

**The Impact of Technical Barriers to Trade (TBT) on
Importing countries - An Analysis Using China's
Manufacturing Firms Level Data**

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Summary

Technical Barriers to Trade (TBTs) are regulatory measures aimed at protecting national security, the environment, and product quality. Despite the relaxation of tariffs, TBTs have increased significantly, with the WTO reporting a rise from 389 in 1995 to 3,958 in 2021. This study examines the impact of TBTs imposed by the Chinese government on Chinese importing firms, particularly focusing on imports and productivity.

This research combines data from Chinese Customs Records and firm surveys (2002-2007), along with TBT information imposed by the Chinese government. The dataset includes import values, origin countries, firm characteristics, and products at the HS4 level. Specific Trade Concerns (STCs) are used to measure TBT impact, distinguishing between countries that raised concerns and those that did not. The Correia (2016) is applied to estimate the Multi-Way Fixed Effects Linear Model of causal relationship between TBTs and trade outcomes.

The analysis reveals that TBTs generally reduce trade flows, decreasing the value of affected imports. Firms adjust their import behavior based on the source: imports from countries that raised concerns decline, while those from unconcerned countries increase. Furthermore, TBT implementation negatively impacts firm productivity, particularly for smaller firms, which experience more significant adverse effects.

These findings highlight the trade diversion effects of TBTs: while TBTs decrease imports from concerned countries, they simultaneously increase imports from unconcerned countries. Most previous studies (e.g., Singh and Chanda, 2021; Fontagné and Orefice, 2018) treat STCs as a binding measure and apply them to all countries, without distinguishing between those that raised concerns and those that did not. This paper, however, differentiates firm imports based on whether they are from concerned or unconcerned countries and analyzes the varying impact of TBTs by origin.

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Contents

Introduction	1
Chapter 1 Literature Review	4
1.1 The effects of non-tariff barriers on trade	4
1.1.1 The effect of non-tariff barriers on exports	4
1.1.1.1 The effect of non-tariff barriers on export trade flows between countries..	4
1.1.1.2 The effect of non-tariff barriers on exporting firms.	5
1.1.2 The effect of non-tariff barriers on imports	7
1.1.2.1 The effect of non-tariff barriers on import trade flows between countries.	7
1.1.2.2 The effect of non-tariff barriers on importing firms.	8
1.2 The effects of tariffs on trade	9
1.2.1 The effect of tariffs on trade flows	9
1.2.2 The effect of tariffs on firm performance.....	10
1.3 Types of TBTs measurement tools	11
1.3.1 Number of notifications	12
1.3.2 Frequency ratio and coverage ratio.....	14
1.3.3 Tariff Equivalence	15
1.3.4 Treating TBTs as a binary variable.....	16
1.4 The role of intermediate imports on firm productivity	17
1.5 Conclusion	18
Chapter 2 Data on Technical Barriers to Trade.....	19
2.1 Technical Barriers to Trade (TBTs) and Specific Trade Concerns (STCs) Datasets on the WTO	19
2.2 Summary Information on the Technical Barriers to Trade (TBTs) and Specific Trade concerns (STCs)	23
2.3 Conclusion	25
Chapter 3 Data on Chinese Importing Firms.....	27
3.1 Chinese Firm-level data on imports	27
3.2 Firm-product observations affected by different measures of TBTs	33
3.3 Conclusion	35
Chapter 4 TBTs Impact on Trade Flows	36
4.1 Introduction	36
4.2 Data	38

4.3 Alternative Measures of TBTs	3 9
4.3.1 Baseline results.....	4 1
4.3.2 Heterogeneity.....	4 7
4.3.2.2 Firm Size.....	4 8
4.3.2.2 Firm Ownership Structure	5 2
4.4 Differential impact of TBTs on trade flows by origins.....	5 7
4.4.1 Baseline results.....	5 8
4.4.2 Heterogeneity.....	6 1
4.4.2.1 Firm Size.....	6 2
4.4.2.2 Firm Ownership Structure	6 6
4.5 The impact of TBT on the extensive margin of trade flows.....	7 0
4.5.1 Baseline results.....	7 1
4.5.2 Heterogeneity.....	7 6
4.5.2.1. Firm Size and import market share	7 8
4.5.2.2. Firm Ownership Structure	8 6
4.6 Conclusion.....	9 4
Chapter 5 Firm productivity and TBT	9 5
5.1 Introduction	9 5
5.2 Data.....	9 7
5.3 The impact of TBT on firm productivity	9 7
5.3.1 Baseline results.....	9 8
5.3.2 Heterogeneity.....	1 0 2
5.3.2.1 Firm Size.....	1 0 2
5.3.2.2 Firm Ownership Structure	1 0 6
5.4 Conclusion.....	1 1 0
Conclusion.....	1 1 1
Reference.....	1 1 4
Appendix	1 2 0
Appendix A TBTs and corresponding STCs of China (2003-2007).....	1 2 0
Appendix B. Robustness checks of Chapter 4.....	1 7 3
B1. Number of source origins per firm	1 7 3
B2. Aggregate effect at country-level.....	1 7 4
B3. The impact of TBTs on the imports that subject to Enforced TBT.....	1 7 5
B4. The dynamic impact of TBTs on the imports	1 7 7

List of Tables

Table 2.1 Annual Number of ‘Announced TBT’, ‘Enforced TBT’, STCs and Products Involved.....	2	1
Table 2.2 Yearly STCs and involved HS4 products of China	2	2
Table 2.3 TBTs and corresponding STCs of China in 2002	2	4
Table 3.1: Yearly number of firms conditional on whether firms affected by the STCs	2	7
Table 3.2: Importer Data Summary Statistic	2	8
Table 3.3: The Share of Firms That Import from different number of origins	2	9
Table 3.4: The share of product category (HS4) that each firm imports	3	0
Table 3.5: Mean of Country market share for the imported products	3	1
Table 3.6: The Share of the number of complain origins each observation (product-year-origin level) that affected by Enforced TBT.....	3	3
Table 3.7: Annual number of firm-product observations affected by different measures of TBTs.....	3	4
Table 4.1 TBT is measured by Announced TBT	4	3
Table 4.1a TBT is measured by Announced TBT	4	4
Table 4.2 TBT is measured by Enforced TBT	4	4
Table 4.2a TBT is measured by Enforced TBT	4	5
Table 4.3 TBT is measured by STC	4	6
Table 4.3a TBT is measured by STC	4	6
Table 4.4 Number of firms in different sizes from 2002-2007	4	9
Table 4.5 Impact on different sizes of firms.....	4	9
Table 4.5a Impact on different sizes of firms.....	5	0
Table 4.6: Ownership structure of Chinese firms (2002-2007)	5	3
Table 4.7 Impact on different ownerships of firms.....	5	4
Table 4.7a Impact on different ownerships of firms	5	5
Table 4.8 Impact on different origins.....	5	9
Table 4.8a Impact on different origins.....	6	0
Table 4.9 Impact on different sizes of firms (different origins).....	6	3
Table 4.9a Impact on different sizes of firms (different origins).....	6	4
Table 4.10 Impact on different ownerships of firms (different origins)	6	6
Table 4.10a Impact on different ownerships of firms (different origins)	6	8
Table 4.11 Impact on extensive margin.....	7	2
Table 4.11a Impact on extensive margin.....	7	3
Table 4.12 Impact on extensive margin (different origins).....	7	4
Table 4.12a Impact on extensive margin (different origins)	7	5
Table 4.13 Impact on different size of firm.....	7	8
Table 4.13a Impact on different size of firm.....	7	9

Table 4.14 Impact on different size of firm (different origins).....	8	1
Table 4.14a Impact on different size of firm (different origins).....	8	2
Table 4.15 Impact on different firm import share.....	8	4
Table 4.16 Impact on different firm import share (different origins).....	8	5
Table 4.17 Impact on different ownership firms.....	8	6
Table 4.17a Impact on different ownership firms.....	8	8
Table 4.18 Impact on different ownership firms (different origins).....	9	0
Table 4.18a Impact on different ownership firms (different origins).....	9	2
Table 5.1 Impact (3 measurements) on productivity.....	9	9
Table 5.1a Impact (3 measurements) on productivity.....	1	0
Table 5.2 Impact (3 measurements) on productivity of different firms (sizes)	1	0
0	3	
Table 5.2a Impact (3 measurements) on productivity of different firms (sizes)	1	0
.....	4	
Table 5.3 Impact on productivity of different firms (ownerships).....	1	0
Table 5.3a Impact on productivity of different firms (ownerships).....	1	0
Appendix A TBTs and corresponding STCs of China (2003-2007)	1	2
Table A1 TBTs and corresponding STCs of China in 2003.....	1	2
Table A2 TBTs and corresponding STCs of China in 2004.....	1	2
Table A3 TBTs and corresponding STCs of China in 2005.....	1	2
Table A4 TBTs and corresponding STCs of China in 2006.....	1	4
Table A5 TBTs and corresponding STCs of China in 2007.....	1	6
Appendix B. Robustness checks of Chapter 4	1	7
Table B1 Number of source origins per firm.....	1	7
Table B2 Aggregate effect at country-level.....	1	7
Table B3 The impact of TBTs on the imports that subject to Enforced TBT..	1	7
7	6	
Table B4 The dynamic impact of TBTs on the imports.....	1	7
	7	

List of Figures

Figure 1: The histogram of the number of origins each observation (product-year-origin level) in 2002, conditional on whether a product had a STC imposed.	3	2
Figure 2: The histogram of the number of importers per HS4 product in 2002, conditional on whether a product had a STC imposed (truncated at 300).....	3	3

Introduction

Technical Barriers to Trade (TBTs) are regulatory measures imposed by governments to safeguard national security, protect the domestic environment, and ensure product quality. They are a key form of non-tariff barriers. Over the past 30 years, governments have consistently increased the use of non-tariff measures, even as tariff measures have been relaxed. According to the WTO, the number of TBTs has grown tenfold, from 389 in 1995 to 3,958 in 2021. Trade Protectionism Theory suggests that governments impose TBTs to limit imports and protect domestic firms. For example, Singh and Chanda (2021) argue that domestic firms can benefit from TBTs by reducing import competition. This dissertation explores whether domestic firms gain from TBTs by examining their impact on importers, with a specific focus on how Chinese firms respond to TBTs imposed by the Chinese government in terms of their imports volumes, prices¹, and productivity.

While numerous studies have examined the effects of Technical Barriers to Trade (TBTs), most of the literature has focused on their impact on international trade flows (Bao and Qiu, 2012) and the performance of exporters (Fontagné and Orefice, 2018). Unlike tariffs, whose effects on the performance of importers is well understood, the impact of TBTs on importers in the imposing country remains underexplored. This dissertation seeks to address this gap by investigating how TBTs introduced by China influence the imports and productivity of its manufacturing firms.

One of the first things of this dissertation is to verify that different measures of Technical Barriers to Trade (TBTs) produce similar results. Specific Trade Concerns (STCs) refer to concerns raised by trading partners through the WTO in response to imposed TBTs. These are commonly used in the literature as an indicator of TBTs, as complaints signal the restrictive nature of the TBTs measures. However, a potential concern is that the estimated effects may only reflect the impact on the countries that

¹ All import prices in this analysis refer to ex-tariff prices.

raised concerns, rather than all affected countries, including those that did not file complaints.

To address this, I compare STCs with alternative measures, such as announced and enforced TBTs. Using Correia (2016) approach, I estimate the multi-way fixed effects model, to compare the impact of the alternative measures of TBTs on firm imports. My findings show that TBTs reduce firm imports, regardless of which of the three measurement methods is used.

The key contribution of this dissertation is to differentiate between firm imports from concerned countries (those that have raised STCs) and those from unconcerned countries. The results indicate that firms decrease imports from the origins where an STC complaint has been lodged and increase imports elsewhere. Specifically, the reduction effect of TBTs on firm imports is mainly driven by smaller firms and only very large firms increased their imports from origins that did not raise a complaint. Moreover, this study investigates the impact of TBTs measured as STCs on firm's probability to import conditional on having imported in the previous period. I find that the imposition of TBTs has a significant and negative effect on the extensive trade margin. This reduction impact is mainly driven by larger firms who possess more market power, so can shift their imports to alternative origins, thereby reducing the likelihood of importing from the same origin.

Finally, I examine the impact of TBTs on firm productivity by following a standard two step procedure as in the literature study on trade liberalization and firm performance (Pavcnik,2002; Amiti and Konings,2007; Fernandes,2007). The first step is to estimate firm-level productivity based on the TFP calculation method from Levinsohn and Petrin (2003). I find TBTs reduce firm productivity and smaller firms suffer more, aligning with our expected outcome.

This dissertation contributes to the literature on TBTs. This literature is small but

growing. Bao and Qiu (2012) assess the trade impact of TBTs from 105 countries between 1995 and 2008. The study finds that while a country's TBT reduce the likelihood of other countries exporting to it, increase the export volumes from the existing exporting countries. Fontagné and Orefice (2018) analyze the effects of TBTs measured as STCs on the exports of French firms from 1997 to 2007. Their findings indicate that more capable multi-origin exporters can shift their focus to TBT-free markets and adjust their export strategies accordingly. Ghodsi (2020) explores the effects of Chinese TBTs on the import of manufacturing products from all countries exporting to China between 2002 and 2015. The study finds no significant overall impact of Chinese TBTs on imports.

The study most similar to mine is Singh and Chanda (2020), which examines how Technical Barriers to Trade (TBTs) affect the markups of Indian manufacturing firms by matching firm-product level data with TBT information measured through Specific Trade Concerns (STCs). Their findings suggest that TBTs imposed by India reduce the markups for Indian firms. The key difference between their research and mine is that they were unable to directly observe the specific imported products affected by TBTs. Instead, they relied on input-output tables and industry-level data to estimate the impact of TBTs. In contrast, my dissertation uses detailed data to identify exactly which imported products are impacted by TBTs, allowing for a more precise analysis. By doing so, this study creates a comprehensive database of TBTs on imports for Chinese manufacturing firms, overcoming the data limitations faced in previous research.

Overall, this dissertation contributes to the literature in several ways. First, unlike Singh and Chanda (2020), it directly observes which firms are affected by TBTs, rather than inferring the impact through input-output tables. Second, it is the first research to differentiate how imports from different sources (concerned countries vs. unconcerned countries) are affected by TBTs. Third, it verifies the effects of alternative measures of TBTs, offering a more robust analysis.

The rest of the dissertation is organized as follows. Chapter 1 is the part of literature review. Chapter 2 describes the data on TBTs. Chapter 3 describes the data on firms. Chapter 4 discusses the trade flow effects and Chapter 5 analyzes the firm productivity and TBTs. Then we conclude in the end.

Chapter 1 Literature Review

This chapter summarizes relevant studies in four areas relevant to the subsequent chapters in this dissertation: the effects of non-tariff barriers on trade, the effects of tariffs on trade, measurements of TBTs, and the role of intermediate imports in firm productivity.

1.1 The effects of non-tariff barriers on trade

This section primarily reviews the impact of non-tariff barriers on both exports and imports. Studies generally show that non-tariff barriers have a diminishing effect on exports, with developing countries being disproportionately affected. The impact of non-tariff barriers on imports, however, varies across industries and depends on how these barriers are measured.

1.1.1 The effect of non-tariff barriers on exports

1.1.1.1 The effect of non-tariff barriers on export trade flows between countries.

The following studies analyze the impact of non-tariff barriers on export trade flows between countries.

Henson and Loader (1999) conduct case studies on export trade (country-product level) from developing countries in Asia (China, India, the Philippines, Thailand) and Africa (Gambia, Tanzania, Uganda, Kenya), utilizing a large-scale questionnaire and in-depth field interviews. The findings reveal that developing countries frequently encounter stringent sanitary and phytosanitary (SPS) measures in the export of

agricultural and food products to developed markets. These challenges stem from technological limitations and poor management practices, leading to significant export losses. As a result, developing countries view SPS measures as the most serious barrier to their exports.

Otsuki et al. (2000) analyze the impact of EU non-tariff barriers (NTBs) related to food aflatoxin standards on cereal and dried fruit exports from African countries, using data from 15 EU countries and 9 African countries from 1989 to 1998. Their findings indicate that a 10% increase in aflatoxin standards leads to an 11% reduction in average export value. Similarly, Iacovone (2003) studies the effect of aflatoxin-related NTBs on nut exports to the EU from 21 Latin American countries using a gravity model and finds that the elasticity of the NTB's impact on exports is -0.67.

Bao and Qiu (2012) empirically assess the trade impact of Technical Barriers to Trade (TBTs) using TBT notifications from 105 World Trade Organization (WTO) member countries between 1995 and 2008. Applying a gravity model, the study finds that while a country's TBT notifications reduce the likelihood of other countries exporting to it, they simultaneously increase the export volumes from those that do export.

1.1.1.2 The effect of non-tariff barriers on exporting firms.

This section summarizes research on the impact of non-tariff barriers (NTBs) on firm performance in relation to exports.

Kee (2006) compares the trade-restrictive effects of non-tariff barriers (NTBs) between developing and developed countries. The study focuses on a number of developing countries from the Middle East, South Asia, and Eastern Europe, using data from the World Bank's NTBs survey and export data from 159 firms across 12 industries. By estimating the ad-valorem equivalents² of NTBs for each country, the

² Ad-valorem equivalents (AVEs) of non-tariff barriers (NTBs) represent a way to quantify the impact of NTBs in terms of an equivalent tariff rate. In simpler terms, an ad-valorem equivalent is the percentage by

study finds that developing countries not only tend to implement more restrictive trade policies, but they also face higher barriers when exporting their goods.

Fontagné et al. (2015) analyze the impact of Sanitary and Phytosanitary (SPS) measures on exporters by linking a detailed panel of French firm exports with a new database of SPS regulations for the 1995-2005 period. Their study reveals that SPS measures deter exporters from entering foreign markets that enforce these regulations and negatively affect the intensive margins of trade. However, these negative effects are less pronounced for larger firms.

Fontagné and Orefice (2018) analyze a database of Technical Barriers to Trade (TBT) measures raised as Specific Trade Concerns (STCs) at the WTO, matching it with a firm-level panel of French exporters from 1997 to 2007. Their findings indicate that more capable multi-origin exporters can shift their focus to TBT-free markets and adjust their export strategies accordingly.

Using firm-level data on Chinese exporters and a Propensity Score Matching Difference-in-Differences (PSM-DID) approach, Wei et al. (2023) examine the impact of TBT shocks in the U.S. market. Their findings indicate that firms exiting the U.S. market experience higher subsequent export growth relative to those that stay, primarily by expanding into new origins and intensifying activity in existing ones. In contrast, staying firms achieve higher export prices and improved product quality by complying with stricter standards. These results highlight the strategic responses firms may adopt in the face of TBTs, including the reallocation of resources across products and markets to sustain or enhance export performance.

which a non-tariff barrier raises the price of an imported good, expressed as if it were a tariff. For example, if a sanitary regulation in a developed country increases the cost of importing a product by 10%, the AVE of that NTB would be 10%.

1.1.2 The effect of non-tariff barriers on imports

1.1.2.1 The effect of non-tariff barriers on import trade flows between countries.

After reviewing the impacts of non-tariff barriers on exports in the prior section, this section discuss the literature on the effects of non-tariff barriers on imports.

Nogues et al. (1986) examine non-tariff barriers (NTBs) affecting imports in sixteen industrial countries from 1981 to 1983. Using the import coverage ratio to assess the impact of NTBs, the study reveals that over 27% of all imports and more than 34% of imports from developing countries were subject to NTBs. Additionally, the study shows a significant increase in NTBs during this period.

Moenius (2004) estimates the effect of mutual recognition standards (MRS)³ and importing country standards on import trade using a gravity model. His analysis covers 12 countries and 471 industries from 1980 to 1995. The estimation results indicate that mutual recognition standards increase the volume of imports. For importing country standards, the findings varied by industry: agricultural imports experiences a negative effect, while manufacturing imports experiences a positive effect.

Moenius (2006) empirically finds that country-specific agricultural standards tend to hinder trade, while the harmonization of standards promotes it. The study uses a data set covering 15 countries and 80 different agricultural industries annually from 1980 to 1995, analyzed through gravity equations. The measurement of standards is based on the number of documents recording these standards. Country-specific standards impede trade by imposing costly testing and product adaptation requirements. However, they also provide essential market information. In contrast, harmonizing

³ MRS (Mutual Recognition Standards) are international standards by which two or more countries agree to recognize one another's conformity technical standards, which include relevant lists of designated laboratories, inspection bodies and conformity assessment bodies in both the EU and the third country. European companies that wish to export to Australia, Canada, Japan, New Zealand, the USA, Israel or Switzerland need to know about Mutual Recognition Agreements (MRAs) and the designated Conformity Assessment Bodies (CABs).

standards reduces the need for product adaptation, thereby lowering costs and encouraging trade. At the same time, harmonization can also reduce product variety, which may negatively impact trade.

Bao and Qiu (2010) examine the influence of TBT imposed by China on the country's imports from 1998-2006. In the sample, China is the only importing country, whereas there are 43 exporting countries/economies, including Hong Kong, India, Indonesia, Iran and so on. The data covers 43 exporters and nine years at HS2-digit level products. They find that China's TBT are trade restricting for agriculture goods but trade promoting for manufacturing goods.

Bao (2014) examines the impact of Technical Barriers to Trade (TBT) imposed by China on its imports. The study focuses on China's unilateral trade flows with 49 trading partners from 1998 to 2006, using a dataset of 543,753 observations (1233 HS4 products \times 49 exporters \times 9 years) and employing a gravity model. The findings indicate that, overall, TBTs reduce the likelihood of China importing from potential new trade partners, but increase the import values from existing trade partners.

Ghodsi (2020) explores the varied effects of Chinese Technical Barriers to Trade (TBTs) on the import of manufacturing products at the HS6-digit from all countries exporting to China between 2002 and 2015. Utilizing a gravity model, the study finds no significant overall impact of Chinese TBTs on imports, contrary to previous research. However, the results suggest that TBTs have a restrictive effect on a small number of exporters, particularly from less developed countries.

1.1.2.2 The effect of non-tariff barriers on importing firms.

Singh and Chanda (2021) investigate how Technical Barriers to Trade (TBTs) affect the markups of Indian manufacturing firms that heavily depend on intermediate imports. They integrate firm-product level data from Prowess with information on

TBTs that member countries have raised as concerns against India in the WTO TBT committee. Their results indicate that TBTs imposed by India notably decrease the markups for firms involved in importing.

To summarize this section of the literature, most studies on the effects of non-tariff barriers (NTBs) have focused on exports and trade flows between countries, while relatively few have investigated their impact on imports and firm performance. To address this gap, this paper will examine the effects of technical barriers to trade (TBTs) from the perspective of importing firms.

1.2 The effects of tariffs on trade

This section reviews the impact of tariffs on trade flows and firm performance. Studies on trade flows show that tariffs and technical barriers to trade (TBTs) exert heterogeneous effects depending on the nature of trade relationships and the measurement of barriers. While TBTs often reduce the probability of initiating new trade, they may enhance trade with existing partners, especially in manufacturing sectors. Tariffs, by contrast, can facilitate entry into new markets but often suppress the value of ongoing trade. Complementing this macro perspective, firm-level analyses reveal that input tariff reductions are particularly effective in boosting productivity, as they lower production costs and expand access to high-quality foreign inputs.

1.2.1 The effect of tariffs on trade flows

The following studies show how the tariffs affect the trade flows between countries.

In their study, Bao and Qiu (2010) compile a database on technical barriers to trade (TBTs) and import tariffs from 1998 to 2006 to assess how China's trade barriers impact its imports. Using a frequency index, the authors find that TBTs have a restrictive effect on trade, with each unit increase in TBTs reducing import value by approximately 0.8%. However, when measured by the coverage ratio, the negative

impact is not statistically significant over the full sample period. Interestingly, when focusing on the years 1998–2001, TBTs appear to have a trade-promoting effect, increasing import value by around 0.2% per unit increase. The study also reveals that TBTs (by both measures) tend to restrict agricultural imports but promote imports of manufactured goods. Overall, tariffs generally hinder trade, though their effects are sometimes statistically insignificant.

Bao (2014) employs a gravity model to investigate the effects of China's technical barriers to trade (TBTs) and import tariffs on its import activities. The study uses data on China's import restrictions—including TBTs, tariffs, licenses, and quotas—covering all HS 4-digit product categories from 1998 to 2006. A modified two-stage gravity model is applied to address both Heckman selection bias and heterogeneity. The results indicate that TBTs tend to lower the likelihood of China importing from new trade partners, while increasing import volumes from existing ones. In contrast, tariffs are found to increase the likelihood of initiating trade with new partners, but reduce the value of imports from ongoing trade relationships.

1.2.2 The effect of tariffs on firm performance

After reviewing the impacts of tariffs on trade flows between countries in the prior section, this section discusses the literature on the effects of tariffs on firm performance.

Amiti and Konings (2007) show that reducing input tariffs leads to significantly larger productivity gains than cutting output tariffs in Indonesian manufacturing. Using firm-level data from 1991–2001, they find that firms importing inputs benefit the most, gaining up to 12% in productivity from a 10-percentage point tariff cut. The study highlights the key role of access to high-quality and diverse foreign inputs in driving productivity, complementing the pro-competitive effects of output tariff reductions.

Topalova and Khandelwal (2011) use India's externally driven 1991 trade reform to

identify the causal impact of tariff reductions on firm productivity. Analyzing firm-level panel data, they find that input tariff cuts had a significantly larger effect than output tariff reductions, with a 10-point drop in input tariffs raising productivity by 4.8%. The gains were concentrated in import-competing and deregulated industries, and among domestic firms. By exploiting the exogenous nature of the reform, the study highlights the critical role of imported inputs and institutional context in mediating the effects of trade liberalization.

Yu (2014) examines how lowering tariffs on both imported intermediate goods and final products influences the productivity of major Chinese trading firms, with particular attention to the preferential tariff policies available to processing trade firms. It develops firm-specific measures of tariffs on both inputs and outputs. The findings show that while tariff cuts generally boost productivity, the benefits diminish as firms rely more heavily on processing imports. In general, reductions in tariffs on final goods lead to greater productivity gains than those on intermediate inputs, though for non-processing firms, input tariff reductions have a stronger effect. Overall, the combined effect of both types of tariff reductions explains at least 14.5% of the total productivity growth across the economy.

Brandt et al. (2017) analyze the impact of China's WTO accession on firm-level markups and productivity. Using detailed manufacturing data and tariff measures, they find that output tariff cuts reduce markups but raise productivity, reflecting pro-competitive effects. Input tariff cuts increase both markups and productivity by lowering costs. The effects differ by firm type: incumbents experience stronger competition, while entrants benefit more from efficiency gains. Their study highlights how trade liberalization enhances performance through both within-firm improvements and market reallocation.

1.3 Types of TBTs measurement tools

International organizations such as the World Bank, international standardization

organizations, government departments, and economists have all contributed to the collection and analysis of TBT data, resulting in significant progress in recent years in quantitative research on TBTs. However, TBT represent one of the most difficult non-tariff measures to quantify (Deardorff and Stern, 1998), different research has chosen different approaches to quantify it.

Beghin and Bureau (2001), Bora et al. (2002), Ferrantino (2006), as well as Korinek et al. (2008), and Maskus and Wilson (2001), provide comprehensive reviews of methods for measuring Technical Barriers to Trade (TBTs). Four common methods for quantifying TBTs include: the number of notifications, frequency ratio, import coverage ratio, and tariff equivalence, along with treating TBTs as a binary variable. Each of these approaches has its own advantages and disadvantages, depending on factors such as the specific nature of the TBT, data availability, and the measurement objectives.

1.3.1 Number of notifications

The number of WTO notifications serves as a key variable for measuring technical barriers to trade (TBTs). WTO members are required to notify the WTO Secretariat of any changes to technical regulations, standards, and conformity assessment procedures. The Secretariat then forwards these notifications to all WTO members. Consequently, the number of notifications issued by a country represents both the frequency and intensity of TBT implementation in that country.

Swann et al. (1996) examine the number of voluntary national and international standards recognized by the UK and Germany as measures of standards from 1985 to 1991. Their research reveals that shared standards have a positive effect on exports but minimal impact on imports. In contrast, unilateral standards positively affect imports while adversely affecting exports.

Du et al. (2009) examine the role of Technical Barriers to Trade (TBTs) in fostering

technological innovation. They measure the implementation status of TBTs in each country by counting the number of TBT notifications issued annually. For example, China had 15 TBT notifications in 1995. To quantify technological innovation, the study tracks the number of patents filed by companies from one country in foreign markets each year. The findings indicate that TBTs promote technological innovation.

Sun and Wu (2006) empirically examine the impact of Technical Barriers to Trade (TBTs) on competitiveness, as measured by Gross Value Added (GVA) across several industries. Their analysis uses data on China's exports in four major sectors—Agricultural and Food Products, Textiles and Clothing, Chemical Products, and Machinery and Transport Equipment—covering the years from 1995 to 2004. Additionally, they assess TBTs through the number of notifications method. The results indicate that TBTs negatively affect the Agricultural and Food Products, Textiles and Clothing, and Chemical Products industries, while positively impacting the Machinery and Transport Equipment sector.

Qin and Ni (2013) employ the number of notifications as a proxy for Technical Barriers to Trade (TBT) to assess its impact on trade, specifically focusing on China's agricultural exports from 1995 to 2011. The results reveal that both TBTs and Sanitary and Phytosanitary Measures (SPS)⁴ significantly reduce the extensive margin of trade; however, the restrictive effect of SPS is greater than that of TBT. Interestingly, while TBT decreases the intensive margin of trade, SPS appears to enhance it.

The number of notifications method offers a straightforward way to quantify data. However, using the count of notifications as a measure of Technical Barriers to Trade (TBT) presents challenges, as the content of each notification varies significantly. For example, some notifications are simply corrections or errata related to previous ones. As a result, relying solely on the number of notifications can lead to measurement

⁴ The Agreement on the Application of Sanitary and Phytosanitary Measures sets out the basic rules on food safety and animal and plant health standards that governments are required to follow.

errors and biased variable selection.

1.3.2 Frequency ratio and coverage ratio

The frequency ratio measures the percentage of product items subject to non-tariff barriers (NTBs) within a specific product category. Specifically, the Technical Barriers to Trade (TBT) frequency index indicates the proportion of product items affected by TBTs, ranging from 0% (no coverage) to 100% (complete coverage). The coverage ratio assesses the intensity of TBTs by comparing the value of products impacted by TBTs to the total value of products in a sector. A higher ratio signifies a greater value of affected products and indicates stricter TBTs in a country. Both the frequency ratio and coverage ratio are commonly utilized in research (Nogués et al., 1986; Bao, 2010).

Bao and Qiu (2010) analyze the technical barriers to trade (TBTs) imposed by China on the country's imports of HS2-digit products from 1998 to 2006 using a gravity model that employs both frequency and coverage ratios. Their findings indicate that TBTs are trade restrictive when assessed with the frequency ratio. Conversely, when the coverage ratio is applied, the negative impacts of TBTs are not statistically significant over the entire period. However, when focusing on the years 1998 to 2001, the authors discover that TBTs have trade-promoting effects. Ultimately, the study concludes that China's TBTs, as measured by both the frequency ratio and coverage ratio, restrict trade for agricultural goods but promote trade for manufacturing goods. Fontagné et al. (2005) utilize a frequency index derived from notifications in the TRAINS database. They gather data on 61 product categories, including agri-food items, for the year 2001. Their study suggests that non-tariff measures, such as standards, adversely affect agri-food trade, while having little to no impact—or even a positive effect—on most manufactured goods.

Disdier et al. (2008) analyze a diverse sample of 154 importing and 183 exporting countries, quantifying the import coverage ratio of 690 agricultural goods at the HS 4-

digit level. This broad scope enables them to differentiate the impact of technical barriers to trade (TBT) across various product categories and on different types of countries, including both developing and developed nations.

Endogeneity poses a significant challenge when using frequency and import coverage ratio indicators. If trade barriers indeed reduce imports, the import coverage ratio may be biased downward. For example, if a country's technical barriers to trade are so stringent that they entirely restrict imports of a specific product, the import volume for that product would be zero. Consequently, the import coverage ratio would also be zero, resulting in a measurement that misrepresents the actual impact of the technical barriers to trade.

1.3.3 Tariff Equivalence

The tariff equivalence approach, a method for quantifying technical barriers to trade, seeks to translate the effects of these barriers into equivalent tariff rates. This method assumes that the price differences between imported and domestic products arise from both tariffs and non-tariff barriers. It involves comparing the prices of similar imported and domestic goods, eliminating the impact of import tariffs, and isolating the price difference attributed to non-tariff barriers. Finally, this difference is equated to the price difference resulting from technical barriers to trade.

Krisoff et al. (1997) and Calvin and Krisoff (1998) utilize the tariff equivalence method to assess technical barriers to trade and their effects on apple trade between the United States and Japan. Their analysis compares the prices of U.S. apples arriving in foreign markets with the wholesale prices of U.S. apples sold domestically. They posit that the observed price difference results from both tariffs and the tariff equivalence created by technical barriers to trade. The researchers employ monthly data, selecting apples of the same type, grade, and size, whenever possible, during the same timeframe and location. They investigate the trade and welfare implications of lifting phytosanitary barriers and tariffs under two scenarios regarding the transmission of the bacterial disease fire blight: first, that transmission through

commercial fruit is not possible and second, that it can occur. Their estimates suggest that the disease-related losses necessary to offset the gains from trade would be significantly greater than those experienced in other countries.

Bradford (2003) calculates the tariff equivalence of non-tariff barriers by analyzing the difference between retail prices and import prices, excluding tariffs, while also considering transportation, taxes, and other circulation costs. His findings reveal that Japan's average tariff equivalent stands at 57%, European countries have equivalents ranging from 48% to 55%, and the United States has the lowest equivalent at 12%.

The tariff equivalence method aims to quantify how much a product is affected by a technical barrier to trade (TBTs) by reflecting changes in price. However, one limitation of this approach is that it primarily captures the effects of non-tariff barriers (NTBs), which are not entirely equivalent to TBTs. By equating TBTs with NTBs, the method inaccurately assumes that their impacts are the same.

1.3.4 Treating TBTs as a binary variable

The binary variable method measures technical barriers to trade (TBTs) by using a dummy variable. When the value is 0, it indicates that no TBTs are currently in place, and when the value is 1, it indicates that TBTs are being implemented. This method then examines the changes in dependent variables before and after the introduction of TBTs.

In her study of the impact of TBTs in the EU, the US, and Japan on China's export volume and export value, Pan (2004) considers that the number of TBTs in the US, Europe, and Japan increased significantly after 1999, so she set TBTs as a binary variable using 1999 as the boundary year, with the value of TBTs before 1999 recorded as 0 and that of TBTs in 1999 and after recorded as 1. The results indicate that TBTs imposed by the European Union, the United States, and Japan have a significant negative impact on the value and volume of Chinese exports.

Guo (2010) also used TBTs as a binary variable when studying the impact of TBTs on China's green tea exports to Japan, the United States, and Germany. After China's entrance to the WTO in 2005, Japan, the United States, and Germany significantly increased the technical barriers to trade for green tea imports. Therefore, this study uses 2005 as the boundary year, denoting TBT before 2005 as 0, and TBT after 2005 as 1. According to the final findings of the study, the technical trade restrictions imposed by Japan, the United States, and Germany have a considerable detrimental impact on the export value and volume of Chinese green tea.

In their study on the impact of technical barriers to trade (TBT) on Egyptian firms' exports between 2005 and 2011, Kamal and Zaki (2018) used a binary variable to measure TBTs. The variable takes a value of 1 if Egyptian export products are affected by a TBT in a given year, and 0 if they are not. Their findings indicate that TBTs reduce the likelihood of Egyptian firms exporting to, and entering, countries that impose these barriers.

Compared to the three TBT measurement methods mentioned above, the binary variable method is simpler to implement and provides a straightforward way to represent the presence of TBTs and assess their impact. Therefore, in this paper, the binary variable method is also used to measure TBTs in the empirical analysis of their effects.

1.4 The role of intermediate imports on firm productivity

With the improvement of micro-level firm data, several studies have begun to examine the relationship between firms' imports of intermediate goods and their productivity. Research has consistently demonstrated the positive impact of imported intermediate goods on firm productivity (Halpern et al., 2015; Augier et al., 2013).

Halpern et al. (2015) identify two primary mechanisms through which imported

intermediate inputs contribute to total factor productivity gains: the quality mechanism and the complementary mechanism. The quality mechanism posits that the superior quality of newly imported inputs compared to domestic ones enhances a firm's total factor productivity. In contrast, the complementary mechanism suggests that combining different types of intermediate inputs (both imported and domestic) can generate a "whole over part" gain. Using panel data on Hungarian manufacturing firms from 1992 to 2003, their study finds that the complementary mechanism predominates, accounting for approximately 60% of total factor productivity improvements.

Augier et al. (2013) investigate how firms' decisions to import intermediate goods affect their total factor productivity, utilizing data from Spanish firms between 1991 and 2002. Their analysis reveals that importing intermediate goods boosts productivity by incorporating foreign frontier technology, which enhances firm performance. However, the successful utilization of these imported goods is contingent upon each firm's ability to absorb new technologies.

Connolly (2003) explores the impact of high-technology imports from developed countries on the output of domestic firms, using data from 40 countries between 1970 and 1985. The empirical findings suggest that the domestic production of these imported high-tech products stimulates imitation and innovation among local firms, resulting in increased productivity for firms in the importing countries.

1.5 Conclusion

Currently, research on technical barriers to trade (TBTs) is primarily focused on their impact on exports (Bao and Qiu, 2012; Fontagné and Orefice, 2017). However, there has been relatively little investigation into TBTs from the perspective of importing countries. Additionally, the limited analysis that does exist on the impact of TBTs on imports is mainly concentrated on trade flows between countries, with few studies exploring other aspects such as firm performance. This paper aims to contribute in the

following way.

Few studies have examined the effects of TBTs from the perspective of imports, and even fewer have conducted firm-level empirical analyses on how TBTs affect imports using firm-level data. Singh and Chanda (2020) estimate the impact of TBTs on markups for Indian manufacturing firms by measuring TBTs as the weighted average incidence of these barriers on intermediate inputs for an output industry, where the weight is the input industry's share of total output. However, they do not differentiate the impact of TBTs on imported inputs by origin. Understanding the differential impact of Specific Trade Concerns (STCs) on specific origins is crucial, given the trade restrictions often associated with these measures. My dissertation addresses this gap by distinguishing between firm imports from countries that have raised STCs and those from countries that have not.

Additionally, due to data limitations, Singh and Chanda (2020) could not directly observe the specific imported products of firms, which is why they relied on input-output tables and industry-level data to measure TBTs. In contrast, my dissertation uses detailed data to identify exactly which imported products are affected by TBTs, rather than inferring which firms are impacted. By doing so, this study creates a comprehensive database of TBTs on imports for Chinese manufacturing firms, overcoming the data limitations present in previous research.

Chapter 2 Data on Technical Barriers to Trade

2.1 Technical Barriers to Trade (TBTs) and Specific Trade Concerns (STCs)

Datasets on the WTO

Trade barriers, also known as trade obstacles, are artificial restrictions imposed by a country on the exchange of foreign goods and services. These restrictions primarily target imports and can be categorized into two main types: tariff barriers and non-tariff barriers. There are twelve types of non-tariff barriers, with the most significant

being technical barriers to trade (TBTs). Other types include sanitary and phytosanitary measures, quotas, licenses, and more. This dissertation focuses on analyzing TBTs.

In practical terms, the enforcement of Technical Barriers to Trade (TBTs) typically involves a range of regulatory activities such as conformity assessment procedures, product testing, certification, inspection, and labeling requirements. Firms attempting to import products that fail to meet the specified technical standards may face delays at customs, be required to undertake costly additional testing or certification, or even experience outright rejection of their shipments. While monetary penalties may not always be imposed, the effective costs of non-compliance are substantial—manifesting in both fixed costs (e.g., redesigning products, updating labels) and variable costs (e.g., longer lead times, administrative burden). These enforcement mechanisms can significantly increase trade costs and serve as a deterrent, especially for smaller firms with limited capacity to absorb such costs.

While Technical Barriers to Trade (TBTs) can, in principle, be either temporary or permanent, the WTO TBT notifications used in this study do not consistently report whether a given measure has a specified duration or expiry date. In most cases, once a TBT measure is notified and enters into force, it remains in place unless it is explicitly amended or withdrawn. Therefore, in the construction of the TBT variables, we treat notified TBTs as persistent over time, assuming that they remain effective from their implementation date onwards. This approach is consistent with prior literature and reflects the limited availability of precise information on the duration of individual TBT measures.

In my research, I use two datasets to assess TBTs: one on technical barriers to trade (TBTs) notifications and another on specific trade concerns (STCs). Both datasets are maintained by the WTO's Information Management System (IMS) and document measures proposed by WTO members. The TBTs notifications dataset covers the

technical regulations imposed by importing countries regarding technology, health, and product quality. The STCs dataset records concerns raised by exporting countries about unreasonable TBTs that create unnecessary barriers to trade, requiring importing countries to explain or adjust their policies.

Comparing TBTs and STCs reveals that STCs are a subset of TBTs with a particularly significant impact on trade, prompting exporting countries to raise the issue with the WTO. This study aims to examine the effect of TBTs on international trade, using the STCs dataset to represent TBTs that have a substantial influence on trade.

For each record in the TBT notifications dataset provided by the WTO Information Management System (IMS), I utilize data on the HS4 products affected, the announcement date of the TBT for adaptation, and the enforcement date of the TBT. Additionally, if other countries raise concerns about a particular TBT, it is included in the STC dataset. Typically, the announcement and enforcement dates of a TBT do not fall within the same calendar year. To account for this, the study uses dummy variables to indicate whether an HS4 product is subject to any form of TBT in a given year, based on the varying dates of each TBT record.

Table 2.1 presents the yearly number of announced TBTs, enforced TBTs, and STCs for China, as well as the number of affected products. For example, in 2002, the Chinese government announced 13 TBTs and enforced 2. Among these, 5 were STCs raised by other exporting countries.

Table 2.1 Annual Number of ‘Announced TBT’, ‘Enforced TBT’, STCs and Products

	Involved					
	Announced TBT	Products	Enforced TBT	Products	STCs	Products
Year2002	13	230	2	163	5	206
Year2003	19	479	20	399	6	210
Year2004	10	39	17	116	1	1

Year2005	59	239	24	33	3	28
Year2006	68	110	81	272	9	252
Year2007	48	41	48	103	6	150

From each record in the STCs dataset of the WTO Information Management System (IMS), we extract the following details: (1) The country that introduced the TBT (referred to as the "maintaining country") and the countries that raised concerns about the TBT (referred to as the "STC concerned countries"), (2) The HS4 products affected by the TBT, and (3) The initial date when the TBT was raised, along with any subsequent dates when it was raised again.

Table 2.2 demonstrates that in 2002, the European Union, Korea, and the US raised concerns about 5 TBTs introduced by China. These TBTs involved a total of 206 HS4 products, indicating that China was implicated in 5 STCs and 206 types of HS4 products in that year.

Table 2.2 Yearly STCs and involved HS4 products of China

Year	Concerns	Concerned Country	Products In total (HS4)
2002	5	EU, Korea, US	206
2003	6	EU, Korea, US	210
2004	1	EU, US, Mexico, Canada, Japan	1
2005	3	EU, US, Japan, Switzerland	28
2006	9	EU, Russia, US, Mexico, Canada,	252

		Japan, Switzerland, Argentina, Kingdom of Saudi Arabia	
2007	6	EU, Russia, US, Japan, Switzerland	150

2.2 Summary Information on the Technical Barriers to Trade (TBTs) and Specific Trade concerns (STCs)

This section provides a summary of the technical barriers to trade (TBTs) introduced by China and the related specific trade concerns (STCs) raised by other countries from 2002 to 2007. For example, in 2002, China introduced a TBT under the notification symbol G/TBT/N/CHN/2. This regulation specifically targets food and cosmetic products, mandating that imports meet specific certification and labeling requirements. The purpose of this TBT is to protect the health and safety of the Chinese population. It was announced on March 1, 2002, and came into effect on July 1, 2002.

Table 2.3 summarizes the TBTs introduced by China in 2002 and the corresponding STCs raised by other countries. Below the details of the TBT (G/TBT/N/CHN/2), three rows list the specific trade concerns brought up by different countries in response to this regulation.

The European Union (EU) was the first to raise an STC on June 21, 2002, expressing concern about the lack of transparency in the TBT, particularly regarding the absence of clear criteria for product certification and labeling. Later, on October 17, 2002, both the EU and Korea filed a joint STC, arguing that the requirements imposed by this TBT were discriminatory and difficult to meet. Korea raised an additional STC on March 20, 2003, claiming that the TBT represented an unnecessary trade barrier due to its stricter standards compared to international norms.

The tables for subsequent years (2003–2007) can be found in the Appendix A.

Table 2.3 TBTs and corresponding STCs of China in 2002

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CH N/2	Food and Cosmetics	Certification and Labelling of Food Products and Cosmetic Products	Human health and safety	01/03/2002	01/07/2002
STC1	21/06/2002	Concerned country: EU		Issue raised: Transparency	
STC2	17/10/2002	Concerned country: EU, Korea		Issue raised: Discrimination	
STC3	20/03/2003	Concerned country: Korea		Issue raised: Unnecessary barriers to trade	
G/TBT/N/CH N/3	Sterilizing products	Sanitary requirements for sterilization, requirements for provision of sterilizing services	Human health and safety	28/03/2002	01/07/2002
G/TBT/N/CH N/1	Boilers, Pressure vessels, Safety appurtenances	Administrative permission system shall be applied to any manufacturer of boilers and pressure vessels whose products are used in China	Human health and safety, Quality	10/07/2002	01/01/2003
STC1	17/10/2002	Concerned country: EU, Korea		Issue raised: Legitimacy and Rationale	
STC2	20/03/2003	Concerned country: Korea		Issue raised: Transparency	
G/TBT/N/CH N/22	Cosmetics and raw materials of cosmetics	Requirements on hygiene and packaging materials for final products and raw materials of cosmetics	Health and Safety	30/09/2002	01/01/2003
G/TBT/N/CH N/4	Organic-inorganic compound fertilizers.	the technical requirements, testing methods, inspection rules, labeling, packaging, transport and storage of organic-inorganic compound fertilizers	Environment, Human Health and Safety	30/09/2002	01/04/2003
G/TBT/N/CH N/5	Animal or vegetable fertilizers, Mineral or chemical fertilizers	the limit quantity of arsenic, cadmium, lead, chromium and mercury content in fertilizers and the testing methods and the inspection rules.	Environment, Human Health and Safety	30/09/2002	01/04/2003
STC1	17/10/2002	Concerned country:		Issue raised:	

		US		Legitimacy and Rationale	
STC2	20/03/2003	Concerned country: EU, US, Korea		Issue raised: Legitimacy and Rationale	
G/TBT/N/CH N/6	Poultry	Technical requirements, test methods, and requirements on labelling, packaging and storage for the products	Human Health and Safety	30/09/2002	01/04/2003
STC1	08/11/2002	Concerned country: US		Issue raised: Transparency	
G/TBT/N/CH N/7	Cotton	Short Fiber Content (SFC) and Nep Count are included into the quality requirements of the national standard for Cotton	Quality	30/09/2002	01/04/2003
G/TBT/N/CH N/8	Hydrogen peroxide for industrial use	The scope, technical requirements, test method, inspection rules, marking, labeling, packaging, storage and transportation of Hydrogen peroxide for industrial use.	Human Health and Safety Consumer Safety or protection	30/09/2002	01/04/2003
G/TBT/N/CH N/9	Motorcycles and mopeds	The limits and measurement methods for exhaust emissions from motorcycles at idle speed	Environment	30/09/2002	01/04/2003
G/TBT/N/CH N/10	Positive ignition (P.I.) engines of vehicles and vehicles equipped with P.I engines	the limits and the measurement methods for emission pollutants exhausted from positive ignition (P.I.) engines	Environment	30/09/2002	01/04/2003
G/TBT/N/CH N/11	Two or three-wheel motor vehicles	the limits and measurement methods for exhaust emissions from motorcycles under running mode	Environment	30/09/2002	01/04/2003
G/TBT/N/CH N/12	Two-wheel or three-wheel moped	the limits and measurement methods for , exhaust emissions from mopeds under running mode	Environment	31/12/2002	01/04/2003

2.3 Conclusion

This chapter provides a detailed analysis of the datasets on technical barriers to trade

(TBTs) and specific trade concerns (STCs) obtained from the WTO Information Management System (IMS). It focuses on how TBTs and STCs affect international trade, particularly in the case of China between 2002 and 2007.

In the first section, it introduces trade barriers, which include both tariff and non-tariff measures, are restrictions imposed by countries on the exchange of foreign goods and services. The focus of this dissertation is on technical barriers to trade (TBTs), a type of non-tariff barrier. Two key datasets are used: one on TBT notifications and another on STCs. The TBT dataset covers technical regulations imposed by importing countries, while the STC dataset records concerns raised by exporting countries about the potential trade impacts of these TBTs.

STCs are a subset of TBTs that have a significant impact on trade and prompt exporting countries to bring the issue to the WTO. The chapter emphasizes the importance of using the STCs dataset to assess how TBTs affect international trade.

Then, the chapter introduces two key dates associated with TBTs: the announcement date (referred to as "Announced TBT") and the enforcement date (referred to as "Enforced TBT"). The STC dataset captures the specific concerns raised by trading partners regarding these TBTs. Table 2.1 illustrates how China was affected by TBTs and STCs.

In the last section, it provides a summary of China's TBTs and the corresponding STCs raised by other countries from 2002 to 2007. Table 2.3 summarizes these TBTs and corresponding concerns. The rest of the data for subsequent years (2003–2007) is available in the appendix.

This chapter lays the groundwork for summarizing TBT and STC data in this dissertation.

Chapter 3 Data on Chinese Importing Firms

3.1 Chinese Firm-level data on imports

The "Chinese Industrial Enterprises Database" provides detailed firm-level data from 2002 to 2007, including imports, exports, and key balance sheet variables such as annual revenue, financial expenses, and labor input. The transaction-level trade data, covering the same period (2002–2007), is drawn from the "China Customs Database." This dataset details import transactions at the HS4 product level for each firm, including the origin of imports, import values, and quantities.

By merging the two datasets using each firm's unique identifier, we create a dataset that includes the firm's ID, the HS4 product being imported, the year of import, the country of origin, and the import value and quantity for each product.

Table 3.1 displays the annual number of firms based on whether or not they were impacted by an STC. A firm is considered impacted if one of its imports are affected by an STC. The data in the table shows that the number of firms affected by STCs is consistently lower than those unaffected. For example, 9,181 firms were impacted by STCs, while 12,737 firms were unaffected in 2002. Overall, about one-third of all firms were affected by STCs, as indicated by the bottom line of the table.

Table 3.1: Yearly number of firms conditional on whether firms affected by the STCs

	No-STC	STC-affected	Total
2002	12,737	9,181	21,918
2003	14,024	10,304	24,328
2004	33,681	701	34,382
2005	30,008	7,013	37,021
2006	22,246	18,002	40,248

2007	31,216	14,214	45,430
Full Sample	143,912	59,415	203,327

We further examine the differences between STC-affected firms and non-STC firms by analyzing key balance sheet variables. According to Table 3.2, the average number of workers across the entire sample is 478.84 per firm. However, STC-affected firms tend to have significantly more workers, averaging 701.69, compared to 386.84 for non-STC firms. Similarly, STC-affected firms have higher mean capital per worker and mean sales per worker than non-STC firms, indicating that STC-affected firms tend to be larger and more capital-intensive.

In contrast, STC-affected firms have a lower average material share in output and a lower import share in materials compared to non-STC firms. This suggests that non-STC firms rely more heavily on material inputs and imported materials in their production processes. Additionally, a higher proportion of foreign-owned firms are found among STC-affected firms than in the non-STC group. Lastly, only 1% of the firms in the entire sample are state-owned enterprises.

Table 3.2: Importer Data Summary Statistic

	Full sample	STC-affected	No-STC
Employment	478.84	701.69	386.84
Capital per worker (thousand RMB)	133.77	197.71	104.37
Sales per worker (thousand RMB)	490.33	678.25	412.80
Material share in	0.91	0.89	0.92

output			
Import share in materials	0.76	0.49	0.88
Foreign owned	0.20	0.28	0.17
State owned	0.01	0.02	0.01
Observations	5,858,470	424,311	5,434,159
Firms	79,544	19,210	60,334

Note: Firms are affected by an STC if at least one of its imported product is in a given year.

In Table 3.3, the sample of importing firms is categorized based on the number of countries (origins) from which they import. The dataset records firm-product-origin observations, detailing which firm imports a specific product from which country. Table 3.3 calculates the share of firms importing from different numbers of countries each year. The results show that more than 50% of firms import from within 10 countries, and only 10% import from more than 30 countries, suggesting that most firms limit their imports to a small number of origins.

Table 3.3: The Share of Firms That Import from different number of origins

	1-10	11-20	21-30	31-40	41-50	50+
2002	57.37	28.78	10.86	1.94	0.70	0.36
2003	55.33	30.12	9.99	3.32	1.24	0.01
2004	56.63	27.38	10.75	3.78	0.94	0.50
2005	55.77	27.47	11.09	4.04	0.92	0.69
2006	52.48	28.76	12.24	4.65	1.15	0.71

2007	53.89	27.65	10.74	5.37	1.67	0.69
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Table 3.4 explores the share of product categories (HS4) imported by firms. It examines how many product categories each firm imports. For instance, in 2002, 69.27% of firms imported within 100 product categories, 18.48% imported between 101 and 200 categories, and 12.11% imported over 200 categories. On average, each firm imported 93.52 product categories in 2002. From 2002 to 2007, around 70% of firms imported fewer than 100 product categories, 20% imported between 101 and 200 categories, and about 10% imported more than 200 categories.

Table 3.4: The share of product category (HS4) that each firm imports

	1-100	101-200	201-300	301-400	401-500	501+	Average number
2002	69.27	18.48	6.87	2.61	1.91	0.72	93.52
2003	68.30	19.18	6.71	3.56	1.36	0.89	95.70
2004	70.03	18.73	6.77	2.82	1.17	0.54	90.44
2005	70.04	18.80	7.50	2.48	0.45	0.73	88.31
2006	72.14	18.37	6.56	1.86	0.54	0.56	83.38
2007	72.08	18.06	6.45	2.29	0.52	0.6	83.37

Table 3.5 provides insights into the country market share of China's imports, distinguishing between imports affected by specific trade concerns (STCs) and those that are not. The trade data at the country-product level, sourced from CEPII, includes details of China's imports for each HS4 product, including the country of origin, import value, and quantity. The market share for each country is determined by dividing the import value of a specific product from that country by the total import value of the product into China.

Table 3.5 compares the mean country market share of STC-affected imports with non-STC imports across various years. In 2002, the mean market share for STC-affected imports was 0.07, which is larger than the 0.05 market share for non-STC imports. A similar trend is observed in 2006, where STC-affected imports again had a higher

mean market share. However, during 2003, 2004, 2005, and 2007, the mean market share for STC-affected imports was lower than that for non-STC imports.

These findings suggest that the impact of STCs on country market share varies over time. While STC-affected imports may sometimes hold a larger market share, this is not consistent across all years.

Table 3.5: Mean of Country market share for the imported products

year	STC-affected	No-STC
2002	0.07	0.05
2003	0.04	0.05
2004	0.03	0.05
2005	0.03	0.04
2006	0.06	0.04
2007	0.03	0.04

Note: The sample contains both imports affected and unaffected by the STCs.

Next section examines how firms respond to the imposition of an STC on their imports. The following histogram illustrates the impact of STCs on importers' choice of source origins. In 2002, the blue bars represent the number of origin countries (exporting countries) for each observation (at the product-year-origin level) without an STC affecting its imports. In contrast, the red bars represent the number of origin countries for firm-product observations that are affected by an STC.

The data distribution shows that products subject to STCs tend to source imports from a smaller range of countries compared to products not affected by STCs. In other words, STC-affected products have a narrower selection of import origins. Additionally, Figure 1 suggests that countries with greater market power are more likely to raise STCs.

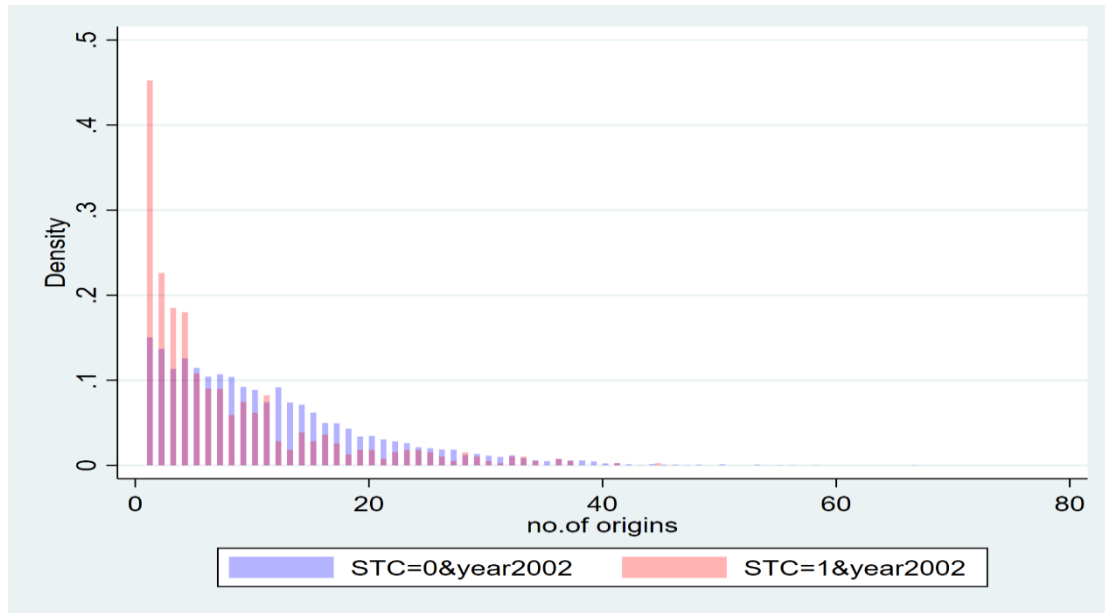


Figure 1: The histogram of the number of origins each observation (product-year-origin level) in 2002, conditional on whether a product had a STC imposed.

Next, I analyze the number of importing firms for each observation (product-year-firm) based on whether the HS4 product is affected by an STC. The figure illustrates that in 2002, the average number of firms importing STC-affected products was lower compared to those importing products not impacted by STCs.

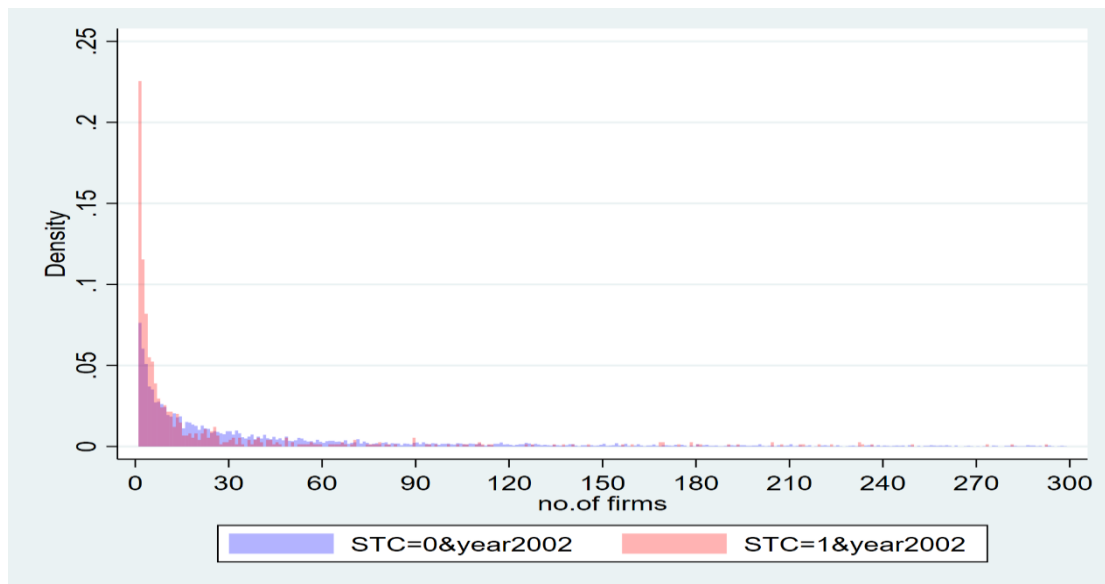


Figure 2: The histogram of the number of importers per HS4 product in 2002, conditional on whether a product had a STC imposed (truncated at 300)

Next, I examine, at the product-year-origin level, how many countries a product affected by an Enforced TBT is imported from, and how many of these countries have raised complaints. For each product affected by an Enforced TBT, I first calculate the total number of countries from which the product is imported and the number of countries that have filed complaints regarding the TBT.

To make this data more interpretable, I create a variable by dividing the number of countries raising complaints by the total number of countries from which the product is imported. From the Table 3.6, it is evident that a minority of countries that raised complaints accounted for the overall number of countries that the enforced TBT affected product imports from.

Table 3.6: The Share of the number of complain origins each observation (product-year-origin level) that affected by Enforced TBT

Year	Share
2002	0.196
2003	0.009
2004	0
2005	0.054
2006	0.183
2007	0.089

3.2 Firm-product observations affected by different measures of TBTs

The TBT notifications dataset includes an announcement date, which indicates when the TBT will be adopted. I have labeled this as 'Announced TBT' in the dissertation.

Additionally, the dataset specifies the enforcement date of the TBT, which I refer to as 'Enforced TBT.' The STCs dataset provides information on specific TBTs about which trading partners have raised concerns with the WTO. In this dissertation, 'STC' denotes that a firm's imports are affected by an STC, regardless of the import origin, while 'STC-concerned' refers to imports from a country that has lodged a complaint about TBTs.

Table 3.7 summarizes the number of firm-product observations in China impacted by four types of TBTs between 2002 and 2007. In 2002, the dataset includes 701,158 firm-product observations of imports by Chinese firms. Of these, 52,306 firm-product observations were affected by STCs, resulting in an STC-affected share of 7.5%. In the second column, only 4,619 firm-product observations were impacted by the 'STC-concerned' variable, representing an affected share of 0.7%.

Table 3.7: Annual number of firm-product observations affected by different measures of TBTs

Year 2002	STC	STC-concerned	Announced TBT	Enforced TBT
0	648,852	696,539	445,656	693,687
1	52,306	4,619	255,502	7,471
Total	701,158	701,158	701,158	701,158
Share of observations affected by a TBT	7.50%	0.70%	36.44%	1.07%
Year2003	STC	STC-concerned	Announced TBT	Enforced TBT
0	721,950	777,428	401,946	460,750
1	61,121	5,643	381,125	322,321
Total	783,071	783,071	783,071	783,071
Share of observations affected by a TBT	7.80%	0.72%	48.67%	41.16%

Year2004	STC	STC- concerned	Announced TBT	Enforced TBT
0	1,021,999	1,023,221	1,014,392	941,710
1	2,261	1,039	9,868	82,550
Total	1,024,260	1,024,260	1,024,260	1,024,260
Share of observations affected by a TBT	0.22%	0.10%	0.96%	8.06%
Year2005	STC	STC- concerned	Announced TBT	Enforced TBT
0	1,040,483	1,076,062	966,933	1,080,631
1	57,455	21,876	131,005	17,307
Total	1,097,938	1,097,938	1,097,938	1,097,938
Share of observations affected by a TBT	5.23%	1.99%	11.93%	1.58%
Year2006	STC	STC- concerned	Announced TBT	Enforced TBT
0	1,062,686	1,154,922	830,653	931,841
1	147,375	55,139	379,408	278,220
Total	1,210,061	1,210,061	1,210,061	1,210,061
Share of observations affected by a TBT	12.18%	4.56%	31.35%	22.99%
Year2007	STC	STC- concerned	Announced TBT	Enforced TBT
0	938,189	996,550	981,543	767,899
1	103,793	45,432	60,439	274,083
Total	1,041,982	1,041,982	1,041,982	1,041,982
Share of observations affected by a TBT	9.96%	4.36%	5.80%	26.30%

3.3 Conclusion

In conclusion, this chapter summarizes the detailed firm-level data from 2002 to 2007 of Chinese firms' imports. By merging the "Chinese Industrial Enterprises Database" with transaction-level trade data from the "China Customs Database," I created a

comprehensive dataset that allows for an in-depth analysis of firm behavior in response to TBTs. The chapter explores two major areas: Chinese firm-level import data and firm-product observations affected by various measures of TBTs.

In section 3.1, I analyze Chinese firm-level import data, focusing on firms impacted by Specific Trade Concerns (STCs) and comparing them with non-STC-affected firms. Through detailed tables, such as those outlining the number of firms impacted by STCs, the number of countries they import from, and the number of product categories imported, this section highlights significant differences in behavior between STC-affected and non-STC firms. The analysis reveals that STCs influence firms' sourcing decisions, product choices, and market shares, suggesting that TBTs play a critical role in shaping import strategies.

Section 3.2 extends the analysis by examining firm-product observations impacted by different types of TBT measures, including announced TBT, enforced TBT, and STCs. The data show a substantial number of firm-product observations affected by these barriers, illustrating the widespread impact of TBTs on Chinese importers.

The findings from this chapter contribute to the growing literature on non-tariff barriers by offering a detailed view of how Chinese firms' response to TBTs in their import processes. In summary, this chapter provides a picture for showing how TBTs influence firm imports based on the data description.

Chapter 4 TBTs Impact on Trade Flows

This chapter examines the impact of the technical barriers to trade (TBTs) on firms' imports.

4.1 Introduction

This chapter explore the impact of Technical Barriers to Trade (TBTs) on firm imports, and how these barriers affect firms differently depending on their size and ownership

structure.

First, to address potential concerns related to the measurement of TBTs, particularly when using Specific Trade Concerns (STCs) as a proxy. I compare the effects of three different TBT measures—announced TBTs, enforced TBTs, and STCs—on firm-level imports, including volumes, quantities, and prices. I find that the impact of TBTs is consistent across all three measures, suggesting that the relationship between TBTs and reduced firm imports is robust and generalizable. This analysis contributes to the literature by confirming that the choice of TBT measure does not significantly alter the observed effects on trade, adding to the reliability of prior studies that primarily rely on STCs.

Given the results above, I delve into the heterogeneity of firm responses to TBTs using STCs as the measure. I explore how firm size influences the impact of TBTs on imports, finding that smaller firms experience a more pronounced reduction in imports, while larger firms are better able to adapt. Interestingly, ownership structure does not significantly affect the impact of TBTs on imports.

Then, I investigate the differential impact of TBTs on firm imports from concerned and unconcerned countries. The results show that firms decrease imports from countries where STCs have been raised, but increase imports from countries that have not raised complaints, suggesting evidence of trade diversion. Moreover, the analysis indicates that the negative effects of TBTs on imports are largely driven by larger firms, which are more capable of shifting their import sources. This serves as a contribution to the literatures (Fontagné and Orefice, 2018, Singh and Chanda, 2020) that examine the impact of TBTs on firms' imports but does not distinguish between imports from the concerned and unconcerned countries. My dissertation shows the differentiated impact of TBTs for different origins.

Lastly, I analyze the impact of TBTs (measured as STCs) on a firm's likelihood of

continuing to import, conditional on having imported in the previous period. The findings reveal that TBTs reduce firms' likelihood of importing, particularly for larger firms with more market power, who tend to shift imports to alternative origins.

I also investigate the heterogeneity of firms' responses based on their import share in the Chinese market. Firms with a larger import share experience a stronger negative impact from TBTs. Additionally, when examining the role of firm size and ownership, the results show that only very large firms reduce their likelihood of importing from the same origin, while smaller firms actually increase their conditional probability of importing. Ownership structure impacts firms located outside mainland China, but has little effect on those based within.

The rest of this chapter is organized as follows: a short description of the data used in this chapter, the impact of TBTs on the intensive margins of firms' imports and the impact of TBTs on the extensive margins of firms' imports.

4.2 Data

For the empirical analysis in this chapter, I utilize three datasets: the WTO TBT notifications dataset, the WTO Specific Trade Concerns (STC) dataset, and the customs imports dataset of Chinese firms. All three datasets are described in detail in Chapter 2 and 3. In addition, we acquire the trade data at the country-product level from the CEPII, which provides details on China's imports of each specific HS4 product. Each transaction record in the data contains the HS4 product code, the year and country of origin for the imported product from China, as well as the import value and quantity. Also, in order to control the impact of tariffs on firms' imports, I obtain the China import tariffs from the WTO Tariff & Trade Data, which provides the import tariffs at HS8 product level.

The WTO TBT notifications dataset provides information on the products affected by a given regulation, the regulation's purpose, its announcement date, and its

enforcement date. To categorize these notifications, we define two groups: 'Announced-TBT' and 'Enforced-TBT.' Additionally, if other countries raise concerns about a TBT due to issues such as lack of transparency, discrimination, or unnecessary trade barriers, the dataset records the corresponding STC. As summarized in Table 2.1, a total of 217 TBTs were announced, of which 192 were enforced between 2002 and 2007. Of these, approximately 30 TBTs attracted complaints from other countries.

Using STCs to measure TBTs offers the advantage of highlighting TBTs that exporting countries actively contest. STCs provide insights into regulations that have already impacted trade, making them a more suitable metric for studying the effect of TBTs on trade. Each WTO STC records the TBT in question, the product affected, the concerned country, the reason for the concern, and the date the STC was raised (as shown in Table 2.3). Between 2002 and 2007, other exporting countries raised 30 STCs against Chinese-imposed TBTs, involving a total of 847 distinct products (classified by HS 4-digit codes).

Chinese customs dataset provides firm-level import data from 2002 to 2007. For each import transaction, the dataset records details such as the imported product, importing firm identity, the exporting country, mode of transport, import value, import quantity, unit of quantity, and other relevant information. To analyze imports from countries that raised STCs as well as those from countries whose products were affected by STCs but did not raise one, I match the STCs data with firm-level import data. Using the combined dataset I examine the impact of TBTs on firm imports.

4.3 Alternative Measures of TBTs

In the literature, Specific Trade Concerns (STCs) are commonly used to assess the impact of Technical Barriers to Trade (TBTs) within a country. STCs are popular because they highlight regulations that have affected trade for some countries. However, there are concerns regarding the use of STCs in evaluating TBTs. TBTs are typically imposed at the product level and are not specific to a particular country,

whereas STCs are raised by individual countries. In studies such as Fontagné and Orefice (2018) and Singh and Chanda (2020), when a country raises an STC, it is often treated as a product-level TBT across all origin countries, regardless of whether those origins raised concerns.

This approach raises the concern that the observed average impact of TBTs, when measured as STCs across different origins, may primarily reflect the effects on the countries that raised concerns, rather than providing an accurate representation of the impact on countries that did not. To determine whether this is a significant issue, this section compares the impact of different TBT measures on firm imports across all source origins.

In section 4.3.1, I measured TBTs as announced TBTs, enforced TBTs, and STCs and checked the impact of these three measures on firm-level imports in terms of their imported volumes, quantities, and prices. I found that the impact on imports is consistent across three different TBT measures, in which the affected imports across all source origins are lower than for imports not affected. The consistent effect across multiple measures demonstrates the robustness of the findings. This implies that the observed relationship between TBTs and imports is not dependent on a specific TBT measure but rather a generalizable result.

Given the results section 4.3.1, in section 4.3.2, I explore the heterogeneity in firm responses to TBTs on firms' imports using the STC measure of the TBTs. I examine the heterogeneity in firms' responses to TBTs on imports, taking into account their size as measured by their annual revenue. The results show that TBTs decrease firm imports, with smaller firms suffering more. Upon examining the various impacts of STCs on firm imports, I discovered that the ownership structure of firms does not significantly influence the impact of STCs on firm imports.

4.3.1 Baseline results

This section compares the estimated impact of three alternative measures of TBTs: announced TBTs, enforced TBTs, and STCs. STCs are the primary measure used in the literature, as they capture TBTs that are known to be restrictive. However, I am concerned that relying solely on STCs may be misleading because they are country-specific. Using concerns raised by one country about a product as a TBT across all origins could introduce bias, as countries that did not raise concerns may not be similarly impacted. This could lead to an inaccurate estimation of the average effect of TBTs.

In this section, I use three alternative measures of TBTs: Announced TBT, Enforced TBTs (the TBT notifications data), and STCs. All three measures are defined at the at the HS4-digit product level. Additionally STCs vary across origins. To investigate the impact of TBTs on firm imports using the three measures I estimate eq 4.1.

$$\ln y_{fpot} = \beta_0 + \beta_1 I[TBT_{pt} = 1] + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.1),$$

$$\ln y_{fpot} = \beta_0 + \beta_1 I[TBT_{pt} = 1] + Tariff_{pt} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.1a),$$

Where the dependent variable $\ln y_{fpot}$ refers to the import value, quantity and price, $I[TBT_{pt} = 1]$ is an indicator function which takes value 1 if an imported product p is affected by TBTs at time t . $I[TBT_{pt} = 1]$ is measured in 3 different ways (Enforced TBT, Announced TBT, STC). $Tariff_{pt}$ is China import tariff. The equation also incorporates firm-fixed effects (μ_f), product-fixed effects (θ_p), year-fixed effects (λ_t) and origin-fixed effects (σ_o). Firm and product fixed effects control for unobserved firm/product-specific factors heterogeneity that could influence the firm's decision to import. Firm-fixed effects typically capture firm specific effects constant over time, e.g., corporate management level, corporate culture and value. Product fixed effects control for unobserved characteristics that vary between products but remain constant over time, such as inherent quality, brand reputation, or unique design features. The year-fixed effect controls for shocks over time that affect the firm's imports. The Origin fixed effects control for unobserved characteristics specific to the origin that

may influence the imports, such as cultural factors, historical background, and geographical advantages or disadvantages. These characteristics remain constant over time but vary across origins.

To estimate the equation, I adopt the estimator proposed by Correia (2016), which offers a computationally efficient and theoretically grounded approach to estimating linear models with multiple high-dimensional fixed effects. This method builds on the insight that the least-squares estimation problem with multi-way fixed effects can be equivalently represented as a linear system on a weighted graph—specifically, a graph Laplacian. By doing so, the estimator leverages recent advances in spectral graph theory and numerical linear algebra, allowing the use of fast solvers with nearly-linear time complexity.

More precisely, the approach replaces the traditional method of alternating projections (e.g., Guimarães and Portugal 2010; Gaure 2013), which can suffer from very slow convergence in the presence of large and sparse fixed effects structures, with symmetric projection operators. These are amenable to conjugate gradient acceleration, which ensures monotonic convergence and significantly reduces computation time.

The algorithm involves several key innovations, including efficient pruning of the fixed effect structure (into a 3-core), reordering using the Reverse Cuthill–McKee algorithm to improve memory access patterns, and solving an “electrical flow” problem using low-stretch spanning trees to accelerate convergence. These techniques not only improve runtime but also make the method feasible on large administrative datasets that would otherwise be intractable using conventional within transformations or dummy variable approaches.

Furthermore, the estimator satisfies the Frisch–Waugh–Lovell theorem, and therefore naturally extends to instrumental variable (2SLS), limited information maximum

likelihood, and GMM contexts. Overall, I use Correia's method because it offers a scalable and robust way to control for multiple sources of unobserved heterogeneity—such as firm, time, and regional effects—without compromising estimation precision or computational feasibility.

Table 4.1 TBT is measured by Announced TBT

Dependent Variable:	$\ln importValue_{fpt}$	$\ln importQuantity_{fpt}$	$\ln importPrice_{fpt}$
$I[TBT_{pt} = 1]$	-0.020*** (0.006)	-0.004 (0.009)	-0.016** (0.007)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.315	0.593	0.778

Cluster-Robust Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.1a TBT is measured by Announced TBT

Dependent Variable:	$\ln import Value_{fpt}$	$\ln import Quantity_{fpt}$	$\ln import Price_{fpt}$
$I[TBT_{pt} = 1]$	-0.021*** (0.006)	-0.005 (0.009)	-0.016** (0.007)
$Tariff_{pt}$	0.018*** (0.003)	0.017*** (0.003)	0.002 (0.02)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.313	0.592	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.2 TBT is measured by Enforced TBT

Dependent Variable:	$\ln import Value_{fpt}$	$\ln import Quantity_{fpt}$	$\ln import Price_{fpt}$
$I[TBT_{pt} = 1]$	-0.026*** (0.006)	-0.012 (0.009)	-0.013* (0.008)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES

Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.315	0.593	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.2a TBT is measured by Enforced TBT

Dependent Variable:	<i>lnimportValue</i> _{tpot}	<i>lnimportQuantity</i> _{tpot}	<i>lnimportPrice</i> _{tpot}
<i>I</i> [<i>TBT</i> _{pt} = 1]	-0.024*** (0.006)	-0.011 (0.009)	-0.013** (0.008)
<i>Tariff</i> _{pt}	0.018*** (0.003)	0.017*** (0.003)	0.002 (0.002)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.313	0.592	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.3 TBT is measured by STC

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
<i>I</i> [<i>TBT</i> _{pt} = 1]	-0.044*** (0.012)	-0.042** (0.019)	-0.003 (0.017)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.315	0.593	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.3a TBT is measured by STC

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
<i>I</i> [<i>TBT</i> _{pt} = 1]	-0.053*** (0.012)	-0.049** (0.019)	-0.003 (0.017)
<i>Tariff</i> _{pt}	0.019*** (0.003)	0.017*** (0.003)	0.002 (0.02)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES

Observations	5,647,354	5,647,354	5,647,354
R2_adjusted	0.315	0.593	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Comparing the results in Tables 4.1–4.3, the coefficients on quantities are similar across all three regressions and are consistently negative. Quantitatively, the effect of TBTs measured through STCs is approximately twice as large as the effect of TBTs measured through announced and enforced TBTs. This aligns with the expectation that STCs focus primarily on the most restrictive measures. Additionally, the results for both prices and quantities are consistent across the regressions, further reinforcing the robustness of these findings.

Looking at the results in Tables 4.1a–4.3a, the inclusion of the import tariff variable in the regressions does not substantially change the coefficients of TBTs, either in terms of sign, magnitude, or statistical significance. Unlike the trade-restrictive impact of TBTs on firms’ imports, tariffs exhibit a trade-promoting effect.

The results indicate that the impact on import values, quantities and prices is consistent across three different TBT measures. This implies that the observed relationship between TBTs and imports is not dependent on a specific TBT measure, but rather a generalizable result. Next, we investigate the impact of TBTs in firm heterogeneity.

4.3.2 Heterogeneity

In this section we explore the heterogeneity in firm response to TBTs on firm’s imports. I test for heterogeneity in firms’ responses to TBTs on imports based on importer size, measured by annual revenue and firm ownership structure. The results

show that TBTs decrease firm imports, with smaller firms reducing imports the most. I find limited impact of ownership type on importer behaviour with response to TBTs.

To test the heterogeneous reaction of firms to TBTs based on firm size and ownership. We classify firm size based on annual revenue (shown on a firm's balance sheet) and examine six types of firms (e.g. state-owned and privately-owned) in relation to their ownership structure. Larger firms or firms with different ownership structures might respond differently to TBTs due to varying levels of resources, market access, and political connections. For example, state-owned firms may have more government backing and access to information about regulatory changes, potentially insulating them from some of the negative effects of TBTs. In contrast, privately-owned firms may be more vulnerable to such barriers, particularly smaller firms that might lack the resources to adapt or comply with complex regulations. We address this issue by adding the interactions between firm size, ownership, and TBT to our baseline model. My approach is similar to Singh and Chanda, 2020 and Fontagné and Orefice, 2018 who explore the effect of TBTs on exporters.

To this end I estimate the following equation:

$$\ln y_{fpot} = \beta_0 + \beta_1 I[STC_{pt} = 1] + \gamma X_{ft} + \delta I[STC_{pt} = 1] * X_{ft} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.2),$$

Where the dependent variable $\ln y_{fpot}$ refers to the import value, quantity and price. $I[STC_{pt} = 1]$ is an indicator function that takes value one if the imported product p is affected by STCs from any of the trading partners in time t . X_{ft} is a set of firm characteristics (size or ownership), γ and δ are vectors of coefficients.

4.3.2.2 Firm Size

In this section I look at how importing firm respond differently to changes in the TBT regulations. I find that for the largest firms the import values increase along with quantities, as prices fall. The rest of the importers reduce their import volumes, with

the smallest importers making the biggest reductions.

To study how firms of different sizes respond to changes in TBT regulations, I estimate eq. (4.2) where X_{ft} is the firm size. In Chapter 3, where I describe the firm data, I categorize firms into four size groups based on annual revenue: small (below 3 million RMB), medium (between 3 million and 20 million RMB), large (between 20 million and 400 million RMB), and extra-large (beyond 400 million RMB). Table 4.4 provides a breakdown of the number of firms in each size group. The extra-large firms are used as the control group, and the regression results are presented in Table 4.5 below.

Table 4.4 Number of firms in different sizes from 2002-2007

Firm type based on size	Number of firms
Small size	793
Medium size	30,665
Large size	44,124
Extra-large size	3,972

Table 4.5 Impact on different sizes of firms

Dependent Variable:	$\ln import Value_{fpt}$	$\ln import Quantity_{fpt}$	$\ln import Price_{fpt}$
$I[STC_{pt} = 1]$	0.074*** (0.024)	0.131*** (0.035)	-0.057** (0.028)
$Small_{ft}$	-0.154*** (0.036)	-0.071* (0.038)	-0.083*** (0.023)
$Medium_{ft}$	-0.376*** (0.015)	-0.267*** (0.014)	-0.109*** (0.008)
$Large_{ft}$	-0.180***	-0.101***	-0.079***

	(0.010)	(0.010)	(0.006)
$I[STC_{pt} = 1] * Small_{ft}$	-0.358***	-0.516***	0.158**
	(0.093)	(0.113)	(0.069)
$I[STC_{pt} = 1] * Medium_{ft}$	-0.273***	-0.381***	0.107***
	(0.044)	(0.051)	(0.035)
$I[STC_{pt} = 1] * Large_{ft}$	-0.178***	-0.266***	0.088***
	(0.030)	(0.036)	(0.026)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778
<hr/>			

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.5a Impact on different sizes of firms

Dependent Variable:	$lnimportValue_{fpot}$	$lnimportQuantity_{fpot}$	$lnimportPrice_{fpot}$
<hr/>			
$I[STC_{pt} = 1]$	0.045*	0.098**	-0.054**
	(0.023)	(0.033)	(0.028)
$Tariff_{pt}$	-0.002	-0.005	0.004
	(0.003)	(0.004)	(0.003)
$Small_{ft}$	-0.235***	-0.196**	-0.039
	(0.060)	(0.073)	(0.041)
$Medium_{ft}$	-0.613***	-0.529***	-0.084***
	(0.025)	(0.033)	(0.022)

<i>Large_{ft}</i>	-0.327*** (0.017)	-0.271*** (0.025)	-0.056** (0.018)
<i>I[STC_{pt} = 1] * Small_{ft}</i>	-0.345*** (0.093)	-0.493*** (0.112)	0.147** (0.071)
<i>I[STC_{pt} = 1] * Medium_{ft}</i>	-0.239*** (0.041)	-0.339*** (0.048)	0.100** (0.036)
<i>I[STC_{pt} = 1] * Large_{ft}</i>	-0.148*** (0.028)	-0.231*** (0.033)	0.083** (0.027)
<i>Tariff_{pt} * Small_{ft}</i>	0.014** (0.005)	0.019** (0.007)	-0.006 (0.004)
<i>Tariff_{pt} * Medium_{ft}</i>	0.030*** (0.003)	0.034*** (0.004)	-0.003 (0.003)
<i>Tariff_{pt} * Large_{ft}</i>	0.021*** (0.002)	0.024*** (0.003)	-0.088 (0.002)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778
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Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.5 shows results for a sample of small, medium, large and extra-large sized importing firms. By looking at the coefficients of the interaction terms, it indicates that the smaller the firms, the larger the negative effect of TBTs on firms. The coefficient on *I[STC_{pt} = 1]* in Table 4.5 reflects the estimated effect of TBTs on “Extra-large” firms, which serve as the reference group in the interaction terms.

Interestingly, the coefficient for extra-large firms is positive, in contrast to the negative coefficients observed for smaller firms. This heterogeneity is consistent with the notion that smaller firms are generally less equipped to handle the additional costs imposed by TBTs—such as product testing, certification, and compliance procedures. These costs can represent a significant barrier for smaller firms, potentially leading to a reduction in their import activities. In contrast, extra-large firms typically have more financial and administrative resources, enabling them to absorb these costs and maintain or even increase their import levels in response to TBTs. This may explain the positive coefficient observed for the largest firms.

As the prediction of Melitz (2003) model, smaller, less productive firms suffer greater harm when trade barriers like TBTs are present which results in a market in which only the most efficient firms (often larger firms) may effectively compete. When TBTs disproportionately impact the exports or imports of smaller firms, either driving them out of the market or forcing them to lower their international trade.

Looking at the results in Table 4.5a, the inclusion of the import tariff variable in the regression does not substantially change the coefficients of TBT, either in terms of their sign, magnitude, or statistical significance.

4.3.2.2 Firm Ownership Structure

In this section I explore the impact of TBTs on importers and how it varies with the importer ownership structure. In the Chinese economy firms can be privately owned, state-owned, foreign-owned, owned by an entity based in Hong Kong, Macao, or Taiwan-or, collectively-owned, (as well as combinations of these ownership types.) One may expect that foreign firms may have special connections to the source origins and maybe less affected than private firms. Similarly, state firms are typically thought to be less efficient and so slower respond to changes in the TBT to trade regulations. I however find that ownership has little impact on firm response to the TBTs.

Table 4.6 summarized the distribution of ownership types. State-owned firms, also known as government-owned corporations, are businesses that are owned or controlled by the government. They account for 5% of the sample. Foreign-owned firms are companies that have a significant portion of their ownership stake, typically a majority, held by foreign investors or parent companies based outside the country in which the firm operates. They account for 22% of the sample. Hong Kong, Macao, and Taiwan-owned firms are companies that are owned or controlled by entities, individuals, or investors from Hong Kong, Macao, or Taiwan and they account for 12% of the sample. Privately-owned firms account for 3% of the sample, which refers to businesses that are owned by private individuals or entities, as opposed to being owned or controlled by the government. Collectively-owned firms account for 2 % of the sample. are businesses that are owned and operated by a group of people who share the profits, decision-making, and responsibilities. Finally, the largest category, the “others” cover firms that do not easily fit into the traditional holding classification, usually because of the complexity and diversity of their ownership structure or, in some cases, the existence of special capital operations. Such as mixed-owned firms, public-held firms, etc.

Table 4.6: Ownership structure of Chinese firms (2002-2007)

Ownership Situation	Number of firms	Percentage of total number of firms
Others	3,320,065	56.67
State-owned	279,059	4.76
Foreign-owned	1,265,778	21.61
Hong Kong, Macao and Taiwan-owned (HMK)	677,493	11.56
Private-owned	186,102	3.18
Collectively-owned	129,967	2.22
Total	5,660,239	100

Table 4.7 Impact on different ownerships of firms

Dependent Variable:	$\ln import Value_{fpt}$	$\ln import Quantity_{fpt}$	$\ln import Price_{fpt}$
$I[STC_{pt} = 1]$	-0.012 (0.039)	-0.034 (0.042)	0.056* (0.032)
$State_{ft}$	0.116*** (0.017)	0.042** (0.020)	0.026* (0.015)
$Foreign_{ft}$	0.049*** (0.012)	-0.041*** (0.013)	0.041*** (0.009)
HMT_{ft}	-0.051*** (0.013)	-0.109*** (0.015)	0.059*** (0.010)
$Others_{ft}$	0.069*** (0.015)	0.025 (0.016)	0.009 (0.012)
$Colletively_{ft}$	0.015 (0.016)	-0.019 (0.018)	0.018 (0.013)
$I[STC_{pt} = 1] * State_{ft}$	-0.034 (0.047)	-0.145** (0.057)	0.085* (0.044)
$I[STC_{pt} = 1] * Foreign_{ft}$	-0.061 (0.043)	0.051 (0.044)	-0.115*** (0.031)
$I[STC_{pt} = 1] * HMT_{ft}$	0.035 (0.046)	0.078 (0.057)	-0.040 (0.038)
$I[STC_{pt} = 1] * Others_{ft}$	-0.073* (0.043)	-0.068 (0.047)	-0.053* (0.031)
$I[STC_{pt} = 1] * Colletively_{ft}$	0.118** (0.047)	0.099* (0.055)	-0.024 (0.042)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.7a Impact on different ownerships of firms

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
<i>I</i> [<i>STC</i> _{pt} = 1]	-0.011 (0.039)	-0.024 (0.042)	0.026* (0.032)
<i>Tariff</i> _{pt}	0.023*** (0.003)	0.022*** (0.020)	0.001 (0.003)
<i>State</i> _{ft}	0.116*** (0.017)	0.042** (0.020)	0.026* (0.015)
<i>Foreign</i> _{ft}	0.049*** (0.012)	-0.041*** (0.013)	0.041*** (0.009)
<i>HMT</i> _{ft}	-0.051*** (0.013)	-0.109*** (0.015)	0.059*** (0.010)
<i>Others</i> _{ft}	0.069*** (0.015)	0.025 (0.016)	0.009 (0.012)
<i>Colletively</i> _{ft}	0.015 (0.016)	-0.019 (0.018)	0.018 (0.013)
<i>I</i> [<i>STC</i> _{pt} = 1] * <i>State</i> _{ft}	-0.014 (0.047)	-0.115** (0.057)	0.055* (0.044)
<i>I</i> [<i>STC</i> _{pt} = 1] * <i>Foreign</i> _{ft}	-0.061	0.051	-0.115***

	(0.043)	(0.044)	(0.031)
$I[STC_{pt} = 1] * HMT_{ft}$	0.031	0.078	-0.040
	(0.046)	(0.057)	(0.038)
$I[STC_{pt} = 1] * Others_{ft}$	-0.043*	-0.061	-0.053*
	(0.043)	(0.047)	(0.031)
$I[STC_{pt} = 1] * Colletively_{ft}$	0.118**	0.079*	-0.024
	(0.047)	(0.055)	(0.042)
$Tariff_{pt} * State_{ft}$	-0.008**	0.004	-0.012**
	(0.003)	(0.005)	(0.004)
$Tariff_{pt} * Foreign_{ft}$	-0.003	0.051**	0.005**
	(0.002)	(0.003)	(0.002)
$Tariff_{pt} * HMT_{ft}$	-0.003	-0.009	0.002
	(0.003)	(0.005)	(0.004)
$Tariff_{pt} * Others_{ft}$	-0.004**	-0.006**	0.002
	(0.002)	(0.003)	(0.003)
$Tariff_{pt} * Colletively_{ft}$	-0.006**	0.001	-0.007**
	(0.003)	(0.004)	(0.002)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778
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Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.7 reports the regression results for a sample of six types of ownership for importing firms; we take the private-owned as the control group. State owned firms

tend to be the largest importers based on the coefficients on sizes, however no one of the ownership types other than the collectively owned ones are impacted by the TBT regulations in terms of revenues. In column (3), we are looking at the coefficients of the interaction term, which indicate that TBTs increase the imported price of state-owned firms and private-owned firms but decrease the imported price of foreign-owned firms. In column (2), the interaction term's coefficient for state-owned firms is negative, indicating that TBTs reduce the quantity of imports for these firms. Conversely, TBTs have a positive impact on the quantity of imports for private-owned firms, though TBTs promote the imported price for private-owned firms. Besides, for foreign-owned firms, TBTs promote their imports though TBTs decline the imported price. Still, when I control the import tariffs, it basically doesn't change the original results of TBTs' impact on firms' imports.

In section 4.3, I assessed the impact of TBT notifications measured as Announced TBT and Enforced TBT, as well as STCs on imports. All measures had comparable impacts on firm imports. Going forward we rely on STCs as a measure of TBTs as is common in the literature. Next, we'll examine the differentiated impact of TBTs on firm imports by origin.

4.4 Differential impact of TBTs on trade flows by origins

Papers that examine the average effect of STCs on firm imports across all origins (e.g., Fontagné and Orefice, 2019; Singh and Chanda, 2021) typically do not differentiate between firm imports from concerned countries (those that raised STCs) and those from unconcerned countries. However, it is essential to understand the differential impact of STCs on specific origins, given the known trade restrictions associated with them. This distinction helps determine whether the observed effects are driven by reverse causality, where the countries raising STCs primarily influence the results, and whether countries that did not raise complaints are affected differently.

In this section, I differentiate between firm imports from concerned countries (those

that raised STCs) and those from unconcerned countries. The results show that firms decrease imports from countries where an STC complaint has been lodged, while increasing imports from other origins. This indicates a reverse causality issue, where the concerned countries primarily drive the trade restriction effect of STCs. Additionally, the findings provide evidence of trade diversion, as importers shift sourcing toward countries that did not raise a complaint, leading to increased imports from these unconcerned origins.

When I look at the heterogeneity of the firm responses in terms of size and ownership. I find that TBTs reduced imports from all size groups, with smaller firms bearing a greater impact. Only very large firms increased their imports from origins that did not raise a complaint, suggesting, that the results in Table 4.8, the increase in imports from unconcerned countries is driven by these firms. Specifically, for firms, TBTs have a greater negative impact on imports from unconcerned countries; this may indicate that the negative impact of TBTs on imports is not reverse causality that the concerned country primarily influences the negative impact. Moreover, the effect of TBTs only applies to private firms in concerned countries, and it intensifies further for state, foreign firms.

4.4.1 Baseline results

In this section we evaluate the impact of TBTs differentiating between imports from origins that raised an STCs and that didn't. This allows us to evaluate whether average impact of TBT across origins reported in the previous section and widely reported in the literature, e.g., Singh and Chanda (2020) adequately describes the impact of TBTs in the concerned and unconcerned countries. Intuitively, countries raise STC with WTO because either they experienced a decline in trade or forecast such a decline. For countries that did not complain the impact of TBTs on imports can go either way. I find that countries that complained saw a reduction in imports and countries that didn't complain actually saw an increase in imports.

$$\ln y_{fpot} = \beta_0 + \beta_1 I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] + \beta_2 I[STC_{pot}^o = 1] + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.3),$$

Where the dependent variable $\ln y_{fpot}$ refers to the import value, quantity and price, $I[STC_{pot}^o = 1]$ (o denotes the origin of exports and $-o$ denotes other countries but the source country of imports for product, firm and time period in question.) indicates imports from origins which lodged an STC complaint themselves versus exporters that were affected by a TBT associated with an STC who didn't lodge a complaint themselves ($I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$).

Table 4.8 Impact on different origins

Dependent Variable:	$\ln importValue_{fpot}$	$\ln importQuantity_{fpot}$	$\ln importPrice_{fpot}$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.040*** (0.015)	0.048* (0.029)	-0.008 (0.019)
$I[STC_{pot}^o = 1]$	-0.246*** (0.043)	-0.256*** (0.045)	0.010 (0.029)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.8a Impact on different origins

Dependent Variable:	$\ln importValue_{fpt}$	$\ln importQuantity_{fpt}$	$\ln importPrice_{fpt}$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.033** (0.015)	0.042 (0.029)	-0.008 (0.019)
$I[STC_{pot}^o = 1]$	-0.257*** (0.043)	-0.266*** (0.045)	0.010 (0.029)
$Tariff_{pt}$	0.019*** (0.003)	0.018*** (0.003)	0.002 (0.002)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.8 demonstrates that imports of TBT-affected products from countries that raised an STC were more than 20% lower than imports of products unaffected by technical regulations. On the other hand, imports from unconcerned countries increased by as much as 4%. As column two of Table 4.8 shows, the effect on quantities is similar to the effect on import values. Imported quantities fell by more than 20% from the concerned origins that lodged a complaint relative to products unaffected by the technical regulations, while the import quantities of the affected products from the unconcerned origins increased by a moderate 4%. Also in Table 4.8a, the tariffs only slightly affect the original effects of TBTs.

As Bao and Qiu, 2012, Singh and Chanda, 2021 highlight TBTs increase the exporters' fixed and variable costs which may explain the results above. Foreign exporters to a country face higher variable and fixed costs when TBTs are implemented. Then the finding that importers lower their imports can reflect two possible mechanisms: (1) Importers lower imports in response to exporters at the source country transferring some costs that they face in response to TBTs to importers; (2) importers themselves reducing imports as they face higher fixed costs of importing (such as additional paperwork and learning about regulations).

These findings in this section paint a picture of trade diversion, in which firms decrease imports from origins where an STC complaint has been lodged and increase imports elsewhere. The results also answer the reverse causality problem that the STCs' trade restriction effect is mainly driven by the complaining country. Next, we will investigate the differentiated impact of TBTs on heterogeneous firms in terms of size and ownership structure.

4.4.2 Heterogeneity

In this section we examine how firms' responses to TBTs vary by size, measured by annual revenue and ownership structure. This helps us understand how factors like firm size and ownership influence how firms deal with trade barriers.

This section examines the heterogeneous response of firms to Technical Barriers to Trade (TBTs) based on their size and ownership structure. As we did before, we categorize the size of firms by their yearly income and analyze the differences between six types of ownership firms (state-owned firms, foreign-owned firms, Hong Kong, Macao, and Taiwan-owned (HMK-owned), private-owned, collectively-owned and others). Due to the reason that firm size and ownership are important factors of a firm, which may cause the potential variation in the effect of TBTs on firm imports based on these factors. To deal with this problem, we incorporate the relationships

among firm size, ownership, and TBT into our baseline model, following the approach taken by previous studies (Singh and Chanda, 2020; Fontagné and Orefice, 2018).

The model we adopt in this section is:

$$\begin{aligned} \ln y_{fpot} = & \beta_0 + \beta_1 I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] + \beta_2 I[STC_{pot}^o = 1] + \gamma X_{ft} + \\ & \varphi I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * X_{ft} + \delta I[STC_{pot}^o = 1] * X_{ft} + \mu_f + \theta_p + \lambda_t + \sigma_o + \\ & \varepsilon_{fpot} \end{aligned} \quad (4.4),$$

Where the dependent variable $\ln y_{fpot}$ refers to the import value, quantity and price. $I[STC_{pot}^o = 1]$ (o denotes the origin of exports and $-o$ denotes other countries but the source country of imports for product, firm and time period in question.) indicates imports from origins which lodged an STC complaint themselves versus exporters that were affected by a TBT associated with an STC who didn't lodge a complaint themselves ($I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$). X_{ft} is a set of firm characteristics (size or ownership), γ , φ and δ are a vector of coefficients.

4.4.2.1 Firm Size

Our initial focus is to examine the distinct impact of TBTs on importers of varying sizes, as given by eq. (4.4). The sample consists of four types of firms grouped by their size: small (with annual revenue below 3 million RMB), medium (with annual revenue between 3 million and 20 million), large (with annual revenue between 20 million and 400 million), and extra-large (with annual revenue beyond 400 million). The control group consists of firms that are classified as extra-large. The regression findings can be found in Table 4.9 below.

Table 4.9 Impact on different sizes of firms (different origins)

Dependent Variable:	$\ln import Value_{f_{pot}}$	$\ln import Quantity_{f_{pot}}$	$\ln import Price_{f_{pot}}$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.189*** (0.034)	0.254*** (0.049)	-0.065** (0.032)
$I[STC_{pot}^o = 1]$	-0.166*** (0.050)	-0.127** (0.055)	-0.039 (0.039)
$Small_{ft}$	-0.154*** (0.036)	-0.070* (0.038)	-0.084*** (0.023)
$Medium_{ft}$	-0.376*** (0.015)	-0.267*** (0.014)	-0.109*** (0.008)
$Large_{ft}$	-0.180*** (0.010)	-0.102*** (0.010)	-0.079*** (0.006)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Small_{ft}$	-0.423*** (0.107)	-0.609*** (0.121)	0.186** (0.076)
$I[STC_{pot}^o = 1] * Small_{ft}$	-0.279** (0.139)	-0.356* (0.186)	0.077 (0.128)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Medium_{ft}$	-0.326*** (0.050)	-0.439*** (0.060)	0.113*** (0.039)
$I[STC_{pot}^o = 1] * Medium_{ft}$	-0.214*** (0.055)	-0.313*** (0.058)	0.099** (0.044)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Large_{ft}$	-0.222*** (0.039)	-0.313*** (0.044)	0.091*** (0.029)
$I[STC_{pot}^o = 1] * Large_{ft}$	-0.117*** (0.032)	-0.199*** (0.039)	0.082*** (0.030)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES

Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.0

Table 4.9a Impact on different sizes of firms (different origins)

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.165*** (0.030)	0.228*** (0.045)	-0.063** (0.032)
$I[STC_{pot}^o = 1]$	-0.207*** (0.052)	-0.172** (0.056)	-0.035 (0.038)
<i>Tariff</i> _{ft}	-0.001 (0.003)	-0.005 (0.004)	0.004 (0.003)
<i>Small</i> _{ft}	-0.237*** (0.060)	-0.198** (0.073)	-0.039 (0.041)
<i>Medium</i> _{ft}	-0.614*** (0.025)	-0.531*** (0.033)	-0.084*** (0.022)
<i>Large</i> _{ft}	-0.329*** (0.017)	-0.273*** (0.025)	-0.056** (0.018)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Small_{ft}$	-0.416*** (0.106)	-0.594*** (0.121)	0.178** (0.078)
$I[STC_{pot}^o = 1] * Small_{ft}$	-0.252*** (0.139)	-0.312* (0.185)	0.069 (0.128)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Medium_{ft}$	-0.299*** (0.046)	-0.406*** (0.056)	0.107** (0.039)
$I[STC_{pot}^o = 1] * Medium_{ft}$	-0.162**	-0.252***	0.090**

	(0.055)	(0.059)	(0.044)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Large_{ft}$	-0.199***	-0.286***	0.088**
	(0.035)	(0.040)	(0.029)
$I[STC_{pot}^o = 1] * Large_{ft}$	-0.071**	-0.147***	0.076**
	(0.032)	(0.039)	(0.030)
$Tariff_{pt} * Small_{ft}$	0.014**	0.019**	-0.006
	(0.005)	(0.007)	(0.004)
$Tariff_{pt} * Medium_{ft}$	0.031***	0.034***	-0.003
	(0.003)	(0.004)	(0.003)
$Tariff_{pt} * Large_{ft}$	0.021***	0.024***	-0.088
	(0.002)	(0.003)	(0.002)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778
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Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.0

Table 4.9 shows the effects of TBTs on firms of different sizes. It shows that the results in Table 4.7 (increasing imports from unconcerned origins) are driven by very large firms (the control group with results reported in the first two lines). For firms of other sizes, small firms, TBTs have a stronger negative impact on imports from unconcerned countries. This pattern also holds for medium and large firms. Across all groups, smaller firms are more negatively affected by TBTs, with only very large firms increasing imports from countries that didn't raise concerns. Table 4.9a

indicates that the included variable of tariffs doesn't affect the original results in Table 4.9.

In Table 4.9, the possible explanation for the results is that the countries that raise complaints are actually more developed. Therefore, the negative impact of imports does not drive the raising of a complaint, suggesting that the negative impact of STCs is not due to reverse causality. When we examine the concerned countries, typically the EU, USA, and Japan, which STCs have the least impact on these developed nations. Less developed countries, on the other hand, have less power to complain and less power to address STCs.

4.4.2.2 Firm Ownership Structure

In Table 4.10, the regression results for a sample of six categories of ownership (state-owned firms, foreign-owned firms, Hong Kong, Macao, and Taiwan-owned (HMK-owned), private-owned, collectively-owned and others) for importing firms are presented. The private-owned firm is designated as the control group. The coefficients of the interaction term, which reveal that the effect of TBTs is only relevant for private firms which import from concerned countries, and its impact is further exacerbated for state and foreign firms. One exception is collectively owned firms.

Table 4.10 results are consistent with Table 4.8. Different ownership firms, except for collectively owned firms, see a decline in imports from a origin that raises concern, while imports from unconcerned countries are not impacted. The heterogeneity analysis reveals that concerned countries drive the decline in imports in Table 4.8, while unconcerned countries increase their imports.

Table 4.10 Impact on different ownerships of firms (different origins)

Dependent Variable:	<i>lnimportValue_{fpot}</i>	<i>lnimportQuantity_{fpot}</i>	<i>lnimportPrice_{fpot}</i>
---------------------	-------------------------------------	----------------------------------------	-------------------------------------

$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.040 (0.037)	0.029 (0.041)	0.054 (0.033)
$I[STC_{pot}^o = 1]$	-0.112* (0.059)	-0.155** (0.068)	0.062 (0.044)
$State_{ft}$	0.119*** (0.017)	0.047** (0.020)	0.025* (0.015)
$Foreign_{ft}$	0.049*** (0.012)	-0.042*** (0.013)	0.041*** (0.009)
HMT_{ft}	-0.051*** (0.013)	-0.109*** (0.015)	0.059*** (0.010)
$Others_{ft}$	0.076*** (0.015)	0.034** (0.016)	0.007 (0.012)
$Colletively_{ft}$	0.018 (0.016)	-0.015 (0.018)	0.016 (0.013)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * State_{ft}$	0.020 (0.051)	-0.080 (0.057)	0.061 (0.052)
$I[STC_{pot}^o = 1] * State_{ft}$	-0.152** (0.066)	-0.290*** (0.092)	0.133** (0.060)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Foreign_{ft}$	-0.012 (0.045)	0.132*** (0.046)	-0.144*** (0.036)
$I[STC_{pot}^o = 1] * Foreign_{ft}$	-0.115* (0.060)	-0.040 (0.069)	-0.079** (0.036)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * HMT_{ft}$	0.027 (0.048)	0.037 (0.061)	-0.007 (0.040)
$I[STC_{pot}^o = 1] * HMT_{ft}$	-0.000 (0.071)	0.115 (0.076)	-0.123*** (0.040)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Others_{ft}$	-0.034 (0.045)	-0.035 (0.048)	-0.058* (0.034)
$I[STC_{pot}^o = 1] * Others_{ft}$	-0.311*** (0.060)	-0.304*** (0.070)	-0.035 (0.040)

$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Colletively_{ft}$	0.094*	0.105*	-0.072
	(0.053)	(0.060)	(0.046)
$I[STC_{pot}^o = 1] * Colletively_{ft}$	0.153**	0.046	0.096
	(0.070)	(0.087)	(0.066)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0. 315	0. 594	0. 778
<hr/>			

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.10a Impact on different ownerships of firms (different origins)

Dependent Variable:	$lnimportValue_{fpot}$	$lnimportQuantity_{fpot}$	$lnimportPrice_{fpot}$
<hr/>			
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.040	0.029	0.054
	(0.037)	(0.041)	(0.033)
$I[STC_{pot}^o = 1]$	-0.112*	-0.155**	0.062
	(0.059)	(0.068)	(0.044)
$Tarif_{pt}$	0.023***	0.022***	0.001
	(0.003)	(0.020)	(0.003)
$State_{ft}$	0.119***	0.047**	0.025*
	(0.017)	(0.020)	(0.015)
$Foreign_{ft}$	0.049***	-0.042***	0.041***
	(0.012)	(0.013)	(0.009)
HMT_{ft}	-0.051***	-0.109***	0.059***

	(0.013)	(0.015)	(0.010)
$Others_{ft}$	0.076***	0.034**	0.007
	(0.015)	(0.016)	(0.012)
$Colletively_{ft}$	0.018	-0.015	0.016
	(0.016)	(0.018)	(0.013)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * State_{ft}$	0.020	-0.080	0.061
	(0.051)	(0.057)	(0.052)
$I[STC_{pot}^o = 1] * State_{ft}$	-0.152**	-0.290***	0.133**
	(0.066)	(0.092)	(0.060)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Foreign_{ft}$	-0.012	0.132***	-0.144***
	(0.045)	(0.046)	(0.036)
$I[STC_{pot}^o = 1] * Foreign_{ft}$	-0.115*	-0.040	-0.079**
	(0.060)	(0.069)	(0.036)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * HMT_{ft}$	0.027	0.037	-0.007
	(0.048)	(0.061)	(0.040)
$I[STC_{pot}^o = 1] * HMT_{ft}$	-0.000	0.115	-0.123***
	(0.071)	(0.076)	(0.040)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Others_{ft}$	-0.034	-0.035	-0.058*
	(0.045)	(0.048)	(0.034)
$I[STC_{pot}^o = 1] * Others_{ft}$	-0.311***	-0.304***	-0.035
	(0.060)	(0.070)	(0.040)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Colletively_{ft}$	0.094*	0.105*	-0.072
	(0.053)	(0.060)	(0.046)
$I[STC_{pot}^o = 1] * Colletively_{ft}$	0.153**	0.046	0.096
	(0.070)	(0.087)	(0.066)
$Tariff_{pt} * State_{ft}$	-0.008**	0.004	-0.012**
	(0.003)	(0.005)	(0.004)
$Tariff_{pt} * Foreign_{ft}$	-0.003	0.051**	0.005**
	(0.002)	(0.003)	(0.002)
$Tariff_{pt} * HMT_{ft}$	-0.003	-0.009	0.002

	(0.003)	(0.005)	(0.004)
$Tariff_{pt} * Others_{ft}$	-0.004**	-0.006**	0.002
	(0.002)	(0.003)	(0.003)
$Tariff_{pt} * Colletively_{ft}$	-0.006**	0.001	-0.007**
	(0.003)	(0.004)	(0.002)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0.315	0.594	0.778
<hr/>			

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

In this section, we have investigated the impact of TBTs on the intensive margin of trade (import values, quantities, and prices), which shows that STCs generally decrease firms' imports. When I further distinguish between firms' imports from countries that are complaining about TBTs and those that are not, I find that STCs only reduce imports from concerned countries, while they actually increase imports from unconcerned countries. Table 4.10a verifies that tariffs will not affect the impact of TBTs on firms' imports. Next, this paper will examine the impact of STCs on the extensive margin of trade. Specifically, we study how the STCs will affect the firm's import probability.

4.5 The impact of TBT on the extensive margin of trade flows

So far, I have demonstrated that TBTs decrease firm imports when measured in three different ways (announced TBTs, enforced TBTs, and STCs). In each case the

imposition of TBTs reduces imports, with the highest measured impact occurring with STCs. I find that while TBTs generally decrease firm imports in terms of import values, quantities, and prices, these are imports from the concerned countries that drive this decline.

In this section, I will investigate the impact of TBTs on the extensive margin of exporting. A number of forces impact the extensive margin of importing. First, TBTs can lead to an increase in the variable cost (e.g., labeling requirements) or the fixed cost (e.g., a new production process) of exporting. As Chinese market becomes unprofitable due to increased fixed costs, exporters leave the and exporters exit the market, fewer Chinese firms import mechanically. As technical barriers to trade impact variable costs and exporters raise prices importers look for alternative sources for their inputs. TBTs also impact importers directly as they may have to investigate the regulations which increases their fixed cost of exporting. This too makes importing less attractive and causes firms to source imports elsewhere.

In this section, I measured TBTs as STCs. First, I study the average effect of TBTs on firm import probability and then further check the differential effect of TBTs on firm import probability for different origins based on whether the source origin raised a complaint with the WTO or not. I find that the imposition of TBTs has a significant and negative effect on the extensive trade margin, whether I distinguish imports from the concerned country or not. This reduction impact is mainly driven by larger firms. Intuitively, this is because large firms have better resources to switch to other markets.

4.5.1 Baseline results

In this section, I applied the eq. (4.5) below to investigate the impacts of TBTs on firm probability of continuing to import the same product from the same origin. As Fontagné et al. (2015) did, I estimated eq. (4.5) via simple linear probability models (LPMs) rather than on non-linear probit (or logit) to avoid the incidental parameter problem due to the sizeable set of fixed effects we include in all regressions.

$$P[y_{fpot} > 0 | y_{fpo(t-1)} > 0] = \beta_0 + \beta_1 I[STC_{pt} = 1] + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.5),$$

Where $P[y_{fpot} > 0 | y_{fpo(t-1)} > 0]$ is the probability that a firm “f” continues to import product p from origin o at time t conditional on having imported the same product from the same origin in t-1. $I[STC_{pt} = 1]$ is an indicator function that takes value one if the imported product p is affected by STCs from any of the trading partners in time t.

Table 4.11 Impact on extensive margin

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	-0.019** (0.003)
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	5, 647, 354
R2_adjusted	0.261

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.11a Impact on extensive margin

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	-0.021*** (0.003)
$Tariff_{pt}$	0.003*** (0.001)
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	5, 647, 354
R2_adjusted	0.261

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.11 displays the regression results. As expected, the imposition of TBTs has a significant and negative effect on the extensive trade margin. It shows that STCs raised by any of the trading partners decrease firms' probability of continuing to import from a certain product-origin market. The lower probability of importing This result is consistent with Fontagné and Orefice (2018), who study the TBTs' impact on French exporters with firm-level panel data and find the negative effect of TBTs on export participation. Also, the result confirms the theory that TBTs increase fixed export costs, causing exporters to exit the affected trade market. Similarly, it's consistent with importers facing higher costs of importing. Besides, Table 4.11a verifies that tariffs have limited effect on the impact of TBTs.

Now to investigate the differential impacts of TBTs on firm probability of continuing to import the same product from the same origin between concerned and unconcerned countries I estimate the following eq. (4.6):

$$P[y_{ipot} > 0 | y_{ipo(t-1)} > 0] = \beta_0 + \beta_1 I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] + \beta_2 I[STC_{pot}^o = 1] + \mu_i + \theta_p + \lambda_t + \sigma_o + \varepsilon_{ipot} \quad (4.6),$$

Where $P[y_{fpot} > 0 | y_{ipo(t-1)} > 0]$ is the probability that a firm “f” continues to import product p from origin o at time t conditional on having imported the same product from the same origin in t-1. $I[STC_{pot}^o = 1]$ (o denotes the origin of exports and $-o$ denotes other countries but the source country of imports for product, firm and time period in question.) indicates imports from origins which lodged an STC complaint themselves versus exporters that were affected by a TBT associated with an STC who didn’t lodge a complaint themselves ($I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$). The control group is the imports that are not affected by STCs.

Table 4.12 Impact on extensive margin (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	-0.016*** (0.003)
$I[STC_{pot}^o = 1]$	-0.026*** (0.006)
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	5, 647, 354
R2_adjusted	0.261

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.12a Impact on extensive margin (different origins)

Dependent Variable:	$P[y_{fpt} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	-0.018*** (0.003)
$I[STC_{pot}^o = 1]$	-0.027*** (0.006)
$Tariff_{pt}$	0.003*** (0.001)
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	5, 647, 354
R2_adjusted	0. 261

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.12 describes the differential impacts of TBTs on the firm's probability to import conditional on having imported in the previous period for origins that raised an STC complaint and those that didn't relative to origins that were not affected by STCs at all (either no TBT was raised regarding a product or no origin raised a TBT). Table 4.11 above shows that the average effect of TBTs across origins decreases the firm's

conditional probability of importing. Now, when I distinguish firm imports from concerned countries and unconcerned countries, Table 4.12 indicates that STCs both decline the conditional probability of importing, whether from concerned countries or unconcerned countries. But the negative impact of TBTs on the conditional probability of importing from concerned countries is greater than effect for importing from unconcerned countries.

The findings suggest that the negative impact on unconcerned countries could potentially indicate that the coefficient in Table 11 is not driven only by concerned countries as countries that didn't complain similarly see a decline. Since the current result suggests that reverse causality doesn't drive the entire average effect in the previous regression. This supports the earlier literature's interpretation of the average effect for both concerned and unconcerned countries as a marginal effect, regardless of the origin's complaint status.

So far, we've shown that TBTs make it less likely for the Chinese firms to keep importing. Fontagné et al. (2015) found that firm size and ownership structure play a crucial role in shaping exporter behavior, and I'm exploring their potential influence on importers' reactions to TBTs and changes in the import market due to TBT.

4.5.2 Heterogeneity

This section investigates firm's probability to import conditional on having imported in the previous period depending on importer size. We first evaluate the impacts of TBTs on firms' conditional probability of importing in accordance with their sizes and ownership structure. The results show that only very large firms decrease the probability to import conditional on having imported in the previous period, while small firms increase the probability of importing.

In addition, when I look at how different firms' respond to TBTs based on firm import share. Firm import share is the share of a firm's imports in a certain geographical

market and HS4 product over total China's imports in the same market and product. So, it could represent, to some extent, a firm's market power in the importing market. I find that TBTs have a greater negative impact on firms with a larger import share. Following this, the ownership structure appears to only impact firms not located on the Chinese mainland.

To estimate the average impact of TBTs on heterogenous firms across origins I use :

$$P[y_{ipot} > 0 | y_{ipo(t-1)} > 0] = \beta_0 + \beta_1 I[STC_{pt} = 1] + \gamma X_{ft} + \delta I[STC_{pt} = 1] * X_{ft} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.7),$$

Where $P[y_{fpot} > 0 | y_{ipo(t-1)} > 0]$ is the probability that a firm “f” continues to import product p from origin o at time t conditional on having imported the same product from the same origin in t-1. $I[STC_{pt} = 1]$ is an indicator function that takes value one if the imported product p is affected by STCs from any of the trading partners in time t. X_{ft} is a set of firm characteristics such as firm size, firm import market share or ownership. γ and δ are a vector of coefficients.

To understand how the impact of TBTs on the extensive margin in countries that raised a concern with a WTO and countries that didn't varies with importer characteristics I interact the independent variables from equation 4.7 with firm size and firm ownership in equation (4.8)

$$\begin{aligned} P[y_{fpot} > 0 | y_{ipo(t-1)} > 0] &= \beta_0 + \beta_1 I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] + \\ &\beta_2 I[STC_{pot}^o = 1] + \gamma X_{ft} + \delta I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * X_{ft} + \delta I[STC_{pot}^o = 1] * \\ &X_{ft} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (4.8), \end{aligned}$$

Where $P[y_{fpot} > 0 | y_{ipo(t-1)} > 0]$ is the probability that a firm “f” continues to import product p from origin o at time t conditional on having imported the same product from the same origin in t-1. $I[STC_{pot}^o = 1]$ (o denotes the origin of exports and $-o$ denotes other countries but the source country of imports for product, firm

and time period in question.) indicates imports from origins which lodged an STC complaint themselves versus exporters that were affected by a TBT associated with an STC who didn't lodge a complaint themselves ($I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$). X_{ft} is a set of firm characteristics (firm size, firm import market share or ownership), γ , φ and δ are a vector of coefficients.

4.5.2.1. Firm Size and import market share

This section examines the TBTs' impact on the heterogenous firms' probability to import conditional on having imported in the previous period based on their sizes and import market share. We categorize the size of firms by their yearly income, and we find that only very large firms decrease the conditional probability of importing, while small firms increase the conditional probability of importing.

In addition to exploring the effect of firm size on probability of importing, we evaluate the impact of importers' import share. The firm import share is defined as the ratio between a firm's imports in a specific geographic and product market by the total number of imports for China in that same country product market. The share measures the importance of the firm in the market, in terms of its imports. This is consistent with large firms who have more buying power to be more able to switch source origins instead of negotiating better terms with the suppliers in response to TBTs.

Table 4.13 Impact on different size of firm

Dependent Variable:	$P[y_{fpot} > 0 y_{fpot(t-1)} > 0]$
$I[STC_{pt} = 1]$	-0.015*** (0.004)
$Small_{ft}$	-0.005 (0.005)
$Medium_{ft}$	0.003

	(0.002)
$Large_{ft}$	0.011***
	(0.001)
$I[STC_{pt} = 1] * Small_{ft}$	0.025*
	(0.014)
$I[STC_{pt} = 1] * Medium_{ft}$	0.004
	(0.009)
$I[STC_{pt} = 1] * Large_{ft}$	-0.008
	(0.006)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 256
<hr/>	

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.13a Impact on different size of firm

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	-0.019***
	(0.004)
$Tariff_{pt}$	0.001*
	(0.001)
$Small_{ft}$	-0.012
	(0.005)

$Medium_{ft}$	-0.015***
	(0.004)
$Large_{ft}$	-0.003
	(0.002)
$I[STC_{pt} = 1] * Small_{ft}$	0.031**
	(0.014)
$I[STC_{pt} = 1] * Medium_{ft}$	0.009
	(0.009)
$I[STC_{pt} = 1] * Large_{ft}$	-0.005
	(0.006)
$Tariff_{pt} * Small_{ft}$	0.001
	(0.014)
$Tariff_{pt} * Medium_{ft}$	0.002***
	(0.001)
$Tariff_{pt} * Large_{ft}$	0.002***
	(0.001)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 256
<hr/>	

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.13 reports the effects of TBTs on conditional probability of importing for various sizes of firms. Only very large firms decrease the conditional probability of importing from the same origin, while small firms increase the conditional probability

of importing from the same origin. This result aligns with Table 4.15, which indicates that firms with a larger import share in the trade market are less likely to continue importing when affected by TBTs. This suggests that the results in Table 4.11, which show that TBTs decrease firm's probability to import conditional on having imported in the previous period, are primarily driven by very large firms. As shown in Table 4.13a, inclusion of Tariff didn't change the TBTs' impact too much.

Table 4.14 Impact on different size of firm (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	-0.010** (0.005)
$I[STC_{pot}^o = 1]$	-0.027*** (0.006)
$Small_{ft}$	-0.005 (0.005)
$Medium_{ft}$	0.003 (0.002)
$Large_{ft}$	0.011*** (0.001)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Small_{ft}$	0.028* (0.015)
$I[STC_{pot}^o = 1] * Small_{ft}$	0.010 (0.023)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Medium_{ft}$	-0.002 (0.010)
$I[STC_{pot}^o = 1] * Medium_{ft}$	0.018* (0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Large_{ft}$	-0.012**

	(0.006)
$I[STC_{pot}^o = 1] * Large_{ft}$	0.001
	(0.006)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 256
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Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.14a Impact on different size of firm (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	-0.013**
	(0.005)
$I[STC_{pot}^o = 1]$	-0.031***
	(0.006)
$Tariff_{ft}$	0.001*
	(0.001)
$Small_{ft}$	-0.012
	(0.008)
$Medium_{ft}$	-0.015***
	(0.004)
$Large_{ft}$	-0.003
	(0.002)

$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Small_{ft}$	0.032**
	(0.015)
$I[STC_{pot}^o = 1] * Small_{ft}$	0.018
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Medium_{ft}$	0.002
	(0.010)
$I[STC_{pot}^o = 1] * Medium_{ft}$	0.023**
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Large_{ft}$	-0.010
	(0.006)
$I[STC_{pot}^o = 1] * Large_{ft}$	0.005
	(0.006)
$Tariff_{pt} * Small_{ft}$	0.001
	(0.001)
$Tariff_{pt} * Medium_{ft}$	0.002***
	(0.001)
$Tariff_{pt} * Large_{ft}$	0.002***
	(0.001)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 256
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Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.14 reports the differential effects of TBTs on conditional probability of

importing of various sizes of firms between concerned countries and unconcerned countries. For very large firms, the results align with Table 4.12, showing that the distinction between concerned and unconcerned has minimal influence on the conditional probability of importing. TBTs only affect small and large firms that import from origins without complaints. Small firms enhance the conditional probability of importing, whereas large firms decrease the conditional probability of importing, potentially indicating from Table 4.12's results that very large firms are the driving force behind the decrease in the conditional probability of importing from countries without complaints. Table 4.14a shows that when tariff is added into the regression, the effects of TBTs are less affected by the inclusion of tariff.

Table 4.15 shows the average effect of TBTs on the conditional probability of importing for different types of firms based on their import share. The coefficient of the first line still indicates that TBTs decrease the conditional probability of importing, though it's not significant. The value of the second line shows that firms with a larger import share in the Chinese import market usually have a greater conditional probability of continuing to import. The third line's negative sign of the coefficient indicates that TBTs have a greater negative impact on firms with a larger import share. This result makes sense because firms with a larger import share typically possess greater market power, making it easier for them to change their sourcing origins when TBTs impact their imports.

Table 4.15 Impact on different firm import share

Dependent Variable:	$P[y_{fpo} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	-0.003 (0.010)
$\ln(firm_share)_{ipo(t-1)}$	1.844*** (0.006)

$$I[STC_{pt} = 1] * \ln(firm_share)_{ipo(t-1)} \quad -0.273^{***}$$

$$(0.025)$$

Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 342

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.16 displays TBTs' differential impacts for different origins on the firms' conditional probability of importing based on their import share. The results are similar to those in Table 4.12, where it finds that distinguishing between concerned and unconcerned has little impact on the conditional probability of importing. Compared to Table 4.15, the coefficients from the last two lines show that TBTs have a bigger effect on firms that import more. They also have a bigger effect on firms that continuously import from concerned countries than from unconcerned countries.

Table 4.16 Impact on different firm import share (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.002
	(0.013)
$I[STC_{pot}^o = 1]$	-0.009
	(0.007)

$\ln(firm_share)_{ipo(t-1)}$	1.843*** (0.009)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * \ln(firm_share)_{ipo(t-1)}$	-0.245*** (0.034)
$I[STC_{pot}^o = 1] * \ln(firm_share)_{ipo(t-1)}$	-0.310*** (0.023)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 342
<hr/>	

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

4.5.2.2. Firm Ownership Structure

In this section, I analyze the various effects of TBTs on six types of ownership firms, to determine whether firm ownership could potentially influence the variation in the impact of TBTs on firm's probability to import conditional on having imported in the previous period. In order to check this, we add the variable of ownership as well as the interaction term with TBTs into the baseline model. We find that the ownership structure appears to only impact firms not located on the Chinese mainland.

Table 4.17 Impact on different ownership firms

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	0.010

	(0.009)
$State_{ft}$	-0.027***
	(0.005)
$Foreign_{ft}$	-0.015***
	(0.004)
HMT_{ft}	-0.058***
	(0.004)
$Others_{ft}$	-0.067***
	(0.005)
$Collectively_{ft}$	-0.029***
	(0.005)
$I[STC_{pt} = 1] * State_{ft}$	-0.015
	(0.013)
$I[STC_{pt} = 1] * Foreign_{ft}$	-0.018**
	(0.008)
$I[STC_{pt} = 1] * HMT_{ft}$	-0.013
	(0.010)
$I[STC_{pt} = 1] * Others_{ft}$	-0.013
	(0.012)
$I[STC_{pt} = 1] * Collectively_{ft}$	-0.009
	(0.014)

Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 305

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.17a Impact on different ownership firms

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pt} = 1]$	0.010 (0.009)
$Tariff_{pt}$	0.005 (0.001)
$State_{ft}$	-0.027*** (0.005)
$Foreign_{ft}$	-0.015*** (0.004)
HMT_{ft}	-0.058*** (0.004)
$Others_{ft}$	-0.067*** (0.005)
$Collectively_{ft}$	-0.029*** (0.005)
$I[STC_{pt} = 1] * State_{ft}$	-0.015 (0.013)
$I[STC_{pt} = 1] * Foreign_{ft}$	-0.018** (0.008)
$I[STC_{pt} = 1] * HMT_{ft}$	-0.013 (0.010)
$I[STC_{pt} = 1] * Others_{ft}$	-0.013 (0.012)
$I[STC_{pt} = 1] * Collectively_{ft}$	-0.009 (0.014)

$Tariff_{pt} * State_{ft}$	-0.001 (0.001)
$Tariff_{pt} * Foreign_{ft}$	0.001** (0.001)
$Tariff_{pt} * HMT_{ft}$	0.001 (0.000)
$Tariff_{pt} * Others_{ft}$	-0.002** (0.001)
$Tariff_{pt} * Collectively_{ft}$	-0.001* (0.001)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 305
<hr/>	

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.17 reports the regression result for a sample of six types of ownership for importing firms; we take the private-owned as the control group. When we look at the coefficients of the five ownership firms (lines 2–6), we can see that, compared to the control group of privately-owned firms, each of these firms has a negative relationship with the conditional probability of importing. The coefficients from the interaction terms indicate that, when compared to private-owned firms, only foreign firms are affected by ownerships structure.

Then, I study the differential impact of TBTs for different origins on the

heterogeneous firm's probability to import, conditional on having imported in the previous period and taking into account the ownership structure. Table 4.18 describes the results for eq. (4.8). The values in the first two lines are consistent with the STCs' differential effects for different origins: STCs promote the conditional probability of importing from uncomplaining countries but lower the conditional probability of importing from complaining countries. All five ownership firms show a negative relationship with the conditional probability of importing, in line with the results presented in Table 4.17. For foreign-owned, HMT-owned, and other types of firms, the coefficients from the interaction terms significantly lower the conditional probability of importing from uncomplaining countries compared to privately owned firms.

The results only find the effect for source origins that didn't complain themselves, and private firms actually increase the firm's probability to import conditional on having imported in the previous period. For private firms, the probability of importing from the same origin increases following a TBT, whereas for foreign firms and firms based in Hong Kong, Macao, and Taiwan, which are not based on the mainland of China, the conditional probability of importing decreases. One explanation for this is that foreign firms, as well as firms not based in China, may have better capability to find alternate resources for importing. Besides, Table 4.17a and 4.18a show that there is no evidence that inclusion of tariffs would affect the TBTs' impact.

Table 4.18 Impact on different ownership firms (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpot(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& \widetilde{STC}_{pot}^o = 1]$	0.018*
	(0.010)
$I[STC_{pot}^o = 1]$	-0.001
	(0.010)

$State_{ft}$	-0.027***
	(0.005)
$Foreign_{ft}$	-0.015***
	(0.004)
HMT_{ft}	-0.058***
	(0.004)
$Others_{ft}$	-0.067***
	(0.005)
$Collectively_{ft}$	-0.029***
	(0.005)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * State_{ft}$	-0.023
	(0.018)
$I[STC_{pot}^o = 1] * State_{ft}$	-0.004
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Foreign_{ft}$	-0.023***
	(0.008)
$I[STC_{pot}^o = 1] * Foreign_{ft}$	-0.013
	(0.011)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * HMT_{ft}$	-0.035***
	(0.011)
$I[STC_{pot}^o = 1] * HMT_{ft}$	0.012
	(0.013)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Others_{ft}$	-0.013
	(0.015)
$I[STC_{pot}^o = 1] * Others_{ft}$	-0.028***
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Collectively_{ft}$	-0.021
	(0.018)
$I[STC_{pot}^o = 1] * Collectively_{ft}$	0.009
	(0.014)

Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 305

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4.18a Impact on different ownership firms (different origins)

Dependent Variable:	$P[y_{fpot} > 0 y_{fpo(t-1)} > 0]$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.018*
	(0.010)
$I[STC_{pot}^o = 1]$	-0.001
	(0.010)
$Tariff_{pt}$	0.005***
	(0.001)
$State_{ft}$	-0.027***
	(0.005)
$Foreign_{ft}$	-0.015***
	(0.004)
HMT_{ft}	-0.058***
	(0.004)
$Others_{ft}$	-0.067***
	(0.005)

$Collectively_{ft}$	-0.029***
	(0.005)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * State_{ft}$	-0.023
	(0.018)
$I[STC_{pot}^o = 1] * State_{ft}$	-0.004
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Foreign_{ft}$	-0.023***
	(0.008)
$I[STC_{pot}^o = 1] * Foreign_{ft}$	-0.013
	(0.011)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * HMT_{ft}$	-0.035***
	(0.011)
$I[STC_{pot}^o = 1] * HMT_{ft}$	0.012
	(0.013)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Others_{ft}$	-0.013
	(0.015)
$I[STC_{pot}^o = 1] * Others_{ft}$	-0.028***
	(0.010)
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1] * Collectively_{ft}$	-0.021
	(0.018)
$I[STC_{pot}^o = 1] * Collectively_{ft}$	0.009
	(0.014)
$Tariff_{pt} * State_{ft}$	-0.001**
	(0.001)
$Tariff_{pt} * Foreign_{ft}$	0.001
	(0.001)
$Tariff_{pt} * HMT_{ft}$	0.001*
	(0.001)
$Tariff_{pt} * Others_{ft}$	-0.002**
	(0.000)

$Tariff_{pt} * Collectively_{ft}$	-0.001** (0.006)
<hr/>	
Product fixed effects	YES
Year fixed effects	YES
Firm fixed effects	YES
Origin fixed effects	YES
Observations	4, 481, 750
R2_adjusted	0. 305
<hr/>	

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

4.6 Conclusion

In conclusion, this chapter provides a comprehensive analysis of the impact of Technical Barriers to Trade (TBTs) on firm imports, with heterogeneous analysis on how these barriers affect firms differently based on their size and ownership structure. Besides, the inclusion of China import tariffs verifies that tariffs doesn't affect the TBTs' impact on firms' imports.

First, I address concerns regarding the use of Specific Trade Concerns (STCs) as a proxy for TBTs by comparing the effects of three TBT measures—announced, enforced, and STCs—on firm imports. The results show consistent impacts across all measures, confirming the robustness of the relationship between TBTs and reduced imports, contributing to the reliability of previous literature.

Based on the results above, I explore the heterogeneity in firm responses to TBTs, finding that smaller firms are more negatively affected by TBTs, while larger firms demonstrate greater adaptability. I also show that ownership structure has minimal influence on the impact of TBTs on imports.

Second, the chapter highlights the differentiated impact of TBTs on different origins. The findings reveal a trade diversion effect, where firms reduce imports from countries that raised concerns but increase imports from other sources. Larger firms primarily drive this behavior.

Lastly, I analyze how TBTs influence a firm's probability of continuing to import. The results suggest that TBTs significantly reduce the likelihood of importing, especially for larger firms with more market power, who tend to shift to alternative import sources. This section also reveals that firms with a larger import share are more negatively impacted by TBTs, and that firm size plays a crucial role, with smaller firms demonstrating a greater likelihood of maintaining trade relationships with the same origins.

This chapter provides a detailed examination of the extensive and intensive margins of firm imports in response to TBTs, offering new insights into how firms of different sizes and ownership structures navigate trade barriers.

Chapter 5 Firm productivity and TBT

5.1 Introduction

This chapter investigates the impact of Technical Barriers to Trade (TBTs) on firm productivity, building on the growing body of literature that explores how trade barriers affect firm performance. Following Pavcnik's (2001) two-step method, which demonstrated that trade liberalization boosts plant-level productivity in Chile, I apply a similar approach to assess the effects of TBTs on the productivity of Chinese importers.

TBTs can raise marginal costs by restricting access to critical imported inputs, potentially decreasing a firm's resource efficiency and lowering productivity. To

capture this, I analyze the impact of TBTs using three measurements of firm-level TBTs: (1) the impact of STCs on one of a firm's imports; (2) the proportion of STC-affected HS4 imported inputs in terms of import number; and (3) the proportion of STC-affected HS4 imported inputs in terms of import value. When using a straightforward measurement—simply assessing whether a firm's imports are impacted by STCs—I find that TBTs seem to boost firm productivity. However, when considering the proportion of affected inputs, both in terms of number and value, TBTs are shown to negatively impact productivity. This suggests that simplified measurements of TBTs may obscure the actual extent of their negative effects.

In addition, I explore how firm size and ownership structure influence the response to TBTs. The results show that smaller firms are disproportionately affected by TBTs, experiencing significant declines in productivity, whereas larger firms are better able to cope with these trade barriers. Interestingly, ownership structure appears to have little impact on how firms respond to TBTs.

This chapter makes contributions to the literature of how TBTs affect firm productivity. By broadening the scope of analysis beyond tariffs, as examined by Amit and Konings (2007), this chapter emphasizes the importance of non-tariff barriers like TBTs and their complex effects on firm performance. Additionally, the findings on firm heterogeneity highlight the vulnerability of smaller firms to trade restrictions, offering valuable insights for policymakers and businesses alike.

This chapter of the study on the impact of TBTs on productivity arranges the following contents: a brief description of the data used in this chapter and an empirical study on the effect of TBTs on the productivity of importers, then followed by the impact of TBTs on productivity of heterogeneous firms in terms of their sizes and ownership structures.

5.2 Data

This chapter utilizes three key datasets: the WTO's Specific Trade Concerns (STCs) dataset, Chinese Customs' Firms Imports data, and the Chinese Industrial Firms dataset.

The Chinese Industrial Firms dataset provides annual balance sheet information for each firm, including variables such as the number of employees, net fixed assets, and operating revenue. These data are essential for estimating firms' total factor productivity using the Levinson and Petrin (2003) method.

The STC dataset is used to measure Technical Barriers to Trade (TBTs), as it captures binding TBTs through complaints raised by exporting countries. By linking the STC dataset with the firm import data, we create a combined dataset that details the STC-affected status of imported products for each firm, as well as the corresponding import value and quantity.

5.3 The impact of TBT on firm productivity

In addition to understanding how TBTs affect a firm's imports, it's crucial to understand how they affect a firm's productivity. Since productivity is an important indicator of overall efficiency for firms, restrictive TBTs can increase marginal costs by reducing access to imported inputs. If a firm's marginal cost increases, it may indicate inefficient resource use, leading to lower productivity for importers.

This section will examine the impact of technical barriers to trade (TBTs) on firm productivity using three different ways: the impact of STCs on a firm's imports, the proportion of STC-affected HS4 imported inputs in terms of imports number, and the proportion of STC-affected HS4 imported inputs in terms of import value. When we measure TBTs in a straightforward manner, i.e., if STCs impact any import of a firm, we find that they boost firm productivity. Measuring TBTs in the other two ways reveals that STCs reduce firm productivity, aligning with our expected outcome. This

suggests that a simple measurement of firm-level TBTs may not accurately capture the extent to which a firm is affected by TBTs.

After examining the average impact, I investigate the heterogeneity of importing firms' responses to TBTs in terms of size and ownership. The findings show that smaller firms are primarily responsible for the negative impact of TBTs on productivity, and the ownership structure has no bearing on this impact.

5.3.1 Baseline results

The last chapter showed how TBTs affect firm imports, so it's worth learning how they affect importer productivity. Protectionist Trade Theory believe that government-imposed TBTs will restrict imports, thereby supporting domestic firms, but is this truly the case? Even if TBTs lower imports, specifically the imports from the complaining countries that we find in Chapter 4, TBTs will cause the limited resources due to importing becoming more costly can lead to lower productivity because of reduced variety and because of lower quality inputs. From a policy perspective, it is therefore important to evaluate the impact of TBTs on productivity. This chapter's goal is to provide such an evaluation.

We estimate the effect of TBTs on productivity following a standard two step procedure followed in the literature on trade liberalization and firm performance (Pavcnik, 2002; Amiti and Konings, 2007; Fernandes, 2007; Topalova and Khandelwal, 2011; De Loecker et al., 2016; Brandt et al., 2017). We first estimate firm-level productivity based on TFP calculation method from Levinsohn and Petrin (2003). LP model shows below,

$$\begin{aligned} y_t &= \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t) + \eta_t \\ &= \beta_l l_t + \varphi(k_t, m_t) + \eta_t, \end{aligned}$$

where $\varphi(k_t, m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$, y_t is the firm's gross revenue, l_t is the logarithm of labor inputs, m_t is the logarithm of intermediate inputs, k_t is the logarithm of capital, ω_t is the transmitted productivity component, η_t is an error term

that is uncorrelated with input choices. By applying the firm's data (firm's gross revenue, labor inputs, intermediates inputs, capital inputs) on the Stata, we can obtain the productivity of China's manufacturing firms.

We measure the impact of TBTs on a firm in three ways. First, we define a firm as TBT-affected if it has STCs on any of its imports. This is a very reduced way to measure the firm-level TBT, but it has clear limitations because it cannot differentiate how seriously the firm is affected by this TBTs. Then that is addressed by the other two measures of TBTs, which the second way is to measure the firm-level TBTs as the share of affected HS4 imported inputs in terms of imports number. And the third measurement of firm-level TBTs is the share of affected HS4 imported inputs in terms of import value.

Then the impact of TBTs on firms' productivity is investigated by applying eq. (5.1).

$$\ln TFP_{ft} = \beta_0 + \beta_1 STC_{ft} + \lambda_t + \mu_f + \varepsilon_{ft} \quad (5.1),$$

where TFP_{ft} is the Total factor productivity of firm. STC_{ft} refers to three measurements of firm-level STCs: 1. $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm. 2. $STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number. 3. $STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Table 5.1 Impact (3 measurements) on productivity

	Dependent Variable: $\ln TFP_{ft}$		
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.018** (0.006)	-0.056*** (0.015)	-0.044*** (0.012)
Year fixed effects	YES	YES	YES

Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0. 747	0. 747	0. 747

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Table 5.1a Impact (3 measurements) on productivity

	Dependent Variable: $\ln TFP_{ft}$		
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.020** (0.006)	-0.055*** (0.014)	-0.044*** (0.010)
$Tariff_{ft}$	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)

Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0. 747	0. 747	0. 747

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Column (1) of Table 5.1 reports results from eq. (5.1) which includes firm and year-fixed effects. The coefficient is positive and significant (0.018), indicating that a one unit increase in STCs would result in a 1.8% increase in importing firms' productivity. This positive impact of STCs on productivity is not consistent with what we expect, the reason of this result might due to the reduced measure of STCs on firms. Because it doesn't take into account the fact that some firms have a large share of imported products that are affected by STCs and some firms only have a small portion of STC-affected imports. The simple measurement of firm-level STCs doesn't quantify the extent of impact on firms. When we measure the firm-level STCs in the share of STC-affected imports of a firm in table 21 and 22, we actually find significant negative effect on productivity.

Column (2) of Table 5.2 presents the outcomes of measuring the firm-level STCs based on the proportion of impacted HS4 imported inputs relative to the total number of imports. It demonstrates that the STCs decrease the productivity of firms, which is consistent with the result we expected. Column (3) of Table 5.3, which measures the firm-level STCs as the proportion of impacted HS4 imported inputs in terms of import value, confirms the detrimental effect of STCs on firms' productivity. Amit and Konings (2007) find the productivity gains resulting from the removal of intermediate input tariffs; this aligns with my findings, which show that even the elimination of tariffs, but firms' productivity reduce due to technical trade barriers. Next, the paper will investigate the impact of STCs on the productivity of heterogeneous firms in terms of size and ownership structure.

Table 5.1a is the results of the inclusion of China import tariff into the eq. (5.1), which

verifies that the TBTs' impact on firms' productivity is not affected by the tariffs. I measure the firm level tariff, $Tariff_{ft}$, as the weighted average of tariffs of these imported products of a firm f . The $Tariff_{ft}$ is given by $Tariff_{ft} = \sum_f \alpha_{pf} * Tariff_{pt}$, where α_{pf} is the share of imported product p in total imports for firm f . $Tariff_{pt}$ is the China import tariff at HS8 product level. Unlike the TBTs' impact on firms' productivity, tariffs promote the firm's productivity.

5.3.2 Heterogeneity

This section investigates the effects of TBTs on the productivities of heterogeneous firms. We specifically assess the degree of heterogeneity in the responses of firms to TBTs on productivities in relation to their size, as measured by annual revenue. Subsequently, we assess the various impacts of TBTs on the productivity of firms in accordance with their ownership structure.

The model we adopt in this section is: $lnTFP_{ft} = \beta_0 + \beta_1 STC_{ft} + \gamma X_{ft} + \varphi STC_{ft} * X_{ft} + \lambda_t + \mu_f + \varepsilon_{ft}$ (5.2), where TFP_{ft} is the Total factor productivity of firm. STC_{ft} refers to three measurements of firm-level STCs: 1. $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm. 2. $STC_{ft}(number)$ indicates that the share of affected HS4 imported imports in terms of imports number. 3. $STC_{ft}(value)$ indicates that the share of affected HS4 imported imports in terms of imports value. X_{ft} is a set of firm characteristics (size or ownership), γ and φ are a vector of coefficients. The interaction term captures the effect of STCs on these particular types of firms (firms with varying sizes or ownerships).

5.3.2.1 Firm Size

Based on the size firms, this section investigates the heterogeneous response of their productivities to TBTs. The size of the firms was categorized by their yearly income, as we had previously done. The effect of TBTs on productivity may differ based on the significance of firm size. In order to address this issue, we incorporate the

relationships between firm size and TBTs into our baseline model.

Table 5.2 Impact (3 measurements) on productivity of different firms (sizes)

	Dependent Variable: $\ln TFP_{ft}$		
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.012 (0.010)	-0.009 (0.031)	0.036* (0.022)
$Small_{ft}$	-6.905*** (0.164)	-7.124*** (0.144)	-7.083*** (0.143)
$Medium_{ft}$	-1.578*** (0.017)	-1.581*** (0.017)	-1.575*** (0.017)
$Large_{ft}$	-0.770*** (0.015)	-0.764*** (0.014)	-0.758*** (0.014)
$STC_{ft} * Small_{ft}$	-0.764** (0.256)	-0.609 (0.637)	-0.845* (0.479)
$STC_{ft} * Medium_{ft}$	-0.037** (0.013)	-0.076** (0.037)	-0.112*** (0.027)
$STC_{ft} * Large_{ft}$	0.014 (0.011)	0.008 (0.032)	-0.035 (0.023)
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0. 882	0. 882	0. 882

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Table 5.2a Impact (3 measurements) on productivity of different firms (sizes)

	Dependent Variable:	$\ln TFP_{ft}$	
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.009 (0.010)	-0.019 (0.028)	0.030* (0.017)
$Tariff_{ft}$	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)
$Small_{ft}$	-7.105*** (0.048)	-7.384*** (0.045)	-7.321*** (0.045)
$Medium_{ft}$	-1.723*** (0.016)	-1.731*** (0.015)	-1.723*** (0.015)
$Large_{ft}$	-0.822*** (0.014)	-0.816*** (0.013)	-0.809*** (0.013)
$STC_{ft} * Small_{ft}$	-0.739*** (0.047)	-0.565*** (0.637)	-0.812*** (0.013)
$STC_{ft} * Medium_{ft}$	-0.032** (0.012)	-0.069** (0.033)	-0.105*** (0.023)
$STC_{ft} * Large_{ft}$	0.016 (0.011)	0.015 (0.029)	-0.031* (0.019)
$Tariff_{ft} * Small_{ft}$	0.025**	0.033***	-0.030***

	(0.004)	(0.004)	(0.004)
$Tariff_{ft} * Medium_{ft}$	0.019***	0.019***	0.019***
	(0.001)	(0.001)	(0.001)
$Tariff_{ft} * Large_{ft}$	0.008***	0.008***	0.008
	(0.001)	(0.001)	(0.001)
<hr/>			
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0.882	0.882	0.882
<hr/>			

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Column (1) of Table 5.2 reports the effects of TBTs on productivity of various sizes of firms. The results indicate that TBTs lead to a decline in productivity in small and medium-sized firms, with smaller firms bearing a disproportionate impact. These results are not consistent with column (1) of Table 5.1, which shows the positive effect of TBTs on productivity. A reason for this inconsistency is the reduced measure of TBT, which actually losing some information (e.g. it didn't capture the extent to which a firm is affected by TBTs.) and the regression doesn't work as well.

Upon closer examination of column (2) of Table 5.2's results, we can observe that when we quantify firm-level TBTs as the proportion of HS4 imported inputs

compared to the total number of imports, TBTs only reduce the productivity of medium-sized firms. Column (3) of Table 5.2's results reveal that TBTs boost the productivity of very large firms, while they also boost the productivity of smaller and medium-sized firms, with small firms bearing the brunt. When measuring TBTs as the share of HS4 imported inputs in terms of import value, column (3) of Table 5.2's results show that smaller firms primarily drive the negative impact of TBTs on productivity. When the firm-level TBTs are measured in the share of STC-affected imports of a firm, the regression results have more consistency with the column (2) and column (3) of Table 5.1, which find the negative impact of TBTs on productivity

5.3.2.2 Firm Ownership Structure

Based on the ownership structure of firms, this section investigates the heterogeneous response of their productivities to TBTs. The six different kinds of firms were analyzed in terms of their ownership structure, as we had previously done. The effect of TBTs on productivity may differ based on the significance ownership in a firm. In order to address this issue, we incorporate the relationships between ownership and TBT into our baseline model.

Table 5.3 Impact on productivity of different firms (ownerships)

	Dependent Variable: $\ln TFP_{ft}$		
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.019 (0.016)	0.020 (0.025)	0.029 (0.022)
$State_{ft}$	-0.041 (0.030)	-0.024 (0.028)	-0.027 (0.027)

$Foreign_{ft}$	-0.071*** (0.016)	-0.014 (0.014)	-0.011 (0.014)
HMT_{ft}	-0.125*** (0.014)	-0.095*** (0.013)	-0.094*** (0.013)
$Others_{ft}$	-0.056** (0.023)	-0.053** (0.023)	-0.055** (0.023)
$Colletively_{ft}$	-0.051* (0.026)	-0.046* (0.024)	-0.053** (0.024)
$STC_{ft} * State_{ft}$	0.010 (0.033)	-0.045 (0.076)	-0.035 (0.053)
$STC_{ft} * Foreign_{ft}$	0.072*** (0.021)	-0.043 (0.044)	-0.059* (0.035)
$STC_{ft} * HMT_{ft}$	0.052** (0.020)	0.013 (0.038)	0.002 (0.032)
$STC_{ft} * Others_{ft}$	-0.068*** (0.018)	-0.205*** (0.037)	-0.180*** (0.030)
$STC_{ft} * Colletively_{ft}$	0.000 (0.032)	-0.000 (0.061)	0.036 (0.051)

Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0. 747	0. 747	0. 747

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

Table 5.3a Impact on productivity of different firms (ownerships)

	Dependent Variable:	$\ln TFP_{ft}$	
	(1) $I[STC_{ft} = 1]$	(2) $STC_{ft}(number)$	(3) $STC_{ft}(value)$
STC_{ft}	0.012 (0.018)	0.012 (0.031)	0.023 (0.027)
$Tariff_{ft}$	-0.000 (0.002)	-0.000 (0.002)	-0.000 (0.002)
$State_{ft}$	-0.044 (0.033)	-0.026 (0.032)	-0.027 (0.032)
$Foreign_{ft}$	-0.038* (0.022)	0.025 (0.020)	0.032 (0.020)
HMT_{ft}	-0.116*** (0.022)	-0.080*** (0.021)	-0.783*** (0.021)
$Others_{ft}$	-0.118** (0.024)	-0.119*** (0.024)	-0.121*** (0.023)
$Colletively_{ft}$	-0.099** (0.034)	-0.093** (0.033)	-0.099** (0.033)
$STC_{ft} * State_{ft}$	0.020 (0.027)	-0.032 (0.058)	-0.025 (0.046)
$STC_{ft} * Foreign_{ft}$	0.067** (0.021)	-0.058 (0.043)	-0.080 (0.034)
$STC_{ft} * HMT_{ft}$	0.049** (0.022)	-0.001 (0.044)	-0.013 (0.036)
$STC_{ft} * Others_{ft}$	-0.055** (0.020)	-0.200*** (0.038)	-0.179*** (0.032)

$STC_{ft} * Colletively_{ft}$	0.004 (0.035)	-0.008 (0.071)	0.032 (0.058)
$Tariff_{ft} * State_{ft}$	-0.000 (0.003)	-0.000 (0.003)	-0.000 (0.003)
$Tariff_{ft} * Foreign_{ft}$	-0.004** (0.002)	-0.006** (0.002)	-0.006** (0.002)
$Tariff_{ft} * HMT_{ft}$	-0.001 (0.002)	-0.002 (0.002)	-0.002 (0.002)
$Tariff_{ft} * Others_{ft}$	0.006*** (0.002)	0.007*** (0.002)	0.007*** (0.002)
$Tariff_{ft} * Colletively_{ft}$	0.006** (0.003)	0.006** (0.003)	0.006** (0.003)

Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Observations	132, 191	132, 191	132, 191
R2_adjusted	0. 747	0. 747	0. 747

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Note: $I[STC_{ft} = 1]$ indicates that there is STC on any import of a firm.

$STC_{ft}(number)$ indicates that the share of affected HS4 imported inputs in terms of imports number.

$STC_{ft}(value)$ indicates that the share of affected HS4 imported inputs in terms of imports value.

In column (1) of Table 5.3, the regression results for a sample of six categories of ownership (state-owned firms, foreign-owned firms, Hong Kong, Macao, and Taiwan-owned (HMK-owned), private-owned, collectively owned and others) for importing

firms are presented. The private-owned firm is designated as the control group. Examining the interaction term's coefficients reveals that the impact of STCs only matters for concerned countries for HMT, others, foreign firms. Specifically, STCs promote the productivity of HMT and foreign firms' while restricting others firms' productivity. Column (2) and (3) confirm that STCs limit the productivity of others firms. In this heterogeneity part, no matter for the firms in different sizes or ownerships, the inclusion of tariff into the original regression basically doesn't affect the TBTs' impact on firms' productivity.

5.4 Conclusion

This chapter evaluate the influence of TBTs on Chinese importers' productivity.

I analyze TBTs using three distinct measurements: (1) the effect of Specific Trade Concerns (STCs) on a firm's imports; (2) the percentage of STC-affected HS4 imported inputs by number; and (3) the percentage of STC-affected HS4 imported inputs by value. When using a simple metric—whether a firm's imports are affected by STCs—TBTs seem to improve firm productivity. However, when considering the proportion of affected inputs, both in terms of number and value, STCs show a negative impact on productivity. This suggests that simplified measurements of TBTs may overlook the full scope of their detrimental effects.

Additionally, I explore the heterogeneity in firm responses to TBTs based on size and ownership structure. The findings reveal that smaller firms are disproportionately harmed by TBTs, experiencing significant productivity declines, while larger firms are better equipped to manage these trade barriers. Interestingly, ownership structure does not seem to play a major role in shaping firms' responses to TBTs.

This chapter makes key contributions to the literature by emphasizing the role of non-tariff barriers like TBTs, which are often overlooked in studies that focus on tariffs, such as Amit and Konings (2007). It also highlights the vulnerability of smaller firms

to such trade restrictions, offering valuable insights for policymakers and businesses seeking to mitigate the negative effects of TBTs.

Conclusion

This dissertation conducts an in-depth investigation of the impact of Technical Barriers to Trade (TBTs) on firm-level outcomes from the perspective of importing firms in China. By integrating detailed customs transaction data with WTO TBT notifications and Specific Trade Concerns (STCs), it offers a novel empirical perspective on the ways in which regulatory trade measures—often framed in the name of safety, quality, or standardization—shape import behavior, input sourcing, and firm productivity.

The analysis generates several key findings. First, TBTs, especially those identified through STCs, have a statistically and economically significant negative effect on firms' import performance. These effects are particularly pronounced for smaller firms, which are more likely to reduce or cease imports when faced with regulatory trade costs. Larger firms, in contrast, exhibit greater adaptability by reallocating sourcing to countries not subject to the TBTs in question. This behavioral asymmetry underscores the heterogeneous burden of non-tariff barriers across firms of different sizes, consistent with the broader literature on firm heterogeneity and trade (e.g., Melitz, 2003; Fontagné et al., 2015).

Second, the results provide robust evidence of trade diversion in response to TBTs: firms reduce imports from countries where regulatory concerns have been raised and instead shift toward "unconcerned" origins. This echoes findings in export contexts (Fontagné and Orefice, 2018; Wei et al., 2023) where firms are shown to strategically reallocate trade to navigate regulatory frictions. Importantly, this study is among the first to document this phenomenon in the import context using firm-level data,

thereby contributing new empirical insights to the literature on trade policy and firm strategy.

Third, the analysis of firm productivity offers a nuanced view of the relationship between TBT exposure and performance. While a coarse binary measure of STC exposure suggests a potential productivity-enhancing effect—possibly reflecting selection bias or quality upgrading among surviving firms—more refined measures based on the share of affected imported inputs (by number and by value) indicate that TBTs in fact exert a negative effect on productivity. This result is in line with prior research (e.g., Singh and Chanda, 2021; Ghodsi, 2020) emphasizing that regulatory measures may disrupt input supply chains and raise marginal costs, thereby reducing operational efficiency.

Beyond the empirical findings, this dissertation contributes to broader discussions on the generalisability of TBT effects. Although the analysis is based on Chinese firms, the underlying mechanisms identified—namely, firms’ sensitivity to import-related compliance costs, their capacity to substitute sourcing origins, and the disproportionate impact of TBTs on smaller firms—are consistent with firm-level patterns observed in other economies. For instance, studies using French firm data (Fontagné et al., 2015) and Indian firm data (Singh and Chanda, 2021) similarly document that larger or more productive firms are better able to navigate technical regulatory environments. These cross-country parallels suggest that the findings are not uniquely China-specific but rather reflect broader patterns in how firms interact with technical trade regulations.

Nevertheless, it is also important to recognize that institutional, regulatory, and industrial contexts vary across countries, which may influence both the magnitude and channels of TBT effects. For example, in economies with less developed customs infrastructure or weaker regulatory enforcement, the de facto implementation of TBTs may be inconsistent, thereby weakening their trade-restrictive effects. Similarly, firms in countries with greater access to government support, information-sharing

mechanisms, or international certification infrastructure may be more resilient to regulatory shocks. These contextual factors should be carefully considered when applying the findings to other settings.

From a policy perspective, the dissertation highlights a potential trade-off between regulatory objectives and economic efficiency. While TBTs often serve legitimate goals related to product safety, environmental protection, and consumer information, they may inadvertently create non-tariff barriers that disproportionately burden smaller firms and distort input markets. Policymakers should therefore consider complementary measures—such as technical assistance, harmonization initiatives, or transitional support—to ensure that regulatory policies do not unduly hinder firm-level competitiveness, especially for resource-constrained firms.

In conclusion, this dissertation advances our understanding of how TBTs affect firms not just at the border, but in terms of their broader strategic behavior and performance. By highlighting the importance of firm heterogeneity, import origins, and compliance costs, it offers both empirical evidence and conceptual clarity on the multifaceted role of technical regulations in shaping international trade and industrial dynamics. These insights are valuable for academics, policymakers, and business practitioners seeking to understand the intersection between trade policy, firm behavior, and economic development in a world increasingly shaped by regulatory complexity.

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Appendix

Appendix A TBTs and corresponding STCs of China (2003-2007)

Table A1 TBTs and corresponding STCs of China in 2003

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CHN/17	Used mechanical and electrical products	Rules on Supervision and Administration of Imported Used Mechanical and Electrical Products	Human health and safety, Environment	01/01/2003	25/04/2003
G/TBT/N/CHN/13	Boilers, Pressure vessels, Safety appurtenances	Requirements on resources, quality management system and quality of product safety.	Consumer Safety or protection, Environment	15/03/2003	01/07/2003
STC1	09/11/2006	Concerned country: Korea		Issue raised: Unnecessary barrier to trade	
G/TBT/N/CHN/14	Boilers, Pressure vessels, Safety appurtenances	Procedures of application, acceptance of application, examination, approving and issuances of certificates as well as procedures for renewing certificates.	Consumer Safety or protection, Environment	15/03/2003	01/07/2003

G/TBT/N/CHN/15	Boilers, Pressure vessels, Safety appurtenances	The principles of supervision and inspection for safety performance of boiler and pressure vessel products.	Consumer Safety or protection, Environment	15/03/2003	01/07/2003
G/TBT/N/CHN/18	Used mechanical and electrical products	The basic procedure and general requirements on inspection, supervision and administration of used mechanical and electrical products	Environment, Human Health and Safety	01/04/2003	01/08/2003
G/TBT/N/CHN/19	Used mechanical and electrical products	The procedure and requirement on inspection, supervision and administration of used mechanical and electrical products	Environment, Human Health and Safety	01/04/2003	01/08/2003
G/TBT/N/CHN/16	Aluminum Pressure Cooker	The definition, product categorization, requirement, experimental method, inspection rule, marking, labelling, user's manual, packaging, transportation, storage and period of validity of aluminum pressure cooker.	Human Health and Safety	25/04/2003	01/10/2003
G/TBT/N/CHN/210	New chemical substances which are not yet produced	This measure specifies the application and registration of new chemical	Environment, Human Health	15/07/2003	15/10/2003

	or used within the territory of the People's Republic of China.	substances prior to production and import.	and Safety		
STC1	09/11/2006	Concerned country: EU		Issue raised: Standards	
STC2	21/03/2007	Concerned country: EU		Issue raised: Standards	
G/TBT/N/CHN/41	Manganese Ore Sand, Aluminum Ore Sand, Marble	Radioactivity inspection	Human Health and Safety, Environment	19/09/2003	18/12/2003
G/TBT/N/CHN/57	Waste materials, waste hardware, engines, and electrical equipment	The management measures on the temporary registration of overseas enterprises exporting waste materials to China	Environment	19/09/2003	01/01/2004
G/TBT/N/CHN/20	Products include yarns, fabrics and their made-up products	The standard specifies general safety technical requirements, test methods and inspection rules for textile products.	Human Health and Safety	03/10/2003	19/03/2004
G/TBT/N/CHN/21	Poly (ethylene terephthalate) (PET) resin	PET resin for bottles used for contacting food applies the analytical method for	Consumer Safety or protection	28/10/2003	19/03/2004

	for bottles	acetaldehyde content in this standard			
G/TBT/N/CHN/23	Single-capped fluorescent lamps	This standards specifies limited values of energy efficiency, evaluating values of energy conservation, test methods and inspection rules of single-capped fluorescent lamps.	Environment	28/10/2003	03/04/2004
G/TBT/N/CHN/24	Peanut oil	The standard specifies the definitions, classification, quality characteristics, test methods and rules as well as requirements on labeling, packaging, storage and transport	Human Health and Safety	28/10/2003	28/04/2004
G/TBT/N/CHN/25	Soybean oil	This standard specifies the definition, classification, quality characteristics, test methods and rules, as well as requirements on labeling, packaging, storage and transport.	Human Health and Safety	28/10/2003	28/04/2004
G/TBT/N/CHN/26	Motor-vehicles of category M1	This standard specifies technical requirements and test methods for the protection of occupants sitting at the front	Human Health and Safety	29/10/2003	28/04/2004

		outboard seats in the event of a frontal collision of M1 vehicles.			
G/TBT/N/CHN/27	Furniture	This national standard specifies basic requirements, methods and contents that should be included in when making an instruction of use of furniture.	Consumer Safety or protection, Environment	30/10/2003	28/04/2004
G/TBT/N/CHN/28	All kinds of electric devices used in voltage	General safety requirements for electric products in designing and manufacturing, selling and using.	Human Health and Safety	15/12/2003	29/04/2004
G/TBT/N/CHN/29	Black and white analog copier and black and white single functional digital copier	The standard prescribes the emission concentration limits of ozone, dust, styrene, etc.	Environment, Human Health and Safety	18/12/2003	30/04/2004

Table A2 TBTs and corresponding STCs of China in 2004

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CHN/58	Waste materials, and waste hardware, engines, and electrical equipment	The conditions of application for registration, documents need to be submitted, registration procedures, approval of registration, new term of validity of registration and the follow-up supervision.	Environment	09/01/2004	08/05/2004
G/TBT/N/CHN/56	Waste materials, and waste hardware, engines, and electrical equipment	The deadline for implementation of AQSIQ Public Notice 115,2003 is postponed to 1 September 2004.	Environment	12/03/2004	01/06/2004
G/TBT/N/CHN/42	Cigarette	All cigarettes produced after 1 July 2004, with the tar content in the mainstream of smoke labelled on packages of cigarettes is more than 15mg/piece, are not allowed to be sold on domestic market.	Consumer Safety or protection	08/05/2004	01/07/2004
G/TBT/N/CHN/44	Road vehicles	The definition of defects of road vehicles, management scope of defective road	Human Health and Safety	01/06/2004	01/10/2004

		vehicles, report, investigation and validation of defective road vehicles, work procedures of voluntary and mandatory recall of the defective road vehicles.			
G/TBT/N/CHN/54	Road vehicle	A compulsory standard specifying the content and structure of VIN, and the requirements for locating and fixing of the VIN on vehicles.	Human Health and Safety	01/07/2004	01/10/2004
G/TBT/N/CHN/55	Power driven vehicles operating on the roads within the territory of China.	A compulsory standard specifying the basic technical requirements and test methods for whole vehicles, main assemblies and safety-protection devices relating to the safety running of motor vehicles, and it also specifies the environmental protection requirements	Human Health and Safety	01/07/2004	01/10/2004
G/TBT/N/CHN/43	Boiler	This rule specifies confines and procedures for the verification of the	Consumer Safety or protection	30/07/2004	30/12/2004

		design documents.			
G/TBT/N/CHN/60	Air conditioner	The minimum allowable values of energy efficiency for room air conditioners.	Environment	31/08/2004	01/03/2005
G/TBT/N/CHN/61	Air conditioner	The minimum allowable values of energy efficiency for unitary air conditioners.	Environment	31/08/2004	01/03/2005
G/TBT/N/CHN/62	Air conditioner	The minimum allowable values of the energy efficiency and energy efficiency grades for water chillers	Environment	31/08/2004	01/03/2005

Table A3 TBTs and corresponding STCs of China in 2005

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CHN/160	Health food	This technical regulation includes the following contents: objectives, applicable scope, definition of health food, the application and approval of health food registration, raw material and excipient, etc.	Human Health and Safety	10/04/2005	01/07/2005
STC1	02/11/2005	Concerned country: US		Issue raised: Transparency	
G/TBT/N/CHN/65	Battery powered and internal combustion engine powered industrial trucks for explosive atmospheres.	General rules of explosion-protect techniques of industrial trucks for explosive atmospheres	Human Health and Safety	10/04/2005	10/10/2005
G/TBT/N/CHN/66	Disc separator, tubular separator, multichamber separator for industry uses.	This standard stipulates safety requirements that should be followed in designing, manufacturing, assembling, using and maintaining of disc separator,	Human Health and Safety	10/04/2005	10/10/2005

		tubular separator, multichamber separator to be used in industries.			
G/TBT/N/CHN/67	Centrifuges for industry uses.	This standard stipulates safety requirements that should be followed in designing, manufacturing, assembling, using and maintaining centrifuges with a metal drum used in industries.	Human Health and Safety	10/04/2005	10/10/2005
G/TBT/N/CHN/68	Glass vessels used for filling with food, drinking water et	The permitted limits of lead, cadmium, arsenic and antimony released from packaging glass containers contacting with food, medicines, alcohol and beverage, etc.	Human Health and Safety	10/04/2005	10/10/2005
G/TBT/N/CHN/70	Fans	Limited values of energy efficiency, evaluating values of energy conservation and test methods for fans.	Environment	10/04/2005	10/10/2005
G/TBT/N/CHN/71	Copper concentrate, lead concentrate, zinc concentrate, lead and zinc bulk concentrate, tin	Limits of harmful element (lead, arsenic, cadmium, mercury and fluorin) content in heavy metal concentrate products.	Environment	10/04/2005	10/10/2005

	concentrate, nickel concentrate, cobalt-sulphur concentrate				
G/TBT/N/CHN/72	All pre-packaged alcoholic beverage	General Standard for the Labelling of Prepacked Alcoholic Beverage	Consumer Safety or protection	10/04/2005	10/10/2005
STC1	23/03/2005	Concerned country: US, EU		Issue raised: Unnecessary barrier to trade	
G/TBT/N/CHN/73	Motorcycles and Mopeds	The limit and measurement method for noise released from motorcycles and mopeds.	Environment	10/04/2005	10/10/2005
G/TBT/N/CHN/74	Motorcycles and Mopeds	The limit and measurement of noise released from accelerating motorcycles and mopeds.	Environment	10/04/2005	10/10/2005
G/TBT/N/CHN/75	Vehicles equipped with positive-ignition gasoline engines and their maximum mass is greater than 3500kg	Limits of emission for appropriate vehicles, and describes measuring methods and test procedures in detail.	Environment	10/04/2005	10/10/2005
G/TBT/N/CHN/76	Vehicles equipped with	Limits of release for appropriate	Environment	10/04/2005	10/10/2005

	positive-ignition gasoline engines and their maximum mass is greater than 3500kg	vehicles, and describes the measuring methods and test procedures in detail.			5
G/TBT/N/CHN/77	Food additive Xylitol	Mandatory technical requirements and voluntary requirements for test methods and inspection rules for food additive xylitol.	Quality	10/04/2005	10/10/2005
G/TBT/N/CHN/78	Cigarettes	Technical requirements for packing, making, storage and transport, etc.	Human Health and Safety	25/04/2005	25/10/2005
G/TBT/N/CHN/80	Compression Ignition Engine (C.I.E) and vehicle equipped with C.I.E	Limits and Measurement Methods for Exhaust Smoke from C.I.E(Compression Ignition Engine) and Vehicle Equipped with C.I.E.	Environment	30/04/2005	01/11/2005
G/TBT/N/CHN/81	Compression ignition engines and gas engines	The limits and measurement methods of our country for exhaust pollutants from compression ignition and gas fueled positive ignition engines used in vehicles in three stages	Human Health and Safety, Environment	01/05/2005	01/11/2005
G/TBT/N/CHN/82	Vehicles equipped with	Limits and Measurement Methods for	Environment	01/05/2005	01/11/2005

	ignition engine	Exhaust Pollutants from Vehicles Equipped Ignition Engine under Two- speed Idle Conditions and Driving Mode Conditions			5
G/TBT/N/CHN/83	Two wheels and three wheels vehicles equipped with ignition gasoline engines of which the maximum mass is lower than 400 kg	The limits of exhaust smoke emissions and states the detailed measurement methods and test procedure for motorcycles and mopeds.	Human Health and Safety, Environment	01/05/2005	01/11/200 5
G/TBT/N/CHN/84	Quadricycles and three- wheeled cars for agricultural transportation	Limit and Measurement of the Voice Outside Accelerating Three wheeled car or Low-speed Truck	Environment	01/05/2005	01/11/200 5
G/TBT/N/CHN/85	Diesel Engines of tri-wheel & low-speed truck	Limits and measurement methods for exhaust pollutants from diesel engines of tri-wheel & low-speed trucks	Human Health and Safety, Environment	01/05/2005	01/11/200 5
G/TBT/N/CHN/86	Color television broadcasting receiver	The limited values of energy efficiency, evaluating values of energy conservation, target values of energy efficiency, test	Environment	01/05/2005	04/12/200 5

		methods and inspection rules for color TVs.			
G/TBT/N/CHN/183	Toilet paper, tissue paper, paper handkerchief, napkin, paper napkin, paper diaper, paper clothing and paper bedsheet	The mandatory inspection and quarantine shall be executed on the entry of these commodities.	Consumer Safety or protection	04/06/2005	01/01/2006
G/TBT/N/CHN/94	Batteries	Notice on Restriction of Hg in Imported Batteries	Environment	01/08/2005	01/01/2006
G/TBT/N/CHN/187	Independent WLAN Products/Products with embedded WLAN modules/Software with WAPI function/Software with WAPI function	Specifies the physical layer specification with high-speed in 5.8GHz.	Quality	21/09/2005	01/01/2006
STC1	23/03/2004	Concerned country: EU, US, Japan, Mexico		Issue raised: Unnecessary barrier to trade	
STC2	17/03/2006	Concerned country:		Issue raised:	

		EU, US, Japan, Mexico		Unnecessary barrier to trade, Legitimacy and Rationale	
STC3	09/06/2006	Concerned country: EU, Japan		Issue raised: Clarification	
STC4	09/11/2006	Concerned country: Japan		Issue raised: Clarification	
G/TBT/N/CHN/188	Independent WLAN Products/Products with embedded WLAN modules/Software with WAPI function/Software with WAPI function	Specifies the physical layer specification with further higher data extension in the 2.4 GHz Band.	Quality	21/09/2005	01/01/2006
STC1	23/03/2004	Concerned country: EU, US, Japan, Mexico		Issue raised: Unnecessary barrier to trade	
STC2	17/03/2006	Concerned country: EU, US, Japan, Mexico		Issue raised: Unnecessary barrier to trade, Legitimacy and	

				Rationale	
STC3	09/06/2006	Concerned country: EU, Japan		Issue raised: Clarification	
STC4	09/11/2006	Concerned country: Japan		Issue raised: Clarification	
G/TBT/N/CHN/189	Independent WLAN Products/Products with embedded WLAN modules/Software with WAPI function/Software with WAPI function	Specifies the enhanced security of WLAN products	Quality	21/09/2005	01/01/2006
STC1	23/03/2004	Concerned country: EU, US, Japan, Mexico		Issue raised: Unnecessary barrier to trade	
STC2	17/03/2006	Concerned country: EU, US, Japan, Mexico		Issue raised: Unnecessary barrier to trade, Legitimacy and Rationale	
STC3	09/06/2006	Concerned country:		Issue raised:	

		EU, Japan		Clarification	
STC4	09/11/2006	Concerned country: Japan		Issue raised: Clarification	
G/TBT/N/CHN/90	Metrological instruments subject to type approval	Catalogue of Metrological Instruments Subject to Type Approval of the People's Republic of China	Consumer Safety or protection	28/09/2005	01/02/2006
G/TBT/N/CHN/91	Sitting W.C. pan, squatting W.C. pan and urinals	Mandatory standards for sanitary wares	Human Health and Safety, Environment	28/09/2005	21/03/2006
G/TBT/N/CHN/92	Rubber suction hose for fire-fighting purpose.	The specification, performance and mark of the rubber suction hose for fire- fighting purpose.	Human Health and Safety	28/09/2005	21/03/2006
G/TBT/N/CHN/93	Fire coupling	General Technical Conditions, Patterns and Basic Parameters for Fire Coupling	Human Health and Safety	28/09/2005	21/03/2006
G/TBT/N/CHN/96	Structural silicon sealants for building	The terms, classification and mark, requirements, test method, inspection rule, package, label, transportation and storage of the structural silicon sealants for building	Human Health and Safety	28/10/2005	28/03/2006

G/TBT/N/CHN/97	Foam Fire Extinguishing Systems and Components	The performance requirements, test methods, inspection rule and the requirements for packaging, transportation and storage of foam fire extinguishing systems and components.	Human Health and Safety	28/10/2005	28/03/2006
G/TBT/N/CHN/98	Fire nozzles	This mandatory standard stipulates the performance requirements and test methods for fire nozzles.	Human Health and Safety	28/10/2005	28/03/2006
G/TBT/N/CHN/99	Microorganisms, human tissues, biological products, human blood and its product	The supervision and administration system for sanitary quarantine approval, spot inspection and surveillance of the entry and exit microorganisms, human tissues, biological products, human blood and its products.	Human Health and Safety	28/10/2005	28/03/2006
G/TBT/N/CHN/190	Foods and cosmetics	The labelling audit system for import and export foods and cosmetics is modified from pre-audit system to the system of conducting the audit during inspection and quarantine after arrival of the goods	Quality	28/10/2005	01/04/2006

		at the port.			
STC1	09/06/2006	Concerned country: EU	Issue raised: Clarification, Unnecessary barrier to trade		
G/TBT/N/CHN/113	Combine harvester	This standard stipulates limits of noise at the operator's position and dynamic environmental noise emitted by the combine harvester	Human Health and Safety	28/10/2005	28/04/2006
G/TBT/N/CHN/114	Mobile cranes	This standard specifies limits and measurement methods for operating noise of mobile cranes (wheel cranes, truck cranes and crawler cranes).	Environment	29/10/2005	28/04/2006
G/TBT/N/CHN/115	M1 and N1 vehicles with R point of the lowest seat no more than 700 mm from the ground under reference mass	Requirements and procedures for lateral collision test, as well as provides the alteration of vehicle	Human Health and Safety	18/11/2005	28/04/2006
G/TBT/N/CHN/116	Automobiles	This standard specifies technical	Human Health	18/11/2005	28/04/2006

		requirements and test methods for horizontal flammable characteristics of decorative materials inside automobiles.	and Safety		6
G/TBT/N/CHN/117	Motor vehicles of categories M and N and all other motor vehicles having less than four wheels fitted with bodywork which partially or wholly encloses the driver	This standard specifies performance requirements for rear view mirrors fixed on vehicles of categories M and N and their installation requirements	Human Health and Safety	18/11/2005	28/04/2006
G/TBT/N/CHN/118	M1 and other types of vehicles equipped with liquid fuel tank	This standard specifies safety requirements and test methods for the fuel system of passenger cars in the event of rear-end collision	Human Health and Safety	18/11/2005	28/04/2006
G/TBT/N/CHN/119	Door locks and door retention components used on either side of the doors of M1 and N1 vehicles for occupant in and out.	This standard specifies the performance requirements and test methods for the door locks and door retention components.	Human Health and Safety	18/11/2005	29/04/2006

G/TBT/N/CHN/120	Metal-halide lamps	This mandatory standard stipulates the minimum allowable values of energy efficiency, energy efficiency grades and test methods for metal-halide lamps	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/121	Ballast of metal-halide lamps	The minimum allowable values of energy efficiency, the evaluating values of energy conservation, the energy efficiency grades, test methods and inspecting rules for ballasts of metal-halide lamps	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/122	Three-phase distribution transformers	This mandatory standard stipulates the minimum allowable values of energy efficiency and test methods for three-phase distribution transformers.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/123	Wastes of bones	This standard stipulates the requirements for the control of the imported waste bones, their carried-wastes and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/124	Slag, dross, scaling, and	This standard stipulates the requirements	Environment	18/11/2005	18/05/2006

	other wastes; ash and residues containing V2O5 more than 10%	for the control of the imported smelt slag, their carried-wastes and radioactive pollution			6
G/TBT/N/CHN/125	Waste and scrap of paper or paperboard	The requirements for the control of the carried-wastes in the imported scrap paper or paperboard and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/126	Wood wastes; cork wastes	The requirements for the control of the carried-wastes in the imported wood wastes and the radioactive pollution control	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/127	Cotton waste, waste fibers, rags and scrap of textile material	The requirements for the control of the carried-wastes in the imported waste and scrap of fibers and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/128	Waste and scrap of iron and steel	This standard stipulates the requirements for the control of carried-wastes in the imported waste and scrap of iron and steel and radioactive pollution	Environment	18/11/2005	18/05/2006

G/TBT/N/CHN/129	Copper scrap, nickel scrap, aluminum scrap, zinc scrap, tin scrap, tantalum scrap, tungsten scrap, magnesium scrap, titanium scrap	This standard stipulates the requirements for the control of the carried-wastes in the imported non-ferrous metal scraps and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/130	Waste electric motors	This standard stipulates the requirements for the control of the imported waste electric motors, their carried-wastes and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/131	Waste wires and cables	This standard stipulates the requirements for the control of the imported waste wires and cables, their carried-wastes and the radioactive pollution control	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/132	Waste metal and electrical appliance scrap	This standard stipulates the requirements for the control of the imported waste metal and electrical appliances, their carried-wastes and the radioactive pollution control.	Environment	18/11/2005	18/05/2006

G/TBT/N/CHN/133	Vessels and other floating structures for breaking u	This standard stipulates the requirements for the control of the carried wastes in the imported vessels for breaking up and the radioactive pollution control	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/134	Waste and scrap of plastics	This standard stipulates the requirements for the control of the carried-wastes in the imported waste and scrap of plastics and the radioactive pollution control.	Environment	18/11/2005	18/05/2006
G/TBT/N/CHN/135	Compressed pieces of waste automobile	This standard stipulates the requirements for the control of the carried-wastes in the imported compressed pieces of waste automobile and the radioactive pollution control.	Environment	05/12/2005	18/05/2006
G/TBT/N/CHN/136	Mills for various uses, such as breaking mill, warming mill, sheeting mill, refining mill and grinding mill, etc	Scope, normative references, terms and definitions, list of hazards, safety requirements and measures, verification of safety requirements and measures, and information for use	Human Health and Safety	31/12/2005	18/05/2006

Table A4 TBTs and corresponding STCs of China in 2006

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CHN/137	Steel wire ropes for elevators	This standard specifies the technical requirements for the ropes of different types of lifts and also specifies the technical requirements of the structure, diameter and tensile strength of the ropes with smooth surface for lift.	Human Health and Safety	01/01/2006	18/05/2006
G/TBT/N/CHN/138	Railway steel rails of 60kg/m and 75kg/m linear mass	This standard specifies the code designations and the mechanical properties of the railway rails of 60kg/m and 75kg/m linear mass, and the technical requirements.	Human Health and Safety	01/01/2006	18/05/2006
G/TBT/N/CHN/139	Electrolytic machine tools	This standard specifies the safety requirements and measures, information for using, and the inspection of the safeguarding requirements for electrolytic machine tools.	Human Health and Safety	01/01/2006	18/05/2006

G/TBT/N/CHN/191	Copper concentrate	The content limits of harmful elements of import copper concentrate	Human Health and Safety, Environment	01/01/2006	01/06/2006
G/TBT/N/CHN/140	Electronic radar products, electronic communication products, broadcast and television products, computer products, etc.	Administration on the Control of Pollution Caused by Electronic Information Products	Human Health and Safety, Environment	10/01/2006	01/07/2006
STC1	02/11/2005	Concerned country: EU, Japan		Issue raised: Standards	
STC2	17/03/2006	Concerned country: US, EU, Japan		Issue raised: Standards, Clarification	
STC3	09/06/2006	Concerned country: US, EU, Japan		Issue raised: Unnecessary barrier to trade, Clarification	
STC4	09/11/2006	Concerned country: Japan		Issue raised: Legitimacy and Rationale, Clarification	
STC5	21/03/2007	Concerned country:		Issue raised:	

		Japan	Standards		
STC6	05/07/2007	Concerned country: Japan	Issue raised: Unnecessary barrier to trade		
G/TBT/N/CHN/141	Superphosphate	The technical requirements, testing methods, inspection procedures, marking, packages, transport and storage of superphosphate manufactured by the reaction of phosphorite and industrial sulfuric acid.	Quality	10/01/2006	10/07/2006
G/TBT/N/CHN/144	Roller skates	This standard provides the classification, requirements, test method, inspection rules and package label of the roller skates	Consumer Safety or protection	10/01/2006	10/07/2006
G/TBT/N/CHN/146	Pesticide	This standard contains: classification of packaging and requirements for packing of pesticides, etc.	Human Health and Safety	10/01/2006	10/07/2006
G/TBT/N/CHN/147	Pesticides	This standard contains the basic requirements for labels of pesticide	Human Health and Safety	10/01/2006	10/07/2006

		products and some other requirements.			
G/TBT/N/CHN/148	Potassium sulfate for agricultural use	It sets the technical requirements, testing methods, inspection procedures, marking, packages, transport and storage for product.	Quality	10/01/2006	10/07/2006
G/TBT/N/CHN/149	Agricultural seeds	This standard specifies the labelling information, printing requirements and the usage supervision of the seed label.	Quality	10/01/2006	10/07/2006
G/TBT/N/CHN/150	Dye products	This standard prescribes the limits and determination of the quantity of 10 heavy-metal elements in dye products.	Human Health and Safety	10/01/2006	10/07/2006
G/TBT/N/CHN/153	Calcium magnesium phosphate	It sets the technical requirements, testing methods, inspection procedures, marking, packages, transport and storage of calcium magnesium phosphate.	Quality	01/03/2006	10/07/2006
G/TBT/N/CHN/207	Equipment for crop protection	This rule specifies the product scope, unit definition, type testing, requirements for factory inspection and supervision, certificates and certification marks, etc	Human Health and Safety, Environment	01/03/2006	01/08/2006

G/TBT/N/CHN/224	Related products for digital television terrestrial broadcasting system	This standard mainly specifies the framing structure, channel coding and modulation for digital television terrestrial broadcasting with frequency range of UHF and VHF.	Quality	01/03/2006	18/08/2006
G/TBT/N/CHN/161	Magnetic switches with reed as switch component used in intruder alarm systems	This standard prescribes the technical requirements, testing methods, inspection specification, mark, packaging and transportation requirements for the products.	Human Health and Safety, Environment	01/03/2006	01/09/2006
G/TBT/N/CHN/162	Low-voltage switchgear and control gear	This standard applies to low-voltage switchgear and control gear used to connect circuits, of which the rated voltage does not exceed 1000V a.c. or 1500V d.c.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/163	Tractors and machinery for agriculture and forestry	The safety requirements and test rules applicable to power-driven soil-working equipment, equipment for crop protection, combine harvesters, etc.	Human Health and Safety	01/03/2006	01/09/2006

G/TBT/N/CHN/164	Tractors, machinery for agriculture and forestry, powered lawn and garden equipment	The general principles for the design and application of safety signs and hazard pictorials permanently affixed to the products.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/165	Tower cranes	The safety technical requirements which should be complied with in the design, manufacture, installation, operation, maintenance and inspection of tower cranes.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/166	Color television broadcasting receiver	The limited values of energy efficiency, evaluating values of energy conservation, target values of energy efficiency, test methods and inspection rules for color TVs.	Environment	01/03/2006	01/09/2006
G/TBT/N/CHN/167	Compression ignition engine	This standard specifies the smoke limit values and Bosch smoke meter measurements for diesel engines under steady-state conditions.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/168	Earth-moving machinery	The objectives of safety sign affixed to	Human Health and	01/03/2006	01/09/2006

		earth-moving machinery, establishes general principles for the design and application of safety signs and hazard pictorials, etc.	Safety		
G/TBT/N/CHN/169	Tubes used in petrochemical engineering, seamless steel tubes for heat exchanger and pressure tube.	The classification, code, dimension, shape, weight, technical requirements, test method, inspection rule, packaging, marking and certification of seamless steel tubes for petroleum cracking.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/170	Inert fire extinguishing agent	The definition, requirement, testing method, inspection rule, marking, packaging, transportation and storage of inert fire extinguishing agent.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/171	Cabinet high-pressure carbon dioxide, FM-200, nitrogen, argon, HFC-23 gas fire extinguishing equipment	The performance requirements, test methods, inspection regulations, marking, packaging, transportation, storage and the requirements for preparing operation manual for the products	Human Health and Safety	01/03/2006	01/09/2006

G/TBT/N/CHN/172	Early suppression fast response (ESFR) automatic sprinklers, pressure switch, grooved couplings and fittings, extended coverage sprinklers, drencher head	The performance requirements, test methods, inspection regulations, requirements for packaging, transportation and storage of the products.	Human Health and Safety	01/03/2006	01/09/2006
G/TBT/N/CHN/173	Vehicles of category N, but not applicable to external rearview mirror and its connecting fittings, antennas and external luggage rack	Mandatory standards for sanitary wares	Human Health and Safety	24/03/2006	01/09/2006
G/TBT/N/CHN/174	Leather, fur and their products used in daily life	The standard specifies the limit of harmful matter and inspection rules for leather and fur products.	Human Health and Safety	01/04/2006	01/09/2006
STC1	09/06/2006	Concerned country: Argentina		Issue raised: Clarification	
G/TBT/N/CHN/175	Spectacle lenses, assembled spectacle lenses,	This standard specifies the transmittance technical requirements and test methods	Human Health and Safety	16/04/2006	01/09/2006

	sunglasses and driver's protective spectacles	for spectacle lenses, sunglasses and related eye wear			
G/TBT/N/CHN/206	Tractors (small or medium type wheeled tractors)	This rule specifies the product scope, unit definition, type testing, requirements for factory inspection and supervision, certificates and certification marks, etc.	Human Health and Safety, Environment	16/04/2006	01/10/2006
G/TBT/N/CHN/208	Food packaging and contact material	This Administrative Rule specifies the implementation requirements for inspection and supervision of import and export food packaging and contact materials.	Consumer Safety or protection	16/04/2006	01/10/2006
G/TBT/N/CHN/176	Disposable particle respirator, elastic respirator facepiece with replaceable filter	This standard specifies the terms, definitions, classifications, markings, technical requirements, test methods and labeling of non-powered air-purifying particle respirator.	Human Health and Safety	16/04/2006	16/10/2006
G/TBT/N/CHN/177	Fire pumps	This standard specifies the nomenclature, definition, classification and type,	Human Health and Safety	16/04/2006	16/10/2006

		performance requirements, test methods, inspection rule and marks.			
G/TBT/N/CHN/178	Shaft sinking winder, maneuver winch, gathering winch, scraper winch, prop winch, etc.	It mainly consists of the list of hazards, safety requirements and measures, verification of requirements, and instructions for user of mine auxiliary winders	Human Health and Safety, Environment	16/04/2006	16/10/2006
G/TBT/N/CHN/179	Mine drum hoist, friction mine hoist, disc braking mine winder and block braking mine winder.	It mainly consists of the list of hazards, safety requirements and measures, verification of requirements, warning signals, hazard signs, and instructions for user about mine hoists and mine winders	Human Health and Safety, Environment	26/04/2006	16/10/2006
G/TBT/N/CHN/180	Flameproof crane and metallurgical and canned motors	The safety requirements are stated in this standard.	Human Health and Safety, Environment	26/04/2006	16/10/2006
G/TBT/N/CHN/181	Crane and metallurgical and canned motors	The safety requirements are stated in this standard.	Human Health and Safety, Environment	26/04/2006	16/10/2006
G/TBT/N/CHN/184	Embedded Chinese	This sectoral standard is developed for	Quality	01/08/2006	26/10/2006

	information processing products.	the solution of problems in installing large-scale dot-matrix fonts to the embedded devices which having limited storage.			
G/TBT/N/CHN/185	Embedded Chinese information processing products.	This sectoral standard is developed for the solution of problems in installing large-scale dot-matrix fonts to the embedded devices which having limited storage.	Quality	01/08/2006	26/10/2006
G/TBT/N/CHN/186	Embedded Chinese information processing products	This sectoral standard is developed for the solution of problems in installing large-scale dot-matrix fonts to the embedded devices which having limited storage.	Quality	01/08/2006	26/10/2006
G/TBT/N/CHN/212	Road transportation vehicle of explosive substance and chemical toxic substance	The requirements for engines, tires, speed regulators, ABS, electrical devices, vehicle structure, vehicle size, etc.	Human Health and Safety, Environment	01/08/2006	01/11/2006
G/TBT/N/CHN/213	Road tank for transportation of dangerous	This standard specifies the technical requirements for the design, fabrication,	Human Health and Safety,	01/08/2006	01/11/2006

	liquid good	test methods, factory inspection, paint, mark and label, periodic test items.	Environment		
G/TBT/N/CHN/192	Safety belt anchorages of forward and rearward seats for adult occupants on M and N vehicles	This standard specifies the position, strength and test methods for safety belt of motor vehicles	Human Health and Safety	01/08/2006	02/02/2007
G/TBT/N/CHN/193	Seats and their fixing devices on vehicles	This standard specifies the terms, definitions, requirements and test methods for seats of motor vehicles.	Human Health and Safety	02/08/2006	02/02/2007
G/TBT/N/CHN/194	Compression ignition engines	This standard specifies the safety requirements for compression ignition engines and their essential auxiliaries used in all applications on land, underground and water.	Human Health and Safety	02/08/2006	02/02/2007
G/TBT/N/CHN/195	Small and medium power diesel engines	This standard specifies the noise limits for small and medium power diesel engines.	Human Health and Safety, Environment	02/08/2006	02/02/2007
G/TBT/N/CHN/196	Storage container, cleaning box and clamps for contact	This standard specifies the terms, classifications, requirements, test	Human Health and Safety, Quality	02/08/2006	02/02/2007

	lenses	methods, inspection rules, logo, labeling, instruction manual, packing, storage and shipping of the accessories for contact lenses.			
G/TBT/N/CHN/197	Wines	This standard specifies the terminologies, definitions, technical requirement and labelling of wines.	Consumer Safety or protection	02/08/2006	02/02/2007
STC1	20/03/2008	Concerned country: EU		Issue raised: Unnecessary barrier to trade	
G/TBT/N/CHN/198	Engines of categories 2G and 3G of group II for use in flammable gas and vapor atmospheres	It describes in details the safety measures and requirements and other main explosion-protect technical requirements	Human Health and Safety, Environment	02/08/2006	02/02/2007
G/TBT/N/CHN/199	Engines of categories 2D and 3D of group II for use in flammable dust atmospheres	It describes in details the safety measures, requirements and other main explosion-protect technical requirements.	Human Health and Safety, Environment	02/08/2006	02/02/2007
G/TBT/N/CHN/200	New current	It specifies the following contents on	Human Health and	02/08/2006	02/02/2007

	transformers for use with electrical measuring instruments and electrical protective devices at frequencies from 15Hz to 100Hz	current transformers: definitions, normal and special service conditions, ratings, design requirements, etc.	Safety		
G/TBT/N/CHN/201	Waste electric motors	It specifies the following contents on inductive voltage transformers: general requirements, normal and special service conditions, ratings, etc.	Human Health and Safety	02/08/2006	02/02/2007
G/TBT/N/CHN/202	Small and medium size rotating electrical machines for general purpose	This standard contains the following contents: foreword, scope, normative references, definitions, general requirements, structure, marking, tests, etc.	Human Health and Safety	02/08/2006	02/02/2007
G/TBT/N/CHN/203	Alternating-current metal-enclosed switchgear and control gear for rated voltages above 3.6kV and	It specifies the technical requirements for the products.	Human Health and Safety, Environment	02/08/2006	02/02/2007

	up to and including 40.5kV				
G/TBT/N/CHN/205	Storage electrical water heater	This standard deals with the safety of electric storage water heaters intended for household and similar purposes and heating water below boiling temperature.	Human Health and Safety	02/08/2006	02/02/2007
G/TBT/N/CHN/225	Simple pressure vessels	This technical regulation lays down mandatory safety technical requirements.	Human Health and Safety	02/08/2006	01/06/2007
G/TBT/N/CHN/214	No.3 Jet fuel manufactured from crude oil or oil distillate	This standard defines the requirements, test methods, inspection rule, mark, packaging, transportation, storage and inspection upon delivery of the products.	Human Health and Safety	01/12/2006	04/06/2007
G/TBT/N/CHN/215	Copper concentrate, Lead concentrate, Zinc concentrate, Lead and zinc bulk concentrate, Tin concentrate, Nickel concentrate, Cobalt-Sulphur concentrate	This National Standard specifies the limitation concentration of natural radioactivity of non-ferrous metal ores and concentrates products.	Environment	04/12/2006	04/06/2007
G/TBT/N/CHN/216	Domestic gas instantaneous	This standard specifies the minimum	Environment	04/12/2006	04/06/2007

	water heater and gas fired heating and hot water combi-boiler.	allowable values of energy efficiency, evaluating values of energy conservation, etc.			
G/TBT/N/CHN/217	Small and medium three-phase asynchronous motor	This standard specifies the minimum allowable values of energy efficiency, evaluating values of energy conservation, etc.	Environment	04/12/2006	04/06/2007
G/TBT/N/CHN/218	Foam extinguish agent	This standard specifies the performance requirement, test method and inspection rule of foam extinguish agent	Human Health and Safety	04/12/2006	04/06/2007
G/TBT/N/CHN/219	Fused Deposition Modeling Machine	The safety requirements and safety measures	Human Health and Safety	04/12/2006	04/06/2007
G/TBT/N/CHN/220	Digital Video Record Equipment of Video Surveillance System that used in Security & Protection Systems	This standard specifies the technical requirements and test methods for Digital Video Record Equipment of Video Surveillance System in Security & Protection Systems.	Quality	04/12/2006	04/06/2007
G/TBT/N/CHN/221	Vehicle security alarm systems installed on	It specifies the technical requirements and test method.	Consumer Safety or protection	04/12/2006	04/06/2007

	passenger cars with 12V negative earth systems				
G/TBT/N/CHN/222	Waste Paper	There should be no noxious or harmful materials in all kinds of waste paper.	Environment	04/12/2006	04/06/2007
G/TBT/N/CHN/223	Bathroom Tissue	The microbiological values of Bathroom Tissue (including Bathroom Tissue Base Paper) should accord with the requirements.	Human Health and Safety	04/12/2006	04/06/2007
G/TBT/N/CHN/64	Vehicles of category M1, M2 and N1, powered by positive-ignition engines or compression-ignition engines, having a maximum gross mass no more than 3.5t, and the maximum designed speed no less than 50km/h.	This document is a compulsory National Standard of China for the 3rd and the 4th phases of controlling pollutant emissions emitted by light-duty vehicles.	Environment	04/12/2006	01/07/2007

Table A5 TBTs and corresponding STCs of China in 2007

TBT	Products	Contents	Objectives	Announced Date	Enforced Date
G/TBT/N/CHN/226	Heavy duty vehicles	This standard stipulates the test procedures and durability requirements of emission control systems for heavy duty vehicles to comply with the phase II and III emission standards.	Human Health and Safety Environment	16/02/2007	16/08/2007
G/TBT/N/CHN/227	Motorcycles	This standard prescribes the limits and measurement methods of the stage III for pollutants emissions from motorcycles under running mode	Human Health and Safety Environment	16/02/2007	16/08/2007
G/TBT/N/CHN/228	Mopeds	This standard prescribes the limits and measurement methods of the stage III for pollutants emissions from mopeds under running mode	Human Health and Safety Environment	16/02/2007	16/08/2007
G/TBT/N/CHN/229	Diesel engines, including industrial drilling rigs,	This standard specifies the limits and measurement methods of emissions from diesel engines (net power \leq 560 kW) of non-	Human Health and Safety Environment	16/02/2007	16/08/2007

	construction equipment, agricultural equipment, etc	road mobile machinery (stage I and stage II).			
G/TBT/N/CHN/230	LPG fueled Vehicles which meet the requirements of GB 19159	This standard specifies the type badge, requirements, test methods, inspection rules, sign, package, transportation and conservation.	Human Health and Safety	16/02/2007	16/08/2007
G/TBT/N/CHN/231	Foundry machinery	This standard provides the requirements to be met by manufacturers to ensure the safety of persons during manufacturing, transportation, etc.	Human Health and Safety	16/02/2007	16/08/2007
G/TBT/N/CHN/232	Hot chamber die casting machine, cold chamber die casting machin	This standard provides the requirements to be met by manufacturers to ensure the safety of persons during manufacturing, transportation, etc.	Human Health and Safety	16/02/2007	16/08/2007
G/TBT/N/CHN/233	Seamless Austenitic and Ferrite Stainless Steel Tubes for Boilers and Heat Exchangers;	This standard specifies the classification, designation, dimension, appearance, weight, technical requirement, testing method, inspection rule, etc.	Human Health and Safety	16/02/2007	16/08/2007

G/TBT/N/CHN/234	dry-type power transformers (including auto-transformers)	This standard mainly specifies the following contents on dry-type power transformers: scope, normative references, terms and definitions, etc.	Human Health and Safety	16/02/2007	16/08/2007
G/TBT/N/CHN/235	Beverage pre-packed with a measured quantity for drinking directly or after diluted with water	The standard specifies the classification, definition and technology requirements for beverage.	Consumer Safety or protection	16/02/2007	16/08/2007
G/TBT/N/CHN/236	External power supplies	This standard specifies the minimum allowable values of energy efficiency	Environment	16/02/2007	16/08/2007
G/TBT/N/CHN/237	Domestic gas cooking appliances	This standard specifies the terms and definitions, classifications, requirements, test methods, inspection rules and marking, package, transportation and storage of domestic gas cooking appliances.	Human Health and Safety	16/02/2007	16/08/2007
STC1	17/03/2006	Concerned country: EU		Issue raised: Unnecessary barrier to trade	

STC2	09/11/2006	Concerned country: EU		Issue raised: Clarification	
STC3	05/07/2007	Concerned country: EU		Issue raised: Clarification	
G/TBT/N/CHN/241	Pencils	The standard prescribes the maximum limits and testing methods of soluble elements Sb, As, Ba, Cd, Cr, Pb, Hg, and Se content of pencil coating	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/242	On-load tap-changers of both resistance type and reactance type, etc	This standard specifies the following contents of tap-changers and their motor drive mechanisms	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/243	Newly manufactured combined transformers	This standard mainly specifies the following contents on combined instrument transformers: scope, normative references, etc.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/244	Industrial X-ray radiographic equipment up to 500kV	This standard specifies the scopes, requirements, X-ray protection during use, rules for using, monitoring and testing.	Human Health and Safety Environment	09/06/2007	09/12/2007
G/TBT/N/CHN/245	Apparatus and	This standard specifies the requirements of	Human Health and	09/06/2007	09/12/2007

	equipment for color printing and processing	safety and test methods for color printers and processors.	Safety Environment		
G/TBT/N/CHN/246	Balancing machines	This standard specifies the general safety requirements, enclosures and other protective measures for the measuring station, safety requirements of electrical equipment, etc.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/247	Hot rolled ribbed bars and hot rolled ribbed bars of fine grains for the reinforcement of concrete	This standard specifies the definition, classification, grades, ordering information, dimensions, shapes, weight and permission tolerance, technical requirements, test method, inspection rules, packaging, marking and quality certificate of the hot rolled ribbed bars for the reinforcement of concrete.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/248	Inner tube of motorcycle tyres	This mandatory standard specifies the classifications, specifications and dimensions, valves, external quality, air-tightness, requirements for physical	Human Health and Safety	09/06/2007	09/12/2007

		performance, test methods and labels of the inner tube of motorcycle tyres.			
G/TBT/N/CHN/249	Cotton - Upland Cotton	This standard sets the quality requirements, classification criteria, testing methods, inspection rules, certificates, packaging and symbols, and the requirements for transportation and storage of upland cotton.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/250	Clinical electronic thermometers	This standard specifies the terms, definitions, requirements, test methods, inspection rules, logo, instruction manual, packaging, storage and transportation of clinical electronic thermometers.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/251	Clinical infrared ear thermometers	This standard specifies the terms, classifications, requirements, test methods, inspection rules, logo, instruction manual, packaging, storage and transportation of the Clinical Infra-red Ear Thermometer.	Human Health and Safety	09/06/2007	09/12/2007
G/TBT/N/CHN/253	Vehicles of category N1	This standard specifies the limits of fuel consumption for light duty commercial	Human Health and Safety	07/08/2007	07/02/2008

		vehicles.	Environment		
G/TBT/N/CHN/254	Motorcycles and mopeds	This standard specifies the limits and measurement methods, the requirements of type approval, inspection of production conformity and determination methods for evaporative pollutants from motorcycles and mopeds	Human Health and Safety Environment	07/08/2007	07/02/2008
G/TBT/N/CHN/255	Gasoline engines of heavy-duty vehicles, heavy-duty gasoline vehicles	This standard specifies the limits and measurement methods of stage III and IV for exhaust pollutants from gasoline engines and heavy-duty vehicles	Human Health and Safety Environment	07/08/2007	07/02/2008
G/TBT/N/CHN/256	Motor vehicle Lamps	This standard specifies the photometric characteristics, test methods and inspection rules of motor vehicle front fog lamps equipped with filament lamps.	Human Health and Safety	07/08/2007	07/02/2008
G/TBT/N/CHN/257	Motor vehicle Lamps	This standard specifies the photometric characteristic, test methods and inspection rules of Motor vehicle headlamps equipped with filament lamps and sealed beam	Human Health and Safety	07/08/2007	07/02/2008

		headlamps.			
G/TBT/N/CHN/258	Motor vehicle Lamps	This standard specifies the photometric characteristics, test methods and inspection rules of reversing lamps for power-driven vehicles and their trailers	Human Health and Safety	07/08/2007	07/02/2008
G/TBT/N/CHN/259	Motor vehicle Lamps	This standard specifies the photometric characteristics, test methods and inspection rules of headlamps equipped with gas - discharge light sources for motor vehicle.	Human Health and Safety	07/08/2007	07/02/2008
G/TBT/N/CHN/260	Headlamp cleaner for vehicles	This standard specifies the technical requirements, test methods and inspection rules of the headlamp cleaner for vehicles.	Human Health and Safety	07/08/2007	07/02/2008
G/TBT/N/CHN/261	Motor vehicle Lamps	This standard specifies the technical requirements, test methods and inspection rules of prescription for installation of the external lighting and light-signaling devices for motor vehicles and their trailers.	Human Health and Safety	07/08/2007	07/02/2008
G/TBT/N/CHN/262	Single-deck buses of class I, class II and class	This standard specifies the safety requirements for construction of single-deck	Human Health and Safety	07/08/2007	07/02/2008

	III of categories M2 and M3	buses of class I, class II and class III of categories M2 and M3, except sleeper buses, school buses and special buses.			
G/TBT/N/CHN/263	Cotton baling, bagging materials and tying materials	This standard prescribes the cotton bale configurations and dimensions, weights, packaging materials, etc.	Human Health and Safety Environment	24/08/2007	24/02/2008
G/TBT/N/CHN/264	Locks	This standard specifies the terms and definitions, requirements, experimental methods and inspection rules of locks. It is the basis of design, production and inspection of locks.	Quality	01/09/2007	01/03/2008
G/TBT/N/CHN/265	Group I engines for use in underground work susceptible to firedamp and/or combustible dust	This standard specifies the following contents of Group I engines for use in underground workings susceptible to firedamp and/or combustible dust	Human Health and Safety	01/09/2007	01/03/2008
G/TBT/N/CHN/266	Mobile phones	This standard specifies the limited values for human local exposure to electromagnetic fields emitted by mobile phones.	Human Health and Safety	01/09/2007	01/03/2008
G/TBT/N/CHN/292	Oil and Gas burners	These rules lay down the requirements of	Human Health and	01/11/2007	01/05/2008

		type test for oil and Gas Burners covered by Safety Technical Regulation for Oil and Gas Burner.	Safety		
G/TBT/N/CHN/328	Wheat	This standard specifies the relevant terms and definitions, classifications, quality requirements, test methods, test rules, the requirements of labels and marks, packaging, storage and transportation of the wheat.	Consumer Safety or protection	21/11/2007	01/05/2008
G/TBT/N/CHN/267	Safety footwear	This standard specifies the terms and definitions, classifications, basic and additional requirements, marking and available information of safety footwear.	Human Health and Safety	21/11/2007	21/05/2008
G/TBT/N/CHN/268	Protective footwear	This standard specifies the terms and definitions, classifications, basic and additional requirements, marking and available information of protective footwear.	Human Health and Safety	21/11/2007	21/05/2008
G/TBT/N/CHN/269	Occupational footwear	This standard specifies the terms and definitions, classifications, basic and	Human Health and Safety	21/11/2007	21/05/2008

		additional requirements, marking and available information of occupational footwear.			
G/TBT/N/CHN/270	Numerically controlled turning machines and turning centre	This standard specifies the safety requirements and/or measures to remove the hazards and to reduce the risks for general purpose large numerically controlled turning and turning centers.	Human Health and Safety	21/11/2007	21/05/2008
G/TBT/N/CHN/271	Numerically controlled turning machines and turning center	This standard specifies the safety requirements and/or measures to remove the hazards and to reduce the risks for general purpose small numerically controlled turning and turning centers.	Human Health and Safety	21/11/2007	21/05/2008
G/TBT/N/CHN/272	Wheeled tractor	This standard prescribes special safety requirements and inspection measures on wheeled tractors with direct drive line.	Human Health and Safety	21/11/2007	21/05/2008
G/TBT/N/CHN/273	Hydraulic lifts	This standard applies to hydraulic lifts.	Human Health and Safety	24/11/2007	21/05/2008
G/TBT/N/CHN/275	Liquefied petroleum	The standard specifies the requirements, test	Consumer Safety or	27/11/2007	24/05/2008

	gases	process and guidelines for inspection of hazardous properties for dangerous goods of liquefied petroleum gases.	protection		
G/TBT/N/CHN/276	Paint	The standard specifies the requirements, test process and guidelines for inspection of hazardous properties of dangerous goods in liquid paint.	Consumer Safety or protection	31/12/2007	27/05/2008

Appendix B. Robustness checks of Chapter 4

B1. Number of source origins per firm

We are first looking at the impact of TBTs on heterogenous firms based on the number of source origins per firm. Fontagné and Orefice (2018) find a link between firm exports and the number of exporting origins for each firm. They assert that multi-origin firms, able to redirect their exports towards TBT-free origins, magnify the negative impact of TBTs on export participation. Thus, we expect importers who import only from one origin to experience an increase in imports when affected by TBTs as they are not able to source their imports from another country in the short run.

$\ln y_{fpot} = \beta_0 + \beta_1 I[TBT_{pt} = 1] + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot}$ (B1), where y_{fpot} refers to the dependent variable which can be of import value, quantity and price, $I[TBT_{pt} = 1]$ is an indicator function which takes value 1 if an imported product p is affected by TBTs at time t . $I[TBT_{pt} = 1]$ is measured in 3 different ways (Enforced TBT, Announced TBT, STC). The equation also incorporates firm-fixed effects (μ_f), product-fixed effects (θ_p), year-fixed effects (λ_t) and origin-fixed effects (σ_o).

We estimate eq. (B1) (TBT_{pt} is measured in the STC.) using the subsample of firm-product combinations that come from only one origin and compare the result with Table 4.3. and compare the result with Table 4.3.

Table B1 Number of source origins per firm

Dependent Variable:	$\ln importValue_{tpot}$	$\ln importQuantity_{tpot}$	$\ln importPrice_{tpot}$
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$I[TBT_{pt} = 1]$	0.044* (0.027)	0.002 (0.030)	0.043*** (0.023)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	570,578	570,578	570,578
R2_adjusted	0.329	0.568	0.771

Cluster-Robust Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B1 reports results from running the baseline regressions with log of imports as the dependent variable for a sub-sample of firm-product combinations that import only from one origin. Compared with the results in Table 4.3 that TBTs decrease firm imports, these results suggest that TBTs increase the imports of firms that only import from one country. Due to the fact that these firm-product combinations rely on a single importing country, they cannot easily shift their imports to another country when affected by the TBT in the short run. In the long run, firm-product combinations that import from a single origin have the ability to switch suppliers, but this process takes time, leading to the results that TBTs do not impact them. Consequently, even if China imposes the TBT on the importing product, the import price may rise, but the firm-product combinations which has only one importing country would still increase the imports at this moment.

B2. Aggregate effect at country-level

To verify the trade diversion effect of TBTs on aggregate import levels, this section investigates the differentiated impact of TBTs on the imports of heterogeneous firms at the country level. The sample includes China's imports at the country-product level.

$$\ln y_{pot} = \beta_0 + \beta_1 I[STC_{pot}^o = 0 \text{ \& } STC_{pot}^{-o} = 1] + \beta_2 I[STC_{pot}^o = 1] + \theta_p + \lambda_t + \sigma_o + \varepsilon_{pot} \text{ (B2),}$$

where y_{pot} refers to the dependent variables of import value, quantity and price. $I[STC_{pot}^o = 1]$ (o denotes the origin and $-o$ denotes other countries but oneself) indicates imports from origins which lodged an STC complaint themselves versus exporters that were affected by a TBT associated with an STC but didn't lodge a complaint themselves ($I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$).

Table B2 Aggregate effect at country-level

Dependent Variable:	$lnimportValue_{fpot}$	$lnimportQuantity_{fpot}$	$lnimportPrice_{fpot}$
$I[STC_{pot}^o = 0 \& STC_{pot}^{-o} = 1]$	0.070*** (0.017)	0.044** (0.019)	0.031 *** (0.008)
$I[STC_{pot}^o = 1]$	-0.086*** (0.026)	-0.046*** (0.028)	-0.038** (0.012)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	681, 696	681, 696	681, 696
R2_adjusted	0. 315	0. 594	0. 778

Cluster-Robust Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B2 shows that imports of STC-affected products from countries that raised an STC decrease, while imports from unconcerned countries (countries that didn't raise STC) increase. This result confirms the differentiated impact of STCs on firm imports based on their source countries at the aggregate level.

B3. The impact of TBTs on the imports that subject to Enforced TBT

In this section, we examine when the firm imports are affected by the Enforced TBTs, how STCs raised by the import origin or other countries affect firm imports. The sample includes firm imports affected by Enforced TBTs. The control group consists of Enforced TBT-affected imports that are not impacted by STCs, whether raised by the exporting country or other countries, either at the current time or previously.

The model used in this section is:

$$\ln y_{fpot} = \beta_0 + \beta_1 STC_{pot}^{own} * STC_{pt}^{other} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \text{ (B3)},$$

where y_{pot} refers to the dependent variables of import value, quantity and price.

$[STC_{pot}^{own} = 0, STC_{pt}^{other} = 0]$, no STC raised from the exporting country or other countries at time t or before.

$[STC_{pot}^{own} = 0, STC_{pt}^{other} = 1]$, no STC raised from the exporting country but from other countries at time t or before.

$[STC_{pot}^{own} = 1, STC_{pt}^{other} = 0]$, with STC raised from the exporting country, but no from other countries at time t or before

$[STC_{pot}^{own} = 1, STC_{pt}^{other} = 1]$, STCs both raised from the exporting country and other countries.

Table B3 The impact of TBTs on the imports that subject to Enforced TBT

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
$[STC_{pot}^{own} = 0, STC_{pt}^{other} = 1]$	0.096*** (0.027)	0.110*** (0.030)	-0.014 (0.019)
$[STC_{pot}^{own} = 1, STC_{pt}^{other} = 0]$	-0.153*** (0.035)	-0.111*** (0.039)	-0.042* (0.024)
$[STC_{pot}^{own} = 1, STC_{pt}^{other} = 1]$	-0.435*** (0.029)	-0.399*** (0.032)	-0.036* (0.020)
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	944, 284	944, 284	944, 284
R2_adjusted	0.315	0.594	0.778

Cluster-Robust Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

The first line of Table B3 shows that when an STC is raised by a country other than the exporting one, firm imports affected by Enforced TBTs actually increase. However, the second and third lines indicate that when an STC is raised by the exporting country, firm imports decrease. Additionally, the group affected by STCs

from both the exporting country and another country (-0.435) experiences an even greater decline. This result suggests that imports decrease only when the STC is raised by the exporting country.

B4. The dynamic impact of TBTs on the imports

This section examines how firms respond when TBTs on their imports are dropped during the middle of the import process. The control group consists of firm imports that were never affected by TBTs throughout the entire period of the firm's operations.

The model used in this section is:

$$\ln y_{fpot} = \beta_0 + \beta_1 STC_{pot}^{before} * STC_{pot}^{now} * STC_{pot}^{unconcerned} + \beta_2 STC_{pot}^{before} * STC_{pot}^{now} * STC_{pot}^{concerned} + \mu_f + \theta_p + \lambda_t + \sigma_o + \varepsilon_{fpot} \quad (B4),$$

where y_{fpot} refers to the dependent variables of import value, quantity and price.

$[STC_{pot}^{before} = 0, STC_{pot}^{now} = 0]$, no STC on a firm's imports during the whole firm's operation period.

$[STC_{pot}^{before} = 0, STC_{pot}^{now} = 1]$, no STC before, with STC on the firm's imports now

$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 0]$, with STC before, no STC on the firm's imports now

$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 1]$, with STC on the firm's imports during all the firm's operation period.

Table B4 The dynamic impact of TBTs on the imports

Dependent Variable:	<i>lnimportValue</i> _{fpot}	<i>lnimportQuantity</i> _{fpot}	<i>lnimportPrice</i> _{fpot}
---------------------	--------------------------------------	-----------------------------------------	--------------------------------------

$[STC_{pot}^{before} = 0, STC_{pot}^{now} = 1] (unconcerned)$	0.098*** (0.009)	0.133*** (0.009)	-0.035*** (0.006)
$[STC_{pot}^{before} = 0, STC_{pot}^{now} = 1] (concerned)$	-0.136*** (0.011)	-0.117*** (0.012)	-0.018** (0.007)
$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 0] (unconcerned)$	0.210*** (0.009)	0.292*** (0.009)	-0.083*** (0.005)
$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 0] (concerned)$	-0.157*** (0.010)	-0.136*** (0.011)	-0.021** (0.007)
$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 1] (unconcerned)$	0.177*** (0.011)	0.229*** (0.012)	-0.051** (0.007)
$[STC_{pot}^{before} = 1, STC_{pot}^{now} = 1] (concerned)$	-0.139*** (0.021)	-0.116*** (0.023)	-0.023* (0.013)
<hr/>			
Product fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Firm fixed effects	YES	YES	YES
Origin fixed effects	YES	YES	YES
Observations	5, 647, 354	5, 647, 354	5, 647, 354
R2_adjusted	0.315	0.594	0.778
<hr/>			

Cluster-Robust Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In Table B4, the coefficients from the unconcerned and concerned groups confirm the differentiated impact of TBTs on imports based on their source countries. Imports from unconcerned countries increase, while imports from concerned countries decrease. By comparing the coefficients across the three groups— (1) no prior STC but currently affected by STCs, (2) previously affected by STCs but no longer, and (3) affected by STCs throughout the firm’s entire operation period—I find that the second group, which was previously affected by STCs but no longer is, experiences the greatest impact from STCs. This is followed by the third group, and the first group experiences the smallest effect. The reason for this pattern may be that the first group is only newly affected by STCs, so they have not yet fully adjusted their response.