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ORIGINAL ARTICLE

Who Embraces Technical Barriers to Trade? The Case of European REACH Regulations

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Abstract

Technical Barriers to Trade are on the rise at a time when the ghost of protectionism looms large across the world economy. They are allegedly trade restrictive and some of them are more burdensome than others, particularly to foreign suppliers. The leading question of this study is who embraces technical barriers to trade better than others and why. This study examines how different countries have reacted to the REACH regulations of the European Union and what factors have motivated some, if not all, of them to harmonize their domestic policies with REACH regulations. With a random-effects ordered logistic regression analysis, this study finds strong statistical support for two out of three diffusion mechanisms – that is, transnational communication and competition pressure for exports market. The causal relationship between intergovernmental institution and the level of harmonization is found statistically insignificant. These findings imply that technical regulations, if understood correctly through communication and/or motivated by strong commercial incentives, can create upward pressure for global regulatory harmonization.

1. Introduction

Technical Barriers to Trade (TBTs) are on the rise at a time when the ghost of protectionism looms large across the world economy. The number of TBTs notified to the World Trade Organization (WTO) has been setting a record high each year since the trade organization was established in 1995. This stands in sharp contrast to the fact that tariff barriers have been reduced to the point at which actual tariff rates are approaching zero in advanced countries. According to the 2017 WTO annual review of the implementation and operation of the TBT Agreement, a total of 82 member economies submitted 2,585 TBT notifications compared to an average of 2,179 submissions in the previous five-year period (G/TBT/40, para. 3.1).

Technical regulations are inherently trade restrictive. They impose specific burdens – such as labelling requirements, standards on technical specifications, and quality standards – not only on domestic producers but also on foreign suppliers. On the surface, all the objectives of technical regulations look legitimate.[1] Underneath the surface, however, some regulations are more burdensome than others, particularly to foreign suppliers. It was no wonder that the 2017 TBT

[1]All the TBT notifications to the WTO in 2017 can be categorized as follows by their objectives: (1) protection of human health or safety, 1,233 (43.5%); (2) quality requirements, 448 (15.8%); (3) protection of the environment, 322 (11.4%); (4) prevention of deceptive practices and consumer protection, 290 (10.2%); (5) consumer information and/or labelling, 231 (8.2%); (6) others, 103 (3.6%); (7) harmonization, 91 (3.2%); (8) protection of animal or plant life or health, 71 (2.5%); (9) reducing trade barriers and facilitating trade, 38 (1.3%); (10) national security requirements, 6 (0.2%); and (11) cost saving and productivity enhancement, 1 (0.04%) (G/TBT/40, para. 3.17).

Committees discussed 178 Specific Trade Concerns (STCs), the largest number ever recorded. Among those cases, 151 have been raised repeatedly, indicating their unrelenting nature.

The United States (US) and the European Union (EU) stand out as the most avid players in terms of technical regulations, leading them to be ranked as the first and third, respectively, in the TBT hierarchy. They are also leading the way in which the norms of technical regulations are formed and implemented (Kelemen and Vogel, 2010; Young, 2015; Filipec, 2017; Michida, 2017).

Most notably, the EU adopted strong regulations on chemicals in 2007, commonly known as the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH). Its principle of 'No Data, No Market' is known to be one of the strictest regulations on chemical substances and chemical-containing products. Chemicals covered by this regulation are not allowed to enter the European market without compliance with REACH requirements (Heyvaert, 2009: 111–112; Naiki, 2010: 182–183).

Since the EU's notification of its implementation plan as a TBT in 2003, the REACH has caused a series of concerns for the EU's trading partners.[2] During the period from 2003 to 2017, a total of 36 countries raised 329 STCs on the REACH at the WTO TBT Committee sessions. Much ink has thus been spilled on the negative impacts of REACH on international trade. For instance, it was transcribed in the TBT Committee records of November 2004 that the member countries were concerned that 'the REACH would be more difficult for non-EU manufacturers to comply with than for EU manufacturers' (G/TBT/M/34, para. 23). The rest of the comments have not diverged from this point: REACH could put foreign suppliers under more trade-restrictive conditions than domestic producers (e.g. G/TBT/M/35, paras. 15–24; G/TBT/M/36, paras. 10–17; G/TBT/M/39, paras. 45–52; G/TBT/M/40, paras. 43–52).[3]

Some concerns notwithstanding, new regulations encourage new technologies and the more efficient allocation of scarce resources under certain conditions (Porter, 1990; Porter and Linde, 1995). As a matter of fact, some foreign suppliers have better adjusted themselves to the new trade environment than others, as indicated by the growing revenues of chemical exports to the EU during the period of 2007–2017. For instance, the average annual growth rates of South Korea, China, and Taiwan were 15%, 11%, and 9%, respectively, while the world average remained at 4% during the same period.[4] This observation raises a puzzling question: who embraces technical barriers to trade better than others and why?

This study begins with this question and aims to examine how different countries have reacted to REACH regulations and what factors have motivated some, if not all, of them to harmonize their domestic policies with REACH regulations. Of course, an individual company undertakes adjustment to a new regulatory environment in the export market through innovation. Nevertheless, the regulatory policy of export countries is equally, or even more, important than individual corporate responses. From a foreign government's perspective, a voluntary convergence of its regulatory policy is crucial for maintaining and encouraging the competitiveness of its exporting companies in the European market. Other things being equal, regulatory harmonization and convergence can promote trade and facilitate innovation (Blind, 2001; Blind and Jungmittag, 2005; De Frahan and Vancauteren, 2006; Portugal-Perez et al., 2010; Vigani et al., 2012).

The remainder of this study unfolds in four sections. Section 2 discusses the theoretical background of regulatory harmonization as a source of adaptive innovation on the part of an exporting country. TBTs exist due to differences in standards, technical regulations, and conformity

[2]WTO members who adopt new technical regulations are required to inform the TBT Committee of their plans in advance. The EU notified other members of its adoption plan four years ahead of its implementation in 2007.

[3]For instance, having raised the STC regarding the REACH 32 times, Australia mentioned that 'although the REACH legislation required registration of chemical products regardless of origin, the fact that substances already registered in the European Communities were not required to be re-registered when bought by a downstream producer in the European Communities was likely to put imported products at a competitive disadvantage' (G/TBT/M/36, para. 11).

[4]This was calculated by the authors using UNCOMTRADE data extracted from HS Nos. 28–38 chemical products, except for No. 30, since pharmaceutical products are not subject to the REACH.

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assessment. They can be trade restrictive unless properly harmonized. This section identifies three distinct mechanisms that induce the harmonization of technical regulations: communication-based, institution-based, and competition-based harmonization.

Section 3 identifies three causal mechanisms of policy convergence that are relevant for the EU REACH case: transnational communication, intergovernmental institutions, and competition for export markets. Based on the extant convergence literature, this section lays out a theoretical foundation for the empirical work that follows.

Section 4 conducts a random-effects ordered logistic regression analysis to test the relationship between the three causal mechanisms and the level of regulatory harmonization to the REACH. The estimation results indicate strong statistical support for two diffusion mechanisms – communication and competition – as predicted.

Section 5 summarizes key findings and draws policy implications. It highlights the fact that TBTs can promote regulatory innovation in some exporting countries when relevant factors exist, particularly the two convergence mechanisms: transnational communication, and competitive pressure for export markets.

2. Mechanisms of Regulatory Harmonization

TBTs include a wide variety of measures that countries adopt to regulate 'product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory' (technical regulation) or to provide 'rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory' (standard) (TBT Agreement Annex 1.1). These measures are usually used for public purposes such as regulating markets, protecting consumers, and/or preserving natural resources.

In consequence, if not in intent, they can also be used to discriminate against imports in order to protect import-competing domestic industries. Country-specific technical regulations may give domestic producers advantages by imposing mandatory standards with which foreign suppliers find it more difficult to comply (Swann et al., 1996: 1298–1299). As foreign suppliers are deterred from entering the market, domestic producers will increase their supplies and enjoy additional 'producer surplus', which is transferred from foreign suppliers.

Foreign governments have two options. They can either complain about the trade restrictiveness of importing countries' new regulations and challenge them at the WTO[5] or adopt similar regulations on their own to mitigate the adverse effect of new barriers to trade. The latter approach – regulatory harmonization – is of interest to this study. By adopting similar measures at home, foreign governments can induce their exporting producers to comply with a new regulatory environment abroad more easily.

Then why do some exporting countries facilitate regulatory harmonization and market-conforming policies instead of settling the differences through international arbitration? Why do some countries embrace otherwise trade-restrictive regulations imposed by other countries? Based on the existing regulatory harmonization and convergence literature,[6] this study identifies

[5]In the meantime, the precise meaning of trade restrictiveness remains ambiguous. In many WTO disputes, the existence or degree of the trade restrictiveness of a measure under challenge is neither clearly defined nor thoroughly addressed, although the question of whether a measure is more trade restrictive than necessary is crucial to the legality of such measures (Voon, 2015).

[6]This study uses the three terms – harmonization, convergence, and diffusion – interchangeably, tending to prefer the first one in the specific context of REACH, whereas the latter two tend to be used in the context beyond REACH. Whichever terms are used, they all refer to the process and result of making policy contents, instruments, and/or goals similar with each other 'with an intent to deal with common policy problems' (Bennett, 1991: 218).

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three distinct but related mechanisms through which regulatory harmonization and policy convergence take place *vis-à-vis* REACH regulations.[7]

First, transnational communication can facilitate policy convergence by disseminating best policy practices. Regular meetings and information sharing among governments can motivate them to emulate policy measures that work well in other countries (DiMaggio and Powell, 1991; Simmons and Elkins, 2004: 175). Most notably, Allport's (1954) contact hypothesis, also known as intergroup contact theory, posits that under certain conditions interpersonal contact has a positive impact on relations between individuals and groups, and that close contact effectively reduces prejudices between them. This can also be extended to interstate relations. The simple act of intergovernmental communication can facilitate international cooperation (Haas, 1964). The key mechanism at work is a better understanding and appreciation of others and their ways, customs, practices, and concerns. Policy diffusion can be further accelerated if intergovernmental communication channels are formalized rather than remaining *ad hoc* or temporary features that may lapse over time (Strang and Meyer, 1993; Kern et al., 2001). They can also take the form of loose networks of policy experts (Haas, 1992).[8]

Second, regime-based harmonization can emerge when like-minded countries work together to address common global or regional problems such as climate change, biodiversity, and epidemic diseases. Due to the cross-border nature of such problems, national efforts alone fall short of resolving the negative externalities of certain issues (Holzinger et al., 2008: 557). Increased communication and connectivity between government officials and non- governmental actors can help develop an international regime, defined as 'sets of implicit or explicit principles, norms, rules and decision–making procedures around which actors' expectations converge in a given area of international relations' (Krasner, 1982). If there is an international regime or institution around which countries' expectations converge, cooperation and collaboration among like-minded countries would become much easier. In particular, dense networks of intergovernmental organization (IGO) membership are known to contribute to the peaceful settlement of mutual conflicts because commonly acquired and shared knowledge through participation in IGOs can reduce uncertainty and the transaction cost of international interactions (Drezner, 2001: 60).[9] In fact, the pace of network building, official and unofficial, formal and informal, and

[7]Among the policy diffusion mechanisms found in the extant literature, a coercion mechanism through which changes in incentives are wrought by powerful actors is not considered here because of the intrinsic nature of technical regulations – namely, trade restrictiveness. Other things being equal, there is no incentive for an importing country to force an exporting country to quickly comply with its new regulations.

[8]Of course, the communication mechanism does not necessarily work if there is no social capital such as 'shared norms, values, beliefs, trust, networks, social relations, and institutions that facilitate cooperation and collective action for mutual benefits' (Bhandari and Yasunobu, 2009: 480). The lack of social capital may foster a sense of dependence and inequality between individuals and groups, particularly in an anarchic setting (Hirschman, 1980 [1945]). For the critics of contact theory, it does not matter whether individuals and groups communicate with each other because increased contact creates potential opportunities for disagreement. For them, the settlement of conflict depends on the structural conditions rather than the attributes of individuals or groups themselves (Waltz, 1979). In addition, governments under anarchy must worry about the relative gains accruing from international cooperation because those asymmetric gains might later be turned into military advantage (Gowa, 1994). Some studies found that contact between individuals reduces prejudices, but increased contact between countries is likely to result in conflict (Forbes, 1997).

[9]In a similar vein, neoliberal institutionalists argue that international regimes modify state incentives in favour of cooperation 'by lengthening the shadow of the future, increasing the reputational costs for cheating, monitoring compliance, facilitating issue linkages, and offering salient solutions' (Keohane, 1984 cited in Koo, 2010: 37). Critics of regime theory have argued that regimes are often defined too broadly and imprecisely to generate empirically testable hypotheses. For them, international regimes such as the WTO, World Bank, and International Monetary Fund are ideologically, and practically, biased in favour of a hegemon, namely the United States (Gilpin, 2001: 82–92). Susan Strange, among others, criticizes that the study of regimes is: (1) for the most part 'a fad … making little in the way of a long-term contribution to knowledge'; (2) 'imprecise and woolly'; (3) 'value-biased, as dangerous as loaded dice'; (4) 'underemphasizing the dynamic element of change in world politics'; and (5) 'narrowminded, rooted in a state-centric paradigm' (Strange, 1982: 479). As Gilpin

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bilateral and multilateral, has grown substantially in the area of technical regulations over the past decades.[10]

Third, regulatory harmonization can also result from fierce competition for export markets. This competitive pressure can work in two opposite directions. It can facilitate the 'regulatory race to the bottom' in which countries keep lowering regulatory standards to reduce production costs (Dobbin et al., 2007: 457–460).[11] Alternatively, the 'regulatory politics of vortex' can induce rivals in the export market to adopt higher technical standards to better respond to foreign consumer preferences for eco-friendly and high-quality products (Vogel, 1997; Holzinger and Knill, 2004; Holzinger et al., 2011; Perkins and Neumayer, 2012). This is particularly true of large export markets such as the EU. As Drezner (2005: 843) notes, 'the larger the economy, the stronger the pull for producers to secure and exploit market excess. As demand increases, firms will have greater incentives to mirror that market's preferences'. Well-informed governments vying for a fixed quantity of trade have little choice but to comply with new technical regulations to keep their exports competitive, especially when other countries competing in the same export market have already done so (Dobbin et al., 2007: 457). Prakash and Potoski (2006) present empirical evidence connecting the market size of an importing country to the regulatory harmonization of the exporting country. They found that trade encourages exporting countries to adopt ISO 14001, the high-level environmental standard, when their major export markets have already adopted that standard.

3. Data and Methods

3.1 Estimation Model

This study uses a panel data regression method for 78 WTO member countries with consistent records of exporting chemical products to the EU during the period of 1995–2017. Twenty-seven EU countries are subject to examination, except for Croatia, which joined the EU in 2013 after the EU REACH regulation came into force in 2007. Meanwhile, Iceland and Norway are included in the analysis as EEA (European Economic Area) countries that are subject to the REACH. The UNCOMTRADE database is used as it classifies total exports by product categories according to the harmonized system (HS) code. Export data on chemical products numbered 28–38 are extracted, with the exception of No. 30 because pharmaceutical products are exempted from the application of the REACH.

This study modifies the gravity model to estimate the degree to which exporting countries harmonize their regulatory policies with the REACH at the bilateral level. There are a number of studies that take advantage of the extensive applicability of the gravity model when measuring the trade policy effects of tariff and/or nontariff measures on a pair of trading partners (Otsuki et al., 2001; Anders and Caswell, 2009; Liu and Yue, 2009; Bao and Qiu, 2010; Ferro et al., 2014; Crivelli and Groeschl, 2016; Koo and Kim, 2018). Even in the WTO-UNCTAD guidance book, the gravity equation is introduced as a proper analytical tool for trade policy analysis (WTO and UNCTAD, 2012: 103–105).

(2001: 85) notes, it is not surprising that very few non-American scholars have contributed to its development with positive inclinations.

[10]According to the International Organization for Standardization (ISO), from the year 1996, the starting year of the archive, to the latest year of 2018, the total number of international standards and standard-type documents in technical sectors more than doubled from 10,745 to 22,467, and the number of newly published ones has gradually increased during the last five-year period. In 1996–2018, the number of different national standards bodies participating in the ISO increased from 120 to 162, and they are selling and adopting the ISO standards nationally (www.iso.org/iso-in-figures.html).

[11]Ecological economists argue that excessive competition for foreign investments causes severe environmental damage because big multinational firms can induce governments to reduce environmental regulations by threatening to relocate their polluting production facilities to countries where environmental regulations are less rigid. Some empirical evidence has shown that fierce competition for capital leads to a regulatory race to the bottom in some developing countries (Massey, 1999; Kunce and Shogren, 2002; Copeland and Taylor, 2003).

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The dependent variable of this study is measured on a nominal scale ranging from 0 to 4. As equal distances between the levels cannot be reasonably assumed for the ordinal dependent variables, we can use an ordered logistic regression model. With a random-effects ordered logistic regression model, this study estimates parameters that best describe the extent of regulatory harmonization adopted by different countries in accordance with the REACH. Unlike fixed-effect estimators, the parameters of the random-effect model can explain the variance of the dependent variable between countries as well as within a country. To address the heteroskedasticity of error terms, this study utilizes robust standard errors clustered by country. Five different regression models have been estimated in a hierarchical order from the base (only control variables included) to the full model (all explanatory variables included) to show that the estimates do not change significantly.

In this model, it is posited that a five-point scale ordered dependent variable Y_{it} is derived from the latent continuous variable Y_{it}^*, such that

$$Y_{it} = \begin{cases} 0 & \text{if} \quad Y_{it}^* \leq T_0 \\ 1 & \text{if} \quad T_0 < Y_{it}^* \leq T_1 \\ \vdots & \\ 4 & \text{if} \quad T_3 < Y_{it}^*. \end{cases}$$

where $T_{0.1.2.3}$ represents a set of four thresholds or cut points to classify the country's regulatory harmonization status into five different levels. In regard to the latent variable Y_{it}^*, the whole latent regression model can be defined as

$$Y_{it}^* = X_{it}\beta + \upsilon_i + \varepsilon_{it}$$

or specified as:

$$\begin{aligned} Y_{it}^* = {} & \beta_1 communication_{it} + \beta_2 institution_{it} + \beta_3 competition_{it} + \beta_4 REACH\ impact_t \\ & + \beta_5 \ln(GDP\ per\ capita_{it} \times EU\ GDP\ per\ capita_t) \\ & + \beta_6 \ln(population_{it} \times EU\ population_t) + \beta_7 EU\ GSP_{it} + \beta_8 EU\ FTA_{it} + \upsilon_i + \varepsilon_{it} \end{aligned}$$

where υ_i is independent and identically distributed $N(0, \sigma_\upsilon^2)$, and explains unobservable individual specific effects which do not change by time (random effects). The error term ε_{it} is posited to follow logistic distribution with mean zero and variance $\pi^2/3$, which is independent of υ_i (Green and Hensher, 2010). The parameter β_k can be obtained using maximum likelihood estimation (MLE) and assuming conditional distribution for the dependent variable with probability of observing outcome m (where $m = 0, 1, 2, 3, 4$).

The logistic model estimates the odds ratio (OR) of an outcome m (e.g., the adoption of a REACH-like integrated chemical control system) occurring relative to the other category (e.g., minimal or no chemical regulations). The OR can be obtained by exponentiating the ordered logit coefficients ($exp(\widehat{\beta_k})$). The log-odds (logit) of cumulative probabilities for categories of m are modelled as linear functions of independent variables. If we view the change in the levels of the dependent variable in a cumulative sense and interpret the coefficients in odds, we are comparing the outcome in categories greater than m versus the one in categories less than or equal to m. In other words, for a one unit change in the independent variable, the odds for cases in a category that is greater than m are the OR times larger than cases in a category that is less than or equal to m.[12]

[12]For example, the coefficient of the first independent variable *communication* in our estimation model as reported in the next section is 0.093 and $exp(\widehat{\beta_1}) = 1.097$. This means that for a one unit increase in *communication*, the logit increases by 0.093, and the odds of obtaining a certain level of the dependent variable (e.g., *convergence* = 4 versus 3, 2, 1, and 0) is 1.097 times or 9.7% larger. In a similar vein, the odds of obtaining *convergence* = 4 and 3 versus 2, 1, and 0 is 1.097 times or 9.7% larger.

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3.2 Dependent Variable

The dependent variable, *convergence*, is a five-point scale ordered variable to measure the degree to which a country adopts chemical regulations in accordance with the EU REACH in a given dyad year. Each scale is derived from a stepwise hierarchy in terms of chemical regulatory harmonization with the REACH. Individual conditions must be met to move up to the next level of scale.

0 = Minimal or no chemical regulations notified to the WTO TBT Committee are present. The exporting country makes no effort at harmonizing its regulatory policy with the EU REACH.

1 = Partial control or standardization of certain chemical substances and products such as fertilizer and detergent are present. The exporting country makes a moderate and partial adjustment without adopting a REACH-like integrated chemical control system.[13]

2 = Relevant regulations used as a basis for a REACH-like integrated chemical control system are present, implying that the exporting country manages and controls chemicals in a comprehensive way. Examples include identification, classification, and labelling requirements for all chemicals. These requirements are a prerequisite for implementing the entire REACH-like procedures.[14]

3 = Regulations requiring registrants to submit and register safety data for all new chemicals to a national regulatory authority are present. The exporting country explicitly applies a REACH-like integrated chemical control system.

4 = Regulations requiring registrants to submit and register safety data for all existing chemicals to a national regulatory authority year after year are present. This level of chemical regulation is fully harmonized with the REACH.[15]

These indicators show the level of stringency of chemical management, which is one of the most important requirements introduced by the REACH. As the regulatory race-to-the-top or race-to-the-bottom literature suggests, any (new) regulations are either upward (more stringent) or downward (less stringent) in terms of the strength of their requirements. Using the TBT notification archive (WTO TBT IMS), all the relevant chemical regulation policies notified by 78 countries as TBTs have been coded accordingly.[16]

[13]The two major advanced economies, the US and the EU, have recognized the necessity of comprehensive chemical control and management to optimize the protection of citizens and have taken the initiative to develop a normative set of regulations for the past decades. The REACH is one of the latest examples (Applegate, 2008).

[14]In this connection, the EU has a regulation called the Classification, Labelling, and Package (CLP) of substances and mixtures. There is much evidence that the CLP has become the basis of the REACH: (1) the classification of chemical substance is one of the most important mandatory procedures of the REACH. The classification and labelling information made pursuant to the CLP must be included in the safety data sheet (SDS), which registrants should submit and register pursuant to the REACH; (2) the CLP classification is used to examine whether a substance is carcinogenic, mutagenic, and toxic to reproduction (CMR), which is subject to the authorization procedure of the REACH; and (3) registrants do not have to notify the European Chemical Agency (ECHA) of their classification and labelling information additionally, since the CLP information stated in the registration dossier is automatically quoted (Herbatschek et al., 2013: 104–105).

[15]The major difference between previous chemical regulations and the REACH is that, unlike the old ones, the REACH requires verification of the safety of existing substances. When designing the REACH, EU legislators considered that over 90% of all the chemical substances circulated in the EU market had been exempted from the old regulations, and thus that there was no information available to control existing chemical substances to the same degree as new ones (Bergkamp and Penman, 2013: 3–4). Exporter countries, including the US and Japan, complained that strengthening the regulatory framework for existing substances would seriously weaken their industrial activities (Naiki, 2010; Botos et al., 2018).

[16]The coding results of individual countries for the period of 1995–2017 are available in the online supplementary materials.

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3.3 Independent Variables

Following the regulatory harmonization and convergence literature, this study hypothesizes the relationship between the degree of regulatory convergence to the REACH and the regulatory harmonization mechanisms.

Hypothesis 1: If an exporting country communicates more with the EU vis-à-vis the REACH than other countries and/or than before, the exporting country is more likely to harmonize its chemical regulations with the REACH than other countries and/or than before.

The communication hypothesis emphasizes information exchange through regular channels. There might be many different paths to transfer and obtain information about potentially better forms of technical regulation. Among them is the TBT Committee that allows WTO members to discuss any STCs that they consider necessary for further information and consultation during the WTO TBT Committee sessions. It is a privilege available for all WTO members pursuant to Article 10 of the WTO TBT Agreement, which demands that a regulation-adopting country answer all inquiries from other members. In terms of regular channels, the WTO holds TBT Committee meetings three times a year.

During the period 1995–2017, the most frequently cited reason for STCs was to 'seek further information and clarification' from TBT-adopting countries, which means that concerned parties are more likely to 'work towards mutually acceptable solutions' (G/TBT/40, para. 3.32) as a result of communication mechanism.[17] In fact, studies have found that many STCs disappear before growing into formal WTO litigations, even though the number of STCs raised each year is on the rise (Horn et al., 2013; Holzer, 2019).[18]

In the estimation model, *communication* cumulatively measures how many times a country has communicated with the EU by raising STCs at STC discussion sessions until a given year during the period 2003–2017. Once an STC is raised, bilateral or multilateral forums for consultation must follow between STC-raising countries and respondent countries. As noted earlier, Australia has submitted the largest number of STCs (32), followed by the US (31), China (27), Japan (24), and Canada (23). A total of 30 out of 78 countries have raised STCs on the REACH and thus communicated with the EU either bilaterally or multilaterally.[19]

Hypothesis 2: If a country has a joint membership with the EU in international IGOs, it is more likely to harmonize its chemical regulations with the REACH than other countries without a joint membership and/or than before when a joint member is absent.

There are two main conditions that stimulate the institutional mechanism to work: one is the pan-regional nature of problems and the other is the presence of an international institution or regime to coordinate matters. The case considered here satisfies the first condition in that the objective of the REACH regulation is to protect people and the environment from the misuse of chemical substances. The case satisfies the second condition as well in that the United

[17]There were 11 different types of concerns raised during the same period: (1) further information and clarification, 371 cases (17.8%); (2) unnecessary barrier to trade, 333 (15.9%); (3) transparency, 308 (14.7%); (4) other issues raised, 250 (12.0%); (5) rationale and/or legitimacy, 232 (11.1%); (6) international standards, 216 (10.3%); (7) discrimination, 170 (8.1%); (8) time to adapt at a 'reasonable interval', 136 (6.5%); (9) non-product-related process and production method (PPM), 43 (2.1%); (10) special and differential treatment (SDT), 23 (1.1%); and (11) technical assistance, 8 (0.4%)

[18]Horn et al. (2013) and Horzer (2019) find that the STC discussion procedure plays a key role in resolving the differences in views on TBT measures. The number of STCs raised has grown during the period of 1995–2017 (G/TBT/42, para.4.2). In contrast, the formal WTO disputes citing the TBT Agreement have remained at a relatively small level – a total of 54 cases during the whole WTO term (www.wto.org/english/tratop_e/dispu_e/dispu_agreements_index_e.htm?id=A22#selected_agreement).

[19]More details about STCs from 30 countries are presented in online supplementary materials.

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Nations (UN) has proactively promoted chemical safety. The United Nations Environmental Program (UNEP) has endorsed a chemical policy framework called the Strategic Approach to International Chemicals Management (SAICM) and led member countries to make a commitment to follow in 2006 (Lee, 2015: 400). Moreover, a multilateral consensus to create globally harmonized chemical classification standards was first formed in 1992. In 2002, it was formally institutionalized as the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) (Winder et al., 2005; United Nations, 2017). According to the United Nations Economic Commission for Europe (UNECE), it is confirmed that 72 countries have implemented the GHS standard so far in various ways.[20] If a country takes part in these regimes and institutions, it is more likely to adopt chemical regulations in accordance with the REACH.

Institution is a binary variable to measure the participation in the UN institution: a value of 1 is given from the year when a country implements the GHS for the first time; it is otherwise 0. A total of 37 out of 78 countries are confirmed to have implemented the GHS standard in their own ways.[21]

Hypothesis 3: If a country has more commercial interests to protect in the European chemical market than other countries or than before, the country is more likely to harmonize its chemical regulations with the REACH than other countries and/or than before.

It is obvious that the European market is attractive enough for many exporters to make the changes necessary to survive in that market. Notwithstanding the strict level of regulation, many countries will be induced to make their regulations harmonized with the REACH. It is no coincidence that major exporters of chemicals such as South Korea, Taiwan, and China have eventually adopted new chemical regulations in line with the REACH (EU SME Center, 2011).

Finally, *competition* measures the share of chemical exports to the EU in a country's total export revenues during 1995–2017. This variable is a proxy to capture the competitive pressure that an exporting country feels from the EU chemical market: if a country depends on the chemical export to the EU market for its national accounts more than others do and/or more than before, it will feel more pressure to maintain its EU market share. It is log transformed to obtain normality as follows:

$$Competition = \log\left(\frac{Total\ annual\ export\ revenue\ of\ chemical\ products\ to\ the\ EU}{Total\ annual\ export\ revenue\ of\ all\ goods\ to\ the\ world}\right)$$

3.4 Control Variables

The estimation model includes a set of control variables that can influence regulatory harmonization. *REACH impact* is a binary variable to measure the effect of policy implementation *per se*. It gives a value of 1 from 2007 when the regulation was implemented (2007–2017); otherwise, it is 9 (1995–2006). This study sets a time lag of one year.

In accordance with the gravity model, two multiplicative variables – $GDP\ per\ capita_{it} \times EU\ GDP\ per\ capita_t$ and $population_{it} \times EU\ population_t$ – are included to capture the joint effect of economic size on the likelihood of stringent chemical regulations to be adopted by an exporting country. Log normalization is used to squeeze the values of GDP and population.

[20]In this regard, the implementation of REACH means that the EU is making a strong contribution to the ongoing international harmonization effort at chemical management. In fact, the EU stipulates a commitment to SAICM in the REACH Preamble (6). Moreover, it has adopted and implemented the regulation of CLP (Classification, Labelling, and Packaging) based on the UN GHS.

[21]The starting years of individual implementations are reported in online supplementary materials.

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Table 1. Descriptive statistics

Variable	Source	M	SD	Min	Max	Grp	Obs
Convergence	WTO TBT IMS	0.62	0.87	0	4	78	1794
Communication	WTO TBT IMS	1.74	5.03	0	32	78	1794
Institution	UNECE, WTO TBT IMS	0.23	0.42	0	1	78	1794
Competition	UNCOMTRADE (USD)	−6.34	2.42	−18.02	−0.67	78	1719[a]
REACH Impact	1995–2006: 0 2007–2017: 1	0.48	0.50	0	1	78	1794
ln(*GDP per capita* × *EU GDP per capita*)	IMF (USD)	18.33	1.49	14.89	21.90	78	1794
ln(*Population* × *EU Population*)	IMF (million people)	8.71	1.83	3.59	13.47	78	1794
EU GSP	European Commission	0.28	0.45	0	1	78	1794
EU FTA	European Commission	0.20	0.40	0	1	78	1794

Note: a. The UNCOMTRADE omits some pieces of data and thus this study considers them as missing values and regresses the model without including them.

EU GSP is a dummy variable, which stands for the generalized system of preferences offered to developing countries by the EU. The concept of GSP is to help the least developed and developing countries stand on their own feet: if a country is designated to be in the GSP group by the EU, it can receive preferential treatments including lower tariff rates and favourable quota. Other things being equal, it is assumed that GSP countries are more likely to adjust their chemical regulations to the REACH than non-GSP countries.[22]

Lastly, *EU FTA* measures the effect of a free trade agreement between an exporting country and the EU on policy convergence. It is coded as 1 if there is a concluded FTA in a given year; otherwise, it is 0. Other things being equal, FTA member countries are more likely to harmonize their regulations with the REACH. Table 1 shows the descriptive statistics of all the variables.

4. Estimation Results

The estimation results show strong statistical support for two diffusion mechanisms – communication and competition – as predicted. These results show who embraces technical barriers to trade better than others and why. Table 2 reports the estimation results.

First of all, the results support Hypothesis 1 that the intergovernmental communication mechanism will facilitate regulatory convergence. In the full model (5), other things being equal, a one-unit increase in communication measures is expected to increase the odds of obtaining *convergence* = $n + 1$ to 1.097 times greater than the odds of obtaining *convergence* $\leqslant n$. This can be interpreted in two different but related terms: (1) if a country has more chances of communication with the EU than other countries, the likelihood of making its regulation more harmonious with the REACH increases more than with other countries ('between' effect); and (2) if a country communicates more with the EU than before, the likelihood of its regulations becoming harmonious with the REACH increases more than before ('within' effect).

[22]The variable includes the status of GSP, GSP+, and EBA (everything but arms). There are some differences in their specific terms and degrees of favour, but the purpose is the same.

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Table 2. Estimation results

Random-effects ordered logistic regression model for panel data (1995–2017)					
	Odds ratio (Robust standard errors)				
Variables	(1)	(2)	(3)	(4)	(5)
Communication	–	1.096** (0.045)	–	–	1.097** (0.050)
Institution	–	–	1.517 (0.775)	–	1.083 (0.603)
Competition	–	–	–	1.189* (0.112)	1.205** (0.111)
REACH impact (one year lagged)	2.642** (1.044)	2.165* (0.948)	2.494** (0.993)	2.549** (1.001)	2.051* (0.883)
ln(*GDP per capita* × *EU GDP per capita*)	9.391*** (3.612)	7.910*** (2.733)	8.535*** (3.596)	9.610*** (3.715)	7.996*** (3.125)
ln(*population* × *EU population*)	4.086*** (1.164)	3.681*** (1.082)	3.906*** (1.184)	3.828*** (1.101)	3.403*** (1.060)
EU GSP (GSP, GSP+, EBA)	2.126 (2.453)	2.224 (2.459)	1.882 (2.150)	3.090 (3.564)	3.263 (3.675)
EU FTA	2.535 (1.486)	2.941* (1.718)	2.657 (1.589)	2.546 (1.479)	2.985* (1.746)
Cut point 0	55.425	51.349	53.285	54.268	49.776
Cut point 1	59.512	55.396	57.364	58.372	53.841
Cut point 2	63.325	59.720	61.241	62.195	58.199
Cut point 3	66.404	63.040	64.369	65.265	61.517
Wald χ^2 (df)	146.14*** (5)	152.50*** (6)	160.04*** (6)	148.14*** (6)	180.17*** (8)
Log pseudo-likelihood	–904.330	–893.716	–902.934	–901.696	–890.481
AIC	1828.660	1809.432	1827.868	1825.392	1806.962
Number of group	78	78	78	78	78
Observation	1660	1660	1660	1660	1660

Note: *, **, and *** denote the level of significance at 10%, 5%, and 1% respectively.

Secondly, Hypothesis 2 is not statistically supported by any models, with a p value larger than the significance level of 10%. We did not find evidence that the joint participation of countries in a credible international institution generates strong commitment or peer pressure to comply with the institution's guidelines.

Thirdly, the findings suggest that competition pressure in the European chemical market encourages exporting countries to harmonize their regulations with the REACH. The full model (5) indicates that a one-unit increase in the competition score, either between countries or within a country, will make the odds of *convergence* = $n + 1$ as compared to *convergence* ⩽ n 1.205 times larger. As predicted, strong commercial ties have a strong influence on regulatory harmonization: if the total export revenue of an exporting country depends on the chemical export to the EU market more than other countries and/or more than before, that country is more likely to harmonize its regulatory policies with the REACH in order to maintain the market

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share in the EU. This finding is of particular interest because it supports the theory of the regulatory politics of vortex or the regulatory race to the top, as opposed to the theory of the regulatory race to the bottom.

With regard to the control variables, the results of all the five models consistently show that implementation of the REACH has a statistically significant positive impact on the level of regulatory harmonization. With other variables held at their means, for a one unit increase in the enforcement of the REACH, the odds of obtaining $convergence = n + 1$ versus $convergence \leqslant n$ are 2.051 times larger.

The classical gravity model variables – the multiplication of GDP per capita and population – have a statistically significant positive impact on the level of regulatory harmonization with p values lower than 1% in all models. The greater the log-transformed multiplication of GDP per capita incomes of an exporting country and the EU, the higher the expected level of regulatory harmonization (OR = 7.996), indicating that rich countries can afford stronger protection to their citizens from chemical hazards. In a similar vein, the log-transformed multiplication of populations of an exporting country and the EU has a statistically significant positive impact on the level of regulatory harmonization (OR = 3.403). Other things being equal, populous countries are more conscious about hazardous chemicals and thus have a higher likelihood of stringent measures to regulate them.

Finally, the estimation results for institutional proximity variables – *EU GSP* and *EU FTA* – are mixed. None of the five models obtained statistically significant results for *EU GSP* to reject the null hypothesis that the favourable export conditions made available by the preferential agreement are not exploited by developing countries. The impact of *EU FTA* on the regulatory harmonization is found to be statistically significant in models 2 and 5. This indicates that, unlike GSP partners, EU's FTA partners take advantage of their preferential market access to the EU.

5. Conclusion and Policy Implications

This study began with an observation that technical barriers to trade are on the rise across the world. For some, this is a worrisome development because TBTs are inherently trade restrictive. For others, however, TBTs are not necessarily counter-productive because under certain conditions they can provide incentives for innovation and a race to the top. Why then do some countries do better than others in terms of addressing new regulatory challenges imposed by an importing country?

The European Union stands out as one of the most active advocates of technical regulations for a variety of products and purposes, Using the case of the European REACH as one of the most stringent regulations on chemicals, this study attempted to unravel the underlying causal mechanisms for regulatory harmonization adopted by different exporting countries. The study first measured how exporting countries have reacted to the REACH regulation and then established three causal mechanisms for regulatory harmonization: transnational communication, intergovernmental institutions, and competitive pressure for export markets.

The random-effects ordered logistic regression analyses yielded strong statistical support for two causal mechanisms: (1) if an exporting country communicates more with the EU *vis-à-vis* the REACH than others and/or than before at the STC discussion sessions, it is more likely to harmonize its chemical regulations with the EU's REACH than others and/or than before due to greater understanding and clarity (Hypothesis 1 on communication); and (2) if the total export revenue of a country depends relatively more on the chemical export to the EU market than other countries do and/or than before, the country is more likely to harmonize its chemical regulations with the EU's REACH than others and/or than before due to greater competitive pressure (Hypothesis 3 on competition). Hypothesis 2 on intergovernmental institutions found no statistical support for its causality.

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The key implications of these findings are as follows. Given the fact that two different harmonization mechanisms work for the REACH, the technical regulations adopted by the REACH can be market-friendly rather than market-distorting. This in turn implies that technical regulations, if understood correctly through communication and/or motivated by strong commercial incentives, can create upward pressure for global regulatory harmonization. South Korea, Taiwan, and China, among others, illustrate this point. It is seemingly ironic that these export-oriented Asian countries have gained more than the others (and more than before) in the European chemical market since the implementation of the REACH. The key is in the regulatory harmonization that these countries have adopted *vis-à-vis* the REACH.

These findings also support the regulation-driven innovation or innovation-friendly regulation argument. Many product innovations can come from the rigorous process of complying with more stringent regulatory requirements. The positive outcomes that the two seemingly contradictory concepts – regulation and innovation – can produce are worth further research. In this regard, more attention will have to be paid to the regulatory politics mechanism of exporting countries, which was treated as a black box in this study. For instance, Wilson (1980) explains that we can better understand how business and government influence each other in a regulatory context by examining how each stakeholder affected by a particular regulation perceives its costs and benefits.

Finally, the findings of this study will contribute to the broad literature on regulatory convergence and the quantitative and qualitative effects of technical regulations and standards in various areas ranging from agriculture to food safety (McDonald, 2005; Mangelsdorf et al., 2012; Vigani et al., 2012; Lazo and Sauve, 2018). It is particularly important during a time when a growing number of governments are being asked to do more to better protect their citizens with or without an intention to discriminate against imports and to protect import-competing domestic industries. This study can also branch out to non-state actors who can affect the way in which their formal counterparts manage such global issues in a country-specific manner (Auer, 2000).

Supplementary Materials. To view supplementary materials for this article, please visit https://doi.org/10.1017/S1474745620000130.

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