Trade Policies Mix and Match: Theory, Evidence and the EU-Sino Electric Vehicle Disputes[*]

Hiau Looi KEE[†]
World Bank

Enze XIE[‡]
Zhejiang University and World Bank

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Abstract

This paper studies the relationship between tariffs and non-tariff measures (NTMs) based on the latest product-level ad valorem equivalent estimates. Reduced-form results show that overall tariffs and NTMs are policy substitutes. The substitutions are larger for high-income importing countries, low-income exporting countries, country pairs with deep trade agreements, and products with consumption externalities. A terms-of-trade model with welfare-maximizing governments confronting externalities rationalizes and confirms the reduced-form results via structural estimations. The model is further used to shed light on the recent EU-Sino battery electric vehicle (BEV) disputes, whereby the EU imposed NTMs on top of the tariffs on China's BEVs.

Keywords: Tariffs, non-tariff measures, ad valorem equivalent, trade policies, externalities, electric vehicles, EU-Sino trade disputes, trade tensions
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[†]Corresponding author. Development Research Group, The World Bank; 1818 H ST NW, Washington, DC 20433. Tel: 1-202-473 4155; Fax: 1-202-522 1159; Email: hlkee@worldbank.org.

[‡]School of Economics, Zhejiang University, China, and Development Research Group, The World Bank. Email: ezxie2019@nsd.pku.edu.cn.

"The old world of trade was a world where production systems were national and where obstacles to trade were about protecting domestic producers from foreign competition. By contrast, the new world is a world where production is transnational along global supply chains of goods and services and where obstacles to trade are about protecting the consumer from risks. This is a new version of the old divide between tariffs and non-tariff measures."

—The New World of Trade, Pascal Lamy, The Third Jan Tumlir Lecture, 2015

1 Introduction

A tariff, the simplest trade policy, is a tax levied when a good is imported and has traditionally been used as a source of government income (Krugman et al. 2018). The successive rounds of multilateral negotiations since the 1950s have brought down tariffs for many countries.[1] In more recent years, with the proliferation of regional trade agreements (see Figure 1), multilateral negotiations are mainly about harmonizing, simplifying, or mutually recognizing non-tariff measures (NTMs) (Ederington 2001). NTMs are policy measures other than tariffs that can potentially have an economic effect on international trade in goods and aim primarily at protecting public health or the environment (UNCTAD 2015). Does this shift in focus in trade negotiations indicate that tariffs and NTMs are policy substitutes? In other words, with tariffs reduced by many trade agreements, do governments resort to NTMs to protect the domestic economies from import competition? What factors determine the degree of substitution between tariffs and NTMs? The answers to these questions could broaden our understanding of how different countries could use different trade policies on different products to address domestic objectives, such as safeguarding public health, and even to advance global objectives, such as combating climate change (Harstad 2024a). The ongoing trade tensions and conflicts, highlighted by the European Union (EU) imposing provisional countervailing duties (CVDs), a type of NTMs, on the imports of battery electric vehicles (BEVs) from China, on top of the existing 10% tariffs, encapsulate governments actively mix and match tariffs and NTMs on critical products, underscoring the urgency and practical significance of answering these questions. This paper aims to provide some explanations to these questions in order to shed light on the recent trade spats.[2]

Many papers have been contributing to this topic, with most papers concluding that tariffs and

[1] For example, the multilateral negotiations starting from the General Agreement on Tariffs and Trade (GATT) in the 1950s, to the establishment of the World Trade Organization (WTO) in the 1990s, pushed down the average tariff of the US from more than 20% to less than 5%. Data source: https://wits.worldbank.org

[2] On July 4, 2024, the EU imposed CVDs on Chinese vehicle manufacturers that EU claims to received state subsidies. On August 9, 2024, China filed a formal complaint at the WTO regarding the EU's CVDs, further escalated the trade dispute. Section 5.1 will shed light on the policy actions of the EU in the context of a model with consumption externalities.

NTMs are policy substitutes.[3] However, anecdotal evidence suggests that the relationship between the two trade policy instruments is more nuanced. For example, Chen et al. (2022) find that during 2018-2019, at the height of US-China trade war, the Chinese government increased tariffs and imposed NTMs on agricultural products from the US. This would suggest that the two policies are complements. Later in 2020, with the signing of the Purchase Agreement, the NTMs on US agricultural goods were removed without changing tariffs, indicating that the two policies are substitutes. Likewise, India is the target of many WTO dispute settlements,[4] with exporting countries such as Brazil, Australia, and Guatemala complaining about India's NTMs on sugar,[5] while Taiwan, China and the EU complaining about India's tariff on information technology products.[6] This could mean that for India, tariffs and NTMs are complementary policies.

This paper first presents new empirical evidence based on detailed estimates of product-level bilateral ad valorem equivalent (AVE) of NTMs from Kee and Nicita (2022). This is the point of departure of this paper from the existing literature, whereby more detailed product-level bilateral AVEs are used to compare the trade impacts of NTMs with the trade impacts of tariffs, in fixed-effects instrumental variable regressions pooling across products, importing and exporting countries. In addition, to capture various characteristics of importing countries, exporting countries, and products that may affect the relationship between tariffs and NTMs, relevant interaction terms and fixed effects are included in the regressions.

Our empirical results confirm that overall tariffs and NTMs are policy substitutes in the sense that governments impose more restrictive NTMs on products or trading partners with lower tariffs. However, depending on the characteristics of the importing countries, exporting countries and products, governments also mix and match tariffs and NTMs, which may turn the relationship between tariffs and NTMs to be less substituting and may even be complementary. For example, importing economies with higher income or are more capital or skilled labor abundant are likely to have more liberal tariffs and restrictive NTMs. Likewise, the exporting countries that are labor abundant or have lower income often face more liberal tariffs and restrictive NTMs. Lower tariffs coupled with restrictive NTMs are also found in country pairs with deep trade agreements while engagement in traditional multilateral agreements such as WTO has no significant impact on the relationship between tariffs and NTMs. Policy substitution is further found in consumption products, agricultural products and food and beverage products. In contrast, intermediate products and capital products which are part

[3]For example, see Beverelli et al. (2019), Bown and Tovar (2011), Feinberg and Reynolds (2007), Herghelegiu (2018), Kee et al. (2009), Ketterer (2016), Kuenzel (2020), Limão and Tovar (2011), Moore and Zanardi (2011), Niu et al. (2018), Orefice (2017).

[4]India has been the respondent in 32 cases of trade disputes and the third party in 182 cases of trade disputes.

[5]Please refer to DS579, DS580 and DS581 for disputes between Brazil, Australia, Guatemala and India on non-tariff measures concerning sugar and sugarcane, respectively.

[6]Please refer to DS582, DS588 for disputes between European Union, Taiwan, China and India on tariff treatment on certain goods in the information and communications technology sector.

of GVCs, often face complementary trade policies.

To rationalize these empirical findings, this paper presents a simple terms-of-trade model built on Ederington (2001). In this model, the government chooses tariffs and NTMs to maximize social welfare. Instead of a negative externality associated with the production of the imported product as in Ederington (2001), in this paper, there is a negative externality associated with the consumption of the imported product which can be reduced by the restrictive NTMs, similar to that of Copeland (1994). The effectiveness of NTMs in reducing externality depends on the governance and institutional quality of the importing country, the compliant capability of the exporting country, and the product characteristics. Jointly, both tariffs and NTMs create a wedge between the world price and the domestic price of the imported goods.[7] Similar to tariffs, NTMs reduce imports and depress the world price, leading to terms-of-trade gains. Furthermore, NTMs also improve social welfare directly by reducing the consumption externalities of imports. In equilibrium, countries with market power will choose to impose positive tariffs and NTMs, which give rise to the policy substitution between the two trade instruments. The weight of the consumption externality in the social welfare function and the severity of externality depends on the characteristics of importing countries and products, which influences how the welfare maximizing government may mix and match the two policies. In particular, for the case of the EU imposing NTMs on top of tariffs on Chinese BEVs, this model shows that such a policy mix is optimal to reduce imports facing a lower world price, when BEVs may impose externalities on EU's social welfare. Structural estimations of the model parameters lend credence to the theory and collaborate with the previous reduced-form findings.

This paper relates to both the theoretical and empirical literature on trade policy determinations, especially regarding the relationship between the use of tariffs and NTMs. Even though many papers have contributed to this topic, these is no clear consensus. On the empirical front, while the earlier evidence indicates that tariffs and NTMs are policy complements (Lee and Swagel 1997), the more recent evidence since 2000 suggests the opposite (Beverelli et al. 2019, Bown and Tovar 2011, Feinberg and Reynolds 2007, Herghelegiu 2018, Kee et al. 2009, Ketterer 2016, Limão and Tovar 2011, Moore and Zanardi 2011, Niu et al. 2018; 2020, Orefice 2017).[8] These recent studies are heterogeneous in the types and empirical measurements of NTMs, tariffs, and sample coverage.[9] Some other work supports that tariffs and NTMs are complementary or the relationship between them is overall substituting but contingent, influenced by the government's bargaining power to special interest groups (Limão

[7]This paper focuses on border NTMs, section 2.1 presents the detailed discussion.

[8]Kuenzel (2020) and Beshkar et al. (2015) find that the tariff overhang instead of tariff *per se* and NTMs are substitutes. Tariff overhang is the difference between WTO members' bound tariff rates and applied tariff rates, namely *water in the tariff*, which reflects the government's flexibility in adjusting tariffs under the WTO regulation.

[9]The NTMs types include anti-dumping, countervailing duties, SPS, TBT, and safeguard. The NTMs empirical measurements include incidence index (i.e., coverage ratio or frequency index), NTM indicator, the count of NTMs and the AVE of NTMs. The tariff measurements include bound tariff and effectively applied tariff. The sample coverage varies across countries, industries and products.

and Tovar 2011), product type (Heo and Choi 2023), countries development stages or growth rates (Beverelli et al. 2019, Heo and Choi 2023, Niu et al. 2018). The closest work to this paper are Niu et al. (2018) and Niu et al. (2020), who also investigate the relationship between NTMs and tariffs using detailed estimates of the AVE of NTMs over time. However, their estimation of AVEs only varies with importers and products, and hides important variations in country pairs and exporters' characteristics. Our highly disaggregated AVE estimates at the importer-exporter-product level enable us to detect richer determinants of the tariffs and NTMs relationships.[10]

The relationships between tariffs and NTMs are also not settled on the theoretical front. In the classic paper of Grossman and Helpman (1994), the government endogenously chooses the combination of trade policy instruments considering the political support from the interest groups, which leads to policy substitutions.[11] Similarly, Yu (2000) shows that the degree of substitution between NTMs and tariffs increases with the government's valuation of political contribution. Limão and Tovar (2011) emphasize that the improved bargaining position of the government relative to interest groups brought by international cooperation commitments motivates the government to use less efficient NTMs.[12] Tariffs and NTMs are complementary in reducing production misallocation in the recent work of Macedoni and Weinberger (2024), because lower tariffs imply less misallocation which requires smaller regulations to correct. This paper contributes to this set of literature by showing that the degree of substitution between tariffs and NTMs depends on the weight of consumption externality in the government's social welfare function, as well as the effectiveness of NTMs in reducing the consumption externality, with collaborating structural estimations of the parameters of the model.

This paper is also related to another strand of literature focusing on the effect of NTMs in reducing market failures such as information asymmetry or externality (Beghin et al. 2015, Ederington 2001, Essaji 2010). Essaji (2010) investigates the relationship between tariffs and product standards, which can reduce consumption externality. Essaji (2010) argues that the relationship between tariffs and product standards is contingent, relying on the importance of tariff revenue in welfare, the effectiveness of NTMs in reducing externality, the weight the government places on consumption externality, and the initial level of tariffs. Building upon Ederington (2001), this paper emphasizes the role of NTMs in reducing consumption externality, in addition to achieving terms-of-trade gains, which serves as a rationale for government to substitute tariffs with NTMs.

Finally, this paper is related to two growing areas of research. The first focuses on the role of

[10]The limitation of the cross section data on NTMs and tariffs refrain us from investigating the relationship between NTMs and tariffs over time. However, using the NTMs faced by exporters in other destinations as instrument variables, our robust empirical results uncover several novel and important determinants of trade policy, such as global value chain (GVC) participation, governance, and engagement depth in regional trade agreements.

[11]Bown (2014) provides a comprehensive review of political-economic research on international trade policy.

[12]Empirical evidence in India finds that anti-dumping and safeguard protection are used to replace tariffs to protect domestic market (Bown and Tovar 2011). Similarly, Ruckteschler et al. (2022) find that politically connected firms receive higher-level NTMs protection after the enrollment of trade agreement.

climate change related NTMs in trade agreements (Cruz and Rossi-Hansberg 2024, Harstad 2024a;b). In these papers, the presence of climate change related NTMs may act as a source of comparative advantage which increases the trade of climate-intensive products, which may include energy-intensive, carbon-intensive, or emission-intensive products; or trade may lead to the deterioration of local climate, which could be addressed with tariffs or NTMs. In particular, Harstad (2024a) shows that with externalities, a trade agreement that mixes tariffs with NTMs will reach the first best outcome that will not deteriorate climate. The findings of our paper that governments may use more NTMs to regulate the trading of climate-intensive goods such as agricultural products, including forestry products, provide the empirical support for Harstad (2024a). The second growing area studies the recent trade spats between the major economies (Fajgelbaum et al. 2019, Fajgelbaum et al. 2024). These papers mainly focus on how the US government raise tariffs to protect the domestic market from Chinese imports. By analyzing the EU government mixing tariffs and NTMs in the EU-China trade disputes, our paper highlights the important of looking at both policy instruments.

This paper proceeds as follows. Section 2 discusses the data used in the analysis and presents some stylized facts. Empirical strategies and reduced-form results are shown in Sections 3 and 4, respectively. Section 5 presents a simple model to rationalize the empirical findings, and to analyze the case where the EU imposes NTMs on top of tariffs on Chinese BEVs. The structural estimation of the model's parameters is shown in Section 6, and the results are related back to the reduced-form findings in Section 4. Section 7 concludes the paper.

2 Data and Stylized Facts

2.1 Data

The highly disaggregated tariff and AVE of the border NTMs data at importer-exporter-products (HS 6-digits) level used in this paper are from Kee and Nicita (2022), which is cross-sectional and assumed to reflect the existing trade policy pattern of 2018.[13] There are 49 importing countries and 117 exporting countries in our sample, including developed and developing countries. According to Ederington and Ruta (2016), based on their differential impact on domestic and international prices, NTMs can be grouped into four groups: customs regulations (alternatively, border management policies or border NTMs), process regulations, customer regulations and producer regulations. In this paper, we focus on the AVE of the border NTMs specifically for the following two reasons: First, border NTMs only influence foreign producers directly but leave domestic producers unaffected other than through some general equilibrium effects. Second, border NTMs are applied at the customs and drive a wedge between domestic price and international price. These two reasons make border NTMs

[13]NTMs are distinguished between border and non-border variables on the basis of the international classification of non-tariff measures (UNCTAD 2015) and the classification method proposed by Ederington and Ruta (2016).

the most comparable alternative trade policy instruments to the tariffs. Furthermore, Kee and Nicita (2022) show a wide range of variations in terms of the coverage ratios of NTMs across countries. As a result, the relationship between border NTMs and tariffs is of first priority and interest.

Other data used in this paper are the updated WTO data set on the content of preferential trade agreements (PTAs) (Hofmann et al. 2017), the WTO NTMs Notification Database (Integrated Trade Intelligence Portal, I-TIP), the World Bank World Development Indicators (WDI), GVC Indicators (Fernandes et al. 2022), CEPII Gravity Database (Conte et al. 2022) and World Governance Indicator (Kaufmann et al. 2011). Appendix A Table A.1 presents the detailed definitions of the variables used in this paper and corresponding data sources.

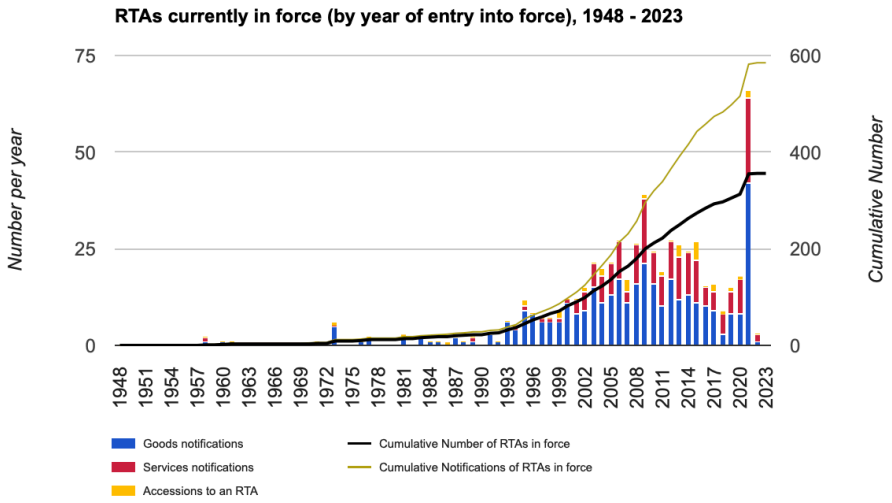
2.2 Stylized Facts

This section presents two stylized facts that motivate our empirical investigation: (1) the shift towards regional trade agreements and the deviation in coverage between regional trade agreement provisions and WTO/GATT regulation, and (2) the overall worldwide reduction in tariffs and increase in NTMs.

2.2.1 Stylized Fact 1: Shift toward Regional Trade Agreement

As pointed out by Ederington and Ruta (2016), given that traditional trade barriers like tariffs have already been reduced to a low level under the effort of the GATT, WTO and early regional trade agreements, more recent regional trade agreements emphasize regulating, simplifying, prohibiting, harmonizing or mutually recognizing NTMs (WTO 2023). Figure 1 shows the cumulative number of the regional trade agreement (RTA) currently in force by year. There is a clear upward-sloping trend in terms of the number of RTA currently in force after the Uruguay Round negotiation in 1994. One possible explanation for that is the progress of the multilateral trade negotiations has been sluggish since the Uruguay Round negotiation (Wolff 2022). As a result, more and more countries resort to regional or bilateral trade agreements as an alternative.

Figure 1: Overall Trend of the Regional Trade Agreement (Source: WTO RTA Database)

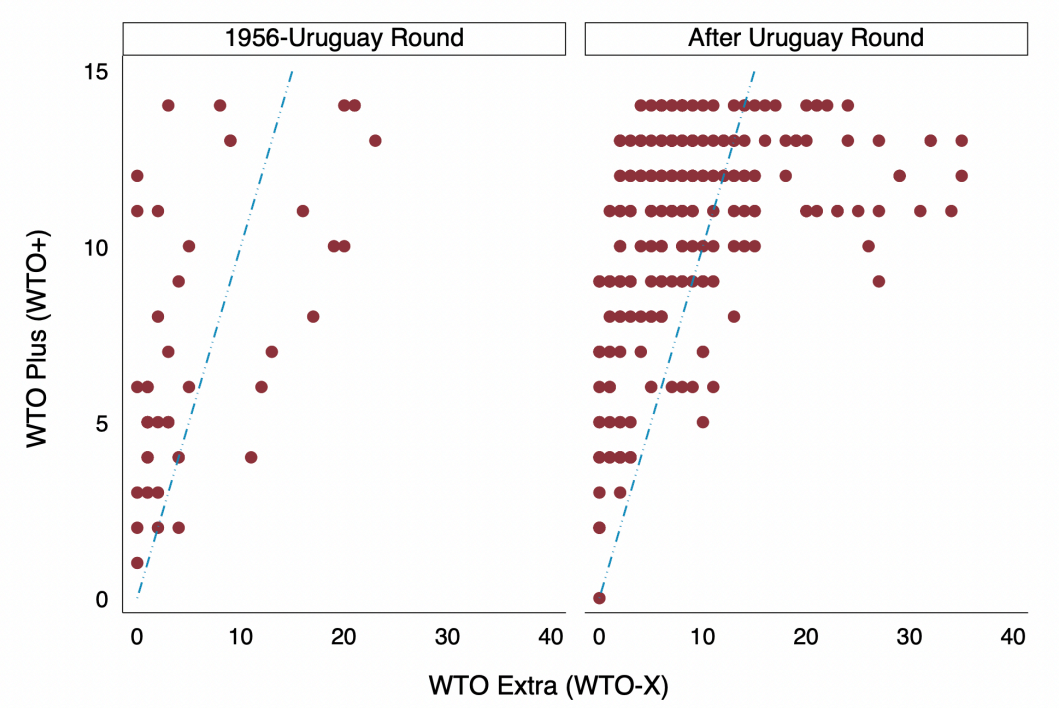


The GATT, WTO agreement and the early-stage trade agreements mostly concentrate on the reduction of traditional trade barriers, that are, tariffs, quotas and so on. In contrast, the recent trade agreements coming into force go beyond the traditional trade barrier and cover more policy areas. The pioneering research on the content of the preferential trade agreements (PTAs), Horn et al. (2010), classify the provisions covered by the present PTAs into two groups: "WTO+ (WTO Plus)" and "WTO-X (WTO Extra)", which contains 14 and 38 provisions, respectively. The former refers to provisions that are also governed by the current mandate of the WTO, but the PTAs contain the same or more stringent commitments. The latter refers to provisions regulated by the PTAs that go beyond the regulation of the WTO.[14]

Using the updated data on the content of the PTAs provided by Hofmann et al. (2017), Figure 2 shows the number of provisions falling into the two categories for each PTA. After the end of the Uruguay Round negotiation in 1994, there was an increasing number of PTAs, which is in line with the message conveyed in Figure 1. Moreover, the number of provisions falling in the two categories both increase, which reflects an increase in the horizontal depth of the PTAs. Finally, more provisions go beyond the mandate of the WTO agreement, which suggests the incremental distinction between global trade negotiations and multilateral or bilateral trade negotiations.

[14]For instance, WTO Plus contains provisions such as tariff liberalization on industrial goods and agriculture goods, elimination of export taxes and so on. WTO Extra includes provisions such as anti-corruption, environmental laws, health, labor market regulations and so on.

Figure 2: The Horizontal Depth of Preferential Trade Agreements (PTAs)



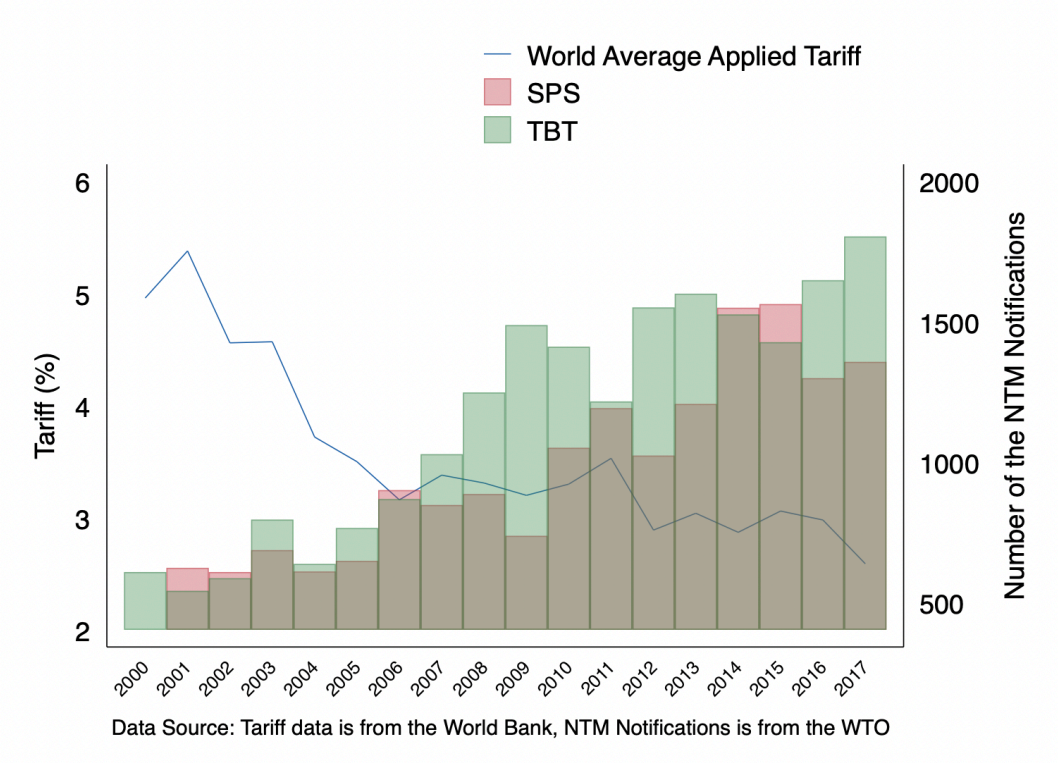
2.2.2 Stylized Fact 2: Decreasing Tariffs and Increasing NTMs

To investigate the relationship between traditional tariff barriers and the NTMs, Figure 3 shows the evolving trend of the world average applied tariff and the number of the notifications of SPS measures and TBT measures from WTO member countries to the WTO.[15] Clearly, there is an overall decrease in tariff and an overall increase in the notification of NTMs in both SPS and TBT, which suggests a potential substitution between these two trade policy instruments.[16]

[15]The brown bar denotes the number of the notifications that belong to both SPS measures and TBT measures.

[16]The data of SPS and TBT notifications from the member countries to the WTO are used because its panel attributes.

Figure 3: Overall Trend of the the Tariffs and NTMs



3 Empirical Strategies

Equation (1) specifies the baseline empirical model to study the overall relationship between the NTMs and tariffs:

$$t_{ijn} = \beta_1 AVE_{ijn} + \sum_k \delta_k + \varepsilon_{ijn}, \tag{1}$$

where t_{ijn} and AVE_{ijn} are the effectively applied tariffs and the AVE of border NTMs imposed by importing country i on product n from exporting country j, respectively. The highly disaggregated AVE estimates allow us to control different multi-dimensional fixed effects, which not only enables us to eliminate omitted variable concerns to the largest extent but also allow us to analyze the relationship between tariffs and NTMs using different level of variations. $\sum_k \delta_k$ denotes different combinations of the fixed effects to control for different sets of omitted variables, including (1) δ_i, δ_j, δ_n, which denote importer fixed effects, exporter fixed effects, and product fixed effects, respectively; (2) δ_{in}, δ_j, which are importer-product fixed effects, and exporter fixed effects; (3) δ_{ij}, δ_n, which denote importer-exporter fixed effects, and product fixed effects; and (4) δ_{jn}, δ_i, which are exporter-product fixed effects and importer fixed effects. ε_{ijn} is an independent and identically distributed (i.i.d) error term, and the standard errors are clustered at importer-product level. The coefficient of interest is β_1,

and tariffs and NTMs are considered policy substitutes if $\beta_1 < 0$. Conversely, tariffs and NTMs are considered policy complements if $\beta_1 > 0$.

Moreover, to capture the contingent relationship between the NTMs and tariffs, which may depend on factors related to the importers, the exporters and the products, as well as any bilateral and multilateral agreements, interaction terms between the *AVE* and the determinants, Φ, are included in the following empirical specification:

$$t_{ijn} = \beta_2 AVE_{ijn} + \beta_3 AVE_{ijn} \times \Phi_{ijn} + \sum_k \delta_k + \varepsilon_{ijn}, \tag{2}$$

where Φ_{ijn} denotes the determinants that may affect the relationship between NTMs and tariffs, including importer characteristics (Φ_i), exporter characteristics (Φ_j), product characteristics (Φ_n), and bilateral characteristics (Φ_{ij}). Other variables' definitions are the same as the baseline regression in equation (1). In this specification, β_3 is the coefficient of interest, with a negative value indicating the interacted variable increases the degree of substitution between tariffs and NTMs, while the converse is true for a positive value.

3.1 Instrumental Variables

We use instrumental variables estimation to address the potential endogeneity of the NTMs stemming from the co-determination of these two trade policy instruments. Finding a suitable IV at the highly disaggregated level is challenging. Following Kee and Nicita (2022), AVE_{ijn} and $AVE_{ijn}X_{ijn}$ are instrumented using the average AVE of exporting country j of the product n in non-i markets AVE_{-ijn} and $AVE_{-ijn}X_{ijn}$, respectively. To justify that the AVE faced by the same exporter and product in the other market is a valid instrumental variable for the AVE of the importing country, we need to first show that the average AVE of other markets is correlated with the AVE of the importing country, given exporter and product (i.e. not weak instrument). We then need to show that the average AVE of the other markets is not correlated with the tariffs of the importing country, given the same exporter and product (i.e. satisfying exclusion restriction).

Specifically, given the same exporter and product, the AVE in the other markets is likely to be correlated with the AVE of the importing country. This is because some NTMs are influenced by both exporter factors and product characteristics, and are not importing country specific. This means that for certain products exported by specific countries, NTMs are necessary to be applied irrespective of who the importers are, which makes the AVE of the other markets not a weak instrument. In addition, AVE_{-ijn} and t_{ijn} are not the trade policies of the same country, which implies that the AVE of other countries may not correlate *a priori* with the tariff of the importing country, hence make the former justifies the exclusion restriction of the instrumental variable. Nevertheless, even though we use the instrumental variables approach to solve the potential endogeneity of the NTMs,

the relationship revealed from our empirical setup is more of the correlation than the causality.

4 Empirical Results

4.1 Baseline Results: The Overall Relationship between Tariffs and NTMs

Table 1 presents the second-stage baseline instrumental variable regression results for the overall relationship between the NTMs and tariffs, as specified in equation (1). In Column (1), tariffs is regressed on the instrumented AVEs, controlling for the importer fixed effects, exporter fixed effects and product fixed effects. The negative and significant coefficient suggests that, the restrictiveness of NTMs and tariffs are negatively correlated, which implies that, overall, NTMs and tariffs are policy substitutes. The high first-stage F-statistic further suggests that the AVE of other markets faced by the same exporter and product has enough explanatory power and is not a weak instrument for the AVE of the importing country.

Column (2) presents the regression result when we regress tariffs on the instrumented AVEs, controlling for the importer-product fixed effects and exporter fixed effects instead. The coefficient on AVE is still significantly negative, which implies that, given the same importer and product, the exporters that enjoy lower tariffs tend to face more restrictive NTMs. This again suggests that the NTMs and tariffs are substituting trade policy instruments. This result is consistent with the observation that when an importing country gives a tariff reduction on a product to an exporting country, the preferential access may come with restrictive NTMs. One example of this is the African Growth and Opportunities Act (AGOA) of the US, where rules of origin requirements are necessary in exchange for the duty-free access to the US market by the African countries, while other countries do not have such an arrangement and face higher tariffs.

Column (3) presents the regression result when we control for the importer-exporter fixed effects and product fixed effects. The coefficient on the AVEs remains negative. This result implies that, given two trading countries, products that face lower tariffs tend to have restrictive NTMs. This would be the case in a trade agreement, such as the US-Peru Free Trade Agreement, where US tariffs on agricultural products will be eliminated provided that NTMs on the agriculture sector, such as the environmental protections are meet.

Column (4) shows the regression result when we control for the exporter-product fixed effects and importer fixed effects. The significantly positive coefficient of interest suggests that when comparing the trade policy stance across all the importing countries, for a specific product from a specific exporting country, importing countries that have higher tariffs tend to have more restrictive NTMs, while importing countries that have lower tariffs have less restrictive NTMs. This positive relationship reflects the overall trade policy environment and stance of the importing countries which determines the usage of both tariffs and NTMs. Countries that are in favor of trade protectionism are likely to

impose both restrictive NTMs and high tariffs simultaneously relative to those more open countries that have lower tariffs and NTMs. Therefore, the positive coefficient in Column (4) is not in conflict with the first three columns in Table 1. One example of this scenario is India, which has high tariffs and restrictive NTMs on all products from all countries, compared to Singapore, which has no tariffs and less restrictive NTMs.

Table 1: Baseline Results

VARIABLES	(1) Tariff	(2) Tariff	(3) Tariff	(4) Tariff
AVE of Border NTM	-0.086***	-0.058***	-0.046**	0.050***
	(0.020)	(0.008)	(0.019)	(0.009)
Importer Fixed Effect	Yes			Yes
Exporter Fixed Effect	Yes	Yes		
Product Fixed Effect	Yes		Yes	
Importer-Product Fixed Effects		Yes		
Importer-Exporter Fixed Effects			Yes	
Exporter-Product Fixed Effects				Yes
Other AVE	0.553***	0.560***	0.555***	-27.608***
First Stage F Statistics	958.12	1148.18	969.1	2221.86
Observations	1,003,854	991,995	1,003,626	923,096

Note: Robust standard errors in paratheses are clustered by importer-product. *, ** and *** indicate that coefficients are significant at 90%, 95% and 99%, respectively. AVE_{nij} is instrumented using the average AVE of exporter j of the product n in non-i markets.

4.2 Further Analysis: What Factors Determine the Relationship between NTMs and Tariffs

As aforementioned, the highly disaggregated data at importer-exporter-HS 6-digit product level enables us to control different combinations of fixed effects. By employing fixed effects to control for omitted variables as much as possible, different combinations of fixed effects enable us to identify the effects of variations at different levels of data as well. In this section, we focus on the last three fixed effects combinations in Table 1 when we investigate the impact of the determinants on the relationship between the NTMs and tariffs.

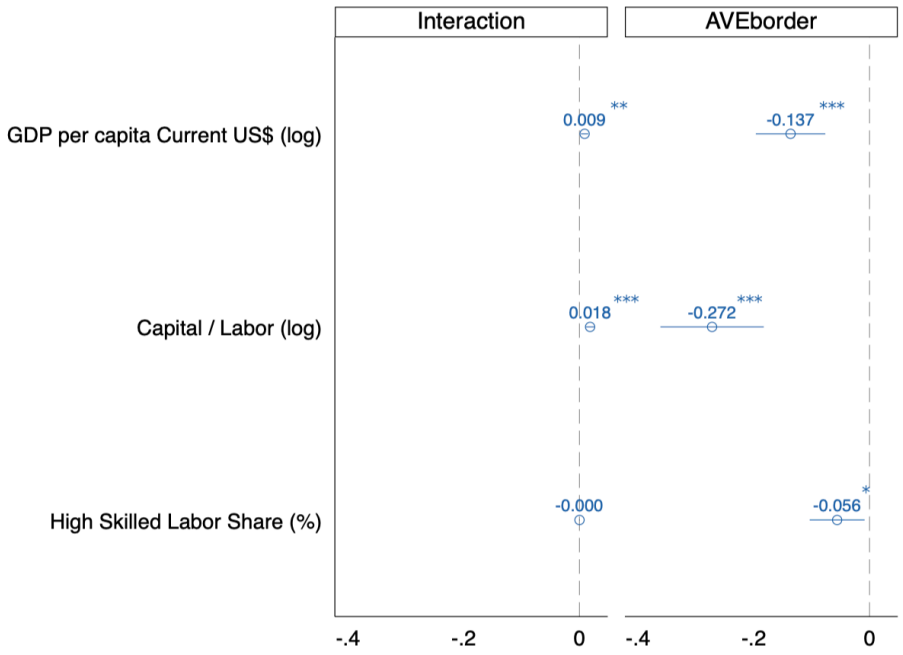
4.2.1 Given Importer-Product, Which Exporter Characteristics Matter?

Figure 4 displays the empirical results of regression specification (2) with the second fixed effects combination: importer-product fixed effects and exporter fixed effects. We control for the exporter characteristics in a separate, consecutive manner. Each row represents one regression result, displaying the estimated coefficient of interaction term between AVE and the determinant with the confidence

interval, as well as the AVE.

The first two rows of Figure 4 show that, the higher GDP per capita and capital-labor ratio of the exporters are associated with a lower degree of substitution between tariffs and the NTMs. Conversely, when the exporting countries have lower income or are more labor abundant, the relationship between tariffs and NTMs tends to be more substituting. This could be because many low income labor abundant exporting countries have preferential tariffs in the high income markets. In order to protect domestic market from their cheaper exports, importing countries may impose restrictive NTMs, which leads to the substitution between tariffs and NTMs. Finally, the skilled labor ratio of the exporting countries has no impact.

Figure 4: Coefficient and Confidence Interval (90%) of the Interactions and AVE



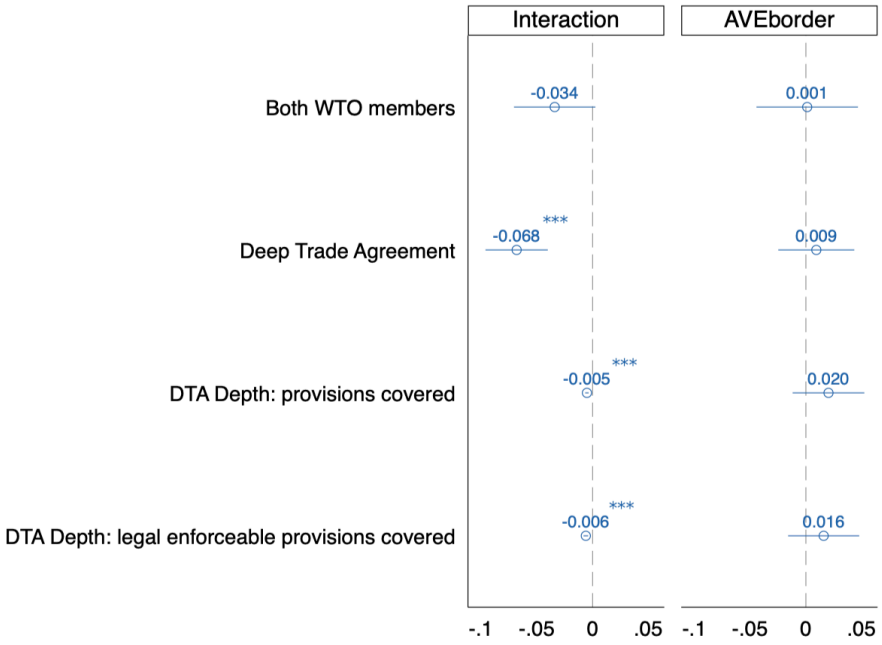
4.2.2 Given Product, Which Importer-Exporter Characteristics Matter?

Figure 5 displays the empirical results of regression specification (2) with the third fixed effects combination, which enables us to investigate the impact of bilateral factors on the relationship between the restrictiveness of NTMs and tariffs.

The first two rows of the Figure 5 show that whether the importing and exporting countries both are the WTO members or not has no impact on the relationship between the NTMs and tariffs. In sharp contrast, when the two countries are engaged in the deep trade agreement (DTA), the relationship between the NTMs and tariffs become more substituting. As pointed out by Ederington and Ruta (2016), the GATT restricts countries to negotiate over the NTMs to prevent from policy substitution. However, the DTAs cover both tariff reduction and the increasing number of NTMs, including the

prohibition of specific NTMs (for instance, the prohibition of all quantitative import restriction), the implementation of SPS or TBT measures, or the harmonization and mutual recognition of product standard (WTO 2023). In addition, the third and fourth rows of Figure 5 further investigate the horizontal depth of the deep trade agreement's impact. Following Hofmann et al. (2017), we use the number of provisions and the number of legal enforceable provisions contained in the deep trade agreement to measure the horizontal depth of it. The results are in line with the second row result.[17] Overall, Figure 5 suggests that, relative to the GATT or WTO, the degree of substitution between tariffs and NTMs is higher under deeper bilateral or multilateral trade agreements.

Figure 5: Coefficient and Confidence Interval (90%) of the Interactions and AVE



4.2.3 Given Importer-Exporter, Which Product Characteristics Matter?

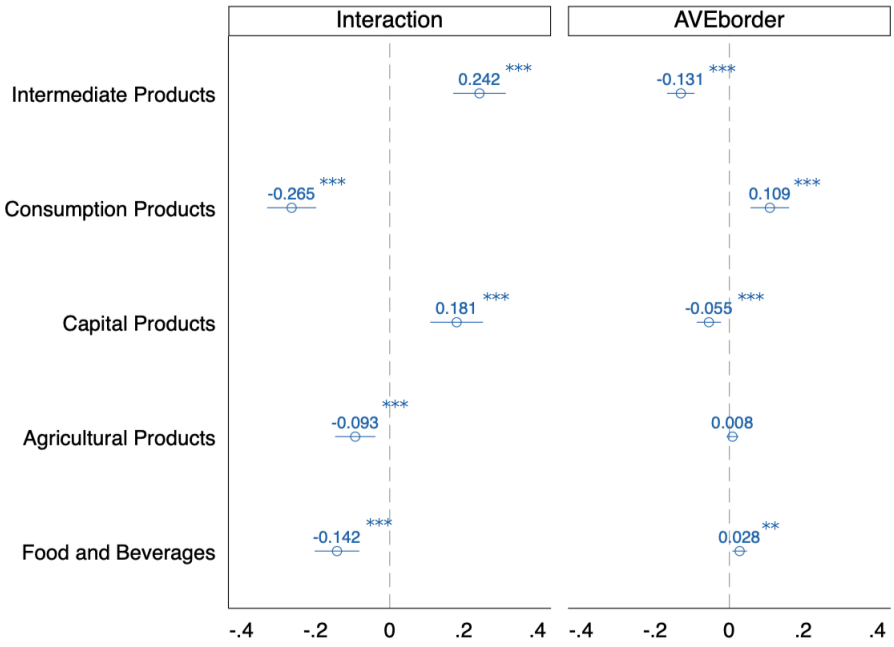
Figure 6 displays the empirical results of regression specification (2) with the third fixed effects combination, when we focus on the impact of product characteristics on the relationship between the tariffs and NTMs for the same importer-exporter pair.

The results show that tariffs and NTMs are policy complement for capital goods and intermediate products. These products are more deeply embedded in the global value chains (GVC), and generally face more liberal trade policies overall, with lower tariffs and less restrictive NTMs. On the other hand, the degree of substitution between tariffs and NTMs is higher for consumption products, agricultural

[17]The magnitude of the coefficients of the interaction term between DTA, DTA depth and AVE of the border NTM differ because, deep trade agreement is a dummy variable which takes the value of one if the importing country and exporting country are engaged in a trade agreement while the DTA depth is the count of the number of provisions.

products[18] and food products.[19] One possible explanation for these findings could be that consumption products, agricultural products and food products may have consumption externalities, which could be addressed by more restrictive NTMs, given tariffs. Note that some agricultural products, such as forestry, are also climate intensive goods. This finding suggests that governments may use NTMs to regulate the trading of climate intensive goods which may contribute to the global climate goals. This result collaborate well with the finding of Harstad (2024a). We will test the hypothesis that agricultural products and food products have larger consumption externalities in Section 6.

Figure 6: Coefficient and Confidence Interval (90%) of the Interaction and AVE



4.2.4 Given Exporter-Product, Which Importer Characteristics Matter?

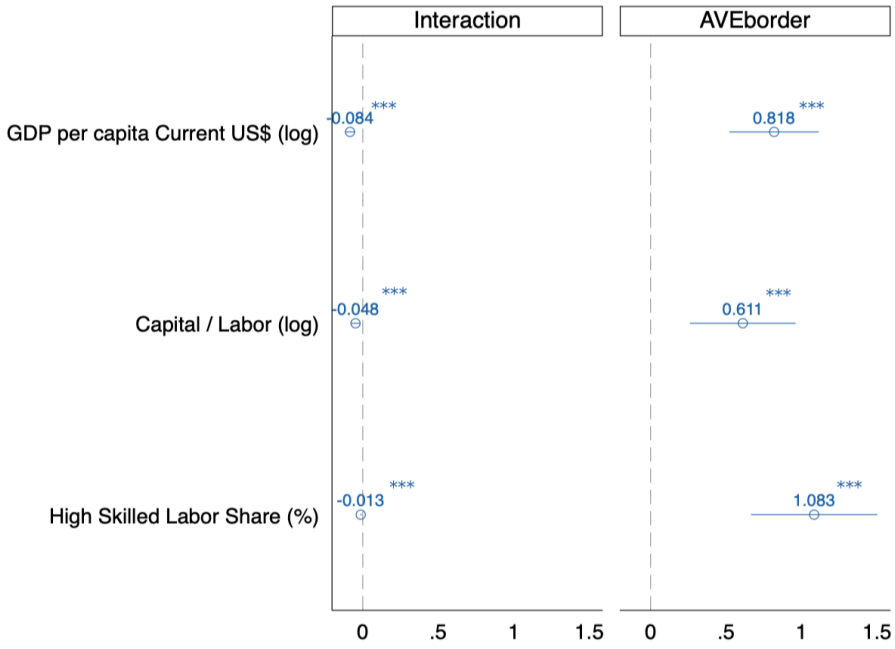
Figure 7 presents the impact of the importer's characteristics on the relationship between tariffs and NTMs, given the same exporter-product. The results show that the degree of substitution between tariffs and NTMs increases with the GDP per capita, capital-labor ratio or skilled-labor ratio of the importing countries. This could be because these high income developed countries have lower tariffs, and at the same time value public health, safety and the environment. To promote these domestic objectives, or to minimize the negative externalities of imports, or to disguise trade protective motives, these countries may resort to more restrictive NTMs, leading to a stronger substitution between tariffs

[18] See https://unstats.un.org/wiki/display/comtrade/HS+2002+Classification+by+Section for the UN industry classification. Section 1-4 (HS 2-digits: 1-24), are defined as agriculture sectors.

[19] The identification of food and beverage products follows the definition of U.S. Department of Agriculture (USDA). Please see https://www.ers.usda.gov/data-products/u-s-food-imports/documentation/ for the detailed HS code list.

and NTMs. We will test the hypothesis that high-income countries value public health, safety and the environment more than low-income countries in Section 6.

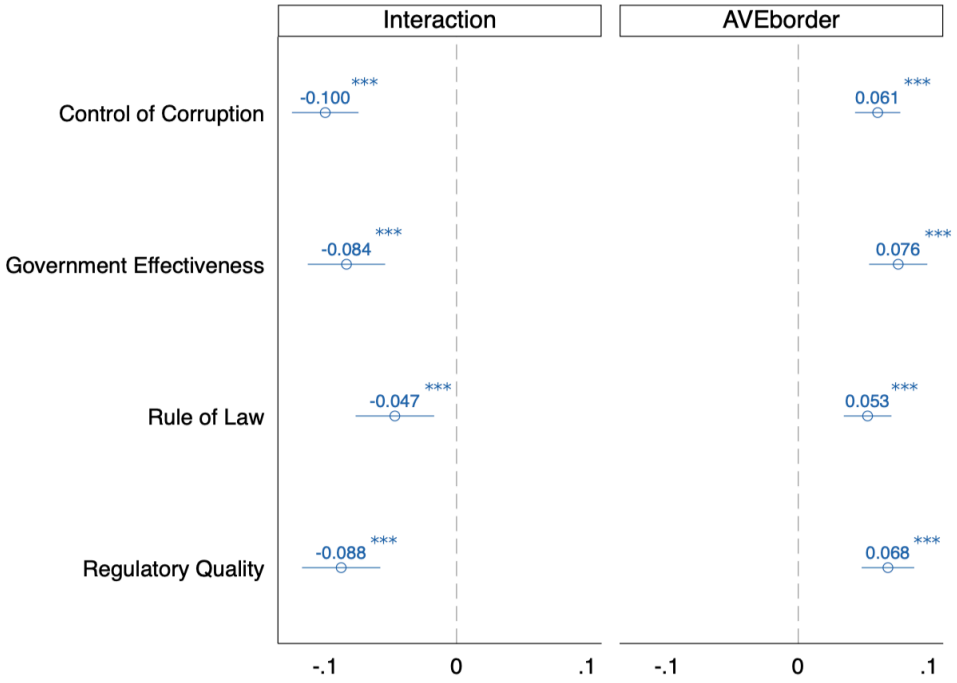
Figure 7: Coefficient and Confidence Interval (90%) of the Interaction and AVE



The determination of trade policies could also depend on the political economy and governance of the importing countries (Grossman and Helpman 1994). As emphasized by Ruckteschler et al. (2022), since NTMs are more complicated and less tangible compared to tariffs, the effect of NTMs is highly dependent not only on NTMs *per se*, but also on the institutional quality and implementation efficiency of the government administration. Figure 8 indicates that, for importers with better control of corruption, more effective government, better rule of law and higher regulatory quality, the degree of substitution between tariffs and NTMs is higher. This could be because countries with these characteristics are better in enforcing NTMs, given that NTMs are more complicated and harder to put into force than tariffs. Another possible explanation could be that firms in these countries have lower NTM compliance costs.[20]

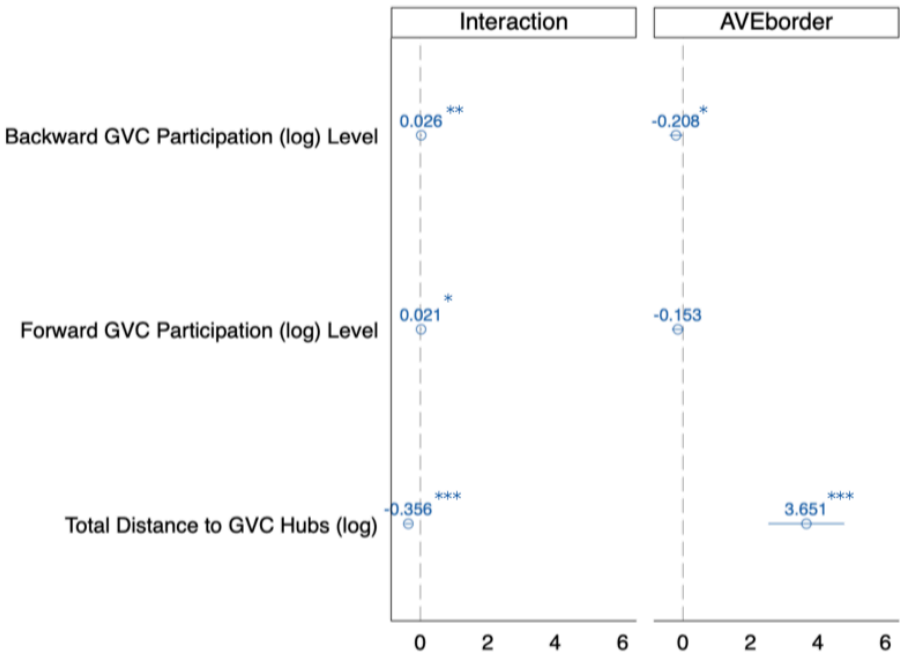
[20] Beverelli et al. (2019) pointed out that the costs of compliance are relatively low for developed countries.

Figure 8: Coefficient and Confidence Interval (90%) of the Interaction and AVE



Finally, Figure 9 explores the impacts of the GVC participation of the importing countries on the relationship between tariffs and NTMs. Specifically, we use three variables from Fernandes et al. (2022) to measure the importing countries' GVC participation: backward GVC participation, forward GVC participation and the total distance to the three GVC hubs (i.e., the US, Germany, and China). The first two measurements capture the import content in the importing countries' exports and the domestic value added in exports, respectively. The results show that, for importing countries that are deeply integrated into the global value chain, the relationship between tariffs and NTMs tends to be more complementary, which means both tariffs and NTMs are lower relative to other countries that are less engaging in GVCs. These results are consistent with the previous finding that intermediate products and capital products generally face more liberal trade policies since these products are widely embedded in GVC trade.

Figure 9: Coefficient and Confidence Interval (90%) of the Interaction and AVE



Overall, the reduced-form regression results suggest that the degree of substitution between tariffs and NTMs depends on the characteristics of the importing countries, exporting countries and products. For the rest of the paper, we will develop a simple terms-of-trade model to explain how different characteristics may affect the substitution between tariffs and NTMs. We will also use this simple model to analyze the EU-China trade disputes, whereby the EU imposed NTMs on top of tariffs to reduce the imports of Chinese BEVs. Furthermore, structural estimation of the parameters of the model will allow us to relate the model to some of the main findings of the reduced-form regressions.

5 Model

This section presents a general equilibrium terms-of-trade model based on the insights of Ederington (2001), which has two goods (X and Y) and two countries (Home and Foreign(*)) with welfare maximizing governments. In Ederington (2001), governments choose tariffs and domestic production taxes to extract terms-of-trade gains and to reduce the negative production externality of good X, such as pollution. In our model, the governments impose tariffs and AVEs of NTMs to extract terms-of-trade gains and to lower the consumption externality of X, such as the public health crisis due to pesticide residuals in food products. AVEs enter the social welfare function directly through the negative consumption externality function, $E(\cdot) > 0$, with a positive weight, θ, that depends on the characteristics of the countries.[21]

[21] $E(\cdot) < 0$ could depict positive externality which will be discussed in Section 5.1.

Specifically, both X and Y are produced in Home and Foreign, with strictly concave and downward sloping production possibility frontier (PPF):

$$Y = F(X); Y^* = F^*(X^*). \tag{3}$$

For each good $i = \{X, Y\}$, domestic consumption, C_i is the sum of domestic production i, and net import, M_i.[22] Assuming that each country has identical citizens and the representative citizen's welfare function, which is also the social welfare function faced by the government, is quasi-linear with respect to the quantity of each good consumed and the negative consumption externality, E:

$$\begin{aligned} W &= C_Y + U(C_X) - \theta E(C_X, AVE), \\ W^* &= C_Y^* + U^*(C_X^*) - \theta^* E^*(C_X^*, AVE^*), \end{aligned} \tag{4}$$

where $\theta > 0$ is the weight of the negative consumption externality in the social welfare, or the marginal welfare impact of the externality. A large θ indicates that the representative citizen cares more about reducing consumption externality to improve the social welfare.

Let us define

$$\lambda \equiv \frac{\partial E}{\partial C_X} > 0, \tag{5}$$

$$\phi \equiv -\frac{\partial E}{\partial AVE} > 0, \tag{6}$$

where λ is the marginal externality from consuming X, and ϕ is the effectiveness of the AVE of NTMs on reducing the negative consumption externality, under the assumption that more restrictive NTMs will directly reduce the negative consumption externality.[23] The magnitude of ϕ depends on the governance and institutional quality of the importing countries in enforcing the rules and regulations related to NTMs. It also depends on the capability of the exporting countries in complying with NTMs. Finally, products with stronger consumption externalities, such as food or agricultural products, may have higher λ and require more restrictive NTMs.

Let p^w and p^d denote the relative world and domestic prices of X. And let X be the natural imported good for Home. The Home government imposes tariff, t and AVE on X, which drive a

[22] For simplicity, we use X and Y to denote the domestic production of product X and Y, respectively.

[23] Disdier et al. (2015) made a similar assumption with the utility of the representative agent affected by a negative externality function, which depends on standard-like NTM policies. Similarly, Costinot (2008), Essaji (2010) and Fischer and Serra (2000) also present a model that consumption is associated with negative externality (pollutants, specifically) while the use of NTMs (product standard, specifically) can reduce the negative externality.

wedge between p^w and p^d. Likewise for the Foreign government on Y:

$$p^d = (1 + t + AVE)p^w, \tag{7}$$

$$p^{d*} = p^w/(1 + t^* + AVE^*). \tag{8}$$

In equilibrium, profit maximization will ensure that the relative domestic price of X equals the marginal rate of transformation between the two goods, which is the absolute value of the slope of the PPF, while utility maximization will also equate relative domestic price of X to the marginal rate of substitution between the two goods:

$$p^d = -F'(X) = U'(C_X). \tag{9}$$

Tariff revenue in Home collected from the net import of X is lump-sum redistributed back to the representative consumer, such that the equilibrium $C_X = X + M_X$ is a function of p^w, t and AVE. The relative world price, p^w, is determined by the market-clearing condition that net imports of the home country of each good are equal to foreign country's net exports:

$$M_i = -M_i^*. \tag{10}$$

Let m denote direct lump-sum transfers (in terms of the numeraire good), then balance of payment requires that for any world price:

$$M_Y + p^w M_X + m = 0, \tag{11}$$

$$M_Y^* + p^w M_X^* - m = 0. \tag{12}$$

Equation (4) can be rewritten all in terms of X:

$$W = F(X) - p^w M_X - m + U(X + M_X) - \theta E(X + M_X, AVE). \tag{13}$$

Home government chooses t and AVE to maximize equation (13), which lead to the following two first order necessary conditions:

$$\frac{\partial W}{\partial t} = F'\frac{\partial X}{\partial t} - \frac{\partial p^w}{\partial t}M_X - p^w\frac{\partial M_X}{\partial t} + U'\left(\frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t}\right) - \theta\lambda\left(\frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t}\right) = 0, \tag{14}$$

$$\frac{\partial W}{\partial AVE} = F'\frac{\partial X}{\partial AVE} - \frac{\partial p^w}{\partial AVE}M_X - p^w\frac{\partial M_X}{\partial AVE} + U'\left(\frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE}\right) - \theta\lambda\left(\frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE}\right) + \theta\phi = 0. \tag{15}$$

Substituting equations (7), (8), (9) and (10) into equation (14), we have the following:[24]

$$t + AVE = \frac{1}{\epsilon} + \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial t}{\partial M_X/\partial t} + 1\right), \tag{16}$$

$$\epsilon \equiv \frac{\partial(-M_X^*)}{\partial p^w}\frac{p^w}{(-M_X^*)} = \frac{p^w}{M_X^*}\frac{\partial M_X^*/\partial t}{\partial p^w/\partial t} > 0 \tag{17}$$

where ϵ is the elasticity of Foreign country's supply of net exports.[25]

Consider when there is no consumption externality ($\lambda = 0$) or when the country does not care about the externality ($\theta = 0$). In this case, the welfare maximizing optimal tariff of Home is $1/\epsilon$ when there are no restrictive NTMs. This is the standard result based on the terms-of-trade effect of tariff: facing an upward sloping foreign export supply curve, the optimal tariff is positive given that tariffs reduce world prices. However, if the tariff is restricted to be less than $1/\epsilon$ due to trade agreements, then the welfare maximizing government will impose restrictive NTMs, such that the sum of tariff and AVE equals $1/\epsilon$. This shows that overall tariffs and AVEs are substitutes, even in the absence of externality and the relationship is completely driven by the terms-of-trade effects of tariffs and NTMs.

Conversely, when there is consumption externality ($\lambda > 0$) and the country does care about the externality ($\theta > 0$), the optimal tariff will be larger than $1/\epsilon$ when there are no restrictive NTMs. This is because, in addition to the terms-of-trade effect of suppressing world price, the higher tariff is also used to curb the negative externality through depressing domestic consumption.[26].

If tariff is lower than the optimal level, then welfare maximizing government will impose restrictive NTMs with positive AVEs which indicates policy substitutions. The subsituting relationship depends on θ, λ and $\partial C_X/\partial t$.

Similarly, substituting equations (7), (8), (9) and (10) into equation (15), we have the following relationship depicting the optimal AVE:

$$t + AVE = \frac{1}{\epsilon} + \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} + 1\right) - \frac{\theta\phi}{p^w \partial M_X/\partial AVE}. \tag{18}$$

Note that, by the definition of AVE, ϵ in equation (18) is same as the export supply elasticity of Foreign in equation (17), since $\frac{\partial M_X^*/\partial t}{\partial p^w/\partial t} = \frac{\partial M_X^*/\partial AVE}{\partial p^w/\partial AVE}$.[27]

If the government does not care about reducing externality ($\theta = 0$), or if NTMs is completely ineffective in curbing externality ($\phi = 0$) and there is no externality ($\lambda = 0$), then the optimal AVE

[24] Please refer to the Appendix B for the derivations.

[25] To see this, we start from the market equilibrium condition, equation (10): $M_X(t) = -M_X^*(p^w) > 0$
$\therefore \frac{\partial(-M_X^*)}{\partial t} = \frac{\partial M_X}{\partial t} = \frac{\partial(-M_X^*)}{\partial p^w}\frac{\partial p^w}{\partial t} \Rightarrow \frac{\partial(-M_X^*)}{\partial p^w} = \frac{\partial(-M_X^*)/\partial t}{\partial p^w/\partial t}$.

[26] By definition of C_X, we have $\frac{\partial C_X}{\partial t} = \frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t} \Rightarrow \frac{\partial C_X}{\partial p^d}\frac{\partial p^d}{\partial t} = \frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t} \Rightarrow \frac{\partial C_X}{\partial p^d}p^w = \frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t} < 0 \Rightarrow \frac{\partial X/\partial t}{\partial M_X/\partial t} + 1 > 0$.

[27] By definition, we have $\epsilon \equiv \frac{\partial M_X^*}{\partial p^w}\frac{p^w}{M_X^*} = \frac{p^w \partial M_X^*/\partial AVE}{M_X^* \partial p^w/\partial AVE}$, therefore we have $\frac{p^w \partial M_X^*/\partial AVE}{M_X^* \partial p^w/\partial AVE} = \frac{p^w \partial M_X^*/\partial t}{M_X^* \partial p^w/\partial t}$.

is the reciprocal of foreign export supply elasticity due to the terms-of-trade effect of NTMs if tariff is zero. If λ, θ and ϕ are all positive, the optimal AVE will be higher than $1/\epsilon$, and it is also higher than the optimal tariff with externality as in equation (16). This is because in addition to reducing world price (terms-of-trade effect), and reducing consumption (curbing externality effect), AVE also directly improves social welfare through ϕ (boosting public confidence). So, the optimal level of AVE will be higher than tariff.

The degree of substitution between tariffs and NTMs depends on θ, which is the weight of the consumption externality in social welfare. A higher θ indicates the importing country values the reduction of consumption externality more, and therefore will have more incentives to impose restrictive NTMs. These are likely to be the high income developed countries, which tend to be more capital and skill abundant. Conversely, developing countries which have lower income and are more labor abundant, will be less inclined to impose restrictive NTMs.

In addition, the degree of substitution between tariffs and NTMs also depends on λ and ϕ, which are the marginal externality from consuming product X, and the effectiveness of NTMs in reducing consumption externalities and boosting public confidence. Importing countries with good governance or better institutions will be more able to enforce the rules and regulations related to NTMs. For these countries, their ϕ will be larger, which implies that there will be more use of restrictive NTMs. On the contrary, small developing exporting countries that are not good in complying with NTMs will have smaller ϕ, which may reduce the substitution between tariffs and NTMs. Consumption products and agricultural products are more affected by NTMs and consumption externalities, which will cause their λ to be larger and lead to higher policy substitution between tariffs and NTMs.

Equations (16) and (18) jointly imply that

$$\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} = \frac{\partial X/\partial t}{\partial M_X/\partial t} + \frac{\phi/\lambda}{\partial M_X/\partial AVE}. \tag{19}$$

In words, equation (19) suggests that for the optimal tariff and AVEs to be both positive, it is necessary that tariffs and NTMs are imperfect substitutes, since $(\phi/\lambda)/(\partial M_X/\partial AVE) < 0$:[28]

$$\frac{\partial M_X/\partial AVE}{\partial M_X/\partial t} < \frac{\partial X/\partial AVE}{\partial X/\partial t}. \tag{20}$$

Thus, given the positive marginal consumption externality, $\phi > 0$, and the effectiveness of AVE in reducing externality, $\lambda > 0$, for the optimal tariff and AVE to be both positive, it is necessary that NTMs are more effective in protecting domestic production while tariffs are more effective in curbing imports. In addition, equation (19) implies that it will be optimal to use higher tariff to curb imports

[28]Please note that tariffs and NTMs are imperfect policy substitutes is the result of our model. This is unlike the existing papers, such as Ederington (2001) which assumes trade and domestic policy are imperfect substitutes.

if ϕ is higher, since $\frac{\partial X/\partial t}{\partial M_X/\partial t}$ will be higher. Conversely, it will be optimal to have more restrictive NTMs if λ is higher, since $\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE}$ will be higher.[29]

For any given tariff level, t, the optimal AVE, according to (18) would be:

$$AVE = \frac{1}{\epsilon} - t + \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} + 1\right) - \frac{\theta\phi}{p^w \partial M_X/\partial AVE}, \tag{21}$$

$$= \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} + 1\right) - \frac{\theta\phi}{p^w \partial M_X/\partial AVE} \text{ if } t = \frac{1}{\epsilon}. \tag{22}$$

Equation (21) depicts the substituting relationship between t and AVE in the equilibrium. In the absence of any externality ($\lambda = 0$ and $\phi = 0$), or if the government do not care about reducing consumption externality ($\theta = 0$), equation (22) shows that the optimal AVE is 0 when $t = 1/\epsilon$. In contrast, in the presence of a negative consumption externality ($\lambda > 0$), the optimal AVE is positive, if the government cares about reducing such externality ($\theta > 0$). The level of AVE will be higher if AVE is very effective in reducing consumption externality ($\phi > 0$). This is true even if the marginal externality of consumption is zero ($\lambda = 0$) as long as $\theta > 0$ and $\phi > 0$, as higher AVE boosts public confidence on the government in addressing externality.[30]

However, if some existing trade agreements which restrict tariffs such that $t < 1/\epsilon$ (i.e. lower than the optimal tariff level), then the optimal AVE is shown in equation (21), which is higher than equation (22). This is to capture some of the terms-of-trade gains, missing from setting $t < 1/\epsilon$. Likewise, if AVE is restricted below the optimal level due to some provisions of a trade agreement, then the government will have an incentive to raise tariff higher than the optimal tariff level, in order to reduce consumption externality. As a result, both scenarios will generate a substituting relationship between tariffs and NTMs.

5.1 EU's Mixed Trade Policies on Chinese BEVs

This section aims to analyze the EU's policy actions regarding imports of Chinese BEVs from a neutral and academic perspective, without delving into the complex reasons behind these actions. Consider the recent trade tension represented by the EU imposing countervailing duties (CVDs) on the imports of Chinese BEVs, on top of the existing 10% tariff. According to UNCTAD (2015), CVDs are a type of contingent trade-protective NTMs, designed and implemented to counteract particular adverse effects of imports in the market of the importing country, contingent upon the fulfilment of

[29] Appendix B shows the detail.

[30] The preconditions of $\theta > 0$ and $\phi > 0$ have two implications: (1) the public cares about the consumption externality; (2) the enforceability and effectiveness of NTMs regulated by the government boost public confidence and raise the welfare as well. For instance, think of a situation when regular inspections at customs are applied to all imported products, some of them may not have negative consumption externality. However, the inspection of these products boost confidence of consumers and serve as a official endorsement for the quality and safety of the product.

specific procedural and substantive requirements.[31]

The extra duties announced on July 4, 2024, targeted various Chinese vehicle manufacturers that EU claims to received "unfair subsidisation" from the Chinese government, which is purportedly causing a threat of economic injury to the EU BEV producers due to the lower world price. These duties include 17.4% for BYD, 19.9% for Geely, and 37.6% for SAIC.[32] The Chinese government and the vehicle producers have publicly denied these accusations.[33] On August 9, 2024, China has lodged a complaint by bringing the case to the WTO's dispute settlement mechanism over EU's CVDs on the import of Chinese BEVs, further escalated the trade dispute.[34]

Without taking a stance on this issue, this section focuses only on shedding light on the policy actions of the EU in response to the lower world price of the BEVs. The underlying reasons of these trade policy actions are likely far more complex than any economic models can capture. The reasons may involve balancing competing objectives, such as developing domestic BEV production capacity in the longer run and addressing current climate issues or pollution. Additionally, domestic political factors as well as the international geopolitical factors are inevitably considered. In the context of this paper, we purposely abstract from all these factors and solely focusing on how the EU government may use NTMs to promote social welfare on a product that may have consumption externality, given that tariffs are already in place. Such a simplification is necessary to distill any policy lessons we can learn from analyzing this current real world dispute.

To analyze this trade dispute through the lens of our model, we look at the goods market equilibrium condition, equation (10), which states that the import of Home (EU) equals the net export of Foreign (China) for good X (BEV), which determines the equilibrium world price, as shown in Figure 10. Any factors Z that will shift the net export curve to the right will lead to a lower world price and an increase in the imports of BEVs. One such factors could be the state subsidies of the Chinese government, as argued by the EU. Other possible factors include technological advancement or productivity gains in China, which could also shift the net export curve to the right, resulting in a lower world price. For the purpose of this analysis, the reasons behind the shift of the net export curve are not as important and will not affect our results.

In addition to the decrease in the price of the BEVs, the rightward shift in the net export curve also increases the import of BEVs, from M_0 to M_1. This may lead to an increase in the overall BEV consumption in the EU, causing negative externalities due to more cars on the road, such as heavy

[31] CVDs are also included in border NTMs studied in this paper.

[32] Source:https://ec.europa.eu/commission/presscorner/detail/en/ip_24_3630 (Press release, the EU).

[33] Source:http://english.mofcom.gov.cn/article/newsrelease/press/202407/20240703522821.shtml (Press release, the Ministry of Commerce, People's Republic of China)

[34] Source:https://www.bnnbloomberg.ca/business/international/2024/08/09/china-takes-europes-ev-tariffs-to-wto-as-trade-tensions-rise/ (BNN Bloomberg)

congestion, the deterioration of the public health and the environment.[35] Such an externality will decrease the welfare of the EU.

To counteract the lower p^w, our model shows that the welfare-maximizing reaction of the EU will be to increase AVE. To see this, from equation (21), set $t = 10\%$:

$$\frac{\partial AVE}{\partial p^w} = -\frac{(-M_X^*)}{(p^w)^2}\left(\frac{\partial p^w/\partial t}{\partial(-M_X^*)/\partial t}\right) - \frac{\theta}{(p^w)^2}\left[\lambda\left(\frac{\frac{\partial X}{\partial AVE}}{\frac{\partial M_X}{\partial AVE}} + 1\right) - \left(\frac{\phi}{\frac{\partial M_X}{\partial AVE}}\right)\right] \quad (23)$$

$$< 0 \text{ if } \frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE} < \frac{\phi}{\lambda} \text{ or } \frac{\partial C_X}{\partial AVE} < \frac{\phi}{\lambda}. \quad (24)$$

The first term of equation (23) captures the effect the world price on the export supply elasticity, ϵ, which is determined by the terms of trade gains due to the tariff, $\frac{\partial p^w}{\partial t}$, and the size of Chinese BEV imports, $-M_X^*$. It is negative indicating, without considering any externalities, it is always optimal for the EU to raise AVE when facing a lower p^w, given fixed tariffs. More Chinese BEV imports will lead to large increases in AVE.

The second term of equation (23) captures the effect of consumption externalities. If the condition in equation (24) holds, then the item in the square brackets will be positive. This implies that the more the EU government cares about externalities, with $\theta > 0$, the more they will raise the AVE. This occurs when the sum of the positive effect of AVE on the domestic production of BEVs and the negative effect of AVE on imported BEVs, is less than the ratio of the effectiveness of NTMs in reducing the externalities directly (ϕ) to the marginal externality of BEVs (λ). If the effectiveness of NTMs is very high (large ϕ) because of public confidence boost, or if the marginal externality of BEVs is very low (small λ) because BEVs are relatively environmental friendly products compared to the gasoline vehicles, such that $\frac{\phi}{\lambda}$ is very high, then the condition in equation (24) will likely hold, implying that it is optimal to increase AVE in response to a decrease in p^w. This is particularly the case if the AVEs do not cause an overall increase in the EU's consumption of BEVs.

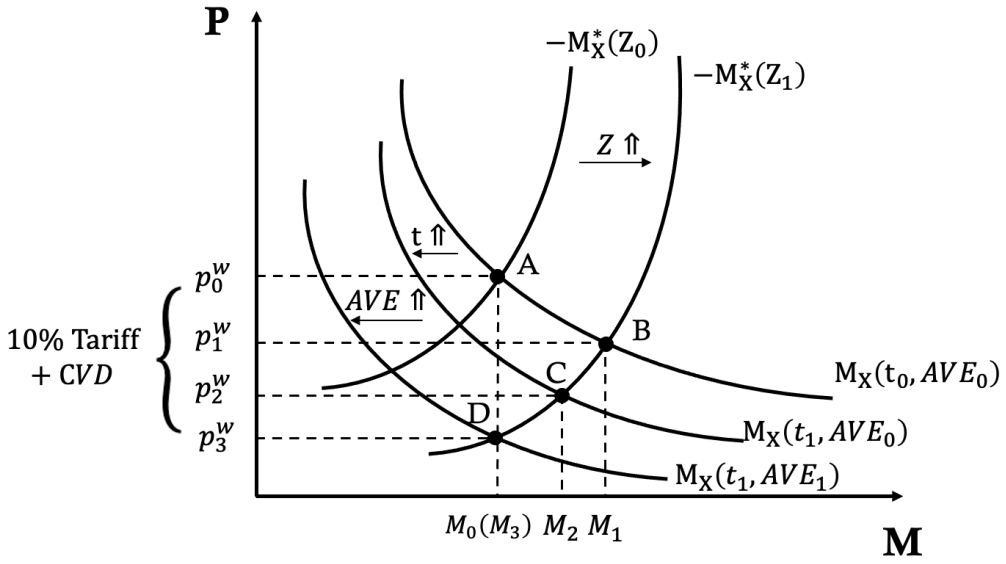
Thus, the optimal response of the EU government in the case with externalities will be larger than that without externalities. In the extreme case, if the Chinese export supply of BEVs is completely not responsive to world price changes, such that ϵ is a constant, then it is still optimal for the EU government to raise AVE to reduce imports and thus consumption externalities.

Figure 10 nicely illustrates the EU-Sino BEV disputes, assuming that the condition in equation (24) holds. Given the initial import demand curve, M_X, and export supply curve, $-M_X^*$, of BEVs, the market equilibrium is at point A, with the world price equals p_0^w and the import of BEVs equals M_0. A change in the supply-side factor, Z, which could be the states subsidies of the Chinese government, technological advancement or productivity gains in China, will shift the $-M_X^*$ curve to the right,

[35] For simplicity, the substitution of gasoline vehicles with BEVs is ignored here. The case with positive externalities will be discussed later.

leading to a lower world price, p_1^w, and an increased imports, M_1, at point B. Confronting the lower world price and the larger imports, EU's existing 10% tariff on imports of BEVs from China shifts M_X curve leftward and reduces the import from M_1 to M_2, at point C. On top of this tariff, imposing NTMs will further shift M_X curve leftward, leading to an additional decrease in the import of BEVs, from M_2 to $M_3 = M_0$, at point D, to fully offset the increase in imports due to the change in Z. The use of NTMs in place of tariffs to further reduce imports nicely demonstrates that they are substituting trade policies. Overall, the mixed use of tariffs and NTMs could capture the terms-of-trade gains and cancel out the impacts on BEV imports due to any supply-side factors such as the Chinese state subsidies or productivity gains.

Figure 10: EU-Sino Battery Electric Vehicle Disputes



Now consider the case if BEVs generate *positive* consumption externalities on the social welfare of the EU.[36] Without changing the model and the government objective function (equation 4), this can be done by making the following adjustments: (1) $E(\cdot) < 0$ is the positive externality function, such that an increase in E is a *decrease* in positive externality; (2) $\lambda = \partial E/\partial C_X < 0$, i.e. an increase in the consumption of BEVs will increase positive externality; (3) $\phi = -\partial E/\partial AVE < 0$, which is that an increase in AVEs will reduce positive externality directly, because of losing public confidence that the government is restricting BEVs. Equation (23) implies that the sufficient condition for raising AVEs when p^w falls is when:

$$\frac{\partial AVE}{\partial p^w} < 0 \text{ if } \frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE} > \frac{\phi}{\lambda} > 0\,, \text{ or } \frac{\partial C_X}{\partial AVE} > \frac{\phi}{\lambda} > 0 \ (\because \phi < 0 \ \& \ \lambda < 0). \quad (25)$$

[36]One could argue that perhaps because people that drive BEVs feel happier that they are contributing to reduce pollution and is good for the environment. Given that happiness breeds happiness, hence the positive externalities!

Thus, if BEVs generate positive externalities, then when facing a lower p^w, it is rational for the EU to raise AVE if higher AVE leads to a substantial increase in X (the domestic BEV production of the EU), which more than offsets the decrease in M_X (the import of BEVs from China), such that C_X (the consumption of BEVs) increases, which leads to an overall welfare gains for the EU.

In summary, without considering consumption externalities, facing the increase in imports of BEVs due to the falling world price, it is optimal for the EU to raise AVEs given fixed tariffs, is because the export supply of Chinese BEVs is sensitive to changes in the world price. If the export supply of Chinese BEVs is fixed or not responsive to changes in the world price, which is the likely scenario in the short run, it is still optimal to raise AVEs, in order to limit the impacts of consumption externalities. If the consumption externality is negative due to congestion, raising AVEs not only reduces imports and promotes domestic production of BEVs, it also boosts the public confidence that the government is addressing a pressing issue with actions. If the consumption externality is positive due to the substitution with gasoline vehicles, raising AVEs is optimal when the AVEs promote domestic production of BEVs so much that it more than offsets the reduction in imports, leading to the increase in the overall consumption of BEVs. This could be because the public will buy BEVs no matter what so there is only a small loss in the public confidence by restricting imports using AVEs.

6 Structural Estimation

To estimate the model structurally, we start with equation (16), which is one of the first-order condition. Rearrange the terms and using the definitions of ϵ^X and ϵ^M, we will have:

$$(t + AVE) \quad = \quad \frac{1}{\epsilon} + \frac{\theta\lambda}{p^w} + \left(\frac{\theta\lambda\epsilon^X X}{p^w M_X \epsilon^M}\right) \tag{26}$$

where $\epsilon \equiv \frac{\partial M_X^*}{\partial p^w}\frac{p^w}{M_X^*}$, $\epsilon^X \equiv \frac{\partial X}{\partial p^d}\frac{p^d}{X}$, $\epsilon^M \equiv \frac{\partial M_X}{\partial p^d}\frac{p^d}{M_X}$. Note that θ is the weight of externality in the social welfare function. Thus θ is importing country specific. The marginal externality of consumption, λ, depends on the product and externality in social welfare function, so it can be assumed to be importer-product specific.

The supply elasticity of X, ϵ^X, is importer-product specific. We can therefore estimate equation (26) based on fixed-effects regressions, regressing $(t + AVE)$ on $1/p^w$, where p^w is the relative unit value of import, and $1/(p^w M_X \epsilon^M)$, with $p^w M_X$ equals the value of imports of X and ϵ^M is the import demand elasticity from Kee and Nicita (2022). Table 2 provides the summary of the variables and parameter used in the following structural estimation.[37]

[37]The unit of measurement is adjusted to be the same within each product. The unreasonable trade unit values are dropped following the criteria by Kee and Nicita (2022).

Table 2: Summary of the Variables and Parameter used in the Structural Estimations

Variable	Definition	Level
t	Tariff	Importer-Exporter-Product
AVE	Ad Volrem Equivalent Tariff of the Border NTMs	Importer-Exporter-Product
p^w	Relative Price (Trade Unit Value)	Importer-Product
$p^w M_X$	Import Value	Importer-Exporter-Product
ϵ^M	Import Demand Elasticity	Importer-Exporter-Product
Parameter	**Definition**	**Level**
ϵ	(Foreign) Export Supply Elasticity	Exporter-Product
θ	The Weight of Negative Externality in the Social Welfare	Importer
λ	The Marginal Consumption Externality	Importer-Product
$\epsilon^X X$	(Home) Domestic Supply Elasticity Multiply with Domestic Production	Importer-Product

With these variables in hand, we will be able to retrieve θ, and λ from the estimation of β's, based on the following specifications:

$$t_{ijn} + AVE_{ijn} = \frac{1}{\epsilon_{jn}} + \beta_{in}\left(\frac{1}{p_n^w}\right) + \gamma_{in}\left[\frac{1}{(p_w M_X)_{ijn}\epsilon_{ijn}^M}\right] + \varepsilon_{ijn} \tag{27}$$

where i, j, n denote importing country, exporting country and product respectively, ε is the error term, and

$$\beta_{in} = \theta_i \lambda_{in} \tag{28}$$

$$\gamma_{in} = \theta_i \lambda_{in} \epsilon_{in}^X X_{in}. \tag{29}$$

Equation (27) shows that ϵ_{jn} can be absorbed by exporter-product fixed-effects, and $\beta_{in}\left(\frac{1}{p_n^w}\right)$ can be proxied by product-importer fixed-effects. In addition, γ_{in} can be obtained by interacting importer-product fixed-effects with the inverse of the product of import value and import elasticity $(p_w M_X)_{ijn}\epsilon_{ijn}^M$, which is available in Kee and Nicita (2022).

$$t_{ijn} + AVE_{ijn} = \alpha_{jn} + \alpha_{in} + \gamma_{in}\left[\frac{1}{(p_w M_X)_{ijn}\epsilon_{ijn}^M}\right] + \varepsilon_{ijn}, \tag{30}$$

$$\alpha_{jn} = \frac{1}{\epsilon_{jn}}, \tag{31}$$

$$\alpha_{in} p_n^w = \theta_i \lambda_{in}, \tag{32}$$

$$\gamma_{in}/(\alpha_{in} p_n^w) = \epsilon_{in}^X X_{in}. \tag{33}$$

To obtain θ_i, we regress the log of $\alpha_{in} p_n^w$ on a full set of importer fixed effects, and the exponents of the importer fixed effects are θ_i

$$ln(\alpha_{in}p_n^w) = ln(\theta_i) + ln(\lambda_{in}) \quad (34)$$

$$ln(\alpha_{in}p_n^w) = \alpha_i + \epsilon_{in}, \quad (35)$$

$$\theta_i = exp(\alpha_i), \quad (36)$$

$$\lambda_{in} = \alpha_{in}p_n^w/exp(\alpha_i). \quad (37)$$

Table 3 presents the regression result for the structural estimation, with the appropriate sets of fixed effects according to equation (30). The coefficient of the right-hand side variable is positive and highly significant, which is consistent with the model. Using the estimated results, θ_i and λ_{in} are constructed based on equations (36) and (37). All the estimated θ_i and λ_{in} are positive.

Table 3: Structural Estimation

VARIABLES	(1) Tariff + AVE
Inverse of Imports × Elasticity	0.058**
	(0.025)
Importer-Product Fixed Effects	Yes
Exporter-Product Fixed Effects	Yes
Observations	244,380
Adjusted R^2	0.792

Note: Robust standard errors in parentheses are clustered by importer-product. *, ** and *** indicate that coefficients are significant at 90%, 95% and 99%, respectively.

6.1 Relating Structural Estimation to Reduced-Form Results

The applicability of our model can be verified by using the parameters to explain the previous reduced-form results. One of the main results in Section 4 is that the degree of substitution between tariffs and NTMs increases with the income level of the importing countries (see Figure 7). On the other hand, our model suggests that the degree of substitution between tariff and NTMs increases with θ, which is the weight of consumption externalities in the social welfare function. For the model to be consistent with the reduced-form results, it is necessary that θ increases with the income level of the importing countries.

Column (1) of Table 4 shows the regression result when we regress the estimated θ_i on the GDP per capita of the importing country. The positive and statistically significant coefficient suggests that θ_i increases with the income level of the importing country, controlling for country size and the share of import duty in total revenue. This is consistent with our previous reduced-form regression result.

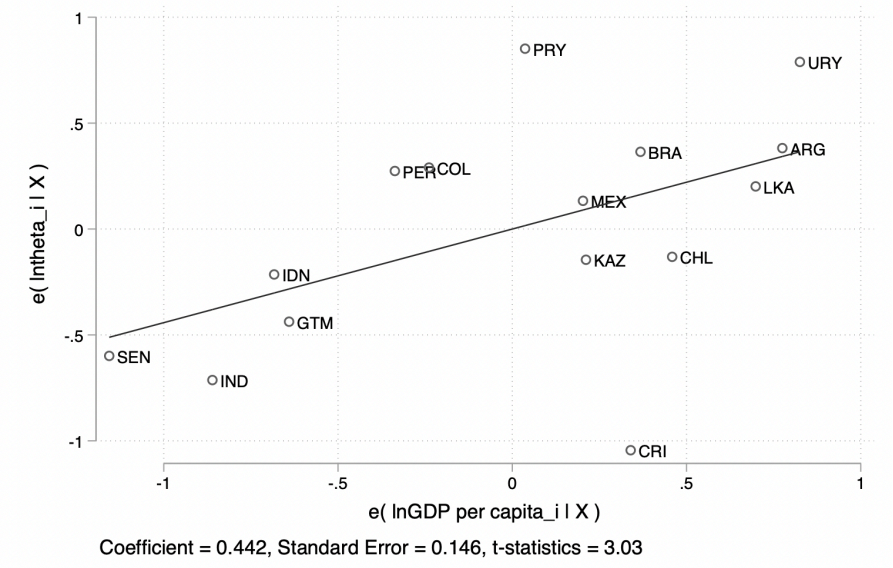
Table 4: The Relationships between Importing Country, Product Characteristics and Parameters

VARIABLES	(1) $\ln(\theta_i)$	(2) $\ln(\lambda_{in})$	(3) $\ln(\lambda_{in})$
ln(GDP per capita)	0.442**		
	(0.146)		
ln(GDP)	0.290**		
	(0.104)		
Duty Share in Revenue	0.071***		
	(0.016)		
Agricultural		2.311***	
		(0.638)	
ln(GDP per capita) × Agricultural		-0.401***	
		(0.073)	
Food			2.106***
			(0.647)
$\ln(\text{GDP per capita})_i \times$ Food			-0.377***
			(0.074)
Observations	15	10,981	10,981
Adjusted R^2	0.333	0.049	0.047
Importer fixed effects	No	Yes	Yes

Note: Robust standard errors in parentheses are clustered by importer in the first column. *, ** and *** indicate that coefficients are significant at 90%, 95% and 99%, respectively.

Figure 11 further presents the positive and significant partial correlation between the estimated θ_i and GDP per capita of the importing countries, confirming both the theoretical and empirical findings.

Figure 11: Partial Correlation between θ and GDP per capita of Importing Countries



Reduced-form regression results from Section 4 further show that the substitution between tariffs and NTMs is higher for agriculture and food products (see Figure 6). In the model product characteristics that may affect the substitution between tariff and NTMs are captured by λ_{in}, which is the marginal consumption externalities. For the model to be consistent with the reduced-form results, λ_{in} should be higher for these products, particularly if there are fewer regulations in the importing countries to reduce consumption externalities.

Columns (2) and (3) of Table 4 show the regression results when we regress the estimated λ_{in} on product characteristics, controlling for importer fixed effects. The results show that agriculture products and food products have statistically larger λ_{in}, which suggests higher marginal consumption externalities for these products. Given that forestry products are included in agricultural products, this result is consistent with Harstad (2024a), highlighting how governments may mix tariffs and NTMs to regulate the trading of products with externality to achieve the first-best goal of combating climate change.

Furthermore, the negative coefficients on the interaction terms with GDP per capita of the importing countries suggests that the marginal consumption externalities of agriculture and food products decrease with the income level of the importing countries. This could be because high-income countries have better regulations and safeguards in place that already reduce the consumption externalities of these products.

Overall, the results based on the structural estimation of the theoretical model presented in Table 4 are consistent with the previous reduced-form regressions. Together, these results show that while tariffs and NTMs are policy substitutes, the degree of substitution depends on the characteristics of the countries and products.

7 Conclusions

This paper studies the relationship between tariffs and non-tariff measures, considering the characteristics of the importing countries, exporting countries, and products. Based on detailed product-level tariff and AVE data with bilateral variations, this paper shows that overall tariffs and NTMs are policy substitutes. However, the degree of substitution between tariffs and NTMs depends on the characteristics of importing countries, exporting countries, products and the bilateral relationship. The degree of substitution between tariffs and NTMs increases with the importing countries' GDP per capita, capital-labor ratio and skilled-labor ratio. The reverse is true facing the exporting countries, except that skilled-labor ratio has no significant impacts. Moreover, when importing countries are more deeply embedded in the global value chains, the relationship between tariffs and NTMs tends to be more complementary. Tariffs and NTMs are also more substituting for consumption, agricultural, and food products, while the opposite holds for intermediate products and capital goods.

Finally, when both importers and exporters engaged in a deep trade agreement or importing countries are more capable of imposing NTMs, the relationship between tariffs and NTMs tends to be more substituting.

To rationalize these findings, this paper builds a general equilibrium model similar to Ederington (2001), whereby welfare-maximizing governments choose tariffs and NTMs to capture terms-of-trade gains and reduce negative consumption externality. In addition, restrictive NTMs also decrease the negative consumption externalities directly. In equilibrium, tariffs and NTMs are policy substitutes, but the degree of substitution depends on the weight of negative consumption externality in social welfare, the effectiveness in enforcing NTMs and the nature of consumption externality. Characteristics of the importing countries, exporting countries and products may affect the weight, effectiveness and the nature of externality, which thus provides economic reasons for the empirical findings. Structural estimation of the model to recover the underlying parameters shows that, indeed, the weight of the negative consumption externality in the social welfare function is increasing with the income level of the importing countries. This is consistent with the finding that high-income countries use tariffs and NTMs to reduce consumption externalities due to imports. In addition, agricultural and food products, including forestry products, tend to have larger marginal externalities in consumption, which leads to higher substitution between tariffs and NTMs, which is consistent with Harstad (2024a).

The recently announced provisional countervailing duties, a type of border NTMs, imposed by the European Commission on China's BEV exporters, with the stated goal of protecting EU's BEV producers from the unfair threat, on top of the existing 10% tariff, nicely encapsulate how governments may mix trade policies to achieve domestic objectives, without violating existing international agreements. The findings of this paper shed light on this and other recent trade tensions and conflicts among the major economies on products that could affect the welfare of the world.

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Appendix A Variables Definitions and Data Sources

Table A.1: Variables Definitions and Data Sources

Variable Name	Definitions	Source
Tariff	Effectively applied tariff rate at importer-exporter-HS 6 digit product level	UNCTAD TRAINS
AVE	Ad valorem equivalent (tariff) of the border NTM	Kee and Nicita (2022)
GDP per capita	GDP per capita (current US$)	World Bank WDI
Capital / Labor (log)	Capital stock (at constant 2017 national prices in mil.2017 US $) devided by total employment	Peen World Tables 10.01
High Skilled Labor Share	Labor force with advanced education (% of total working-age population with advanced education)	World Bank WDI
Duty Share in Revenue	Customs and other import duties (% of tax revenue)	World Bank WDI
Control of corruption	the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	World Governance Indicators
Government Effectiveness	the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	World Governance Indicators
Rule of Law	the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	World Governance Indicators
Regulatory Quality	the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Governance Indicators
Intermediate Products	HS 6-digits Products falling into the group of intermediate products	Broad Economic Classifications
Consumption Products	HS 6-digits Products falling into the group of consumption products	Broad Economic Classifications
Capital Products	HS 6-digits Products falling into the group of capital products	Broad Economic Classifications
Agricultural Products	HS 6-digits products falling into the chapters 1-24 of the Harmonized System	WTO Agreement on Agriculture
Food and Beverages	HS 6-digits products, edible products (food and beverages)	USDA Economic Research Service
WTO members	The indicator that taking value of one if both importer and exporters are WTO members and zero otherwise	CEPII Gravity Database
Deep trade agreement	The indicator that taking value of one if importer and exporter are engaged in a trade agreement and zero otherwise	Hofmann et al. (2017)
DTA depth	The horizontal depth of deep trade agreement, measured by the number of provisions covered in the DTA	Hofmann et al. (2017)
DTA depth LE	The horizontal depth of deep trade agreement, measured by the number of legally enforceable provisions covered in the DTA	Hofmann et al. (2017)
Backward GVC participation (log)	The import content of country's exports, the intensity of GVC participation	Fernandes et al. (2022)
Forward GVC participation (log)	The domestic value-added in exports that is used by the country's bilateral partner countries for export production	Fernandes et al. (2022)
RTA number	The number of Regional trade agreements currently in force	WTO RTA database
NTM notifications	The number of NTM notifications from the WTO member countries to the WTO	WTO NTM database
Distance to GVC hubs (log)	Logarithm of sum of distance to China, Germany, and the United States (capital city to capital city)	CEPII Gravity Database

Appendix B Model Derivation

$$max_{t,AVE}\, W = F(X) - p^w M_X - m + U(X + M_X) - \theta E(X + M_X, AVE) \tag{B.1}$$

First order condition with respect to Tariffs

$$\begin{aligned}\frac{\partial W}{\partial t} &= F'\frac{\partial X}{\partial t} - \frac{\partial p^w}{\partial t}M_X - p^w\frac{\partial M_X}{\partial t} + U'\left(\frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t}\right) - \theta\lambda\left(\frac{\partial X}{\partial t} + \frac{\partial M_X}{\partial t}\right) \\ &= \big(F' + U' - \theta\lambda\big)\frac{\partial X}{\partial t} + \big(U' - p^w - \theta\lambda\big)\frac{\partial M_X}{\partial t} - \frac{\partial p^w}{\partial t}M_X = 0\end{aligned} \tag{B.2}$$

Plug the price equations (7), (8) and the equilibrium conditions (9), (10) into equation (B.2) to obtain:

$$\begin{aligned}\big[(t + AVE)p^w - \theta\lambda\big]\frac{\partial M_X}{\partial t} &= \frac{\partial p^w}{\partial t}M_X + \theta\lambda\frac{\partial X}{\partial t} \\ \big[(t + AVE)p^w - \theta\lambda\big] &= \frac{\partial p^w}{\partial t}M_X\frac{\partial t}{\partial M_X} + \theta\lambda\frac{\partial X}{\partial t}\frac{\partial t}{\partial M_X} \\ (t + AVE) &= \frac{\partial p^w}{\partial M_X}\frac{M_X}{p^w} + \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial t}{\partial M_X/\partial t} + 1\right)\end{aligned} \tag{B.3}$$

First order condition with respect to AVE

Similarly, we can express the first order condition with respect to AVE.

$$\begin{aligned}\frac{\partial W}{\partial AVE} &= F'\frac{\partial X}{\partial AVE} - \frac{\partial p^w}{\partial AVE}M_X - p^w\frac{\partial M_X}{\partial AVE} + U'\left(\frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE}\right) - \theta\lambda\left(\frac{\partial X}{\partial AVE} + \frac{\partial M_X}{\partial AVE}\right) + \theta\phi \\ &= (F' + U' - \theta\lambda)\frac{\partial X}{\partial AVE} + (U' - p^w - \theta\lambda)\frac{\partial M_X}{\partial AVE} - \frac{\partial p^w}{\partial AVE}M_X + \theta\phi\end{aligned} \tag{B.4}$$

Plug the price equations (7), (8) and the equilibrium conditions (9), (10) into equation (B.4) to obtain:

$$\begin{aligned}\big[(t + AVE)p^w - \theta\lambda\big]\frac{\partial M_X}{\partial AVE} &= \frac{\partial p^w}{\partial AVE}M_X + \theta\lambda\frac{\partial X}{\partial AVE} - \theta\phi \\ \big[(t + AVE)p^w - \theta\lambda\big] &= \frac{\partial p^w}{\partial AVE}M_X\frac{\partial AVE}{\partial M_X} + \theta\lambda\frac{\partial X}{\partial AVE}\frac{\partial AVE}{\partial M_X} - \theta\phi\frac{\partial AVE}{\partial M_X} \\ (t + AVE) &= \frac{\partial p^w}{\partial M_X}\frac{M_X}{p^w} + \frac{\theta\lambda}{p^w}\left(\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} + 1\right) - \frac{\theta\phi}{p^w\partial M_X/\partial AVE}\end{aligned} \tag{B.5}$$

The impact of parameter ϕ and λ on trade policy determination:

Rearrange equation (19) , we have:

$$\frac{\partial X/\partial t}{\partial M_X/\partial t} = \frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} + \frac{\phi/\lambda}{-\partial M_X/\partial AVE} \tag{B.6}$$

where $\partial M_X/\partial AVE < 0$, $\partial M_X/\partial t < 0$, $\partial X/\partial AVE > 0$ and $\partial X/\partial t > 0$.

Rearrange equation (20), we have:

$$\frac{\partial X/\partial t}{\partial M_X/\partial t} > \frac{\partial X/\partial AVE}{\partial M_X/\partial AVE} \tag{B.7}$$

As a result, an increase in ϕ implies an increase in the difference between $\frac{\partial X/\partial t}{\partial M_X/\partial t}$ and $\frac{\partial X/\partial AVE}{\partial M_X/\partial AVE}$, and increase in λ implies a decrease in the difference between them.

More specifically, an increase in ϕ, may corresponding to the following two cases: $\partial M_X/\partial t$ decreases, or $\partial M_X/\partial AVE$ increases. These two cases imply that tariff is more effective in curbing imports. It will be optimal to use higher tariffs to curb imports and capture terms-of-trade gains. On the contrary, an increase in λ implies that, tariff is more effective in boosting domestic production, but less effective in curbing imports.