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The Impact of Chinese Technical Barriers to Trade on its Manufacturing Imports

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Abstract

In the past few decades China has put substantial efforts into liberalising its trade and economy that accelerated after its accession to the World Trade Organisation (WTO) in December 2001. In this period China has significantly reduced its tariffs on manufacturing imports. However, the proliferation of non-tariff measures (NTMs) imposed by China has made it the country notifying the second largest number of technical barriers to trade (TBTs) to the WTO after the United States. This paper investigates the impact of Chinese TBTs and tariffs on the imports of manufacturing products at the 6-digit level of the Harmonised System (HS) during 2002-2015. Heterogeneity of exporting firms, sample selection bias, multilateral resistances, and endogeneity bias are controlled for according to the recent strands of gravity modelling. Results suggest a positive impact of tariff reduction and the imposition of TBTs by China on its import values and quantities. The impact of Chinese TBTs is also differentiated across exporting countries. Since import prices are not significantly affected by TBTs, the imposed standards and regulations embedded in these trade policy measures allowed the economy to gain access to more products from the more developed economies, leading to trade creation.

JEL classification: F13, F14
Keywords: World Trade Organisation, trade liberalisation, trade policy, technical barriers to trade

The author

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Abstract

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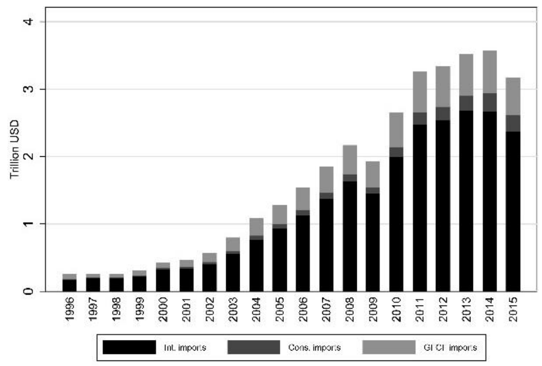
1. Introduction

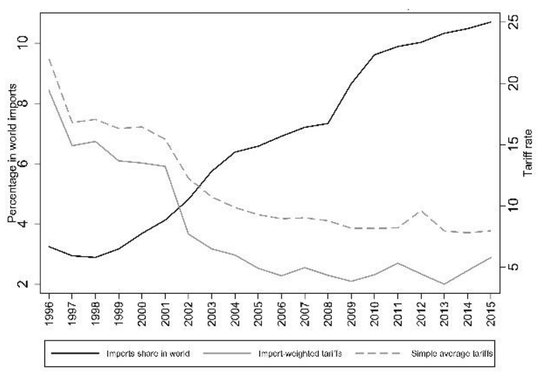
In the recent decades, China has decided to open its economy to the world. Before that, at the beginning of the 1980s, China had introduced high tariffs of around 56% on average, though those were gradually decreasing thereafter. Reducing tariff rates and quota restrictions went along with other policies which started from the 1990s when the Chinese authorities decided to establish and improve Special Economic Zones (SEZs). These SEZs were intended to attract foreign investors to establish their firms in China, importing inputs of production and then exporting their final products, and employing domestic labour, all without government interventions. The number of firms having a licence to trade was only twelve state-owned firms in 1978, which drastically increased to 35,000 at the beginning of the millennium (Imbruno, 2016; Autor et al., 2016). In a theoretical framework, Jie et al. (2003) argue that Chinese external liberalisation by accession to the WTO could even reduce the interregional trade barriers within China, thus reducing the trade cost and increasing firms' efficiency within the country.

Figure 1 – Manufacturing imports to China by Broad Economic Categories (BEC)



Source: Author's calculation, UN Comtrade.

Figure 2 – Chinese import liberalisation of manufacturing



Source: Author's calculation, UN Comtrade, TRAINS, WTO IDB.

China's accession to the WTO in December 2001 required further tariff reductions in advance, leading to average tariffs of around 15%. This gradually led to further expansionary trade policies with more SEZs in China. China was becoming more and more involved in global value chains (GVCs), importing large volumes of intermediate inputs and gross fixed capital formation (GFCF) goods to enhance its production capacities (Figure 1). Assembly lines for the production of iPads and iPhones in China are good examples, using upstream high-tech and knowledge-intensive design originating in the R&D sector in the US and the Silicon Valley (Autor et al., 2016).

China's ambitions for liberalising trade and its rejection of US President Trump's protectionist rhetoric have been reiterated recently by President Xi. China aims at facilitating trade with its pledged USD 124 billion investment[1] in the 'One Belt, One Road' project that is to connect 65 countries along the ancient 'Silk Road' (Barisitz et al., 2016). The largest nation of the world is now playing a major role within the global economy, promising innovation and more involvement in supply chains (Jin et al., 2016; Overholt, 2016).

[1] https://www.ft.com/content/88d584a2-385e-11e7-821a-6027b8a20f23
http://fortune.com/2017/05/15/china-xi-jinping-belt-road-summit-protectionism/

To join the WTO, concession commitments required China to reduce tariffs and apply most-favoured-nation (MFN) rates in addition to eliminating quantitative non-tariff barriers (NTBs) such as quotas and licences; this increased trade flows to China (Imbruno, 2016). Figure 2 shows that the trade-weighted tariff is even much smaller than the simple average. This suggests that low tariff rates are aimed at large trade volumes to further step up liberalisation. WTO entry and benefiting from the upstream intermediate inputs coming from the resourceful mineral and steel industry in China and neighbouring countries boosted the Chinese economy additionally (Ianchovichina and Martin, 2006). Taylor (2016) comments that Chinese market reforms have brought greater economic freedom as well as sharp economic growth, and at the same time improved the well-being of hundreds of millions of people and helped them move out of poverty.

However, the global trend in tariff reductions coincides with a proliferation of non-tariff measures (NTMs) attracting the attention of economists and policy-makers. Technical barriers to trade (TBTs) are one of the most important subcategories of these NTMs that have been frequently used by governments. The nature of these instruments is very complex and opaque and the true motivation of governments for implementing them is not easily evident. The introduction of legitimate regulations and standards within TBTs are expected to improve market efficiencies. For instance, with mandatory labelling of products, transparency can increase the information provided to the consumers and producers in the market, which will improve the welfare of consumers, producers, and the entire society. Moreover, these measures can be levied for the protection of human health, environmental quality, national security, etc. These aims behind TBTs have been usually referred to as legitimate approaches to the introduction of TBTs which is the reason why these policy instruments are not referred to as 'barriers' but as 'measures'. Countries can impose these NTMs in line with the agreements of the WTO such as the TBT agreement, which specifies legal guidelines for their imposition, notification, and implementation, emphasising their transparency, which could facilitate trade further. By contrast, some TBTs might be in pursuit of restrictive protectionism of domestic producers, which might raise concerns of other WTO members or ultimately cause dispute settlements.

While countries are obliged to notify their NTMs directly to the WTO secretariat, the WTO regulations provide also for another system: countries can also discuss issues related to other members' policies and notify them to the meetings of the TBT Committee (where the discussions are reported in the WTO minutes). In case a country notifies its own policies directly to the secretariat, other countries can raise their own Specific Trade Concerns (STCs). While a TBT is a unilateral regulation imposed against all exporters, a TBT STC is discriminatory, meaning that there are specific exporters raising those concerns against a given TBT.

The WTO secretariat has compiled a database on different types of NTMs notified to the WTO which is provided via the Integrated-Trade Intelligence Portal (I-TIP). Although China acceded to the WTO only at the end of 2001, it ranks already second, after the United States, in notifying the largest number of TBTs to the WTO. In fact, during the period 2002-2015, China notified 1,146 TBTs, showing the important role of TBTs in its trade policy-making. Other WTO members imposing large numbers of TBTs such as the United States and the European Union (EU) have allegedly been 'requested for consultations' for violation of the TBT agreement in the dispute settlement (DS) mechanism more than any other country. China, however, has not been a respondent to any DS cases on the violation of the TBT agreement. This could hint towards the non-restrictiveness of the TBTs imposed by China.

The present contribution extends the literature by analysing the impact of TBTs imposed by China on disaggregated manufacturing product imports at the 6-digit level of the Harmonised System (HS) originating from all exporting countries in the world during a very recent period, from 2002 to 2015. Bao and Qiu (2010) also studied the impact of TBTs on Chinese 2-digit aggregate imports for the period 1998-2006. They used disaggregated trade values as trade weights for the calculation of the TBT coverage ratio (CR) for a 2-digit sector. In their study, the frequency index (FI) was also measured as the number of 6-digit trade lines affected by TBTs relative to all traded lines within the 2-digit sector. Then, they estimated the impact of CR and FI on trade values at the 2-digit level. Despite using lags of these explanatory variables in the estimations, both trade weights and the number of tariff lines could cause serious endogeneity bias in the gravity modelling. Therefore, the main advantage of the present contribution in comparison to their study is to estimate trade flows at the 6-digit level including TBTs aimed at 6-digit level products, which essentially reduces the endogeneity bias.

Another important contribution of the study is using the number of TBTs imposed on each product instead of a dummy variable indicating only the existence of TBTs on a given product. Sometimes a TBT is imposed as an amendment to previous TBTs to either facilitate trade or make a stricter regulation. Thus, analysing the impact of TBTs on trade flows using count variables would well indicate the aim and implication of the TBT proliferation. This study applies relevant estimation techniques in the recent strand of the gravity literature controlling for zero trade flows, multilateral resistances, and endogeneity of the trade policy. Moreover, the impact of TBTs will be differentiated by countries of origin. The results indicate a positive aggregate effect of these trade policy instruments and diverse effects over different countries.

The structure of the rest of the paper is as follows: In the next section, a brief literature review is provided. The third section focuses on the methodology of the analysis, data description and estimation specifications. In the fourth section, the estimation results are presented and discussed. The final section provides a summary of the main findings and concluding remarks.

2. Literature review

The empirical analysis of bilateral trade was first introduced by Tinbergen (1962) modelling trade flows as an increasing function of the income of the two trading partners and as a decreasing function of the distance between the two. Since then a large body of literature on the topic has accumulated. Anderson (1979) introduced a theoretical framework for the gravity model using constant elasticity of substitution. Eaton and Kortum (2002) and Anderson and van Wincoop (2003) formulated the gravity in an imperfect competition framework to further account for multilateral resistances (MLR). Chaney (2008), Helpman et al. (2008), and Melitz and Ottaviano (2008) applied the New New Trade Theory à la Melitz (2003) to address the extensive and intensive margins of trade for different exporting destinations with different trade costs. Then, zero trade flows could be accounted for in the context of heterogeneity of firms.[2]

Many authors have analysed the impact of NTMs and specifically TBTs on international trade. Essaji (2008) analysed the impeding effect of technical regulations imposed by the US government on the imports of 6-digit HS products. He found that these regulations imply a huge burden on poor countries with weak capacities, restricting their exports of products by prohibitive trade policy instruments. TBTs usually aim at higher standards of the imported products. Higher standards within these measures

[2] Refer to Head and Mayer (2014) for a detailed discussion on gravity modelling.

usually increase the quality of production processes and products (Wilson and Otsuki, 2004; Trienekens and Zuurbier, 2008).

Disdier et al. (2008) analyse the impact of Sanitary and Phytosanitary (SPS) measures and TBTs on agricultural trade flows. In their estimations, they use either the presence of TBT notifications to the WTO, the frequency index of TBTs, or ad-valorem equivalents of TBTs. Disdier et al. (2010) studied the impact of TBTs and SPS measures on imports of tropical products. In a gravity estimation controlling for fixed effects in 2004, their results showed a significant negative influence of these measures on imports. Li and Beghin (2012) also found a negative effect of TBTs on trade controlling for endogeneity and including time fixed effects in gravity estimations.

Bao and Chen (2013) also tested the impact of TBTs on trade components. Their empirical analysis, covering 103 countries over the period 1995-2008, suggested that TBTs decrease the probability of trade (extensive margin) while they increase the number of products traded. However, it was found that TBTs have no statistically significant impact on the trade value of each product (intensive margin). Bao and Qiu (2012) analyse the impact of TBTs on aggregate trade flows between 105 WTO members during 1995-2008. In a two-stage gravity framework controlling for sample selection bias and firm heterogeneity, they find that developing countries' TBTs significantly affect only the imports of developing countries, while TBTs of developed countries affect all countries.

Many scholars investigated the role of NTMs on trade for specific sectors. For instance, Wilson et al. (2003), Wilson and Otsuki (2004), Chen et al. (2008) and Disdier and Fontagné (2010) focused on trade in agricultural products; Blind (2001), Blind and Jungmittag (2005) and Fontagné et al. (2005) studied manufacturing sectors.

In a seminal paper, Kee et al. (2009) estimate the ad-valorem equivalent (AVE) of NTMs using a binary variable for any existing NTM on 6-digit products traded between 78 countries. In cross-sectional gravity estimations, they find that the average estimated AVE is equivalent to a 12% tariff. Extending this framework to capture the positive externalities related to qualitative NTMs, Beghin et al. (2015) estimate the AVEs and find that 39% of traded products are affected positively by NTMs. Bratt (2017) finds trade promotion by estimating AVEs of NTMs in a similar framework. Ghodsi et al. (2016) extend the methodology further to estimate the importer-specific AVE for nine types of NTMs notified to the WTO.[3] Then, using the intensity of NTMs by counting the number of measures in force, and taking advantage of the variations over time within a panel database, the AVE of each NTM imposed on a 6-digit product imported to each WTO member is estimated. According to the results, the AVE of TBTs imposed by China averaged across all affected products is equivalent to a 7.5% tariff, while using the imports weights this reduces to 3.1%.

Fontagné et al. (2015) analyse the impact of SPS specific trade concerns (STCs) notified to the WTO on trade margins using a firm-level database. They find that these restrictive measures reduce the probability of exporting to a destination (extensive margins), but the larger the size of the firm, the higher is the probability of exporting while facing these regulations. SPS STCs increase the probability for a firm to exit a market, while larger firms are more likely to stay in that destination. Besides, these measures have also a negative impact on the volume of trade. However, large firms' exports to a given country imposing these regulations are affected positively, but not strongly significantly. Studying the

[3] The I-TIP database used in Ghodsi et al. (2016) is augmented by imputing HS codes similar to this study. However, in the former study, some approximation matching was also added in the imputation procedure, which increased the number of affected tariff lines extensively. For the difference between the databases used here and there, refer to Step 5 in Ghodsi et al. (2017), p. 26.

impact of SPS STCs on the exports of Egyptian firms, El-Enbaby et al. (2016) find a significant negative impact of these measures on the extensive margins to export while no statistically significant impact on the intensive margins.

Chinese trade and trade policies have been studied in a gravity framework by several scholars. Bingzhan (2011) and Gao et al. (2014) analyse the growth of Chinese exports by decomposing the extensive margin, quality, and quantity effects. Caporale et al. (2015) study the determining factors of China's aggregate exports to the rest of the world during 1992-2012 in a gravity framework using fixed effect vector decomposition (FEVD). Their results are similar to those of other gravity modelling. In fact, they find that bilateral exports from China increase when both countries have larger income, are WTO members, are closer to each other geographically, and when the FDI in China is larger.

Chandra (2016) finds evidence on the diversion effect of temporary trade barriers (TTBs) such as anti-dumping and countervailing duties imposed by the United States against products exports from China. These NTMs actually redirect exports of Chinese products to other destinations in the world but with heterogeneity across the various products and destinations.

Yousefi and Liu (2013) investigate the role of TBTs on trade between China, Japan, Korea and the United States for manufacturing industries. In a gravity framework, they find a negative impact of TBTs on trade in the long run. Park (2009) finds that the Chinese anti-dumping measures between 2002 and 2004 hampered imports to China significantly, causing diversion effect.

Bao and Qiu (2010) study the impact of TBTs on China's imports during the period 1998-2006. They use the import data of HS 2-digit level products from 43 countries to China. Both coverage ratio and frequency index (see Bora et al., 2002) of TBTs imposed on the disaggregated trade flows within each 2-digit sector are used in the analysis. The authors find that the negative impact of TBTs on trade flows is statistically significant only for the frequency index. While TBTs are trade-restrictive for agricultural products imported to China, they are promoting imports of manufacturing to China. Bao (2014) conducted a similar study but at the 4-digit level of aggregation. Controlling for sample selection bias as proposed by Heckman et al. (2008), Bao (2014) finds a negative impact of TBTs on the extensive margins to trade to China. However, in the present contribution, trade at the 6-digit level of the HS will be studied, which does not require the use of indexes such as those used by Bao and Qiu (2010) and Bao (2014) that might cause a potential endogeneity bias. Lee et al. (2013) examine the import flows of 8-digit products to China during 2000-2008 in gravity settings.

Imbruno (2016) also uses Chinese imports at the 6-digit product level without considering the partner dimension. The study focuses on quantitative NTBs such as import quotas, licences, and tendering requirements rather than qualitative NTMs such as TBTs. In order to reduce the endogeneity bias, the trade-policy measures are lagged in the regressions (similar to Bao and Qiu, 2012). Using product and time fixed effects, Imbruno (2016) shows that tariffs and licences reduced imports of products to China over the period 2000-2006, while tendering requirements increased the import values to China.

3. Methodology and data

3.1. Specification

In this paper, the impact of TBTs imposed by China on imports of products at the 6-digit level of the Harmonised System (HS) revision 1 to China in the period 2002-2015 is analysed using a gravity framework. Following the literature on gravity (Head and Mayer, 2014), the preliminary version of the estimation equation is as follows:

$$m_{Cjht} = \alpha_{10} + \alpha_{11} \ln(TBT_{Cjht} + 1) + \alpha_{12} \ln(T_{Cjht} + 1) + \alpha_{13} G_{Cjt} + \alpha_{14} D_{Cj} + \omega_{Cjh} + \omega_t + \varepsilon_{Cjht} \quad (1)$$

where m_{Cjht} is the import values of 6-digit product h to China from partner country j at time t[4]. TBT_{Cjht} is the number of TBTs imposed by China on product h imported from country j at time t and α_{11} is the estimated elasticity of imports with respect to TBTs. T_{Cjht} is the effectively applied tariff rate imposed on the traded product at time t. G_{Cjt} includes a set of gravity covariates common in the literature capturing time-varying variables. Since the importer is only one country, these variables are country-pair characteristics that consist of classical gravity variables and factor endowments. Thus, G_{Cjt} includes the traditional market potential of trading partners, which is the natural logarithm of the summation of both countries' expenditure-side real GDP (g_{Cjt}). According to the gravity modelling literature, this variable is expected to increase trade flows. Additionally, we use real GDP per capita for the economic development of a country and employ it in the indicator similar to the one proposed by Helpman (1987) as follows:

$$y_{Cjt} = \left(\frac{GDPpc_{Ct}^2}{\left(GDPpc_{Ct} + GDPpc_{jt}\right)^2} + \frac{GDPpc_{jt}^2}{\left(GDPpc_{Ct} + GDPpc_{jt}\right)^2} \right) - \frac{1}{2}, y_{Cjt} \in (0, 0.5) \quad (2)$$

In addition, G_{Cjt} includes the distance between the trading partner and China in three relative factor endowments similar to the one used by Baltagi et al. (2003)[5]: labour force L, capital stock K, and agricultural land area A, as follows:

$$\mathrm{f_{kCjt}} = \ln\left(\frac{\mathrm{F_{kjt}}}{\mathrm{GDP_{jt}}}\right) - \ln\left(\frac{\mathrm{F_{kCt}}}{\mathrm{GDP_{Ct}}}\right), \mathrm{F_k} \in \{\mathrm{L}, \mathrm{K}, \mathrm{A}\} \quad (3)$$

Further gravity variables that enter our regressions are the exchange rate of China per partner's currency (Xr_{Cjt}), and a dummy variable if the partner country is a WTO member in that year ($\mathrm{WTO_{jt}}$). $\mathrm{D_{Cj}}$ includes a set of time-invariant bilateral variables traditionally used in gravity modelling – distance, contiguity, common language, same country, and history of common colony.

[4] Since there is only one single importer, subscript C referring to China could be removed from all variables. However, since some aggregate country-pair variables such as y_{Cjt} are calculated, this subscript is retained across the whole text.

[5] Baltagi et al. (2003) use the distance of relative factor endowment in absolute terms, which omits the important information whether the trading partner has higher or lower factor endowments relative to China. Moreover, using the absolute terms gives inconsistent estimates of some variables. For instance, the coefficient of tariffs becomes positive or the coefficient of the summation of GDP becomes negative when absolute terms are included. The estimation results including the distance of relative factor endowments in absolute terms are available upon request.

ω_{Cjh} is country-pair-product (i.e. exporter-product ω_{jh} here because of having only one importer), and ω_t is time fixed effects; ε_{Cjht} is the error term. All variables except dummies are in logarithmic forms. Other combinations of fixed effects to control for multilateral resistances will be discussed below.

3.2. Estimation issues

According to the literature, trade policy could potentially cause endogeneity bias in the regressions. The two reasons for the endogeneity bias could be, first, the unobserved effects and, second, the simultaneity bias. A recent strand of the literature on the structural gravity framework (Anderson and van Wincoop, 2003; Head and Mayer, 2014) suggests that country-sector-time fixed effects controlling for multi-lateral resistances may reduce the unobserved effects. Additionally, the endogeneity issue stems from the fact that protectionist trade policy measures might be imposed to control trade flows. This means that an increasingly large trade flow is correlated with the imposition of new NTMs causing simultaneous bias in the estimation that is referred to as dual causality. To control for that, one can use instrumental variables in a two-stage estimation. Moreover, Helpman et al. (2008) point to a selection bias in the zero trade flows due to the heterogeneity of firms in their productivity to export. Using a probit estimation, the extensive margin of trade to China with respect to trade policy measures will also be assessed. The results of this estimation will then be used to assess the intensive margin of trade controlling for the export selection to China as well as the endogeneity bias. Zero trade flows and endogeneity bias are the main issues that will be discussed next, which will also be taken into consideration presenting the results.

3.2.1. Zero trade flows

Since trade flows are included in logarithmic form, zero trade values will be excluded from the regressions as missing values, which gives biased estimation results. Some studies in the literature make use of Poisson estimation of the trade values at levels, while others use a two-stage Heckman (1977) procedure in order to account for the zero trade flows. Helpman et al. (2008) show theoretically that zero trade flows are due to firm heterogeneity as firms are responding to trade costs differently because of their differences in productivity. In the present paper the two-stage estimation proposed by Helpman et al. (2008) is applied[6], which was also used in other studies such as Bao and Qiu (2012). This approach will also provide estimation results for the extensive margins to trade in the first-stage estimation as follows:

$$\rho_{Cjht} = Pr(m_{Cjht} > 0) = \beta_{10} + \beta_{11}\ln(TBT_{Cjht} + 1) + \beta_{12}\ln(T_{Cjht} + 1) + \beta_{13}G_{Cjt} + \beta_{14}D_{Cj} + \omega_t + \epsilon_{Cjht} \qquad (4)$$

where $Pr(m_{Cjht} > 0)$ is the probability of positive trade flows of product h from country j to China in year t, and the rest of variables are as mentioned above. Equation (4) is estimated via a probit regression including time fixed effects controlling for global shocks across different years. Taking advantage of the panel structure of data, the random effect (RE) probit estimator is used[7]. Using the estimates for the

[6] The reason to opt for this methodology of controlling for zero trade flows instead of Poisson estimation is that the instrumental variable generalised method of moments (GMM) would not be feasible using Poisson regression.

[7] For robustness checks, equation (4) is also estimated by each year, giving similar results that are available upon request.

probability of exports $\hat{z}^*_{Cjht} = \Phi^{-1}(\hat{\rho}_{Cjht})$, and the inverse Mills ratio (IMR)[8] $\hat{\bar{\eta}}^*_{Cjht} = \varphi(\hat{z}^*_{Cjht})/\Phi(\hat{z}^*_{Cjht})$, the second-stage estimation is as follows:

$$m_{Cjht} = \alpha_{20} + \alpha_{21}\ln(TBT_{Cjht}+1) + \alpha_{22}\ln(T_{Cjht}+1) + \alpha_{23}G_{Cjt} + \alpha_{25}\hat{\bar{\eta}}^*_{Cjht} + \alpha_{26}\hat{z}^*_{Cjht} + \alpha_{27}{\hat{z}^*_{Cjht}}^2 + \alpha_{28}{\hat{z}^*_{Cjht}}^3 + \omega_{Cjh} + \omega_t + \zeta_{Cjht} \tag{5}$$

where a polynomial of order 3 with respect to the firm heterogeneity $\hat{z}^*_{Cjht}$ is estimated using normal OLS; $\hat{\bar{\eta}}^*_{Cjht}$ controls for the sample selection bias à la Heckman (1977), and using country-pair-product ω_{Cjh} and time fixed effects ω_t. Due to the inclusion of the former fixed effects, time-invariant variables D_{Cj} in equation (1) are automatically dropped. For exclusion restriction purposes of the two-stage estimation, WTO membership of the exporting country is dropped from the second stage regression. This stems from the fact that becoming a WTO member is more likely to affect only extensive margins while other remaining variables that are country-pair variables and trade policy variables could also have a substantial impact on intensive margins to trade as well as extensive margins.

3.2.2. Multilateral resistances

One of the major causes of the endogeneity bias in the gravity estimation is the omitted variable bias or the unobserved effects in the error term correlating with the dependent variable $E(m_{Cjht}\,\zeta_{Cjht}) \neq 0$. Anderson and van Wincoop (2003) and other scholars in the literature argue that multilateral resistances (MLR) are the reason for such a bias. In fact, when an exporter is facing a trade policy imposed by China, its total exports of the product to other destinations could also be influenced through changes in prices or quantities. In order to control for such a bias, country-time effects are included in structural gravity estimations of aggregate trade flows. In equation (1), product trade flows should be controlled for by using country-product-time effects. However, since only one importing country is under investigation, such fixed effects will exhaust all the degrees of freedom. Thus, instead, country-sector-time – with HS 4-digit sectors H – is controlled for in the fixed effects ω_{jHt} in addition to country-pair-product fixed effects ω_{Cjh}:

$$m_{Cjht} = \alpha_{30} + \alpha_{31}\ln(TBT_{Cjht}+1) + \alpha_{32}\ln(T_{Cjht}+1) + \alpha_{35}\hat{\bar{\eta}}^*_{Cjht} + \omega_{jHt} + \omega_{Cjh} + \vartheta_{Cjht} \tag{6}$$

Since ω_{jHt} controls for time and exporter-time fixed effects, time-variant country variables G_{Cjt} are automatically dropped from the estimation (the reason is having only one importer). Moreover, the inclusion of heterogeneity of firms $\hat{z}^*_{Cjht}$ (which was the cumulative distribution function of the estimated probability in a pooled panel with RE) is exporter-sector-time specific causing collinearity in this estimation and, therefore, $\hat{z}^*_{Cjht}$ are excluded. However, $\hat{\bar{\eta}}^*_{Cjht}$ is included to control for the zero trade flows because it is changing over time due to the variations in the probability density to exports with respect to the estimated probability.

3.2.3. Simultaneity bias

Another major cause of endogeneity in the gravity estimation is that trade policies are usually changed by the trade flows. This dual causality makes the error term correlated with the dependent variable,

[8] IMR is the ratio of the probability density function to the cumulative distribution function of the estimated probability of exports.

causing endogeneity $E(m_{Cjht}\,\vartheta_{Cjht}) \neq 0$. In fact, if larger trade induces authorities to impose more protectionist measures (higher tariffs or more TBTs), then these variables in equation (6) could be biased. In order to overcome the issue, some scholars (Bao and Qiu, 2012; Imbruno, 2016) employ the lagged variables of trade policy, which will also be used in this paper. This solution is better suited for tariffs, which can change rapidly. In contrast, TBTs are technical regulations that stay in force for a longer period. Thus, using the lags of them cannot completely solve the problem. Therefore, an instrumental variable (IV) approach for TBTs may be more appropriate.

The exogenous instruments for TBTs could be categorised in two groups. The first group includes the number of TBTs that the trading partner j imposes against its imports from China on a given product h in a given year t, TBT_{jCht}, which might induce the Chinese government to impose TBTs on the same product in retaliation or in cooperation. Thus, the first group refers to retaliatory or cooperative trade measures by China against trade measures of the trading partner (de Almeida et al., 2012).

The second category refers to the upgrading of the standards setting in China by observing the global set of regulations imposed. Two instruments in this category that are not affected by imports to China but might affect the imposition of TBTs by the Chinese authorities could be TBTs of the trading partner and the TBTs in the whole world. Since the price effect of TBTs could signal cost effectiveness of the trade policy measure, the second category of instruments is constructed using price weights of trade flows. In fact, the proliferation of TBTs in the world and by a trading partner could induce China to introduce TBTs to either stay at the same high level of standards as other countries, or to increase regulations of the market as others do. However, this decision is not directly affected by trade flows to China causing dual causality.

Therefore, the first stage including three exogenous instruments and other second-stage explanatory variables will be as follows:

$$\begin{aligned}\ln(TBT_{Cjht}+1) &= \beta_{21}\ln(TBT_{jCht}+1) + \beta_{22}\ln(\overline{TBT}^{u}_{wht}+1) + \beta_{23}\ln(\overline{TBT}^{u}_{jht}+1) + \beta_{24}\ln(T_{Cjht-1}+1) \\ &\quad + \beta_{25}\hat{\hat{\eta}}^{*}_{Cjht} + \omega_{jHt} + \omega_{Cjh} + \mu_{Cjht}, \quad C \neq j\end{aligned} \tag{7}$$

$$\overline{TBT}^{u}_{jht} = \sum_{k}\frac{u_{jkht}}{\sum_{k} u_{jkht}} TBT_{jkht}, \quad k \neq C \neq j \tag{8}$$

$$\overline{TBT}^{u}_{wht} = \sum_{j}\sum_{k}\frac{u_{jkht}}{\sum_{k} u_{jkht}} TBT_{jkht}, \quad k \neq C \neq j \tag{9}$$

where the dependent variable is the natural logarithm of the number of TBTs imposed by China $\ln(TBT_{Cjht}+1)$. As exogenous instruments on the right-hand side, first there is TBT_{jCht}, which is the number of TBTs imposed by trading partner j importing product h from China in year t. Second, there is $\overline{TBT}^{u}_{jht}$, which is the number of TBTs imposed by China's partner country j to the imports from all countries (other than China), weighted by the unit values across trades to that partner country excluding those from China in the given product h in year t. Second, there is $\overline{TBT}^{u}_{wht}$, which is the number of TBTs imposed by all countries other than China, weighted by the unit values across trade flows of a given product between countries except those from China. Thus, the weights (unit price) used in the second instrument exclude exports from China, and in the third instrument both exports from and imports to China are excluded. The instruments are also transformed to their logarithmic forms.

The estimated value of the Chinese TBTs from (7) $\widehat{TBT}_{Cjht} = \ln(\widehat{TBT_{Cjht}+1})$ then can be used in the second stage excluding the exogenous instruments:

$$m_{Cjht} = \alpha_{40} + \alpha_{41}\widehat{TBT}_{Cjht} + \alpha_{42}\ln(T_{Cjht-1} + 1) + \alpha_{45}\hat{\hat{\eta}}^{*}_{Cjht} + \omega_{jHt} + \omega_{Cjh} + \sigma_{Cjht}, \quad E(m_{Cjht}\,\sigma_{Cjht}) = 0, \quad E(m_{Cjht}\,TBT_{jCht}) = 0, \quad E(m_{Cjht}\,\overline{TBT}^{u}_{wht}) = 0, \quad E(m_{Cjht}\,\overline{TBT}^{u}_{jht}) = 0 \tag{10}$$

Finally, it is worth mentioning that in all the estimations, the robust standard errors are clustered by country-pair-products Cjh to control for shocks on each bilateral trade flow during the years. This reduces the heteroscedasticity within the error structure. Most importantly, two-step feasible GMM estimation is used to achieve consistent unbiased estimates.[9] In the next section, a Durbin–Wu–Hausman test (DWH) as proposed by Davidson and MacKinnon (1993) on the consistency of IV estimations compared to simple Ordinary Least Squares (OLS) pointing to endogeneity of TBTs will be provided. Additionally, test statistics on the exogeneity of instruments as proposed by Anderson and Rubin (1949) and a Hansen J test[10] on the validity of overidentification restriction will be presented.

3.2.4. Differentiation by partner

Quality standards and regulations embedded within TBTs can have diverse impacts on bilateral trade flows depending on the type of product and the exporting partner. If the production process and the quality of standards of the two trading partners are at a similar level, the impact of NTMs might promote trade. This happens because of the trade diversion from countries that produce the product with lower standards (compared to those in the imposing country) to the countries with equal or higher standards as those existing in the imposing country. Thus, the trade implications of NTMs could give more insights if exporters are differentiated.

In order to determine the impact of China's TBTs on the export of different exporters, the TBT variable is interacted with the exporter dummies in equation (6)[11] as follows:

$$m_{Cjht} = \alpha_{50} + \sum_{j \neq i} \omega_j \alpha_{51} \ln(TBT_{Cjht} + 1) + \alpha_{52}(T_{Cjht} + 1) + \alpha_{55}\hat{\hat{\eta}}^{*}_{Cjht} + \omega_{jHt} + \omega_{Cjh} + \vartheta_{Cjht} \tag{11}$$

where $\omega_j \alpha_{51}$ is the estimated elasticity of exports of exporter j to China with respect to the TBTs imposed by China[12].

In addition to the value of the imported products, traded quantities and prices (unit values) are used as dependent variables in separate models. Their results are presented in the appendix. This will give better insights on the impact of trade policy measures and other explanatory variables on the trade flows to China.

[9] There is, however, one minor problem when instrumenting a discrete variable such as TBTs and retrieving its fitted value. The problem actually arises for the tariff lines that are targeted by no TBT, but after the first stage, the estimated value is not always zero. Replacing those fitted values with zeros, however, does not change the estimators in the second stage significantly, which could indicate the consistency of the estimate.

[10] The Hansen J test is a version of the Sragan-Hansen test on the validity of an instrument that is used with efficient GMM, and it is consistent in the presence of heteroscedasticity.

[11] An estimation using the instrumented TBT similar to that of equation (10) is also used.

[12] In order to achieve unbiased standard errors from the instrumental variable estimations, interacting the endogeneous variable with exporter dummies requires a system of simultaneous estimations with the number of equations equal to the number of exporters. Since the estimation of such a system is not feasible, the point estimates $\omega_j \alpha_{51}$ from instrumental variable regressions are presented here, although the standard errors could be biased.

3.3. Data

Trade data have been collected from UN Comtrade through WITS[13]. Trade of manufacturing products corresponding to 2-digit sectors 16 through 97 is included in the analysis. This means that both food manufacturing products (HS16 through HS24) and other manufacturing products are covered in the analysis. Tariffs have been compiled as AVEs of simple average tariffs at 6-digit level estimated by UNCTAD method. Since there are some quantity-based tariffs or tariff quotas at more disaggregated levels, the AVE of tariffs could give a uniform price-based tariff. The priority of tariff information is, first, effectively applied rates (AHS); where those are not available, preferential (PRF) tariffs are used; and if none of those are available, most-favoured nation (MFN) tariffs will be used[14]. This allows for the actually lowest implemented tariff rates. Data on tariffs are collected from WITS provided by TRAINS. However, since there are some missing values, especially for the years 2012 and 2013, data from the WTO Integrated Data Base (IDB) are also collected to complement.

Data for real GDP, real GDP per capita, labour force, gross capital formation, agricultural land area, and exchange rates are gathered from the World Development Indicator (WDI) of the World Bank. Where the data are missing, data from national statistics offices are collected. Data on distance, contiguity, common language, same country, and colonial history are collected from the CEPII database. Data on WTO membership are gathered from the WTO.

The main block of the analysis is built upon the TBT notifications. These data are provided by the WTO Secretariat via the Integrated-Trade Intelligence Portal (I-TIP). From 2002 to 2015 China imposed 1,090 non-discriminatory (unilateral) TBTs against all exporters. During this period, 56 specific trade concerns (STCs) were raised against the TBTs imposed by China. These STCs are usually restrictive measures that are raised by one or several trading partners during the TBT Committee meetings at the WTO. Within the I-TIP data, these TBT STCs are separated from unilateral TBTs. In addition, I-TIP also provides information on some STCs being raised on some of the unilateral TBTs as well. However, the partner country raising the concerns on those unilateral TBTs is not identified to be relevant as discriminatory here. The TBT variable used in the econometrics analysis is constructed as the summation of both discriminatory and non-discriminatory TBTs. It is important to note that the estimation results on only non-discriminatory TBTs are very close to the results presented below, showing the consistency of estimates. These additional results on only non-discriminatory TBTs are available upon request.

The I-TIP database includes many notifications with missing HS codes. Only 497 out of a total of 1,146 Chinese TBTs notified to the WTO have defined HS codes. Thus, the rest of the notifications cannot be used in an econometric analysis. In a related research, Ghodsi et al. (2017) improved the database by imputing the respective HS codes. There are several stages to improve the data. Here, stages 1 to 3 (Ghodsi et al., 2017, p. 26) are used to impute the HS codes: first, the WTO interpreted HS codes; second, the HS codes corresponding to the notified International Classification Standards (ICS) codes; and third, the HS codes in other NTM's products whose descriptions exactly match the product descriptions with missing HS codes. These procedures find HS codes for 438 TBT notifications of China. This results in 935 Chinese TBT notifications that can be used in the analysis. It can be seen

[13] http://wits.worldbank.org/default.aspx

[14] This is in line with the definition of effectively applied tariffs on the WITS website: 'WITS uses the concept of effectively applied tariff which is defined as the lowest available tariff. If a preferential tariff exists, it will be used as the effectively applied tariff. Otherwise, the MFN applied tariff will be used.' However, even the AHS tariffs data provided by WITS are not completely covering all the trade flows. Therefore, PRF and MFN are substituted for AHS where the latter is missing.

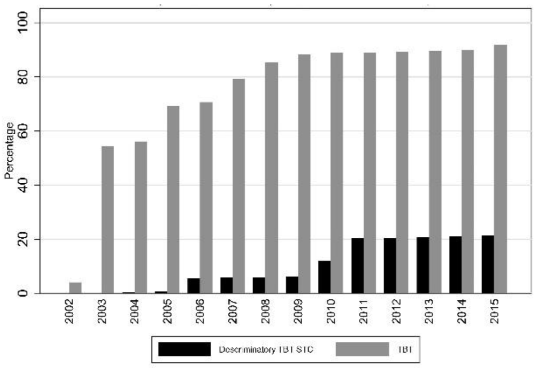
from Table 1 that during the recent financial crisis, China's imposition of TBTs accelerated, reaching its peak of 210 in 2009, which could hint at regulating the market at the time of the global financial crisis.

Table 1 – Notified TBTs on manufacturing by China to the WTO, with imputed HS codes

	Non-discriminatory TBT				TBT STC				
Year	**Original HS**	**Imputed HS**	**Missing HS**	**Notified TBT**	**Original HS**	**Imputed HS**	**Missing HS**	**Notified TBT STC**	**All TBT**
2002	11	0	1	**12**	0	2	3	5	**17**
2003	10	11	7	**28**	0	0	1	1	**29**
2004	10	8	4	**22**	0	0	1	1	**23**
2005	62	18	26	**106**	0	1	2	3	**109**
2006	38	18	5	**61**	0	3	4	7	**68**
2007	41	16	29	**86**	0	0	3	3	**89**
2008	69	97	15	**181**	0	2	3	5	**186**
2009	89	70	46	**205**	0	1	4	5	**210**
2010	29	25	6	**60**	0	3	1	4	**64**
2011	32	47	10	**89**	2	1	3	6	**95**
2012	31	37	7	**75**	0	0	2	2	**77**
2013	26	40	14	**80**	0	2	1	3	**83**
2014	14	26	6	**46**	0	2	2	4	**50**
2015	32	4	3	**39**	1	4	2	7	**46**
Total	**494**	**417**	**179**	**1090**	**3**	**21**	**32**	**56**	**1146**

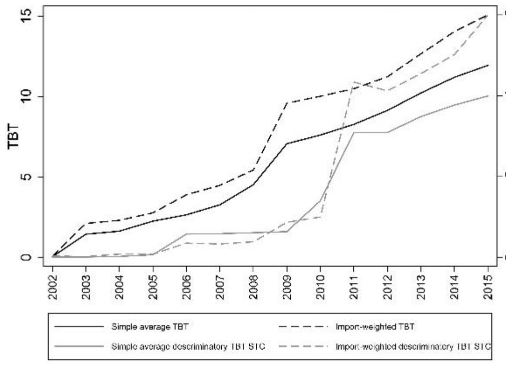
Source: Ghodsi et al. (2017), WTO I-TIP.

Figure 3 – Percentage of positive 6-digit Chinese manufacturing import lines affected by TBTs



Source: Author's calculations, I-TIP, Comtrade.

Figure 4 – Chinese TBTs averaged over positive manufacturing import flows



Source: Author's calculations, I-TIP, Comtrade.

Having merged the TBTs with the HS codes, the effectiveness of measures can be calculated. Figure 3 indicates a large jump in the percentage of positive import flows affected by unilateral TBTs in 2003. This share gradually increased until 2009 and remained relatively constant thereafter, covering close to 90% of manufacturing products imports. A similar pattern is observed for TBT STCs. For these discriminatory measures, the affected number of import flows increased from 2006 to 2011 and remain above 20% until 2015.

Figure 4 depicts the number of Chinese TBTs averaged over positive import flows of manufacturing. Import-weighted TBTs are larger than the simple averaged number of TBTs during the whole period.

This indicates that TBTs are generally affecting larger trade flows. However, the situation is reverse for TBT STCs before 2009. This indicates that TBT STCs were aimed at smaller trade flows. It might show that these discriminatory measures were either more trade restrictive (see Fontagné et al., 2015) or potential trade disputes. In this paper the main variable of interest is the total number of TBTs including both the discriminatory and non-discriminatory ones. However, as noted earlier, estimations excluding TBT STCs provide very similar results.

4. Estimation results

4.1. General results

Table 2 presents the estimation results of the 6-digit manufacturing products imports to China from all trading partners over the period 2002-2015. The second and third columns to the left (*Prob.* and *Prob.-Lag*) show the estimation of extensive margins to trade controlling for time fixed effects ω_t, using an RE estimator. Model *Prob*. uses the present values of tariffs and TBTs in the regressions, while model *Prob.-Lag* includes the lag of these variables to reduce the endogeneity bias of trade policies. In both models, higher tariffs reduce the probability of export of products to China. Present tariffs, however, show a larger impact on the extensive margin than the lagged tariffs, which might indicate an upward endogeneity bias, as higher protectionist tariffs aim at positive trade flows. In contrast to the findings by Bao (2014), TBTs in both models increase the probability of exporting to China. This could hint towards market efficiency improvements by the introduced regulations and standards within TBTs.

As expected by the gravity modelling literature, positive statistically significant coefficients of summation of the GDP of the two trading partners g_{Cjt} indicate the positive impact of income on the extensive margin. The larger the distance of the two partner countries in terms of GDP per capita y_{Cjt} and labour f_{LCjt}, and the smaller the distance in terms of capital formation f_{KCjt}, and land area endowment f_{ACjt}, the larger is the probability of exporting to China. These results suggest that positive import flows to China are originating mostly from advanced economies with higher GDP per capita, larger labour endowment, and lower endowment of capital and land area relative to China.

Moreover, WTO members, countries with Chinese language, and countries that were in the same country as China was historically, show higher probability of exports of manufacturing products to China. A weaker renminbi against the trading partner's currency has a positive impact on the extensive margins of trade to China. While distance has the expected negative impact in the first two probit models, contiguity shows negative coefficients. It suggests that neighbouring countries of China have lower probability of exports to China than other countries do, *ceteris paribus*. Countries sharing colonial ties with China have also less probability of exporting to China.

The fourth and fifth columns to the left, model *M1* and *M1-Lag*, respectively, refer to the intensive margins to trade to China from equation (5). *M1* (*M1-Lag*) includes the inverse Mills ratio $\hat{\bar{\eta}}^{*}_{Cjht}$ and the heterogeneity of firms $\hat{z}^{*}_{Cjht}$ in polynomial orders of one to three obtained from the extensive margin estimation model *Prob.* (*Prob.-Lag*). Controlling for the country-pair-product ω_{Cjh} excludes the time-invariant variables, and also including time fixed effects ω_t in addition gives a large goodness of fit with the R-square around 80%. As explained earlier on the exclusion restriction criterion, the WTO variable is excluded from these second-stage models. Land area endowment difference has now a positive impact on intensive margins to trade. However, the rest of the variables indicate a significant impact similar to the extensive margin estimations. For instance, according to *M1*, a one per cent increase in the total GDP of the two trading partners is expected to increase the trade value by 0.76%.

Table 2 – Gravity estimation results of manufacturing 6-digit product imports to China – 2002-2014

Dep.: m_{Cjht}	**Prob.**	**Prob.-Lag**	**M1**	**M1-Lag**	**M2**	**M2-Lag**	**IV-1st**	**IV-2nd**	**IV-1st-Lag**	**IV-2nd-Lag**
T_{Cjht} , T_{Cjht-1}	-0.81*** (0.030)	-0.56*** (0.033)	-0.50*** (0.16)	-0.99*** (0.15)	-1.13*** (0.41)	-0.93** (0.42)	2.05*** (0.00)	-1.38** (0.70)	2.12*** (0.00)	-1.95* (1.18)
TBT_{Cjht}, TBT_{Cjht-1}	0.076*** (0.0022)	0.069*** (0.0024)	0.17*** (0.012)	0.18*** (0.013)	0.34*** (0.061)	0.20*** (0.071)		0.46* (0.26)		0.74 (0.49)
$\overline{TBT}^{u}_{wht}$							0.005*** (0.00)		0.003*** (0.00)	
$\overline{TBT}^{u}_{jht}$							0.006*** (0.00)		0.005*** (0.00)	
$\overline{TBT}^{u}_{jCht}$							0.35*** (0.00)		0.22*** (0.00)	
g_{Cjt}	2.50*** (0.015)	2.56*** (0.016)	0.76** (0.32)	1.72*** (0.41)						
y_{Cjt}	1.17*** (0.028)	0.98*** (0.030)	5.85*** (0.27)	7.07*** (0.34)						
f_{LCjt}	0.035*** (0.0033)	0.037*** (0.0035)	0.55*** (0.081)	0.75*** (0.11)						
f_{KCjt}	-0.011*** (0.00031)	-0.011*** (0.00032)	-0.020*** (0.0017)	-0.027*** (0.0021)						
f_{ACjt}	-0.036*** (0.0026)	-0.035*** (0.0027)	0.84*** (0.085)	0.84*** (0.11)						
WTO_{jt}	0.31*** (0.0084)	0.33*** (0.0090)								
Xr_{Cjt}	0.0077*** (0.00051)	0.015*** (0.00074)	0.0089*** (0.0029)	0.0038 (0.0048)						
$Cont_{Cj}$	-0.67*** (0.012)	-0.65*** (0.012)								
$Lang_{Cj}$	0.25*** (0.016)	0.22*** (0.016)								
$Colony_{Cj}$	-0.96*** (0.058)	-1.13*** (0.062)								
$Same_{Cj}$	0.39*** (0.019)	0.35*** (0.020)								
$Dist_{Cj}$	-0.65*** (0.0084)	-0.66*** (0.0088)								
$\hat{\eta}^{*}_{Cjht}$			-0.82*** (0.28)	0.78** (0.37)	3.53*** (0.88)	2.92** (1.47)	-4.83*** (0.00)	4.12*** (1.59)	-4.83*** (0.00)	6.79 (4.35)
$\hat{z}^{*}_{Cjht}$			-0.71*** (0.20)	-0.065 (0.25)						
${\hat{z}^{*}_{Cjht}}^{2}$			-0.26*** (0.040)	-0.56*** (0.056)						
${\hat{z}^{*}_{Cjht}}^{3}$			0.071*** (0.0029)	0.099*** (0.0044)						
N			1206541	902918	991231	739665	991231	991231	739665	739665
R-sq			0.799	0.815	0.875	0.886	0.999	0.875	0.999	0.886
adj. R-sq			0.771	0.790	0.802	0.818	0.999	0.802	0.999	0.818
Hansen J p-v								0.48		0.56
Anderson-Rubin F p-v								0.22		0.35
Anderson-Rubin Chi-sq pv								0.12		0.22
DWH								0.00		0.00
Fixed Effects	RE, ω_t	RE, ω_t	ω_t, ω_{Cjh}	ω_t, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}

Standard errors in parentheses, robust clustered by country-pair-product Cjh.
* p<0.1, ** p<0.05, *** p<0.01.
Models Prob. and Prob.-Lag are referring to extensive margins of trade from equation (4); models M1 and M1-Lag refer to equation (5); models M2 and M2-Lag refer to equation (6) controlling for multilateral resistances (MLR); models IV-1st and IV-1st-Lag refer to the first-stage instrumental approach in equation (7), models Iv-2nd and IV-2nd-Lag refer to the second-stage instrumental variable controlling for MLR in equation (10). All models with '-Lag' include a lag of tariffs T_{Cjht-1} instead of current tariffs; and models Prob.-Lag, M1-Lag, and M2-Lag have a lag of TBTs TBT_{Cjht-1} instead of current TBTs.

As robustness checks, similar models are run over traded quantities and traded prices (unit values). Table 4 presents the results of estimations on traded quantities with similar sign and significance of coefficients as obtained from the models on trade value. However, the exchange rate is no longer statistically significantly affecting the traded quantities of the products. According to the results of model *M1* on the traded price in Table 5, appreciation of the trading partner's currency relative to the renminbi makes the imported products to China more expensive, which finally leads to a higher traded value but leaves the traded quantity statistically unaffected.

The GDP of the two trading partners statistically significantly reduces the traded prices, which might indicate an economy of scale effect. The further the two trading partners are from each other in terms of GDP per capita (level of development), the cheaper the price of the imported product to China. Larger labour endowment relative to China has a statistically significant positive impact only on traded quantities, while leaving the traded prices unaffected. Imports of products from countries with larger relative capital endowment are more expensive, which might be an indication to the quality of products. However, the traded quantity from such countries to China is lower, leading to a lower traded value obtained from the estimation results in Table 2. This might partly point to lower preferences and demand for higher-quality products in China as a country with lower GDP per capita in comparison to advanced economies with higher capital endowment.

The impact of present tariffs in model *M1* indicates a negative elasticity of import values with respect to tariffs. The negative impact of tariffs is slightly stronger on import quantities. However, tariffs do not have a statistically significant impact on traded prices. In other words, a one per cent increase in the ad-valorem equivalent (AVE) of tariffs reduces the traded quantity by 0.55% while reducing the traded value by 0.5%. This impact is stronger and closer to unity for lag of tariffs. This shows that the impact of tariffs after a year is stronger than the instant impact, because the importer had time to adjust to the changes in tariffs.

The impact of TBTs in force on the intensive margin is larger than their impact on the extensive margins to trade to China. A one per cent increase in the number of current TBTs in force increases the import values by around 0.17%, while a one per cent increase in TBTs that went into force in the previous year would improve the current imports of products by about 0.18%. According to models *M1* and *M1-Lag* in Table 4, TBTs also increase the quantity of imports to China. However, according to those models in Table 5, TBTs reduce the price of imports of products weakly significantly. This might indicate that, provided that the prices of imports are unaffected by TBTs, Chinese regulations could provide the Chinese economy with better access to foreign producers. Therefore, the overall impact of TBTs on trade values becomes positive and statistically significant.

The sixth and the seventh columns in Table 2 refer to the estimation results of equation (6) controlling for MLR and sample selection bias. Thus, in addition to country-pair-products ω_{Cjh}, these two models include partner-time-sector fixed effects ω_{jHt}. Using the latter excludes all country time-varying variables. Model *M2* includes the contemporaneous values of tariffs and TBTs and the inverse Mills ratio (IMR) obtained from model *Prob.*, and model *M2-Lag* includes the lag values of tariffs and TBTs and the obtained IMR from the *Prob.-Lag* model. MLR fixed effects improve the goodness of fit of model *M2* to 88% R-square, and that of model *M2-Lag* to 90%. Again, trade shows statistically significant negative elasticity to tariffs but positive to TBTs imposed by China. However, comparing *M2* with *M2-Lag*, the contemporaneous endogeneity of these trade policies induces an overestimation bias of the effects. Results of *M2-Lag* show that a one per cent increase in tariffs reduces import values of products to China in the next year by 0.93%. Besides, a one per cent larger number of TBTs in force increases the import values in the next year by 0.20%. Controlling for MLR, the impact of tariffs on the traded quantities (Table 4) and prices (Table 5) becomes weakly significant. However, in contrast to model *M1*, controlling for MLR in model *M2* the impact of current TBTs on traded quantities and prices is statistically significant and positive. In fact, the elasticity of TBTs on trade values is around 0.35%, which could be disentangled into around 0.23% positive elasticity on the traded quantities and around 0.12% on the traded prices.

The last four columns from the left side of Table 2 show results of the two stages of IV estimations. MLR and sample selections are controlled for in these estimations, resulting in a large goodness of fit. *IV-1st* and *IV-1st-Lag* are the first-stage estimations referring to equation (7). The results suggest that China's imposition of TBTs on manufacturing imports is statistically significantly affected by trading partners' TBTs against all partners in the world excluding China $\overline{TBT}^{u}_{jht}$, non-Chinese global TBTs against all partners excluding China $\overline{TBT}^{u}_{wht}$, and also according to retaliatory motivations against the trading partner's TBT_{jCht} on imports from China. The statistically significant positive coefficients of tariffs in both models *IV-1st* and *IV-1st-Lag* indicate complementarity of these traditional trade policy tools with the imposition of TBTs. In fact, when Chinese tariffs on a particular 6-digit product increase by one per cent, the number of imposed TBTs on that tariff line increases by above 2 per cent.

IV-2nd and *IV-2nd-Lag* are the second-stage instrumental estimation models in equation (10). P-values of the Hansen J test are above 0.5 in all regressions that cannot reject the joint null hypothesis of having valid instruments, meaning that the instruments are uncorrelated with the error term. The Anderson-Rubin F test of endogenous regressors, and the Anderson-Rubin chi-squared test of significance of endogenous regressors show the suitability of instruments used in the first stage. In fact, these tests suggest the exogeneity of the additional (excluded) instruments, i.e. they are not correlated with the import values or with the error term in the reduced form model. The Durbin–Wu–Hausman (DWH) test also rejects the consistency of the model without the instrumental variable. Using the lag of tariffs in *IV-2nd-Lag* shows a larger negative impact on import values but at weaker level of significance than that in model *IV-2nd*. While TBTs in model *IV-2nd-Lag* are not statistically significant, the weakly significant coefficient of TBTs in model *IV-2nd* still shows a trade promotion effect of TBTs imposed by China on its manufacturing products trade. This result could be interpreted as Chinese TBTs induced by global TBTs and partners' TBTs having still a positive effect on import flows of products to China but weakly significantly.

4.1.1. Robustness: food vs. non-food manufacturing

In further robustness specifications, food manufacturing imports are separated from non-food manufacturing imports. The reason is mainly because TBTs could be mostly aimed at the non-food industries while Sanitary and Phytosanitary (SPS) measures are those covering human health and safety issues affecting the food products imports. Therefore, the number of SPS measures imposed by China on 6-digit products imports are also included as additional explanatory variables in the regressions. Moreover, there are other non-quality (quantitative) NTMs that are controlled for in the regressions. The new variable on other quantitative NTMs, $qNTM_{Cjht}$, is measured as the logarithmic form of the summation of antidumping duties (ADP), countervailing duties (CV), import licences (LIC), quantitative restrictions (QR), safeguards (SG), state trading enterprises (STE), and tariff-rate quotas (TRQ) that China implemented in year t on a given product h imported from country j[15]. Food manufacturing covers HS 2-digit sectors 16 through 24; other sectors from 25 through 97 include non-food manufacturing products. The estimation will be similar to that of equation (6) controlling for MLR as follows:

[15] For description of these types of NTMs see https://i-tip.wto.org/goods/Forms/Methodology.aspx

$$m_{Cjht} = \alpha_{30} + \alpha_{31}\ln\left(TBT_{Cjht}+1\right) + \alpha_{31}\ln\left(SPS_{Cjht}+1\right) + \alpha_{31}\ln\left(qNTM_{Cjht}+1\right) + \alpha_{32}\ln\left(T_{Cjht}+1\right) + \alpha_{35}\hat{\hat{\eta}}^{*}_{Cjht} + \omega_{jHt} + \omega_{Cjh} + \vartheta_{Cjht} \tag{12}$$

where the inverse Mills ratio $\hat{\hat{\eta}}^{*}_{Cjht}$ is obtained from the first stage including both SPS_{Cjht} and $qNTM_{Cjht}$; the rest of the variables are defined as above. The estimation results are presented in Table 3.

The last two columns from the left, covering all manufacturing products and including the two new NTM variables, give coefficients of tariffs and TBTs very similar to the models in Table 2. This indicates the consistency of estimates of tariffs and TBTs while additional trade policy variables are included. However, the significant impact of current TBTs is majorly driven by the significant impact of non-food TBTs, because the current TBTs imposed on food manufacturing imports have a statistically insignificant coefficient. Lag of TBTs increases the current import values at the 5% level of significance for all product categories.

Table 3 – Gravity estimation results of manufacturing 6-digit product import values to China – 2002-2015

Food vs. non-food manufacturing

	Food (HS16-HS24)		**Non-food (HS25-HS97)**				**All**	
Dep.: m_{jht}	**M2**	**M2-Lag**	**M2**	**M2-Lag**	**IV-2nd**	**IV-2nd-Lag**	**M2**	**M2-Lag**
T_{Cjht} , T_{Cjht-1}	-2.63	-4.42***	-1.10***	-0.77*	-1.55**	-2.15*	-1.16***	-0.93**
	(1.70)	(1.69)	(0.42)	(0.42)	(0.72)	(1.23)	(0.41)	(0.42)
TBT_{Cjht}, TBT_{Cjht-1}	3.20	5.27**	0.34***	0.19**	0.56**	0.87*	0.34***	0.19**
	(2.22)	(2.22)	(0.067)	(0.076)	(0.26)	(0.50)	(0.067)	(0.075)
$qNTM_{Cjht}$, $qNTM_{Cjht-1}$			-0.32***	-0.32***			-0.33***	-0.32***
			(0.099)	(0.12)			(0.099)	(0.12)
SPS_{Cjht}, SPS_{Cjht-1}	1.93***	1.22*	0.23*	0.24			0.27**	0.27*
	(0.69)	(0.72)	(0.14)	(0.15)			(0.13)	(0.14)
$\hat{\hat{\eta}}^{*}_{Cjht}$	2.55	6.37	3.59***	2.77*	4.67***	7.94*	3.59***	2.97**
	(3.97)	(6.33)	(0.89)	(1.48)	(1.63)	(4.49)	(0.87)	(1.46)
N	26144	18769	965087	720896	965087	720896	991231	739665
R-sq	0.859	0.873	0.875	0.886	0.875	0.886	0.875	0.886
adj. R-sq	0.744	0.766	0.803	0.819	0.803	0.819	0.802	0.818
Hansen J p-v					0.50	0.88		
Anderson-Rubin F p-v					0.11	0.31		
Anderson-Rubin Chi-sq pv					0.044	0.18		
Fixed Effects	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}

Standard errors in parentheses, robust clustered by country-pair-product Cjh.
* p<0.1, ** p<0.05, *** p<0.01.
Dependent variable in these estimations is the log value of imports of 6-digit products from all exporting countries.
Manufactured food products are separated from non-food manufacture products.

Since the impact of TBTs is mostly originating from the non-food manufactures, and because of consistency of estimates excluding other NTM variables[16], as a robustness check to the instrumental variable approach, the two-stage GMM estimation is run only over the sample of non-food manufacturing imports. Estimation results of models *IV-2nd* and *IV-2nd-Lag* on sectors 25 through 97 are presented in the sixth and seventh columns from the left of Table 3, respectively. It is observed that the positive impact of instrumented TBTs on imports of non-food manufactures is statistically

[16] Including other trade policy measures would still cause the simultaneity bias requiring a system of equations with suitable instruments for them as well as those for TBTs to control for the endogeneity bias. The estimation of such a system with fixed effects controlling for MLR does not render appropriate test statistics and standard errors are inflated in the second stage.

significant and now stronger than in the model including all manufacturing products. This points to the fact that Chinese TBTs promote imports of mostly non-food manufacturing products[17].

While there exist few non-quality NTMs on food manufacturing imports, including both MLR fixed effects ω_{jHt} and bilateral product fixed effects ω_{Cjh} excludes them from the regressions because these NTMs do not have much variation during time for a given bilateral sector. Nevertheless, these measures statistically significantly hamper the import values of non-food manufacturing products to China. This result is in line with previous findings by Bao and Qiu (2010) and Imbruno (2016). As Imbruno (2016) documents, China has reduced these non-quality measures over the years to further liberalise its trade.

SPS measures as another important quality of NTMs imposed by China also have a statistically significant positive impact on the imports of products to China. This impact is mostly due to the SPS measures imposed on food manufacturing imports, while the effect of current SPS measures on non-food manufactured imports is statistically positive only at the 10% level of significance.

4.2. Differentiating results by trading partners

Figure 5 presents the impact of TBTs imposed by China on manufacturing products imports during the period 2002-2015, differentiating by the exporting countries. While the figures only present the estimated coefficients, the exact point estimates with significant thresholds could be calculated using the standard errors of the coefficients in Table 6 in the Appendix. *M2* and *IV-2nd* refer to their designated models in Table 2. Although the average impact of TBTs controlling for MLR and country-pair-product fixed effects resulted in positive coefficients of TBTs in both models, some countries' exports to China have been negatively affected by these policy measures.

According to the results from model *M2*, those affected statistically significantly and negatively by the Chinese TBTs are mostly some developing and least developed countries, with few exceptions from emerging economies[18]. However, the countries whose exports are promoted statistically significantly by the Chinese TBTs are diverse.

According to model *M2*, among the top 10 trading partners of China, exports from Korea, Australia, Malaysia, and Russia are affected statistically positively (below 10% level of significance) by the imposed TBTs. For instance, a one per cent increase in Chinese TBTs would increase Korean manufacturing exports to China by around 0.45%, a result which is statistically significant at the 5% level. Among these countries, Russian manufacturing export is promoted by Chinese TBTs according to both models *M2* and *IV-2nd* at the 10% level of significance.

According to model *M2*, Chinese TBTs have a positive impact on manufacturing exports to China from 36 countries at the 10% level of statistical significance; among them are eight members of the EU (Austria, Estonia, Hungary, Luxemburg, Latvia, Malta, Poland, and Portugal). According to the instrumental variable approach, exports from 38 countries have been positively affected at the 10% level of significance. According to model *IV-2nd*, Austria, Spain, Estonia, Greece, Hungary, Lithuania, Luxemburg, and Latvia are the EU countries, besides several other advanced economies, affected positively by the instrumented TBTs. This indicates that the proliferation of TBTs in China might have

[17] Results of the instrumental variable approach on food manufacturing show no significant impact of TBTs (results are available upon request).
[18] Classification on economic development of countries is borrowed from Upadhyaya (2013)

led to an improvement in the Chinese standards framework that made it closer to the trading partners promoting the exports from these advanced economies. Therefore, higher required standards embedded within TBTs had a trade creation effect which allowed the Chinese economy to gain access to a higher quality of foreign goods originating in advanced economies.[19]

5. Summary and conclusions

This paper investigates the impact of Technical Barriers to Trade (TBTs) maintained by China on its manufacturing product imports. While the imposition of TBTs is allowed in the framework of WTO regulations for justifiable reasons, some of the TBTs have resulted in Specific Trade Concerns (STCs) being raised during the TBT Committee meetings, and further led to dispute settlement cases within the WTO. During 2002-2015, China was the country notifying the second largest number of TBTs to the WTO after the United States. However, there has been no dispute settlement case against China citing the TBT agreement.

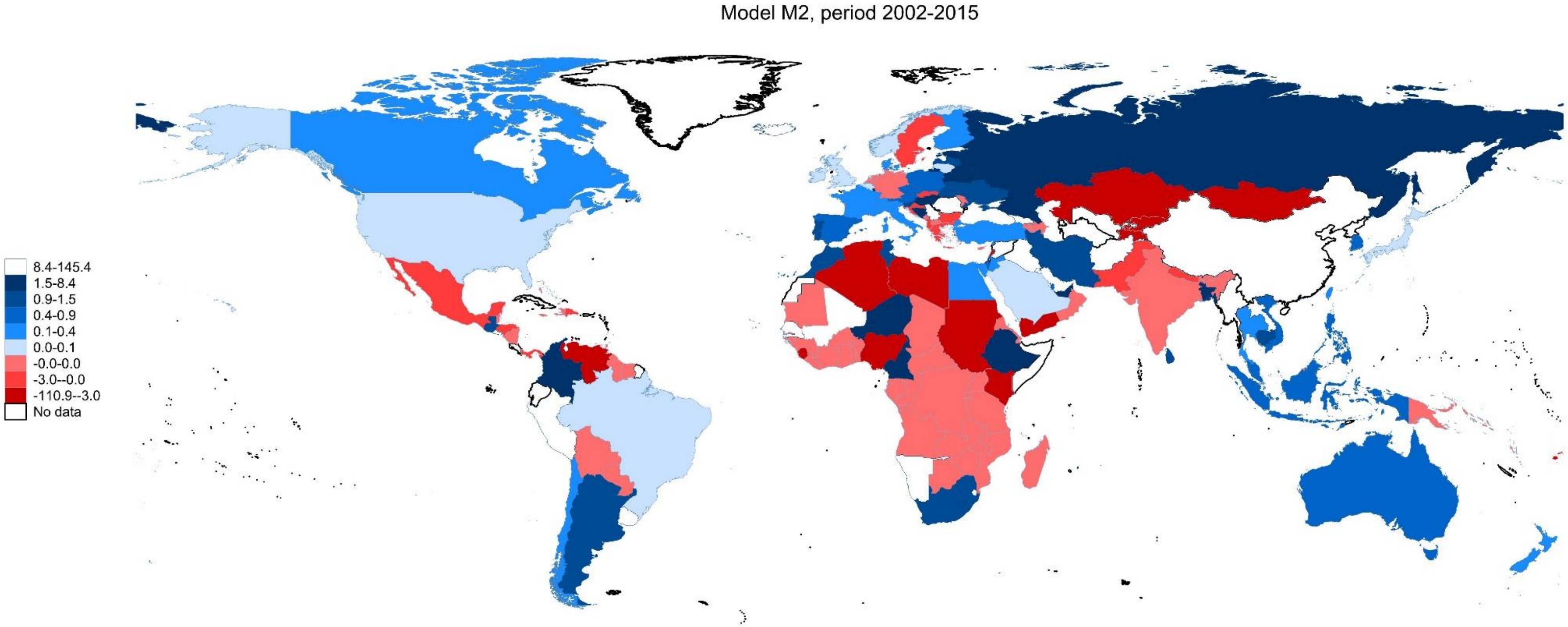
Imports of products at the 6-digit level of the Harmonised Systems (HS) during 2002-2015 were considered in the analysis. The impact of Chinese TBTs and tariffs on the values, quantities, and prices of imports to China has been analysed using the recent literature on structural gravity models. According to the heterogeneity of firms literature (Helpman et al., 2008), in addition to the sample selection bias, exporter heterogeneity was controlled for using a two-stage gravity framework. Moreover, multilateral resistances (MLR) based on the literature (Anderson and van Wincoop, 2003; Head and Mayer, 2014) were controlled for using country-sector-time fixed effects. Finally, the endogeneity bias of trade policy measures was addressed and controlled for using the lag of variables and instrumental variable (IV) regressions.

The econometrics results provide evidence towards a negative impact of tariffs and a positive impact of TBTs imposed by China on the import values and quantities of manufacturing products. This result is in line with the previous study by Bao and Qiu (2010), who found a positive impact of TBTs on Chinese 2-digit aggregate imports for the period 1998-2006. However, controlling for endogeneity reduces the significance of the impact for both trade policy measures. Price-averaged TBTs in the world, price-averaged TBTs by the trading partner on a given product, and the number of TBTs imposed by the trading partner on imports from China have proved suitable instruments for the Chinese proliferation of TBTs. The instrumented TBTs indicated a statistically significant positive impact on import flows especially for non-food manufacturing products.

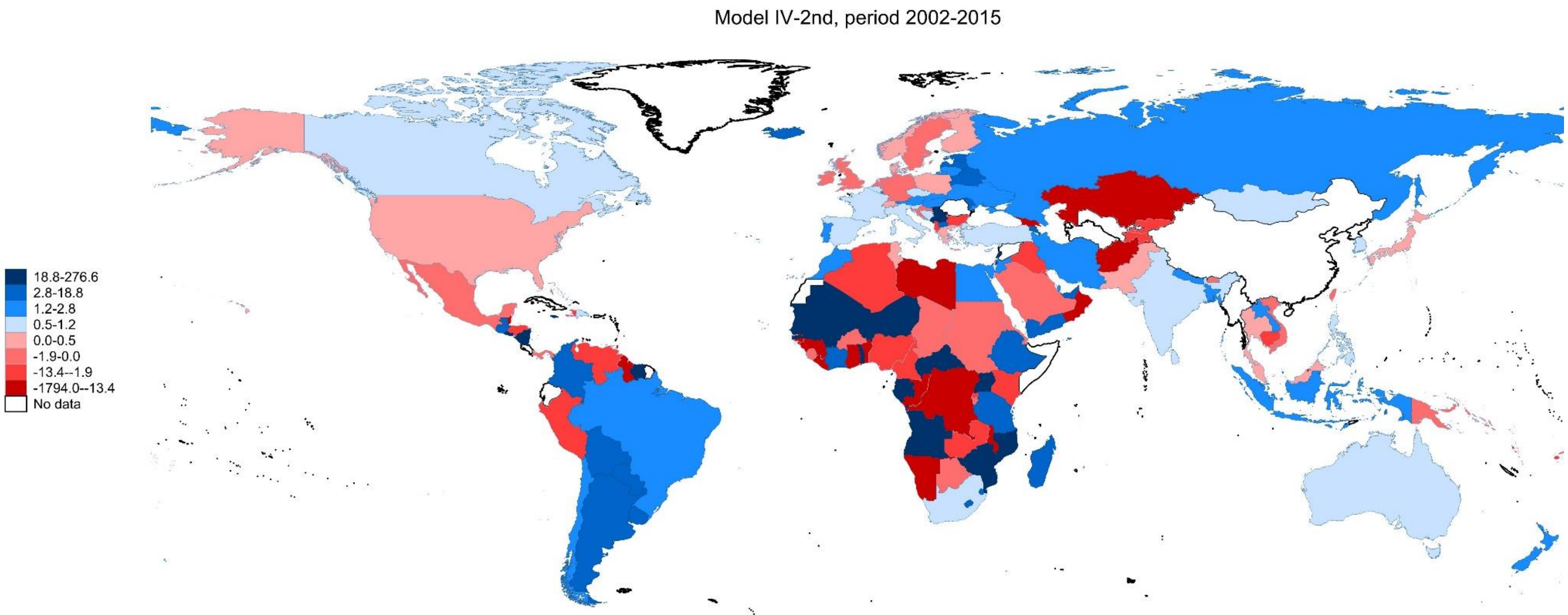
TBTs imposed on food manufacturing showed to have an insignificant impact on imports while the major positive impact of TBTs proved to be on the imports of non-food manufacturing products. It is important to mention that Sanitary and Phytosanitary (SPS) measures were also used in the analysis whose impact on the import flows of food manufacturing to China was also found to be positive. Finally, the impact of Chinese TBTs differentiated across exporting countries was presented to reiterate the diverse impact of these measures reported in the literature. Overall, based on the econometrics results of this analysis, one can observe a process of trade liberalisation of China by its tariffs reduction and implementation of trade-promotive TBTs, which benefited mostly exporters from advanced economies and many EU Member States.

[19] This argument is mainly because the impact of TBTs on the export prices from most of these advanced countries is statistically insignificant, therefore, no significant effect on quality or cost of the imported product. Estimation results on traded unit values and quantities differentiated by exporting countries are also available upon request.

Figure 5 – Estimated impact of Chinese manufacturing TBTs on imports – by exporters



Source: Estimated results of model M2 in.



Source: Estimated results of model IV-2nd in.

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Appendix

Table 4 – Gravity estimation results of manufacturing 6-digit product quantity imports to China – 2002-2015

Dep.: q_{Cjht}	**M1**	**M1-Lag**	**M2**	**M2-Lag**	**IV-1st**	**IV-2nd**	**IV-1st-Lag**	**IV-2nd-Lag**
$\boldsymbol{T_{Cjht}}$, $\boldsymbol{T_{Cjht-1}}$	-0.55***	-1.08***	-0.92*	-0.54	2.05***	-1.62*	2.12***	-2.62*
	(0.18)	(0.17)	(0.49)	(0.48)	(0.00)	(0.83)	(0.00)	(1.40)
$\boldsymbol{TBT_{Cjht}}$, $\boldsymbol{TBT_{Cjht-1}}$	0.18***	0.19***	0.23***	0.14*		0.54*		1.12*
	(0.013)	(0.014)	(0.073)	(0.082)		(0.30)		(0.57)
$\boldsymbol{\overline{TBT}^{u}_{wht}}$					0.005***		0.003***	
					(0.00)		(0.00)	
$\boldsymbol{\overline{TBT}^{u}_{jht}}$					0.006***		0.005***	
					(0.00)		(0.00)	
$\boldsymbol{\overline{TBT}^{u}_{jCht}}$					0.35***		0.22***	
					(0.00)		(0.00)	
$\boldsymbol{g_{Cjt}}$	1.00***	2.20***						
	(0.35)	(0.44)						
$\boldsymbol{y_{Cjt}}$	6.67***	7.99***						
	(0.29)	(0.36)						
$\mathbf{f_{LCjt}}$	0.58***	0.69***						
	(0.087)	(0.11)						
$\mathbf{f_{KCjt}}$	-0.022***	-0.030***						
	(0.0019)	(0.0022)						
$\mathbf{f_{ACjt}}$	0.88***	1.05***						
	(0.090)	(0.12)						
$\boldsymbol{Xr_{Cjt}}$	0.0044	0.0018						
	(0.0032)	(0.0052)						
$\boldsymbol{\widehat{\overline{\eta}}^{*}_{Cjht}}$	-1.03***	0.82**	3.83***	2.56		5.47***		10.4**
	(0.30)	(0.40)	(1.01)	(1.67)		(1.87)		(5.11)
$\boldsymbol{\hat{z}^{*}_{Cjht}}$	-0.91***	-0.16						
	(0.21)	(0.27)						
$\boldsymbol{\hat{z}^{*}_{Cjht}}^{2}$	-0.22***	-0.57***						
	(0.043)	(0.059)						
$\boldsymbol{\hat{z}^{*}_{Cjht}}^{3}$	0.067***	0.100***						
	(0.0032)	(0.0046)						
N	1206541	902918	991231	739665	991231	991231	739665	739665
R-sq	0.816	0.835	0.884	0.896	0.999	0.884	0.999	0.896
adj. R-sq	0.791	0.812	0.816	0.834	0.999	0.816	0.999	0.834
Hansen J p-v						0.66		0.58
Anderson-Rubin F p-v						0.26		0.16
Anderson-Rubin Chi-sq pv						0.15		0.075
Fixed Effects	ω_t, ω_{Cjh}	ω_t, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}

Standard errors in parentheses, robust clustered by country-pair-product Cjh.
* p<0.1, ** p<0.05, *** p<0.01.
Dependent variable in these estimations is the log quantity of imports of 6-digit products from all exporting countries.
Models Prob. and Prob.-Lag refer to extensive margins of trade from equation (4); model M1 and M1-Lag refer to equation (5); models M2 and M2-Lag refer to equation (6) controlling for multilateral resistances (MLR); models IV-1st and IV-1st-Lag refer to the first-stage instrumental approach in equation (7), models Iv-2nd and IV-2nd-Lag refer to the second-stage instrumental variable controlling for MLR in equation (10). All models with '-Lag' include a lag of tariffs T_{Cjht-1} instead of current tariffs; and models Prob.-Lag, M1-Lag, and M2-Lag have a lag of TBTs TBT_{Cjht-1} instead of current TBTs.

Table 5 – Gravity estimation results of manufacturing 6-digit product price imports to China – 2002-2015

Dep.: u_{Cjht}	**M1**	**M1-Lag**	**M2**	**M2-Lag**	**IV-1st**	**IV-2nd**	**IV-1st-Lag**	**IV-2nd-Lag**
T_{Cjht} , T_{Cjht-1}	0.049 (0.060)	0.085 (0.059)	-0.20 (0.16)	-0.39** (0.17)	2.05*** (0.00)	0.24 (0.33)	2.12*** (0.00)	0.69 (0.56)
TBT_{Cjht}, TBT_{Cjht-1}	-0.0084* (0.0051)	-0.010* (0.0055)	0.12*** (0.034)	0.059 (0.037)		-0.087 (0.13)		-0.39* (0.24)
$\overline{TBT}^{u}_{wht}$					0.005*** (0.00)		0.003*** (0.00)	
$\overline{TBT}^{u}_{jht}$					0.006*** (0.00)		0.005*** (0.00)	
$\overline{TBT}^{u}_{jCht}$					0.35*** (0.00)		0.22*** (0.00)	
g_{Cjt}	-0.24* (0.14)	-0.48*** (0.17)						
y_{Cjt}	-0.82*** (0.11)	-0.92*** (0.13)						
f_{LCjt}	-0.027 (0.033)	0.062 (0.043)						
f_{KCjt}	0.0018** (0.00077)	0.0027*** (0.00089)						
f_{ACjt}	-0.042 (0.035)	-0.21*** (0.045)						
Xr_{Cjt}	0.0045*** (0.0013)	0.0020 (0.0021)						
$\hat{\bar{\eta}}^{*}_{Cjht}$	0.21* (0.12)	-0.038 (0.15)	-0.30 (0.32)	0.36 (0.57)		-1.36* (0.74)		-3.68* (2.07)
$\hat{z}^{*}_{Cjht}$	0.20** (0.084)	0.097 (0.10)						
${\hat{z}^{*}_{Cjht}}^{2}$	-0.037** (0.016)	0.015 (0.021)						
${\hat{z}^{*}_{Cjht}}^{3}$	0.0040*** (0.0012)	-0.0012 (0.0016)						
N	1206541	902918	991231	739665	991231	991231	739665	739665
R-sq	0.810	0.840	0.882	0.900	0.999	0.882	0.999	0.900
adj. R-sq	0.784	0.818	0.814	0.840	0.999	0.814	0.999	0.840
Hansen J p-v						0.78		0.96
Anderson-Rubin F p-v						0.85		0.41
Anderson-Rubin Chi-sq pv						0.78		0.27
Fixed Effects	ω_t, ω_{Cjh}	ω_t, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}	ω_{jHt}, ω_{Cjh}

Standard errors in parentheses, robust clustered by country-pair-product Cjh.
* p<0.1, ** p<0.05, *** p<0.01.
Dependent variable in these estimations is the log unit value of imports of 6-digit products from all exporting countries.
Models Prob. and Prob.-Lag refer to extensive margins of trade from equation (4); model M1 and M1-Lag refer to equation (5); models M2 and M2-Lag refer to equation (6) controlling for multilateral resistances (MLR); models IV-1st and IV-1st-Lag refer to the first-stage instrumental approach in equation (7), models Iv-2nd and IV-2nd-Lag refer to the second-stage instrumental variable controlling for MLR in equation (10). All models with '-Lag' include a lag of tariffs T_{Cjht-1} instead of current tariffs; and models Prob.-Lag, M1-Lag, and M2-Lag have a lag of TBTs TBT_{Cjht-1} instead of current TBTs.

Table 6 – Impact of Chinese TBTs on 6-digit manufacturing product imports differentiated by exporter – 2002-2015

Partner	Imports, period-summed, USD billion	Imports, period-averaged, USD million	M2			IV-2nd		
			$\omega_j\alpha_{51}$	z-value	S.E	$\omega_j\alpha_{51}$	z-value	S.E
AFG	0.04	0.07	47.22	0.52	74.06	-16.86	0.16	12.05
AGO	235.58	841.37	0.00			44.36	0.00	4.33
ALB	1.24	1.19	-2.37	0.00	0.78	-3.04	0.03	1.41
ARE	77.04	9.53	2.29	0.00	0.41	3.56	0.00	0.67
ARG	13.90	2.43	1.33	0.36	1.47	3.11	0.11	1.93
ARM	0.66	1.16	0.00			12.27	0.82	54.17
AUS	612.29	19.96	0.53	0.09	0.31	0.49	0.26	0.43
AUT	41.61	1.69	0.89	0.03	0.42	1.29	0.03	0.58
AZE	1.60	5.40	0.00			930.79	0.01	343.67
BDI	0.05	1.04	0.00			0.00		
BEL	70.05	2.33	0.00	0.99	0.29	0.52	0.26	0.47
BEN	1.82	11.51	0.00			-17.26	0.00	2.00
BFA	1.73	24.43	0.00			0.00		
BGD	3.61	0.89	1.99	0.03	0.89	1.81	0.47	2.51
BGR	4.94	0.75	-1.92	0.01	0.75	-2.05	0.04	1.02
BHR	2.08	2.44	5.46	0.00	0.77	-7.66	0.74	23.34
BHS	0.13	1.28	0.00			0.00		
BIH	0.45	0.29	2.60	0.15	1.82	1.07	0.90	8.80
BLR	6.77	2.31	7.64	0.05	3.88	10.60	0.03	4.84
BLZ	0.03	0.24	0.00			-276.18	0.00	5.81
BOL	2.42	3.57	0.00			8.19	0.00	2.21
BRA	276.95	16.02	0.03	0.96	0.50	1.22	0.05	0.63
BRB	0.07	0.36	0.00			45.80	0.65	100.60
BRN	3.83	9.78	0.00			-82.50	0.07	44.94
BTN	0.00	0.02	0.00			0.00		
BWA	0.77	7.47	0.00			0.00		
CAF	0.24	2.44	0.00			24.06	0.00	0.00
CAN	155.79	5.13	0.42	0.19	0.32	0.80	0.08	0.46
CHE	103.47	3.35	0.18	0.55	0.31	0.28	0.34	0.30
CHL	164.91	38.27	0.30	0.84	1.50	2.68	0.12	1.72
CIV	1.52	4.50	0.00			5.36	0.00	0.51
CMR	5.14	10.49	3.18	0.26	2.82	-12.69	0.00	3.56
COD	14.94	66.98	0.00			-251.78	0.00	32.76
COG	41.62	123.15	0.00			-52.11	0.43	66.61
COL	26.14	9.94	2.88	0.42	3.60	6.55	0.07	3.62
COM	0.00	0.00	0.00			0.00		
CPV	0.00	0.00	0.00			0.00		
CYP	0.29	0.38	0.00			1.11	0.86	6.22
CZE	17.85	1.07	0.47	0.38	0.53	0.66	0.23	0.55
DEU	753.56	15.59	-0.05	0.82	0.20	-0.08	0.78	0.27
DJI	0.00	0.11	0.00			0.00		
DNK	26.27	1.12	0.09	0.75	0.29	0.16	0.64	0.35
DOM	2.06	1.11	-0.85	0.85	4.48	0.89	0.89	6.56
DZA	12.80	13.60	-7.80	0.07	4.26	-2.49	0.82	11.21
EGY	9.25	2.03	0.22	0.85	1.15	1.62	0.32	1.63
ERI	0.00	0.06	0.00			0.00		
ESP	56.19	1.72	0.45	0.28	0.41	0.97	0.08	0.54
EST	1.59	0.39	2.95	0.00	0.69	3.45	0.00	0.83
ETH	0.23	0.42	1.91	0.00	0.05	3.76	0.00	1.31
FIN	42.75	2.21	0.16	0.68	0.38	0.21	0.65	0.47
FJI	0.14	0.62	-8.08	0.00	2.37	-7.80	0.00	1.63
FRA	192.49	4.58	0.11	0.65	0.25	0.53	0.15	0.37
GAB	9.71	52.79	0.00			246.95	0.00	0.00
GBR	139.04	3.38	0.04	0.88	0.26	-0.17	0.67	0.39
GEO	0.31	0.33	47.61	0.01	17.44	-13.44	0.28	12.53
GHA	2.37	4.92	0.00			-18.06	0.87	109.77
GIN	0.37	1.62	0.00			-30.52	0.00	0.00
GMB	0.28	2.50	0.00			-1039.76	0.00	0.00
GNB	0.10	2.31	0.00			-371.12	0.00	0.00
GNQ	21.28	256.38	0.00			49.78	0.00	0.00
GRC	2.93	0.40	-0.25	0.57	0.44	0.46	0.02	0.20
GTM	0.79	0.77	1.16	0.47	1.60	5.65	0.30	5.48
GUY	0.18	1.16	0.00			-235.57	0.00	41.44
HKG	131.02	3.58	0.49	0.12	0.32	0.50	0.17	0.36
HND	1.04	1.00	-3.00	0.53	4.80	-8.08	0.66	18.63
HRV	0.71	0.20	-0.97	0.58	1.77	-0.30	0.79	1.13
HTI	0.08	0.28	0.00			-3.57	0.86	20.44
HUN	19.38	1.52	1.48	0.00	0.51	1.26	0.01	0.50

Partner	Imports, period-summed, USD billion	Imports, period-averaged, USD million	M2			IV-2nd		
			$\omega_j\alpha_{51}$	z-value	S.E	$\omega_j\alpha_{51}$	z-value	S.E
IDN	194.05	7.62	0.80	0.01	0.32	1.31	0.01	0.48
IND	171.70	5.83	-0.04	0.90	0.33	0.78	0.07	0.44
IRL	32.16	2.93	0.06	0.91	0.50	-1.00	0.25	0.88
IRN	208.78	45.08	0.92	0.43	1.17	1.64	0.44	2.13
IRQ	87.32	185.40	9.43	0.23	7.90	-10.35	0.71	27.80
ISL	0.10	0.10	10.03	0.15	7.00	11.66	0.64	24.97
ISR	19.15	1.28	0.57	0.29	0.54	0.69	0.22	0.56
ITA	154.19	3.59	0.33	0.22	0.27	0.50	0.17	0.36
JAM	1.18	3.37	0.00			31.72	0.00	7.47
JOR	2.07	1.50	0.28	0.00	0.07	2.15	0.01	0.87
JPN	1,656.75	32.02	0.06	0.71	0.16	0.45	0.15	0.31
KAZ	100.96	50.43	-9.99	0.03	4.51	-13.48	0.06	7.18
KEN	0.43	0.36	-3.54	0.00	0.37	-4.66	0.01	1.76
KGZ	1.05	1.51	-3.03	0.41	3.68	-2.25	0.54	3.64
KHM	1.94	0.61	1.14	0.01	0.45	-3.97	0.21	3.17
KOR	1,315.83	27.77	0.45	0.04	0.23	0.53	0.13	0.36
KWT	68.52	88.42	27.93	0.00	4.30	-9.33	0.55	15.63
LAO	6.48	5.09	12.47	0.00	0.65	1.61	0.71	4.27
LBN	0.23	0.24	-40.28	0.00	13.49	21.23	0.07	11.73
LBR	0.96	7.64	0.00			-15.32	0.00	0.86
LBY	7.21	43.44	-39.29	0.06	20.75	-23.13	0.79	86.38
LCA	0.00	0.01	0.00			-32.39	0.75	100.22
LKA	1.10	0.20	0.91	0.18	0.68	1.17	0.11	0.74
LSO	0.06	0.34	14.61	0.04	7.27	11.40	0.13	7.55
LTU	0.71	0.18	0.05	0.92	0.51	2.19	0.05	1.10
LUX	3.00	0.62	2.21	0.00	0.49	2.79	0.00	0.34
LVA	0.62	0.23	1.24	0.09	0.74	3.63	0.00	0.74
MAC	3.20	0.54	-0.86	0.00	0.28	-0.16	0.82	0.74
MAR	5.01	1.13	1.37	0.02	0.57	1.42	0.00	0.46
MDA	0.12	0.10	0.00			7.23	0.46	9.80
MDG	0.86	0.50	0.00			2.85	0.27	2.57
MEX	71.69	3.96	-0.26	0.67	0.60	-0.12	0.85	0.66
MKD	0.79	0.67	0.00			4.22	0.81	17.65
MLI	1.07	4.75	-1543.84	0.00	0.05	83.74	0.00	2.96
MLT	5.37	2.47	1.39	0.03	0.65	1.43	0.06	0.75
MNE	0.10	0.69	0.00			20.59	0.36	22.39
MNG	29.26	19.76	-10.91	0.00	1.42	0.78	0.95	11.88
MOZ	2.29	6.40	0.00			168.66	0.38	194.02
MRT	10.34	81.43	0.00			140.02	0.76	465.81
MUS	0.07	0.05	2.55	0.00	0.03	-4.34	0.67	10.05
MWI	0.25	1.65	0.00			-1461.79	0.00	0.00
MYS	406.91	14.46	0.55	0.08	0.31	0.39	0.35	0.42
NAM	2.76	5.33	34.90	0.04	16.91	-20.39	0.24	17.49
NER	0.10	0.39	2.67	0.00	0.06	140.10	0.01	57.19
NGA	12.64	8.57	-39.09	0.04	19.41	-2.56	0.89	18.12
NIC	0.33	0.58	0.00			71.41	0.37	79.12
NLD	71.00	2.23	-0.04	0.90	0.30	-0.33	0.37	0.37
NOR	28.64	2.01	0.08	0.82	0.37	0.08	0.87	0.46
NPL	0.16	0.06	-0.85	0.05	0.43	2.68	0.18	1.99
NZL	24.11	1.74	0.38	0.43	0.48	1.21	0.06	0.65
OMN	143.16	188.62	0.00			-64.15	0.01	26.25
PAK	20.62	2.81	-0.13	0.80	0.51	0.31	0.42	0.38
PAN	0.72	0.80	-1.67	0.04	0.83	-0.40	0.82	1.76
PER	66.57	20.20	8.38	0.00	0.55	-1.91	0.58	3.42
PHL	163.69	9.86	0.80	0.09	0.47	0.63	0.37	0.71
PNG	0.19	7.13	0.00			0.00		
POL	18.57	1.14	0.76	0.05	0.38	0.10	0.84	0.49
PRT	9.21	0.73	1.23	0.07	0.67	1.29	0.10	0.79
PRY	0.50	1.02	0.00			18.80	0.26	16.61
QAT	40.25	26.39	0.74	0.46	0.99	2.37	0.18	1.77
RUS	287.23	21.26	2.01	0.01	0.72	2.51	0.04	1.19
RWA	0.57	5.78	0.00			-6.66	0.00	0.40
SAU	381.99	68.13	0.03	0.94	0.47	-0.16	0.79	0.59
SDN	41.94	79.89	-11.81	0.37	13.16	-0.83	0.94	10.55
SEN	0.12	0.41	38.93	0.00	0.07	90.46	0.00	0.19
SGP	215.12	6.78	0.20	0.59	0.37	0.20	0.71	0.54
SLB	0.00	0.00	0.00			0.00		
SLE	3.85	10.26	-110.89	0.22	90.19	-1.89	0.83	8.99
SLV	0.13	0.16	16.51	0.00	1.27	30.06	0.08	16.91
SRB	0.43	0.29	23.47	0.14	15.91	47.24	0.02	20.77

Partner	Imports, period-summed, USD billion	Imports, period-averaged, USD million	M2			IV-2nd		
			$\omega_j \alpha_{51}$	z-value	S.E	$\omega_j \alpha_{51}$	z-value	S.E
SUR	0.21	1.66	0.00			86.90	0.00	19.38
SVK	17.95	2.19	-0.23	0.80	0.90	2.82	0.23	2.37
SVN	2.01	0.23	0.93	0.23	0.77	1.05	0.27	0.97
SWE	64.57	2.45	-0.23	0.46	0.30	-0.14	0.77	0.46
SWZ	0.40	0.98	10.57	0.02	4.69	17.19	0.26	15.20
TCD	2.15	17.79	0.00			0.00		
TGO	0.50	2.20	0.00			276.56	0.11	172.89
THA	296.00	9.47	0.17	0.63	0.35	0.14	0.78	0.51
TJK	0.61	2.07	-7.04	0.00	0.06	-13.21	0.00	0.12
TON	0.00	0.01	0.00			0.00		
TTO	1.04	4.63	0.00			-77.07	0.33	78.40
TUN	1.44	0.34	1.18	0.06	0.62	0.32	0.31	0.31
TUR	28.00	1.56	0.34	0.40	0.40	0.84	0.11	0.53
TWN	1,072.93	24.27	0.34	0.11	0.21	-0.12	0.69	0.30
TZA	2.72	3.63	0.00			3.93	0.57	6.97
UGA	0.27	0.81	0.00			18.80	0.53	30.07
UKR	22.95	4.08	0.95	0.52	1.48	2.02	0.48	2.83
URY	4.96	3.16	145.45	0.00	32.49	8.58	0.48	12.23
USA	986.15	19.50	0.09	0.63	0.19	0.46	0.13	0.30
VCT	0.00	0.08	0.00			0.00	1.00	0.00
VEN	47.88	42.33	-11.76	0.00	2.27	-6.73	0.81	28.12
VNM	99.26	5.61	0.73	0.26	0.65	-0.01	0.99	0.74
VUT	0.00	0.05	0.00			-1794.02	0.00	0.00
YEM	30.37	51.92	-29.95	0.02	12.36	11.46	0.06	6.06
ZAF	125.22	9.55	1.33	0.00	0.34	1.13	0.01	0.46
ZMB	15.93	49.48	0.00			-9.07	0.19	6.93
ZWE	1.05	6.06	0.00			235.18	0.00	58.55

Estimated coefficients using robust standard errors (SE) clustered by country-pair-product.
M2 refers to model M2 in Table 2; model IV-2nd refers to model IV-2nd in Table 2.