ASIAN INFRASTRUCTURE INVESTMENT BANK

Protectionism and Trade in Renewable Energy Infrastructure

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Abstract

International trade in renewable energy infrastructure is essential for countries to meet their development and environmental objectives such as the Sustainable Development Goals. This paper explores the role of protectionism in renewable energy. Using detailed product-level data on imports, tariff and non-tariff measures, it presents evidence that burdensome measures negatively impact trade flows in this infrastructure. Results further suggest that these measures may have heterogenous impact on exporting countries depending on their level of development. This points to the need to lower costs to support renewable energy development.

Keywords trade; renewable energy; non-tariff measures; protectionism

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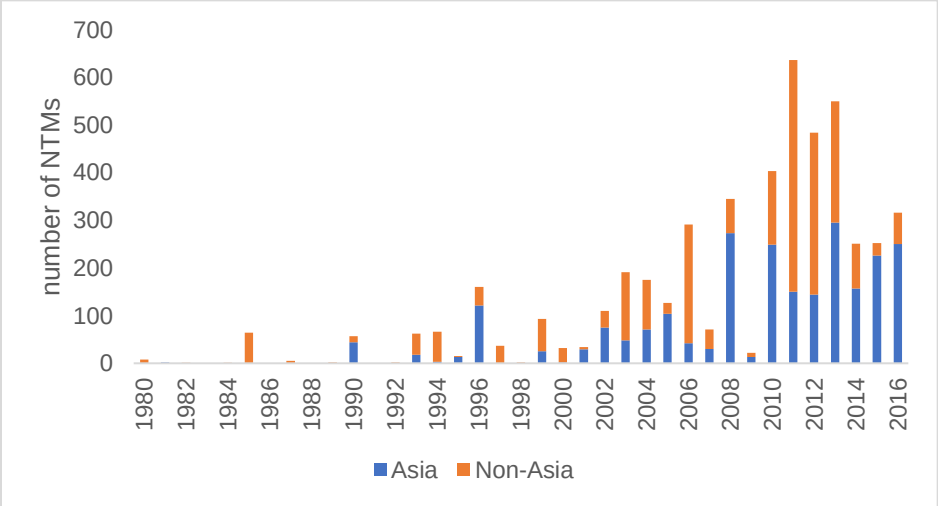
1 Introduction

Development of renewable energy (RE) infrastructure is essential for countries to meet their development and environmental goals, particularly the commitments under the 2015 Paris Agreement and the United Nations' Sustainable Development Goals (SDGs). Considering limited natural resources and rising energy needs, rapid development of RE is seen by countries as a solution to accelerate economic growth, on the one hand, and preserve the environment and mitigate climate change, on the other. Renewable energy investments totaled around USD280 billion in 2017, with a cumulative investment of USD2.9 trillion since 2004 (Frankfurt School-UNEP Centre and BNEF, 2018).

In 2016, renewable energy plants accounted for a significant portion of global trade in environmentally related goods (EGs), representing about 35% of some 1.26 trillion USD of such exports.[1] There is likewise an upward trend in RE trade. From 2003 to 2016, it has grown at a very high average annual rate of 8.9% (higher than the 7.5% average for all EG trade), which is in line with increased global shift towards renewable energy use, especially in electricity generation (Garsous, 2019).

Against the backdrop of growing RE demand, countries have put in place measures aiming to develop domestic capabilities in RE infrastructure, for example, through local content requirements (LCRs), subsidies, or favorable access to financing. These measures do have some elements of protectionism. Countries have also established regulations on RE goods imports under the rationale of consumer safety and environmental protection. In fact, non-tariff measures (NTMs) in RE infrastructure have been increasing globally, and one sees similar trends in Asia (Figure 1).[2]

Figure 1: Number of Non-tariff Measures on Imports of Renewable Energy Goods



[1] Other EGs include: waste water management and portable water treatment; clean up or remediation of soil and water; management of solid and hazardous waste and recycling systems; noise and vibration abatement; natural resources protection; environmental monitoring, analysis and assessment equipment; heat and energy management; environmentally preferable products based on end use or disposal characteristics; cleaner or more resource efficient technologies and products; air pollution control. See (Garsous, 2019) for more details.
[2] The Asian countries considered are AIIB's regional members.

NTM = non-tariff measures
Source: UNCTAD TRAINS NTMs Database.
Note: The chart presents the number of outstanding NTMs by the year of implementation. Data is as of the most recent NTM survey per country. One NTM is counted if the importing country has an NTM for any exporting country for a given combination of NTM type and HS6-level product.

Both developed and developing economies have contributed to the increase in NTMs. In Canada, for example, specifically in Ontario, NTMs in the form of LCRs serve as a pre-requisite for feed-in-tariffs (FiTs) participation by investors in wind and solar projects. Following complaints by Japan and the European Union, the World Trade Organization (WTO) considered such subsidies to be a violation under the General Agreement on Tariff and Trade (GATT) and Agreement on Trade-Related Investment Measures (TRIMS) , although it did not conclude on whether Ontario's case constituted a 'prohibited subsidy' under the 2013 Agreement on Subsidies and Countervailing Measures (SCM) (Kuntze & Moerenhout, 2013). In its rise as a top solar photovoltaics (PV) manufacturer, China allowed its domestic companies to benefit from top-down subsidies and LCRs attached to FiTs. Due to fiscal pressures however, the government has since mid-2018 shifted to a market-based approach (i.e., solar PV auctions), and restricted new installations that required subsidies from the National Renewables Development Fund (BNEF, 2018). While NTMs have increased, customs tariffs, another form of protectionism, have been declining across goods (not only RE) and across countries over the past decade, even though some developing economies have scope to reduce RE-related tariffs further.

One rationale for the use of incentives promoting RE is that its use can boost local industries and local demand, thereby improving competitiveness in the RE infrastructure over time. Nevertheless, one countervailing rationale is that protectionism can increase the costs of production for importers. Higher input costs can be passed on to consumers and that goes against the objective of enabling affordable energy access to households and industry.

Protectionism may also have implications for countries' commitments under the Paris agreement and the SDGs. (WTO, ITC, UNCTAD, 2019) notes that international trade is a means to help countries access products and services needed for sustainable development. By the same token, potential trade barriers may stifle RE trade and investments, and thus RE development to meet the SDGs. SDG 7, which is about 'ensuring access to affordable, reliable, sustainable and modern energy for all', has a focus on RE. Specifically, SDG 7.2 aims to 'increase substantially the share of renewable energy in the global energy mix by 2030'.

Hence, analyzing the possible effects of trade barriers is a relevant endeavor. The central question we pose in this paper is whether trade barriers, such as tariffs and NTMs, affect global trade in RE infrastructure goods.

This paper is structured as follows. Section 2 provides a snapshot of global trends in RE NTMs and tariffs with a focus on Asia. Section 3 reviews the literature on the impact of protectionism on trade flows. Section 4 provides a description of data sources. Section 5 presents the empirical strategy and the results. Section 6 concludes.

2 Trends in potential barriers to trade

This section explores the trends in direct and indirect forms of trade protectionism, particularly in Asia.

NTMs are non-tariff policy measures that have a potential impact on trade flows, such as quotas, price controls, or technical measures intending to achieve non-trade goals, i.e., health and environmental protection (UNCTAD, 2018).[3] While NTMs do not necessarily entail an adverse impact on trade, there are some cautionary tales about NTMs. First, like mentioned, many NTMs are perceived to have protectionist intent (UNCTAD, 2018). Specifically, non-technical NTMs such as quantity- and price-control measures tend to be considered as non-tariff barriers as most have objectives to protect domestic producers against foreign firms (Knebel & Peters, 2019). Second, NTMs may be in excess of what is needed to achieve the objective of protecting the public, thereby potentially creating distortive effects. Compliance with technical NTMs requirements, such as sanitary and phytosanitary measures (SPS) or technical barriers to trade (TBTs), may be costly and time-consuming (Kee & Nicita, 2016). Finally, NTMs, particularly import-related ones, are reflective of market access conditions in the country (ERIA, 2019)[4]—namely, excessive prevalence of NTMs is indicative of barriers to access to those markets.

NTMs are on the rise in RE infrastructure. Among countries in Asia, the total number of import related NTMs applied to RE products has increased from 44 in 1990 to 250 in 2016. Asia accounts for over three-quarters of NTMs in the RE sector imports implemented between 2014 and 2016. Close to 40% of current NTMs were enacted in the past five years, suggesting that the industry is facing an increasing number of regulatory requirements. Most of these NTMs are imposed by importing countries on imports regardless of origin, with some measures imposed bilaterally. Yet, even though most NTMs are broadly applied across countries, costs related to NTMs may differ across exporting countries (Kee & Nicita, 2016).

The most common type of import-related NTMs in RE infrastructure are technical NTMs, particularly TBTs which comprise about three-quarters of all NTMs. TBTs pertain mainly to conformity with established technical standards and regulations, import restrictions set out in TBT agreements (e.g., established under the rationale of consumer safety, environmental protection or national security) as well as labeling and packaging requirements. About 20% of NTMs are non-technical, such as non-automatic licensing, quotas and other quantity-control measures, price-control measures and measures affecting competition (e.g., support for state enterprises).[5] The composition of NTMs by type is similar between Asia and the rest of the world (Table 1).

Table 1: Types of Non-tariff Measures in Renewable Energy Infrastructure

	NTM types	**World**	**Asia**
Technical	Sanitary and Phytosanitary measures	4.30%	0.55%
	Technical barriers to trade	72.54%	79.74%
	Pre-shipment inspection and other formalities	5.18%	3.48%
	Contingent trade-protective measures	0.88%	0.00%

[3] All NTMs are collected by UNCTAD regardless of perceived effects (UNCTAD 2017).
[4] Therefore, to be reflective of market access conditions, export-related NTMs (e.g., export subsidies) are not included in the analysis.
[5] For more information, see (UNCTAD, 2018) and (UNCTAD, 2015).

	Non-automatic licensing, quotas, prohibitions and quantity-control measures other than SPS or TBT reasons	7.65%	5.20%
	Price-control measures, including additional taxes and charges	6.87%	7.13%
	Finance measures	0.72%	0.13%
	Measures affecting competition	1.65%	3.44%
	Trade-related investment measures	0.08%	0.17%
Non-technical	Subsidies (excluding export subsidies)	0.04%	0.00%
	Intellectual property	0.08%	0.17%

Source: UNCTAD TRAINS NTMs Database.
Note: Classification is based on UNCTAD–MAST Classification of Non-Tariff Measures.

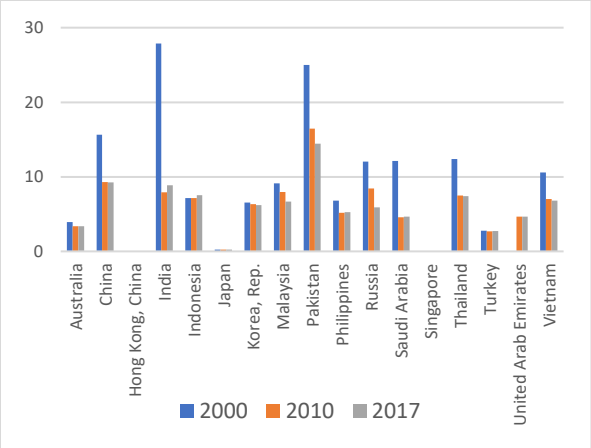
Price-control measures, a form of non-technical NTMs, are measures to affect the prices of imports (e.g., increase the cost of imported goods), and thus are also referred to as para-tariff measures (UNCTAD, 2015). Technical NTMs also impose trade costs for exporting countries, especially when excessive, even if they stem from non-trade rationale to protect consumers or the environment.

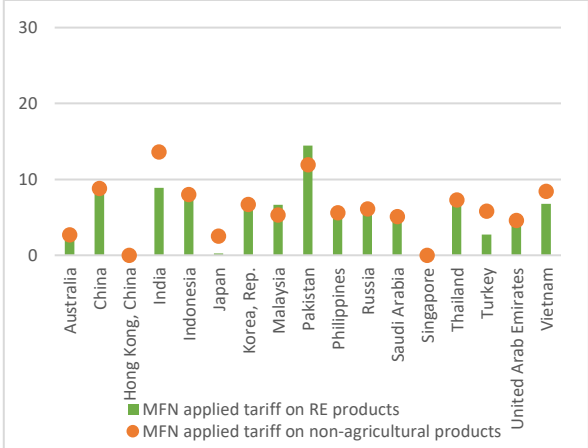
In contrast to NTMs, there is a declining trend in import tariffs—a direct form of protectionism—for RE products. Since the creation of GATT in 1948 as well as the subsequent trade liberalization efforts by WTO members around the world, tariffs have been reduced across all (non-agricultural) products, including among RE goods. Figure 2 shows a significant decline in the average applied tariffs on a most-favored-nation (MFN) basis between 2000 and 2017 among top Asian importers of RE goods. Moreover, average applied tariff rates in these economies for non-agricultural products and for RE products are similar.[6]

Notwithstanding these positive developments, the current trade tensions between the United States and its major trading partners (e.g., China) have led to some reversal: an escalation in tariffs. Some of these involve trade in RE infrastructure, such as steel imports for wind turbines, and solar panels. It remains to be seen whether these tariff increases are temporary or permanent. In fact (Fajgelbaum, Goldberg, Kennedy, & Khandelwal, 2019) already found a significant adverse short-run impact of tariffs on the US economy, such as reduced trade and higher import prices that are being passed on to US consumers and producers.

Figure 2: Average Most Favored Nation Applied Tariffs, 2000 to 2017 (left) and Tariff Rates on Renewable Energy vs. Non-agricultural Products (right)

[6] That said, tariffs in some markets, such as Pakistan and Thailand, remain relatively high.





Note: MFN = most favored nation
Source: WITS TRAINS Dataset and (WTO, ITC, UNCTAD, 2019).

3 Literature Review

A literature has emerged that analyzes the growing use of NTMs as a trade policy instrument across countries, and their economic impact. One strand of literature focuses on specific aspects of NTMs in the RE sector, another on quantifying NTMs' impact for a broad set of products (not just RE goods).

The literature on protectionism in RE specifically (and EGs, more broadly) has so far focused on niche aspects of NTMs. It presents mixed evidence of NTMs' economic effects. (Kuntze & Moerenhout, 2013), for example, consider the use of LCRs,[7] a form of non-technical NTMs, and find that countries justify their application with an intent to boost local jobs and develop infant industries. Other perceived benefits include containment of imports to address current account imbalances (for countries with persistent trade deficits), and reduction in import-dependency in the protected sector. (Sauvage, 2014) provides some evidence of positive benefits of environmental standards, a form of technical NTMs, finding that stronger environmental regulatory measures intended to abate pollution are positively associated with export performance of environmental products in the municipal solid waste treatment and wastewater treatment sectors, provided that such regulations do not pose excessive burden on producers.

Studies also point to potential pitfalls of protectionism in RE. Identified costs associated with LCRs, for example, include inefficient allocation of resources (as LCRs may incentivize local players to invest in RE sectors inefficiently), and reduced competition between local and foreign market players, particularly when countries impose restrictively high levels of local content (Kuntze & Moerenhout, 2013). (OECD, 2015) finds that LCRs targeted at midstream manufacturing (e.g., solar panel and wind turbines) risk creating a domestic intermediate industry (but not a complete solar or wind value chain), and do not necessarily provide positive effects on job creation and domestic output across the value chains.

[7] LCRs require that a minimum amount of inputs (goods or services) be manufactured or procured domestically, often serving as a pre-requisite attached to public tenders/auctions, feed-in tariffs, access to finance programs or other related government support measures (BNEF, 2017) (Kuntze & Moerenhout, 2013). LCRs play a prominent role in RE markets in both developed and emerging economies. Globally, about 20 large emerging economies have LCRs in RE subsidies, including Brazil, China, India, Russia, Saudi Arabia, South Africa and Turkey (BNEF, 2017).

Quantifying the impact of removing LCRs and FiTs on RE goods, (Jha, 2013) finds that LCRs and FiTs are more likely to be detrimental to facilitating and sustaining growth in trade in RE goods. Further, an econometric analysis by (OECD, 2015) finds that investment is more likely to flow to countries which do not have LCRs in their FiTs programs in the solar PV and wind energy sectors.

From a project standpoint, import restrictions can potentially lead to higher costs for the industry and affect project costs by pushing auction bid prices upwards. In Brazil, for example, LCRs raised the average bidding prices by over 140% in wind projects; in Russia, stringent LCRs resulted in undersubscribed auctions and higher winning tariffs (BNEF, 2017). Also, such restrictions may force producers to adopt inferior technology compared with more advanced substitutes (often imported from developed markets) and this may increase operations and maintenance costs of RE infrastructure in the future.

A growing literature on NTMs is trying to quantify their impact, using two main approaches: estimation of ad-valorem equivalents (AVE) of NTMs and analysis of prevalence of NTMs. Such empirical literatures mainly focus on broad types of NTMs and on broad product groups, with a few focused on specific sectors other than RE infrastructure. This literature has so far been pointing to the negative impact of NTMs.

(Kee & Nicita, 2016), for example, developed a methodology to estimate the AVEs of NTMs in order to directly compare the impact of NTMs vs. tariffs on trade. Using cross-sectional data, they show that firms facing higher AVEs may be committing product or origin frauds to circumvent burdensome NTMs, as suggested by large discrepancies in both volume and quantity of NTM-affected products reported by exporting vs. importing countries. (Grubler, Ghodsi, Stehrer, & Reiter, 2017) use a similar approach for a broader set of product groups. For instance, they find that NTMs are generally trade-restricting and that they are most restrictive for countries in Sub-Saharan Africa, and for certain product groups such as luxury goods, minerals, and agri-food products. Focusing on agricultural products, (Disdier, Fontagne, & Mimouni, 2008) likewise find that NTMs in the form of SPS and TBTs are more restrictive than other OECD trade requirements. Analyzing environmentally related goods, (Jacob & Moller, 2017) find that a higher prevalence of NTMs imposed by importers has a negative effect on exporting countries.

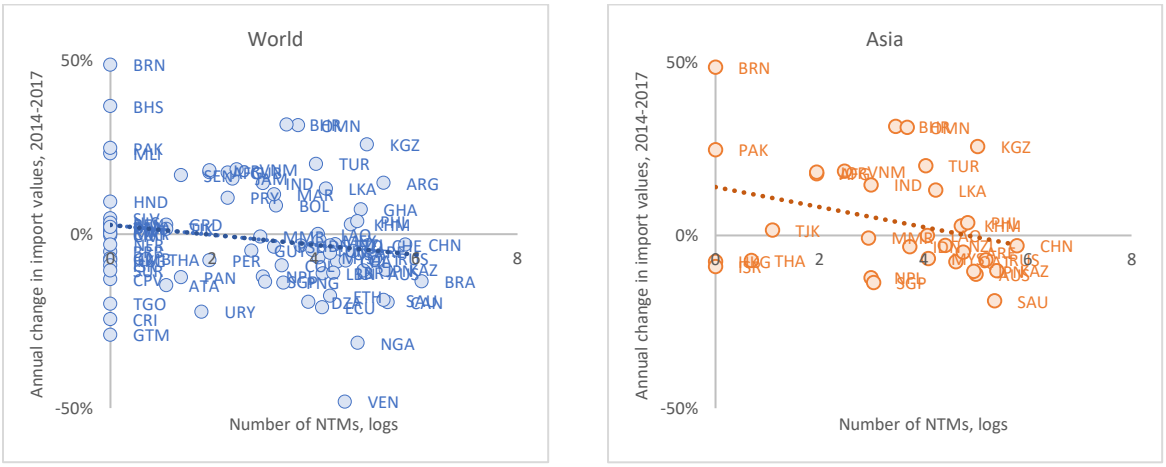
The literature also analyzes the heterogenous impact of protectionist measures on exporting countries. (Disdier, Fontagne, & Mimouni, 2008) find that NTMs and tariffs negatively affect developing countries' exports into OECD countries for agricultural goods trade. (Jacob & Moller, 2017) find that the impact of NTMs on trade in environmental goods is more strongly felt by exports from low income countries than more developed ones. (Grubler, Ghodsi, Stehrer, & Reiter, 2017) also show that different types of NTMs have different effects: while NTMs have a smaller negative impact on richer countries than on lower-income countries for SPS measures, TBT measures tend to be more restrictive for higher-income countries.

3.1 Contributions of This Study

This paper contributes to the literature by analyzing the impact of protectionism for a global sample of importing and exporting countries. To the best of our knowledge, there is scant literature as yet that focuses on NTMs' impact on international trade in RE infrastructure. We measure the prevalence of NTMs by the total number (count) of NTMs for a particular combination of a country pair and a product group. We further investigate whether the impact of NTMs prevalence (as well as that of tariffs) differs between exporting countries.

The initial graphical analysis lends support to the postulation, found in the literature, of negative effects of the prevalence of NTMs on trade in RE infrastructure. Scatterplots in Figure 3 present some evidence that countries with more NTMs have slower import growth on balance, suggesting potential trade-distortion effects of excess NTMs. This negative correlation is likewise pronounced when considering Asian countries only.

Figure 3: Renewable Energy Sector: Import Flows and Non-tariff Measures



Source of basic data: BACI International Trade database, UNCTAD TRAINS NTMs Database
Note: Annual changes of import values at each product line for every importer-exporter pair are aggregated at the country level.

4 Data

This paper utilizes data from various sources to analyze the impact of protectionism on global trade in RE infrastructure. The availability of NTM data determines the year coverage of the analysis—the latest available vintage of NTMs data for most countries is 2016. Data includes import flows between all RE goods importers and their respective partners, tariff rates and number of NTMs. Each of these variables of interest are publicly available at the Harmonized System (HS)-6 product level. With the inclusion of importer-exporter-product combination with zero trade flows, the assembled dataset totaled over 1 million data points.

Identification of RE products relies on the Combined List of Environmental Goods (CLEG) (see (Garsous, 2019) and (Sauvage, 2014)). Out of 248 environmental products, there are 54 renewable energy goods at the HS-6 product line.

4.1 Import values

Import values come from BACI International Trade Database assembled by the Center for Prospective Studies and International Information (CEPII). BACI contains a repository of import values recorded by the importing country from partner countries at the HS-6 product level. CEPII researchers further cleaned the data by imputing trade flows where they were missing, using

techniques that reconcile flows reported by importers and exporters.[8] Import values in the final database are recorded free on board. We use 2016 values to correspond to the year of NTM data.

To account for zero trade flows, we expand the dataset to include, for all existing importers, all importer-exporter-product combinations that were not in the database, and assume there was no trade between the respective countries for that particular product in 2016. Ultimately there are 111 RE-goods-importing countries and 189 exporting partners. Over 85 percent of data points have zero trade at the HS-6 product level.

4.2 Prevalence of NTMs

NTMs data comes from the NTMs Trade Analysis Information System (TRAINS) Database.[9] NTMs are identified based on regulations imposed by the importing country at the detailed product level ("tariff line"). Regulations for every product line are classified and differentiated based on UNCTAD (2012)'s Multi-Agency Support Team (MAST) classification of NTMs at the numerical 3-digit level. In the TRAINS dataset individual tariff-line NTMs are summed up within, and aggregated to, the HS-6 level. NTMs can be imposed bilaterally or imposed upon the world regardless of import origin.

We process and incorporate the TRAINS dataset in the following way: (i) only import-related NTMs are retained, (ii) the dataset contains an indicator when a regulation has been implemented, as well as when it has ended—where it ended prior to 2016, the datapoints is dropped from the analysis (i.e. only NTMs outstanding as of 2016 remain), (iii) since the European Union (EU) apply the same NTMs (and tariffs) on their exporting partners, each individual EU importing country has the same NTM situation, (iv) whenever an NTM is applied against the world, we expand this item into 189 items—one for each individual exporter. The final database contains distinct types of NTMs (counted only once) for every combination of HS-6 RE product by importer-exporter pair.

Table A 1 presents the list of importers included in our sample, along with their NTM prevalence scores—defined as the average number of NTMs affecting any given imported product. As can be seen, there is heterogeneity in terms of prevalence scores among importers. On one extreme Brazil has over 8 various (types of) NTMs affecting a typical RE imported product on average, on the other importers such as Togo and Israel have none. Globally, countries with NTMs implement 1.5 NTMs on average per product group, with a minimum of 1 and a maximum of 18 NTMs. Out of 111 NTM reporting countries, 86 countries have at least 1 NTM for one or more of its traded RE infrastructure goods.

Developed countries use NTMs more often than developing countries.[10] Among developed countries in the data sample, almost all (97%) impose one or more NTMs on its RE imports, compared with 68% of developing countries. This is consistent with (Grubler, Ghodsi, Stehrer, & Reiter, 2017)'s observation that richer countries implement more NTMs than poorer countries. This observation is also similar to (Hoekman & Nicita, 2008) which find that the use of NTMs increases with the level of development (although higher income economies tend to have lower tariff rates). The proportion of exporters affected by one or more NTMs are similar between developing vs. developed countries (at 78%), since most NTMs are imposed regardless of origin.

[8] For more information, see (Gaulier & Zignago, 2010).
[9] Data is downloaded from UNCTAD website: https://trains.unctad.org/Forms/Analysis.aspx
[10] Classification of developed and developing economies comes from UNCTAD. See: https://unctadstat.unctad.org/EN/Classifications.html

This paper takes advantage of this variation across countries to estimate the impact of NTMs.

4.3 Tariff

Tariff data is generated from TRAINS through the WITS website. Tariff is defined as the simple average MFN applied tariffs from all tariff lines within the corresponding HS 6 product.

Almost all countries impose non-zero tariffs on at least one of its RE imports. On average, tariff rate for RE goods is 8.5% across countries in the sample. Developed economies impose 3% on average, whereas developing economies impose close to 11%, suggesting that richer countries are more liberalized in terms of tariffs. Most (97%) developing and developed exporters are affected by tariffs for at least one of their RE products.

4.4 Gravity variables

Database of "gravity" variables is sourced from CEPII, and includes commonly used geographic variables such as bilateral distance between importing and exporting partners and a common border, as well as cultural proximity variables (e.g., sharing a common language, having a prior colonial relationship or a common colonizer). The database also indicates whether country pairs are members of regional trade agreements or the EU. Except for bilateral distance, all gravity indicators are dummies corresponding to the description of the respective gravity characteristics.

These variables are merged with bilateral trade data for the regression analysis in the next section.

5 Impact of NTMs

5.1 Empirical Strategy

We analyze empirically the impact of NTMs on import flows by estimating an augmented gravity equation using a pseudo Poisson maximum likelihood (PPML) estimator (Santos Silva & Tenreyro, 2006).[11] The interpretation of coefficients from the PPML estimator is analogous to that of elasticity estimates from the usual log-linear specification. Our empirical model is:

$$ImportFlow_{ijk} = \exp\left(\beta_1 NTM_{ijk} + \beta_2 Tariff_{ijk} + Gravity_{ij}\beta + \delta_i + \delta_j\right) + \varepsilon_{ijk}$$

Where *i*, *j*, *k* corresponds to the exporter, importer, and HS-6 level product.

[11] The rationale for choosing PPML estimator is to address issues such as potential selection bias and the presence of heteroscedasticity, as is common in bilateral trade data. Estimation methods such as ordinary least squares (OLS) excludes zero flows. Moreover, log-linear models estimated by OLS, for example, may be biased and inefficient in the presence of heteroskedasticity. A Breusch-Pagan test performed on our sample suggests that our data is heteroscedastic. The Poisson estimation method proposed by (Santos Silva & Tenreyro, 2006) avoids biased estimation results by correcting for heteroscedasticity in the error term, can handle the large presence of zero import observations, and is consistent in the presence of fixed effects. For a review of literature on gravity estimation issues and procedures, see (Shepherd, 2016).

The dependent variable $ImportFlow_{ijk}$ represents the dollar value of country *j*'s imports from country *i* for product *k*. The main variable of interest is NTM_{ijk} which is a count of NTMs imposed by importer *j* on exporter *i*'s product within every HS-6 product line.

Other independent variables are the following: $Tariff_{ijk}$ represents the logarithm of the average tariff applied by importer *j* on exporter *i*'s HS-6 product *k* plus one. $Gravity_{ij}$ represents a set of gravity variables related to *i* and *j* (see above). δ_i and δ_j represent exporter-industry and importer-industry fixed effects ("industry" refers to the HS2 product level) that control for country-specific and HS-2 industry-specific effects. ε_{ijk} reflects the error term, clustered at the importer-exporter pair.

By controlling for pair fixed effects, we control for potential sources of the omitted variable bias and rely on the cross-country variation within country-industry pairs[12] to identify the impact of trade policies. Traded goods to construct RE infrastructure involve industries such as metal, aluminum, plastics, glass and steel, as well as more sophisticated ones such as turbines, motor engines and heat pumps, and generators and transformers. By including industry-specific importer and exporter fixed effects, we control for industry characteristics related to market structure (e.g., size of industry), intensity of trade, and product differentiation between countries. For example, countries may have comparative advantages in certain industries and can be affected by agglomeration effects and availability of domestic inputs. Or, lack of intermediate inputs in the domestic economy within these industries can increase import demand in certain RE products.

Standard errors for all regressions are clustered at the country-pair level. This accounts for correlation patterns in either directions between importer and exporter, essentially allowing the error term to have a fixed bilateral element common to country pairs *i* and *j*.

5.2 Regression results and Discussion

Using import values as the dependent variable, Table 2 reports detailed results for a series of regressions on the impact of NTMs and tariffs on trade performance. Column 1 shows a statistically significant relationship in the trade elasticity of these variables. These results confirm that NTMs, as well as tariffs, are important trade costs that cannot be overlooked. They also confirm that the negative impact of NTMs across broad product groups, alluded to in the Literature Review section, holds also for RE goods. The coefficient for tariffs (in logs) is -0.679. This means that a 10% increase in tariffs is associated with an estimated 6.8% decrease in trade flows. The coefficient for the number of NTMs is -0.050. Hence, when a country imposes an additional NTM, this is associated with RE sector imports lower by an estimated 4.9% (i.e., e^ (-0.050)-1) *100).

Based on these coefficients, we can also calculate an estimate of the cost of NTMs in tariff terms, at which both measures induce the same change in imports. Taking the ratio of the estimated coefficients in Column 1 of Table 2 for NTMs and tariffs shows that one additional NTM is equivalent to a 10% tariff increase of 0.72 times (i.e., 4.9 divided by 6.8). This means that the negative impact of one additional NTM is equivalent to about three-quarters of a 10% tariff

[12] There are 888 importer-industry fixed effects (111 importers*8 industries) and 1512 exporter-industry fixed effects (189 exporters*8 industries).

increase. This is the average cost related to one additional NTM when a RE good is imported, relative to a counterfactual situation of no increase in NTMs.[13]

Column 2 of Table 2 differentiates between technical and nontechnical NTMs—they both have negative impact on trade flows. Controlling for non-technical NTMs, compliance costs in the form of technical NTMs is associated with reduced trade of 3.5% (i.e., e^ (-0.036)-1) *100). Controlling for compliance costs (technical NTMs), additional non-technical NTMs is linked to a trade reduction of 32% (i.e., e^ (-0.383)-1) *100). While the magnitude of the coefficient is much larger for non-technical NTMs, the confidence interval is wider—testing for the equality of coefficients for technical and non-technical NTMs shows that they are not statistically different (chi-squared at 2.53; p-value at 0.1114), hence we cannot rule out that both NTM types have actually the same effect on import performance.

Across all regressions, gravity-related variables display the expected results. For example, sharing a land border and having a regional trade agreement intensifies trading between countries, while distance inhibits bilateral trade flows. In terms of cultural proximity, sharing the same language is correlated with higher flows, although existence of a previous colonial relationship between partners does not seem to have an impact.

We also control for intra-EU trade using EU importer-exporter dummy. Harmonization of EU rules in terms of tariffs and NTMs (wherein EU members are expected to have zero tariffs and NTMs between one another's trade) may be a special case that the RTA dummy is unable to capture. Results show that the coefficient is negative and statistically significant, indicating that intra-EU trade flows of RE infrastructure is lower than the rest of the world. Indeed, contrasting intra-EU and extra-EU trade flows[14] shows that the latter is 60% larger: in 2016, aggregate trade value was USD70 billion in the former and USD112 billion in the latter. Not controlling for intra-EU trade would likely result in a downward bias in the coefficients for tariffs and NTMs.

Table 2: Regression Results

	(1)	(2)	(3)
	Dependent variable: Import flows in 2016		
NTMs	-0.050**		
	[0.020]		
Technical NTMs		-0.036**	
		[0.017]	
Nontechnical NTMs		-0.383*	
		[0.222]	
ln (tariffs +1)	-0.679***	-0.682***	
	[0.080]	[0.080]	
NTMs * Developed country exporters			-0.045**
			[0.019]

[13] Note however that because compliance costs may differ at exporting country and product levels, there can be variations in average costs of NTMs (Kee & Nicita, 2016). This is not further explored in this paper.
[14] Extra-EU flows refers to either the following: when importer is an EU member and exporter is non-EU, or when exporter is an EU member and importer is not.

NTMs * Developing country exporters			-0.055**
			[0.025]
ln (tariffs +1) * Developed country exporters			-0.583***
			[0.072]
ln (tariffs +1) * Developing country exporters			-0.757***
			[0.094]
Common border	0.288***	0.287***	0.300***
	[0.073]	[0.073]	[0.076]
Common language	0.147*	0.148*	0.127
	[0.078]	[0.078]	[0.081]
ln (distance)	-0.778***	-0.779***	-0.778***
	[0.045]	[0.045]	[0.047]
Colonial relationship	0.143	0.142	0.140
	[0.119]	[0.119]	[0.122]
Common colonizer	-0.075	-0.080	-0.092
	[0.184]	[0.183]	[0.186]
RTA	0.145**	0.144**	0.154**
	[0.070]	[0.070]	[0.071]
EU member	-0.931***	-0.861***	-0.837***
	[0.171]	[0.161]	[0.175]
Observations	1,015,656	1,015,656	1,015,656
R-squared	0.729	0.729	0.729

Standard errors in brackets are clustered by importer-exporter pair.
*** p<0.01, ** p<0.05, * p<0.1

While we now know that the prevalence of NTMs, on average, is likely to create distortive effects on trade in RE infrastructure, we further explore whether NTMs and tariffs have different impact for exporting countries by their level of development; see Column 3 of Table 2.

Interacting NTMs and tariffs with both developed and developing exporter dummies leads to the following results: NTMs imposed on developing economies are associated with trade reduction of about 5.5% compared with 4.5% reduction for NTM-affected imports from developed countries. However, the difference between these coefficients is not statistically significant, suggesting that NTMs may actually have a similar adverse effect on import performance across countries. Regarding tariffs, trade is reduced more for goods that come from developing countries compared with those from developed economies (-0.757 versus -0.583). The difference between these regression coefficients is statistically significant, suggesting that the adverse impact of tariffs may be more acute for developing exporters than developed ones.

One possible reason why tariffs affect developing country exports more is the volume channel: developing countries are exporting more products protected by tariffs. As much as 80% of developing countries' exports is subject to tariffs, compared with 56% of exports by developed countries. Also, a significant share (about 60%) of developing countries' exports go to other developing countries, which tend to implement higher tariff rates. The adverse impact of tariffs on trade calls for further reductions of RE-related tariffs, especially among developing countries.

Taken together, results show that NTMs and tariffs make it more challenging for countries to export their RE goods regardless of the level of development. Moreover, developing economies face larger consequence on trade, compared with developed exporters, when subjected to tariffs.

5.2.2 Robustness checks

The set of fixed effects controls as well as gravity variables can control for a significant portion of the omitted variable bias. These variables control for observed policy factors (such as common trade agreements, language, etc.) and country-sector specific characteristics that affect both NTMs and import flows.

We further conduct two robustness exercises to address certain issues. First, we include country-pair fixed effects.[15] This accounts for unobservable bilateral characteristics between country pairs. Also, the country pair fixed effects absorb all time- and industry-invariant sources of variation in trade that are specific to every country pair. In sum, country-pair fixed effects account for time-invariant covariates of gravity characteristics such as geographic distance, language, etc. as well as unobserved time invariant sources of variation. These fixed effects also partly address endogeneity due to reverse causality concerns: for example, countries overregulate by imposing NTMs (or tariffs) on goods and sectors with already-large import flows, especially when it is considered a sector of importance for the local economy (UNCTAD, 2018).

Our estimation equation becomes:

$$ImportFlow_{ijk} = \exp(\beta_1 NTM_{ijk} + \beta_2 Tariff_{ijk} + \delta_i + \delta_j + \delta_{ij}) + \varepsilon_{ijk}$$

Where fixed effects are importer-HS2, exporter-HS2 and country-pair fixed effects.

As can be seen, when country-pair fixed effects are included, time-invariant gravity variables such as distance and common border are absorbed, and gravity equation drops these variables. Table A 2 presents the results for these regressions. In all cases, the negative signs and statistical significance hold.

Second, to control for year-specific effects, we re-estimate Column 1 of Table 2 using time periods *t-1* and *t+1*, where *t* is the year 2016. Results confirm baseline specifications using *t-1* (2015) and *t+1* (2017) trade data, although results using 2017 data are weaker and the coefficient for NTMs is smaller. Table A 3 presents these results.

5.2.3 Limitations of the regression results

Fixed effects implemented in this paper may not fully control for endogeneity arising from reverse causality. Thus, if endogeneity is unaccounted for (e.g., by using the instrumental variable approach), estimates can have a downward bias (UNCTAD, 2018). This is considered a limitation of the study, given difficulties in finding instruments at the product level, and is an area for further research.

[15] Because we have a cross-sectional data sample, gravity bilateral pairs are dropped with the inclusion of such fixed effects.

6 Conclusion

This paper contributes to the existing RE and trade policy literature by estimating the impact of trade policies, focusing on NTMs and tariffs, on international trade in RE infrastructure goods. Regression results confirm that NTMs and tariffs have an adverse impact on RE goods import performance. We also show that NTMs and tariffs are trade-restrictive for exporting countries regardless of their development status, but exposure to tariffs is more detrimental for developing countries than for developed ones.

Overall, our analysis points to the need to lower trade costs in order to support RE development and help reach the SDGs. Specifically, countries may effectively boost trade flows by further reducing excessive protectionist measures. In line with the East Asian industrialization experience (e.g., Japan, Singapore, South Korea), countries have grown through key measures that facilitate foreign trade and investments, such as enhancing productive infrastructure. Possible alternatives to achieve similar economic goals without protectionist measures could be considered, such as improving domestic manufacturing capabilities of RE sectors through technological skills trainings (OECD, 2015) and harmonizing RE infrastructure standards.

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Annex

Table A 1: Data Sample

Importer	NTM Year	Prevalence score	Importer	NTM Year	Prevalence score
AFG	2012	0.18	JPN	2016	2.74
ARE	2015	2.11	KAZ	2017	1.20
ARG	2016	0.00	KGZ	2017	3.25
ATA	2016	0.03	KHM	2015	2.49
AUS	2016	0.38	KWT	2015	0.00
AUT	2016	2.42	LAO	2015	1.10
BEL	2016	2.63	LBN	2016	1.39
BEN	2014	0.00	LBR	2014	1.48
BFA	2012	0.00	LKA	2016	1.50
BGR	2016	1.89	LTU	2016	1.75
BHR	2015	0.52	LVA	2016	1.41
BHS	2015	0.00	MAR	2016	0.55
BOL	2016	0.42	MEX	2016	1.40
BRA	2016	8.83	MLI	2014	0.00
BRB	2015	0.00	MLT	2016	1.98
BRN	2015	0.00	MMR	2015	0.28
CAN	2015	0.06	MRT	2015	0.00
CHE	2015	0.79	MYS	2015	1.11
CHL	2016	1.61	NER	2014	0.00
CHN	2016	2.47	NGA	2013	2.67
CIV	2012	0.00	NIC	2016	0.00
CMR	2015	0.00	NLD	2016	2.55
COL	2016	0.42	NPL	2012	0.26
CPV	2014	0.00	NZL	2016	1.65
CRI	2016	0.00	OMN	2015	1.01
CUB	2016	0.25	PAK	2016	0.00
CYP	2016	1.64	PAN	2016	0.05
CZE	2016	2.40	PER	2016	0.07
DEU	2016	2.97	PHL	2015	2.34
DMA	2015	0.00	PNG	2016	0.80
DNK	2016	2.23	POL	2016	2.31
DZA	2016	1.10	PRT	2016	2.15
ECU	2016	0.93	PRY	2016	0.09
ESP	2016	2.67	PSE	2014	0.50
EST	2016	1.93	QAT	2016	2.22
ETH	2015	1.45	ROU	2016	1.95
FIN	2016	2.49	RUS	2016	0.62
FRA	2016	3.00	SAU	2016	4.98
GBR	2016	2.87	SEN	2012	0.07
GHA	2014	3.10	SGP	2015	0.42
GMB	2013	0.00	SLV	2016	0.00
GRC	2016	1.85	SUR	2015	0.00
GRD	2015	0.05	SVK	2016	2.21
GTM	2016	0.00	SVN	2016	1.87
GUY	2015	0.26	SWE	2016	2.49
HKG	2016	0.00	TGO	2014	0.00
HND	2016	0.00	THA	2015	0.01
HRV	2016	1.76	TJK	2015	0.04
HUN	2016	2.25	TTO	2015	1.20
IDN	2015	0.58	TUN	2016	1.05
IND	2012	0.45	TUR	2016	0.91
IRL	2016	2.47	URY	2016	0.16
ISR	2016	0.00	USA	2014	1.19
ITA	2016	2.97	VEN	2016	1.80
JAM	2015	0.17	VNM	2015	0.13
JOR	2016	0.11			

Source: UNCTAD TRAINS.
Note: We considered all NTM-reporting countries across all product groups. Thus, for countries which have zero ratios, these countries may have reported NTMs for other non-RE products. They are kept in the analysis. Prevalence score counts the number of different measures that apply to any single product. This is essentially the average number of NTMs affecting an imported product. Even when data collection year is 2017, the implementation year for all NTMs is 2016 or earlier.

Table A 2: Regression Results with Country Pair Fixed Effects

	(1)	(2)	(3)
Dependent variable: Import flows in 2016			
NTMs	-0.057***		
	[0.020]		
Technical NTMs		-0.043***	
		[0.016]	
Nontechnical NTMs		-0.373*	
		[0.223]	
ln (tariffs +1)	-0.679***	-0.681***	
	[0.080]	[0.080]	
NTMs * Developed country exporters			-0.042**
			[0.019]
NTMs * Developing country exporters			-0.064**
			[0.031]
ln (tariffs +1) * Developed country exporters			-0.481***
			[0.075]
ln (tariffs +1) * Developing country exporters			-0.850***
			[0.107]
Observations	435,103	435,103	435,103
R-squared	0.717	0.717	0.718

Standard errors in brackets are clustered by importer-exporter pair.
*** p<0.01, ** p<0.05, * p<0.1

Table A 3: Regression Results for 2015 and 2017 Trade Flows

Dependent variable: Import flows	(a1) Year: 2015	(a2) Year: 2017
NTMs	-0.052**	-0.025^{+}
	[0.024]	[0.017]
ln (tariffs +1)	-0.588***	-0.664***
	[0.055]	[0.105]
Common border	0.305***	0.208**
	[0.073]	[0.087]
Common language	0.121	0.261***
	[0.078]	[0.081]
Common colonizer	0.024	-0.167
	[0.171]	[0.195]
ln (distance)	-0.780***	-0.778***
	[0.048]	[0.050]
Colonial relationship	0.172	0.253**
	[0.131]	[0.124]
RTA	0.181**	0.096
	[0.076]	[0.085]
EU member	-0.892***	-0.890***
	[0.178]	[0.192]
Observations	1,013,502	989,939
R-squared	0.734	0.711

Standard errors in brackets are clustered by importer-exporter pair.
*** p<0.01, ** p<0.05, * p<0.1, $^{+}$ p<0.15