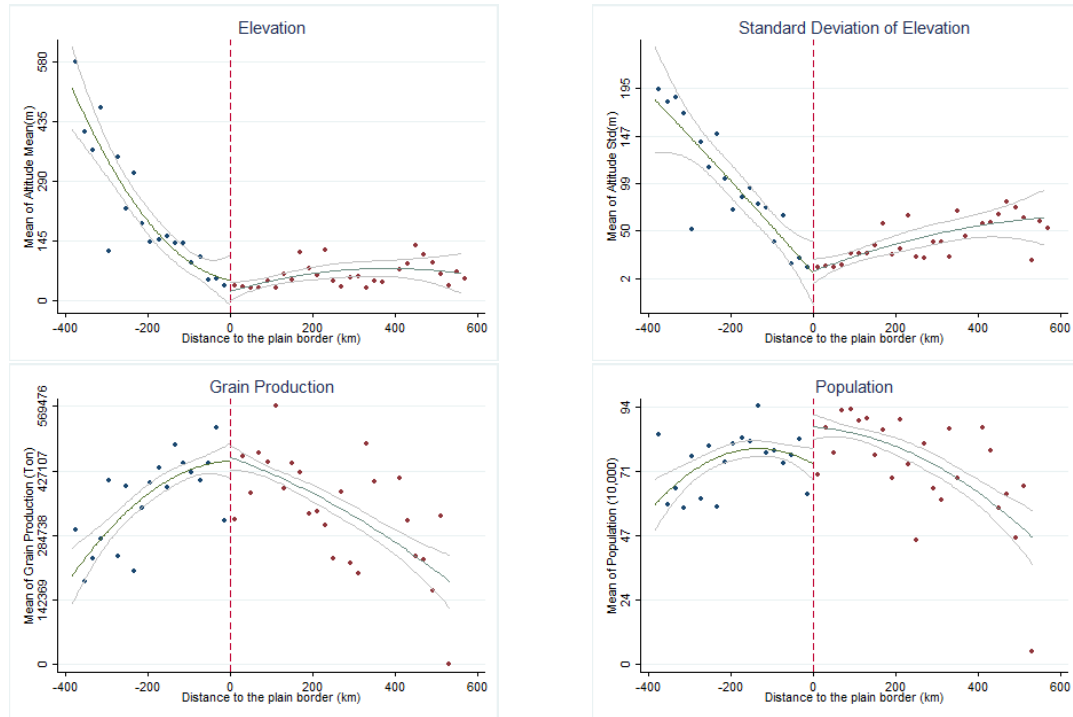


Figure 3.4: (Dis)continuities Across the Border

Notes: The graphs show the scatter plot between Y and distance to the borderline. The bin is set to be 20 km. Each point denotes the mean of observations within that bin. Quartic fitting lines with 95% confidence intervals are also included.

side of the border. Manufacturing export is also significantly higher on the east of the provincial border. Exporting share does not seem to increase abruptly across the border. However, from the last graph, it shows that the eastern provinces have a higher share of foreign output. This indicates that foreign firms play a more significant role in eastern counties than western counties.

3.3.3 Economic Geography in the Plains Provinces

To have a better picture of the distribution of manufacturing activities in the plains provinces, I draw the distribution of manufacturing production, manufacturing export, and the number of manufacturing firms.

Figure 3.6 shows the distribution of manufacturing output in 2007. There is a sharp contrast between the eastern provinces and the western provinces, especially on the south border of Anhui and Jiangsu province. Figure 3.7 shows the distribution of manufacturing export in 2007, and Figure 3.8 shows the distribution of manufacturing firms in 2007. All the figures show the same pattern: the eastern provinces have a much higher economic density than the western provinces. This is not surprising, as eastern provinces have better access to the world market, and enjoy better policies in

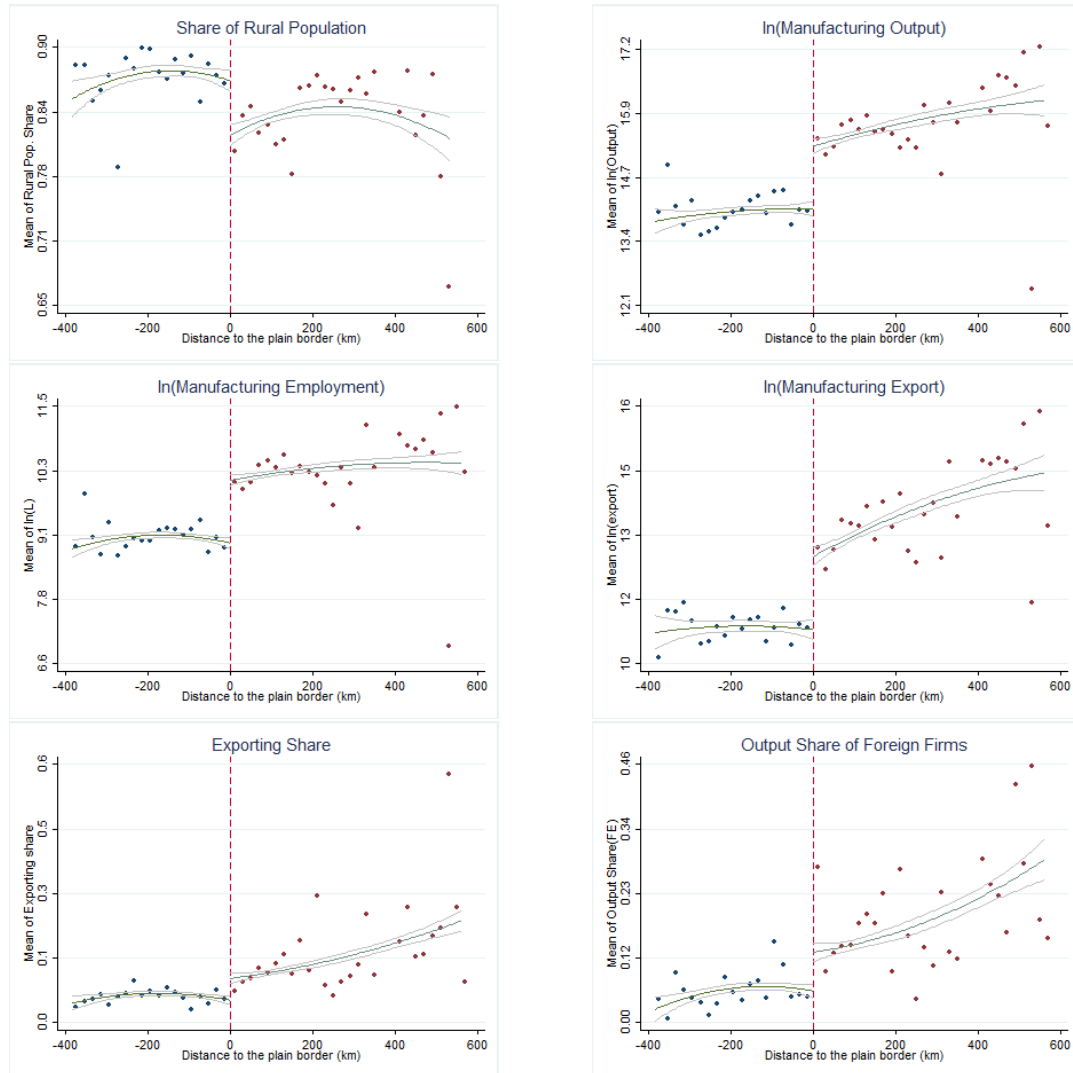


Figure 3.5: Economic Discontinuities Across the Border

Notes: The graphs shows the scatter plots between Y and distance to the borderline. The bin is set to be 20 km. Each point the mean of observations within that bin. Quartic lines with 95% confidence intervals are also included.

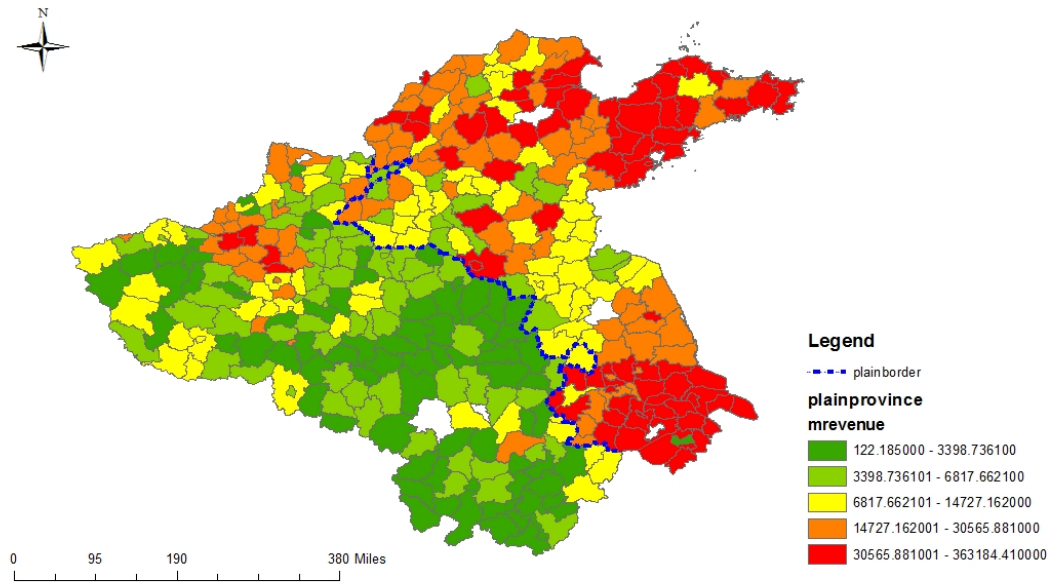


Figure 3.6: Manufacturing Output in 2007

Notes: The graph depicts manufacturing production (measured in million yuan) in each county in 2007.

international trade. What is surprising is the sharp contrast of manufacturing density at the provincial borders. The density of manufacturing activities (both production and export) decreases from the coast to inland region, and drop sharply once crossing the east/non-east provincial borders.

Next, I compare counties in the western provinces with counties in the eastern provinces; I also select counties contiguous to the east/non-east border and compare counties in the east with counties in the west. Table 3.1 shows the comparisons. The first two columns compare all counties in the western provinces (Anhui, Henan) with counties in the eastern provinces (Jiangsu, Shandong). The last two columns use only counties contiguous to the provincial borders and compares counties in the west with counties in the east. The counties in both the eastern and the western provinces have similar size of the population. However, manufacturing production and employment are much higher in the eastern provinces than in the western provinces. Manufacturing employment in the east is about 4 times as high as that in the west. Manufacturing production is more than 5 times as high. Manufacturing export is nearly 20 times as high. Looking at the last two columns, A large part of the gap between the eastern and the western counties appears at the border. Manufacturing employment on the east of the border is nearly 4 times as high as that on the west of the border. Manufacturing production is more than 5 times as high. Manufacturing export is nearly 9 times as high.

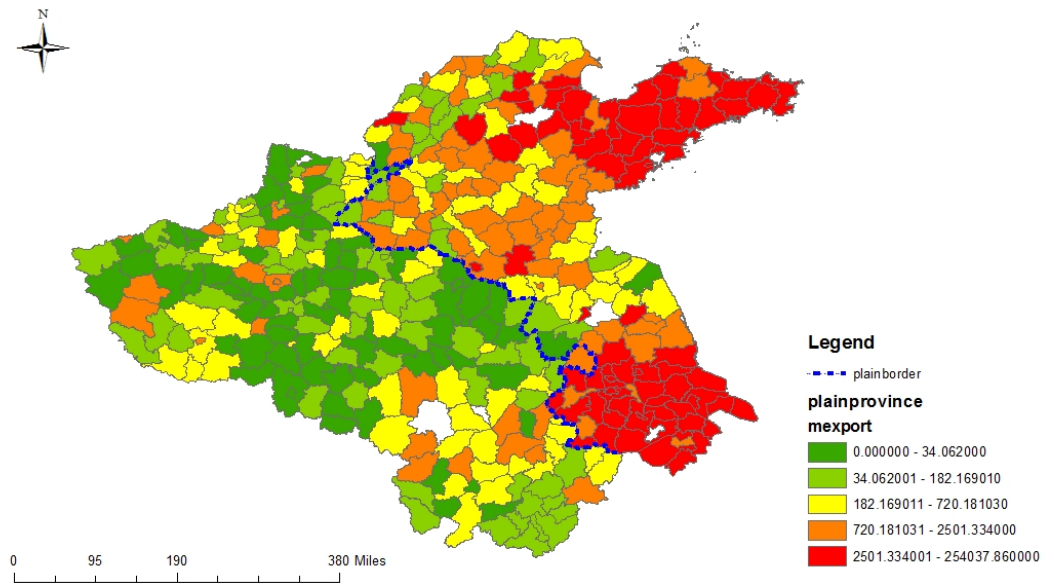


Figure 3.7: Manufacturing Export in 2007

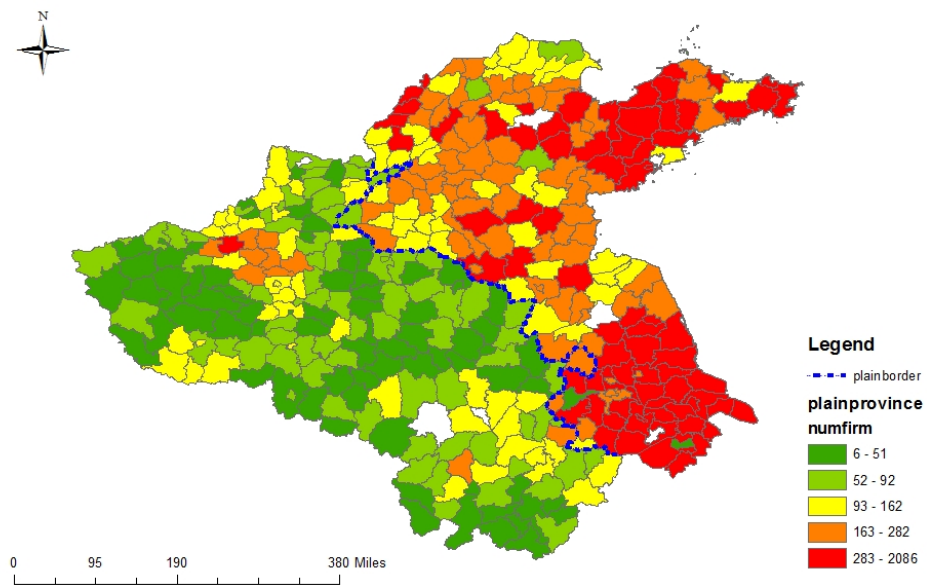


Figure 3.8: Number of Manufacturing Firms in 2007

Table 3.1: Comparison between Counties in the East and the Non-east

	Non-east County		East County		west of border		east of border	
	mean	sd	mean	sd	mean	sd	mean	sd
Industry employment	10,984	8,941	43,296	51,685	9,125	5,940	28,727	27,611
Industry Production (millian yuan)	2,296	3,270	13,981	26,814	2,013	2,451	8,031	13,621
Export (millian yuan)	124	240	2,463	9,950	125	228	663	1,218
Num. of firms	48	35	184	220	48	29	135	164
Output Share(SOE)	0.18	0.22	0.13	0.18	0.17	0.23	0.14	0.20
Output Share(PE)	0.76	0.23	0.71	0.21	0.77	0.24	0.75	0.21
Output Share(FE)	0.06	0.11	0.15	0.16	0.06	0.08	0.10	0.14
Exporting share	0.06	0.08	0.13	0.11	0.06	0.07	0.08	0.07
exporting probability	0.16	0.22	0.21	0.13	0.15	0.18	0.16	0.11
Rural Pop. Share	0.87	0.07	0.83	0.07	0.86	0.05	0.83	0.06
Population (10,000)	75.47	36.23	80.66	31.54	72.39	26.13	88.72	27.19
Distance port	456.56	148.47	154.70	93.95	289.39	85.71	260.18	96.74
Altitude Mean(m)	161.1	194.2	50.9	70.8	47.1	23.8	35.9	15.8
Altitude Std(m)	77.12	96.04	25.03	37.04	22.95	30.13	12.43	16.35
Observations	1901		1671		260		210	

¹ The table pooled data from different years. *Industry employment* to *exporting probability* are from Annual Survey of Industrial Firms (1998-2007); *Rural Pop. Share* and *Population* are from County Census Yearbook (2002-2004; 2006;2007). *Rural Pop. Share* is the share of population with agricultural household registration (agricultural hukou).

² The first column includes all counties in Henan and Anhui, the second column includes all counties in Jiangsu and Shandong; the last two columns includes only counties that are contiguous to the east/non-east provincial border.

³ *OutputShare(SOE)* is the production share of state owned firms. *OutputShare(PE)* is the production share of private firms. *OutputShare(FE)* is the production share of foreign firms. *ExportingShare* is the share of manufacturing production that is exported. *ExportingProbability* is the share of firms participating in export.

Economic structure is also different between the east and the west. Counties in the eastern provinces have a lower share of rural population. On average, the share of rural population is 87% in the western provinces and 83% in the eastern provinces. Across the border from the west to the east, the share of rural population decreased from 86% to 83%. Counties in the eastern provinces also have a higher share of foreign production and a higher exporting share. On average, manufacturing production share of foreign firms (Output Share (FE)) is 6% in the west, and it is 15% in the east. Economic structure also seems to change abruptly across the provincial borders. Across the border from the west to the east, the production share of foreign firms increases from 6% to 10%. The exporting share is 6% in the western provinces, and it is 13% in the eastern provinces. However, the exporting share only increases from 6% to 8% across the provincial borders.

Overall, counties in the eastern provinces have a much higher manufacturing density than those in the western provinces. And the provincial border accounts for a large part of the gap between the east and the non-east.

3.3.4 The Border Effect

To quantify the effects of provincial borders, I run a regression using only counties contiguous to the east/non-east provincial borders. The regression equation specified as:

$$y_{rt} = \beta_0 + \beta_1 East_r + \beta_2 distance_r + \beta_3 elevation_r + \beta_4 anhuijiangsu_r + \gamma_t + \varepsilon_{rpt} \quad (3.1)$$

where $East_r$ is a dummy variable that equals 1 if a county is on the east side of the border, $distance_r$ is the distance (km) of a county to the nearest seaport. $elevation_r$ is the average elevation of a county. Although I choose my sample to be counties contiguous to the provincial borders to avoid geographic differences between the east and the east, there could still be some small geographic differences. I include distance to the seaport and elevation to control for possible difference in access to the world market and trade costs to other regions. $anhuijiangsu_r$ is a dummy variable that equals one for counties in Anhui and Jiangsu province. The variable is included to control for the border segment fixed effect.

Table 3.2: The Border Effect of Economic Development

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
East	-0.0322*	0.870***	0.796***	1.060***	0.0230	0.0601*
	(0.0166)	(0.230)	(0.201)	(0.368)	(0.0190)	(0.0338)
Observations	293	466	466	423	466	466

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

I examine the border effects for the following six variables that measure the industry development: share of rural population, manufacturing output, manufactur-

ing employment, manufacturing export, exporting share, production share by foreign firms. Table 3.2 shows the effects of provincial borders on industrial development. Crossing the provincial border from the west to the east, a county's share of rural population decreases by 3%; manufacturing output increases by 87%, manufacturing employment increases by 80%, and manufacturing export increases by 106%. Although exporting share of manufacturing products does not change much (2.3%) across the border, production share of foreign firms (column 6) increases by 6% from the west to the east of the border. This means that foreign firms play a more important role in the east than in the west.

Table 3.2 shows large discontinuities across the east/non-east borders. How much do the discontinuities at the border account for the provincial gap? I next run the following equation:

$$y_{rpt} = \beta_0 + \beta_1 y_{pt} + \beta_2 distance_r + \beta_3 elevation_r + \beta_4 anhuijiangsu_r + \gamma_t + \varepsilon_{rpt} \quad (3.2)$$

where y_{rpt} is the response variable in county r , province p and year t ; y_{pt} is the average y in province p and year t .⁶ The coefficient β_1 measures the share of provincial level difference that can be accounted for by the gap between border counties.⁷ The results are in Table 3.3.

Table 3.3: The Border Effect as a Share of the Provincial Gap

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
Y_{pt}	0.698** (0.297)	0.513*** (0.120)	0.569*** (0.132)	0.365*** (0.124)	0.221 (0.167)	0.368* (0.201)
Observations	293	466	466	423	466	466

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From Table 3.3, the border gap accounts for about 70% of the difference in rural population share between provinces, more than half of the difference in manufacturing production and employment, and about 37% of the difference in manufacturing export between provinces. It also explains 37% of the difference in foreign firm production share between east and non-east provinces.

Table 3.2 and Table 3.3 show the large manufacturing discontinuities across the provincial borders. The large east/non-east divide is unlikely to be explained by geographic conditions and cultures, as we show in the previous section that geographic conditions and culture do not change abruptly across the provincial border. Table

⁶I also tried to exclude counties contiguous to the east/northeast border and use the remaining counties to compute provincial average y_{pt} . It does not change the main results. The results are in the appendix.

⁷Compare a border country r_1 in the eastern province p_1 with a border county r_2 in the western province p_2 , $\beta_1 = \frac{y_{r_1 p_1 t} - y_{r_2 p_2 t}}{y_{p_1 t} - y_{p_2 t}}$, which is the ratio of cross-county difference over cross-province difference. It gives a measure of how large the border gap compared to the provincial gap.

3.3 also shows that a border county is more similar to the average county within the same province than the neighboring counties in the other province. This indicates that provincial level policy variables can probably account for the large border effects.

3.4 Heterogeneity in the Border Effect

3.4.1 State and Non-state sectors

China's economic reform and openness started by letting non-state sectors to grow. The state sector is under direct control of the government and state-owned firms are more evenly distributed across the country⁸. However, the development of non-state sectors is "outside the control". The eastern provinces experienced a higher growth in non-state sectors than the western provinces since the economic reform and openness. Since the economic reform and opening-up was first initiated in the coastal region, the coastal (and eastern) provinces also have a better policy environment for the development of non-state sectors. Thus, we expect to see a large discontinuity in non-state sectors, but a small discontinuity in the state sector.

In Table 3.4, I divide industrial output into state-owned (SOE) sector, private (PE) sector, and foreign (FE) sector, and run regression (3.1) for each sector separately. For both private sector and foreign sector (non-state sectors), there are significant discontinuities across the east/non-east borders for manufacturing output, manufacturing employment, and manufacturing export (column 4-9). The discontinuity seems to be stronger in the foreign sector. Indeed, China's incremental reform strategy gave the coastal region a lot of preferential policies in economic development and international trade. All those policies encourage the development of non-state economy, attract foreign investment, and promote international trade. Those policies could lead to non-state sector to develop faster in the coastal region than in the inland region. In the state sector, however, the manufacturing discontinuity is not statistically significant (column 1-3). Since the distribution of state-owned firms is more affected by government policies, and China's industrial policy before economic reform focus on self-sufficiency and regional equality, the distribution of the state sector is more evenly distributed and we do not see a discontinuity across the east/non-east borders. The results indicate that difference in reform and openness level since the economic reform can account for the large economic discontinuities across the east/non-east borders.

⁸Actually, before China's economic reform, government's industrial plans favored the inland regions over the coastal regions, for fear of wars.

Table 3.4: Border Effect of Economic Development (by Ownership)

	State sector			Private sector			Foreign sector		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Output	Employment	Export	Output	Employment	Export	Output	Employment	Export
East	0.793	0.579	1.269	0.841***	0.767***	1.002**	1.305***	1.324***	0.825***
	(0.483)	(0.395)	(0.937)	(0.266)	(0.239)	(0.406)	(0.324)	(0.287)	(0.290)
Observations	379	379	134	465	466	391	385	386	286
R^2	0.206	0.413	0.179	0.579	0.420	0.257	0.452	0.403	0.398

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.4.2 Borders in the Plain and Borders in the Mountain

In the previous section, I use only counties contiguous to the borders of the plains provinces. The reason is to avoid confounding factors that could also cause economic discontinuities, such as differences in geographic conditions and cultures. When there is no geographic barrier, and cultures are similar, economic discontinuities across the borders can be attributed to policy differences. However, the preferential policies also need favorable locations to function well.⁹ Previous literature, such as Demurger et al. (2002), have emphasized the importance of both geographic conditions and preferential policies, but has not examined the interaction of these two forces. Here, I use the whole east/non-east border, and check if the border effect differs by geographic conditions.

Figure 3.9 depicts the borders between the east and the non-east of China. Some parts of the east/non-east border are in the plain regions, and other parts are in the mountainous regions. I define mountain counties as counties with an average elevation of 500 meters or higher and their neighboring counties on the other side of the east/non-east border. There are 195 border counties, 83 counties are counted as mountain counties, and 112 counties are non-mountain counties. An interesting fact is that for mountain borders, both counties in the east and counties in the west have high elevations, and thus less favorable conditions for industrial development.

I divide counties contiguous to the east/non-east provincial borders into a mountain sample and a non-mountain sample (shown in Figure 3.9). I then run regression (3.1) with the whole sample, the mountain sample, and the non-mountain sample respectively. The results are shown in Table 3.5. For the whole sample (Panel A), there is an east/non-east border effect in manufacturing output, manufacturing export, exporting share, and production share of foreign firms. Manufacturing output increases by 26.4% from the non-east to the east; manufacturing employment increases by 10.1%; manufacturing export increases by 71.3%; exporting share increases by 4.15%; production share of foreign firms increases by 6.01%. In general, there are large economic discontinuities across the east/non-east borders.

However, results in Panel B and Panel C show that the border effects are very different between mountain borders and non-mountain borders. For the mountain sample, the eastern counties do not have statistically higher manufacturing output, manufacturing employment, and manufacturing export than counties in the west. Yet, they still have higher exporting shares and higher production share by foreign firms. As we know, preferential policies in the eastern provinces promote industrial development, but a region's industry development also depends on its geographic conditions. For mountain counties, even if they enjoy preferential policies, that would not

⁹One only need to look at Guangdong province, the first province to implement the opening-up policy. While its GDP size has increased to be the largest since China's economic reform, Its growth is unbalanced. Most of growth is due to the development of the Pearl River Delta, which is adjacent to Hong Kong, and also close to the world market. Its mountainous north and west regions are among the poorest and most underdeveloped regions in China. For example, Shenzhen's GDP per capita is more than 7 times of Meizhou, a city in north Guangdong.

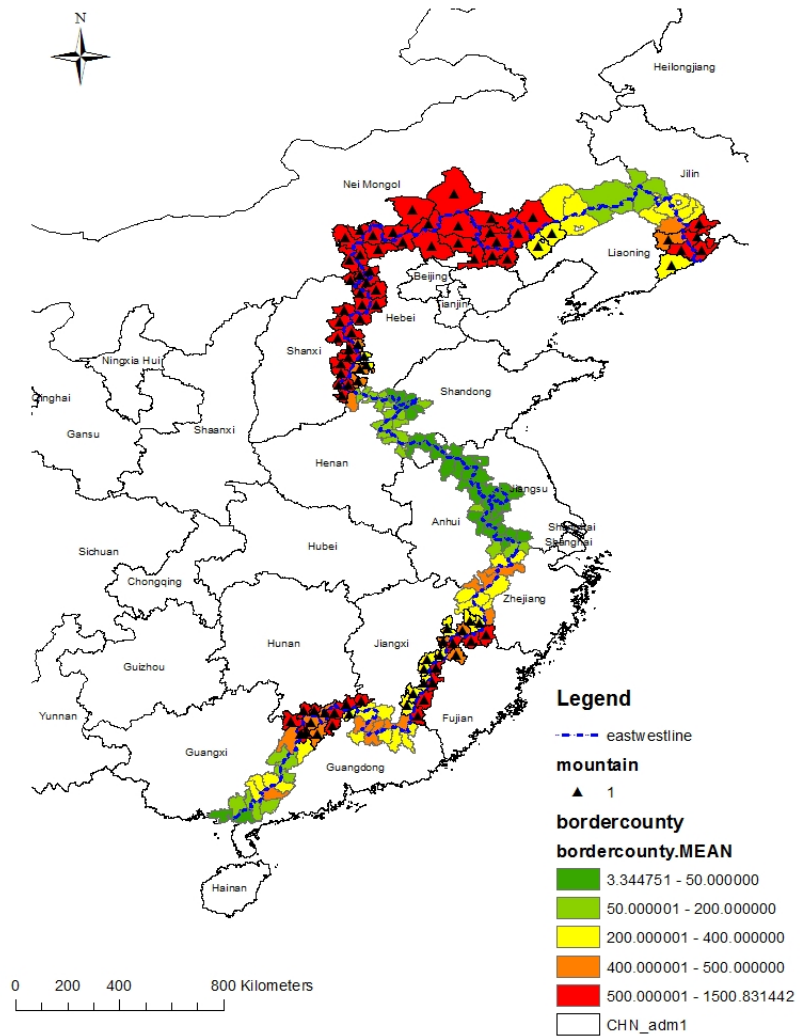


Figure 3.9: Counties Contiguous to the East/non-east Borders

Table 3.5: The Border Effect of Manufacturing Development

	(1)	(2)	(3)	(4)	(5)
	ln(Output)	ln(L)	ln(Export)	Export share	Foregin Share
Panel A: Whole sample					
East	0.264*	0.101	0.713***	0.0415**	0.0601***
	(0.152)	(0.130)	(0.209)	(0.0173)	(0.0213)
Observations	1892	1877	1373	1892	1892
R^2	0.599	0.485	0.445	0.293	0.283
Panel B: Mountain sample					
East	-0.0855	-0.124	0.510	0.0492*	0.0752**
	(0.252)	(0.212)	(0.370)	(0.0257)	(0.0369)
Observations	804	794	463	804	804
R^2	0.488	0.326	0.318	0.169	0.235
Panel C: Non-Mountain sample					
East	0.425**	0.178	0.747***	0.0301	0.0499*
	(0.173)	(0.165)	(0.246)	(0.0255)	(0.0279)
Observations	1088	1083	910	1088	1088
R^2	0.611	0.451	0.496	0.365	0.357

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

overcome their natural disadvantages, and thus we do not find significant difference in manufacturing activities across the borders. However, it seems that the preferential policies do attract more foreign firms, and the eastern counties have a higher share of production by foreign firms, and also a higher exporting share.

For the non-mountain sample, the counties in the east have significantly higher manufacturing output, manufacturing employment, manufacturing export, and production share of foreign firms than counties in the west. Comparing Panel A with Panel C, it can be seen that the east/non-east border effect for the whole sample is mostly driven by the non-mountain part. When there is no obvious geographic barrier, preferential policies have a large effect on industrial development. The east counties enjoy preferential policies, and thus have a higher manufacturing density.¹⁰ When elevations are high, trade costs are high and the counties are not suitable for industrial development. Thus, the preferential policies do not have a significant effect on industrial development and we do not see an east/non-east divide in mountainous regions.

¹⁰It should also be noted that our plain sample is a part of the non-mountain sample, where the border effects are the strongest.

3.5 The Border Effects Explained

The above analysis shows there are economic discontinuities across the east/non-east provincial borders, and it points to the possibility that different policies between the eastern and the western provinces caused the economic discontinuities across the border. However, I did not provide any direct measure of policies in previous sections. In this section, I try to find some policy measures and examine if the policy differences across provincial borders help to explain the east/non-east economic discontinuities.

3.5.1 Opening-up Policy

China's economic reform and openness began from the coastal region. In 1980, four special economic zones were established in the coastal Guangdong and Fujian provinces to experiment with the market economy and to integrate into the world economy. In 1984, China further opened up 14 coastal cities. In the late 1980s, China set up the policy of "coastal development strategy" to open up the whole coastal region, hoping to extend the opening-up policy to more regions and push forward the economic reform.(Yang (1991)) By now, all regions in China have opened up to international trade, but the coastal region still enjoys better policies in international trade. All the special economic zones are in the coastal region. There are more National Technology and Development Zones (ETDZs)¹¹ in the east. And many of the reform and opening-up policies are implemented in the coastal region first. The east (and coastal) provinces still have considerable policy advantages over the non-east provinces.

While it is hard to measure the openness level of a province precisely, I use the number of National Economic and Technological Development Zones (ETDZs) as a proxy for the openness level of the province. ETDZs are small zones within cities that enjoy many of the policies of special economic zones, including tax benefit, preferential land policies, and protection of private properties(Wang (2013)). The distribution of ETDZs is concentrated in the coastal regions. The first 14 ETDZs opened in 1980s are all in coastal provinces. By 2016, there are 219 ETDZs in China, and every province has at least one ETDZ. In 2016, Jiangsu has 26 ETDZs, and Shandong has 15; the non-east Anhui and Henan province have only 12 and 9 ETDZs respectively.

To examine the relationship between openness level and manufacturing activity, I run equation (3.1) but replacing the dummy variable *East* with the level of openness variable (number of ETDZs). The results are shown in Table 3.6.

During the sample period from 1998 to 2007, Anhui province started with 1 ETDZ in 1998, and ended up with 2 ETDZs in 2008; the number of ETDZs in Henan increased from 0 to 2; in the eastern provinces, the number of ETDZs increase from 4 to 5 for Jiangsu, and the number of ETDZs stays constant at 5 for Shandong province. The eastern provinces have a mean number of ETDZs of 4.79, and the

¹¹ETDZs can be seen as smaller special economic zones that focus on attracting foreign direct investment and export. They are usually located in cities.

Table 3.6: Openness and the Border Effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
ETDZ	-0.00881* (0.00471)	0.185*** (0.0611)	0.185*** (0.0529)	0.268*** (0.0981)	0.00797 (0.00554)	0.0151* (0.00893)
Observations	293	466	466	423	466	466
R^2	0.281	0.552	0.389	0.325	0.088	0.108

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

western provinces have a mean number of ETDZs of 1.51. Looking at Table 3.6, openness level has a negative effect on rural population share, and positive effects on manufacturing output, manufacturing employment, manufacturing export, and production share of foreign firms. The gaps in openness level between the east and the west can account for 2.9% of the difference in rural population share between the east and the west¹², 60.7% of the difference in manufacturing output, 60.7% of the difference in manufacturing employment, 88% of the difference in manufacturing export, and 5% of the difference in production share of foreign firms. Compare the results of Table 3.2, we can see that openness level can account for a large part of the east/non-east divide.

Of course, there is another interpretation of the number of ETDZs. The number of ETDZs can also be seen as a measure of the strength of spillover effects.¹³ If provincial borders prevent the spillover effects of ETDZs, the counties in provinces with more ETDZs will benefit more from ETDZ spillovers than counties in provinces with less number of ETDZs. Thus, the east/non-east divide can also be interpreted as the different level of spillover effects from openness centers.

3.5.2 Market Liberalization

China's reform and opening-up policies are mainly market liberalization policies. Indeed, the whole aim of the market reform is to establish the "socialist market economy"¹⁴. Since the eastern provinces were opened up first and they enjoy preferential policies, counties in the east have a higher level of market liberalization than counties in the west. The higher level of market liberalization could cause border counties in the east to have more manufacturing activities than those in the west.

To measure the level of market liberalization, I include the market index by Fan et al. (2003). The Fan market index gives each province a synthetic index of market liberalization based on the following five aspects: (1) Government intervention of the market; (2) Development of non-state sectors; (3) Development of final product

¹²Since the east has 3.28 more ETDZs, and one more ETDZ is associated with 0.881% decrease of rural population share, the openness gap implies a difference of 2.9% in rural population share.

¹³None of the border counties in the sample has an ETDZ.

¹⁴It is stated in the 14th China Communist Party's National Congress in 1992.

market; (4) Development of factor market; (5) Development of market intermediates. As a widely used index of market liberalization, it gives a measure of how resources and prices are determined by the market force, as well as the development of laws and financial system. I use it as a proxy for market liberalization, and examine how the level of market liberalization affects industrial development.

Table 3.7: Market Liberalization and the Border Effect

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
Market Index	-0.0189** (0.00844)	0.493*** (0.116)	0.430*** (0.0977)	0.517** (0.196)	0.00634 (0.00886)	0.0316* (0.0178)
Observations	293	466	466	423	466	466
R^2	0.314	0.600	0.445	0.330	0.069	0.118

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.7 shows that effects of market liberalization on east/non-east border gap. It shows that market index has a negative effect on the share of rural population, and strong positive effects on manufacturing production, employment, export, share of production that is exported, and the share of production by foreign firms. Given that the east counties have a mean market index of 7.15 and the west counties have a mean market index of 5.54, the gap of market liberalization (1.61) across the borders can account for 3% of the difference in the share of rural population, 79% of the difference in manufacturing output, 69% of the difference in manufacturing employment, 83% of the difference in manufacturing export, 1% of the difference in exporting share, and 5.1% of the difference in foreign production share. Compare the above calculations with the results in Table 3.2, we also see that market liberalization can explain a large part of the east/non-east provincial border effect.

3.6 Robustness

3.6.1 Human Capital and Local Public Goods

In the previous section, I use only counties contiguous to the provincial borders to examine the effect of political borders on the distribution of manufacturing activity. The reason is that border counties are similar in geography and culture, so the economic discontinuities can only be explained by policy factors. However, there may be some other local factors that are statistically different and may also cause economic discontinuities. Here we examine two factors: local human capital and local public good. Human capital is an important factor in determining economic growth, and if the east counties have a higher level of human capital, they will have more manufacturing production and employment. I follow Mankiw et al. (1992) and use students at primary and middle school as a measure of human capital. Local public good can also contribute to local economic growth. I use length of railway and length of the paved road as proxies for local public goods. Adding these control variable into

the equation (3.1), I obtain the following results:

Table 3.8: The East/Non-east Border Effect (with controls)

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
East	-0.0422*** (0.0119)	1.029*** (0.272)	0.860*** (0.240)	1.091** (0.493)	0.0110 (0.0214)	0.0833* (0.0418)
ln(hc)	0.0254 (0.0271)	-0.491 (0.432)	-0.565 (0.361)	-3.168** (1.520)	-0.0689 (0.0657)	0.0200 (0.124)
ln(road)	0.00438 (0.00455)	-0.00914 (0.112)	0.133 (0.0829)	0.356 (0.286)	0.0167 (0.0136)	-0.0159 (0.0152)
ln(rail)	-0.00461 (0.00335)	0.160* (0.0930)	0.106 (0.0656)	0.0958 (0.126)	-0.00473 (0.00582)	-0.000641 (0.00987)
Observations	287	283	283	258	283	283
R^2	0.640	0.756	0.640	0.478	0.151	0.167

¹ Standard errors in parentheses clustered at county level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

² human capital(hc): number of primary and middle school students per 10,000 population. Road: length (in kilometer) of paved road. Rail: length (in kilometer) of railway.

³ The regression equations also control for distance to the nearest seaport, elevation, year fixed effect, border segment fixed effect, as well as culture (measured by dialect).

Adding these local control variables does not change our main results. The coefficient of the dummy variable *East* is still statistically significant and the magnitude is similar to Table 3.2. However, after controlling for the east/non-east dummy, local public good variables and local human capital variables are not statistically significant. The results show that the large economic discontinuities are not due to local factors, and it gives us more confidence that the border discontinuities are caused by policy differences at the provincial level.

3.6.2 The “False” Border Effect

Are the effects we found really the provincial border effects? If economic activities change discontinuously from county to county, we will find economic discontinuity in the main analysis even if provincial borders have no effect. In this section, I check if economic activities change abruptly across a hypothetical border. Specifically, I check if there is an economic discontinuity between counties on the west border and the other counties in the western provinces, and also examine if economic activities change abruptly from counties on the east border to the other counties in the eastern provinces.

Figure 3.10 shows how I choose the comparison groups. I use counties within 100 km from the border but are not contiguous to the borders as my comparison counties¹⁵. In the figure, the red ones are counties contiguous to the borders, and

¹⁵I also use other ways to construct comparison counties. In the appendix B.3, I use counties adjacent to the border counties as the comparison group, and the results are similar.

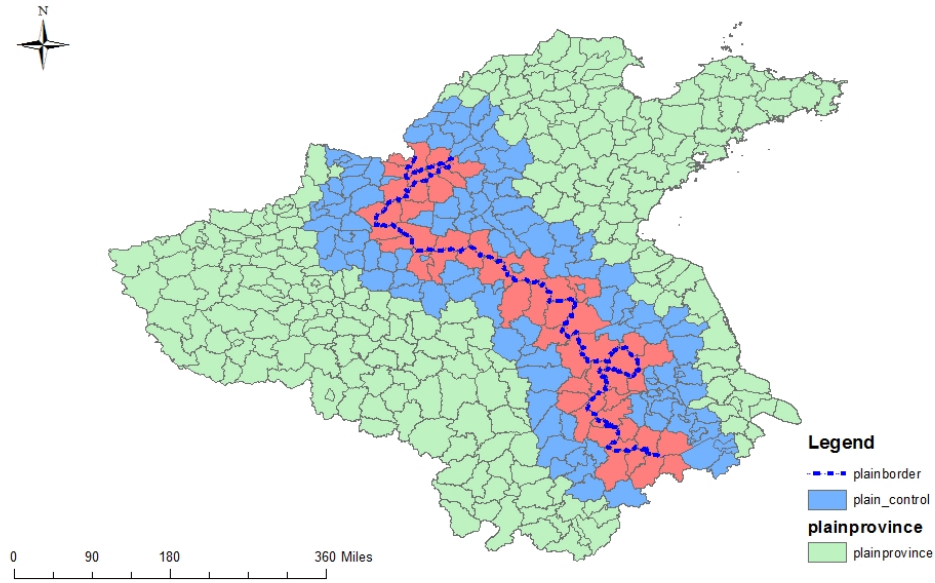


Figure 3.10: Border Counties and Comparison Counties

the blue ones are my comparison counties. The first comparison is between western counties contiguous to the border and western counties within 100 km from the border line (but not contiguous to the border). The second comparison is between eastern counties contiguous to the borders and eastern counties within 100 km from the border line. In both cases, I run equation (3.1) to check if economic discontinuities exist in the false borders.

Table 3.9: The Effects of False Borders

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
Panel A: The Effects of the False Border in the West						
East	-0.0280** (0.0114)	0.233 (0.163)	0.198 (0.155)	-0.130 (0.292)	-0.00987 (0.0163)	-0.0257 (0.0307)
Observations	453	767	767	635	767	767
R^2	0.229	0.450	0.112	0.158	0.164	0.035
Panel B: The Effects of the False Border in the East						
East	-0.00760 (0.0171)	-0.0214 (0.245)	-0.0654 (0.192)	-0.0536 (0.372)	-0.00466 (0.0192)	0.00846 (0.0304)
Observations	455	812	812	795	812	812
R^2	0.208	0.545	0.368	0.458	0.239	0.180

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel A of Table 3.9 shows the effects of the false border in the west. The coefficients of the dummy variable *East* are small and insignificant in all cases except for the share of rural population. Panel B shows the effects of the false border in the east. The coefficients of the dummy variable *East* are insignificant for all regressions. The results show that there is no economic discontinuity between counties within the same provinces. The results implies that manufacturing discontinuities across the east/non-east border are not due to local factors, and supports that provincial level policy differences cause the east/non-east divide.

3.7 Conclusion

This paper documents the economic discontinuities between the east and the non-east of China. Using borders on the plain regions, I show that the economic discontinuities are not due to geographic barriers or cultural differences. Further analysis shows that the economic discontinuities are stronger in the private sector and the foreign sector than in the state sector, and are stronger in non-mountain regions than in mountain regions. I also use measures of openness level and market liberalization and show that both openness level and market liberalization can account for the large economic discontinuities across the east/non-east borders.

The results in this paper support that subnational (provincial) policies could cause regional disparities for regions with similar geographic conditions. For an economically decentralized country like China, it also shows that place-based policies not only increase economic growth in regions that have the preferential policy, but also increase regional inequalities.

Border effect is still a black box that needs more research and exploration. This paper takes a small step to try to understand the border effect. Future work should focus more on specific policy differences across the border, as well as barriers to trade and migration.

Chapter 4 The Ending of the Multi-fiber Arrangement and Its Impacts on Textiles and Clothing Industry in China

4.1 Introduction

The Multi-fiber Arrangement (MFA) ended in 2005. The sudden and exogenous change of trade policy provides an opportunity to examine the effect of a special kind of trade liberalization, the removal of quota restrictions. As the world's largest textile and clothing (T&C) exporter, China was relatively more constrained under the MFA and experienced larger export growth when the quotas were lifted. Extensive research has been done using the expiration of the MFA to test the effects of quota restriction on export price and quality (Harrigan and Barrows (2009)), the distortions caused by inefficient quota allocations (Khandelwal et al. (2013)), and the responses of firms in developed countries in facing the intensified competitions from China (Utar (2014)). In this paper, I look at how regions within a country respond to external trade liberalization by examining the regional response of export growth after the MFA expired. I also examine the adjustments by incumbents and entrants during the quota removal.

I start by examining the effect of the MFA removal. After the MFA ended, export of a product to a destination that faced quotas (MFA export) experienced 65.4% higher increase than the export of the product to a destination that did not face quota (Non-MFA export). However, the large increase of MFA exports compared to non-MFA exports only shows up in the coastal region, but not in the inland region. This implies that the effects of trade liberalizations are not evenly distributed within a country. Using distance to the seaport as a measure of world market access, I show that regions with better access to the world market experienced a higher growth of MFA export compared to non-MFA export. I check with alternative explanations and show that regions with more T&C production before the quota removal also experienced a higher export growth of MFA products compared to non-MFA products. However, regions with more abundant labor (lower capital-labor ratio) did not experience a higher export growth of MFA products compared to non-MFA products.

The results show that trade liberalization has heterogeneous effects on regions within a country. Recent research emphasizes the importance of internal geography in determining the effects of international trade. Coşar and Fajgelbaum (2016) show that trade liberalization leads to regions with better access to the world market to specialize in industries that the country has comparative advantages on. The alternative theory based on Melitz (2003) suggests that even within an industry, production will agglomerate in regions with better access to the world market during a trade liberalization. Using only textile and clothing exports, this paper shows that the trade liberalization had a larger effect on the coastal region, even within the narrowly defined industry.

I next examine how incumbents and entrants respond to the trade liberalization. I show that export growth of incumbents is not statistically different between MFA

products and non-MFA products. On the other hand, entrants have a large impact on the increase of MFA exports compared to non-MFA exports. I also show that most of the entries are by existing firms expanding their product and exporting destinations (adders), not by new firms entering the T&C market. The results show that although extensive margin adjustment are important during the trade liberalization, most of the extensive margin adjustments are within-firm adjustments by existing firms. Further analysis shows that existing firms adjust by mainly expanding to similar products within the same HS2 category.

While there is a large increase of MFA exports compared to non-MFA exports, the effects of the MFA removal are mostly due to adjustments by existing firms, not new firms. Recent literature has focused on multiple product firms and within-firm adjustments during the trade liberalization. Bernard et al. (2011) develop a model to show that trade liberalizations induce multiple-product firms to expand to more products and export to more destinations. Upward and Wang (2016) also use the ending of the MFA and show that the quota removal induced firms to expand their product scope. This paper, while focuses on industry-level analysis, shows that product and destination expansions by existing firms are both significant during the trade liberalization.

The rest of the paper proceeds as follows. Section 2 briefly reviews the evolution of the Multi-fiber Arrangement and describes the distribution of textile and clothing exports in China. Section 3 measures the effect of the MFA removal and show its heterogeneous effects on coastal and inland regions. Section 4 discusses several explanations for the heterogeneous response of coastal and inland regions to the external trade liberalization. Section 5 examines firm entry and within-firm adjustment during the quota removal. Section 6 concludes.

4.2 The Multi-fiber Arrangement and Chinese Textile and Clothing Exports

4.2.1 The Evolution of the Multi-fiber Arrangement

The Multi-fiber Arrangement (MFA) was a quota system that governed the exports of textile and clothing (T&C) products from developing countries to developed countries (the US, the EU, and Canada). It was established in 1974 to protect the textile and clothing industries in developed countries, which had lost comparative advantages when competing with competitors such as east and southeast Asian countries. As a result of the MFA, trade of textile and clothing products were kept out of multilateral trade negotiations under the General Agreement on Tariffs and Trade (GATT). When the World Trade Organization (WTO) replaced the GATT in 1995, the Agreement on Textile and Clothing (ATC) was signed to integrate textile and clothing products into the WTO rules. Quotas on textiles and clothing products were scheduled to be removed step by step in 4 phases. In the first phase, which began on January 1, 1995, countries had to remove quotas representing 16% of their 1990 import volume. The next 3 phases, which began on January 1 of 1998, 2002, 2005 respectively, requires countries to remove quotas representing 17%, 18% and the

remaining 49% of their 1990 import volume. Meanwhile, the ATC also requires quota growth rate to accelerate over the first three phases. At the beginning of the first phase, existing quotas' growth rate was increased by 16%, and the quota growth rate was increased further by another 25% and another 27% in Phase II and Phase III respectively.¹ However, countries can decide quotas on which products be removed first and quotas on which products be retired last. Thus, the first two phases of quota removal did not cause much pain to the developed countries. But the removal of phase III and phase IV quotas actually dismantled the protection on T&C industries. When the MFA finally expired in 2005, T&C exports from developing countries to the developed countries surged.

China faced stricter quota restrictions than other developing countries under the MFA. Due to its large economic size and rapid economic growth, the quota restrictions for China were more binding. China was ineligible for the first two phases of quota removal until it joined the WTO in December 2001. Quotas on the first two phases products, as well as quotas on phase III products, were removed at the beginning of 2002. Then on January 1, 2005, the remaining phase IV quotas were removed.

4.2.2 Distribution of the T&C Industry in China

As the world's largest country in population and world's largest developing country, China has a comparative advantage in labor intensive industries in international trade. Since China's economic reform and openness in 1978, its export of T&C products has been growing rapidly, and it is now the largest producer and exporter of textile and clothing products. In 2013, China's T&C export accounts for 33.7% of world's total T&C exports. Textile and clothing industry is also an important sector of the Chinese economy. It accounts for 14.5% of China's total export in 2013.² As a typical labor-intensive sector, it absorbed 15.4% of the manufacturing employment and produced 8.3% of total manufacturing output during 1998-2007.

China's exports of textile and clothing products are highly concentrated in the coastal region³. The coastal region accounts for more than 90% of total T&C exports. Among the coastal provinces, 4 provinces in the Yangtze River Delta (Shanghai, Jiangsu, and Zhejiang) and the Pearl River Delta (Guangdong) account for about 3 quarters of all exports.

Table 4.1 shows that geographic distribution of T&C exports in China. The coastal region dominated the T&C exports in China. From 2003 to 2006, the exporting share of the coast region increased slightly. There is also relocation of exports within the coastal region. Guangdong's share of exports has more than doubled from 2003 to 2006, while Beijing, Shanghai, and Zhejiang's share of exports has decreased

¹For example, a product with quota growth rate equals 10% before 1995 would grow at 11.6% ($10\% \times 1.16$) in Phase I, 14.5% ($11.6\% \times 1.25$) in Phase II, and 18.4% ($14.5\% \times 1.27$) in Phase III.

²Calculated from World Integrated Trade Solution.

³The coastal region are defined as provinces that have coastlines. It includes Fujian, Guangdong, Guangxi, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang. However, Beijing is also included in the coastal region.

significantly. In the inland region, almost all the provinces experienced the decline of export share from 2003 to 2006.

4.3 The Effects of the MFA Removal

4.3.1 Data

The data used are from China's transaction-level custom data, which record the universe of firm exports. The dataset has a range of variables including the firm identifier, 8-digit product code (the first 6 digit is Harmonized System (HS) 6-digit code), the location of exporting firms⁴, destination countries, as well as exporting volume, value and unit price. I only use the T&C export data between 2003 and 2006, because the focus of the paper is only on the removal of the phase IV quotas.

According to the Agreement on Textile and Clothing (ATC), T&C products are defined as those with HS two digit code between 50 and 63⁵. Data on quota restrictions are from Khandelwal et al. (2013). During 2003-2006, China exported 1108 T&C products, among which 543 faced Phase IV quotas either in the US, EU or Canada. Of the Phase IV products, 157 faced quotas in all destinations (US, EU, and Canada), and 386 products faced quotas in some destinations, but not the others. A product may face quota in one country but does not face quota in another country. Out of the 386 products that faced quota in some countries but not in others, I define MFA products as product-destinations that faced quotas, and non-MFA products as product-destinations that did not face quota. For example, "Men/boys shirts, of cotton, not knitted" (HS 620520) was subject to quota restrictions in the US and the EU, but not in Canada. Thus, export of this product to US and EU is defined as MFA product, and export of this product to Canada is defined as a non-MFA product. There are 539 MFA products, and 547 non-MFA products in the sample.

The ending of the MFA had a large effect on MFA products than on non-MFA products. Meanwhile, regions respond to the MFA expiration differently. From Figure 4.1, we see that before the MFA expired, MFA export accounts for about 60% of the total export in Phase IV products in both coastal and inland regions. However, MFA export as a share of total phase IV product exports increased to 72% in the coastal region but only increased to 65% in the inland region. Although the share of MFA exports had increased in both regions, the increase was much larger for the coastal region (12.47%) than for the inland region (6.98%). This implies that the coastal region responded more to the trade liberalization, and concentrated its export to product-destinations that experienced trade liberalization (the quota removal).

⁴Location of firms can be identified by both zip code and prefecture code. There are some discrepancies when using zip code and prefecture code to identify firm location. The two measures reveal same information of firm's location of prefectures for 87.48% of the observation. I use prefecture code in the analysis because it has less missing values.

⁵Definition on T&C products can be found on the WTO website: https://www.wto.org/english/docs_e/legal_e/16-tex_e.htm

Table 4.1: Geographic Distribution of the T&C Exports

	2003	2004	2005	2006
Beijing	2.613	2.632	2.130	1.928
Fujian	4.764	3.168	3.906	3.560
Guangdong	7.539	7.217	13.958	17.178
Guangxi	0.155	0.107	0.112	0.108
Hainan	0.177	0.113	0.103	0.048
Hebei	2.209	2.105	1.643	1.570
Jiangsu	17.853	19.749	19.453	18.979
Liaoning	1.497	1.344	1.654	1.694
Shandong	8.482	8.254	8.307	7.956
Shanghai	15.131	15.212	12.760	12.288
Tianjin	2.775	2.463	1.938	1.791
Zhejiang	29.476	30.812	28.125	27.665
Coast	92.670	93.345	94.271	94.789
Anhui	1.979	1.889	1.495	1.242
Chongqing	0.087	0.098	0.077	0.071
Gansu	0.164	0.120	0.059	0.040
Guizhou	0.015	0.025	0.018	0.010
Heilongjiang	0.163	0.141	0.151	0.112
Henan	0.796	0.653	0.583	0.564
Hubei	1.115	1.011	0.878	0.961
Hunan	0.375	0.351	0.328	0.275
Jiangxi	0.330	0.356	0.516	0.444
Jilin	0.107	0.073	0.103	0.092
Neimenggu	0.738	0.687	0.529	0.519
Ningxia	0.242	0.254	0.221	0.198
Qinghai	0.080	0.099	0.066	0.048
Shaanxi	0.421	0.300	0.208	0.160
Shanxi	0.082	0.034	0.048	0.046
Sichuan	0.517	0.484	0.396	0.375
Xinjiang	0.048	0.031	0.032	0.024
Xizang	0.028	0.015	0.001	0.002
Yunnan	0.043	0.028	0.027	0.022
Inland	7.330	6.655	5.729	5.211

¹ The table shows geographic distribution of T&C exports of China. Each cell is the T&C export of a province as a share (%) of the national total export in a year (from 2003 to 2006).

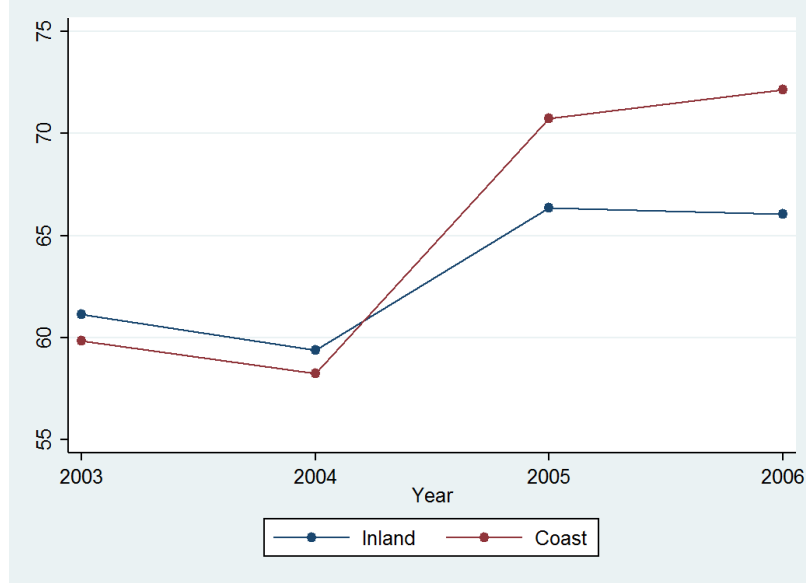


Figure 4.1: The Share of MFA Exports in the Coastal and Inland Regions (%)

Note: The graph shows export of MFA product as a share of total export of phase IV products in the coastal region and the inland region.

4.3.2 The Overall Effects of the MFA Removal

Following Khandelwal et al. (2013), I use the export of a product to a country without quota (Non-MFA product) as the comparison group for the export of the same product to a country with quota constraint under the MFA (MFA product). The identification strategy here exploits the quota restriction variations to different destinations and identifies the effects of trade liberalization within an industry. It only requires that the export trends of a product to different countries be the same were there no quota constraint. Using this identification strategy, I examine if total export, as well as the number of exporting firms, increased more in product-destinations that faced quotas than product-destinations that were quota free after the MFA expired. The regression equation is:

$$y_{pdt} = \beta_0 + \beta_1 Quota_{pd} \times PostMFA_t + \alpha_{pd} + \gamma_{dt} + \eta_{pt} + \varepsilon_{pdt} \quad (4.1)$$

where y_{pdt} is the *log* of export or number of firms of product p exported to destination d in year t . $Quota_{pd} = 1$ if the product-destination faced quota before 2005. $PostMFA_t = 1$ after 2005. The coefficient β_1 measures the effect of the quota removal.

The results show that after the MFA expired in 2005, MFA products experienced 65.4% higher export growth compared to non-MFA products. MFA products also experienced (49.4%) more net entries than non-MFA products, indicating the extensive margin adjustment to quota removal is significant.

Table 4.2: The Effects of the MFA removal

	(1)	(2)
	ln(Export)	ln(Num.Firm)
<i>Quota</i> × <i>PostMFA</i>	0.654***	0.490***
	(0.151)	(0.0629)
Observations	4006	4006
R^2	0.959	0.982

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.3.3 The Heterogeneous Effects of the Trade Liberalization on Coastal and Inland Regions

Standard trade theory assumes that a country is a point, thus missing the heterogeneous response of regions within a country to trade liberalizations. However, when different regions have different access to the world market, trade liberalization can have heterogeneous effects on regions within a country. In the case of China, the coastal region has better access to the world market and also enjoys preferential policies compared to the inland region. To examine the heterogeneous effects of the quota removal on the coastal region and the inland region, I run regression (4.1) for the coastal region and the inland region separately, and the results are shown in Table 4.3.

Table 4.3: The Effects of the MFA removal: Inland v.s. Coast

	Inland		Coast	
	(1)	(2)	(3)	(4)
	ln(Export)	ln(Num.Firm)	ln(Export)	ln(Num.Firm)
<i>Quota</i> × <i>PostMFA</i>	0.372	0.167	0.652***	0.492***
	(0.232)	(0.107)	(0.151)	(0.0631)
Observations	2499	2499	3985	3985
R^2	0.939	0.961	0.957	0.981

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

It can be seen that after the MFA expired, the coastal region experienced a higher increase in MFA products than in non-MFA products in both total export and number of exporting firms. Total export in MFA products increased 65.2% higher compared to non-MFA products after the quota removal; total number of firms in MFA products increased 49.2% higher compared to non-MFA products. For the inland region, the increase of MFA exports compared to non-MFA exports is smaller and insignificant. The results show that the significant effect of MFA expiration on MFA products is

mainly due to the large increase of MFA exports in the coastal region.

Previously literature studying the regional response to trade liberalization (Coşar and Fajgelbaum (2016)) has emphasized the cross-industry adjustment and implies that regions with better access to the world market specialize in industries that the country has comparative advantages on during the trade liberalization. The results here shows that even within the same industry, regions with different access to the world market still respond differently. Regions with better access to the world market export experienced higher increase in export to destinations that removed quota. The results show that regional adjustment to trade liberalization within the industry are important and needs more extensive research.

4.4 Market Access, Agglomeration, and Comparative Advantage

Chinese T&C exports are highly concentrated in the coastal region, and the coastal region had experienced a higher increase of MFA export after the quotas were removed. It is natural to relate the agglomeration of the T&C industries in the coastal region with its better access to the world market. The coastal region has both a better geographic location and enjoys preferential policies in international trade (Demurger et al. (2002)), thus it will benefit more from trade liberalization. However, there are some other factors that affect the distribution of T&C exports. New economic geography theory implies that firms tend to agglomerate to reduce input costs (forward linkage) or to take advantage of the spillover effects (external economies). Thus, reduction of trade costs could induce agglomeration of exports in regions with already more productions. Meanwhile, factor proportion theory argues that trade liberalizations will benefit the more abundant factors. And in the case of the MFA removal, it indicates that regions with more abundant labors (a lower capital-labor ratio) will benefit more from the trade liberalization. In this section, I examine if market access matters for the trade liberalization, and also check if factor composition and agglomeration economies work.

4.4.1 Market Access to International Markets

Why is the effect of the MFA removal much larger in the coastal region than in the inland region? One explanation is that the coastal region has better access to the world market, and trade liberalization magnifies the location advantages of the coastal region (Guo (2017)). The hub effect (Krugman (1993)) leads to agglomeration in the coastal region. To test this, I use the *log* distance to the seaport (kilometer) as a measure of access to the world market and examine whether regions⁶ with better access to the world market also experienced higher growth of export in MFA products after the quotas were removed.

⁶I use prefecture as my observation region. A prefecture is an administration unit below province and above county.

I run the following regression equation:

$$y_{rpd} = \beta_0 + \beta_1 \text{quota}_{pd} \text{PostMFA}_t + \beta_2 \text{Dist}_r \text{quota}_{pd} \text{PostMFA}_t + \gamma_{rpd} + \eta_{rt} + \varepsilon_{rpd} \quad (4.2)$$

where y_{rpd} is export or number of firms in prefecture r in year t that export product p to country d . I control for prefecture-country-year fixed effect to account for the fact that prefectures have different exporting structure. I also control for prefecture-year fixed effect to allow prefectures to have different growth trends of export. The coefficient of the triple-interaction term $\text{Dist}_r \text{quota}_{pd} \text{PostMFA}_t$ measures the heterogeneous effect of MFA removal with respect to world market access. A negative estimate of β_2 indicates that MFA had a larger effect on regions with better access to the world market (closer to the seaport).

Table 4.4: World Market Access and the Effects of the MFA Removal

	(1)	(2)
	ln(Export)	ln(Num. Firm)
<i>Quota</i> × <i>PostMFA</i>	0.809*** (0.135)	0.456*** (0.0510)
<i>Distance</i> × <i>Quota</i> × <i>PostMFA</i>	-0.0918*** (0.0291)	-0.0609*** (0.0103)
Observations	79499	79499
R^2	0.836	0.893

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.4 shows that MFA products experienced a higher growth in export and number of exporting firms than non-MFA products after the quotas were removed. It also shows that prefectures closer to the seaport had a larger increase in MFA products compared to non-MFA products. Specifically, the regression model predicts that the quota removal increased MFA export by 81% more than non-MFA export in prefectures at the seaport⁷. It also shows that the effect of the MFA removal will decrease by 9.2% when doubling the distance to the seaport. The result in column 2 shows that the number of firms increased 45.6% more in MFA products than in non-MFA products at the seaport. The effect of the quota removal decreases by 6.1% when doubling the distance to the seaport.

⁷Actually, it is for a prefecture of 1 km from the seaport (log distance equals zero). Since distance is measured as the distance from the center of a prefecture to the seaport, the distance is greater than 1 km for every prefecture.

4.4.2 Agglomeration

Prefectures closer to the seaport not only have better access to the world market, but are also closer to production center of T&C products. There are at least two reasons for the agglomeration of export near production centers. First, locating firms closer to the production center saves costs of intermediate input and raw materials (forward linkage). Meanwhile, firms closer to the production center could benefit from spillover effects of other firms and a larger local labor market. Both firm-level increasing returns to scale and external spillover indicate that firms will agglomerate near production center, and trade liberalization could magnify the agglomeration. I run a regression model which include the triple interaction term $Output \times Quota \times PostMFA$. A positive coefficient implies that the MFA removal had a larger effect on regions with higher T&C productions.

To alleviate the simultaneity problem, I use the T&C output in previous period as a measure of agglomeration force. $Output$ is defined as the *log* total T&C output between 2000 and 2002 in a prefecture⁸. The results are shown in Table 4.5.

Table 4.5: Production Linkage and the Effects of the MFA Removal

	(1)	(2)
	ln(Export)	ln(Num. Firm)
$Quota \times PostMFA$	-2.510*** (0.473)	-1.121*** (0.154)
$Output \times Quota \times PostMFA$	0.174*** (0.0279)	0.0775*** (0.00935)
Observations	72451	72451
R^2	0.833	0.887

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From Table 4.5, prefectures with more textile and clothing productions between 2000 and 2002 also experienced a higher increase in MFA exports relative to non-MFA exports. A prefecture with 100% higher T&C production between 2000-2002 experienced a 17.4% higher increase of MFA exports than non-MFA exports after the quotas were removed. The prefecture with more T&C production also had 7.75% more entries in MFA exports than in non-MFA exports after the MFA ended.

The results show that regions with more T&C production benefit more from the quota removal. It indicates that agglomeration force (external economies and increasing returns to scale within the firm) also helps to explain the heterogeneous effects of the quota removal.

⁸T&C employment data are obtained from Annual Surveys of Industrial Firms of China, because the custom transaction data have no information about total output.

4.4.3 The Comparative Advantage in Labor-intensive Industries

China's rapid development is believed to have been benefited from its abundant labor. As a labor-intensive sector, textile and clothing industry in China has grown significantly. Factor proportion theory implies that trade liberalization will benefit the more abundant factors. Thus, for regions with abundant labors (lower capital-labor ratio), I expect their MFA exports to increase more after the quota removal. I define a prefecture's capital-labor ratio as total manufacturing fixed asset over total manufacturing employment between 2000 and 2002⁹, and examine if regions with a comparative advantage in labor-intensive industries (a lower capital-labor ratio) experienced a larger increase of MFA exports compared to non-MFA exports.

I include the triple interaction term $KLratio \times Quota \times PostMFA$ in the regression model, where $KLratio$ is the *log* of capital-labor ratio. Its coefficient measures the heterogeneous effect of MFA removal on regions with different capital-labor ratios. A negative estimate of the coefficient implies that regions with more abundant labors experienced a higher growth of MFA export compared to non-MFA export. The results are shown in Table 4.6.

Table 4.6: Factor Proportion and the Effects of the MFA Removal

	(1)	(2)
	ln(Export)	ln(Num. Firm)
$Quota \times PostMFA$	0.0244 (0.552)	-0.285 (0.200)
$KLratio \times Quota \times PostMFA$	0.0913 (0.126)	0.108** (0.0453)
Observations	72506	72506
R^2	0.832	0.886

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From column 1 of Table 4.6, regions with a comparative advantage in labor-intensive industries (low capital-labor ratio) did not experience higher increase in MFA exports compared to non-MFA exports. Column 2 shows that there are actually more entries in MFA exports compared to non-MFA exports for regions with higher capital-labor ratios, which is not consistent with the implication of factor proportion theory.

4.4.4 Market Access, Agglomeration, and the Comparative advantage

In this part, I include distance to the seaport, T&C output, and capital-labor ratio in the regression model at the same time, and examine whether the effect of one

⁹This measure is calculated using Annual Surveys of Industrial Firms.

factor is influenced by other factors.

Table 4.7: Market Access, Agglomeration, and the Comparative Advantage

	(1)	(2)
	ln(Export)	ln(Num. Firm)
<i>Quota</i> × <i>PostMFA</i>	-2.550*** (0.791)	-1.287*** (0.290)
<i>Distance</i> × <i>Quota</i> × <i>PostMFA</i>	-0.0631 (0.0452)	-0.0498*** (0.0163)
<i>Output</i> × <i>Quota</i> × <i>PostMFA</i>	0.151*** (0.0325)	0.0596*** (0.0112)
<i>KLratio</i> × <i>Quota</i> × <i>PostMFA</i>	0.164 (0.132)	0.160*** (0.0468)
Observations	72451	72451
R^2	0.833	0.887

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

When including all three measures into the model, it still shows that the MFA removal has a larger effect on regions with better access to the world market (row 2). The heterogeneous effect of the MFA removal on export becomes insignificant¹⁰, but the heterogeneous effect on the extensive margin (number of firms) is still significant and the magnitude is similar to what is shown in Table 4.4. The inclusion of measures of agglomeration economies and comparative advantage has weakened the effects of the world market access. It is probably because that regions with better world market access also produced more T&C products, so the effect of market access absorbed by the measure of agglomeration economies. The results in row 3 show that the MFA removal has a larger effect on regions that have produced more T&C products, even after controlling for market access and capital-labor ratio. The last row shows that the MFA removal has a large effect on regions with higher capital-labor ratios. Again, this is not what would expect from factor proportion theory.

4.5 Margins of Adjustment

4.5.1 Incumbents and Entrants

The previous sections have shown that the MFA removal had significant effects on products that had faced quotas before, and the effects of the trade liberalization

¹⁰It is only significant at the 15% significant level.

are larger for coastal regions, which are closer to the world market and have produced more T&C products. How do firms respond to the trade liberalization? Do existing firms increase their exports in MFA products, or do they expand exports to more products and more countries? Or do new firms enter the exporting market? In this section, I examine the relative importance of each margin of adjustment in determining the effects of the MFA removal.

I divide exports into the intensive margin and the extensive margin. If a firm exports a product to a destination in both year $t - 1$ and t , this *firm-product-destination* observation is counted as an incumbent in year t . If a firm exports a product to a destination in year t but not in year $t - 1$, the observation is counted as an adder. If the firm exports the same product to other destinations in year $t - 1$, the adder is counted as a destination adder; if the firm does not export the same product to any destination in year $t - 1$, it is counted as a product adder. If a firm exports a product to a destination in year t but the firm does not export any T&C product in year $t - 1$, the observation is counted as a new firm. The market shares of incumbents, adders, and new firms between 2004 and 2006 are shown in Table 4.8.

Table 4.8: Share of Export by Margins (%)

	2004		2005		2006	
	Non-MFA	MFA	Non-MFA	MFA	Non-MFA	MFA
Incumbent	76.64	78.26	70.41	59.66	77.61	74.53
Adders	16.18	14.68	23.82	33.52	15.79	15.98
<i>Product Adder</i>	10.21	8.57	12.16	13.67	14.91	14.97
<i>Destination Adder</i>	5.97	6.11	11.66	19.85	0.87	1.01
New Firm	7.17	7.07	5.77	6.82	6.61	9.50

Table 4.8 shows that there are more entries in the year 2005, when the MFA expired. Market shares of incumbents are both over 70% in 2004, when quotas were still in effect, and in 2006, when quotas had no effect on T&C exports. However, the market share of incumbents is significantly lower in 2005. For non-MFA products, incumbents' share of export in 2005 is 70%; for MFA products, the share is only 60%. It indicates that there are more entries in MFA exports than in non-MFA exports when the MFA expired.

For entrants, adders (product and destination expansion by existing firms) have a higher share than new firms. In 2004, adders account for 16.18% in non-MFA exports and 14.68% in MFA exports; in 2005, adders account for 23.81% in non-MFA exports and 33.54% in MFA exports. The share of adders is about 10% higher in MFA exports than in non-MFA exports when quotas were removed in 2005. On the other hand, the share of new firms is below 10% and it decreased from 2004 to 2005.

Among the adders, the share of destination adders increased significantly from 2004 to 2005. After the MFA expired, firms became free to export to product-destinations that faced quotas before. It seems that the immediate response of existing firms is to export to countries that liberalized quota constraints, as we see

that the share of destination adders increased from 5.97% to 11.66% in non-MFA exports, but increased from 6.11% to 19.85% in MFA exports. In 2006, however, the share of destination adders becomes smaller, as existing firms had almost entered all destinations when the MFA expired in 2005.

For new firms, its share of export is about 7% in both MFA exports and non-MFA exports in 2004. The share of new firms became higher in MFA exports than in non-MFA exports after the quotas were removed, and the gap becomes larger in 2006 compared to 2005. This could be explained by firm adjustment costs. In the short run, it is easier for existing firms to adjust product and export destinations. But eventually, new firms enter and gain larger a market share.

4.5.2 Decomposing the Effects of the MFA removal by Different Margins

In this section, I decompose the effect of MFA removal into different margins: incumbents, product adders, destination adders, and new firms. I calculated the export growth rate based on different margins from 2004 to 2006. Non-MFA products did not face any quota from 2004 to 2006. For MFA-products, their export growth was not affected by quota restrictions from 2005 to 2006; the export growth was under the quota constraints from 2003 to 2004; the export growth was affected by the quota removal from 2004 and 2005. Thus, for MFA-products, export growth in 2006 can be seen as the export growth rate when there is no quota constraint; export growth in 2004 is the growth rate under quota control; export growth in 2005 measures the change of export growth when quotas were suddenly removed. In the following analysis, I use 2006 as the base year and study the effects of quota constraints and quota removal on different margins of export growth. The regression equation is specified as:

$$g_{pdt} = \beta_0 + \sum_{j=2004}^{2005} \beta_j Quota_{pd} \times 1\{Year = j\} + \alpha_{pd} + \gamma_{pt} + \eta_{dt} + \varepsilon_{pdt} \quad (4.3)$$

where g_{pdt} is the export growth rate of incumbents (column 1), incumbents plus destination adders (column 2), incumbents plus product adders (column 3), and incumbents plus new firms. $1\{Year = j\}$ is a dummy variable for year j . I control for product-destination fixed effect, and allow products and destination countries to have flexible export growth trends. The coefficient of $Quota_{pd} \times 1\{Year = 2005\}$ measures the effects of quota removal, and the coefficient of $Quota_{pd} \times 1\{Year = 2004\}$ measures the effect of quota constraint. The results are shown in Table 4.9.

Column 1 shows the results for all firms. Compared with the year 2006, growth rate is 58.6% higher in MFA exports than in non-MFA exports. It shows that the MFA removal has a large effect on MFA export growth than non-MFA export growth overall. However, growth rate between MFA exports and non-MFA exports is not statistically different in 2004. For incumbents (in column 2), MFA exports did not significantly grow faster than non-MFA exports when the MFA expired in 2005; MFA exports did not significantly grow slower than non-MFA exports when there were

Table 4.9: Different Margins of Adjustment

	(1)	(2)	(3)	(4)	(5)
	All	Incumbent	I+AddCountry	I+AddProduct	I+Newfirm
$Quota \times 2004$	-0.0672 (0.164)	-0.182 (0.153)	-0.0183 (0.166)	-0.0218 (0.171)	-0.174 (0.175)
$Quota \times 2005$	0.586*** (0.210)	0.223 (0.158)	0.588** (0.229)	0.623*** (0.221)	0.285 (0.208)
Observations	2867	2460	2506	2663	2530
R^2	0.658	0.761	0.722	0.718	0.742

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

quota constraints in 2004. The results imply that adjustment by incumbents is not a significant factor for the large export growth in MFA products when the quotas were removed.¹¹ It also shows that quota constraints did not affect the incumbents' growth differently between MFA exports and non-MFA exports. In the next three columns, I examine the effects of the MFA on extensive margins of exports. In column 3, it shows that when including destination adders, MFA export growth is 58.8% higher than non-MFA export growth in 2005. This shows the large export expansion by destination adders when quotas were removed. However, MFA export growth is not statistically different from non-MFA export growth in 2004. Column 4 includes product adders and shows that MFA exports growth increased 62.3% higher than non-MFA exports growth in 2005. It shows that there is a large export expansion by product adders when quotas were removed. Column 5 includes new firms with incumbents. Although the coefficient of $Quota_{pd} \times 1\{Year = 2005\}$ is positive, its magnitude is small and it is not statistically significant. It shows that export growth of new firms is not significant to explain the larger growth of MFA exports when the quotas were removed.

Results in Table 4.9 points to the importance of entrants in explaining the effect of the MFA removal, and implies that adjustments by existing firms explain the large increase of MFA exports growth.

4.5.3 Entry Rate

Since the effect of the MFA removal on export is not due to incumbents, I focus on the extensive margin and examine how the MFA removal affects entry rates.¹² I calculate the entry rate in each product-destination from 2004 to 2006. Net entry

¹¹The coefficient of 0.223 is not statistically significant. It could be because that incumbents' growth is not measured precisely. However, when compared with the results in column 1, the contribution of incumbent is small in magnitude.

¹²Firm exit is not statistically different between MFA products and non-MFA products. Thus, I only consider firm entry here. Results on firm exit can be found at Appendix A.

rate is defined as the difference of log number of firms between two consecutive years. Entry rate is defined in a similar manner but excluding exiting firms in each year. Firm entry rate is calculated as $\ln(y_{pdt-1} + entry_{pdt}) - \ln(y_{pdt-1})$, the difference between the log number of firms in the last period plus the number of entrants in current period and the log number of firms in last period. Entries can be divided into existing firm adding product-destinations, or new firms entering the market. Thus, I also calculate the entry rate using only adders, and entry rate using only new firm entries. Table 4.10 shows entry rates in MFA and non-MFA products in each year. It is clear that entry rate, measured in every margin, is higher in MFA products than in non-MFA products in 2005. But the difference in entry rate between MFA products and non-MFA products is not significant in 2004 and 2006. From the table, we also see that most of the entry is by existing firms expanding their product-destinations, not by new firms entering the market.

Table 4.10: Firm Entry Rates

	Net entry		Entry		Adder		Newfirm	
	non-MFA	MFA	non-MFA	MFA	non-MFA	MFA	non-MFA	MFA
2004	0.128	0.093	0.570	0.565	0.498	0.512	0.117	0.087
2005	0.354	0.893	0.728	1.139	0.663	1.048	0.126	0.263
2006	0.074	0.037	0.559	0.568	0.485	0.484	0.116	0.133

Since it is the adders that dominate the entry, I further examine whether the product expansion or destination expansion is more significant. I calculate the entry rate of destination adders and product adders. Since firms need to pay costs to adjust their export, and it is easier for firms to expand exports to similar products, I also examine whether the expansions of existing firms are mainly in similar products or non-similar products. If an adder has exported any other product within the same HS2 category in the previous year, the adder is counted as “add within HS2”; If not, the adder is defined as “add HS2”. Table 4.11 shows that entry rates by different margins of adders between 2004 and 2006.

From Table 4.11, we can see that the entry rate of product adders is high for both MFA products and non-MFA products. The entry rate of product adders has increased significantly for MFA products in 2005 when the MFA expired, but it did not change much for non-MFA products. For destination adders, its entry rate also increased significantly for MFA products in 2005. However, when there is no quota constraint (the year 2006), entry rate of destination adders became very small for both MFA and non-MFA products. The last two columns show that entry rate is much higher for adders within HS2 than adders outside HS2. It indicates that the adjustment among similar products is more significant than adjustment across dissimilar products during the quota removal.

Table 4.11: Growth Rate of Adders at Different Margins

	Add product		Add destination		Add within HS2		Add HS2	
	non-MFA	MFA	non-MFA	MFA	non-MFA	MFA	non-MFA	MFA
2004	0.358	0.348	0.190	0.220	0.456	0.488	0.064	0.040
2005	0.485	0.784	0.269	0.520	0.603	0.973	0.105	0.198
2006	0.463	0.467	0.036	0.029	0.436	0.439	0.072	0.073

4.5.4 Effects of the MFA Removal on Firm Entry

The previous section shows that entry rates of various margins are higher in MFA exports than in non-MFA exports when the MFA were removed in 2005. In this section, I examine the effects of the quota removal on entry rates of various margins. I run the following regression model:

$$g_{pdt} = \beta_0 + \sum_{j=2004}^{2005} \beta_j Quota_{pd} \times 1\{Year = j\} + \alpha_{pd} + \gamma_{pt} + \eta_{dt} + \varepsilon_{pdt} \quad (4.4)$$

where g_{pdt} is the entry rate (net entry rate, entry rate, adder entry rate, new firm entry rate) in product-destination pd and year t . I control for product-destination fixed effect, product-year fixed effect and destination-year fixed effect. The base year is 2006, when both MFA and non-MFA products face no quota. The coefficient of $Quota_{pd} \times 1\{Year = 2005\}$ measures the effect of quota removal on firm entry rate. The coefficient of $Quota_{pd} \times 1\{Year = 2004\}$ measures the effect of quota constraint on firm entry rate.

Table 4.12: Quotas and Firm Entry

	(1)	(2)	(3)	(4)
	dln(Num. Firm)	dln(Entry)	dln(Adder)	dln(New Firm)
$Quota \times 2004$	-0.0308 (0.0667)	-0.0327 (0.0408)	-0.00183 (0.0390)	-0.0516*** (0.0194)
$Quota \times 2005$	0.456*** (0.0652)	0.315*** (0.0415)	0.319*** (0.0396)	0.0661*** (0.0198)
Observations	2867	2972	2972	2972
R^2	0.737	0.765	0.768	0.725

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.12 shows the effects of quota constraint and quota removal on firm entry. Column 1 shows the effect of net entry. Compare with the year 2006, the net entry

rate in MFA exports is 45.6% higher than in non-MFA exports when quotas were removed in 2005. But the entry rate in 2004 is not statistically different between MFA and non-MFA products. Column 2 shows the effects of the MFA on total entry rate. Compared with 2006, the entry rate is 31.5% higher in MFA products than in non-MFA products in 2005, but the entry rate is not statistically different between non-MFA exports and MFA exports in 2004. From column 3, it can be seen that most of the higher entry rate in MFA exports came from existing firms expanding their product-destinations. In column (4), it shows that compared with 2006, entry rate by new firms is 6.61% higher in MFA exports than in non-MFA exports when the MFA expired in 2005; but the entry rate by new firms is 5.16% lower in MFA exports than in non-MFA exports in 2004. Compared with no quota (in the year 2006), quotas constraints (in the year 2004) restricted the entry of new firms into MFA exports.

Table 4.13: Quotas and Margins of Adders

	(1)	(2)	(3)	(4)
	Add product	Add det	Add Within HS2	Add HS2
<i>Quota</i> × 2004	-0.0480 (0.0349)	0.0694*** (0.0244)	0.0162 (0.0373)	-0.0225 (0.0165)
<i>Quota</i> × 2005	0.240*** (0.0355)	0.225*** (0.0249)	0.302*** (0.0379)	0.0919*** (0.0168)
Observations	2972	2972	2972	2972
R^2	0.761	0.808	0.768	0.773

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 4.13, I further decompose the entry rate of adders into entry rate by product adders and destination adders (column 1 and 2), or entry rate by adders within HS2 and adders outside HS2 (column 3 and 4). Results show that entry rates for both production adders and destination adders increased higher in MFA exports than in non-MFA exports when the MFA expired in 2005. The entry rate due to product adders increased 24% higher in MFA products than in non-MFA products in 2005; the entry rate due to destination adder increased 22.5% higher in MFA products than in non-MFA products in 2005. From column (3) and column (4), entry rate increased higher in MFA exports than in non-MFA exports for both adders within HS2 and adders outside the HS2, but the magnitude is much larger for adders within the same HS2 than for adders outside HS2. Entry rate due to adders within the same HS2 increased 30.2% higher in MFA products than in non-MFA products after the quotas were removed in 2005; entry rate due to adders outside the HS2 category increased 9.19% higher in MFA products than in non-MFA products in 2005. Results in Table 4.13 show that both product adders and destination adders are important to explain the effects of the MFA removal on the extensive margin of export, but most of the within-firm adjustments are by adders within the same HS2.

4.6 Conclusion

In this paper, I examine the effects of the quota removal on textile and clothing exports during the removal of the MFA. While products that faced quotas experienced a higher export growth after the MFA expired, the effect is heterogeneous among regions. The ending of the MFA had large and significant effects on the coastal region, but small and insignificant effects on the inland region. Further analysis shows that regions with better access to the world market and regions that have produced more T&C products experienced a higher export growth in MFA products than in non-MFA products when quotas were removed. The results show that world market access and agglomeration forces are important to explain the heterogeneous effects of the trade liberalization on regions within a country. However, I do not find that regions with lower capital-labor ratio experienced higher growth of MFA export.

The large increase of MFA exports compared to non-MFA exports were not due to incumbents, but due to entrants. Among the entrants, existing firms expanding their product and exporting destinations accounts for larger shares than new firms entering the T&C export market. The results show that within-firm adjustments are important during the expiration of the MFA.

Appendix A Chapter 2 Appendix

A.1 Solve the Open Equilibrium

Cutoff threshold and the exporting threshold in the coastal region can be solved by combining the ZCP curve and FE curve, noticing that $\frac{\varphi_{Cx}^*}{\varphi_C^*} = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}\tau_x$. The exporting threshold φ_{Ix}^* can be solved using equation (2.14), $\varphi_{Ix}^* = \tau\varphi_{Cx}^*$. Substitute this into the ZCP curve of region I , and combine with the FE curve, we can get φ_I^* . Labor allocations can be solved using the following equations.

$$L_{CM} + L_{CA} = L_C \quad (\text{A.1})$$

$$L_{IM} + L_{IA} = L_I \quad (\text{A.2})$$

$$L_{CM} + L_{IM} = \beta(L_C + L_I) \quad (\text{A.3})$$

$$\begin{aligned} (1 - \beta)L_C - L_{CA} &= M_C r_{IC} - M_I r_{CI} + n\tau_x^{1-\sigma}[M_C p_{Cx}(r_{xCC} + r_{xIC})] - \\ &\quad n\tau_x^{1-\sigma}[M_C p_{Cx} r_{xCC} + M_I p_{Ix} r_{xCI}] \\ &= M_C r_{IC} - M_I r_{CI} + n\tau_x^{1-\sigma}[M_C p_{Cx} r_{xIC} - M_I p_{Ix} r_{xCI}] \end{aligned} \quad (\text{A.4})$$

The first 2 equations are labor market clearing conditions, the third is utility maximization condition; the last one is balanced trade condition. To solve the system of equations, we also need to know the price level, the number of firms, and firm revenue in both regions:

$$\begin{aligned} r_{IC} &= \beta L_I (P_I \rho \tilde{\varphi}_C)^{\sigma-1} \tau^{1-\sigma} \\ r_{CI} &= \beta L_C (P_C \rho \tilde{\varphi}_I)^{\sigma-1} \tau^{1-\sigma} \\ r_{xIC} &= \beta L_I (P_I \rho \tilde{\varphi}_{Cx})^{\sigma-1} \tau^{1-\sigma} \\ r_{xCI} &= \beta L_C (P_C \rho \tilde{\varphi}_{Ix})^{\sigma-1} \tau^{1-\sigma} \\ M_C &= \frac{L_{CM}}{\bar{r}_C} = \frac{L_{CM}}{\sigma(\bar{\pi}_C + f + n p_{Cx} f_x)} \\ M_I &= \frac{L_{IM}}{\bar{r}_I} = \frac{L_{IM}}{\sigma(\bar{\pi}_I + f + n p_{Ix} f_x)} \\ P_C^{1-\sigma} &= M_C (\rho \tilde{\varphi}_C)^{\sigma-1} + M_I (\rho \tilde{\varphi}_I)^{\sigma-1} \tau^{1-\sigma} + n\tau_x^{1-\sigma} (M_C p_{Cx} (\rho \tilde{\varphi}_{Cx})^{\sigma-1} + \\ &\quad M_I p_{Ix} (\rho \tilde{\varphi}_{Ix})^{\sigma-1} \tau^{1-\sigma}) \\ P_I^{1-\sigma} &= M_C (\rho \tilde{\varphi}_C)^{\sigma-1} \tau^{1-\sigma} + M_I (\rho \tilde{\varphi}_I)^{\sigma-1} + n(\tau\tau_x)^{1-\sigma} (M_C p_{Cx} (\rho \tilde{\varphi}_{Cx})^{\sigma-1} + \\ &\quad M_I p_{Ix} (\rho \tilde{\varphi}_{Ix})^{\sigma-1} \tau^{1-\sigma}) \end{aligned}$$

The system of nonlinear equations can be solved since it has 12 equations and 12 unknowns: $L_{iM}, L_{iA}, M_i, P_i, r_{ij}, r_{xij}$.

Assume the productivity draw follows Pareto distribution: $G(\varphi) = 1 - \varphi^{-\theta}$, where $\varphi \geq 1$ and $\theta > \sigma - 1$. Combine the ZCP curve with the FE curve, we get:

$$\varphi_C^* = \left[\frac{\sigma - 1}{\delta f_e (\theta - \sigma + 1)} (f + n f_x \left[\left(\frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau_x \right]^{-\theta}) \right]^{1/\theta} \quad (\text{A.5})$$

$$\varphi_{Cx}^* = \left(\frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau_x \varphi_C^* \quad (\text{A.6})$$

$$\varphi_{Ix}^* = \tau \varphi_{Cx}^* \quad (\text{A.7})$$

Substitute A.7 into the ZCP curve of region I, we get:

$$\varphi_I^* = \left[\frac{f^{\frac{\sigma-1}{\theta-\sigma+1}}}{\delta f_e - n (\varphi_{Ix}^*)^{-\theta} f_x^{\frac{\sigma-1}{\theta-\sigma+1}}} \right]^{1/\theta} \quad (\text{A.8})$$

Exporting probability in both regions are:

$$p_{Cx} = \left(\frac{\varphi_{Cx}^*}{\varphi_C^*} \right)^{-\theta} = \left[\left(\frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau_x \right]^{-\theta} \quad (\text{A.9})$$

$$p_{Ix} = \left(\frac{\varphi_{Ix}^*}{\varphi_I^*} \right)^{-\theta} \quad (\text{A.10})$$

Average profits of firms in region C and region I are:

$$\bar{\pi}_C = \delta f_e (\varphi_C^*)^\theta \quad (\text{A.11})$$

$$\bar{\pi}_I = \delta f_e (\varphi_I^*)^\theta \quad (\text{A.12})$$

Average firm revenue in region C and region I are:

$$\bar{r}_C = \sigma (\bar{\pi}_C + f + n p_{Cx} f_x) \quad (\text{A.13})$$

$$\bar{r}_I = \sigma (\bar{\pi}_I + f + n p_{Ix} f_x) \quad (\text{A.14})$$

With all these equations in hand, the system of nonlinear equations above can be solved. A numerical example is given in Table A.1. Assume that $\beta = 0.3$, $\delta = 0.2$, $\sigma = \theta = 6$, $\tau = 1.3$, $\tau_x = 1.8$, $f = 1$, $f_x = 1$, $f_e = 2$. Assume there are 10 foreign countries, and they are all symmetric with the home country.

The first row show the result when $L_C = 2000$, $L_I = 1000$; The second row show the result when $L_C = 1000$, $L_I = 1000$; and in the last row, $L_C = 900$, $L_I = 1000$. Notice that cutoff threshold and exporting threshold are not functions of L_i . Productivities in the coastal and inland region are not affected by the relative size

of the two region. Numerical results show that the inland region has a lower cutoff threshold but a higher exporting threshold; firms in the coastal region are larger and more profitable. The coastal region has more than proportional share of M industry, and has a higher percentage of firms participating in international trade.

Table A.1: A Numerical Example

L_C/L_I	φ_C^*	$\varphi_{C_x}^*$	φ_I^*	$\varphi_{I_x}^*$	$\bar{\pi}_C$	$\bar{\pi}_I$	\bar{r}_C	\bar{r}_I	p_{C_x}	p_{I_x}	L_{CM}/L_{IM}	ω_C/ω_I
2	1.5903	2.8625	1.5357	3.7213	6.4701	5.247	46.5844	37.7783	0.0294	0.0049	7.51	1.066
1	1.5903	2.8625	1.5357	3.7213	6.4701	5.247	46.5844	37.7783	0.0294	0.0049	1.32	1.019
0.9	1.5903	2.8625	1.5357	3.7213	6.4701	5.247	46.5844	37.7783	0.0294	0.0049	1.09	1.012

^a L_C/L_I is relative size of the coastal region and the inland region; φ_i^* , $\varphi_{i_x}^*$, $\bar{\pi}_i$, \bar{r}_i , p_{i_x} are cutoff threshold, exporting threshold, average firm profit, average firm revenue, exporting probability in region $i \in \{C, I\}$, respectively. L_{CM}/L_{IM} is the relative size of labor employment in sector M because the two regions; ω_C/ω_I is relative real wage between coastal and the inland regions.

^b $\beta = 0.3$, $\delta = 0.2$, $\sigma = \theta = 6$, $\tau = 1.3$, $\tau_x = 1.8$, $f = 1$, $f_x = 1$, $f_e = 2$, and $n = 10$.

A.2 External and Internal Trade Liberalizations

A.2.1 Trade Liberalizations On the Coastal Region

Combine the ZCP curve and the FE curve: $\frac{\delta f_e}{1-G(\varphi_C^*)} = fk(\varphi_C^*) + np_{Cx}f_xk(\varphi_{Cx}^*)$, and define $j(\varphi_C^*) = k(\varphi_C^*)(1 - G(\varphi_C^*))$, we get:

$$fj(\varphi_C^*) + nf_xj(\varphi_{Cx}^*) = \delta f_e \quad (\text{A.15})$$

Notice that $j'(\varphi) < 0$. Since

$$\frac{\varphi_{Cx}^*}{\varphi_C^*} = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}} \frac{P_{Ct}}{P_f} \tau_x$$

equation (A.15) is an implicit function of φ_C^* .

Increase in n:

$$\frac{\partial \varphi_C^*}{\partial n} = -\frac{f_x j(\varphi_{Cx}^*)}{f j'(\varphi_C^*) + n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \varphi_C^*} > 0 \quad (\text{A.16})$$

$$\frac{\partial \varphi_{Cx}^*}{\partial n} = \frac{\varphi_{Cx}^*}{\varphi_C^*} \frac{\partial \varphi_C^*}{\partial n} > 0 \quad (\text{A.17})$$

So both φ_C^* and φ_{Cx}^* increase as n increase.

Decrease in τ_x :

$$\frac{\partial \varphi_C^*}{\partial \tau_x} = -\frac{n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \tau_x}{f j'(\varphi_C^*) + n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \varphi_C^*} < 0 \quad (\text{A.18})$$

$$\frac{\partial \varphi_{Cx}^*}{\partial \tau_x} = -\frac{f j'(\varphi_C^*)}{n f_x j'(\varphi_{Cx}^*)} \frac{\partial \varphi_C^*}{\partial \tau_x} > 0 \quad (\text{A.19})$$

Thus, φ_C^* increases and φ_{Cx}^* decreases as τ_x decreases.

Decrease in f_x :

$$\frac{\partial \varphi_C^*}{\partial f_x} = -\frac{n j(\varphi_{Cx}^*) + n f_x j'(\varphi_{Cx}^*) \frac{\varphi_{Cx}^*}{(\sigma-1)f_x}}{f j'(\varphi_C^*) + n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \varphi_C^*} \quad (\text{A.20})$$

Since $j'(\varphi_{Cx}^*) \varphi_{Cx}^* = -(\sigma - 1)(j(\varphi_{Cx}^*) + 1 - G(\varphi_{Cx}^*))$, substitute it into the above equation, we get:

$$\frac{\partial \varphi_C^*}{\partial f_x} = \frac{n(1 - G(\varphi_{Cx}^*))}{f j'(\varphi_C^*) + n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \varphi_C^*} < 0 \quad (\text{A.21})$$

$$\frac{\partial \varphi_{Cx}^*}{\partial f_x} = -\frac{f j'(\varphi_C^*) \frac{\partial \varphi_C^*}{\partial f_x} + n j(\varphi_{Cx}^*)}{n f_x j'(\varphi_{Cx}^*)} > 0 \quad (\text{A.22})$$

Hence φ_C^* increases and φ_{Cx}^* decreases as f_x decreases.

Decrease in τ : If domestic trade costs in all countries decrease, cutoff threshold and exporting threshold do not change. Domestic trade cost change does not affect firm productivity in the coastal region. If only the home country reduce its domestic trade, and the home country is a small country so that it does not affect price level in other country, then decreasing domestic trade cost also would not affect firm productivity in the coastal region. To see this, notice the exporting threshold in the coastal region must satisfy $\frac{R_f}{\sigma}(P_f \rho \varphi_{Cx}^*)^{\sigma-1} \tau_x^{1-\sigma} = f_x$. If foreign price does not change, φ_{Cx}^* should also stay constant. Combine the FE condition and ZCP curve of the coastal region, we have $\delta f_e = [1 - G(\varphi_C^*)]fk(\varphi_C^*) + n f_x [1 - G(\varphi_{Cx}^*)]k(\varphi_{Cx}^*)$, then φ_C^* also does not change. Thus, decreasing domestic trade cost would not change firm productivity in the coastal region.

$$\frac{\partial \varphi_C^*}{\partial \tau} = 0 \quad (\text{A.23})$$

$$\frac{\partial \varphi_{Cx}^*}{\partial \tau} = 0 \quad (\text{A.24})$$

A.2.2 Trade Liberalizations On the Inland Region

Combine the ZCP curve and the FE curve of inland region :

$$fj(\varphi_I^*) + n f_x j(\varphi_{Ix}^*) = \delta f_e \quad (\text{A.25})$$

The relationship between cutoff threshold and exporting threshold is:

$$\frac{\varphi_{Ix}^*}{\varphi_I^*} = \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}} \frac{P_{It}}{P_f} \tau \tau_x \quad (\text{A.26})$$

Increase in n :

$$\frac{\partial \varphi_I^*}{\partial n} = - \frac{f_x j(\varphi_I^*) + n f_x j'(\varphi_{Ix}^*) \left(\frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial n} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial n} \right)}{f j'(\varphi_I^*) + n f_x j'(\varphi_{Ix}^*) \varphi_{Ix}^* / \varphi_I^*} \quad (\text{A.27})$$

and $\frac{\partial \varphi_{Ix}^*}{\partial n} = \tau \frac{\partial \varphi_{Cx}^*}{\partial n}$.

Decrease in τ_x :

$$\frac{\partial \varphi_I^*}{\partial \tau_x} = - \frac{n f_x j'(\varphi_{Ix}^*) \left(\frac{\varphi_{Ix}^*}{\tau_x} + \frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial \tau_x} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial \tau_x} \right)}{f j'(\varphi_I^*) + n f_x j'(\varphi_{Ix}^*) \varphi_{Ix}^* / \varphi_I^*} \quad (\text{A.28})$$

and

$$\frac{\partial \varphi_{Ix}^*}{\partial \tau_x} = - \frac{f j'(\varphi_I^*)}{n f_x j'(\varphi_{Ix}^*)} \frac{\partial \varphi_I^*}{\partial \tau_x} \quad (\text{A.29})$$

Decrease in f_x : Total differentiate equation (A.25) and use $\frac{\partial \varphi_{Ix}^*}{\partial f_x} = \frac{\varphi_{Ix}^*}{\varphi_I^*} \frac{\partial \varphi_I^*}{\partial f_x} +$

$\frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial f_x} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial f_x} + \frac{\varphi_{Ix}^*}{f_x(\sigma-1)}$, we get:

$$\frac{\partial \varphi_I^*}{\partial f_x} = - \frac{n j(\varphi_{Ix}^*) + n f_x j'(\varphi_{Ix}^*) \left(\frac{\varphi_{Ix}^*}{(\sigma-1)f_x} + \frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial f_x} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial f_x} \right)}{f j'(\varphi_I^*) + n f_x j'(\varphi_{Ix}^*) \varphi_{Ix}^* / \varphi_I^*}$$

and using $j'(\varphi_{Ix}^*) \varphi_{Ix}^* = -(\sigma-1)(j(\varphi_{Ix}^*) + 1 - G(\varphi_{Ix}^*))$, substitute it into the above equation, we get:

$$\frac{\partial \varphi_I^*}{\partial f_x} = \frac{n(1 - G(\varphi_{Ix}^*)) - n f_x j'(\varphi_{Ix}^*) \left(\frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial f_x} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial f_x} \right)}{f j'(\varphi_C^*) + n f_x j'(\varphi_{Cx}^*) \varphi_{Cx}^* / \varphi_C^*} \quad (\text{A.30})$$

and

$$\frac{\partial \varphi_{Ix}^*}{\partial f_x} = - \frac{f j'(\varphi_I^*) \frac{\partial \varphi_I^*}{\partial f_x} + n j(\varphi_{Ix}^*)}{n f_x j'(\varphi_{Ix}^*)} \quad (\text{A.31})$$

Decrease in τ : Total differentiate the equation and use $\frac{\partial \varphi_{Ix}^*}{\partial \tau} = \frac{\varphi_{Ix}^*}{\varphi_I^*} \frac{\partial \varphi_I^*}{\partial \tau} + \frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial \tau} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial \tau} + \frac{\varphi_{Ix}^*}{\tau}$, we get:

$$\frac{\partial \varphi_I^*}{\partial \tau} = - \frac{n f_x j'(\varphi_{Ix}^*) \left(\frac{\varphi_{Ix}^*}{\tau} + \frac{\varphi_{Ix}^*}{P_{It}} \frac{\partial P_{It}}{\partial \tau} - \frac{\varphi_{Ix}^*}{P_f} \frac{\partial P_f}{\partial \tau} \right)}{f j'(\varphi_I^*) + n f_x j'(\varphi_{Ix}^*) \varphi_{Ix}^* / \varphi_I^*} < 0 \quad (\text{A.32})$$

and

$$\frac{\partial \varphi_{Ix}^*}{\partial \tau} = - \frac{f j'(\varphi_I^*)}{n f_x j'(\varphi_{Ix}^*)} \frac{\partial \varphi_I^*}{\partial \tau} > 0 \quad (\text{A.33})$$

The price level P_{It} and P_f makes it difficult to determine the sign of the derivatives above. In a special case when φ follows Pareto distribution, we can prove φ_C^* change in the same direction with φ_I^* (A proof is in the section A.2.3.). Thus, trade liberalizations (increase of n , decrease of τ_x , f_x and τ) increase the cutoff threshold and decrease the exporting threshold in the inland region.

A.2.3 Trade Liberalizations and the Welfare of Coastal and Inland Regions

In models where there is no internal geography within a country, the price level of the country is determined by the cutoff threshold of the country.

$$\frac{R}{\sigma} (P \rho \varphi^*)^{\sigma-1} = f$$

Thus,

$$P = \left(\frac{\sigma f}{R} \right)^{\frac{1}{\sigma-1}} \frac{1}{\rho \varphi^*}$$

Real wage $\omega = \frac{w}{P^\beta} = P^{-\beta}$ if wage is normalized to be 1. Thus, real wage is positively related with cutoff threshold. The cutoff threshold is a ‘‘sufficient’’ statistic of welfare.

In my model, however, there is no such correspondence between cutoff threshold and welfare. Since

$$\frac{R_t}{\sigma}(P_{Ct}\rho\varphi_C^*)^{\sigma-1} = f$$

$$\frac{R_t}{\sigma}(P_{It}\rho\varphi_I^*)^{\sigma-1} = f$$

and

$$R_t = R_C + R_I$$

$$P_{Ct}^{\sigma-1} = \frac{R_C}{R_t}P_C^{\sigma-1} + \frac{R_I}{R_t}P_I^{\sigma-1}\tau^{1-\sigma}$$

$$P_{It}^{\sigma-1} = \frac{R_C}{R_t}P_C^{\sigma-1}\tau^{1-\sigma} + \frac{R_I}{R_t}P_I^{\sigma-1}$$

Solving P_i from the above two equations of P_{it} , we get:

$$P_C^{\sigma-1} = \frac{R_t}{R_C(1-\phi^2)}(P_{Ct}^{\sigma-1} - \phi P_{It}^{\sigma-1})$$

$$P_I^{\sigma-1} = \frac{R_t}{R_I(1-\phi^2)}(P_{It}^{\sigma-1} - \phi P_{Ct}^{\sigma-1})$$

Substitute P_{it} with the zero profit conditions,

$$P_C^{\sigma-1} = \frac{\sigma f}{(1-\phi^2)R_C\rho^{\sigma-1}}(\varphi_C^{*1-\sigma} - \phi\varphi_I^{*1-\sigma})$$

$$P_I^{\sigma-1} = \frac{\sigma f}{(1-\phi^2)R_I\rho^{\sigma-1}}(\varphi_I^{*1-\sigma} - \phi\varphi_C^{*1-\sigma})$$

Differentiate P_i with respect to φ_i^* ,

$$\text{sgn}\left(\frac{\partial P_C^{\sigma-1}}{\partial \varphi_C^*}\right) = \text{sgn}(-\varphi_C^{*-\sigma} + \phi\varphi_I^{*-\sigma}\frac{\partial \varphi_I^*}{\partial \varphi_C^*}) \quad (\text{A.34})$$

$$\text{sgn}\left(\frac{\partial P_I^{\sigma-1}}{\partial \varphi_I^*}\right) = \text{sgn}(-\varphi_I^{*-\sigma} + \phi\varphi_C^{*-\sigma}\frac{\partial \varphi_C^*}{\partial \varphi_I^*}) \quad (\text{A.35})$$

Next, notice that

$$fj(\varphi_C^*) + nf_xj(\varphi_{Cx}^*) = \delta f_e$$

$$fj(\varphi_I^*) + nf_xj(\varphi_{Ix}^*) = \delta f_e$$

where $j(\varphi) = k(\varphi)(1 - G(\varphi))$. Under Pareto distribution, ZCP curve is horizontal and $k(\varphi) = \frac{\sigma-1}{\theta-\sigma+1}$ is a constant. Thus

$$k(\varphi_C^*)f\varphi_C^{*-\theta} + k(\varphi_{Cx}^*)nf_x\varphi_{Cx}^{*-\theta} = \delta f_e$$

$$k(\varphi_I^*)f\varphi_I^{*-\theta} + k(\varphi_{Ix}^*)nf_x\varphi_{Ix}^{*-\theta} = \delta f_e$$

Combine the above two equations and use $\varphi_{Ix}^* = \tau\varphi_{Cx}^*$, we get:

$$f(k(\varphi_I^*)k(\varphi_{Cx}^*)\varphi_I^{*-\theta} - k(\varphi_C^*)k(\varphi_{Ix}^*)(\tau\varphi_C^*)^{-\theta}) = \delta f_e(k(\varphi_{Cx}^*) - \tau^{-\theta}k(\varphi_{Ix}^*))$$

From above, we can get $\varphi_I^* < \tau\varphi_C^*$. Differentiate with respect to φ_C^* ,

$$\begin{aligned} \frac{\partial\varphi_I^*}{\partial\varphi_C^*} &= \tau^{-\theta}\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{-\theta-1}\frac{k(\varphi_C^*)k(\varphi_{Ix}^*)}{k(\varphi_I^*)k(\varphi_{Cx}^*)} \\ &= \tau^{-\theta}\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{-\theta-1} \end{aligned} \quad (\text{A.36})$$

and

$$\frac{\partial\varphi_C^*}{\partial\varphi_I^*} = \tau^\theta\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{\theta+1} \quad (\text{A.37})$$

Substitute (A.36) (A.37) into (A.34) - (A.35), since

$$\begin{aligned} -\varphi_C^{*- \sigma} + \phi\varphi_I^{*- \sigma}\frac{\partial\varphi_I^*}{\partial\varphi_C^*} &= (\phi\tau^{-\theta}\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{-\theta+\sigma-1} - 1)\varphi_C^{*- \sigma} \\ &< (\tau^{-\theta+\sigma-1}\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{-\theta+\sigma-1} - 1)\varphi_C^{*- \sigma} \\ &= \left(\frac{\varphi_C^*\tau}{\varphi_I^*}\right)^{-\theta+\sigma-1} - 1)\varphi_C^{*- \sigma} \\ &< 0 \end{aligned}$$

Thus,

$$\frac{\partial P_C^{\sigma-1}}{\partial\varphi_C^*} < 0 \quad (\text{A.38})$$

Since

$$\begin{aligned} -\varphi_I^{*- \sigma}\frac{\partial\varphi_I^*}{\partial\varphi_C^*} + \phi\varphi_C^{*- \sigma} &= \phi\varphi_C^{*- \sigma} - \varphi_I^{*- \sigma}\tau^{-\theta}\left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{-\theta-1} \\ &= \phi\varphi_C^{*- \sigma}\left(1 - \left(\frac{\varphi_I^*}{\varphi_C^*\tau}\right)^{\theta-\sigma+1}\right) \\ &> 0 \end{aligned}$$

Thus,

$$\frac{\partial P_I^{\sigma-1}}{\partial\varphi_C^*} > 0 \quad (\text{A.39})$$

We can also prove that $\frac{\partial P_C^{\sigma-1}}{\partial\varphi_I^*} < 0$ and $\frac{\partial P_I^{\sigma-1}}{\partial\varphi_C^*} > 0$. Now, the welfare (real wage) of a region is determined not just by the cutoff threshold of that region, but also the cutoff threshold of the other region. The welfare of the coastal region will increase when the cutoff threshold in the coastal region and the inland region increases, and the welfare of the inland region will decrease when the cutoff threshold in the coastal region and the inland region increases.

When international trade cost (τ_x) or fixed export cost (f_x) decreases, both φ_C^* and φ_I^* increase. Therefore, real wage in the coastal region increases, but the real wage in the inland region decreases. Here, we actually have a case in which (external) trade liberalization hurts the inland region.

The change from open to closed case amounts to increasing the international trade cost to infinity. In this sense, when a closed economy open up to international trade, the welfare in the coastal region increases, and the welfare in the inland region decreases. The inland region loses from trade and international trade liberalizations.

A.2.4 Trade Liberalizations and Firm Convergence (Divergence)

Using the cutoff threshold conditions of coastal and inland regions:

$$\begin{aligned} \left(\frac{\varphi_C^*}{\varphi_I^*}\right)^{\sigma-1} &= \left(\frac{P_{It}}{P_{Ct}}\right)^{\sigma-1} \\ &= \frac{P_I^{\sigma-1} + \tau^{1-\sigma} P_C^{\sigma-1}}{P_C^{\sigma-1} + \tau^{1-\sigma} P_I^{\sigma-1}} \\ &= \frac{1 + \tau^{1-\sigma} (P_C/P_I)^{\sigma-1}}{(P_C/P_I)^{\sigma-1} + \tau^{1-\sigma}} \end{aligned}$$

$\frac{\varphi_C^*}{\varphi_I^*}$ increases as $\frac{P_C}{P_I}$ decreases. As we have proved that $\frac{P_C}{P_I}$ decreases when international trade costs (τ_x, f_x) decrease¹, $\frac{\varphi_C^*}{\varphi_I^*}$ increases during external trade liberalizations, so is the relative average productivity $\frac{\bar{\varphi}_C}{\bar{\varphi}_I}$.

Under Pareto distribution, $\pi_i = \delta f_e \varphi_i^{*\theta}$, so $\frac{\pi_C}{\pi_I} = \left(\frac{\varphi_C^*}{\varphi_I^*}\right)^\theta$. Thus, $\frac{\pi_C}{\pi_I}$ increases when international trade costs are reduced. Since

$$\frac{\bar{r}_C}{\bar{r}_I} = \frac{\bar{\pi}_C + f + n p_{Cx} f_x}{\bar{\pi}_I + f + n p_{Ix} f_x},$$

$$\frac{p_{Cx}}{p_{Ix}} = \left(\frac{\varphi_C^*}{\varphi_{Cx}^*}\right)^{\theta-1} \left(\frac{\varphi_{Ix}^*}{\varphi_C^*}\right)^{\theta-1} = \left(\tau \frac{\varphi_C^*}{\varphi_I^*}\right)^{\theta-1},$$

$\frac{p_{Cx}}{p_{Ix}}$ and $\frac{\bar{r}_C}{\bar{r}_I}$ also increase when international trade costs are reduced. Thus, external trade liberalizations lead to firm divergence between coastal and inland regions.

What would happen during internal trade liberalizations? If $\frac{\varphi_C^*}{\varphi_I^*}$ decreases during an internal trade liberalization, the difference in firms between the coastal region and the inland region also decreases. Internal trade liberalizations lead to firm convergence between coastal and inland regions.

¹In this case, P_C decreases and P_I increases, so that $\frac{P_C}{P_I}$ increases. The result is derived under Pareto distribution. But $\frac{P_C}{P_I}$ can increase even if not assuming Pareto distribution of φ .

A.2.5 Model Parameters In the Simulation

The model parameters in the simulation example are specified as follows. Assume firm productivity is drawn from Pareto distribution, with $G(\varphi) = 1 - \varphi^{-\theta}$. Assume that $\beta = 0.3$, $\delta = 0.2$, $\sigma = \theta = 6$; $\tau = 1.3$, $\tau_x = 1.8$, $f = 1$, $f_x = 0.8$, $f_e = 2$; $n = 10$, $L_1 = L_2 = 1000$.

A.3 Appendix Figures



Figure A.1: Coastal and Inland Regions in China

Notes: The shared areas are coastal regions. The remaining areas are inland regions. The triangles denotes seaports. Seaport information are obtained from the World Port Index.

Distance to the sea port

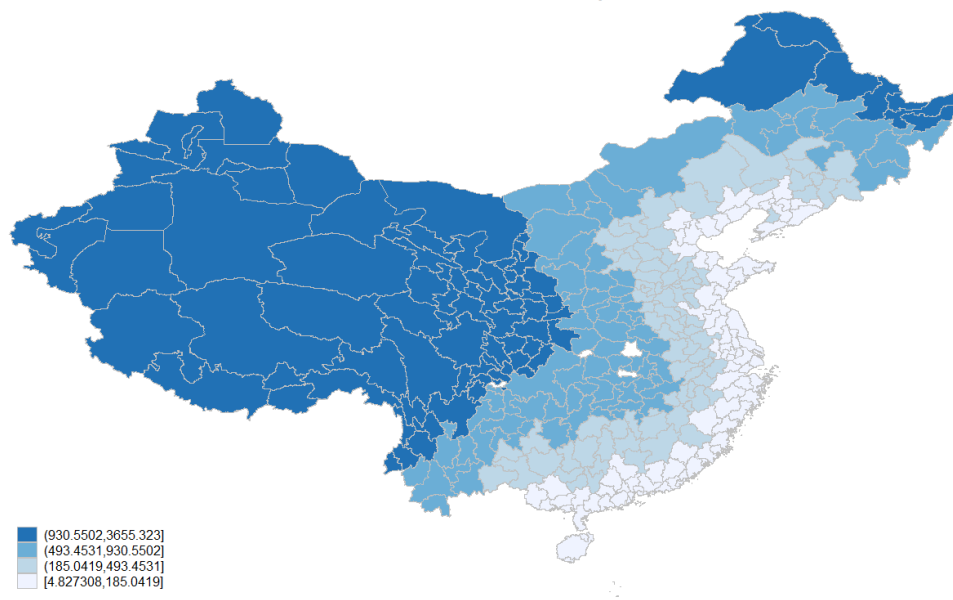
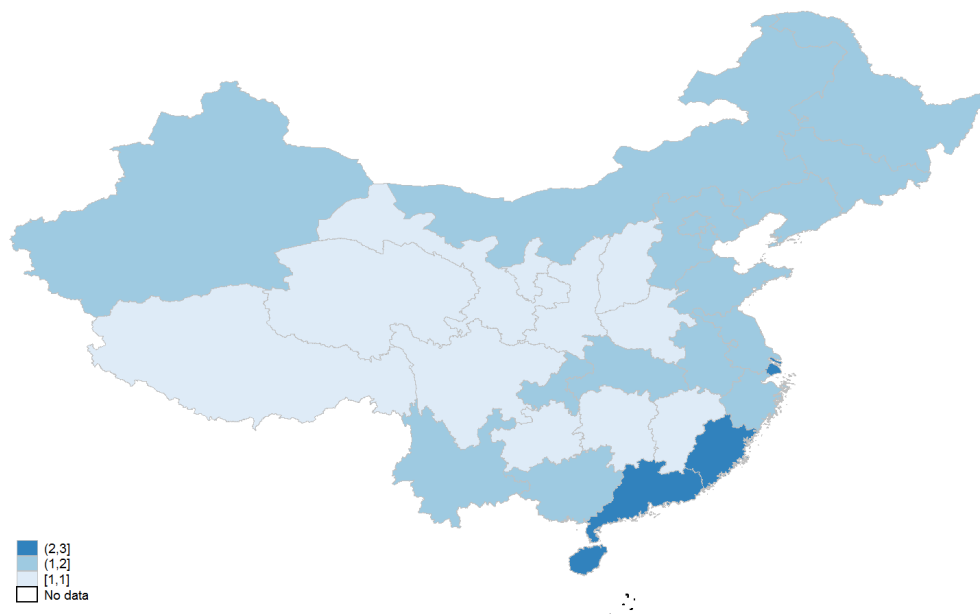


Figure A.2: Access to the World Market

Notes: The maps show distance (km) of each prefecture to the nearest seaport. The seaport information is from World Port Index.



Data source: Demurger et. al. (2002)

Figure A.3: Opening-up Policy Gradient in 1998

Notes: I use the preferential policy index from Demurger et al. (2002). The policy index are defined as follows. 3: SEZ and Shanghai. 2: Economic and Technological Development Zone (NTDZ) and Border Economic Cooperation Zone (BECZ). 1: Coastal open city, coastal open economic zone, open coastal belt, major city in Yangtze river, bonded area, and capital city of inland province or autonomous region.

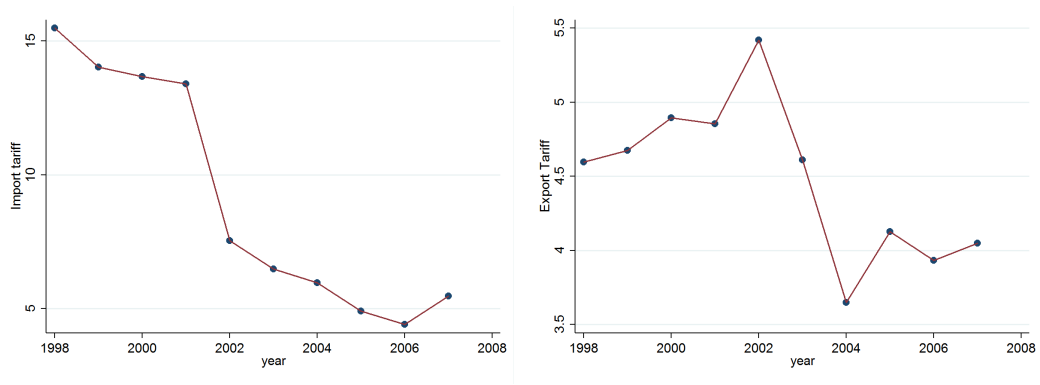


Figure A.4: Import and Export Tariffs Faced by Chinese Firms

Notes: The tariff data are from United Nation Trade Analysis Information system. The tariffs are weighted average tariff weighted by import or export.

Appendix B Chapter 3 Appendix

B.1 Data Sources

In this paper, I use county as the observation unit. In 2007, the four plain provinces have 510 county-level administration units, including 197 city districts, 84 county-level cities, and 229 counties¹.

I obtain China's county-level map from GADM database. The map has 400 county-level administration units in the four plain provinces². There are 54 counties on the border.

I obtain manufacturing data in each county by aggregating firm data from Annual Survey of Industrial Firms (1998-2007). There are 508 counties in the sample.

County-level social-economic data are from China County Yearbook (2000-2004, 2006, 2007). The county yearbook only has data on counties and county-level cities, but not on city districts. There are 330 counties in the sample.

Dialect data are from Liu et al. (2015), who collect the county-level dialect data in 1986 using Xu et al. (1999). I am able to match with 484 counties in the plain provinces in 2007.

Data on elevation are from DIVA-GIS. The shape file of rivers is from Natural Earth website.

B.2 Regression Discontinuity at the Border

The main analysis in the paper use only counties contiguous to the border. In this section, I check if results change when using different sample and estimation methods. I first run a parametric regression discontinuity model:

$$y_{rt} = \beta_0 + \beta_1 East_r + f(d_r) + East_r \times g(d_r) + \gamma_t + \varepsilon_{rt} \quad (\text{B.1})$$

where $f(d_r)$ and $g(d_r)$ are second order polynomials of distance to the borderline; $East_r$ is a dummy variable that equals one if a county is in the east provinces; γ_t is the year fixed effect. The regression use all counties in the four provinces. The results are shown in Table B.1.

The results in Table B.1 are very similar to the main results in Table 3.2, indicating that the selection of only bordering counties in the main analysis is not crucial to the results here.

I also run a nonparametric model to estimate the border effect. I set the local

¹City district, county-level city, and counties have the same administration level. Henceforth, I call them "county".

²When a prefecture-level city has several city districts, in the map the city districts are usually combined into one region. In the map, there are 34 city districts, 261 counties, and 105 county level cities.

Table B.1: Economic Discontinuities across the Border

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(export)	Export share	Foreign Share
east	-0.0526*** (0.0160)	1.262*** (0.222)	1.204*** (0.189)	1.780*** (0.354)	0.0514*** (0.0197)	0.0698*** (0.0251)
Observations	2063	3542	3542	3154	3542	3542
R^2	0.112	0.535	0.365	0.404	0.155	0.156

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

polynomials to be second order and choose the optimal bandwidth. The results are shown in Table B.2.

The results from non-parametric estimation are smaller in magnitude compared to those in Table 3.2. However, coefficients of *East* are significant in all specifications except for manufacturing export (column 4). In general, the economic discontinuities are robust and are not sensitive to the choice of estimation methods.

Table B.2: Economic Discontinuities across the East/non-east Borders (Non-parametric)

VARIABLES	(1) Rural Pop. Share	(2) ln(Output)	(3) ln(L)	(4) ln(export)	(5) Export share	(6) Foreign Share
RD_Estimate	-0.0349	1.006	0.861	0.453	-0.0325	0.0964
Observations	1680	1862	2020	1992	2157	2196
Robust 95% CI	[-.1 ; -.01]	[.43 ; 2.07]	[.52 ; 1.5]	[-.57 ; 1.53]	[-.08 ; -.01]	[.05 ; .21]
Kernel Type	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
BW Type	CCT	CCT	CCT	CCT	CCT	CCT
Conventional Std. Error	0.016	0.277	0.165	0.353	0.015	0.027
Conventional p-value	0.029	0.000	0.000	0.199	0.035	0.000
Robust p-value	0.022	0.003	0.000	0.372	0.019	0.001
Order Loc. Poly. (p)	2.000	2.000	2.000	2.000	2.000	2.000
Order Bias (q)	3.000	3.000	3.000	3.000	3.000	3.000
BW Loc. Poly. (h)	150.448	133.361	147.630	160.921	158.800	160.383
BW Bias (b)	195.163	173.171	187.961	192.871	247.030	219.895

B.3 An Alternative Method to Construct Comparison Counties

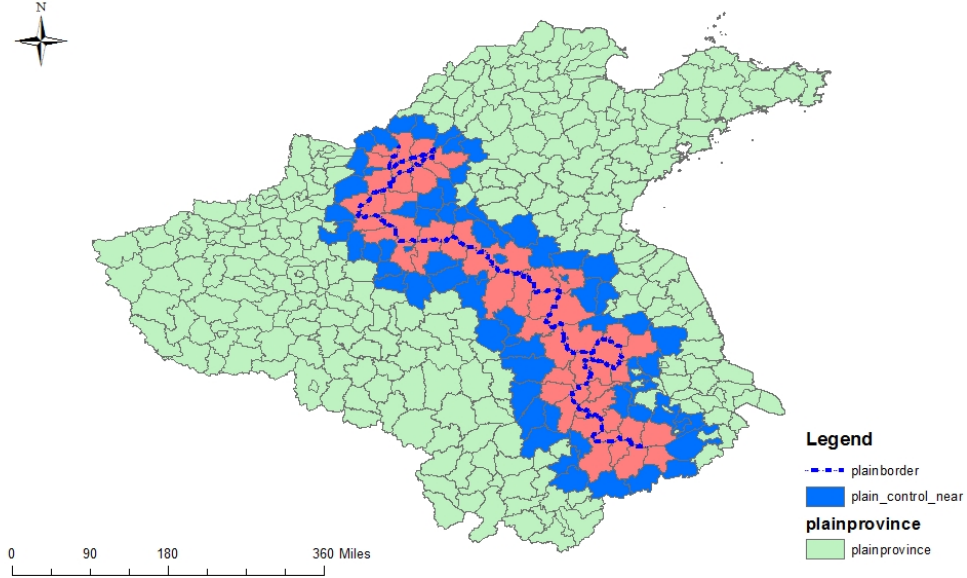


Figure B.1: Bordering counties and comparison counties

In the main analysis, I build a buffer of 100 kilometers to construct comparison counties when examining the false border effect. Another way to construct the comparison group is to use counties adjacent to the border counties as comparison counties. In the map above, the blue counties are chosen as comparison counties. Using the same procedure as in section 6, we can check if the false border in the west or in the east has a significant effect on manufacturing activities. The results are shown in Table B.3 and B.4.

Table B.3: The Effects of the False Border in the West

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
East	-0.0250** (0.0114)	0.229 (0.152)	0.210 (0.146)	0.00315 (0.792)	-0.0102 (0.0179)	-0.0269 (0.0349)
Observations	283	507	507	507	507	507

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All the coefficients in Table B.3 and B.4 (except for rural population share in Table B.4) are small in magnitude and statistically insignificant. The results give

Table B.4: The Effects of the False Border in the East

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
East	0.00946 (0.0175)	-0.179 (0.248)	-0.205 (0.188)	-0.450 (0.486)	-0.00962 (0.0180)	0.00406 (0.0303)
Observations	308	522	522	522	522	522

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

strong evidence that there are no economic discontinuities within the province, and the economic discontinuities we find do happen at provincial borders.

B.4 The Border effect as a Share of Provincial Gap (Excluding Border Counties)

In running regression equation (2.2), I use the provincial level gap to explain border county gap. Since border counties are also used to calculate provincial level Y_{pt} , there may be some simultaneity problem. Here I exclude counties contiguous to the borders and use the remaining counties to calculate Y_{pt} . The regression results are shown below.

Table B.5: The Border Effect as a Share of the Provincial Gap

	(1)	(2)	(3)	(4)	(5)	(6)
	Rural Pop. Share	ln(Output)	ln(L)	ln(Export)	Export share	Foreign Share
Y_{pt}	0.651** (0.283)	0.482*** (0.113)	0.533*** (0.123)	0.343*** (0.118)	0.176 (0.145)	0.337* (0.189)
Observations	293	466	466	423	466	466

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results in Table B.5 are very similar to the results in Table 3.3. This indicates that provincial gaps are not driven by gaps in bordering counties.

Appendix C Chapter 4 Appendix

C.1 The Effect of the MFA on Firm Exit

This section intent to show that exit rate is not statistically different between MFA products and non-MFA products, whether before or after the MFA expired. I calculate the exit rate by different margins. Firm exit rate is calculated as $\ln(y_{pdt-1}) - \ln(y_{pdt-1} - exit_{pdt})$, the difference between log number of firms in the last period and log number of firms in the last period minus the number of exiting firms in this period. Exit can be divided into existing firms withdrawing from some markets, thus reducing their number of product-destinations (Reducer), or firms completely exit the exporting market (Leaver). Thus, I also calculate the exiting rate using only reducers and the exiting rate using only leavers. The exit rate by different margins from 2004 to 2006 are shown in Table C.1. From the table, It can be seen that most of the exit is from existing firms reducing number of product-destinations (reducers), not by firms exiting the T&C export market. However, there does not seem to be systematic difference in exit rate between MFA products and non-MFA products among all margins.

Table C.1: Firm Exit Rate

	Exit		Reducer		Leaver	
	Non-MFA	MFA	Non-MFA	MFA	Non-MFA	MFA
2004	0.969	0.986	0.889	0.944	0.033	0.025
2005	0.929	0.907	0.819	0.844	0.043	0.035
2006	1.069	1.210	0.964	1.099	0.045	0.040

I next run regression equation (4.4) to examine the effects of quota constraints and quota removal on firm exit. The dependent variables are total exit rate, exit rate due to firms reducing product-destinations, and exit rate due to firms leaving the export market respectively. The results are shown in Table C.2.

Column 1 shows that the overall firm exit rate is not statistically different between MFA products and non-MFA product in both 2004 and 2005, compared with that in 2006. Column 2 and 3 further show that exit rate are not different between MFA products and non-MFA products for reducers and leavers. Results here show that quota and quota removal does not affect firm exit behavior.

Table C.2: Quotas and Firm Exit

	(1)	(2)	(3)
	dln(exit)	dln(Reducer)	dln(Leaver)
<i>Quota</i> × 2004	-0.00322 (0.0502)	0.0486 (0.0457)	0.00525 (0.0112)
<i>Quota</i> × 2005	-0.0459 (0.0492)	0.00735 (0.0450)	-0.0120 (0.0113)
Observations	2460	2568	2950
R^2	0.843	0.833	0.717

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Bibliography

- Acemoglu, D. and M. Dell (2010). Productivity differences between and within countries. *American Economic Journal: Macroeconomics* 2(1), 169–188.
- Acemoglu, D. and J. A. Robinson (2013). *Why nations fail: The origins of power, prosperity, and poverty*. Crown Business.
- Alder, S., L. Shao, and F. Zilibotti (2015). Economic reforms and industrial policy in a panel of chinese cities. *Journal of Economic Growth*, 1–45.
- Atkin, D. and D. Donaldson (2015). Who's getting globalized? the size and implications of intra-national trade costs. Technical report, National Bureau of Economic Research.
- Bai, C.-E., Y. Du, Z. Tao, and S. Y. Tong (2004). Local protectionism and regional specialization: evidence from china's industries. *Journal of international economics* 63(2), 397–417.
- Bajona, C. and T. Chu (2003). Economic effects of liberalization: The case of china's accession to the world trade organization. Technical report, Minnesota working papers/University of Minnesota, Center for Economic Research, Department of Economics.
- Baldwin, R., R. Forslid, P. Martin, G. Ottaviano, and F. R. Nicoud (2003). *Economic Geography and Public Policy*. Princeton University Press.
- Baldwin, R. E. and T. Okubo (2006). Heterogeneous firms, agglomeration and economic geography: spatial selection and sorting. *Journal of Economic Geography* 6(3), 323–346.
- Bernard, A. B., S. J. Redding, and P. K. Schott (2011). Multiproduct firms and trade liberalization. *The Quarterly Journal of Economics* 126(3), 1271–1318.
- Chan, K. W. and L. Zhang (1999). The "hukou" system and rural-urban migration in China: processes and changes. *The China quarterly* 160(160), 818–855.
- Coşar, A. K. and P. D. Fajgelbaum (2016). Internal geography, international trade, and regional specialization. *American Economic Journal: Microeconomics* 8(1), 24–56.
- Demurger, S., J. D. SACHS, W. T. Woo, B. Shuming, and G. Chang (2002). The relative contributions of location and preferential policies in china's regional development: being in the right place and having the right incentives. *China Economic Review* 13(4), 444–465.
- Démurger, S., J. D. Sachs, W. T. Woo, S. Bao, G. Chang, and A. Mellinger (2002).

- Geography, economic policy, and regional development in china. *Asian Economic Papers* 1(1), 146–197.
- Faber, B. (2014). Trade integration, market size, and industrialization: Evidence from china’s national trunk highway system*. *The Review of Economic Studies*, rdu010.
- Fajgelbaum, P. and S. J. Redding (2014). External integration, structural transformation and economic development: Evidence from argentina 1870-1914. Technical report, National Bureau of Economic Research.
- Fan, G., X. Wang, L. Zhang, and H. Zhu (2003). China market reform index by province. *Economic Research(Chinese)* 3(10).
- Fewsmith, J. (2001). The political and social implications of china’s accession to the wto. *The China Quarterly* 167, 573–591.
- Guo, H. (2017). External integration, internal liberalization, and coastal agglomeration. *Unpublished manuscript*.
- Harrigan, J. and G. Barrows (2009). Testing the theory of trade policy: Evidence from the abrupt end of the multifiber arrangement. *The Review of Economics and Statistics* 91(2), 282–294.
- Holmes, T. J. (1998). The effect of state policies on the location of manufacturing: Evidence from state borders. *Journal of Political Economy* 106(4), 667–705.
- Holz, C. A. (2009). No razor’s edge: Reexamining alwyn young’s evidence for increasing interprovincial trade barriers in china. *The Review of Economics and Statistics* 91(3), 599–616.
- Khandelwal, A. K., P. K. Schott, and S.-J. Wei (2013). Trade liberalization and embedded institutional reform: Evidence from chinese exporters. *American Economic Review* 103(6), 2169–2195.
- Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review* 70(5), 950–959.
- Krugman, P. (1991). Increasing returns and economic geography. *The Journal of Political Economy* 99(3), 483–499.
- Krugman, P. (1993). The hub effect, or threeness in interregional trade. *Theory, policy and dynamics in international trade*, 29–37.
- Liu, Y., X. Xu, and Z. Xiao (2015). The pattern of labor’s cross-dialect migration. *Economic Research Journal (in Chinese)* 50(10), 134–146.
- Lu, J. and Z. Tao (2009). Trends and determinants of China’s industrial agglomeration. *Journal of Urban Economics* 65(2), 167–180.

- Ma, S. (2017). The effects of cultural similarity on foreign direct investment and productivity of domestic firms: Identification from borders of chinese dialect zones. *Unpublished manuscript*.
- Mankiw, N. G., D. Romer, and D. N. Weil (1992). A contribution to the empirics of economic growth. *The quarterly journal of economics* 107(2), 407–437.
- Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71(6), 1695–1725.
- Melitz, M. J. and S. J. Redding (2012). Heterogeneous firms and trade. Technical report, National Bureau of Economic Research.
- Pinkovskiy, M. L. (2017). Growth discontinuities at borders. *Journal of Economic Growth* 22(2), 145–192.
- Rappaport, J. and J. D. Sachs (2003). The united states as a coastal nation. *Journal of Economic growth* 8(1), 5–46.
- Tan, Q. (1987). *China Historical Map*, Volume 8. SinoMaps Press.
- Tang, M.-K. and S.-J. Wei (2009). The value of making commitments externally: evidence from wto accessions. *Journal of International Economics* 78(2), 216–229.
- Upward, R. and Z. Wang (2016). Quota restrictions and intra-firm reallocations: Evidence from chinese exports to the us. *Economics Letters* 144, 71–74.
- Utar, H. (2014, October). When the floodgates open: "northern" firms' response to removal of trade quotas on chinese goods. *American Economic Journal: Applied Economics* 6(4), 226–50.
- Vogel, E. F. (1989). One step ahead in china. *Guangdong Under Reform*, Cambridge-London.
- Wang, J. (2013). The economic impact of special economic zones: Evidence from chinese municipalities. *Journal of development economics* 101, 133–147.
- Wong, C., R. Bird, et al. (2008). China's fiscal system: a work in progress. *China's great economic transformation*, 429–466.
- Xu, B. et al. (1999). *Chinese Dialect Dictionary*, Volume 5. Zhonghua Book Company.
- Xu, C. (2011). The fundamental institutions of china's reforms and development. *Journal of Economic Literature* 49(4), 1076–1151.
- Yang, D. L. (1991). China adjusts to the world economy: the political economy of china's coastal development strategy. *Pacific Affairs*, 42–64.
- Young, A. (2000). The razor's edge: Distortions and incremental reform in the people's republic of china. *The Quarterly Journal of Economics* 115(4), 1091–1135.

Vita

Hao Guo

- EDUCATION Sun Yat-sen University, Guangzhou, China
- M.S., Economics, Jun. 2012.
 - B.S., Applied Meteorology, Jul. 2010
- EMPLOYMENT University of Kentucky
- Primary Instructor*
ECO 391: Business & Economics Statistics, (4 sections)
- Teaching Assistant*
ECO 590: Intro Quantitative Economics, Fall 2014.
ECO 601: Microeconomic Theory I, Fall 2014.
ECO 603: Research Methods in Economics, Fall 2016.
ECO 701: Microeconomic Theory II, Spring 2015.
ECO 706: Introduction to Econometrics II, Fall 2016.
- University of Cincinnati
- Primary Instructor*
ECON 3083: Economy of China, Summer 2015, 2016.
- HONORS & AWARDS
- China Scholarship Council (CSC)- Kentucky Fellowship, 2012-2016.
 - Lockett Fellowship, 2015-2016.
 - Gatton Fellowship, 2013-2015.
 - Mullineaux award (Outstanding PhD student in the Gatton College), 2016
- PLACE OF BIRTH Henan, China