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WTI WORKING PAPER SERIES
WTI working paper no. 1/2025

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UNIVERSITÄT
BERN

General equilibrium effects of technical non-tariff measures: evidence from bilateral trade cost estimates*

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January 23, 2025

Abstract

We estimate the trade and income effects of regulatory developments concerning standard-like non-tariff measures (NTMs) over 2012–2017 combining structural gravity estimates and general equilibrium projections. The trade cost effects of regulatory changes vary at the country-pair and across sectors. Overall, NTM-related regulatory changes over 2012–2017 increased trade costs in goods, which reduced global trade by 1.4%. The majority of this reduction corresponds to a decline in goods trade equivalent to more than 40% of the actual worldwide decrease of nominal goods trade over this period. Yet, the implied reduction of real income is a small. We highlight significant variation of these effects at the country and sector level and show that excluding pair-specific trade frictions and third-country effects introduces omitted variable bias. Our findings imply that advances in international coordination of technical regulation can further reduce trade frictions and enhance trade and real income.

Keywords: Non-tariff measures (NTM), trade, regulatory harmonization, regulatory divergence, structural gravity model, general equilibrium model, ex-post analysis.
JEL: F13, F14, F15

*Fernández-Amador and Vogt acknowledge funding from the H2020 project "Better Agri-food Trade Modelling for Policy Analysis (BatModel)", grant agreement number 861932. Furthermore, Vogt acknowledges funding from the SNF project "Regulatory Heterogeneity in International Trade: From Measures to Systems", project number 178880. We thank Peter Egger, Douglas Nelson, Miriam Manchin, participants at the 2023 BatModel NTM-CGE workshop, 2023 World Trade Forum, and 2024 GTAP conference for constructive feedback and discussions.

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1 Introduction

Non-tariff measures (NTMs) and associated frictions to international trade are currently a major policy issue (see e.g. Lamy, 2013). These measures do not only include policies that primarily regulate trade, but also policies with non-trade and non-economic objectives, reflecting citizens' preferences, such as health and quality concerns.[1] Standard-like technical measures are the most prevalent type of NTMs and typically apply to domestic and foreign firms. However, regulatory differences across countries and sectors result in heterogeneous regulatory profiles in terms of the number, stringency and types of the measures imposed. This causes (to a large degree unintended) trade costs that impact all import sources and vary on the country-pair level. Omitting pair-specific regulatory differences may bias estimates of NTMs' economic impact.

This study analyzes the trade costs related to bilateral regulatory differences and stringency of standard-like technical measures and the economic effects of regulatory changes related to NTMs accounting for general equilibrium effects in an economy characterized by global supply chains with intermediate and sectoral linkages. Specifically, we study the effects of trade costs changes induced by technical regulation taking place from 2012–2017 on global trade patterns and real income.[2] We first estimate sector- and pair-specific trade elasticities and ad-valorem equivalent trade costs (AVEs) related to NTM changes conditioned on a structural gravity equation that incorporates two measures of regulatory changes; namely regulatory stringency and bilateral regulatory differences. Regulatory stringency is the average number of technical measures per product in a given sector, which varies by sector and importer and is common across exporters. Bilateral regulatory differences measure the difference between harmonization and divergence events and vary by sector and country pair.

The fact that technical measures mostly apply in a non-discriminatory fashion across all import sources requires modeling associated trade costs in a general equilibrium framework to correctly account for their indirect effects. Therefore, we assess the effects of trade cost changes induced by NTM changes over 2012–2017 in a counterfactual simulation using a general equi-

[1] We follow the definition established by multiple international institutions and define NTMs as measures "...that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both" (UNCTAD, 2017, p. 3). This wide definition translates into a classification of NTMs that includes policies not thought of as traditional trade policy instruments but with spillover effects on trade (see UNCTAD, 2019).

[2] Although we focus on trade and real income effects, we acknowledge that non-economic welfare objectives are an important raison d'être of technical measures (see e.g. Disdier and Marette, 2010; Otsuki et al., 2001).

librium model that nests our structural gravity equation and includes sectoral input-output linkages. The model is aggregated to 78 regions and 20 goods sectors, such that the gains from accounting for sectoral disaggregation and input-output linkages can be realized. Furthermore, we investigate how changes in trade costs, trade flows and real income differ when accounting for bilateral regulatory differences and how they depend on the specification of trade costs in the general equilibrium model—i.e. whether NTM trade costs are modeled as iceberg costs or as price margins.

We find that the net increase of trade costs caused by changes in technical regulation during 2012–2017 reduces global trade by 1.4%. This effect is driven by a 1.8% decrease in merchandise trade, which is equivalent to more than 40% of the actual decrease of global nominal merchandise trade over the same period. Real income decreases much less, 0.06%, which is explained by the relatively small size of exports relative to income, as well as the compensating increase of domestic sales. These average effects across all countries are relatively small compared to macroeconomic effects of trade policy changes such as trade facilitation or deep preferential trade agreements (PTAs) reported by other studies. However, real income effects are very heterogeneous on the country level and for individual countries regulatory changes can have sizeable effects that are comparable to those of deep PTAs. Moreover, we demonstrate that ignoring bilateral regulatory differences and conditioning the econometric model on a single NTM indicator leads to biased results in terms of underestimating trade costs associated with regulatory divergence and to underestimating the potential of trade-promoting effects of regulatory stringency. Decomposing the contribution of different trade cost dimensions highlights that bilateral regulatory divergences alone led to a global loss of trade and real income of 2.6% and 0.2%, respectively, over 2012–2017. Yet, the loss from regulatory divergence is partly compensated by gains from regulatory harmonization. In terms of modeling regulatory changes, our findings further show that the non-discriminatory nature of most technical measures and the bilateral nature of the NTM incidence imply that changes in technical regulation are best modeled with a wide geographic scope. Geographically isolated scenarios may neglect important third-country effects. The qualitative aspects of our analysis are robust to uncertainty in the estimated parameters, as well as to whether NTM-related trade costs are defined as an iceberg trade cost or as a trade tax.

Our research contributes to the econometric identification of NTM effects on trade and to the assessment of general equilibrium effects of NTMs in four ways. First, we consider the effects of all NTM policy changes vis-á-vis all partners because of the non-discriminatory character of most technical measures—this is quantitatively relevant. To the best of our knowledge, this is the first study to conduct a global evaluation of the economic impact of changes in technical measures. Second, the effects are conditioned on a pair-specific incidence of changes in technical regulation and pair-specific econometric estimates of corresponding trade elasticities. Third, we highlight how NTM cost sectoral trends matter quantitatively by disentangling their contribution to trade and income effects. Finally, we show how different specifications of trade policy changes in the general equilibrium model affect our results and provide a statistical distribution of income effects based on the distribution of parameters identified in the econometric model.

The trade cost specification in our structural gravity equation extends those in Xiong and Beghin (2014) and Vogt (2022) by allowing for heterogeneous NTM coefficients in the form of interactions of the NTM variables with predicted trade shares in spirit of Chen and Novy (2021).[3] Unlike using aggregate import demand equations to estimate NTM effects on trade (e.g. Beghin et al., 2015; Kee et al., 2009), the gravity framework also allows us to introduce trade costs varying at the pair level to account for regulatory harmonization and divergence between partners. These bilateral differences in regulatory profiles are important to isolate the trade-restricting component of standard-like NTMs from the trade-promoting component that technical measures may entail. The empirical distinction between trade-promoting and trade-restricting components of NTMs based on the inclusion of bilateral regulatory differences contrasts prior research that only includes NTMs with a priori trade-restrictive properties as part of the identification strategy,[4] which excludes a significant number of NTMs that are often the result of citizens' preferences and relevant market access requirements for firms, and thus may bias the estimated effects of policy changes if the excluded NTMs are related to the ones included in the analysis—e.g. if the implementation of policy changes takes place

[3]Many studies estimate the trade effects of different NTMs using a gravity model (e.g. Bratt, 2017; Ghodsi, 2019; Ghodsi and Stehrer, 2022; Kinzius et al., 2019) and using country-level import equations (e.g. (Niu et al., 2018). Cadot and Gourdon (2016) and Disdier et al. (2023) analyze the effect of NTMs on prices and quality, respectively. The use of predicted trade shares follows Chen and Novy (2021) and addresses the simultaneity bias associated with trade share interactions. Other studies (e.g. Kee and Nicita, 2022) interact NTMs with world trade shares.

[4]E.g. Fontagné et al. (2015) use WTO Specific Trade Concerns to assess their heterogeneous effect on different margins of firm-level trade, and Kee and Nicita (2022) estimate the effect of trade-restrictive border measures on fraudulent customs declarations. This approach relates in part to studies suggesting that specific NTMs substitute for reductions in tariffs implemented over the past decades (Anderson and Schmitt, 2003; Beverelli et al., 2019; Niu et al., 2020).

through different types of technical measures and a subset of them is excluded from the analysis. Finally, in line with recent developments in the gravity literature, we use an interaction with the international border (see Heid et al., 2021) to identify the international trade effect of the non-discriminatory component of technical measures, captured by a stringency index.[5]

Our research further relates to the structural estimation of trade and macroeconomic effects of trade policies. Most of the literature estimating the effects of NTMs in general equilibrium models constructs policy scenarios using direct information about the NTM policy or inferring NTM costs indirectly from policies that address the underlying NTMs, most notably trade agreements (i.e. World Trade Organization (WTO) or PTAs).[6] The direct approach has been used to model the macroeconomic effects of trade cost changes related to, inter alia, technical measures (Walmsley and Strutt, 2021; Webb et al., 2020), sanctions (Chowdhry et al., 2024), services trade policies (Reverdy, 2023), PTAs (CEPR, 2013), or the Brexit (Dhingra et al., 2017).[7] By contrast, studies that rely on the indirect approach either use an outcome variable that proxies for the incidence of an underlying NTM policy (see e.g. Oberhofer et al. 2021, who use time at the border as a proxy for trade facilitation policies), or disentangle the tariff from the non-tariff components of PTAs by augmenting the gravity equation with applied tariffs (e.g. Egger et al., 2015; Felbermayr et al., 2022).[8] In general, the estimated trade and welfare effects can be very sensitive to the modeling approach—e.g. the Transatlantic Trade and Investment Partnership's (TTIP) welfare effects vary widely between 0.2% and 10.1% depending on the study design (Bekkers and Rojas-Romagosa, 2019), and the welfare losses associated with Brexit range from 0.8% to 2.1% (Dhingra et al., 2017; Felbermayr et al., 2024).

Our estimates of NTM policy shocks are directly identified based on a structural gravity model estimated using data on technical regulations from NTMTRAINS (UNCTAD, 2017), which is based on full legislative reviews conducted at a given point in time and is thus the most suitable source to analyze regulatory differences. The use of NTMTRAINS determines the estimation of the gravity specification as a cross section. Once expressed as AVE trade cost changes, our estimates of NTM regulatory changes are introduced into a (multi-sectoral) general equi-

[5]Other studies use an international border interaction to identify the international trade effect of e.g. services trade policies (Reverdy, 2023), institutions (Beverelli et al., 2023), and trade facilitation (Oberhofer et al., 2021).
[6]Bekkers et al. (2018) refer to them as bottom-up vs. top-down approaches.
[7]Policy variables include those that merely indicate the presence of an NTM, restrictiveness indexes, or indicators based on survey information.
[8]The identification assumption is that PTA-inclusive applied tariffs capture the tariff effect of PTAs, rendering the remaining effect of PTAs on trade as non-tariff (e.g. PTA-based mutual recognition of standards and certification procedures). For the WTO, MFN tariffs are captured by fixed effects (Felbermayr et al., 2024).

librium model to estimate general equilibrium trade and real income effects.[9]

The next section describes the structural gravity model and the general equilibrium model in which it is nested. Section 3 introduces the counterfactual policy experiment, while we discuss the results in detail in Section 4. Section 5 concludes.

2 Methodology

The analysis is conducted in three steps. First, we estimate pair-specific NTM trade costs at the sectoral level based on a structural gravity equation that disentangles NTM trade effects that are common across all import sources and those caused by bilateral regulatory differences. Second, conditional on the estimated coefficients we construct sectoral, pair-specific AVE trade costs corresponding to NTM changes, i.e. introduction and withdrawal, between 2012 and 2017. Third, we simulate the general equilibrium effects of these sectoral trade cost changes on trade and real income.

2.1 Empirical gravity equation

Equation (1) describes the empirical gravity model estimated using a cross-section for each sector $s \subseteq [1, \ldots, S]$ in 2017 using a Pseudo Poisson Maximum Likelihood estimator (PPML, Santos Silva and Tenreyro, 2006).

$$X_{od} = \exp\left[\beta_{od}^{Dif} B_{od} Dif_{od} + \beta_{od}^{Str} B_{od} Str_d - \sigma t_{od} + Z_{od}\gamma + \mu_o + \eta_d + \varepsilon_{od}\right] \tag{1}$$

The dependent variable X_{od} represents trade flows from origin o to destination d, including internal and zero trade flows. The specification identifies the discriminatory effect of NTMs on international trade and distinguishes between NTM trade effects that are common across all import sources and those caused by bilateral regulatory differences (Vogt, 2022; Xiong and Beghin, 2014). These are captured, respectively, by two measures of NTM trade costs, strin-

[9]Our structural gravity equation is consistent with several theoretical models featuring different demand- and supply-side specifications (Arkolakis et al., 2012; Head and Mayer, 2014) that account for, inter alia, the role of sectoral disaggregation (e.g. Caliendo and Parro, 2015; Ossa, 2015) and intermediate linkages (Caliendo and Parro, 2015). These include the Armington-based specification of import demand (Anderson, 1979; Anderson and van Wincoop, 2003; Armington, 1969), which is the basis of the general equilibrium model used in this study.

gency (Str_d) and bilateral regulatory difference (Dif_{od}), which are the variables of interest. We control for applied tariffs T_{od}, which enter (1) as $t_{od} = \ln(1 + T_{od}/100)$, and a set of bilateral trade costs captured by the vector Z_{od}. Origin and destination fixed effects μ_o and η_d control for origin- and destination-specific determinants of trade, including inward and outward multilateral resistances (Anderson and van Wincoop, 2003).[10] B_{od} is a border indicator equal to 1 for international trade, and 0 for domestic sales.

Bilateral regulatory differences are captured by the difference between harmonization and divergence events, $Dif_{od} = Har_{od} - Div_{od}$, where Har_{od} is the number of common measure types imposed by origin o and destination d, and Div_{od} is the number of measure types only applied by destination d but not by origin o. It captures that complying with similar types of measures on the destination market d as imposed on the origin market o may lower relative trade costs of exporting firms. Thus, although the types of technical measures included in Dif_{od} apply to foreign and domestic firms, the underlying trade cost captured is specific to international trade. Because Dif_{od} increases in harmonization and decreases in divergence events, we expect its associated coefficient to be positive.[11]

Regulatory stringency (Str_d) is the average number of measures per product in a given sector and varies by destination country d. It includes all technical measures—those levied on foreign and domestic firms (e.g. labeling, conformity assessments, restricted use of substances), as well as those imposed on foreign firms only (e.g. pre-shipment inspections, importer registration requirements).[12] After controlling for the trade cost effects of Dif_{od}, Str_d represents the net effect of trade-promoting effects (e.g. through reduction in asymmetric information) and trade-restricting effects (e.g. through compliance cost increases) associated with regulatory stringency. We interact Str_d with the international border dummy (B_{od}), such that it captures the discriminatory effect on international relative to domestic trade. The border interaction also resolves the collinearity with the destination fixed effects η_d (Heid et al., 2021).[13] Str_d can have positive or negative discrimination effects and its coefficient is a priori ambiguous.[14]

[10] Further details on the set of controls in Z_{od} and on underlying data sources can be found in Appendix A.

[11] We apply a control function approach to deal with endogeneity between Dif_{od} and trade flows (see Appendix B).

[12] For more detail, see Appendix A. Also, note that Har_{od}, Div_{od}, Str_d are based on binary data and thus are proxies for regulatory similarity, divergence, and stringency.

[13] Note that fixed effect η_d controls for endogeneity of Str_d (see Appendix B).

[14] NTMs can be trade restrictive when they introduce costs to producers or consumers and trade promoting when e.g. they reduce informational asymmetries between exporting firms and consumers in the importer country and when they relate to harmonization and mutual recognition. See e.g. Crivelli and Groeschl (2016), Bao and Qiu (2012) and Bratt (2017) for reasons underlying positive trade effects of technical measures. Dif_{od} is trade-

In Equation (1), we allow for heterogeneity of the NTM effects with respect to trade shares of the importer and exporter, as well as technical PTA provisions.[15] The pair-specific parameters associated with the regulatory difference and stringency measures follow the specification:

$$\beta^i_{od} = \beta^i_1 + \beta^i_2 \hat{m}_{od} + \beta^i_3 \hat{e}_{od} + \beta^i_4 PTA^{T,pre}_{od} + \beta^i_5 PTA^{T,pos}_{od} \tag{2}$$

where $i = \{Dif, Str\}$. Equation (2) characterizes (asymmetric) pair-specific effects of the NTM indicators through a constant baseline effect (β^i_1) and several interactions—namely, interactions of the NTM indicators with the share of source o in imports of destination d (import share, $\hat{m}_{od}$), with the share of a destination d in exports of o (export share, $\hat{e}_{od}$), and with the indicator variables $PTA^{T,pre}_{od}$ and $PTA^{T,pos}_{od}$ for PTAs between the pair od that contain legally enforceable technical provisions and enter into force before and after 2012, respectively. Thus, we allow for possible phase-in effects of those agreements entering into force between 2012 and 2017.

The interactions with import and export shares capture different considerations which imply that compliance costs of technical measures vary at the pair level. Specifically, import and export shares affect the trade effect of technical measures by capturing the degree of market integration, exporter competitiveness, potential motivation to implement trade protective measures, and market power. Both, import and export, shares reflect proximity of trade partners in terms of natural determinants of trade integration. Also, the import share in country d is a proxy for competitiveness of source o in destination d, while the export share in source o is related to market power of a destination d in source country o.[16]

The expected effects of import and export shares are a priori ambiguous. On the one hand, the magnitude of the NTM elasticity may decrease with increasing import and export shares when large trade shares primarily reflect a high degree of market integration and corresponding closer regulatory preferences between trade partners. For trade-restricting effects, this implies

promoting by construction, i.e. an increase reflects harmonization or less divergence leading to bilateral trade cost reductions.

[15] Kee et al. (2009) allow for varying trade effects depending on comparative advantage in import demand equations, and several studies allow for varying elasticities of trade costs in the gravity framework depending on variables capturing comparative advantage and GDP (Bratt, 2017), based on different locations on the demand curve characterized by the level of trade between two countries (Chen and Novy, 2021), and resulting from market power of the importer or exporter (Kee and Nicita, 2022).

[16] Note that importer and exporter shares have a different meaning in Kee and Nicita (2022), because they use importer and exporter shares in world trade to measure market power.

that changes in technical measures induce relatively lower changes in compliance costs, while for trade-promoting effects, this implies that informational asymmetries are lower between natural trading partners. In both cases, the trade effects are lowered with increasing trade shares. Also, the trade effects of NTMs decrease if larger trade shares reflect larger market power of the importer, such that compliance costs are not passed through to consumers in the destination country, provided the exporter's supply is sensitive. Conversely, if smaller trade shares reflect less market power, the full effect of NTMs passes through to the importers without attenuation.

On the other hand, larger import shares may also exacerbate NTM effects. This is the case if large import shares induce the imposition of technical measures that are particularly trade restrictive and cause exporters with large market shares to divert trade to other destinations (see also Kee and Nicita, 2022).[17] Furthermore, trade-promoting effects of technical measures may be amplified if relatively competitive exporters with large trade shares are able to better leverage them.[18]

To address potential simultaneity bias of export and import shares in the interaction terms, we follow Chen and Novy (2021) and construct exogenous trade shares. For this, we regress X_{od} on exogenous trade cost determinants (distance, differences in latitude, common language, common colonizer, common border and international border dummy, as well as on origin and destination fixed effects).[19] Conditional on the predicted exogenous part of X_{od}, $\hat{X}_{od}$, we construct the share of origin o in d's imports $\hat{m}_{od} = \hat{X}_{od}/\sum_o \hat{X}_{od}$ and the share of destination d in o's exports $\hat{e}_{od} = \hat{X}_{od}/\sum_d \hat{X}_{od}$.

Finally, we include two interactions with dummies capturing the presence of legally enforceable technical provisions in PTAs entering into force pre-2012 and post-2012. PTAs active before 2012 are expected to attenuate the effect of technical measures to the extent that they represent high integration between partners before NTM changes, especially if PTAs include provisions relative to harmonization and mutual recognition. PTAs signed after 2012 may also attenuate the trade-restricting effects of NTMs if they enter into force before the techni-

[17] Kee and Nicita (2022) also note that exporters may not be able to divert exports if the importer has a very large import share relative to the world. In this case, we may expect that the parameter associated with predicted import shares is close to zero at the upper tail of the world import share distribution. We consider this extreme case as empirically rare and do not model nonlinearities in the interactions.

[18] See e.g. Herghelegiu (2018) for the effect of transnational business groups attendance at the WTO Ministerial Conferences on the presence of NTMs.

[19] Chen and Novy (2021) show the validity of their procedure in simulated experiments.

cal measure. Yet, PTAs signed after 2012 may amplify the trade-promoting effects of existing technical measures by including technical provisions that further reduce informational asymmetries between partners (e.g. harmonization and mutual recognition).

2.2 General equilibrium model

We simulate the trade and real income impacts of global regulatory changes between 2012 and 2017 using the general equilibrium model documented in Corong et al. (2017) and Mensbrugghe (2018). The model is a global, comparative static general equilibrium model that captures international, sector-level input-output linkages. On the supply side, the model features a constant elasticity of substitution (CES) production structure, while its demand side is modeled with Cobb-Douglas preferences. Moreover, we assume that the trade balance is fixed, which reflects the historical persistence of trade imbalances and isolates investment responses to changes in NTM-induced trade costs.

The international trade module within the general equilibrium model can be summarized by three components. First, consistent with our Armington-based gravity framework, international import demand is governed by a CES function with products from different countries being imperfect substitutes. Accordingly, the first component is the derived (Marshallian) demand for good s from origin o to destination d:

$$q_{sod} = \lambda_{sod}^{\sigma_s - 1} \left(\frac{P_{so}}{p_{sod}} \right)^{\sigma_s} Y_d \tag{3}$$

where λ_{sod} is a parameter capturing the level of technology, and of which the inverse can be interpreted as an iceberg cost ($\lambda_{sod}^{-1} = t_{sod}^{\tau}$), P_{so} is the CES dual price index, p_{sod} is the price of imports of good s in destination d from origin country o, and Y_d is income of the destination country d, which is equal to aggregate import demand across all origin countries. The substitution elasticity σ_s is sector specific and applies to substitution between different international import sources and substitution between domestic and international trade. It is estimated using Equation (1) as the coefficient associated with the tariff and used to transform the trade volume effect of changes in NTMs into AVE trade cost changes.

The second component is the CES dual price index:

$$P_{so} = \left[\sum_s \left(\frac{p_{sod}}{\lambda_{sod}} \right)^{(1-\sigma_s)} \right]^{1/(1-\sigma_s)} \tag{4}$$

The third component is the structure characterizing the price of imports of good s in destination d from origin country o, which defines the international price p_{sod} as a function of the factory-gate price (p_{so}), export taxes (t^{exp}_{sod}), international services margin (υ^{cif}_{sod}), and tariffs (t^{imp}_{sod}).

$$\begin{aligned} p_{sod} &= p^{cif}_{sod} t^{imp}_{sod} \\ p^{cif}_{sod} &= p^{fob}_{sod} \upsilon^{cif}_{sod} \\ p^{fob}_{sod} &= p_{so} t^{exp}_{sod} \end{aligned} \tag{5}$$

We model changes in NTMs as changes in iceberg trade costs (λ^{-1}_{sod}), and test the sensitivity of results by alternatively implementing trade cost changes as export and import taxes (t^{exp}_{sod} and t^{imp}_{sod}, respectively). In general, all three mechanisms cause a price distortion between the domestic price in the exporting country and the price paid by consumers in the importing country. This leads to deviations in trade patterns from an undistorted state (allocative inefficiencies) and affects prices received for exports and paid for imports (terms-of-trade). In this regard, export and import taxes can be understood as price shifters rather than as export taxes and import tariffs when modeling NTM changes.

Trade taxes additionally affect welfare via tax revenues, which in the context of our work can be interpreted as economic rents from NTMs captured by domestic firms in destination country d and exporting firms in origin country o and accruing to a country-level regional household (see e.g. Walmsley and Strutt, 2021).[20] Specifically, implementing trade cost changes via export taxes (t^{exp}_{sod}) drives a wedge between the domestic price in the exporting country and the free-on-board (FOB) price. In this case, changes in tax revenue due to regulatory changes (NTM-related rents) between 2012 and 2017 accrue to the exporting country. By contrast, implementing trade cost changes via import taxes (t^{imp}_{sod}) affects the difference between the cost, insurance, and freight (CIF) price and prices paid by consumers, with changes in NTM-related rents accruing to the importing country.

[20] Arguments of NTMs as policy instruments that generate economic rents are in line with a trade policy substitution argument (Beverelli et al., 2019; Niu et al., 2020, e.g.) and a positive relationship between lobbying activities at WTO Ministerial Conferences and the presence of technical measures (Herghelegiu, 2018, e.g.).

Finally, changes in iceberg trade costs (t^{τ}_{sod}) enter Equation (3) in two ways and imply additional changes in efficiency on the importer side. First, analogous to import taxes, iceberg cost changes are levied on (shift) the CIF price and induce a (price-based) substitution effect.[21] Furthermore, a reduction (increase) in iceberg trade costs further features an efficiency improvement (deterioration) by changing the quantities of a good that need to be shipped to satisfy demand (Hertel et al., 2001). This expansion effect is akin to a technology shift for the importer whose production costs increase with NTM-related costs. The expansion effect, after disentangling the substitution effect, is equal to t^{τ}_{sod}, such that it is one-to-one proportional to the NTM-related trade cost change. However, it is smaller than the substitution effect, which is governed by $\sigma_s > 1$. Accordingly, a reduction in iceberg trade costs generally increases trade volumes if opposite general equilibrium effects do not dominate.

3 Policy scenario design

We estimate the effect of regulatory changes from 2012 to 2017 based on real changes in NTMs captured by the underlying database. The five-year period under investigation is compatible with the NTM data, collected between 2012 and 2017. The Global Trade Analysis Project (GTAP) database used in the gravity estimations and the simulation exercise is for 2017 and consequently undistorted with respect to shifts in trade patterns due to the 2020 COVID pandemic and trade policy developments after the 2016 US election. The role of cyclical fluctuations in NTM changes is minimized by choosing 2012 as the initial year, which is also sufficiently long after the 2008/2009 financial crisis.

In particular, we analyze the state of the economy in 2017 if NTM regulatory changes over 2012-2017 had not taken place. Therefore, we calculate the contribution of trade cost changes due to regulatory developments since 2012 to trade and income in 2017. We define ΔStr_d and ΔDif_{od}, respectively, as the change in regulatory stringency and differences from base year 2017 to 2012, and calculated as $(Str_{d,t=2012} - Str_{d,t=2017})$ and $(Dif_{od,t=2012} - Dif_{od,t=2017})$. $\Delta Dif_{od} < 0$ for a pair od means that exporters face fewer measures imposed on the import market but not necessarily on their home market (i.e. higher divergence, lower harmonization or both) in 2017 compared to 2012, and vice versa for $\Delta Dif_{od} > 0$; whereas $\Delta Str_d < 0$ cap-

[21] This is easily seen after operating terms in Equation (3) and obtaining $(t^{\tau}_{sod} p_{sod})^{\sigma_s}$. Thus, modeling NTMs via import taxes and iceberg trade costs compared to export taxes leads to a larger absolute price distortion because the percent change in trade costs is levied over a larger base that includes the CIF-margin.

tures an increase in the average number of measures per product in a given sector imposed by destination country d in 2017 compared to 2012, and vice versa for $\Delta Str_d > 0$.

We design four scenarios to assess the relevance of bilateral regulatory differences as a determinant of trade and income changes by estimating Equation (1) with and without Dif_{od}. The specification including Dif_{od} is referred to as the heterogeneous NTM effect (HET) model, whereas the specification with Str_d alone is referred to as the single NTM indicator (SI) model.

The first scenario (HET-All) includes all the NTM variables and assesses the contribution to trade and income in 2017 of trade cost changes caused by bilateral regulatory differences and changes in regulatory stringency imposed in a non-discriminatory fashion. This is our benchmark scenario. The second and third scenarios decompose the total effect simulated in the first scenario. The second scenario (HET-Dif) isolates the contribution of trade cost changes caused by bilateral regulatory harmonization and divergence to trade and income in 2017 and further disentangles bilateral regulatory differences into a harmonization and divergence component. For this, we use the coefficient associated with Dif_{od} representing the effect of an unit change in Dif_{od} on trade, which are caused by harmonization and divergence events. These events are treated separately in this scenario assuming that their average effects are governed by the coefficient of Dif_{od}. The third scenario (HET-Str) isolates the contribution to trade and income in 2017 of trade cost changes caused by changes in regulatory stringency imposed in a non-discriminatory fashion, based on the gravity specification that includes bilateral regulatory differences. By contrast, the fourth scenario (SI) assesses the contribution to trade and income in 2017 of trade cost changes caused by changes in regulatory stringency imposed in a non-discriminatory fashion based on Equation (1) being estimated under exclusion of bilateral regulatory differences Dif_{od}. Thus, it allows us to evaluate the potential omitted variable bias from not accounting for pair-specific regulatory differences captured by Dif_{od}.

To map the econometric estimates of the effects of NTM changes into the general equilibrium model, we follow Bekkers et al. (2018) and calculate the AVE trade cost changes ΔT_{sod} of ΔDif_{sod} and ΔStr_{sd} for each scenario via:

$$\begin{aligned} &(1-\hat{\sigma}_s)\ln(1+\Delta T_{sod}/100) = \hat{\beta}^{Dif}_{sod}\,\Delta Dif_{sod} + \hat{\beta}^{Str}_{sod}\Delta Str_{sd} \\ &\Leftrightarrow \Delta T_{sod} = \left[\exp\left\{\frac{\hat{\beta}^{Dif}_{sod}\,\Delta Dif_{sod} + \hat{\beta}^{Str}_{sod}\Delta Str_{sd}}{(1-\hat{\sigma}_s)}\right\} - 1\right] * 100 \end{aligned} \tag{6}$$

where $\hat{\beta}^{Dif}_{sod}, \hat{\beta}^{Str}_{sod}$ depend on the interactions with the predicted importer ($\hat{m}_{sod}$) and exporter ($\hat{e}_{sod}$) trade shares, as well as a technical PTA provision dummy (see Equation (2)), and $\hat{\sigma}_s$ is the (sectoral) trade elasticity estimated directly from applied tariffs.[22] Thus, trade cost changes ΔT_{sod} depend on the elements underlying $\hat{\beta}^{Dif}_{sod}$, $\hat{\beta}^{Str}_{sod}$, and the change in NTM variables. We ensure the robustness of both components with respect to the precision of the coefficients, outliers of ΔT_{sod}, and the definition of the shock in the general equilibrium model as follows.

First, for each $i \in \{Str, Dif\}$ we evaluate the significance of β^i_{od} at the average level of importer and exporter trade shares and perform a joint test of significance of all the coefficients in Equation (2), i.e. the base coefficient and coefficients of the interaction terms. We use β^i_{od} including all interaction terms for calculating trade cost changes ΔT_{sod} if either test is significant. If both tests are insignificant we estimate a model without interaction terms and evaluate whether the homogeneous effect of β^i_{od} is significant and use it for the calculation of ΔT_{sod} accordingly.

In addition, we assume that the effect of our regulatory difference indicator is positive ($\beta^{Dif}_{sod} > 0$), consistent with the view that NTM harmonization (divergence) decreases (increases) trade costs. Thus, we set $\hat{\beta}^{Dif}_{sod}$ to zero for observations for which $\hat{\beta}^{Dif}_{sod} < 0$. This concerns a small share (2.7%) of all observations. With respect to regulatory stringency Str_{sd}, we assume that the coefficient represents the net effect of trade-promoting properties of quality-related measures and the trade cost increasing impact of more stringent regulation and technical border NTMs. Thus, a trade-promoting effect of Str_{sd} ($\hat{\beta}^{Str}_{sod} > 0$) suggests dominating demand side effects, whereas a trade decreasing effect of Str_{sd} ($\hat{\beta}^{Str}_{sod} < 0$) suggests dominating trade cost effects.

Second, we investigate the statistical evidence of the results derived by our model. In particular, we calculate the distribution of the predicted AVEs (ΔT_{sod}) based on Equation (6) by sampling the coefficients associated with the NTM variables. For that purpose, we condition the calculations on the bootstrapped sample of the coefficients of the gravity model. Therefore, we first bootstrap the vector of coefficients 500 times and calculate ΔT_{sod} using Equation (6). Next, we shock the general equilibrium model with each bootstrap draw and estimate the corresponding general equilibrium effects.

[22] We rescale ΔT_{sod} with the hyperbolic tangent function to dampen extreme values, which are cut off beyond 1 and -1 (Cadot and Gourdon, 2016). The function is defined as $[\exp(2\Delta T_{sod}/100) - 1]/[\exp(2\Delta T_{sod}/100) + 1]$. It condenses values approximately between $[0.8, 1]$ and $[-1, -0.8]$ but leaves values ranging from $[-0.8, 0.8]$ relatively unchanged. The largest and smallest value of the final set of ΔT_{sod} shift from 0.75 to 0.63 and -0.47 to -0.44, respectively. Thus, the most extreme trade cost changes are mildly damped but not cut off. The condensed values are subsequently expressed in percentage terms.

Third, we treat changes in technical measures for values that suggest outlying observations, which can generate relatively large trade cost changes. For most countries regulatory data is only available for a specific cross section with entry-into-force dates indicating the year from when a certain measure type is imposed. Thus, we know when NTM measures entered into force that are still imposed in the year of data collection. Yet, the data lack information about the complete regulatory profile prior to the year of data collection such that there is potential for false changes in regulatory structure if the new measure is a replacement of an existing policy. Therefore, our procedure focuses on potential false positives—i.e. country-sector-level observations for which the number of measures introduced over 2012–2017 is very large relative to the number of measures existing in 2017. To detect cases outlying regulatory changes we regress NTMs on technical measures of neighboring and reference countries, as well as SPS and TBT notifications to the WTO.[23] We then predict changes in NTMs based on changes in the underlying NTM data and validate the predictions from this model for a subset of countries for which data were collected in 2012 and 2017. Outlying regulatory changes are defined at the country-sector level for cases that show much larger observed regulatory changes than estimated by our model and replaced by the corresponding predicted changes. A comparison of the results from data including outlier correction and the original data show that treating outliers results in more conservative predictions (see details in Appendix G).[24]

Fourth, the total trade cost change (ΔT_{sod}) calculated in Equation (6) can enter the general equilibrium model through changes in the following three variables $\left\{t^{\tau}_{sod}, t^{imp}_{sod}, t^{exp}_{sod}\right\}$. These three variables reflect whether the NTM measures represent a firm's production cost or a price shifter imposed either on the exporter or the importer side. Therefore, a distribution along the three mechanisms is required. We postulate the following three allocations. First, all the trade cost changes are modeled as technology changes, such as changes in product standards and other non-tax cost changes, captured by t^{τ}_{sod} (complete iceberg trade cost implementation). Second, trade cost changes are assumed to be 50% iceberg trade costs (t^{τ}_{sod}) and 50% rents on the importer side (tariffs, t^{imp}_{sod}). Third, trade cost changes are assumed to be 50% iceberg

[23] We identify reference countries by k-means clustering on polity, governance, and trade facilitation indicators, GDP per capita, and countries' latitude. Thus, NTMs are a function of countries' development in addition to geographic proximity via neighboring countries. See Guimbard et al. (2012) for an application of the reference country approach to tariff aggregation. See details in Appendix C. SPS and TBT stand for sanitary and phytosanitary measures and technical barriers to trade, respectively.

[24] Additionally, we analyze the sensitivity of our results to an scenario based on the predicted values from the model used to detect and correct outliers. The results of that scenario are highly correlated with those of our main scenario, which is also relatively conservative. See details in Appendix G.

trade costs (t^{τ}_{sod}) and 50% rents of which regulatory differences are divided equally between the importer and exporter (t^{imp}_{sod} and t^{exp}_{sod}), and stringency-related rents accrue on the importer side (t^{imp}_{sod}).[25]

4 Results

This section presents results of the gravity estimations, the predicted AVE trade costs of regulatory changes between 2012 and 2017, and the resulting effects on trade and real income. Our benchmark modeling approach accounts for bilateral regulatory differences and regulatory stringency in the econometric specification (HET model) and models trade costs as iceberg trade costs in the general equilibrium model. We also analyze the sensitivity of the results to using a model relying on a single indicator for regulatory stringency (SI model) and to modeling trade costs as a combination of iceberg costs, import tariffs and export taxes.

4.1 Gravity estimations

The results from the econometric gravity model establish that trade effects of NTMs are pair specific, as a relevant share of the effects relate to bilateral regulatory differences and depend on market shares. Table 1 presents the results of estimating Equation (1) on the sector level, focusing on the coefficients of the NTM variables and their interaction terms. The estimates incorporate endogeneity corrections and we instrument the Dif variable, and the PTA dummy. Details on the instrumentation and selection of instruments per sector can be found in Appendix D. We highlight the following findings.

First, for the majority of sectors a relative increase in harmonization versus divergence promotes trade, while regulatory stringency can have trade promoting and restricting effects depending on the sector. In general, a reduction in bilateral regulatory differences reduces trade costs associated with additional compliance requirements that exporting firms do not encounter on the home market. The coefficient corresponding to the difference indicator (Dif) shows the effect of regulatory differences absent of effects from interactions with trade shares and no technical provisions included in PTAs (baseline effect) and is positive for all sectors.

[25] For a broader set of regulations and in the context of transatlantic trade, firm-level surveys indicate 60% trade cost increasing vs. 40% rent generating NTMs (CEPR, 2013). This distribution is also used by Jafari and Britz (2018) who further split the rent-generating component over 1/3 export and 2/3 import taxes.

By contrast, the coefficient of the stringency baseline effect ($Str * Border$) is positive or negative depending on the sector, implying trade promoting or restricting effects common across all import sources. This confirms the results from previous studies (e.g. Beghin et al., 2015; Fernandes et al., 2021; Ghodsi, 2019) and suggests that technical measures combine trade-cost and demand-side effects resulting in an a priori ambiguous net effect on trade. Regarding the magnitude of the effects, we observe the largest elasticities of bilateral regulatory differences for automobile, electrical computer products, light manufacturing and grains, while the largest elasticities with respect to regulatory stringency are found for metals and textiles.[26] Additionally, we find net trade promoting effects of regulatory stringency for textiles, light manufacturing, minerals, chemical and plastic products, and for the automobile sector.[27]

Second, the effects of NTMs vary at the pair level depending on trade shares. Trade share interactions can augment, weaken or even revert the base effects, depending on the size of the coefficient and the trade share. For the Dif indicator, larger trade shares significantly modulate the positive trade effect of regulatory harmonization relative to divergence in half of the sectors. Most of the significant interaction effects are negative, such that the trade elasticity of bilateral regulatory differences decreases with rising trade shares. This is the case of light manufacturing, pharmaceuticals, electronic computers, and automobile. This is consistent with two explanations. First, higher market integration captures closer regulatory preferences, such that exporters are more likely to possess adequate compliance capacity. Second, higher market shares convey information about the importer's market power and on whether importers are more likely able to pass on compliance costs to exporters. There are also positive effects of the trade share interactions in some sectors, which suggest that competitive, larger exporters are more capable of realizing trade cost reductions induced by regulatory similarity.

Furthermore, we find evidence across most sectors that trade-promoting effects of regulatory stringency decrease with larger trade shares consistent with the view that natural, highly integrated trading partners have less informational asymmetries.

[26] Note that high elasticities in manufacturing sectors may be the outcome of lower variation in the underlying NTM indicators compared to agri-food products. Agri-food products are highly regulated by SPS and TBT measures. By contrast, SPS measures are hardly imposed on manufactures. This results in a higher standard deviation. For example, the average number of measures per product (regulatory stringency) is 12.6 vs. 2.7 for agri-food and manufactures, respectively.

[27] These trade-promoting effects also hold when evaluating the effect of regulatory stringency at average import and export shares.

	Tariff	Dif	Dif*Msh	Dif*Xsh	Dif*PTA Tech pre2012	Dif*PTA Tech post2012	Str*Border	Str*Msh	Str*Xsh	Str*PTA Tech pre2012	Str*PTA Tech post2012
Grains	-9.190 ***	0.476 ***	-0.009	0.512	-0.013	-0.093	0.005				
Veg & Fr	-3.444 ***	0.236 ***	0.431	-0.461	-0.059 **	-0.004	-0.029 ***	0.072	0.156 *	-0.018 *	0.005
Crops	-5.856 ***	0.339 **	0.364	0.975	-0.149 *	0.105	0.010				
Animal	-14.389 ***	-0.043					-0.001				
Extr Nrg	-15.981 ***						-0.171 *				
Fd Anm	-3.514 ***	0.181 ***	0.212	0.057	0.029	0.094	0.003				
Fd Plant	-3.280 ***	0.176 ***	-0.027	0.200	-0.007	-0.126 ***	-0.001				
Tex	-10.751 ***	0.333 **	0.485	-0.314	0.132	0.474 ***	0.298 ***	0.043	-0.510	0.015	0.172
Lgt Mfc	-12.343 ***	0.533 **	-1.775 *	-1.351	-0.523 *	-0.128	0.190 **	-1.990 **	-2.458 **	-0.483 ***	-0.360
Chem	-11.913 ***	-0.109					0.102 ***	-0.930 ***	-0.202	-0.011	-0.014
Pharma	-17.585 ***	0.084	-1.923 ***	-1.124	-0.119	-0.513	-0.042	-0.331	-0.800 ***	-0.012	-0.111
Plastics	-8.504 ***	0.211					0.124 *	-0.903 ***	-0.964 ***	-0.086 **	-0.066
Mineral	-12.452 ***	0.085					0.161	-2.416 **	-2.422	0.038	-0.125
Metal	-8.672 **	0.139					-0.565 **	0.298	-0.163	-0.064	0.367
Metal pr	-10.143 ***						0.041	-1.511 **	-2.512 **	-0.174 *	0.036
El Comp	-14.286 ***	0.950 ***	-0.246	-1.347 ***	-0.234	0.255	0.087 **	-0.259	0.203	-0.159 **	0.073
El Eq	-11.285 ***	0.280 ***	0.536	0.744 **	-0.296 ***	-0.260 **	0.018	-0.569 ***	-0.830 ***	-0.158 ***	-0.117 ***
Machine	-12.386 ***	0.255 *					0.034	-0.383 ***	-0.759 ***	-0.063 **	0.027
Trans	-12.909 ***	-0.259					0.104	-4.065 ***	-1.219	-0.002	0.035
Auto	-11.496 ***	1.091 ***	-2.152 ***	-0.046	-0.235	-0.099	0.073 *	-0.127	-0.421	-0.052	-0.028

Table 1: Summary of gravity estimations

p-values based on bootstrapped standard errors (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. See complete results in Appendix D. N= 11,025 observations across all models. All models include importer and exporter fixed effects. Xsh/Msh: predicted exporter/importer share.

However, for very large trade shares the elasticity becomes negative, which indicates that large import shares relate to trade restrictive measures that can lead exporters with larger market power to divert trade. The latter effect is supported by negative coefficients of exporter-share interactions.

The interaction effects of technical PTA provisions with NTM-related trade costs is significant in only nine out of the 20 sectors—vegetables & fruits, crops, plant-based food, textiles, light manufacturing, plastics, electronic computers, electrical equipment, and machinery. These interaction effects are mostly negative, while the effect of the presence of technical PTA provisions is positive, suggesting that some of the trade-promoting effects of harmonization and regulatory stringency are related to technical PTA provisions (see Tables 14 and 15 in Appendix D for results of the PTA base coefficients). It can also indicate, for the case of trade-restrictive measures, that countries impose them in response to PTA liberalization when they are not covered by the agreement. In most cases, the significant effects are associated with PTAs in force before 2012, which is consistent with the fact that technical provisions in PTAs require a phase-in period before developing an effect on trade.

The trade elasticities directly estimated from tariffs ($\hat{\sigma}$) are in most sectors higher than the estimates of Fontagné et al. (2022), who use ITC-based tariff data and pool product-level trade to estimate sectoral and aggregate trade elasticities, and higher than the elasticities provided by the GTAP database (see Appendix D for a sector-by-sector comparison). The difference between these estimates and ours may be caused by the inclusion of domestic sales in our gravity model, which allows us to capture trade diversion from the domestic to the international market due to tariffs reductions, akin to effects found for gravity-based PTA estimates (Yotov et al., 2016).

4.2 Regulation-induced trade cost changes

Based on the estimated elasticities, we predict the AVE trade cost changes (ΔT_{sod}) corresponding to changes in bilateral regulatory differences and regulatory stringency over 2012–2017. Table 2 depicts these AVEs for imports, differentiated by NTM dimension, region and sector.[28] The predicted trade cost changes are conditioned on observed NTM changes, which cover in-

[28]Throughout this study we present results by the following regions: East Asia & Pacific (EAP), Europe & Central Asia (ECA), Latin America & Caribbean (LAC), Middle East & North Africa (MENA), North America (NA), South Asia (SA), and Sub-Saharan Africa (SSA). These are aggregated from the individual (country-level) results. For a mapping of countries to income groups and geographic regions see Appendix A.

creases in the average number of measures (regulatory stringency) ranging from about 9% to 24%, net harmonization trends in most agri-food sectors of up to 8%, and net divergence trends in manufacturing of up to 15% (See Table 18 in Appendix C for details). Consequently, regulatory trends across sectors are heterogeneous, which implies that studies using homogeneous cost shocks in counterfactual simulations ignore significant sectoral differences.

The first three columns of Table 2 list trade-weighted NTM AVEs and tariffs by sector across all countries in 2017 and put the magnitude of NTM-related trade cost changes implemented during 2012–2017 into perspective.[29] The comparison between NTM- and tariff-related trade costs highlights the importance of NTMs as trade distortions. NTM AVEs are in general of comparable magnitude to tariffs, although there is much heterogeneity across sectors and in many cases NTMs represent higher trade costs. Between 2012 and 2017, NTM-related trade costs increase by a tariff equivalent of 0.2%, of which changes in bilateral regulatory differences and stringency contribute with an increase of 0.04% and 0.15%, respectively (see columns All, Dif, and Str). These small changes are a function of our relatively large estimates

	All 17	SI 17	Tar 17	All	Dif	Str	SI	High	UM	LM	Low
Grains	13.01	–	15.37	0.99	0.99	–	–	1.23	1.14	0.62	-1.54
Veg & Fruits	33.36	49.95	5.93	-1.45	-3.94	2.55	4.46	-3.21	4.02	-1.56	-3.71
Crops	10.44	6.54	6.11	1.00	1.00	–	0.54	-0.64	2.47	0.52	-0.33
Animal	–	–	4.05	–	–	–	–	–	–	–	–
Extr Nrg	2.42	2.42	1.25	0.27	–	0.27	0.27	0.41	0.08	0.06	0.04
Food Anm	-1.64	–	15.24	-0.28	-0.28	–	–	-1.50	2.36	-1.90	-1.45
Food Plant	9.10	13.80	9.24	-1.49	-1.49	–	1.17	-1.32	-0.79	-3.48	-0.14
Tex	-2.59	-5.16	6.30	-0.43	0.33	-0.78	-0.48	-0.49	-0.38	-0.21	-0.28
Light Mfc	3.62	3.42	2.54	0.27	0.26	0.00	0.40	0.28	0.34	-0.02	0.31
Chem	-2.67	-3.18	3.21	-0.68	–	-0.68	-0.81	-0.62	-0.95	-0.14	-0.08
Pharma	5.78	4.60	1.28	1.10	0.03	1.07	0.88	0.93	2.01	0.12	0.12
Plastics	-1.40	0.28	3.13	-0.41	–	-0.41	0.07	-0.48	-0.40	-0.04	0.16
Mineral	-0.94	–	3.66	-0.25	–	-0.25	–	-0.37	-0.06	-0.09	0.12
Metal	12.44	13.88	2.10	1.75	–	1.75	1.93	2.87	0.62	0.13	0.34
Metal products	1.12	1.12	3.25	0.13	–	0.13	0.13	0.15	0.15	0.00	0.24
Electr Comp	3.36	4.95	2.78	0.04	0.19	-0.15	0.74	0.04	0.26	-0.73	-0.19
Electr Eq	6.48	5.27	3.00	0.60	-0.22	0.82	0.80	0.32	1.55	-0.28	0.21
Machinery	2.28	1.79	2.37	0.35	0.24	0.11	0.28	0.33	0.59	-0.20	0.03
Transport	1.37	-3.00	2.96	0.08	–	0.08	-0.25	0.10	0.03	0.07	0.00
Auto	5.93	–	4.05	0.64	0.60	0.03	–	0.71	0.65	-0.45	0.20
Total	3.77	3.50	3.38	0.19	0.04	0.15	0.43	0.22	0.32	-0.39	-0.07

Table 2: Trade costs and AVE trade cost changes by sector (HET-All, in %)
Trade-weighted trade cost changes calculated for imports across countries. All/SI 2017 are respective baseline values of total NTM-related trade costs for heterogeneous effect (HET) and single indicator (SI) models. Tar 17 (trade-weighted) 2017 baseline applied tariffs. Dif, Str, and All are trade cost changes based on the HET model. SI are trade cost changes based on the SI model. See Appendix A for a detailed listing of sectors and country groups.

[29] In an accompanying database to this paper we provide the 2017 NTM AVEs of harmonization, divergence, as well as stringency estimated using the heterogeneous effects and single indicator model. The database is bilateral, and covers 20 sectors and 78 countries (EU28 as one region). It is available upon request.

of the tariff elasticity, which, by extension, means that small changes in trade costs lead to relatively large trade impacts. Additionally, estimating trade cost changes of NTMs omitting bilateral regulatory differences from the model (column SI) overestimates global trade cost increases (0.4% instead of 0.2%) because of omission of the harmonization trends occurring between 2012 and 2017.

There is significant sectoral heterogeneity also depending on the nature of the effects of regulatory changes (bilateral differences vs. regulatory stringency). On average, we find the largest trade cost changes for metals (1.8%), vegetables and fruits (-1.5%), and plant-based food products (-1.5%). Trade cost reductions of vegetables and fruits, and plant-based food products are caused by harmonization effects that outweigh costs associated with regulatory stringency and divergence. For chemicals, plastics, and textiles the net trade-promoting effects of more stringent standard-like regulation cause trade costs to fall over 2012–2017. By contrast, the regulatory divergence trends across manufacturing sectors increase trade costs for these sectors (Column Dif). Yet, the trade cost reduction for electronic equipment suggests that in this sector countries harmonize with close trade partners rather than with other countries.

Comparing the developments of NTM-related trade costs between 2012 and 2017 to NTM and tariff levels in 2017 shows that the overall trade cost increase of 0.2% is only a small share of tariffs (3.4%) and NTM-related trade costs (3.8%). However, on the sectoral level these changes can represent more than 80% of 2017 tariffs (pharmaceuticals and metals) and about 30% of 2017 NTM trade costs (plastics, minerals, chemicals). Furthermore, these aggregate figures mask significant heterogeneity across NTM trade cost dimensions that unfold bilaterally. For example, divergence- and harmonization-related AVE trade cost changes (of 0.7% and -0.7%, respectively) are about a quarter of tariffs in 2017 and, correspondingly, about 10% and 20% of their 2017 values, which is substantial considering that we capture only 5 years of regulatory developments.

In addition to the heterogeneity observed on the sector-level, we find significant differences in trade cost changes between income groups and between regions. Trade cost changes vary considerably across income groups and sectors, and reach a maximum of 4% (see columns High to Low in Table 2). We observe the largest trade cost reductions for lower-middle income countries, the largest trade cost increases for high and upper-middle income countries, and little change for low income countries. Table 3 reports trade-weighted trade cost changes

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
High	0.31	0.48	-0.27	-0.18	0.43	0.40	0.24	-0.38	0.39	-0.16	-0.24	0.32
UM	0.21	-0.03	-0.48	-0.24	0.30	-0.13	0.03	-0.34	0.20	-0.45	-0.36	0.08
LM	-0.24	0.02	-0.69	0.06	0.17	-0.83	0.17	-0.23	-0.18	-0.40	-0.28	-0.22
Low	-0.15	1.71	0.56	3.73	2.81	0.06	0.78	-0.45	0.19	-0.11	2.26	0.58
EAP	-0.19	0.19	-0.42	-0.15	0.23	-0.51	-0.43	-0.50	-0.41	-0.44	-0.33	-0.11
ECA	0.49	0.25	-0.35	-0.49	0.62	0.44	0.01	-0.28	0.34	-0.24	-0.27	0.35
LAC	1.12	1.11	-1.13	2.38	1.53	-0.03	0.70	-1.60	1.33	-1.23	-1.50	0.99
MENA	0.28	-0.22	0.02	-0.08	0.10	0.32	0.08	-0.24	0.35	0.04	-0.21	0.13
NA	0.32	0.48	-0.43	-0.41	0.24	0.35	0.38	-0.37	0.47	-0.04	-0.58	0.33
SA	-0.06	0.16	-1.15	0.12	-0.01	-0.41	-0.10	0.11	-0.04	-0.04	0.32	-0.12
SSA	0.79	1.78	1.18	1.42	3.04	0.92	1.50	-0.23	1.01	0.08	0.59	1.03
Total	0.22	0.32	-0.39	-0.07	0.37	0.05	0.17	-0.35	0.27	-0.29	-0.26	0.19

Table 3: Trade-weighted AVE trade cost changes by region and income (in %)
AVE trade cost changes calculated for imports (columns) and exports (rows) using trade weights. Trade cost changes based on the heterogeneous effect (HET) model. Tables 19 and 20 in Appendix E provide a differentiation of trade cost changes into harmonization, divergence, and stringency (HET/SI), as well as an overview of trade cost changes by importing and exporting country, and NTM dimension, respectively. See Appendix A for a detailed listing of country groups.

in a matrix of income groups and regions with rows and columns indicating exporters and importers, respectively. We find notable export cost increases for low (0.6%) and high (0.3%) income countries, and relatively large import and export cost decreases of 0.4% and 0.2% for lower-middle income countries, respectively. For low income countries, trade costs reductions are mostly due to harmonization events related to agri-food sectors, while for lower-middle income countries trade cost reductions are present across most sectors (see also Table 2).

Finally, with respect to regional patterns, intra-regional trade costs rise in most regions except for Middle East & North Africa and South Asia. Trade cost increases with geographically close trade partners (i.e. within region and with neighbor regions) are noteworthy in and between Latin and North America. For Latin American & Caribbean exporters, the combination of intra-regional trade cost increases and higher trade costs with large markets in East Asia & Pacific and Europe & Central Asia results in an overall trade cost increase despite significant export cost reductions with other regions. By contrast, regulatory changes faced by East Asia & Pacific exporters lead to further integration into the world economy as their export costs drop across most regions for agri-food and manufacturing sectors alike. Lastly, the apparent heterogeneity in trade cost changes shown in Table 3 is mostly due to changes in bilateral regulatory differences and missing in the single indicator model (see Table 19 in Appendix E for a comparison).

4.3 Trade and income effects in general equilibrium

We first assess the general equilibrium effects on aggregate and sectoral trade flows of NTM-related trade cost changes over 2012-2017. In contrast to partial equilibrium effects, general equilibrium effects factor in trade cost changes in third countries through multilateral resistances and input-output linkages and account for the effects of all NTM changes and their impacts on prices and income simultaneously. Overall, this decouples the relationship between partial and general equilibrium effects. Partial and general equilibrium effects show a correlation of 0.75 for country pairs subject to NTM trade cost changes and of 0.61 for all pairs. The differential between between general and partial equilibrium effects is on average 2.2% for pairs subject to NTM changes and 1.07% for all pairs. These averages mask large heterogeneity with the 90% central mass of the distribution of the differential between general and partial equilibrium effects lying between -7.6% and 15.9% for pairs subject to NTM changes and between -5% and 9% for all pairs (see Appendix F for details). A summary of the estimated general equilibrium trade effects is shown in Table 4.

The NTM-related trade cost changes implemented during 2012–2017 decrease global trade by 1.4%. This overall effect is composed of a 1.8% decrease in goods trade and a 0.15% increase in services trade. Given that we only model trade cost changes in goods sectors, service trade changes are diversion effects. The reduction in goods trade is equivalent to about 40% of the

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
High	-1.82	-2.09	-0.15	0.48	-1.20	-2.47	-2.43	0.45	-2.83	0.36	-0.37	-1.76
UM	-1.95	0.68	-0.09	-0.74	-2.06	-1.23	-0.83	-1.20	-0.45	-0.05	-1.53	-1.21
LM	-0.08	-0.49	1.62	0.21	-0.73	0.76	0.02	0.05	-0.11	1.10	0.63	0.00
Low	0.47	-2.00	1.32	-3.86	-1.99	-0.29	-1.40	1.82	0.41	1.58	-2.52	-0.05
EAP	-1.27	-1.36	-0.85	-1.62	-2.31	-0.59	0.59	-0.72	0.35	-0.43	-1.98	-1.24
ECA	-1.92	-1.19	0.71	1.61	-0.91	-2.61	-0.12	0.43	-2.17	0.86	-0.20	-1.49
LAC	-2.35	-1.10	3.66	-2.64	-0.80	-2.45	-1.59	1.59	-2.36	3.48	2.57	-1.70
MENA	-1.27	2.29	0.18	0.33	1.05	-1.91	-1.01	0.17	-1.82	0.11	0.13	-0.31
NA	-2.46	-2.66	0.80	0.95	0.05	-2.09	-3.95	-0.01	-4.42	0.71	0.65	-2.35
SA	0.01	0.15	3.15	-0.11	1.20	0.36	-0.52	-0.80	-0.16	1.14	-0.32	0.30
SSA	-1.35	-1.33	0.61	-0.63	-1.44	-1.81	-4.25	1.50	-1.88	1.52	0.19	-0.91
Total	-1.71	-1.35	0.04	-0.08	-1.40	-1.71	-1.89	0.03	-1.79	0.33	-0.66	-1.43

Table 4: Trade changes by region and income (in %)
Trade flow changes calculated for imports based on the heterogeneous effect (HET) model. A differentiation of trade changes into harmonization, divergence, and stringency effects (HET/SI) is provided in Table 23 in Appendix F. See Appendix A for a detailed listing of country groups.

actual global decline in merchandise trade that took place over the same period.[30] Therefore, the changes in technical regulation seem to contribute significantly to the global decline in goods trade over 2012–2017, while corresponding spillover effects on services trade only explain a small fraction services trade growth during this period.

Table 4 presents these trade effects differentiating by income groups and regions. The top-left quadrant and corresponding totals in the last row (imports) and column (exports) show trade changes by income levels. Trade cost changes decrease trade of high and upper-middle income countries by 1.2% and 1.8%, whereas trade of low and lower-middle income countries remain relatively unchanged. Patterns of trade changes between income groups show further heterogeneity. High income countries trade less with each other (-1.8%) and upper-middle income countries (-2.1% for exports, -2% for imports), while upper-middle income countries trade more among themselves (0.7%) but less with the rest of the world. Low income countries shift their export orientation from upper-middle and other low income countries to high and lower-middle income countries resulting in a slight overall decrease of exports of 0.1%, while their total imports decrease by 0.1% driven by lower import volumes from upper-middle and low income countries.

The bottom-right quadrant and corresponding totals in the last row (imports) and column (exports) show trade changes on a regional level. Regulatory developments lead to reductions of imports and exports in most regions of up to almost 2.4% (in North America). South Asia's trade benefits from regulatory changes, increasing exports to Asia and Europe and imports from most regions, while in Middle East & North Africa total trade flows remain unchanged. By contrast, trade decreases significantly in the Americas, East Asia & Pacific, Europe & Central Asia. Especially, NTM changes in the Americas divert trade away from the continent in favor of imports from East Asia & Pacific and exports to African and South Asian countries. This is also the case of East Asia & Pacific, which reduce intra-regional trade by 2.3%. In this regard, integrating with oversea markets at the cost of diverging from important existing trade partners seems to reduce overall trade as trade costs changes apply to larger trade volumes. We further observe a reorientation of trade flows of Sub-Saharan Africa associated with a net decrease of imports and exports. In particular, Sub-Saharan Africa imports significantly less from East Asia & Pacific, exports more to neighboring Middle East & North Africa and South

[30] Global exports of goods decrease by about 4.1% and global exports of services increase by about 20% from 2012 to 2017 according to the World Development Indicators.

Asia, and exports less to high and upper-middle income markets in Europe & Central Asia and North America. Overall, these trade changes suggest a more relevant role of South Asia and Middle East & North Africa in the global trade network.

The changes in trade on the country and regional level shown in Table 4 are driven by highly heterogeneous sectoral patterns. Figure 1 displays sectoral changes (points) and contributions to global trade changes for the different NTM-cost dimensions (bars). Globally, regulatory changes most significantly affect trade in chemical and pharmaceutical products, metals, motor vehicles and electrical equipment. These are also the most important sectors in terms of the contribution of trade cost changes to shifts in world trade. Summing across bars results in the total decrease in world trade volume of 1.4% shown in Table 4, of which harmonization, divergence and stringency contribute approximately 1.8, -2.6, and -0.6 percentage points, respectively.[31] The significant contribution of manufacturing sectors to world trade changes is a consequence of their relatively high trade shares and elasticities, although agri-food sectors are affected by larger trade cost changes. Additionally, the dominance of divergence over harmonization effects mainly derives from manufacturing sectors, whereas in most agri-food sectors trade benefits from relatively larger harmonization effects. Finally, regulatory stringency notably shows trade-promoting effects in chemicals, textiles, and electrical computers, which significantly contribute to overall changes in trade.

Turning to the real income effects of trade costs from NTM changes over 2012–2017, Figure 2 shows a scatter plot of the estimated real income and AVE changes aggregated at the country level, differentiating by the absolute change in regulatory stringency (size of dots) and development level (color of dots). Real income and NTM-related trade cost changes are mildly negatively correlated, with a stronger correlation with respect to import costs. Several factors contribute to these patterns. First, fitted lines reflect an upper bound of the negative relationship between real income and trade cost changes, as they include countries with zero net trade cost changes. Some of these countries simply do not show much regulatory activity and the corresponding dots are small (e.g. export cost changes for Jamaica), whereas other countries display significant regulatory activity, with relatively big corresponding dots (e.g. import cost changes for China). Second, regulatory activity can target sectors of small economic importance or sectors with relatively inelastic supply and demand. In these cases, the

[31] The decomposition is not exact because of the non-linear transformation of trade volume effects into AVE trade cost changes in Equation (6).

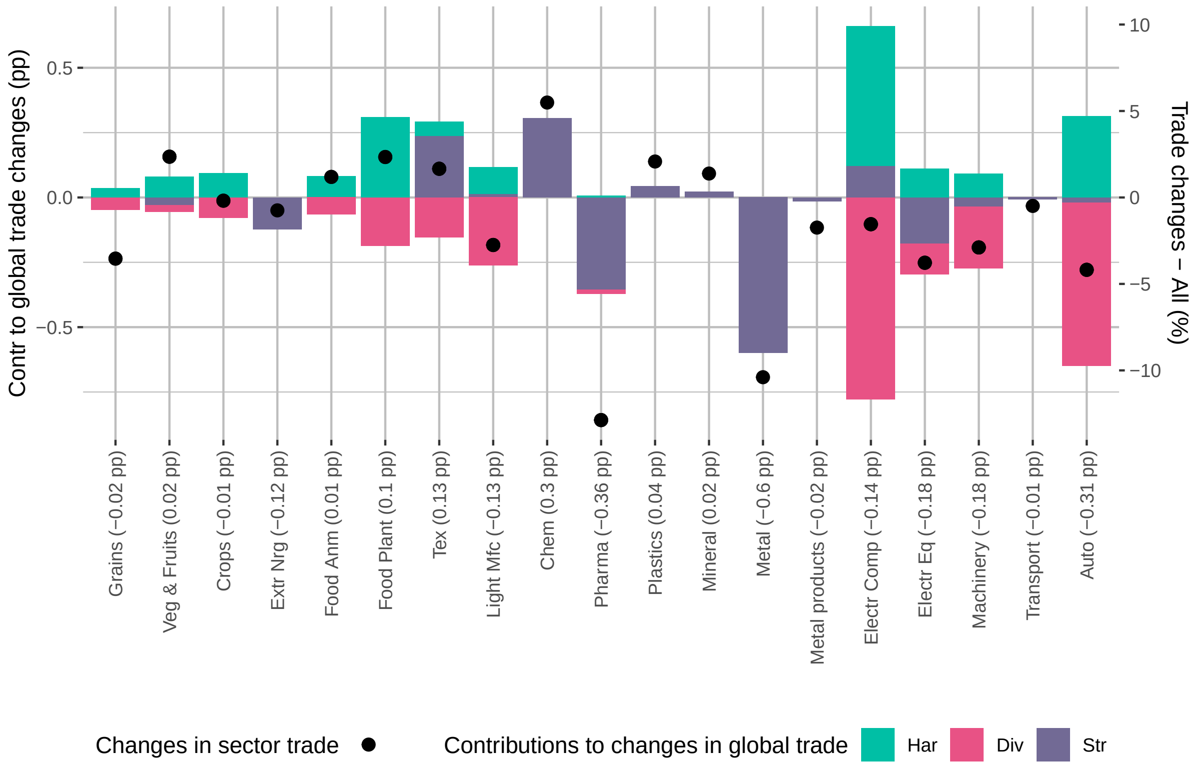

Figure 1: Trade changes (in %) and contributions to world trade changes (pp)
Results calculated for imports and based on the heterogeneous effect (HET) model. Total trade flows by sector are represented by black dots with the secondary/right y-axis as reference. Contributions are in percentage points (pp) to global trade flow changes and represented by bars with primary/left y-axis as reference. Total contributions in pp to global trade flow changes in parentheses. See Appendix A for a detailed listing of sectors.

macroeconomic effects are expected to be small. This seems to be the case for Russia, which despite decreasing import and export costs does not display significant real income effects. Third, regulatory changes may lead to export and import cost changes that have opposing effects, which renders real income changes as a net effect of the two. The stronger correlation of changes in real income and import costs suggests that import cost changes dominate real income effects over export cost changes. Finally, third-country (e.g. multilateral resistance) effects affect the strength of the relationship. This is relevant in our experiment, as we simulate the effects of NTM changes introduced by all countries. Prior research highlights that, although bilateral effects of a trade policy change outweigh indirect, third-country effects, the accumulation of third-country effects from many policy shocks can be a significant share of total effects of trade policy changes (e.g. Fernández-Amador and Garcés, 2024).

Country-level real income changes presented in Figure 2 translate into a global loss of real income of 0.06%. Two factors explain the small income effect when compared to the global trade effect. First, our trade shocks are restricted to international trade effects (border effects) on goods, which represent about 30% of global goods production.[32] Second, negative international trade effects are compensated by an increase in domestic sales. The net decline of real income is the result of negative divergence and net negative stringency effects dominating positive harmonization effects. In total, regulatory differences and stringency have similar effects of about -0.03%. Table 5 presents a decomposition of the contribution of these trade cost dimensions to real income changes and highlights that the total effect is heterogeneous across income groups and regions ranging from -0.11% to 0.08% and -0.13% to 0.14%, respectively. The income loss of 0.03% related to changes in regulatory differences is composed of much larger harmonization and divergence effects of 0.19% vs. -0.22%, respectively. We find net real income gains from changes in bilateral regulatory differences for lower-middle income countries, as well as countries in Europe & Central Asia, Middle East & North Africa, and South Asia, where positive harmonization effects dominate negative divergence effects.

To establish the statistical evidence of the results, we further estimate the distribution of the real income effects conditioned on the bootstrapped sample of the coefficients of the gravity

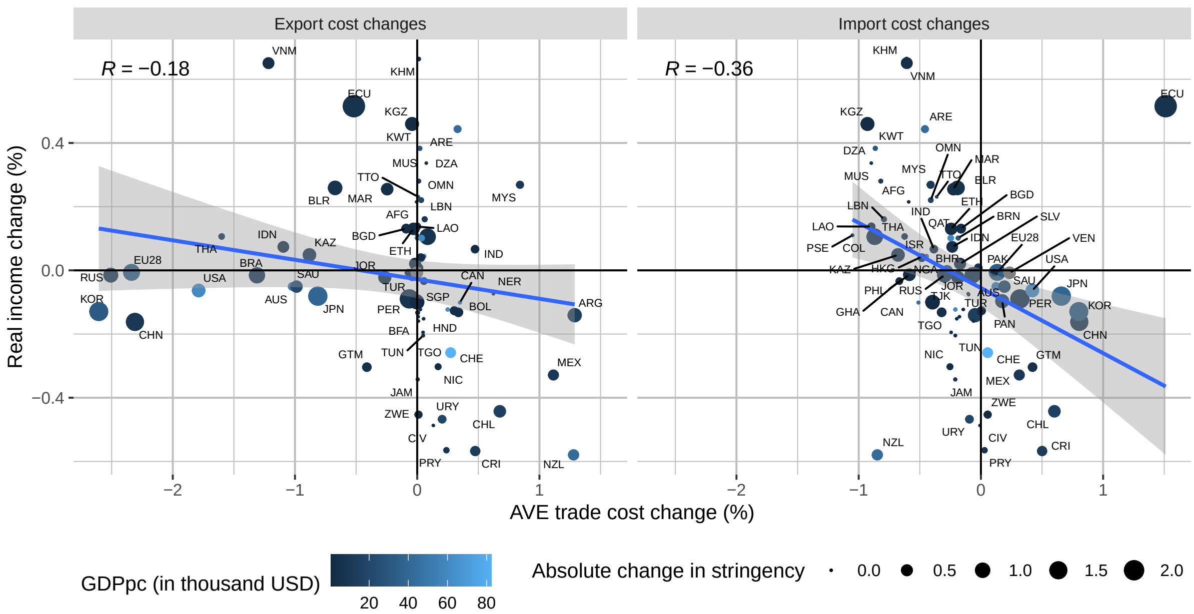

Figure 2: Trade costs and real income changes in general equilibrium
Estimates shown based on the heterogeneous effect (HET) model. Dot size is determined by the absolute change in the average number of measures per product from 2012–2017, i.e. regulatory stringency.

[32]Across all sectors, including services, the trade share of goods is about 10% in our dataset. Trade in goods and services as a share of GDP is ca. 30% (World Development Indicators).

model. Figure 3 displays the boxplots corresponding to the income effects per income group and region. In general, the results are statistically robust, as the central 50% of the distribution mass is different from zero. Although less strict than typical significance levels, this criterion seems an appropriate statistical range, as our experiment accounts for statistical variation of a large number of trade cost shocks (71,188). On a more conservative approach, we can observe that a large segment of the whiskers are also different from (do not cross) zero. Only the boxes for low income countries and the Europe & Central Asia region contain zero changes, while a large whiskers' segment crosses zero for high income countries and for the East Asia & Pacific and Sub-Saharan Africa regions.

Our macroeconomic results seem conservative compared to prior research. Webb et al. (2020) and Walmsley and Strutt (2021) estimate a 20% reduction of NTM-related trade costs of and within ASEAN countries and find positive GDP effects between 0.2% to 1.3% and 0.1% to 0.3%, respectively. We attribute this difference to the different modeling approach in the gravity estimation and the short time frame of our simulations.[33] Furthermore, our income estimates are smaller than the effects of upgrading all existing PTAs to deep PTAs (0.4% GDP growth, Fontagné et al., 2021), improving trade facilitation infrastructure in middle and low income countries (0.98% change in real consumption, Oberhofer et al., 2021), and the Brexit on the UK economy (1.3% change in equivalent variation as share in consumption, Dhingra et al., 2017). The difference to our estimates can be explained by the larger scope of the economic integration processes modeled in these studies relative to the five years of regulatory trends analyzed in this study. Additionally, income effects at the country level can be much larger than overall average effects.

Finally, there are different sectoral dynamics underlying these aggregate income effects. Figure

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
All	-0.05	-0.11	0.08	-0.04	-0.10	-0.02	-0.13	0.14	-0.07	0.06	-0.05	-0.06
Difference	-0.01	-0.11	0.06	-0.02	-0.10	0.01	-0.04	0.15	-0.02	0.05	-0.03	-0.03
Divergence	-0.15	-0.40	-0.13	-0.33	-0.46	-0.12	-0.20	-0.06	-0.11	-0.02	-0.14	-0.22
Harmonization	0.15	0.31	0.20	0.34	0.38	0.13	0.17	0.22	0.09	0.07	0.12	0.19
Stringency	-0.04	-0.01	0.02	-0.02	0.00	-0.03	-0.09	-0.01	-0.05	0.02	-0.02	-0.03

Table 5: Decomposition of real income changes of HET-All scenario (in %)
NTM shock is 100% iceberg cost (t^{τ}_{sod}). Fully disaggregated country-level real income estimates provided in Table 24 in Appendix F. See Appendix A for a detailed listing of country groups.

[33] Real GDP effects of the six ASEAN countries in our benchmark scenario are on average 31% smaller. Mimicking scenarios of Webb et al. (2020) and Walmsley and Strutt (2021), a 20% reduction in Str based on the single indicator gravity model results in 41% and 63% lower real GDP effects. Details and results of the ASEAN-only simulations are available upon request.

4 shows the sectoral contributions to real income of five aggregate sectors by income groups and regions. Harmonization trends in agri-food sectors and trade-promoting technical measures in textiles and chemicals contribute positively to real income changes across most regions and income levels. Particularly, these positive effects are noticeable in the Middle East & North Africa and South Asia, where regulatory changes in agri-food sectors and textiles drive the overall positive real income effects highlighted in Table 5. By contrast, for the majority of regions and income groups, there are negative real income effects from regulatory divergence trends in manufacturing and transport sectors, and from increasing trade-restricting stringency in minerals and metals.

4.4 Robustness of the results

We perform a series of robustness checks to analyze the sensitivity of the results to our modeling assumptions (see Appendix G for details). First, we compare gravity estimates, trade

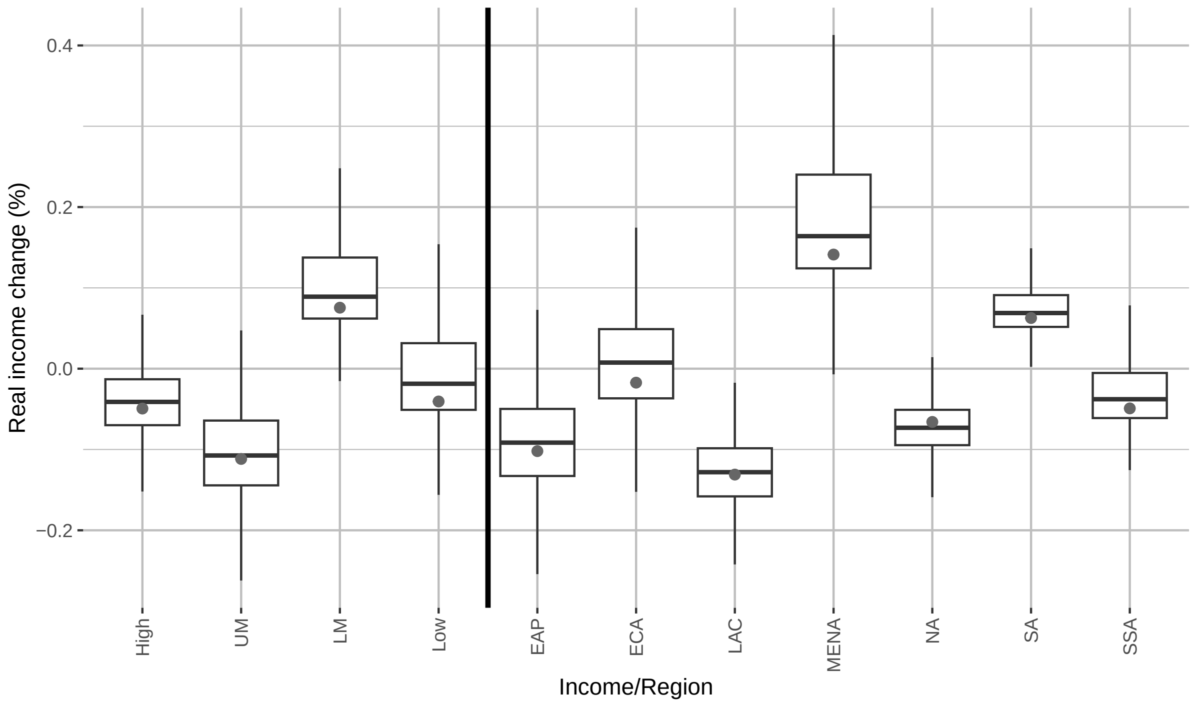

Figure 3: Distribution of real income changes (in %)
Estimates of real income changes based on the heterogeneous effect (HET) model. Distribution of real income changes based on trade cost changes calculated for each of the 500 bootstraps b of Equation (1). We calculate ΔT^{b}_{sod} of Equation (6) for each $\hat{\beta}^{Dif,b}_{sod}$, $\hat{\beta}^{Str,b}_{sod}$ and $\hat{\sigma}^{b}_{s}$ and simulate corresponding trade and income effects. Shock implemented as iceberg trade cost implementation $\{t^{\tau}_{sod}\}$. Dots indicate real income changes based on the main (average) scenario presented throughout the text. See Figure 10 in Appendix F for country-level results. See Appendix A for a detailed listing of country groups.

and income results of our benchmark model (HET model) to the single indicator model (SI model), which does not account for pair-specific effects of NTMs. With respect to the gravity regressions, excluding bilateral regulatory differences wrongly attributes part of their trade cost effect to the regulatory stringency indicator, which is biased and tends to be more restrictive (see also Vogt, 2022; Xiong and Beghin, 2014).[34] The bias implies attributing trade cost changes of bilateral nature (associated with bilateral regulatory differences) to a destination-specific variable (regulatory stringency), which can significantly affect policy simulations.

Comparing the general equilibrium results between the HET and the SI model shows that accounting for bilateral regulatory differences when modeling NTM-related trade costs leads to significantly different changes in trade patterns. Although both modeling approaches lead to a total reduction of global trade volume of 1.4%, country-level changes in exports vary significantly with the chosen econometric specification. Changes in regulatory stringency are less trade restrictive in the benchmark (HET) model due to including bilateral regulatory differences. Thus, under exclusion of bilateral regulatory differences in the estimation of the gravity model (SI model), the regulatory stringency indicator captures part of the bilateral trade cost

Figure 4: Contribution of aggregate sectors to real income changes (in %)
Estimates of real income changes based on the heterogeneous effect (HET) model. See Appendix A for a detailed listing of sectors and country groups.

[34]See Appendix G for detailed regression results.

effects, resulting in biased, more trade-restrictive general equilibrium outcomes. Additionally, while we find positive and negative real income and GDP effects in the benchmark model (HET), the single indicator model mostly yields negative macroeconomic effects.

Second, we analyze the effect of modeling trade cost shocks in the general equilibrium model through changes in iceberg costs, import tariffs or export taxes. Overall, the choice of the modeling approach does not significantly affect the patterns of real income effects across regions and income groups. Modeling regulatory changes as iceberg trade costs results in larger income effects, which is consistent with efficiency gains and losses and the corresponding expansion effect associated with changes in iceberg trade costs. Modeling changes in NTM trade costs as import tariffs vs. export taxes does not lead to significantly different results.

Finally, we test the sensitivity of our results to the inclusion of outliers in regulatory changes that we correct for in the benchmark scenario. Total income effects are slightly larger when the outlying regulatory changes are not corrected. However, the results are qualitatively very similar across income groups and regions and only change sign for Europe & Central Asia.

5 Conclusion

Changes in standard-like NTMs over 2012–2017 increased trade costs by a tariff equivalent of 0.2%, which led to a global decrease in trade by 1.4%. For merchandise trade alone, the corresponding decrease of 1.8% represents about 40% of the actual decline in trade from 2012–2017. A a result, world real income dropped by ca. 0.06%. The aggregate figures mask significant heterogeneity in trade cost at the bilateral level, which are captured by regulatory harmonization- and divergence trends. These are equivalent to trade cost changes representing about a quarter of 2017 tariffs. The pairwise heterogeneity in trade costs, the MFN nature of NTMs, as well as the impact through global supply chains determines significant variation in trade and income effects at the country and sector level.

Trade patterns shifted towards a relatively more relevant role of South Asia and Middle East & North Africa in the global trade network. The shift in trade patterns reflected changes across all sectors with the highest contribution of auto, chemical, and metal sectors. Overall, these effects are substantial, given the short time period (5 years) considered.

This study conveys two lessons for modeling NTMs in emphasizing the relevance of accounting for pair-specific trade frictions and third-country effects of regulatory changes. First, introducing bilateral regulatory differences that reflect the underlying trade cost structure of standard-like NTMs captures regulatory harmonization and divergence trends and matters significantly for the final outcome of regulatory reform simulations. Second, modeling isolated scenarios of NTM reforms leads to biased inference because most NTM regulations change vis-á-vis all countries and are not confined to a limited set of countries. Furthermore, the interaction between regulatory changes across trading partners is a source of third-country effects which are quantitatively relevant.

Our findings imply that the design of technical regulation significantly changes trade costs vis-á-vis import sources and export destinations. A regulatory strategy that aims to promote trade with new markets should be assessed against its consequences for current trading relationships, and policy reforms involving technical regulatory changes should be informed by regulatory developments of main trading partners. Moreover, addressing market failures through technical regulation does not necessarily lead to larger trade costs when there is a net harmonization effect with all trading partners. Long-term policy reforms that account for the international trade cost environment are expected to generate significant trade and income gains beyond their primary regulatory objective. Technical provisions in PTAs seemed to deepen regulatory coordination between members, decreasing associated trade costs and increasing trade and real income over 2012–2017. Nevertheless, further improvements can be expected from advancing international coordination on technical measures and standards.

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Appendices

- A: Data description
- B: Endogeneity correction
- C: Outlier detection & imputation of regulatory change
- D: Results from gravity regressions
- E: Trade cost estimates
- F: Additional trade and macroeconomic results
- G: Sensitivity analysis

A Data description

The analysis is carried out for a disaggregation of 78 countries and regions and 21 sectors (see Tables 6 and 8). Table 9 provides a summary of the variables used. We source data on technical regulations from NTMTRAINS (UNCTAD, 2017), which contains detailed product-level information about the number and types of technical measures. NTMTRAINS is based on full legislative reviews conducted at a given point in time and is thus suitable to analyze regulatory differences, which contrasts notification-based data sources that contain information on changes in regulation but do not offer complete regulatory profiles.

Depending on the year of data collection, NTMTRAINS records the earliest year for which a specific type of measure is in force, which enables us to calculate changes in regulatory differences between 2012 and 2017. However, the number of measures of a certain type is constant for each vintage of data collection—e.g. if three conformity assessment requirements are imposed in 2017 the data only indicates the earliest year in which any of those three measures was introduced and omits information on potential joint introduction or phasing-in of additional measures. Therefore, only information about entry into force of measure types is available.[35] For example, if there are two labeling requirements in force in 2017, NTMTRAINS provides information about when the older of the two enter into force. Moreover, it is uncertain whether technical measures are new or a replacement of existing regulation—e.g. a labeling requirement that enters into force in 2016 and is imposed in the year of data collection (e.g. 2017) may be a new measure type (i.e no labeling requirement in force before 2016) or may be a replacement of a labeling policy in force before 2016. In the former (latter) case, the regulatory structure of the country imposing the measure changes (remains constant). Thus, uncertainty about the entry into force of measures when more than one measure of a specific type exist and about whether a measure introduces substantially new regulation constrains the information about the number of measures per country and product to a cross section. Consequently, we collapse the dataset into a cross section. If a legislative review is not available for the reference year 2017, we give preference to information from the latest available collection year prior to 2017 over data collected after 2017. In either case, we use entry into force dates for specific measure types to limit the analysis to measure types in force in 2017.

[35] The difference between unique number of specific measure types and total number of measures is particularly significant in agri-food sectors.

Tables 10 and 11 provide a description of the technical measures included in the bilateral regulatory difference (Dif) and regulatory stringency (Str) indicators. In total, our analysis includes 76 types of technical measures of which 39 are likely imposed on domestic firms and defined sufficiently narrow to enter indicators reflecting regulatory differences.[36] Thus, for Dif_{od} we exclude measures defined at high levels of the MAST classification or those coded as "not elsewhere specified/classified" because for such broadly defined measure groups we cannot establish whether regulatory profiles are (dis)similar and lead to corresponding changes in difference-based trade costs captured by Dif_{od}. Furthermore, we source WTO notifications from Ghodsi et al. (2017) to construct indicators of change in regulatory stringency used to detect outliers (see Appendix C). Ghodsi et al. (2017) impute HS codes based on text matching techniques, which increases the product coverage compared to notification directly obtained from the WTO. Their data is available until 2016 such that changes from 2012 to 2016 are a reasonable proxy for changes from 2012 to 2017.

Applied tariffs are the simple average of tariffs compiled at the 6-digit HS-level from ITC MacMap, the TRAINS database, and WTO. We give preference to preferential and MFN tariffs from MacMap because it is the main data provider to the GTAP database. We fill gaps in MacMap with TRAINS' preferential or applied MFN tariffs, as well as WTO bound rates if MacMap and TRAINS do not contain any tariff information. Reporting gaps are filled with the latest available rates, assuming that for preferential rates the reporting gap is shorter than 5 years.

The variables in vector Z_{od} and instruments I_{od} include standard trade cost variables from CEPII (log of physical distance, contiguity, log of differences in latitude, common legal background, colonial past, time difference, common religion, common official language), a common language variable from Gurevich et al. (2021), PTA information from Hofmann et al. (2017), and an indicator variable representing whether two countries used to be the same. Moreover, to control for bilateral differences in governance, polity and endowments we use the first three components of a principal component analysis of absolute bilateral difference in governance indicators from the World Bank (voice and accountability, political stability and absence of violence, government effectiveness, rule of law, control of corruption), polity indicators from

[36] Data in NTMTRAINS is coded according the NTM classification developed by the Multi-Agency Support Team (MAST), which distinguishes between over 170 different types of technical and non-technical NTMs (UNCTAD, 2019).

Freedom House (level of democracy, civil liberties, political rights), Polity IV (regime durability), political competition (Vanhanen, 2019) and political constraints (Henisz, 2017), as well as endowments captured by differences in the capital-labor ratio, a human capital index (both taken from the Penn World Tables), and land area retrieved from the World Bank. Additionally, Z_{od} includes an international border interaction with the OECD trade facilitation indicator and a variable representing the combined economic mass of the country pair (log of combined GDP retrieved from the World Bank), which captures inter-sectoral spillover effects and supply chain integration that increase with the size of the economy.

Lastly, we obtain international and domestic trade data for the gravity estimations from the GTAP 11 database (Aguiar et al., 2022), which is also the underlying database for the general equilibrium model. We model the trade and real income effects of changes in NTMs for 78 countries (see Table 6) that are represented in the GTAP and NTMTRAINS database with one rest-of-world (ROW) region and the EU as one bloc.[37] On the sectoral level, GTAP's goods sectors are aggregated to 20 sectors (see Tables 6 and 8), for which we assume that trade cost determinants included in the gravity regressions are relatively homogeneous. In total, the analysis – i.e. trade between non-ROW countries – covers 84% of world goods trade.

[37]NTMTRAINS data are collected for EU legislation. EU countries enter separately into the gravity equation to allow for a clear pairwise mapping of trade cost variables (e.g. colonial history, common language). For the general equilibrium assessment we aggregate EU countries to one bloc to avoid varying trade cost changes depending on which EU country is importer or exporter. Thus, countries' AVE trade cost changes with EU countries are aggregated based on their respective trade weights. Moreover, rest of the world (ROW) countries do not enter the gravity estimations and are not affected by trade cost changes.

ISO	Name	ISO	Name	ISO	Name
AFG	Afghanistan	GIN	Guinea	NPL	Nepal
ARE	United Arab Emirates	GTM	Guatemala	NZL	New Zealand
ARG	Argentina	HKG	Hong Kong SAR China	OMN	Oman
AUS	Australia	HND	Honduras	PAK	Pakistan
BEN	Benin	IDN	Indonesia	PAN	Panama
BFA	Burkina Faso	IND	India	PER	Peru
BGD	Bangladesh	ISR	Israel	PHL	Philippines
BHR	Bahrain	JAM	Jamaica	PRY	Paraguay
BLR	Belarus	JOR	Jordan	PSE	Palestinian Territories
BOL	Bolivia	JPN	Japan	QAT	Qatar
BRA	Brazil	KAZ	Kazakhstan	RUS	Russia
BRN	Brunei	KGZ	Kyrgyzstan	SAU	Saudi Arabia
BWA	Botswana	KHM	Cambodia	SEN	Senegal
CAN	Canada	KOR	South Korea	SGP	Singapore
CHE	Switzerland	KWT	Kuwait	SLV	El Salvador
CHL	Chile	LAO	Laos	TGO	Togo
CHN	China	LBN	Lebanon	THA	Thailand
CIV	Cote d'Ivoire	LKA	Sri Lanka	TJK	Tajikistan
CMR	Cameroon	MAR	Morocco	TTO	Trinidad & Tobago
COL	Colombia	MEX	Mexico	TUN	Tunisia
CRI	Costa Rica	MLI	Mali	TUR	Turkey
DZA	Algeria	MUS	Mauritius	URY	Uruguay
ECU	Ecuador	MYS	Malaysia	USA	United States
ETH	Ethiopia	NER	Niger	VEN	Venezuela
EU28	European Union	NGA	Nigeria	VNM	Vietnam
GHA	Ghana	NIC	Nicaragua	ZWE	Zimbabwe

Table 6: Country ISO codes and names

	High	UM	LM	Low
EAP	AUS; BRN; HKG; JPN; KOR; NZL; SGP	CHN; MYS; THA	IDN; KHM; LAO; PHL; VNM	
ECA	CHE; EU28	BLR; KAZ; RUS; TUR	KGZ	TJK
LAC	CHL; PAN; TTO; URY	ARG; BRA; COL; CRI; ECU; GTM; JAM; MEX; PER; PRY; VEN	BOL; HND; NIC; SLV	
MENA	ARE; BHR; ISR; KWT; OMN; QAT; SAU	DZA; JOR; LBN	MAR; PSE; TUN	
NA	CAN; USA			
SA		LKA	BGD; IND; PAK	AFG; NPL
SSA		BWA; MUS	CIV; CMR; GHA; NGA; SEN; ZWE	BEN; BFA; ETH; GIN; MLI; NER; TGO

Table 7: Country regional aggregation and income levels

Nr	Aggregation	GTAP Sector
1	Grains	pdr: Paddy rice; wht: Wheat; gro: Cereal grains nec
2	Veg & Fruits	v_f: Vegetables, fruit, nuts
3	Crops	osd: Oil seeds; c_b: Sugar cane, sugar beet; pfb: Plant-based fibers; ocr: Crops nec
4	Animal	ctl: Bovine cattle, sheep and goats, horses; oap: Animal products nec; rmk: Raw milk; wol: Wool, silk-worm cocoons; fsh: Fishing
5	Extr Nrg	coa: Coal; oil: Oil; gas: Gas; oxt: Other Extraction (formerly omn Minerals nec); frs: Forestry; p_c: Petroleum, coal products
6	Food Anm	cmt: Bovine meat products; omt: Meat products nec; mil: Dairy products
7	Food Plant	vol: Vegetable oils and fats; pcr: Processed rice; sgr: Sugar; ofd: Food products nec; b_t: Beverages and tobacco products
8	Tex	tex: Textiles; wap: Wearing apparel; lea: Leather products
9	Light Mfc	lum: Wood products; ppp: Paper products, publishing; omf: Manufactures nec
10	Chem	chm: Chemical products
11	Pharma	bph: Basic pharmaceutical products
12	Plastics	rpp: Rubber and plastic products
13	Mineral	nmm: Mineral products nec
14	Metal	i_s: Ferrous metals; nfm: Metals nec
15	Metal products	fmp: Metal products
16	Electr Comp	ele: Computer, electronic and optical products
17	Electr Eq	eeq: Electrical equipment
18	Machinery	ome: Machinery and equipment nec
19	Transport	otn: Transport equipment nec
20	Auto	mvh: Motor vehicles and parts
21	Services	ely: Electricity; gdt: Gas manufacture, distribution; wtr: Water; cns: Construction; trd: Trade; afs: Accommodation, Food and service activities; otp: Transport nec; wtp: Water transport; atp: Air transport; whs: Warehousing and support activities; cmn: Communication; ofi: Financial services nec; ins: Insurance (formerly isr); rsa: Real estate activities; obs: Business services nec; ros: Recreational and other services; osg: Public Administration and defense; edu: Education; hht: Human health and social work activities; dwe: Dwellings

Table 8: Sector aggregation

Table 9: Variable description

Variable	Type	Description	Source
Dif	Continuous	Bilateral regulatory difference indicator	NTMTRAINS, Authors
Str	Continuous	Regulatory stringency indicator	NTMTRAINS, Authors
Tariff	Continuous, log	Applied tariffs, entering as ln(1 + Tariff/100)	MacMap/TRAINS/WTO
Tariff Margin	Continuous, log	Difference in MFN and applied tariff, entering as ln(1 + Margin/100)	MacMap/TRAINS/WTO
Msh	Continuous	Predicted import share	Authors
Xsh	Continuous	Predicted export share	Authors
EU	Indicator	1 if both countries are in the EU	Authors
PTA pre/post 2012	Indicator	1 if two countries are in a PTA (PTA in force pre/post 2012)	World Bank
PTA Tech pre/post 2012	Indicator	1 if two countries are in a PTA that has a SPS or TBT provision (PTA in force pre/post 2012)	World Bank
Border	Indicator	1 if international trade	Authors
Trade Facilitation	Continuous	Trade facilitation index	OECD
Contiguity	Indicator	Country pair shares a common border	CEPII
Distance	Continuous, log	Log of distance	CEPII
Latitude	Continuous	Absolute difference in latitude	Authors
Time diff	Continuous	Absolute difference in GMT offset	CEPII
Comcol	Indicator	1 if countries share a common colonizer post 1945	CEPII
Col 45	Indicator	1 if countries are or were in colonial relationship post 1945	CEPII
Same col ever	Indicator	1 if pair ever had the same colonizer (incl. before 1948)	CEPII
Col dep ever	Indicator	1 if pair ever was in colonial or dependency relationship (incl. before 1948)	CEPII
Same country	Indicator	1 if two countries were the same before	Authors
Comlang	Continuous	Language similarity	Gurevich et al. (2021)
Comlang off	Indicator	1 if countries share common official or primary bilateral language	CEPII
Comrelig	Continuous	Similarity in religious composition	CEPII
Comlegal (pre)	Indicator	1 if countries share common legal origins before 1991	CEPII
Comlegal (post)	Indicator	1 if countries share common legal origins after 1991	CEPII
Mass	Continuous, log	Economic mass of country pair, entering as $\ln(GDP_o + GDP_d)$	World Bank
PCA1	Continuous	Index for absolute difference in endowments, governance and polity (PCA, first component)	Various
PCA2	Continuous	Index for absolute difference in endowments, governance and polity (PCA, second component)	Various
PCA3	Continuous	Index for absolute difference in endowments, governance and polity (PCA, third component)	Various
PCA Variables			
AREA	Continuous	Land area	World Bank
KL	Continuous	Capital/Labor ratio calculated from PWT data	PWT
hc	Continuous	Human capital index	PWT

Variable	Type	Description	Source
vae	Continuous	Voice and Accountability	World Bank, WGI
pve	Continuous	Politial stability and absence of violence/terrorism	World Bank, WGI
gee	Continuous	Government effectiveness	World Bank, WGI
rqe	Continuous	Regulatory quality	World Bank, WGI
rle	Continuous	Rule of law	World Bank, WGI
cce	Continuous	Control of curruption	World Bank, WGI
fh_cl	Continuous	Civil liberties	Freedom House
fh_pr	Continuous	Political rights	Freedom House
fh_ipolity2	Continuous	Level of democracy	Freedom House
p_durable	Continuous	Regime durability	Polity IV
van_comp	Continuous	Political competition	Vanhanen (2019)
h_polcon5	Continuous	Political constraint index	Henisz (2017)

Measure group	Detailed measure description
SPS tolerance and use	A200: Tolerance limits for residues and restricted use of substances ; A210: Tolerance limits for residues of or contamination by certain (non-microbiological) substances; A220: Restricted use of certain substances in foods and feeds and their contact materials
SPS labels and marking	A300: Labelling, Marking and Packaging requirements; A310: Labeling requirements; A320: Marking requirements; A330: Packaging requirements
SPS Hygiene	A400: Hygienic requirements; A410: Microbiological criteria of the final product; A420: Hygienic practices during production; A490: Hygienic requirements n.e.s.
Post-prod. Treatment	A500: Treatment for elimination of plant and animal pests and disease-causing organisms in the final product or prohibition of treatment; A510: Cold/heat treatment; A520: Irradiation; A530: Fumigation; A590: Treatment for elimination of plant and animal pests and disease-causing organisms in the final product, n.e.s.
SPS Process control	A600: Other requirements on production or post-production processes; A610: Plant growth processes; A620: Animal raising or catching processes; A630: Food and feed processing; A640: Storage and transport conditions; A690: Other requirements on production or post-production processes, n.e.s
SPS conformity assessment	A800: Conformity assessment related to SPS; A810: Product registration and approval requirement ; A820: Testing requirement; A830: Certification requirement; A840: Inspection requirement; A850: Traceability requirements; A851: Origin of materials and parts; A852: Processing history; A853: Distribution and location of products after delivery; A859: Traceability requirements, n.e.s.; A890: Conformity assessment related to SPS n.e.s.
TBT tolerance and use	B200: Tolerance limits for residues and restricted use of substances; B210: Tolerance limits for residues of or contamination by certain substances; B220: Restricted use of certain substances
TBT labels and marking	B300: Labeling, Marking and Packaging requirements; B310: Labeling requirements; B320: Marking requirements; B330: Packaging requirements
TBT process control	B400: Production or Post-Production requirements; B410: TBT regulations on production processes; B420: TBT regulations on transport and storage; B490: Production or Post-Production requirements n.e.s.
TBT identity & performance	B600: Product identity requirement; B700: Product quality, safety or performance requirements
TBT conformity assessment	B800: Conformity assessment related to TBT; B810: Product registration/approval requirements; B820: Testing requirement; B830: Certification requirement; B840: Inspection requirement; B850: Traceability information requirements; B851: Origin of materials and parts; B852: Processing history; B853: Distribution and location of products after delivery; B859: Traceability requirements, n.e.s.; B890: Conformity assessment related to TBT n.e.s.

Table 10: Measures included in bilateral regulatory difference and regulatory stringency

Measure group	Detailed measure description
SPS	A100: Prohibitions/restrictions of imports for SPS reasons; A110: Prohibitions for sanitary and phytosanitary reasons ; A120: Geographical restrictions on eligibility; A130: Systems Approach; A140: Special Authorization requirement for SPS reasons; A150: Registration requirements for importers; A190: Prohibitions/restrictions of imports for SPS reasons n.e.s.; A860: Quarantine requirement
TBT	B100: Import authorization/licensing related to technical barriers to trade; B140: Authorization requirement for TBT reasons; B150: Registration requirement for importers for TBT reasons; B190: Import authorization/licensing related to technical barriers to trade not elsewhere specified
Pre-shipment inspections	C000: Pre-shipment inspection and other formalities; C100: Pre-shipment inspection; C200: Direct consignment requirement; C300: Requirement to pass through specified port of customs; C400: Import monitoring and surveillance requirements and other automatic licensing measures; C900: Other formalities, n.e.s.

Table 11: Measures additionally included in regulatory stringency

B Endogeneity correction

Regulatory stringency and bilateral regulatory differences are a function of trading relationships between countries and consequently are likely to be subject to bias. Endogeneity of regulatory stringency is controlled for by the destination fixed effects, which capture all sources of endogeneity at the destination level such as the imposition of trade restrictive policies as reaction to high levels of imports (Beverelli et al., 2023; Heid et al., 2021). Endogeneity of bilateral regulatory differences is addressed by using a control function approach (Cameron and Trivedi, 2013). For this we include residual ϕ_{od} from an OLS regression for Dif_{od} in Equation (1).

$$Dif_{od} = Z^{\#}_{od}\beta + I_{od}\beta^{I} + \pi_o + \lambda_d + \phi_{od} \ , \tag{B.1}$$

where $Z^{\#}_{od}$, is a vector composed of all control variables of Z_{od} in the main equation except PTA and border dummies, I_{od} is the vector of instruments, and π_o and λ_d are origin and destination fixed effects, respectively.

Analogously, to control for the endogeneity of PTAs we follow Egger et al. (2011) and augment Equation (1) with the inverse Mills ratio based on a Probit regression for a general PTA dummy (PTA^D) and technical provision dummy PTA^T, i.e. $PTA \in \{PTA^D, PTA^T\}$:

$$PTA = Z^{\#}_{od}\beta + I_{od}\beta^{I} + \pi_o + \lambda_d + \zeta_{od} \ , \tag{B.2}$$

where the symbols correspond to the same definitions as in Equation (B.1).[38]

The selection of the j instruments in the vector I_{od}, and by extension the composition of $Z\#_{od}$ and of Z_{od} in Equation (1), follows Egger et al. (2011). Regulatory differences and PTA membership are a function of shared history, common culture, geography, and existing trading relationships. Therefore, the pool of candidate instruments is composed of variables representing common legal and colonial history, common religion, distance, and whether two countries used to be the same country, geographic proximity, as well as cultural similarities.[39]

[38] Equations (B.1) and (B.2) exclude domestic observations because corresponding regulatory differences are by design zero and countries cannot form a PTA with themselves. The control function for these observation is set to zero, i.e. it enters Equation 1 as mean-neutral.

[39] See e.g. Egger et al. (2015, 2011) and Helpman et al. (2008), who use the same or similar sets of variables to instrument for the selection into PTAs and trade. With respect to NTMs, Kee and Nicita (2022) justify using neighboring countries' technical measures as instrumental variables based on cultural and historical ties, as

We follow Egger et al. (2011) for the final selection of j instruments for each sector and, by extension, the composition of Z_{od} in Equation (1). The set of instruments included is based on a test of their joint significance (relevance) in Equations (B.1) and (B.2). In particular, we test whether we can reject $H_0 : \beta_j^I = 0, \forall j$ in favor of $H_1 : \beta_j^I \neq 0$ for at least one j. Furthermore, we estimate Equation (1) including I_{od} and test whether $H_0 : \beta_j^I = 0, \forall j$ cannot be rejected in favor of $H_1 : \beta_j^I \neq 0$, i.e. whether any of the instruments significantly determines trade (exclusion restriction). Both tests of joint significance are conducted based on bootstrapped standard errors. Finally, we keep candidate instruments as controls in Equation (1) if they are significant and consequently violate the exclusion restriction, which leads to varying instrument assignment in specifications by sector. The complete results of estimating Equation (1) for the heterogeneous effect (HET) model are presented in Appendix D, while the results of estimating Equation (1) for the single indicator (SI) specification are shown in Appendix G.

For most sectors we select instruments that capture historical ties or represent cultural similarities, namely, same colonizer ever, common religion, common legal background pre transition, colonial dependency ever, and colonial relationship after 1945 for 13, 12, 11, 9, and 9 sectors, respectively. Other instruments, with the number of sectors in brackets, are: same country ever (7), common colonizer after 1945 (6), time difference (6), common official language (3), common legal background post transition (2), and difference in latitude (1). We instrument with at least three variables in each of the first stage equations. Table 16 of Appendix D provides the detail by sector of the selection of instruments and the test statistics of the test of joint significance with respect to the relevance and exclusion restriction of instruments.

well as similar trade patterns. In contrast to their approach, we directly use indicators for cultural similarities and historical relationships as instruments, which allows us to control for multilateral resistance and other destination- and origin-specific determinants of trade by including fixed effects μ_o and η_d in Equation (1).

C Outlier detection and imputation of regulatory change

The analysis uses NTM data from NTMTRAINS, which is the only global NTM data source sufficiently detailed to calculate bilateral regulatory differences based on specific measure types. NTMTRAINS records the earliest entry into force date for measure types in force at the time of data collection. For example, if there are two labeling requirements in force in 2017, NTMTRAINS provides information about when the older of the two enter into force. As a consequence, it is uncertain whether technical measures are new or a replacement of existing regulation. If a measure is merely a replacement bilateral regulatory differences remain unchanged, whereas the introduction of a new measure type results in a harmonization or divergence event.

A relatively high share of new measure types implies that a significant part of regulation in force in 2017 enters into force in the previous five years. For example, in the extreme case of Korea NTMTRAINS data suggest that all of Korea's technical regulation enter into force between 2012 and 2017. By extension, this implies that all bilateral harmonization and divergence with Korea as a partner takes place between 2012 and 2017. By contrast, for 18 countries we cannot observe any changes in regulatory measures, which may under-represent regulatory changes taking place over 2012–2017. This is in part a function of which year data were collected.[40]

These potentially unrealistic representations of actual regulatory activity found in the NTM data lead us to search and correct regulatory changes N^i_Δ, for $i \in \{\text{Str}, \text{Dif}\}$, for outliers before constructing scenarios (see Section 3 in the main text). Thus, outlier corrections are not applied to the original NTM data used for the gravity estimations, but are only relevant for the calculation of trade cost changes.

To identify outliers we construct a benchmark regulatory change $N^i_{\Delta B}$, for $i \in \{\text{Str}, \text{Dif}\}$, which is the predicted regulatory change conditioned on an econometric model and the changes in the underlying determinants. Thus, the benchmark regulatory change $N^i_{\Delta B}$ is calculated as the weighted sum of changes in underlying determinants of N^i with weights given by coefficients' estimates of the corresponding OLS regression with N^i as dependent variable.

As covariates for N^i we use the average NTM profile of the five closest neighboring countries

[40] See Table 13 for an overview of when NTM data were collected by country, as well as a summary of the share of new measure types entering into force between 2012 and 2017 by country (Column New).

in terms of geographic distance ($N^{i,D}$, where D refers to distance) and the NTM profile of a group of reference countries identified by k-means clustering on polity, governance, and trade facilitation indicators, GDP per capita, and countries' latitude ($N^{i,R}$, where R refers to reference). Ghodsi (2019) and Kee and Nicita (2022) use neighboring countries' NTM profiles as instruments in gravity regressions, and Guimbard et al. (2012) use reference countries to construct trade-based weights to address bias in tariff aggregation. Thus, we assume that NTMs are a function of neighboring countries' trade policy, as well as institutions and economic development. We also use the average number of SPS and TBT measures notified to the WTO ($N^{\text{Str},WTO}$) by country d as an additional source of regulatory activity.

The process follows three steps: (i) regress N^i of 2017 on determinants of NTMs; (ii) predict benchmark regulatory change $N^i_{\Delta B}$ based on regression coefficients and changes in determinants from 2017 to 2012; (iii) use $N^i_{\Delta B}$ to identify outlier regulatory change.[41] In what follows, we describe the model for each of the variables—regulatory stringency and bilateral regulatory difference.

C.1 Regulatory stringency

We pool across all sectors s and estimate the following model via OLS:

$$N^{\text{Str}}_{ds} = \sum_p \beta^p N^p_{ds} + \delta_d + \varepsilon_{ds} \tag{C.1}$$

$$\text{with} \quad p \in \left\{N^{\text{str},D}_{ds}, N^{\text{str},R}_{ds}, N^{\text{str},WTO}_{ds}\right\}$$

N^{str}_{ds} is the average number of technical measures imposed by country d in sector s in 2017, and δ_d represents a country dummy capturing country-specific effects across all sectors. The benchmark change in regulatory stringency is defined by:[42]

$$N^{\text{str}}_{\Delta B,ds} = \sum_p \hat{\beta}^p N^p_{\Delta,ds}$$

with $N^p_{\Delta,ds}$ representing changes in neighboring and reference countries' regulatory stringency

[41] To investigate the effect of regulatory activity potentially ignored by the data, Appendix G compares a scenario with fully imputed regulatory change (i.e. $N^i_{\Delta B}$) vs. the main scenario presented in the text.

[42] For countries not members of the WTO we estimate a model without WTO notification to retrieve weights $\hat{\beta}$.

from 2017 to 2012, as well as number of WTO notifications from 2016 to 2012.[43]

To identify outliers we construct a sector-specific maximum threshold value $N_{\Delta,ds}^{\text{str, max}}$ defined by $Q1 - 1.5 * IQR$ with $Q1$ and IQR the first quartile and interquartile range of $N_{\Delta B,ds}^{\text{str}}$, respectively. Changes in regulatory stringency in the original data that are larger than the maximum threshold value, $N_{\Delta,ds}^{\text{str}} > N_{\Delta,ds}^{\text{str, max}}$, are replaced by $N_{\Delta B,ds}^{\text{str}}$, resulting in a corrected change in regulatory stringency by each country d. To reflect that we generally trust information on NTMs that are phased-out over time we do not set a minimum threshold value. Therefore, we restrict the definition of outliers to observations for which the original data is much larger than the estimated threshold (maximum).

C.2 Regulatory differences

Our measure of bilateral regulatory differences is based on measure-type similarity and constructed as the difference of harmonization and divergence events. Thus, it depends on the number of unique measure types imposed by a given country. The construction of changes in bilateral regulatory differences accounts for this and is conducted in three steps.

1. **Changes in the unique number of measures**

   We follow the same steps as for regulatory stringency and estimate the regression Equation (C.1) with the unique number of measure types imposed by country d (N_{ds}^{Unq}) as dependent variable and explanatory variables $p \in \left\{N_{ds}^{\text{Unq},D}, N_{ds}^{\text{Unq},R}, N_{ds}^{\text{str},WTO}\right\}$. The inclusion of WTO notifications depends on WTO membership of country d.

   As a result, we obtain a benchmark change in unique measures of each country, i.e. $N_{\Delta B,ds}^{\text{Unq}}$:

   $$N_{\Delta B,ds}^{\text{Unq}} = \sum_{p} \hat{\beta}^{p} N_{\Delta,ds}^{p}$$

   The identification of outliers follows. The definition of the threshold value and the construction of the corrected $N_{\Delta,ds}^{\text{Unq}}$ are analogous to the procedure described for $N_{\Delta,ds}^{\text{str}}$.

[43] We use WTO notification data from Ghodsi et al. (2017), which include notifications until 2016. We prefer the significantly enhanced information on products affected by a notification in Ghodsi et al. (2017) over original WTO notification data available until 2017 but with a significant amount of missing HS-codes.

2. **Changes in bilateral regulatory differences**

   Additionally, we pool across all sectors s to estimate the following model via OLS for each N^{j}_{ods} with $j \in \{\text{Dif}, \text{Har}, \text{Div}\}$:

$$N^{j}_{ods} = \sum_{p} \beta^{p} N^{p}_{ods} + \delta_d + \gamma_o + \alpha_s + \varepsilon_{ods} \tag{C.2}$$

$$\text{with} \quad p \in \left\{ N^{\text{Unq}}_{ds}, N^{\text{Unq}}_{os}, N^{\text{Har},D}_{ods}, N^{\text{Har},R}_{ods}, N^{\text{Div},D}_{ods}, N^{\text{Div},R}_{ods} \right\}$$

   N^{j}_{ods} represent indicators of regulatory differences between countries o and d in 2017—i.e. N^{Har}_{ods}, N^{Div}_{ods}, and N^{Dif}_{ods} as presented in the text. Therefore, these are a function of harmonization and divergence events in neighboring and reference countries, as well as the unique number of measures imposed by countries o and d. The benchmark regulatory change for each indicator is defined by:[44]

$$N^{j}_{\Delta B,ods} = \sum_{p} \hat{\beta}^{p} N^{p}_{\Delta,ods}$$

   Note that $N^{\text{Unq}}_{\Delta,ds}$ and $N^{\text{Unq}}_{\Delta,os}$ are the final values derived in the previous step. The definition of a minimum threshold value and construction of final $N^{\text{Har}}_{\Delta,ods}$ is analogous to $N^{\text{Str}}_{\Delta,ds}$.

3. **Changes in regulatory difference and consistency check**

   We construct two versions of benchmark $N^{\text{Dif}}_{\Delta B,ods}$:

   - $N^{\text{Dif1}}_{\Delta B,ods}$, which is calculated based on regression (C.2) of N^{Dif}_{ods};
   - $N^{\text{Dif2}}_{\Delta B,ods}$, which is calculated as the difference of the benchmark values of harmonization and divergence events derived from regression (C.2) of N^{Har}_{ods} and N^{Div}_{ods}.

   We impose two consistency checks for $N^{\text{Dif}}_{\Delta B,ods}$: a) the maximum of $N^{\text{Dif}}_{\Delta B,ods}$ is determined by the origin (destination) country if there is no regulatory change in the destination (origin) country, and b) $N^{\text{Dif}}_{\Delta B,ods}$ cannot exceed the sum of absolute changes in unique measure types across origin and destination country (i.e. $|N^{\text{Unq}}_{\Delta,ok}| + |N^{\text{Unq}}_{\Delta,ds}|$).

   Furthermore, both benchmark regulatory difference indicators are compared to actual regulatory changes in the data for a set of countries, which we refer to as benchmark

[44] By design of regression Equation (C.2), $N^{\text{j}}_{B,ods}$ is asymmetric. To obtain a symmetric benchmark change when $j = \text{Har}$ we average $N^{\text{Har}}_{\Delta B,ods}$ over a symmetric origin-destination-sector identifier.

countries. These benchmark countries are: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, European Union, Mexico, Paraguay, Peru, Uruguay. For these benchmark countries NTM data were collected in 2012 and 2017 (2016 for the European Union), and we can test the reliability of our procedure to correct for outliers. For this, we conduct a t-test to compare the mean of the benchmark (estimated) change in regulatory differences to regulatory differences based on changes in NTMTRAINS for this set of countries. We select the version of $N^{\text{Dif}}_{\Delta B,ods}$ that best fits the data.

C.3 Estimated values of regulatory change

For the sample of benchmark countries, Table 12 compares actual regulatory changes as represented in NTMTRAINS (columns Mean) versus estimated regulatory changes (columns Estimated) calculated via the procedure outlined in Sections C.1 and C.2. The presented p-values are based on a t-test comparing means. $p > 0.1$ indicates that we cannot reject the hypothesis that the difference between original and imputed mean is zero.[45]

With respect to regulatory stringency, Table 12 demonstrates that estimated regulatory changes are not statistically different from actual ones in the data across 13 out of the 15 sectors for which regulatory changes are modeled. Thus, we are confident that the estimated values of N^{Str}_{Δ} used to replace outliers are a suitable reflection of actual regulatory changes between 2012 and 2017. For those sectors for which means significantly differ (Extr Nrg, Light Mfc), the estimated regulatory changes are smaller and thus more conservative than those directly obtained from the original data—e.g. on average in Light Mfc 0.39 additional measures were introduced between 2012 and 2017, while we estimate 0.17. Therefore, our estimated regulatory changes are good, conservative measure of regulatory changes over 2012–2017.

Regarding bilateral regulatory differences, Table 12 shows that both methods to calculate benchmark changes yield similar results (columns Dif1 versus Dif2) with Dif2 selected across 8 out of 12 sectors. For 3 out of 12 sectors the mean actual change in bilateral regulatory differences is significantly different to our estimated values (Tex, Light Mfc, Electr Comp). Here, we estimate smaller regulatory divergence—e.g. on average in Light Mfc the regulatory difference indicator decreases by 0.13 (representing divergence), while we estimate a lower decrease of 0.05. Again, our estimates are relatively conservative relative to the original data but do not

[45]Note that missing values (–) indicate that respective NTM dimensions are not significant in the gravity regressions and, as a consequence, no regulatory change is modeled for these sectors.

	Stringency			Difference					
	Mean	Estimated	Test p-val	Mean	Dif1 Estimated	Dif1 Test p-val	Dif2 Estimated	Dif2 Test p-val	Select Dif
Grains	–	–	–	0.60	0.61	0.98	0.20	0.17	Dif1
Veg & Fruits	4.98	3.59	0.46	-0.17	0.03	0.22	0.03	0.22	Dif2
Crops	–	–	–	0.05	0.01	0.77	0.01	0.77	Dif2
Animal	–	–	–	–	–	–	–	–	–
Extr Nrg	0.40	0.25	**0.05**	–	–	–	–	–	–
Food Anm	–	–	–	0.20	0.19	0.97	0.19	0.97	Dif2
Food Plant	–	–	–	-0.13	0.09	0.12	0.09	0.12	Dif2
Tex	0.57	0.21	0.21	-0.29	0.00	**0.00**	-0.03	**0.00**	Dif1
Light Mfc	0.39	0.17	**0.07**	-0.13	-0.05	**0.01**	-0.05	**0.01**	Dif2
Chem	0.43	0.43	1.00	–	–	–	–	–	–
Pharma	1.78	1.26	0.31	-0.03	-0.03	0.88	-0.11	0.13	Dif1
Plastics	0.35	0.21	0.54	–	–	–	–	–	–
Mineral	0.26	0.15	0.53	–	–	–	–	–	–
Metal	0.32	0.09	0.36	–	–	–	–	–	–
Metal products	0.18	0.11	0.50	–	–	–	–	–	–
Electr Comp	0.51	0.19	0.18	-0.13	-0.03	**0.02**	-0.03	**0.02**	Dif2
Electr Eq	0.90	0.39	0.18	-0.09	0.06	0.17	0.06	0.17	Dif2
Machinery	0.50	0.29	0.39	-0.17	-0.11	0.52	-0.11	0.52	Dif2
Transport	0.13	0.05	0.33	–	–	–	–	–	–
Auto	0.51	0.17	0.08	0.00	-0.02	0.74	-0.06	0.32	Dif1

Table 12: Original and estimated regulatory changes (2012 to 2017) for benchmark countries
Mean columns are the average change in indicator values in NTMTRAINS. Estimated columns are the average estimated change. *p*-values based on a paired *t*-test for difference in means. Bold *p*-values indicate that estimated changes differ significantly from actual changes found in NTMTRAINS. Benchmark countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, European Union, Mexico, Paraguay, Peru, Uruguay. See Appendix A for a detailed listing of sectors.

change the conclusion extracted from the regulatory changes as they preserve the same sign.

Across all non-zero observations of trade cost changes modeled in the main scenario we correct 37%, 32%, and 26% of total, bilateral regulatory difference-based, and stringency-based trade cost changes, respectively. The slightly larger share of total trade cost changes relative to the difference-based trade cost changes reflects that a small portion of the corrected observations in the difference-based and stringency-based trade cost changes do not overlap. Table 13 summarizes our correction by NTM trade cost dimension (Dif, Str) and whether a country is origin (o) or destination (d). Overall, about half (46%) of the corrections are outliers that involve one of the 10 countries with more than 80% new measures since 2012 (see column New). These countries are Korea, Costa Rica, Honduras, El Salvador, Guatemala, Venezuela, Kyrgyzstan, Panama, Japan, Jordan. Given that the corrected values imply lower regulatory activity than in the original data, the impact of regulatory changes between 2012 and 2017 estimated in the simulation of the benchmark scenario (HET-All) are conservative.

	New	Dif (d)	Dif (o)	Str (d)	Str (o)	Year Data		New	Dif (d)	Dif (o)	Str (d)	Str (o)	Year Data
KOR	1.00	0.89	0.65	1.00	0.24	2016	LAO	0.09	0.17	0.33	0.00	0.26	2015
CRI	0.99	0.40	0.42	0.36	0.26	2017	ARE	0.08	0.30	0.27	0.11	0.26	2015
HND	0.98	0.18	0.44	0.14	0.26	2017	**URY**	0.08	0.10	0.25	0.00	0.27	2017
SLV	0.98	0.17	0.33	0.00	0.27	2017	**BOL**	0.08	0.10	0.24	0.00	0.26	2017
GTM	0.97	0.43	0.47	0.20	0.26	2017	MYS	0.06	0.14	0.25	0.00	0.26	2015
VEN	0.97	0.75	0.46	1.00	0.24	2017	BWA	0.06	0.05	0.36	0.00	0.26	2017
KGZ	0.90	0.85	0.61	1.00	0.24	2017	OMN	0.06	0.25	0.27	0.12	0.26	2015
PAN	0.89	0.29	0.45	0.29	0.26	2017	**BRA**	0.05	0.18	0.15	0.00	0.27	2017
JPN	0.89	0.69	0.38	0.87	0.25	2016	GHA	0.05	0.27	0.23	0.00	0.26	2014
JOR	0.81	0.18	0.37	0.00	0.27	2016	QAT	0.04	0.19	0.32	0.00	0.26	2016
TJK	0.67	0.41	0.29	0.71	0.25	2015	THA	0.03	0.24	0.21	0.08	0.26	2015
BLR	0.63	0.68	0.48	0.67	0.25	2017	LBN	0.03	0.22	0.25	0.00	0.26	2016
RUS	0.55	0.66	0.53	0.60	0.25	2016	IND	0.03	0.32	0.21	0.00	0.26	2017
KAZ	0.52	0.71	0.51	0.73	0.25	2017	MLI	0.02	0.13	0.31	0.00	0.26	2014
IDN	0.44	0.19	0.34	0.08	0.26	2015	BRN	0.02	0.35	0.28	0.33	0.26	2015
ECU	0.41	0.40	0.27	0.00	0.27	2017	KWT	0.01	0.39	0.24	0.00	0.26	2015
CHN	0.40	0.76	0.23	1.00	0.24	2016	ISR	0.01	0.18	0.25	0.00	0.26	2016
ETH	0.37	0.18	0.32	0.14	0.26	2015	MUS	0.01	0.20	0.25	0.00	0.26	2017
NGA	0.36	0.30	0.27	0.67	0.25	2013	**PRY**	0.01	0.11	0.26	0.00	0.26	2017
ZWE	0.30	0.03	0.36	0.00	0.26	2017	CAN	0.01	0.38	0.17	0.10	0.26	2017
PAK	0.28	0.03	0.31	0.00	0.27	2016	SGP	0.00	0.23	0.26	0.00	0.26	2015
USA	0.25	0.29	0.25	0.13	0.26	2017	JAM	0.00	0.13	0.35	0.00	0.00	2015
BGD	0.25	0.48	0.46	0.33	0.26	2017	KHM	0.00	0.25	0.28	0.00	0.26	2015
VNM	0.24	0.38	0.48	0.14	0.26	2015	TUN	0.00	0.22	0.30	0.00	0.00	2016
COL	0.22	0.20	0.20	0.00	0.27	2017	PSE	0.00	0.27	0.21	0.00	0.26	2014
PER	0.22	0.19	0.33	0.00	0.26	2017	AFG	0.00	0.16	0.36	0.00	0.00	2012
BEN	0.21	0.07	0.29	0.00	0.26	2014	BFA	0.00	0.06	0.38	0.00	0.00	2012
CHL	0.21	0.30	0.22	0.00	0.27	2017	CIV	0.00	0.00	0.41	0.00	0.00	2012
ARG	0.21	0.38	0.24	0.00	0.27	2017	CMR	0.00	0.18	0.37	0.00	0.00	2015
MEX	0.20	0.22	0.24	0.00	0.27	2017	DZA	0.00	0.40	0.21	0.00	0.00	2016
SAU	0.18	0.33	0.25	0.10	0.26	2016	GIN	0.00	0.21	0.36	0.00	0.00	2012
BHR	0.18	0.26	0.28	0.14	0.26	2015	HKG	0.00	0.15	0.34	0.00	0.00	2016
MAR	0.16	0.35	0.37	0.00	0.26	2016	NER	0.00	0.24	0.35	0.00	0.00	2014
PHL	0.16	0.27	0.25	0.31	0.26	2015	NPL	0.00	0.04	0.40	0.00	0.00	2012
CHE	0.16	0.32	0.22	0.17	0.26	2015	SEN	0.00	0.10	0.39	0.00	0.00	2012
NIC	0.15	0.22	0.25	0.12	0.26	2017	TGO	0.00	0.09	0.39	0.00	0.00	2014
AUS	0.12	0.33	0.25	0.27	0.26	2016	TTO	0.00	0.14	0.35	0.00	0.00	2015
EU28	0.11	0.33	0.16	0.00	0.27	2016	TUR	0.00	0.07	0.30	0.00	0.00	2016
LKA	0.10	0.17	0.25	0.00	0.27	2016	NZL	-0.17	0.30	0.26	0.08	0.26	2016

Table 13: Share of non-zero trade cost changes corrected for outlier regulatory changes
Benchmark countries for which NTMTRAINS collected data for each year between 2012 and 2017, and for the EU28 between 2012 and 2016 in bold. Benchmark countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, European Union, Mexico, Paraguay, Peru, Uruguay. New refers to the number of new measures from 2012–2017 as a share of the number of measures in 2017.

D Results from gravity regressions

D.1 Heterogeneous effects (HET) model

Table 14: Gravity estimations – Heterogeneous effect model 1/2

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
Distance	-0.839 ***	-0.396 ***	-0.799 ***	-0.853 ***	-0.440 ***	-0.422 ***	-0.410 ***	-0.374 ***	-0.449 ***	-0.498 ***
	(0.215)	(0.120)	(0.165)	(0.103)	(0.100)	(0.078)	(0.047)	(0.076)	(0.102)	(0.063)
Contiguity	1.088 ***	0.163	0.147	0.405 *	0.335	0.704 ***	0.536 ***	0.713 ***	0.986 ***	0.178
	(0.371)	(0.259)	(0.304)	(0.208)	(0.239)	(0.184)	(0.146)	(0.179)	(0.214)	(0.121)
Latitude	0.270 **	0.128 **	0.005	-0.185 ***	-0.053	-0.017	0.012	-0.024	-0.113 ***	-0.194 ***
	(0.126)	(0.055)	(0.066)	(0.057)	(0.048)	(0.045)	(0.029)	(0.041)	(0.038)	(0.033)
Comlang	0.274	0.262	0.506	0.299	0.589 **	1.405 ***	0.938 ***	-0.270	1.012 ***	1.211 ***
	(0.542)	(0.324)	(0.371)	(0.335)	(0.285)	(0.341)	(0.186)	(0.257)	(0.297)	(0.179)
Mass	-0.077	0.131 **	0.297 ***	0.211 ***	0.326 ***	0.171 ***	0.123 ***	0.435 ***	0.471 ***	0.200 ***
	(0.117)	(0.061)	(0.074)	(0.062)	(0.061)	(0.050)	(0.030)	(0.051)	(0.054)	(0.040)
PCA1	-0.027	0.061 **	0.141 ***	0.144 ***	0.018	0.046	-0.004	0.077 ***	0.041 *	-0.055 ***
	(0.043)	(0.029)	(0.034)	(0.026)	(0.023)	(0.029)	(0.016)	(0.020)	(0.021)	(0.017)
PCA2	0.011	-0.037	0.125 **	-0.008	0.052	0.012	0.044 **	-0.004	0.053 *	0.070 ***
	(0.065)	(0.039)	(0.055)	(0.046)	(0.040)	(0.044)	(0.022)	(0.034)	(0.031)	(0.019)
PCA3	0.172	0.070	-0.055	-0.003	0.002	0.024	0.001	-0.175 ***	-0.105 **	0.036
	(0.114)	(0.057)	(0.066)	(0.054)	(0.049)	(0.051)	(0.034)	(0.043)	(0.050)	(0.030)
Border	-10.686 ***	-15.057 ***	-20.983 ***	-17.741 ***	-15.040 ***	-14.843 ***	-11.616 ***	-16.017 ***	-19.493 ***	-12.785 ***
	(2.969)	(1.907)	(2.042)	(1.711)	(1.560)	(1.515)	(0.854)	(1.619)	(1.562)	(1.111)
Trade Facilitation	0.484 ***	0.484 ***	0.661 ***	0.454 ***	0.153 *	0.278 ***	0.308 ***	-0.026	0.235 ***	0.359 ***
	(0.166)	(0.107)	(0.124)	(0.082)	(0.091)	(0.075)	(0.045)	(0.091)	(0.062)	(0.056)
EU	-3.412 *	-0.043	-0.593	2.498 **	0.259	1.586 ***	-0.640 **	-0.962	-1.198	1.114
	(1.814)	(0.454)	(0.901)	(1.192)	(0.357)	(0.400)	(0.273)	(0.960)	(0.938)	(0.882)
PTA pre2012	-0.031	1.339 ***	-1.078 *	0.584 *	-0.159	0.561 *	0.169	0.566	0.040	0.121
	(0.549)	(0.301)	(0.564)	(0.353)	(0.341)	(0.335)	(0.210)	(0.359)	(0.287)	(0.191)
PTA Tech pre2012	1.714 ***	0.428	2.045 ***	0.987 ***	0.992 ***	1.350 ***	0.626 ***	0.100	0.646 *	0.599 ***
	(0.588)	(0.452)	(0.604)	(0.336)	(0.342)	(0.375)	(0.182)	(0.330)	(0.334)	(0.219)
PTA post2012	-0.941	1.654 ***	-1.078 *	-1.941 ***	0.198	-1.985 ***	-0.802 ***	-1.201 ***	-0.958 ***	-0.217
	(0.735)	(0.385)	(0.649)	(0.457)	(0.471)	(0.414)	(0.266)	(0.443)	(0.351)	(0.403)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
PTA Tech post2012	2.314 **	-1.107	2.036 **	3.724 ***	0.884	3.671 ***	1.191 ***	1.335 ***	1.752 **	0.145
	(0.911)	(1.018)	(0.801)	(0.552)	(0.556)	(0.512)	(0.287)	(0.470)	(0.711)	(0.526)
Tariff	-9.190 ***	-3.444 ***	-5.856 ***	-14.389 ***	-15.981 ***	-3.514 ***	-3.280 ***	-10.751 ***	-12.343 ***	-11.913 ***
	(2.574)	(0.950)	(1.881)	(2.415)	(4.357)	(0.868)	(0.885)	(1.831)	(2.053)	(2.553)
Tariff Margin*PTA	-6.820 ***									
	(1.823)									
Dif	0.476 ***	0.236 ***	0.339 **	-0.043		0.181 ***	0.176 ***	0.333 **	0.533 **	-0.109
	(0.159)	(0.045)	(0.141)	(0.130)		(0.046)	(0.029)	(0.162)	(0.244)	(0.178)
Dif*Msh	-0.009	0.431	0.364			0.212	-0.027	0.485	-1.775 *	
	(0.256)	(0.408)	(1.025)			(0.393)	(0.307)	(0.395)	(0.957)	
Dif*Xsh	0.512	-0.461	0.975			0.057	0.200	-0.314	-1.351	
	(0.676)	(0.368)	(0.885)			(0.280)	(0.279)	(0.508)	(1.436)	
Dif*PTA Tech pre2012	-0.013	-0.059 **	-0.149 *			0.029	-0.007	0.132	-0.523 *	
	(0.060)	(0.029)	(0.084)			(0.036)	(0.026)	(0.111)	(0.308)	
Dif*PTA Tech post2012	-0.093	-0.004	0.105			0.094	-0.126 ***	0.474 ***	-0.128	
	(0.108)	(0.066)	(0.130)			(0.111)	(0.044)	(0.167)	(0.504)	
Str*Border	0.005	-0.029 ***	0.010	-0.001	-0.171 *	0.003	-0.001	0.298 ***	0.190 **	0.102 ***
	(0.015)	(0.008)	(0.016)	(0.012)	(0.093)	(0.008)	(0.006)	(0.070)	(0.095)	(0.030)
Str*Msh		0.072						0.043	-1.990 **	-0.930 ***
		(0.119)						(0.308)	(0.899)	(0.250)
Str*Xsh		0.156 *						-0.510	-2.458 **	-0.202
		(0.088)						(0.350)	(1.042)	(0.225)
Str*PTA Tech pre2012		-0.018 *						0.015	-0.483 ***	-0.011
		(0.010)						(0.104)	(0.155)	(0.025)
Str*PTA Tech post2012		0.005						0.172	-0.360	-0.014
		(0.029)						(0.151)	(0.348)	(0.060)
Comlegal (post)	0.711 ***	-0.042	0.178	-0.076	-0.036	-0.000	-0.008	0.001	0.006	0.039
	(0.228)	(0.113)	(0.154)	(0.136)	(0.159)	(0.094)	(0.063)	(0.079)	(0.084)	(0.058)
Comlegal (pre)	-0.566 **		-0.370 **	0.618 ***	0.138					
	(0.262)		(0.168)	(0.161)	(0.177)					
Comcol		0.292		-0.247	0.777 ***	0.260		-0.764 **	0.967 ***	
		(0.396)		(0.409)	(0.213)	(0.342)		(0.339)	(0.364)	
Col45	1.482 ***		0.349				0.357	0.352		0.573 **
	(0.511)		(0.258)				(0.220)	(0.260)		(0.288)
Col dep ever		0.694 ***		0.297	0.386 **		0.400 **	0.500 ***	0.078	-0.311 *

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
		(0.224)		(0.226)	(0.193)		(0.172)	(0.191)	(0.166)	(0.184)
Comrelig	0.011 *				0.018 ***	0.001				0.004 *
	(0.006)				(0.004)	(0.004)				(0.002)
Comlang off			-0.719 ***	-0.235		-0.030	-0.045	-0.225	0.161	-0.120
			(0.252)	(0.205)		(0.179)	(0.112)	(0.187)	(0.198)	(0.119)
Same country	-1.714 **	-1.305				0.201	0.115		-0.129	
	(0.750)	(1.083)				(0.442)	(0.424)		(0.586)	
Same col ever		0.516 **	0.800 ***				0.002	0.823 ***		
		(0.238)	(0.274)				(0.115)	(0.277)		
Time diff	-0.089 **		0.115 ***	0.079 ***	-0.100 ***	0.076 ***			0.035	-0.026
	(0.044)		(0.030)	(0.021)	(0.021)	(0.018)			(0.026)	(0.017)
CF Dif	-0.546 ***	-0.239 ***	-0.275	0.115		-0.194 ***	-0.198 ***	-0.432 **	-0.528 *	0.094
	(0.163)	(0.048)	(0.177)	(0.156)		(0.052)	(0.039)	(0.173)	(0.272)	(0.181)
CF PTA	0.178	-0.307 **	0.100	-0.691 ***	0.192	-0.435 ***	-0.071	-0.294 **	-0.029	-0.070
	(0.251)	(0.154)	(0.199)	(0.167)	(0.166)	(0.162)	(0.107)	(0.143)	(0.139)	(0.107)
CF PTA Tech	-0.724 ***	-0.284 *	-0.679 ***	-0.300 *	-0.430 **	-0.175	-0.145 *	-0.124	-0.001	-0.205 **
	(0.276)	(0.145)	(0.233)	(0.166)	(0.170)	(0.183)	(0.087)	(0.134)	(0.164)	(0.103)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Table 15: Gravity estimations – Heterogeneous effect model 1/2

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
Distance	-0.087	-0.611 ***	-0.701 ***	-0.255 ***	-0.457 ***	-0.449 ***	-0.558 ***	-0.434 ***	-0.255 **	-0.484 ***
	(0.087)	(0.076)	(0.096)	(0.081)	(0.079)	(0.116)	(0.074)	(0.068)	(0.107)	(0.082)
Contiguity	0.355 **	0.678 ***	0.482 **	0.505 ***	0.877 ***	0.570 **	1.050 ***	0.890 ***	1.066 ***	0.915 ***
	(0.161)	(0.201)	(0.189)	(0.168)	(0.226)	(0.225)	(0.275)	(0.200)	(0.282)	(0.316)
Latitude	-0.156 ***	-0.117 ***	-0.199 ***		-0.126 ***	0.056	0.054	-0.020	-0.054	0.050
	(0.049)	(0.035)	(0.040)		(0.041)	(0.048)	(0.045)	(0.038)	(0.073)	(0.045)
Comlang	1.056 ***	0.649 ***	0.821 ***	2.730 ***	0.567 **	0.338	0.866 ***	0.587 ***	-0.390	0.348
	(0.304)	(0.213)	(0.244)	(0.474)	(0.224)	(0.302)	(0.242)	(0.210)	(0.441)	(0.275)
Mass	0.413 ***	0.392 ***	0.376 ***	0.288 ***	0.388 ***	0.405 ***	0.522 ***	0.424 ***	0.313 ***	0.409 ***
	(0.066)	(0.048)	(0.048)	(0.062)	(0.050)	(0.062)	(0.054)	(0.039)	(0.083)	(0.070)
PCA1	-0.098 ***	0.042 **	0.000	0.065 ***	0.064 ***	0.110 ***	0.079 ***	0.005	-0.088 ***	-0.037
	(0.022)	(0.021)	(0.026)	(0.022)	(0.023)	(0.023)	(0.021)	(0.020)	(0.024)	(0.023)
PCA2	0.028	0.033	0.041	0.034	0.038	0.157 ***	0.023	0.018	0.124 ***	-0.018
	(0.033)	(0.025)	(0.029)	(0.033)	(0.025)	(0.046)	(0.023)	(0.023)	(0.039)	(0.031)
PCA3	0.019	-0.026	0.028	0.027	-0.030	-0.115 **	-0.089 **	-0.037	0.049	-0.025
	(0.041)	(0.046)	(0.055)	(0.046)	(0.050)	(0.057)	(0.045)	(0.040)	(0.067)	(0.050)
Border	-21.737 ***	-15.205 ***	-15.652 ***	-14.342 ***	-15.583 ***	-19.965 ***	-19.553 ***	-19.469 ***	-21.441 ***	-17.279 ***
	(1.715)	(1.369)	(1.358)	(1.575)	(1.585)	(1.795)	(1.414)	(1.093)	(2.534)	(1.841)
Trade Facilitation	0.546 ***	0.048	0.084	0.366 ***	0.031	0.452 ***	0.140 *	0.326 ***	0.614 ***	0.183 **
	(0.084)	(0.056)	(0.069)	(0.066)	(0.074)	(0.086)	(0.079)	(0.080)	(0.112)	(0.083)
EU	2.030 **	0.439	0.710	1.967	1.146 ***	-4.333 ***	-0.297	-0.661	1.629	-0.857
	(0.920)	(1.054)	(1.646)	(2.102)	(0.368)	(1.426)	(0.834)	(1.293)	(1.346)	(0.571)
PTA pre2012	1.725 ***	0.454	0.229	1.177 ***	0.239	0.688 **	1.106 ***	0.665 ***	0.090	0.499
	(0.312)	(0.298)	(0.285)	(0.358)	(0.333)	(0.316)	(0.247)	(0.217)	(0.367)	(0.308)
PTA Tech pre2012	-1.227 ***	0.973 ***	0.650 **	-0.542	0.624 *	1.501 ***	1.001 ***	0.456	0.236	0.712
	(0.332)	(0.277)	(0.267)	(0.405)	(0.331)	(0.408)	(0.368)	(0.289)	(0.451)	(0.442)
PTA post2012	0.838 **	-0.781 **	-0.936 ***	0.446	-0.536	-0.550	0.180	-0.128	-0.640	-0.915 *
	(0.384)	(0.362)	(0.325)	(0.459)	(0.395)	(0.348)	(0.304)	(0.281)	(0.506)	(0.476)
PTA Tech post2012	-0.454	1.482 ***	1.273 ***	-0.150	0.406	2.010 ***	1.192 ***	0.299	0.889	1.078
	(0.524)	(0.432)	(0.443)	(0.712)	(0.521)	(0.544)	(0.427)	(0.372)	(0.817)	(0.710)
Tariff	-17.585 ***	-8.504 ***	-12.452 ***	-8.672 **	-10.143 ***	-14.286 ***	-11.285 ***	-12.386 ***	-12.909 ***	-11.496 ***
	(4.994)	(2.222)	(2.237)	(3.465)	(2.508)	(3.526)	(2.063)	(2.474)	(2.916)	(1.716)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
Tariff Margin*PTA										
Dif	0.084	0.211	0.085	0.139		0.950 ***	0.280 ***	0.255 *	-0.259	1.091 ***
	(0.178)	(0.205)	(0.406)	(0.549)		(0.196)	(0.107)	(0.142)	(0.478)	(0.235)
Dif*Msh	-1.923 ***					-0.246	0.536			-2.152 ***
	(0.408)					(0.530)	(0.364)			(0.395)
Dif*Xsh	-1.124					-1.347 ***	0.744 **			-0.046
	(0.810)					(0.447)	(0.349)			(2.036)
Dif*PTA Tech pre2012	-0.119					-0.234	-0.296 ***			-0.235
	(0.159)					(0.174)	(0.082)			(0.181)
Dif*PTA Tech post2012	-0.513					0.255	-0.260 **			-0.099
	(0.345)					(0.295)	(0.132)			(0.261)
Str*Border	-0.042	0.124 *	0.161	-0.565 **	0.041	0.087 **	0.018	0.034	0.104	0.073 *
	(0.027)	(0.069)	(0.218)	(0.252)	(0.077)	(0.044)	(0.023)	(0.030)	(0.193)	(0.037)
Str*Msh	-0.331	-0.903 ***	-2.416 **	0.298	-1.511 **	-0.259	-0.569 ***	-0.383 ***	-4.065 ***	-0.127
	(0.250)	(0.300)	(1.020)	(0.692)	(0.592)	(0.210)	(0.133)	(0.077)	(1.067)	(0.220)
Str*Xsh	-0.800 ***	-0.964 ***	-2.422	-0.163	-2.512 **	0.203	-0.830 ***	-0.759 ***	-1.219	-0.421
	(0.286)	(0.338)	(1.859)	(0.521)	(1.024)	(0.217)	(0.155)	(0.213)	(1.268)	(0.642)
Str*PTA Tech pre2012	-0.012	-0.086 **	0.038	-0.064	-0.174 *	-0.159 **	-0.158 ***	-0.063 **	-0.002	-0.052
	(0.027)	(0.042)	(0.122)	(0.084)	(0.103)	(0.065)	(0.032)	(0.027)	(0.153)	(0.060)
Str*PTA Tech post2012	-0.111	-0.066	-0.125	0.367	0.036	0.073	-0.117 ***	0.027	0.035	-0.028
	(0.071)	(0.082)	(0.302)	(0.283)	(0.157)	(0.091)	(0.044)	(0.036)	(0.147)	(0.061)
Comlegal (post)	0.182 *	0.083	0.077		0.348 ***		0.321 ***	0.486 ***	0.049	0.313 ***
	(0.096)	(0.076)	(0.083)		(0.114)		(0.116)	(0.110)	(0.124)	(0.091)
Comlegal (pre)				-0.095	-0.271 **	-0.272 **	-0.185	-0.423 ***		
				(0.089)	(0.117)	(0.135)	(0.132)	(0.121)		
Comcol	-1.257 ***	-0.463 *		0.854 ***	-0.230	-0.391	-0.469		0.195	-0.856 **
	(0.371)	(0.255)		(0.314)	(0.252)	(0.296)	(0.297)		(0.319)	(0.392)
Col45	-0.299	0.445 *	0.515 *	1.040 ***	0.473 **			0.485 **		
	(0.306)	(0.266)	(0.277)	(0.262)	(0.190)			(0.242)		
Col dep ever			-0.196	-0.422 **					0.283	-0.473 *
			(0.144)	(0.215)					(0.270)	(0.243)
Comrelig				0.006 *			0.005		0.009 **	0.011 ***
				(0.004)			(0.003)		(0.005)	(0.004)
Comlang off	0.206	-0.047	-0.149	-0.523 ***	-0.074	0.053	-0.208	-0.103	0.440 *	-0.362 **

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
	(0.201)	(0.143)	(0.195)	(0.203)	(0.168)	(0.187)	(0.171)	(0.154)	(0.236)	(0.160)
Same country	1.013	0.785 **	0.321		1.012 ***	-0.006	0.686 *	0.714 **	0.334	
	(0.735)	(0.376)	(0.526)		(0.336)	(0.363)	(0.403)	(0.351)	(0.549)	
Same col ever				-0.975 ***		0.510 **				0.207
				(0.228)		(0.230)				(0.321)
Time diff	-0.002	0.031 *	0.048 *	-0.032 *		0.079 ***	0.047 **	0.033 **		
	(0.019)	(0.018)	(0.028)	(0.019)		(0.028)	(0.019)	(0.016)		
CF Dif	0.093	-0.115	0.057	0.181		-0.954 ***	-0.254 **	-0.188	0.772 *	-0.825 ***
	(0.208)	(0.238)	(0.449)	(0.604)		(0.216)	(0.118)	(0.151)	(0.461)	(0.214)
CF PTA	-1.051 ***	-0.175	-0.205	-0.472 ***	-0.137	-0.577 ***	-0.668 ***	-0.343 **	0.096	-0.390 **
	(0.153)	(0.143)	(0.149)	(0.160)	(0.159)	(0.191)	(0.182)	(0.148)	(0.325)	(0.175)
CF PTA Tech	0.569 ***	-0.313 ***	-0.358 ***	0.351 *	-0.089	-0.555 ***	-0.125	-0.080	-0.213	0.046
	(0.165)	(0.111)	(0.133)	(0.192)	(0.122)	(0.196)	(0.137)	(0.114)	(0.267)	(0.221)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

D.2 Instrumentation test statistics

	Grains	Veg & Fruits	Crops	Animal	Extr Nrg	Food Anm	Food Plant	Tex	Light Mfc	Chem	Pharma	Plastics	Mineral	Metal	Metal products	Electr Comp	Electr Eq	Machinery	Transport	Auto
Latitude														•						
Comlegal (post)														•		•				
Comlegal (pre)		•				•	•	•	•	•	•	•	•						•	•
Comcol	•		•				•			•			•					•		
Col45		•		•	•	•			•							•	•		•	•
Col dep ever	•		•			•					•	•			•	•	•	•		
Same country			•	•	•			•		•				•						•
Same col ever	•			•	•	•			•	•	•	•	•		•		•	•	•	
Time diff		•					•	•							•				•	•
Comrelig		•	•	•			•	•	•		•	•	•		•	•		•		
Comlang off	•	•			•															
P-values Chisq test of joint significance of instruments																				
Exclusion restriction																				
Model HET	0.58	0.73	0.74	0.25	0.46	0.81	0.43	0.48	0.41	0.32	0.79	0.28	0.38	0.32	0.46	0.19	0.25	0.21	0.74	0.79
Model SI	0.92	0.33	0.81	0.24	0.46	0.48	0.30	0.14	0.23	0.29	0.21	0.34	0.41	0.32	0.46	0.12	0.35	0.15	0.78	0.28
Relevance of instruments																				
Dif	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PTA	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
PTA Tech	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16: Instrumentation by sector

Standard errors for test of joint significance based on bootstrapped standard errors, 500 replications. Dots indicate instruments used.

	Sigma HET	Sigma SI	ESUBM	FGO
Grains	9.19	9.01	5.99	3.22
Veg & Fruits	3.44	2.44	3.70	7.83
Crops	5.86	3.49	5.53	4.82
Animal	14.39	14.23	3.53	3.99
Extr Nrg	15.98	15.98	10.19	6.01
Food Anm	3.51	3.66	7.99	7.68
Food Plant	3.28	2.67	4.04	4.10
Tex	10.75	10.56	7.59	8.43
Light Mfc	12.34	10.52	6.90	2.86
Chem	11.91	11.92	6.60	8.28
Pharma	17.58	17.84	6.60	3.64
Plastics	8.50	9.18	6.60	6.46
Mineral	12.45	12.58	5.80	7.63
Metal	8.67	8.56	7.42	10.09
Metal products	10.14	10.14	7.50	7.04
Electr Comp	14.29	8.80	8.80	3.76
Electr Eq	11.28	11.24	8.80	6.04
Machinery	12.39	11.04	8.10	4.02
Transport	12.91	13.60	8.60	3.84
Auto	11.50	11.64	5.60	2.75

Table 17: Comparison of trade elasticities
Aggregation of Fontagné et al. (2022, FGO) elasticities weighted by number of 6-digit tariff lines in original GTAP sector. ESUBM refers to the substitution elasticities in the GTAP database. See Appendix A for a detailed listing of sectors.

E Trade cost estimates

E.1 Summary of modeled changes in regulation and corresponding trade costs

Table 18 presents sectoral averages of the NTM indicators in 2017 (Panel I), as well as their percentage change from 2012 to 2017 (Panel II). Panel II takes into account that certain NTM variables are insignificant in some sectors and consequently not modeled. Increases in the average number of measures (regulatory stringency) range from about 9% to 24% and changes in bilateral regulatory difference range from -15% to 8% with negative and positive values representing a net divergence and harmonization trends, respectively.

	(I) 2017 values		(II) Change (%)	
	Str	Dif	Str	Dif
Grains	18.52	-2.01	–	0.01
Veg & Fruits	17.00	-1.59	12.27	3.68
Crops	8.81	-1.30	–	-4.27
Animal	10.58	-1.23	–	–
Extr Nrg	0.98	-0.60	15.94	–
Food Anm	18.42	-1.39	–	8.00
Food Plant	14.16	-1.87	–	1.44
Tex	1.32	-0.71	8.78	-5.46
Light Mfc	1.25	-0.58	13.14	-11.46
Chem	2.23	-1.01	21.31	–
Pharma	5.30	-1.37	20.83	-5.13
Plastics	1.31	-0.62	23.84	–
Mineral	0.80	-0.49	13.78	–
Metal	0.55	-0.34	16.20	–
Metal products	0.67	-0.41	13.48	–
Electr Comp	1.32	-0.57	16.93	-11.26
Electr Eq	1.90	-0.81	16.04	-8.11
Machinery	1.31	-0.68	16.84	-14.72
Transport	0.86	-0.50	9.56	–
Auto	2.16	-0.73	10.24	-3.13

Table 18: Changes in regulation 2012 to 2017
Panel I: Average values of stringency and regulatory difference indicators in 2017. Panel II: %-change in indicator values since 2012. See Appendix A for a detailed listing of sectors.

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
Panel I: Har												
High	-0.64	-0.72	-0.50	-0.45	-0.88	-0.48	-0.50	-0.46	-0.61	-0.18	-0.28	-0.65
UM	-0.64	-1.19	-0.92	-0.94	-1.14	-0.86	-0.63	-0.45	-0.46	-0.42	-0.46	-0.79
LM	-0.84	-0.99	-1.08	-0.42	-1.08	-0.93	-0.54	-0.57	-0.89	-0.45	-0.54	-0.90
Low	-0.68	-1.32	-1.23	-0.04	-2.31	-0.60	-0.25	-0.48	-2.48	-0.42	-0.27	-0.89
EAP	-0.83	-0.69	-0.68	-0.86	-0.79	-0.90	-0.67	-0.40	-0.82	-0.39	-0.45	-0.77
ECA	-0.44	-0.87	-0.50	-0.81	-0.91	-0.52	-0.44	-0.41	-0.46	-0.20	-0.29	-0.59
LAC	-0.62	-1.86	-2.32	-0.55	-2.58	-1.42	-0.68	-1.76	-0.34	-1.04	-1.24	-1.05
MENA	-0.19	-0.14	-0.05	-0.27	-0.04	-0.31	-0.11	-0.51	-0.07	-0.01	-0.32	-0.16
NA	-0.78	-1.02	-1.13	-0.70	-1.98	-0.62	-0.49	-0.54	-0.53	-0.26	-0.52	-0.87
SA	-0.51	-0.45	-1.68	-0.29	-1.02	-0.48	-0.16	-0.44	-0.64	-0.40	-0.31	-0.60
SSA	-0.28	-0.83	-0.41	-0.04	-1.20	-0.25	-0.01	-0.26	-0.36	-0.05	-0.13	-0.38
Total	-0.66	-0.86	-0.72	-0.61	-0.98	-0.69	-0.54	-0.47	-0.57	-0.30	-0.39	-0.72
Panel II: Div												
High	0.62	1.06	0.19	0.26	1.21	0.46	0.28	0.07	0.64	-0.03	0.02	0.73
UM	0.65	1.12	0.36	0.61	1.21	0.58	0.66	0.09	0.52	-0.09	0.12	0.71
LM	0.75	1.13	0.31	0.47	1.07	0.90	0.79	0.30	0.61	0.01	0.29	0.79
Low	0.38	2.77	1.32	3.76	4.59	0.36	0.71	0.02	2.26	0.08	2.54	1.24
EAP	0.66	0.88	0.20	0.66	0.86	0.77	0.36	-0.09	0.47	-0.10	0.14	0.66
ECA	0.55	1.06	0.12	0.25	1.47	0.34	0.26	0.11	0.68	-0.09	-0.02	0.68
LAC	1.19	2.61	1.09	2.90	3.61	0.50	1.13	0.10	1.20	-0.20	-0.23	1.56
MENA	0.17	0.21	0.04	0.20	0.11	0.32	0.16	0.20	0.13	0.01	0.13	0.16
NA	0.58	1.14	0.61	0.22	2.17	0.54	0.27	0.15	0.27	0.11	-0.10	0.75
SA	0.80	0.62	0.48	0.41	0.76	1.13	0.36	0.50	0.49	0.29	0.65	0.72
SSA	0.74	2.37	1.28	1.46	3.71	0.75	0.89	0.02	1.13	0.04	0.72	1.11
Total	0.64	1.08	0.27	0.51	1.20	0.56	0.42	0.10	0.59	-0.05	0.13	0.73
Panel III: Str – HET												
High	0.31	0.10	0.03	0.00	0.04	0.42	0.45	0.02	0.34	0.06	0.03	0.21
UM	0.17	-0.02	0.03	0.07	0.14	0.14	-0.02	0.01	0.14	0.05	-0.02	0.12
LM	-0.17	-0.17	0.08	-0.01	0.13	-0.80	-0.10	0.03	0.07	0.04	-0.03	-0.14
Low	0.14	0.11	0.45	0.00	0.31	0.31	0.32	0.01	0.30	0.23	0.01	0.20
EAP	-0.04	-0.02	0.03	0.02	0.13	-0.39	-0.14	0.00	-0.08	0.05	-0.03	-0.02
ECA	0.36	0.02	0.02	0.06	-0.01	0.62	0.18	0.01	0.09	0.04	0.04	0.23
LAC	0.54	0.15	0.03	0.00	0.21	0.93	0.22	0.05	0.46	0.03	0.01	0.41
MENA	0.30	-0.31	0.03	-0.03	0.03	0.30	0.03	0.05	0.28	0.05	-0.03	0.13
NA	0.49	0.29	0.06	0.04	-0.11	0.42	0.60	0.01	0.74	0.10	0.03	0.41
SA	-0.38	-0.06	0.03	0.00	0.21	-1.08	-0.30	0.02	0.08	0.05	-0.02	-0.27
SSA	0.32	0.11	0.31	0.00	0.40	0.42	0.67	0.02	0.21	0.09	0.00	0.28
Total	0.21	0.05	0.04	0.02	0.08	0.17	0.29	0.02	0.24	0.05	0.00	0.15
Panel IV: Str – SI												
High	0.52	0.37	0.08	0.06	0.31	0.84	0.64	0.06	0.38	0.08	0.06	0.43
UM	0.57	0.28	0.17	0.25	0.48	0.80	0.34	0.09	0.27	0.09	0.08	0.46
LM	0.31	0.29	0.23	0.08	0.54	-0.01	0.35	0.12	0.34	0.11	0.08	0.29
Low	0.39	0.42	0.95	0.32	1.14	0.51	0.71	0.05	1.33	0.53	0.27	0.52
EAP	0.42	0.37	0.13	0.21	0.47	0.54	0.25	0.05	0.11	0.09	0.07	0.37
ECA	0.55	0.26	0.06	0.14	0.28	0.88	0.30	0.07	0.17	0.06	0.07	0.42
LAC	0.70	0.38	0.31	0.35	0.39	1.34	0.59	0.23	0.53	0.19	0.15	0.59
MENA	0.41	-0.28	0.04	0.02	0.05	0.54	0.12	0.10	0.30	0.05	0.02	0.20
NA	0.72	0.57	0.21	0.12	0.29	1.08	0.78	0.07	0.69	0.17	0.08	0.65
SA	0.00	0.11	0.19	0.07	0.37	-0.38	-0.08	0.10	0.25	0.14	0.10	0.04
SSA	0.56	0.58	0.56	0.14	1.04	0.63	1.66	0.05	0.58	0.16	0.10	0.55
Total	0.52	0.35	0.13	0.14	0.39	0.73	0.54	0.08	0.33	0.09	0.07	0.43

Table 19: Changes in trade costs between regions and income level (in %)
Trade cost changes based on the heterogeneous effect (HET) model and the single indicator (SI) model. Panels: I Harmonization, II Divergence, III Stringency (HET), IV Stringency (SI). See Appendix A for a detailed listing of country groups.

Table 20: Trade-weighted changes in trade costs by country and scenario

	Destination								*Origin*							
	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org
AFG	-0.29	-0.29	-0.59	0.00	-0.59	0.00	-0.36	0.60	-0.01	0.01	-0.01	0.00	0.00	0.01	0.04	0.00
ARE	-0.24	-0.20	-0.46	0.00	-0.46	0.00	-0.28	0.66	-0.27	0.44	0.19	0.14	0.33	0.23	1.34	-0.61
ARG	-0.59	0.67	0.09	-0.14	-0.05	0.27	-0.02	0.25	-0.64	1.74	1.17	0.13	1.29	0.48	1.16	-1.73
AUS	-0.41	0.04	-0.37	0.49	0.12	0.30	-0.43	-0.09	-0.82	-0.37	-1.14	0.11	-1.02	0.09	-0.82	1.14
BEN	-1.82	3.02	1.24	0.00	1.24	0.38	0.72	-1.23	-0.03	0.00	-0.02	0.00	-0.02	0.01	-0.01	-0.02
BFA	-0.03	-0.03	-0.06	0.00	-0.06	0.00	0.07	0.06	0.00	0.01	0.01	0.00	0.01	0.01	0.11	-0.03
BGD	-1.13	0.87	-0.22	0.06	-0.16	0.19	-0.27	0.92	-0.06	0.01	-0.05	-0.04	-0.09	-0.02	-0.19	0.18
BHR	-0.77	0.41	-0.36	0.08	-0.28	0.20	0.04	0.47	-0.03	0.02	-0.01	0.00	0.00	0.01	0.03	0.00
BLR	-1.29	0.51	-0.74	0.55	-0.19	0.82	-0.20	1.99	-0.75	0.02	-0.73	0.06	-0.67	0.09	-0.80	3.01
BOL	-0.19	-0.14	-0.34	0.01	-0.32	0.10	-0.28	0.34	-0.13	0.42	0.31	0.02	0.34	0.16	0.20	-0.35
BRA	-0.39	0.20	-0.19	0.12	-0.07	0.33	-0.10	1.08	-2.24	0.76	-1.43	0.12	-1.31	0.41	0.04	1.37
BRN	-0.16	-0.03	-0.19	0.01	-0.19	0.00	-0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BWA	-0.04	-0.04	-0.08	0.01	-0.08	0.01	-0.09	0.09	0.00	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
CAN	-0.48	-0.37	-0.87	0.36	-0.51	0.36	-0.66	1.04	-0.79	0.79	0.08	0.27	0.35	0.37	0.66	-0.69
CHE	-0.10	0.11	0.01	0.05	0.06	0.16	0.27	0.00	-0.13	0.18	0.06	0.22	0.27	0.29	0.42	-0.41
CHL	-0.48	0.90	0.43	0.17	0.60	0.35	0.16	-0.63	-0.38	0.77	0.43	0.26	0.68	0.49	0.57	-1.39
CHN	-1.09	1.90	0.90	-0.09	0.80	0.30	0.92	-2.03	-6.14	3.64	-2.32	-0.03	-2.31	2.87	-5.53	3.21
CIV	0.00	0.00	-0.01	0.00	-0.01	0.00	-0.58	0.01	0.00	0.11	0.11	0.02	0.13	0.04	0.61	-0.29
CMR	-0.09	-0.08	-0.18	0.00	-0.18	0.00	-0.50	0.19	-0.01	0.01	0.01	0.00	0.01	0.00	0.02	-0.02
COL	-0.91	0.31	-0.60	-0.29	-0.87	0.12	0.25	0.91	-0.31	0.37	0.09	0.00	0.08	0.15	0.19	-0.17
CRI	-0.30	0.75	0.44	0.06	0.50	0.22	-0.26	-1.80	-0.26	0.69	0.45	0.02	0.47	0.08	0.42	0.04
DZA	-0.37	-0.51	-0.90	0.00	-0.90	0.00	-0.57	1.81	0.01	0.04	0.05	0.03	0.07	0.03	0.06	-0.08
ECU	-1.62	2.69	1.33	0.20	1.51	1.11	0.67	-0.69	-0.56	-0.02	-0.58	0.06	-0.52	0.16	-0.61	0.52
ETH	-0.86	0.61	-0.22	-0.02	-0.24	0.16	0.09	0.12	-0.04	0.01	-0.03	0.00	-0.03	0.01	-0.06	0.07
EU28	-0.67	0.59	-0.08	0.21	0.13	0.94	-0.04	0.65	-5.99	3.26	-2.55	0.19	-2.34	1.33	-2.57	3.17
GHA	-0.46	-0.20	-0.67	0.00	-0.67	0.06	-0.43	1.44	-0.01	0.06	0.05	0.01	0.05	0.03	0.07	-0.07
GIN	-0.09	-0.10	-0.20	0.00	-0.20	0.00	-0.34	0.40	0.00	0.04	0.04	0.01	0.05	0.02	0.07	-0.17
GTM	-0.21	0.41	0.18	0.24	0.42	0.34	-0.61	-1.24	-0.42	0.00	-0.43	0.01	-0.41	0.10	-0.28	1.78

Trade cost changes based on the heterogeneous (HET) effect and single indicator (SI) model. Trade cost changes differentiated by imports (Destination) and exports (Origin). NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

	Destination								Origin							
	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org
HKG	-0.23	-0.24	-0.48	0.00	-0.48	0.00	-1.02	0.76	0.00	0.03	0.02	0.01	0.03	0.02	0.05	-0.15
HND	-0.56	0.51	-0.05	0.06	0.00	0.14	-0.18	-0.15	0.07	0.21	0.27	0.04	0.30	0.05	0.14	0.18
IDN	-1.00	0.73	-0.24	0.00	-0.23	0.19	0.09	0.67	-1.13	0.04	-1.08	-0.01	-1.10	0.14	-1.23	1.25
IND	-0.24	-0.17	-0.41	0.03	-0.38	0.06	0.04	1.42	-0.92	1.32	0.44	0.04	0.47	0.30	0.17	0.25
ISR	-0.23	-0.20	-0.44	0.00	-0.45	0.01	-0.57	0.76	-0.02	0.08	0.06	-0.01	0.05	0.02	0.23	-0.13
JAM	-0.11	-0.09	-0.21	0.00	-0.21	0.00	-0.09	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.03
JOR	-0.88	0.61	-0.24	0.05	-0.19	0.28	-0.47	-0.55	-0.16	-0.10	-0.27	0.01	-0.27	0.01	0.21	0.62
JPN	-1.25	1.65	0.49	0.18	0.66	0.69	0.98	0.15	-1.17	0.43	-0.73	-0.09	-0.81	0.21	-0.21	2.14
KAZ	-1.56	0.57	-0.99	0.31	-0.68	0.57	-0.87	2.59	-0.98	-0.07	-1.06	0.17	-0.88	0.21	-2.44	2.24
KGZ	-1.70	1.52	-0.15	-0.79	-0.93	-0.02	-1.02	4.62	-0.04	-0.01	-0.05	0.00	-0.04	0.01	-0.05	0.22
KHM	-0.31	-0.28	-0.61	0.00	-0.61	0.00	-0.70	1.23	0.00	0.02	0.02	-0.01	0.01	0.00	0.04	-0.06
KOR	-1.43	1.57	0.28	0.53	0.80	1.04	1.07	-3.38	-1.61	-0.99	-2.64	0.04	-2.61	0.27	-3.68	7.68
KWT	-0.42	-0.42	-0.87	0.00	-0.86	0.00	-0.35	1.87	-0.01	0.01	0.00	0.02	0.02	0.02	0.06	-0.03
LAO	-1.09	0.25	-0.82	-0.08	-0.90	0.20	0.17	1.33	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
LBN	-0.38	-0.38	-0.77	-0.03	-0.79	-0.01	-0.68	1.56	-0.03	0.07	0.05	0.01	0.06	0.03	0.10	-0.16
LKA	-0.15	-0.03	-0.18	0.16	-0.02	0.21	-0.40	0.26	-0.02	0.04	0.02	0.00	0.01	0.02	0.05	-0.03
MAR	-0.79	0.47	-0.30	0.07	-0.23	0.25	-0.39	0.47	-0.22	-0.01	-0.23	-0.01	-0.25	0.01	-0.34	0.39
MEX	-0.51	0.26	-0.26	0.57	0.31	0.82	-0.37	-0.38	-0.26	1.20	0.95	0.18	1.11	0.29	0.89	-1.42
MLI	-0.04	0.01	-0.03	0.02	-0.01	0.02	-0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.02	-0.01
MUS	-0.43	-0.38	-0.82	0.00	-0.82	0.00	-0.36	0.96	-0.01	0.03	0.02	0.00	0.01	0.00	0.02	-0.01
MYS	-0.33	-0.07	-0.40	-0.01	-0.41	0.18	-0.53	0.95	-0.30	1.14	0.86	-0.02	0.84	0.19	1.03	-1.01
NER	-0.05	-0.05	-0.10	0.00	-0.10	0.00	-0.21	0.10	0.00	0.62	0.62	0.00	0.62	0.05	0.18	-0.62
NGA	-0.24	-0.24	-0.49	0.00	-0.48	0.06	-0.30	0.71	-0.05	0.05	0.00	0.03	0.03	0.05	0.11	-0.06
NIC	-0.42	-0.14	-0.58	0.32	-0.25	0.22	0.00	3.55	-0.18	0.31	0.14	0.03	0.17	0.06	0.00	-0.32
NPL	0.00	0.00	-0.01	0.00	-0.01	0.00	-0.25	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01
NZL	0.60	-1.47	-0.79	-0.05	-0.85	-0.21	-1.53	1.43	0.50	0.76	1.25	0.03	1.28	0.05	1.15	-2.14
OMN	-0.28	-0.14	-0.43	0.02	-0.41	0.06	-0.06	0.61	-0.02	0.05	0.03	0.00	0.03	0.01	0.08	-0.05
PAK	-0.14	0.05	-0.08	0.19	0.11	0.24	-0.03	-0.11	-0.16	0.11	-0.05	-0.02	-0.07	0.02	1.37	-0.02
PAN	-0.53	0.52	0.00	0.17	0.17	0.30	0.16	-0.50	-0.02	0.01	-0.01	0.00	-0.01	0.00	-0.02	0.06
PER	-1.13	1.14	0.09	0.23	0.32	0.62	0.69	-0.29	-0.51	0.33	-0.13	0.07	-0.06	0.27	-0.13	0.01

Trade cost changes based on the heterogeneous (HET) effect and single indicator (SI) model. Trade cost changes differentiated by imports (Destination) and exports (Origin). NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

	Destination								Origin							
	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org	Har	Div	Dif	Str – HET	All	Str – SI	Imp	Org
PHL	-0.79	0.17	-0.62	0.04	-0.59	0.14	-0.30	1.27	-0.16	0.09	-0.07	0.04	-0.04	0.11	-0.01	-0.03
PRY	-0.02	-0.01	-0.03	0.06	0.03	0.09	-0.25	-0.02	-0.05	0.28	0.24	0.00	0.24	0.07	0.19	-0.38
PSE	-0.56	-0.47	-1.05	0.00	-1.05	0.00	-0.44	1.16	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
QAT	-0.15	-0.12	-0.27	0.02	-0.25	0.02	-0.42	0.52	0.00	0.00	0.00	0.03	0.04	0.03	0.08	-0.09
RUS	-1.58	1.11	-0.45	0.16	-0.30	0.52	-0.59	1.25	-3.42	-0.20	-3.61	1.10	-2.51	1.41	-4.01	10.60
SAU	-1.04	1.12	0.15	0.04	0.19	0.23	0.29	0.68	-0.83	-0.23	-1.07	0.08	-0.99	0.12	-0.98	1.76
SEN	-0.07	-0.07	-0.14	0.00	-0.14	0.00	-0.41	0.14	0.00	0.02	0.02	0.00	0.03	0.01	0.27	-0.04
SGP	-0.12	-0.09	-0.21	0.00	-0.21	0.00	-0.28	0.67	-0.10	0.23	0.14	0.11	0.25	0.19	0.31	-0.34
SLV	-0.71	0.71	0.00	-0.17	-0.17	0.05	-0.13	0.06	-0.20	0.15	-0.05	0.04	-0.02	0.05	0.11	-0.46
TGO	-0.13	-0.11	-0.24	0.00	-0.24	0.00	-0.33	0.25	0.00	0.05	0.05	0.00	0.05	0.01	0.15	-0.06
THA	-0.32	-0.27	-0.61	-0.02	-0.62	0.04	-0.43	1.01	-2.73	1.14	-1.53	-0.07	-1.60	0.47	0.84	1.64
TJK	-1.79	0.86	-0.90	0.50	-0.40	0.91	-1.74	-0.30	-0.02	0.01	-0.01	0.01	0.00	0.01	0.02	-0.03
TTO	-0.18	-0.17	-0.36	0.00	-0.36	0.00	-0.41	0.49	0.00	0.01	0.01	0.00	0.01	0.00	-0.01	-0.02
TUN	-0.10	-0.11	-0.21	0.00	-0.21	0.00	-0.57	0.40	0.00	0.05	0.05	0.00	0.05	0.02	0.05	-0.06
TUR	-0.38	0.27	-0.10	0.00	-0.10	0.00	-0.14	0.19	-0.45	0.41	-0.03	-0.05	-0.08	0.13	0.43	-0.83
URY	-0.21	0.06	-0.15	0.05	-0.09	0.10	-0.20	0.16	-0.02	0.22	0.20	0.00	0.20	0.04	0.16	-0.28
USA	-0.59	0.77	0.20	0.22	0.42	0.33	0.88	0.37	-6.14	2.56	-3.47	1.68	-1.79	2.95	-4.30	0.37
VEN	-1.00	1.18	0.21	0.02	0.23	0.21	0.46	-4.41	-0.01	0.00	-0.01	0.00	0.00	0.01	0.02	-0.01
VNM	-1.64	0.86	-0.67	0.07	-0.61	0.23	-0.13	1.57	-0.97	-0.17	-1.16	-0.06	-1.22	0.19	-1.92	2.79
ZWE	-0.13	0.13	0.00	0.05	0.06	0.09	-0.24	-0.06	-0.01	0.02	0.01	0.00	0.01	0.00	0.02	-0.02

Trade cost changes based on the heterogeneous (HET) effect and single indicator (SI) model. Trade cost changes differentiated by imports (Destination) and exports (Origin). NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

E.2 AVE NTM-related trade costs for 2017 and trade cost changes

We use Equation (6) presented in Section 3 and the value of the different NTM indicators in 2017 to calculate the bilateral AVE trade cost incidence of all measures in force in 2017. Figures 5 and 6 depict the overall patterns of technical measures' trade restrictiveness in 2017 with two main conclusions. First, a lower (higher) regulatory incidence in the form of fewer (more) technical regulation translates into lower (higher) import costs and higher (lower) export costs. As highlighted by Figure 5 these patterns correlate with income. Thus, fewer (more) regulatory measures are imposed by developing (developed) countries, such that importers in developing (developed) countries face lower (higher) costs of importing, whereas exporters in developing (developed) countries face higher (lower) costs of exporting. Second, Figure 6 shows that these differences in the NTM trade cost incidence are mainly caused by regulatory divergence, i.e. types of measures imposed on the export market that are not applied on the domestic market.

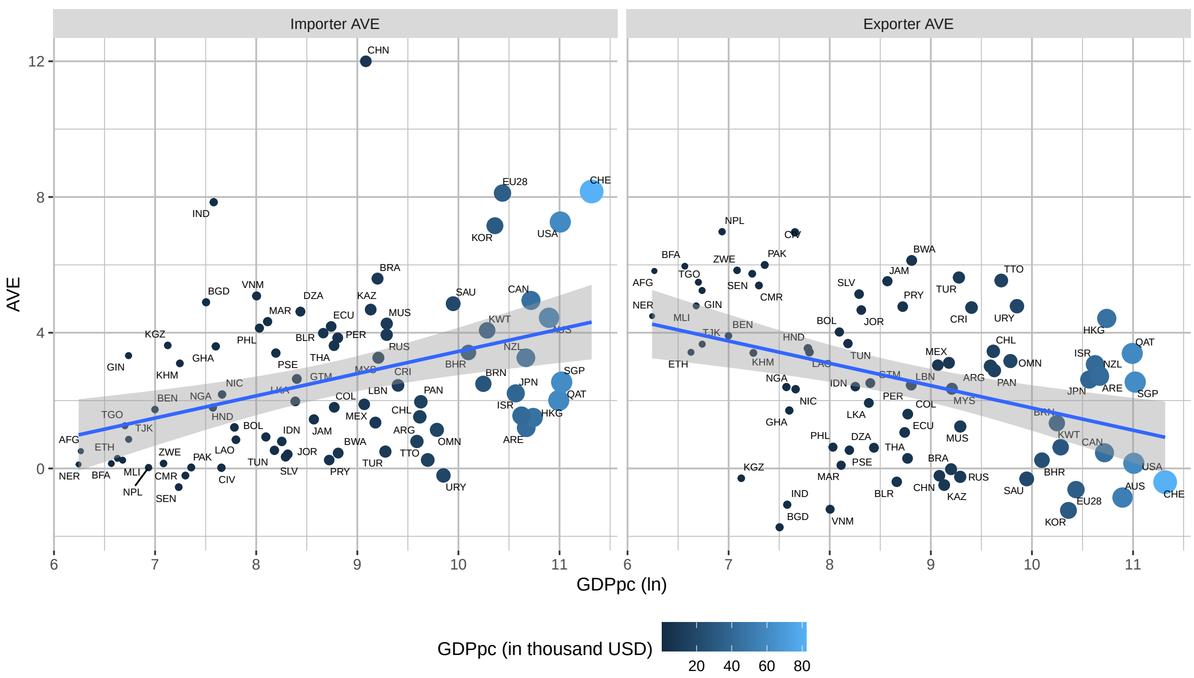

Figure 5: Importer and exporter NTM trade cost (AVE in %) vs. GDPpc, 2017
Sector-level AVEs averaged per country pair using number of 6-digit Harmonized System (HS) tariff lines as weights. Bilateral AVEs are subsequently averaged by importer and exporter. Point size indicates GDP per capita (GDPpc) in thousand USD.

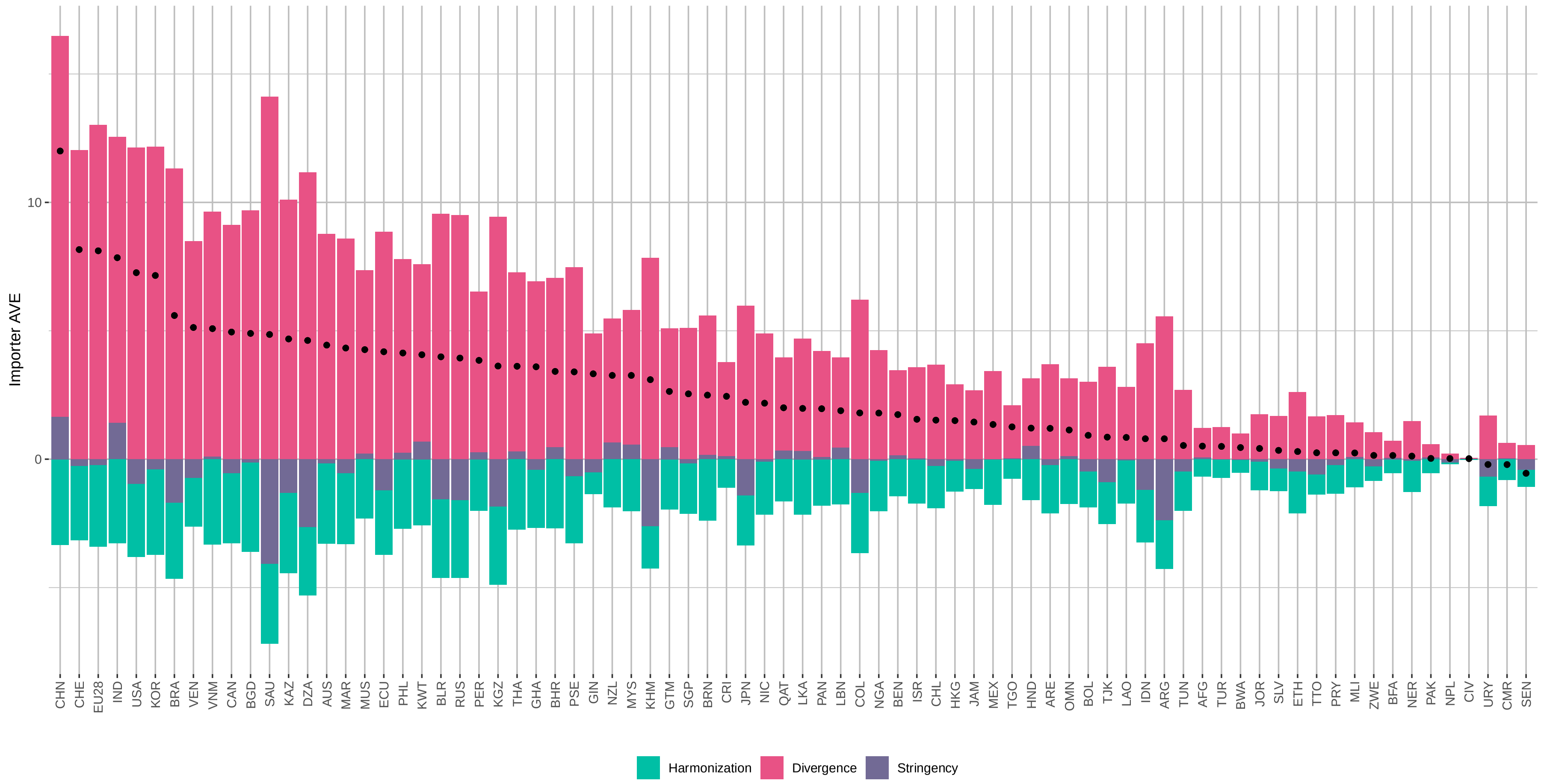

Figure 6: Importer NTM trade cost by NTM dimension, 2017
Sector-level AVEs averaged per country pair using number of 6-digit Harmonized System (HS) tariff lines as weights. Bilateral AVEs are subsequently averaged by importer. Points indicate total AVE trade cost across all NTM dimensions.

All results are available in a database accompanying this study for the sectoral and regional aggregation used throughout the analysis (see Appendix A). The database is available upon request. For comparison, we provide AVEs calculated on the basis of the heterogeneous effect (HET) model and the single indicator (SI) model. Figure 7 highlights the distribution of the different AVEs across all sectors, while Tables 21 and 22 describe variables in the database and summary statistics, respectively.

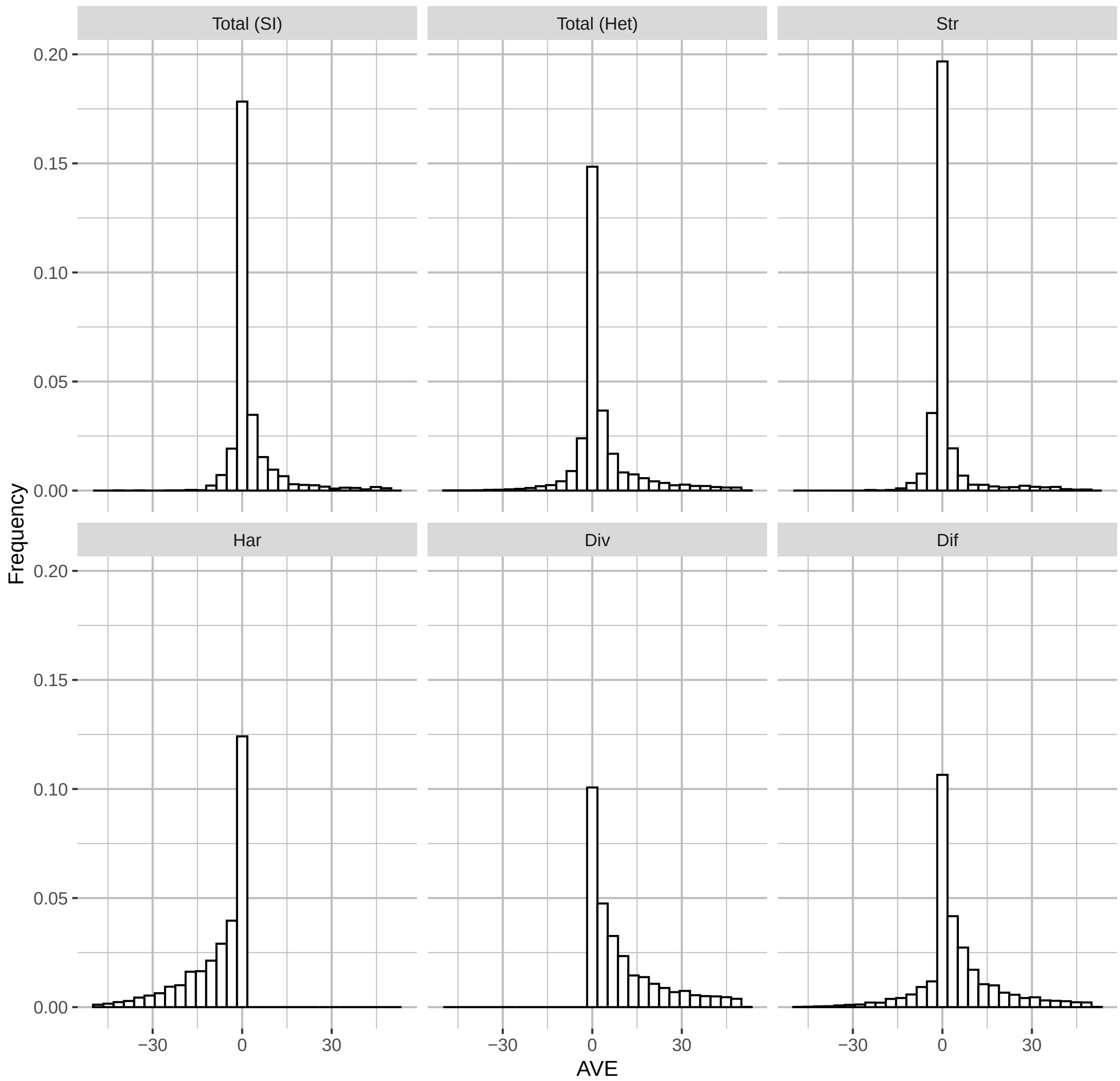

Figure 7: Distribution of AVEs (in %) by NTM dimension (2017)
Includes non-zero AVEs across all sectors. Figure constrained to AVEs in the interval $[-50, 50]$.

Variable	Description
iso_o	ISO 3-character code origin (exporting) country
iso_d	ISO 3-character code destination (importing) country
sector	Sector (see Appendix A)
ave_total_str_si	AVE of regulatory stringency Str_{17} derived from single indicator model
ave_total_het	AVE across all NTM dimensions included in heterogeneous effect model (Str_{17}, Dif_{17})
ave_str_het	AVE of regulatory stringency Str_{17} derived from heterogeneous effect model
ave_har_het	AVE of regulatory harmonization/similarity Har_{17}
ave_div_het	AVE of regulatory divergence/dissimilarity Div_{17}
ave_dif_het	AVE of regulatory difference indicator $Dif_{17} = Har_{17} - Div_{17}$

Table 21: Variable description AVE database, 2017

Variable	Mean	SD	Min	Q1	Q2	Q3	Max	Zero sh
ave_total_str_si	4.21	12.91	-43.07	-0.22	0.20	2.57	100.00	0.31
ave_total_het	5.93	17.68	-57.71	-0.47	0.30	4.71	100.00	0.12
ave_str_het	1.40	8.52	-31.77	-0.95	-0.12	0.46	98.02	0.32
ave_har_het	-8.17	10.61	-58.44	-12.87	-3.46	-0.30	0.00	0.57
ave_div_het	16.40	22.18	0.00	1.08	6.45	22.49	99.98	0.46
ave_dif_het	8.40	19.61	-57.71	0.08	1.91	10.71	99.93	0.46

Table 22: Summary statistics AVE database, 2017
Summary statistics are calculated for non-zero observations across all sectors. Zero sh: share of zero AVEs across all sectors and observations.

F Additional trade and macroeconomic results

- F.1: Changes in trade
- F.2: Harmonization vs. divergence
- F.3: Partial vs. general equilibrium effects
- F.4: Changes in real income

F.1 Changes in trade

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
Panel I: Har												
High	1.29	2.46	0.78	0.43	2.67	1.20	1.20	0.52	0.99	0.27	0.24	1.62
UM	2.12	3.06	2.01	1.02	2.86	3.11	2.07	0.02	1.42	1.29	0.51	2.29
LM	1.54	1.81	1.30	0.18	1.80	2.18	1.51	0.13	1.14	0.65	0.41	1.56
Low	1.09	1.11	1.39	-1.77	0.77	1.38	0.74	0.87	2.75	0.93	-1.07	1.02
EAP	2.78	2.30	1.31	0.77	2.09	3.72	2.93	0.24	3.02	0.83	0.34	2.44
ECA	0.95	3.61	1.26	1.24	4.43	1.21	2.31	0.60	-0.11	0.92	0.62	1.78
LAC	0.84	2.74	3.28	-2.44	3.60	1.45	0.90	0.02	0.76	1.39	-0.28	1.46
MENA	0.29	0.41	0.18	-0.14	0.25	0.41	0.98	0.57	0.06	0.10	0.05	0.30
NA	1.15	2.11	1.27	0.73	3.38	1.64	0.61	0.19	0.28	0.12	0.36	1.42
SA	0.77	0.94	2.02	-0.09	1.69	0.98	0.70	-0.32	0.87	0.43	-0.32	0.88
SSA	0.43	1.05	0.23	-0.63	0.56	0.36	0.97	0.28	1.10	0.20	-0.13	0.44
Total	1.59	2.54	1.29	0.53	2.64	1.98	1.45	0.37	1.15	0.64	0.34	1.82
Panel II: Div												
High	-2.03	-3.71	-1.48	-0.15	-3.97	-1.99	-1.09	-0.31	-2.21	-0.29	-0.32	-2.52
UM	-3.25	-2.61	-2.17	-1.18	-4.07	-3.87	-3.34	-1.23	-1.25	-1.62	-1.49	-2.99
LM	-1.64	-3.47	0.21	0.30	-2.07	-3.55	-1.85	0.45	-0.73	-0.02	0.46	-1.86
Low	0.05	-3.01	-0.53	-2.48	-3.04	-0.01	-1.22	0.59	-1.92	-0.05	-1.82	-0.78
EAP	-3.98	-2.91	-2.29	-1.43	-3.24	-5.23	-3.23	-0.52	-3.50	-1.43	-1.59	-3.44
ECA	-1.79	-4.73	-1.11	-0.18	-6.12	-1.10	-1.30	-0.60	-2.11	-0.33	-0.40	-2.62
LAC	-1.00	-3.52	-0.42	-0.95	-4.23	-0.77	-1.99	0.72	-0.86	1.16	1.96	-1.61
MENA	-0.69	-0.44	-0.30	0.32	-0.38	-1.44	-0.90	-0.29	0.27	-0.26	0.16	-0.57
NA	-1.71	-3.72	-1.29	0.04	-5.11	-3.21	-1.14	-0.66	0.07	-0.28	0.01	-2.25
SA	-1.25	-0.69	0.84	0.27	-0.06	-2.70	-1.07	0.05	-0.29	0.00	0.27	-0.94
SSA	-0.61	-2.32	-0.22	-0.07	-2.19	-0.69	-2.30	0.76	-1.43	0.44	0.06	-0.75
Total	-2.41	-3.45	-1.58	-0.43	-3.83	-2.81	-1.73	-0.45	-1.76	-0.68	-0.63	-2.61
Panel III: Str – HET												
High	-1.08	-0.83	0.62	0.23	0.12	-1.70	-2.37	0.28	-1.66	0.43	-0.26	-0.85
UM	-0.83	0.52	0.16	-0.49	-0.63	-0.52	0.47	-0.01	-0.57	0.30	-0.51	-0.45
LM	0.08	1.37	0.11	-0.30	-0.37	2.30	0.43	-0.53	-0.50	0.51	-0.26	0.39
Low	-0.67	0.40	0.47	0.21	0.63	-1.67	-0.79	0.42	-0.34	0.83	0.24	-0.20
EAP	-0.07	-0.61	0.21	-0.85	-1.05	0.96	0.95	-0.42	0.77	0.21	-0.66	-0.19
ECA	-1.01	-0.24	0.63	0.62	0.56	-2.71	-0.78	0.47	0.18	0.37	-0.37	-0.65
LAC	-2.25	0.26	0.80	0.42	0.60	-3.41	-0.46	0.61	-2.27	0.84	0.43	-1.43
MENA	-0.85	2.39	0.29	0.14	1.23	-0.87	-0.89	-0.05	-2.16	0.28	-0.09	-0.01
NA	-1.94	-0.92	0.91	0.17	1.94	-0.62	-3.33	0.49	-4.87	0.87	0.28	-1.51
SA	0.57	-0.03	0.39	-0.36	-0.40	2.30	-0.05	-0.47	-0.79	0.78	-0.35	0.43
SSA	-1.12	0.37	0.47	0.04	0.33	-1.46	-2.93	0.46	-1.41	0.92	0.26	-0.55
Total	-0.89	-0.36	0.40	-0.14	-0.13	-0.89	-1.48	0.13	-1.19	0.40	-0.34	-0.62
Panel IV: Str – SI												
High	-1.70	-1.86	-0.29	-0.31	-1.18	-2.91	-2.16	-0.24	-1.63	-0.18	-0.85	-1.62
UM	-1.83	-0.19	-0.07	-0.23	-1.44	-2.66	-0.20	0.48	-0.62	0.29	-0.18	-1.30
LM	-0.61	0.34	0.10	-0.20	-0.85	0.35	-0.10	-0.06	-0.53	0.39	-0.11	-0.30
Low	-0.80	-0.12	0.06	0.17	-0.23	-1.77	-0.78	0.59	-0.68	0.42	0.14	-0.46
EAP	-1.33	-1.40	-0.19	-0.52	-1.78	-1.99	0.13	0.15	0.19	0.19	-0.29	-1.19
ECA	-2.25	-2.15	-0.68	-0.32	-1.88	-3.63	-1.77	-0.46	-1.16	-0.89	-1.31	-2.10
LAC	-2.13	-0.37	0.06	0.11	-0.21	-3.93	-0.85	0.46	-1.85	0.29	0.17	-1.55
MENA	-1.06	2.25	0.07	0.05	1.02	-1.42	-0.83	0.06	-1.78	0.07	-0.18	-0.20
NA	-1.76	-1.28	0.42	0.44	0.66	-2.16	-2.55	0.68	-2.79	0.56	0.29	-1.51
SA	-0.07	-0.29	0.14	-0.25	-0.80	0.91	-0.13	-0.09	-0.90	0.44	-0.17	-0.09
SSA	-1.30	-0.28	0.31	0.11	-0.32	-1.61	-4.01	0.64	-1.71	0.80	0.28	-0.78
Total	-1.65	-1.32	-0.17	-0.24	-1.22	-2.50	-1.54	-0.04	-1.19	0.04	-0.51	-1.41

Table 23: Changes in trade between regions and income level (in %)
Trade flow changes based on the heterogeneous effect (HET) model and the single indicator (SI) model. Panels: I Harmonization, II Divergence, III Stringency (HET), IV Stringency (SI). See Appendix A for a detailed listing of country groups.

F.2 Harmonization vs. divergence

We separately simulate trade cost changes of regulatory harmonization and divergence and juxtapose their effects on total, country-level exports in Figure 8. To calculate trade cost changes, we use Equation (6) and apply the gravity coefficient of the regulatory difference indicator ($\hat{\beta}_{sod}^{Dif}$) to changes in harmonization (ΔHar_{sod}) and divergence (ΔDiv_{sod}).[46] This comparison highlights that the net effect of harmonization on exports is positive for relatively few countries (e.g. BLR, KGZ, ECU, ETH), while for the majority of countries harmonization and divergence neutralize each other (countries along the 45 degree line) or divergence effects dominate (e.g. ARG, USA, PAK). This pattern is consistent with higher divergence-induced decreases (-2.6%) compared to harmonization-induced increases (1.8%) in global trade depicted in Table 23.

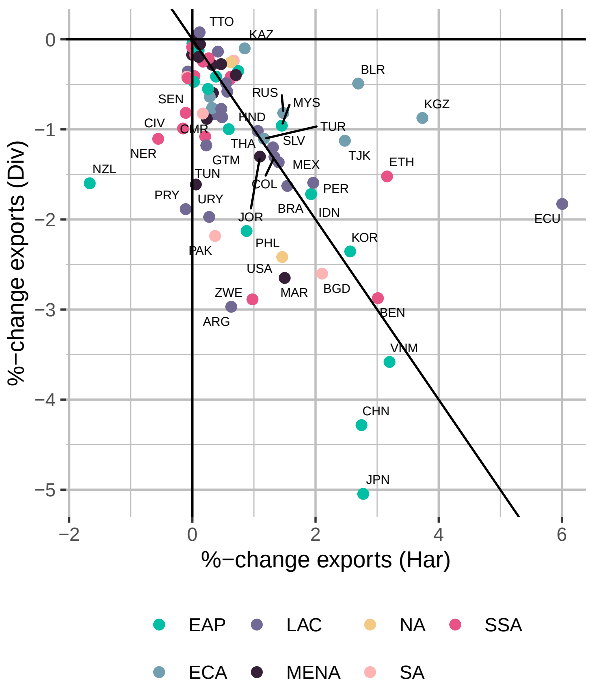

Figure 8: Changes in export (in %): Harmonization vs. divergence
Changes in aggregate exports for trade cost changes based on harmonization (Har) vs. divergence (Div).

[46] Corresponding AVE trade cost changes aggregated to the country and region/income level are presented in Table 20, and Panel I and II of Table 19, respectively.

F.3 Partial vs. general equilibrium effects

General equilibrium effects of trade flow changes are smaller compared to partial equilibrium predictions of the gravity equation, which demonstrates that inter-sectoral linkages, as well as adjustment to trade cost changes through factor prices (e.g. wages) and multilateral resistances are relevant for evaluating regulatory changes. Figure 9 compares general equilibrium changes in trade flows with their partial equilibrium counterparts. On the left-hand side we average over all pairwise sectoral trade flows, in the middle we exclude services sectors, which are not subject to shocks as these are estimated only for trade in goods, while on the right-hand side we average only over pairwise sectoral trade flows that are subject to a trade cost change. Across all goods sectors, 59% of bilateral trade flows are affected by such changes. There is a strong positive correlation (correlation coefficient 0.75) of general and partial equilibrium trade flow changes if we include only directly affected trade flows. This correlation is significantly lower if we compare partial and general equilibrium trade flows changes across all pairs because averages of all country-pair-sector combinations are influenced by zero and very small changes in partial and general equilibrium, respectively.

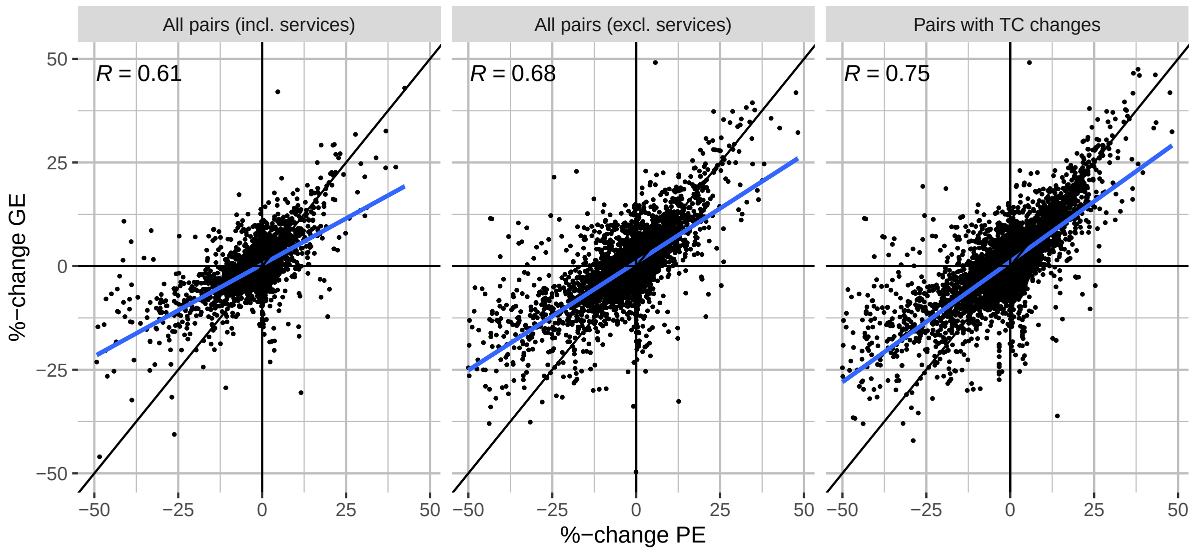

Figure 9: Changes in total bilateral trade flows (in %): Partial equilibrium vs. general equilibrium

PE: Partial equilibrium effects. GE: General equilibrium effects. Trade flow changes based on the heterogeneous effect (HET) model. The left-hand side presents changes in total bilateral trade averaged over all bilateral sectoral trade flows. The middle presents changes in total bilateral trade averaged over all bilateral goods trade flows. The right-hand side presents changes in total bilateral trade averaged over bilateral goods trade flows affected by a trade cost change. Observations outside the $[-50, 50]$ interval excluded. R is the correlation coefficient.

F.4 Changes in real income

Table 24: Change in real income by scenario (in %)

	All			Dif			Div			Har			Str – HET		Str – SI		Imp	Org
	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}$
AFG	0.21	0.04	0.11	0.23	0.05	0.13	0.03	-0.06	0.00	0.21	0.11	0.13	-0.02	-0.02	-0.05	-0.05	-0.18	0.09
ARE	0.44	0.17	0.27	0.47	0.23	0.33	0.19	0.06	0.14	0.29	0.16	0.20	-0.02	-0.06	-0.05	-0.09	0.29	0.55
ARG	-0.14	-0.19	-0.09	-0.17	-0.20	-0.10	-0.25	-0.28	-0.16	0.10	0.08	0.06	0.03	0.01	-0.04	-0.03	-0.13	-0.23
AUS	-0.05	-0.06	-0.04	0.07	0.02	0.04	-0.07	-0.09	-0.02	0.14	0.10	0.07	-0.11	-0.08	-0.10	-0.09	0.07	-0.26
BEN	-0.98	-0.36	-0.86	-0.87	-0.24	-0.73	-2.31	-1.10	-1.78	1.61	0.89	1.11	-0.11	-0.13	-0.42	-0.30	-0.48	-1.39
BFA	-0.16	-0.25	-0.19	-0.03	-0.06	0.00	-0.03	-0.06	0.01	0.00	0.01	0.00	-0.13	-0.19	-0.17	-0.24	-0.31	-0.39
BGD	0.13	0.14	0.16	-0.02	-0.04	-0.02	-0.25	-0.16	-0.17	0.23	0.13	0.15	0.16	0.19	0.08	0.11	0.09	0.07
BHR	0.00	-0.04	-0.02	0.04	-0.01	0.01	-0.35	-0.22	-0.25	0.44	0.20	0.28	-0.04	-0.03	-0.12	-0.08	-0.25	-0.01
BLR	0.26	0.23	-0.02	0.88	0.68	0.43	-0.24	-0.05	-0.18	1.18	0.78	0.61	-0.63	-0.46	-0.81	-0.56	0.36	1.41
BOL	-0.13	-0.26	-0.12	0.00	-0.10	0.04	-0.08	-0.16	0.02	0.08	0.05	0.04	-0.13	-0.16	-0.19	-0.21	-0.05	-0.15
BRA	-0.02	-0.04	-0.02	0.00	-0.02	0.00	-0.15	-0.19	-0.07	0.17	0.16	0.09	-0.02	-0.02	-0.07	-0.06	-0.04	0.08
BRN	0.10	0.04	0.06	0.10	0.08	0.09	0.06	0.07	0.08	0.04	0.01	0.02	0.00	-0.04	0.02	-0.01	0.18	0.00
BWA	-0.02	-0.06	-0.04	-0.01	-0.02	0.00	-0.04	-0.05	-0.04	0.04	0.03	0.03	-0.02	-0.04	-0.04	-0.06	-0.01	-0.06
CAN	-0.10	-0.24	-0.11	0.25	0.07	0.20	0.03	-0.08	0.09	0.21	0.13	0.12	-0.35	-0.32	-0.32	-0.29	-0.17	-0.20
CHE	-0.26	-0.29	-0.25	-0.10	-0.10	-0.06	-0.19	-0.17	-0.11	0.09	0.07	0.06	-0.17	-0.19	-0.30	-0.31	-0.24	-0.48
CHL	-0.44	-0.48	-0.33	-0.27	-0.26	-0.10	-0.41	-0.41	-0.19	0.18	0.13	0.10	-0.19	-0.22	-0.25	-0.29	-0.30	-1.01
CHN	-0.16	-0.06	-0.14	-0.20	-0.10	-0.18	-0.57	-0.38	-0.48	0.38	0.28	0.29	0.04	0.04	-0.13	-0.10	-0.21	-0.51
CIV	-0.49	-0.64	-0.39	-0.47	-0.59	-0.35	-0.39	-0.52	-0.28	-0.08	-0.06	-0.06	-0.03	-0.05	-0.10	-0.15	-0.34	-0.85
CMR	-0.15	-0.19	-0.14	-0.10	-0.13	-0.07	-0.12	-0.15	-0.09	0.03	0.02	0.02	-0.05	-0.06	-0.09	-0.11	-0.06	-0.23
COL	0.11	0.02	0.06	0.04	-0.01	0.03	-0.12	-0.11	-0.07	0.17	0.09	0.11	0.05	0.03	-0.03	-0.03	-0.09	0.06
CRI	-0.57	-0.58	-0.51	-0.32	-0.29	-0.23	-0.41	-0.40	-0.26	0.12	0.06	0.05	-0.25	-0.28	-0.31	-0.36	-0.82	-0.48
DZA	0.34	0.18	0.24	0.37	0.24	0.29	0.20	0.14	0.18	0.16	0.09	0.11	-0.03	-0.06	-0.03	-0.06	0.22	0.55
ECU	0.52	0.74	0.29	0.55	0.77	0.32	-0.19	0.21	-0.10	0.81	0.71	0.45	-0.05	-0.04	-0.25	-0.16	0.57	0.76

Changes in real income based on the heterogeneous (HET) effect and single indicator (SI) model. NTM shock: ($\tilde{t}^{s,\tau}$) 100% iceberg, ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$) 50% iceberg, 50% rents on importer side only, and ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$) 50% iceberg, 50% rents with harmonization rents equally split between importer and exporter, and stringency- and divergence-related rents accrue to importer. NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

	All			Dif			Div			Har			Str – HET		Str – SI		Imp	Org
	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}$
ETH	0.13	0.07	0.07	0.09	0.04	0.05	-0.36	-0.28	-0.30	0.47	0.32	0.35	0.04	0.02	-0.07	-0.06	0.08	0.09
EU28	-0.01	0.03	0.05	0.00	0.00	0.01	-0.11	-0.06	-0.04	0.10	0.06	0.06	-0.01	0.03	-0.09	0.01	0.00	0.10
GHA	-0.03	-0.25	-0.08	0.02	-0.17	0.00	-0.16	-0.30	-0.12	0.20	0.13	0.13	-0.06	-0.09	-0.12	-0.16	-0.11	-0.07
GIN	-0.15	-0.43	-0.23	-0.05	-0.23	-0.04	-0.08	-0.21	-0.03	0.02	0.00	0.01	-0.12	-0.19	-0.13	-0.23	-0.10	-0.35
GTM	-0.30	-0.28	-0.23	-0.20	-0.17	-0.13	-0.16	-0.14	-0.09	-0.03	-0.03	-0.04	-0.11	-0.10	-0.17	-0.18	-0.22	0.34
HKG	0.04	-0.13	-0.07	0.16	0.04	0.10	0.00	-0.06	-0.02	0.16	0.09	0.11	-0.12	-0.18	-0.15	-0.17	0.22	-0.27
HND	-0.13	-0.12	-0.08	-0.02	-0.03	0.01	-0.37	-0.29	-0.20	0.37	0.25	0.23	-0.10	-0.09	-0.21	-0.21	-0.71	0.13
IDN	0.07	0.06	0.04	0.05	0.04	0.01	-0.16	-0.09	-0.09	0.22	0.13	0.11	0.02	0.02	-0.03	-0.02	-0.02	0.09
IND	0.07	0.03	0.05	0.07	0.03	0.05	0.01	0.00	0.03	0.06	0.03	0.03	0.00	0.00	-0.02	-0.02	-0.06	0.14
ISR	0.04	-0.03	0.04	0.02	-0.04	0.02	-0.04	-0.08	-0.01	0.07	0.04	0.04	0.02	0.02	-0.01	-0.01	0.05	-0.03
JAM	-0.34	-0.56	-0.44	-0.03	-0.16	-0.04	-0.10	-0.19	-0.08	0.08	0.03	0.04	-0.31	-0.41	-0.36	-0.48	-0.23	-0.72
JOR	-0.02	-0.02	-0.04	0.02	0.01	-0.02	-0.26	-0.05	-0.15	0.29	0.06	0.14	-0.03	-0.02	-0.13	-0.05	0.08	-0.33
JPN	-0.08	-0.01	-0.03	-0.09	-0.04	-0.06	-0.44	-0.30	-0.33	0.39	0.27	0.28	0.00	0.03	-0.11	-0.04	-0.20	0.24
KAZ	0.05	-0.05	-0.03	0.20	0.10	0.11	-0.22	-0.16	-0.20	0.44	0.26	0.31	-0.16	-0.14	-0.23	-0.18	0.12	-0.07
KGZ	0.46	-0.18	-0.32	-0.24	-0.20	-0.33	-1.52	-0.34	-0.97	1.32	0.18	0.64	0.75	0.04	-0.06	-0.21	0.74	3.17
KHM	0.66	0.34	0.71	0.24	-0.14	0.24	-0.08	-0.32	0.07	0.33	0.18	0.20	0.45	0.50	0.27	0.30	0.36	0.66
KOR	-0.13	0.05	-0.06	0.13	0.20	0.09	-0.45	-0.16	-0.34	0.69	0.42	0.45	-0.26	-0.14	-0.39	-0.17	-0.16	-0.65
KWT	0.38	0.20	0.26	0.38	0.22	0.28	0.17	0.10	0.13	0.20	0.12	0.15	0.01	-0.03	-0.01	-0.04	0.14	0.57
LAO	0.14	-0.16	0.07	0.17	-0.11	0.12	-0.22	-0.22	-0.10	0.40	0.15	0.23	-0.04	-0.06	-0.19	-0.15	-0.38	-0.25
LBN	0.16	-0.06	0.06	0.22	0.01	0.13	0.07	-0.04	0.05	0.15	0.05	0.08	-0.06	-0.07	-0.08	-0.09	0.05	0.21
LKA	0.01	0.01	0.07	-0.02	-0.05	0.01	-0.08	-0.09	-0.02	0.05	0.03	0.03	0.04	0.06	-0.02	0.01	0.06	-0.08
MAR	0.25	0.24	0.17	0.21	0.17	0.10	-0.31	-0.16	-0.21	0.55	0.37	0.33	0.05	0.07	-0.11	-0.05	0.25	0.45
MEX	-0.33	-0.30	-0.13	-0.02	-0.12	0.06	-0.21	-0.20	-0.05	0.19	0.09	0.11	-0.31	-0.18	-0.34	-0.16	-0.35	-0.68
MLI	-0.13	-0.19	-0.16	-0.08	-0.11	-0.08	-0.10	-0.14	-0.10	0.03	0.03	0.02	-0.05	-0.09	-0.10	-0.14	-0.16	-0.30
MUS	0.28	0.17	0.21	0.22	0.09	0.14	0.04	-0.03	0.05	0.19	0.12	0.09	0.06	0.07	0.02	0.02	0.04	0.23
MYS	0.27	0.11	0.29	0.16	0.00	0.18	-0.20	-0.30	0.01	0.37	0.29	0.20	0.12	0.12	-0.09	-0.05	0.06	0.40
NER	-0.07	-0.16	0.05	-0.11	-0.19	0.02	-0.09	-0.18	0.04	-0.01	-0.01	-0.02	0.04	0.04	0.03	0.03	0.05	-0.09
NGA	0.04	0.00	0.01	0.05	0.02	0.04	0.01	-0.01	0.01	0.04	0.02	0.03	-0.01	-0.02	-0.02	-0.03	0.01	0.04

Changes in real income based on the heterogeneous (HET) effect and single indicator (SI) model. NTM shock: ($\tilde{t}^{s,\tau}$) 100% iceberg, ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$) 50% iceberg, 50% rents on importer side only, and ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$) 50% iceberg, 50% rents with harmonization rents equally split between importer and exporter, and stringency- and divergence-related rents accrue to importer. NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

	All			Dif			Div			Har			Str – HET		Str – SI		Imp	Org
	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}},\tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}},\tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}},\tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}},\tilde{t}^{s,\text{exp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$	$\tilde{t}^{s,\tau}$	$\tilde{t}^{s,\tau}$
NIC	-0.30	-0.51	-0.15	0.04	-0.24	0.12	-0.25	-0.47	-0.04	0.31	0.23	0.17	-0.34	-0.26	-0.34	-0.33	-0.34	2.06
NPL	-0.02	-0.02	-0.01	-0.02	-0.03	-0.02	-0.04	-0.03	-0.03	0.01	0.01	0.01	0.00	0.01	-0.02	-0.01	-0.05	-0.08
NZL	-0.58	-1.25	-0.19	-0.59	-1.23	-0.17	-0.29	-0.83	-0.01	-0.30	-0.28	-0.15	0.00	-0.01	0.01	-0.03	-0.44	-0.87
OMN	0.22	0.11	0.16	0.20	0.11	0.16	0.06	0.03	0.06	0.14	0.08	0.10	0.02	0.00	-0.01	-0.02	0.09	0.17
PAK	-0.01	0.00	0.04	-0.05	-0.07	-0.03	-0.07	-0.07	-0.03	0.02	0.01	0.01	0.04	0.07	0.01	0.04	0.01	-0.12
PAN	-0.10	-0.06	-0.06	-0.01	-0.01	-0.01	-0.17	-0.08	-0.12	0.16	0.07	0.11	-0.08	-0.05	-0.12	-0.06	-0.10	-0.13
PER	-0.09	-0.07	-0.08	0.00	0.02	0.00	-0.21	-0.11	-0.09	0.23	0.14	0.12	-0.09	-0.09	-0.16	-0.14	-0.10	-0.21
PHL	-0.01	-0.15	-0.03	-0.02	-0.15	-0.03	-0.28	-0.28	-0.16	0.27	0.13	0.14	0.00	0.00	-0.08	-0.08	-0.12	-0.19
PRY	-0.56	-0.71	-0.48	-0.52	-0.68	-0.44	-0.54	-0.75	-0.47	0.04	0.08	0.03	-0.05	-0.04	-0.15	-0.17	-0.46	-1.09
PSE	0.11	0.03	0.07	0.12	0.04	0.08	0.04	0.00	0.02	0.09	0.04	0.05	-0.01	-0.01	-0.02	-0.01	-0.01	0.08
QAT	0.10	0.03	0.05	0.12	0.09	0.11	0.05	0.04	0.05	0.08	0.06	0.06	-0.02	-0.06	-0.04	-0.08	0.15	0.17
RUS	-0.02	-0.04	-0.07	0.04	0.02	0.00	-0.23	-0.13	-0.18	0.28	0.16	0.19	-0.05	-0.06	-0.14	-0.12	0.08	-0.04
SAU	-0.05	-0.04	-0.08	-0.03	0.00	-0.04	-0.28	-0.15	-0.24	0.29	0.17	0.21	-0.02	-0.04	-0.08	-0.08	-0.07	0.01
SEN	-0.12	-0.23	-0.10	-0.08	-0.17	-0.04	-0.10	-0.17	-0.04	0.03	0.01	0.01	-0.05	-0.06	-0.06	-0.08	-0.04	-0.27
SGP	-0.12	-0.26	-0.14	-0.05	-0.17	-0.04	-0.18	-0.26	-0.12	0.13	0.09	0.08	-0.07	-0.11	-0.10	-0.13	-0.12	-0.21
SLV	0.02	0.03	0.00	0.00	0.03	0.01	-0.26	-0.09	-0.13	0.26	0.12	0.15	0.03	0.00	-0.06	-0.04	-0.06	0.11
TGO	-0.19	-0.51	-0.26	-0.12	-0.39	-0.14	-0.25	-0.46	-0.21	0.15	0.08	0.08	-0.08	-0.12	-0.09	-0.14	-0.23	-0.59
THA	0.11	-0.14	0.10	0.02	-0.21	0.03	-0.22	-0.40	-0.05	0.25	0.18	0.10	0.09	0.08	-0.04	-0.05	-0.09	-0.18
TJK	-0.10	-0.25	-0.14	0.25	-0.02	0.08	-0.57	-0.33	-0.41	0.84	0.30	0.50	-0.36	-0.23	-0.54	-0.29	0.30	-0.85
TTO	0.23	0.16	0.19	0.17	0.12	0.15	0.08	0.05	0.07	0.10	0.07	0.08	0.06	0.04	0.06	0.05	0.34	0.27
TUN	-0.20	-0.29	-0.08	-0.41	-0.52	-0.30	-0.40	-0.49	-0.26	0.01	-0.03	-0.03	0.22	0.24	0.04	0.04	-0.09	-0.58
TUR	-0.08	-0.14	-0.11	0.04	0.01	0.04	-0.14	-0.10	-0.07	0.18	0.11	0.12	-0.12	-0.16	-0.16	-0.21	-0.07	-0.20
URY	-0.47	-0.68	-0.31	-0.50	-0.73	-0.36	-0.54	-0.78	-0.36	0.07	0.08	0.03	0.03	0.03	-0.06	-0.06	-0.36	-0.64
USA	-0.06	-0.02	-0.04	-0.04	-0.02	-0.04	-0.12	-0.06	-0.08	0.08	0.04	0.04	-0.02	-0.01	-0.05	-0.03	-0.09	-0.04
VEN	-0.01	0.00	-0.01	-0.02	-0.01	-0.02	-0.10	-0.05	-0.08	0.08	0.05	0.06	0.01	0.01	-0.01	0.00	-0.02	-0.48
VNM	0.65	0.34	0.44	0.53	0.14	0.26	-1.32	-0.75	-0.82	1.99	1.05	1.15	0.11	0.16	-0.29	-0.17	0.22	0.90
ZWE	-0.45	-0.64	-0.32	-0.43	-0.62	-0.30	-0.53	-0.84	-0.35	0.16	0.18	0.09	-0.03	-0.03	-0.13	-0.16	-0.41	-0.73

Changes in real income based on the heterogeneous (HET) effect and single indicator (SI) model. NTM shock: ($\tilde{t}^{s,\tau}$) 100% iceberg, ($\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}}$) 50% iceberg, 50% rents on importer side only, and ($\tilde{t}^{s,\tau},\tilde{t}^{s,\text{imp}},\tilde{t}^{s,\text{exp}}$) 50% iceberg, 50% rents with harmonization rents equally split between importer and exporter, and stringency- and divergence-related rents accrue to importer. NTM dimensions: Harmonization (Har), Divergence (Div), Difference (Dif), Stringency (Str). All, Imp, Org refer to total trade cost changes based on heterogeneous effect model for regulatory changes corrected for outliers (All), fully imputed (Imp), and not corrected for outliers (Org).

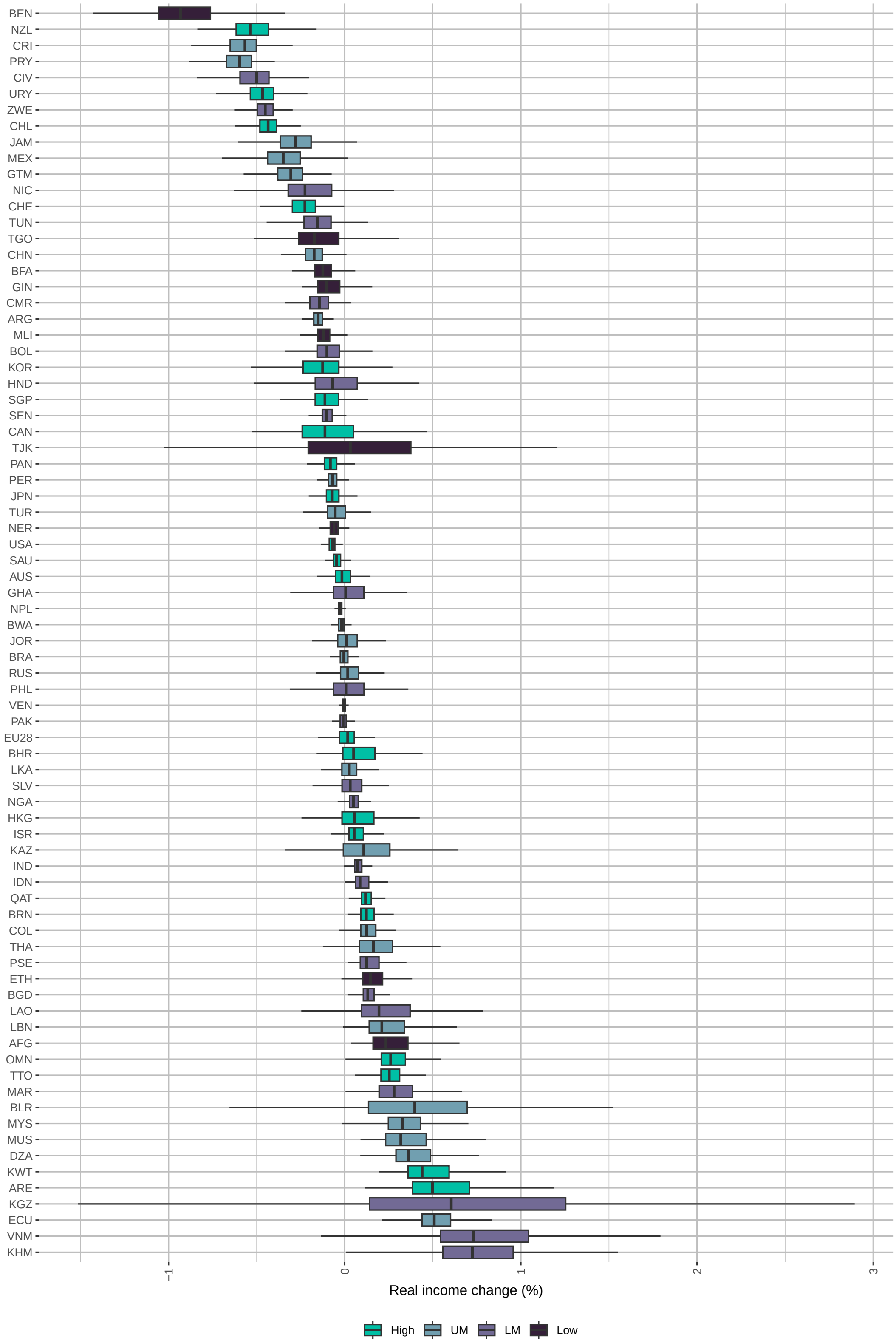

Figure 10: Distribution of real income changes by country (in %)
Real income changes based on the heterogeneous effect (HET) model. Distribution of real income changes based on trade cost changes calculated for each of the 500 bootstraps b of Equation (1). We calculate ΔT_{sod}^{b} of Equation (6) for each $\hat{\beta}_{sod}^{Dif,b}$, $\hat{\beta}_{sod}^{Str,b}$ and $\hat{\sigma}_{s}^{b}$ and simulate corresponding trade and income effects using the 100% iceberg trade cost implementation $\left(t_{sod}^{\tau}\right)$.

G Sensitivity analysis

We perform a series of robustness checks to analyze the sensitivity of the results to our modeling assumptions. First, we compare the trade and macroeconomics results of the benchmark model with those obtained based on the single indicator gravity specification. Second, we analyze the effect of modeling the trade cost shocks in the general equilibrium model through changes in iceberg costs, import tariffs or export taxes. Third, we test the sensitivity of our results to the inclusion of outliers in regulatory changes that we correct for in the benchmark scenario. Fourth, we analyze an artificial scenario that is based on the imputed/estimated regulatory changes used to correct outliers to assess the sensitivity to potentially omitting regulatory changes not represented in the underlying NTM data.

G.1 Heterogeneous effect vs. single indicator model

We compare the results using our benchmark model including the bilateral regulatory indicator and the stringency indicator (HET model) to the single indicator model (SI model), which does not account for pair-specific effects of NTMs.

To analyze the effect of omitting the bilateral differences indicator on the effect of NTMs, we run regressions excluding bilateral regulatory differences (SI model) and compare the coefficients' estimates. The results from the benchmark (HET) model specification are available in Appendix D, while the results from the SI model are in Tables 25 and 26 in this Appendix. These regressions show evidence that part of the trade cost effect of bilateral regulatory differences is wrongly attributed to the regulatory stringency indicator, which is biased (see also Vogt, 2022; Xiong and Beghin, 2014). Across most sectors, the effect of regulatory stringency tends to be less restrictive (the associated coefficient increases) when bilateral regulatory differences are included compared with the effect when only regulatory stringency is included (single indicator model). Furthermore, the bias induced by the omission of bilateral regulatory differences is of particular relevance in our context because it implies attributing trade cost changes of bilateral nature (associated with bilateral regulatory differences) to a destination-specific variable (regulatory stringency). This bias can significantly affect policy simulations that rely on the gravity estimates.

The comparison of the results from the general equilibrium model under the coefficient's estimates from the HET and SI models demonstrates that accounting for bilateral regulatory differences when modeling NTM-related trade costs leads to significantly different changes in trade patterns. Figure 11 juxtaposes export changes at the country level conditioned on the heterogeneous effects model and the single indicator model by trade cost dimension (All, Dif, Str). Although both modeling approaches lead to a total reduction of global trade volume of 1.4%, the notable dispersion around the 45-degree line in the figure on the left (All) demonstrates that country-level changes in exports vary significantly with the chosen econometric specification. The figure in the middle (Dif) shows that the difference is mainly due to including bilateral regulatory differences. Divergence dominates harmonization effects, which reflected by the negative effects on exports for most countries in the plot on the middle (Dif).[47] The figure on the right (Str) highlights that changes in regulatory stringency are less trade restrictive in the heterogeneous effects model (which predicts less negative export changes). Therefore, under exclusion of bilateral regulatory differences in the estimation of the gravity model (SI model), the regulatory stringency indicator captures part of the bilateral trade cost effects, resulting in biased, more trade-restrictive general equilibrium outcomes.

This omitted variable bias has relevant implications at the macroeconomic level, too. Figure 12 compares changes in real GDP and real income by country in the heterogeneous effect model versus the single indicator specification. Although in the benchmark (HET) model regulatory changes lead to positive and negative effects on real GDP and real income ranging from ca. -0.3 to 0.7% and -0.6 to 0.7%, respectively, the absence of harmonization-related trade cost reductions and lower potential trade-promoting effects of regulatory stringency in the single indicator model mostly yields negative macroeconomic effects. In total, the single indicator model results in a real income loss of 0.1% (see Table 27).

[47] Figure 8 in Appendix F further shows changes in exports due to regulatory harmonization versus divergence.

Table 25: Gravity estimations – Single indicator model 1/2

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
Distance	-1.200 ***	-0.459 ***	-0.678 ***	-0.820 ***	-0.440 ***	-0.486 ***	-0.511 ***	-0.464 ***	-0.495 ***	-0.494 ***
	(0.215)	(0.123)	(0.126)	(0.114)	(0.100)	(0.075)	(0.044)	(0.067)	(0.099)	(0.061)
Contiguity	0.711 **	0.288	0.237	0.391 *	0.335	0.707 ***	0.555 ***	0.536 ***	0.837 ***	0.194 *
	(0.302)	(0.291)	(0.272)	(0.222)	(0.239)	(0.183)	(0.152)	(0.158)	(0.203)	(0.114)
Latitude	0.103	0.085	-0.038	-0.159 ***	-0.053	-0.052	-0.051 *	-0.071 *	-0.118 ***	-0.183 ***
	(0.097)	(0.057)	(0.063)	(0.053)	(0.048)	(0.045)	(0.027)	(0.042)	(0.039)	(0.028)
Comlang	0.246	0.213	0.512	0.276	0.589 **	1.254 ***	0.948 ***	-0.211	1.053 ***	1.206 ***
	(0.501)	(0.342)	(0.383)	(0.321)	(0.285)	(0.330)	(0.193)	(0.268)	(0.306)	(0.177)
Mass	-0.247 **	0.111 *	0.181 ***	0.211 ***	0.326 ***	0.144 ***	0.108 ***	0.414 ***	0.491 ***	0.207 ***
	(0.111)	(0.059)	(0.068)	(0.059)	(0.061)	(0.050)	(0.034)	(0.051)	(0.055)	(0.041)
PCA1	-0.033	0.010	0.120 ***	0.134 ***	0.018	0.019	-0.043 ***	0.074 ***	0.038 *	-0.051 ***
	(0.044)	(0.030)	(0.032)	(0.027)	(0.023)	(0.029)	(0.015)	(0.020)	(0.020)	(0.017)
PCA2	0.003	-0.056	0.128 **	-0.013	0.052	0.026	0.051 **	-0.006	0.063 **	0.068 ***
	(0.067)	(0.042)	(0.057)	(0.046)	(0.040)	(0.045)	(0.022)	(0.034)	(0.029)	(0.019)
PCA3	0.194 *	0.179 **	-0.015	0.007	0.002	0.055	0.028	-0.157 ***	-0.097 *	0.033
	(0.116)	(0.069)	(0.069)	(0.056)	(0.049)	(0.053)	(0.034)	(0.043)	(0.052)	(0.031)
Border	-5.868 *	-16.956 ***	-20.579 ***	-17.935 ***	-15.040 ***	-15.353 ***	-12.354 ***	-15.101 ***	-19.688 ***	-12.845 ***
	(3.198)	(1.960)	(2.146)	(1.654)	(1.560)	(1.534)	(0.910)	(1.689)	(1.582)	(1.121)
Trade Facilitation	0.556 ***	0.676 ***	0.881 ***	0.448 ***	0.153 *	0.397 ***	0.428 ***	-0.028	0.197 ***	0.352 ***
	(0.161)	(0.106)	(0.099)	(0.080)	(0.091)	(0.078)	(0.044)	(0.090)	(0.063)	(0.054)
EU	1.858 ***	2.513 ***	1.675 ***	2.113 ***	0.259	2.764 ***	0.867 ***	1.020 ***	0.741 ***	0.593 ***
	(0.568)	(0.381)	(0.367)	(0.378)	(0.357)	(0.284)	(0.218)	(0.308)	(0.283)	(0.181)
PTA pre2012	-0.118	1.385 ***	-0.704	0.530	-0.159	0.432	0.042	0.353	0.210	0.136
	(0.573)	(0.345)	(0.487)	(0.378)	(0.341)	(0.345)	(0.210)	(0.320)	(0.281)	(0.191)
PTA Tech pre2012	0.780	0.455	1.647 ***	1.497 ***	0.992 ***	1.776 ***	0.628 **	0.269	0.711 **	0.558 ***
	(0.748)	(0.439)	(0.552)	(0.489)	(0.342)	(0.489)	(0.264)	(0.328)	(0.326)	(0.205)
PTA post2012	-0.743	1.545 ***	-0.400	-2.046 ***	0.198	-2.244 ***	-1.054 ***	-1.404 ***	-0.799 **	-0.194
	(0.708)	(0.430)	(0.577)	(0.487)	(0.471)	(0.423)	(0.254)	(0.419)	(0.341)	(0.396)
PTA Tech post2012	1.998 **	-0.734	2.130 **	3.423 ***	0.884	4.218 ***	1.076 ***	1.506 ***	1.763 **	0.087
	(0.958)	(0.889)	(0.906)	(0.770)	(0.556)	(0.805)	(0.391)	(0.456)	(0.704)	(0.506)
Tariff	-9.009 ***	-2.436 **	-3.495 **	-14.230 ***	-15.981 ***	-3.657 ***	-2.667 ***	-10.559 ***	-10.516 ***	-11.919 ***
	(2.775)	(0.982)	(1.590)	(2.530)	(4.357)	(0.791)	(0.910)	(1.929)	(1.987)	(2.561)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
Tariff Margin*PTA	-6.806 ***									
	(1.877)									
Str*Border	-0.001	-0.029 ***	-0.030 *	0.005	-0.171 *	0.004	-0.007	0.199 ***	0.042	0.113 ***
	(0.016)	(0.008)	(0.015)	(0.013)	(0.093)	(0.007)	(0.006)	(0.043)	(0.065)	(0.018)
Str*Msh	0.017	0.082	0.493 *	0.366		-0.060	-0.113	-0.122	-1.989 **	-0.910 ***
	(0.065)	(0.081)	(0.276)	(0.450)		(0.127)	(0.081)	(0.201)	(0.942)	(0.243)
Str*Xsh	0.115	0.125	0.097	-0.011		0.021	-0.098	-0.461	-2.442 ***	-0.204
	(0.150)	(0.087)	(0.093)	(0.221)		(0.083)	(0.087)	(0.314)	(0.906)	(0.222)
Str*PTA Tech pre2012	0.026 *	-0.016 *	-0.013	-0.023		-0.009	0.006	-0.056	-0.268 ***	-0.009
	(0.015)	(0.009)	(0.020)	(0.021)		(0.011)	(0.008)	(0.057)	(0.089)	(0.025)
Str*PTA Tech post2012	-0.005	0.002	-0.057	0.009		-0.006	0.021	-0.028	-0.322	-0.013
	(0.024)	(0.023)	(0.043)	(0.030)		(0.025)	(0.013)	(0.104)	(0.241)	(0.061)
Comlegal (post)	0.814 ***	0.028	0.202	-0.026	-0.036	0.027	0.043	-0.012	0.049	0.034
	(0.228)	(0.116)	(0.156)	(0.133)	(0.159)	(0.092)	(0.063)	(0.078)	(0.085)	(0.059)
Comlegal (pre)	-0.654 **		-0.359 **	0.569 ***	0.138					
	(0.257)		(0.166)	(0.156)	(0.177)					
Comcol		0.457		-0.189	0.777 ***	0.068		-0.757 **	1.050 ***	
		(0.408)		(0.423)	(0.213)	(0.371)		(0.332)	(0.364)	
Col45	1.664 ***		0.496 *				0.738 ***	0.576 **		0.528 *
	(0.450)		(0.275)				(0.219)	(0.257)		(0.290)
Col dep ever		0.525 **		0.347	0.386 **		0.178	0.309 *	-0.038	-0.288
		(0.228)		(0.227)	(0.193)		(0.163)	(0.184)	(0.160)	(0.178)
Comrelig	0.009				0.018 ***	-0.001				0.004 *
	(0.006)				(0.004)	(0.003)				(0.002)
Comlang off			-0.747 ***	-0.235		0.052	0.022	-0.244	0.103	-0.124
			(0.257)	(0.205)		(0.174)	(0.113)	(0.184)	(0.207)	(0.120)
Same country	-0.817	-1.280				0.613	0.186		-0.126	
	(0.737)	(1.135)				(0.463)	(0.464)		(0.567)	
Same col ever		0.660 ***	0.839 ***				-0.073	0.879 ***		
		(0.246)	(0.285)				(0.126)	(0.259)		
Time diff	-0.039		0.094 ***	0.080 ***	-0.100 ***	0.075 ***			0.040	-0.027
	(0.042)		(0.024)	(0.023)	(0.021)	(0.019)			(0.025)	(0.017)
CF PTA	0.155	-0.392 **	0.128	-0.687 ***	0.192	-0.455 ***	0.011	-0.181	-0.062	-0.082
	(0.257)	(0.179)	(0.185)	(0.171)	(0.166)	(0.160)	(0.103)	(0.139)	(0.137)	(0.106)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications).
***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Grains	Veg & Fr	Crops	Animal	Extr Nrg	Fd Anm	Fd Plant	Tex	Lgt Mfc	Chem
CF PTA Tech	-0.570 **	-0.197	-0.519 ***	-0.298 *	-0.430 **	-0.175	-0.206 **	-0.202	-0.048	-0.186 *
	(0.280)	(0.142)	(0.196)	(0.170)	(0.170)	(0.173)	(0.088)	(0.135)	(0.167)	(0.096)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Table 26: Gravity estimations – Single indicator model 2/2

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
Distance	-0.126	-0.632 ***	-0.714 ***	-0.262 ***	-0.457 ***	-0.459 ***	-0.550 ***	-0.425 ***	-0.261 **	-0.498 ***
	(0.090)	(0.074)	(0.091)	(0.080)	(0.079)	(0.117)	(0.074)	(0.068)	(0.106)	(0.093)
Contiguity	-0.002	0.675 ***	0.468 **	0.514 ***	0.877 ***	0.128	1.104 ***	0.848 ***	1.000 ***	0.698 ***
	(0.170)	(0.200)	(0.188)	(0.164)	(0.226)	(0.240)	(0.269)	(0.210)	(0.292)	(0.251)
Latitude	-0.116 **	-0.112 ***	-0.194 ***		-0.126 ***	-0.040	0.025	-0.039	-0.012	0.105 *
	(0.046)	(0.034)	(0.040)		(0.041)	(0.056)	(0.044)	(0.037)	(0.077)	(0.053)
Comlang	1.042 ***	0.673 ***	0.811 ***	2.710 ***	0.567 **	0.785 **	0.794 ***	0.648 ***	-0.540	0.460
	(0.324)	(0.216)	(0.240)	(0.466)	(0.224)	(0.343)	(0.250)	(0.203)	(0.444)	(0.295)
Mass	0.385 ***	0.357 ***	0.375 ***	0.286 ***	0.388 ***	0.500 ***	0.490 ***	0.428 ***	0.219 ***	0.385 ***
	(0.067)	(0.048)	(0.049)	(0.060)	(0.050)	(0.066)	(0.056)	(0.039)	(0.076)	(0.062)
PCA1	-0.103 ***	0.043 **	-0.000	0.065 ***	0.064 ***	0.127 ***	0.080 ***	0.013	-0.072 ***	-0.040
	(0.023)	(0.020)	(0.025)	(0.024)	(0.023)	(0.024)	(0.020)	(0.019)	(0.024)	(0.028)
PCA2	0.012	0.034	0.040	0.035	0.038	0.202 ***	0.041 **	0.030	0.127 ***	0.019
	(0.033)	(0.025)	(0.028)	(0.032)	(0.025)	(0.042)	(0.020)	(0.022)	(0.039)	(0.029)
PCA3	0.043	-0.021	0.025	0.023	-0.030	-0.036	-0.045	-0.009	0.028	-0.017
	(0.043)	(0.046)	(0.053)	(0.047)	(0.050)	(0.062)	(0.050)	(0.037)	(0.067)	(0.055)
Border	-20.995 ***	-14.336 ***	-15.595 ***	-14.285 ***	-15.583 ***	-20.212 ***	-18.786 ***	-19.366 ***	-19.468 ***	-17.483 ***
	(1.783)	(1.384)	(1.349)	(1.511)	(1.585)	(1.896)	(1.459)	(1.138)	(2.249)	(1.711)
Trade Facilitation	0.545 ***	0.057	0.082	0.364 ***	0.031	0.264 ***	0.141 *	0.296 ***	0.642 ***	0.234 **
	(0.084)	(0.056)	(0.070)	(0.067)	(0.074)	(0.090)	(0.085)	(0.079)	(0.115)	(0.102)
EU	2.007 ***	1.349 ***	0.986 ***	2.454 ***	1.146 ***	2.223 ***	2.105 ***	1.493 ***	0.841 **	1.751 ***
	(0.280)	(0.290)	(0.331)	(0.314)	(0.368)	(0.327)	(0.317)	(0.266)	(0.400)	(0.411)
PTA pre2012	1.921 ***	0.338	0.193	1.154 ***	0.239	1.393 ***	0.943 ***	0.670 ***	0.071	0.594
	(0.315)	(0.319)	(0.284)	(0.358)	(0.333)	(0.282)	(0.272)	(0.226)	(0.371)	(0.393)
PTA Tech pre2012	-1.193 ***	1.000 ***	0.694 ***	-0.496	0.624 *	1.260 ***	0.933 ***	0.478 *	0.343	0.781 *
	(0.324)	(0.281)	(0.267)	(0.404)	(0.331)	(0.399)	(0.358)	(0.290)	(0.439)	(0.441)
PTA post2012	0.962 **	-0.909 **	-0.987 ***	0.400	-0.536	0.168	0.138	-0.197	-0.741	-0.838
	(0.375)	(0.380)	(0.327)	(0.459)	(0.395)	(0.336)	(0.333)	(0.291)	(0.512)	(0.545)
PTA Tech post2012	-0.311	1.486 ***	1.319 ***	-0.064	0.406	1.943 ***	0.821 *	0.385	1.105	0.998
	(0.490)	(0.416)	(0.438)	(0.718)	(0.521)	(0.508)	(0.429)	(0.378)	(0.827)	(0.727)
Tariff	-17.837 ***	-9.180 ***	-12.578 ***	-8.556 **	-10.143 ***	-8.798 **	-11.237 ***	-11.037 ***	-13.597 ***	-11.639 ***
	(5.194)	(2.297)	(2.234)	(3.520)	(2.508)	(3.956)	(2.222)	(2.418)	(2.960)	(1.755)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
Tariff Margin*PTA										
Str*Border	-0.042 **	0.082 **	0.130	-0.610 ***	0.041	-0.072 ***	-0.013	0.004	0.268 **	0.005
	(0.020)	(0.037)	(0.080)	(0.075)	(0.077)	(0.025)	(0.017)	(0.016)	(0.126)	(0.036)
Str*Msh	-0.298	-0.871 ***	-2.326 **	0.311	-1.511 **	-0.269 *	-0.476 ***	-0.387 ***	-3.192 **	-0.160
	(0.338)	(0.294)	(0.992)	(0.680)	(0.592)	(0.140)	(0.094)	(0.080)	(1.256)	(0.322)
Str*Xsh	-0.549 **	-0.979 ***	-2.342	-0.178	-2.512 **	0.389 *	-0.746 ***	-0.716 ***	-0.363	-0.480
	(0.247)	(0.334)	(1.790)	(0.488)	(1.024)	(0.222)	(0.161)	(0.223)	(1.332)	(0.502)
Str*PTA Tech pre2012	-0.006	-0.091 **	0.033	-0.078	-0.174 *	-0.087 **	-0.089 ***	-0.069 **	-0.028	-0.009
	(0.015)	(0.041)	(0.120)	(0.083)	(0.103)	(0.042)	(0.027)	(0.027)	(0.145)	(0.049)
Str*PTA Tech post2012	-0.047	-0.067	-0.128	0.355	0.036	0.001	-0.056	0.031	0.036	0.020
	(0.039)	(0.076)	(0.297)	(0.283)	(0.157)	(0.067)	(0.040)	(0.036)	(0.153)	(0.054)
Comlegal (post)	0.233 **	0.088	0.089		0.348 ***		0.295 **	0.434 ***	0.051	0.370 ***
	(0.107)	(0.074)	(0.084)		(0.114)		(0.118)	(0.105)	(0.130)	(0.102)
Comlegal (pre)				-0.093	-0.271 **	-0.133	-0.202	-0.337 ***		
				(0.089)	(0.117)	(0.132)	(0.131)	(0.110)		
Comcol	-1.183 ***	-0.418		0.842 ***	-0.230	-0.010	-0.298		0.304	-0.604
	(0.376)	(0.261)		(0.314)	(0.252)	(0.293)	(0.277)		(0.329)	(0.382)
Col45	-0.241	0.518 **	0.550 **	1.070 ***	0.473 **			0.577 **		
	(0.278)	(0.261)	(0.261)	(0.263)	(0.190)			(0.245)		
Col dep ever			-0.200	-0.434 **					0.366	-0.627 ***
			(0.131)	(0.211)					(0.269)	(0.217)
Comrelig				0.006 *			0.006 *		0.011 **	0.009 **
				(0.003)			(0.003)		(0.005)	(0.004)
Comlang off	0.174	-0.062	-0.145	-0.521 **	-0.074	-0.118	-0.109	-0.125	0.445 *	-0.452 **
	(0.226)	(0.144)	(0.194)	(0.203)	(0.168)	(0.202)	(0.185)	(0.154)	(0.235)	(0.217)
Same country	0.967	0.953 ***	0.338		1.012 ***	0.339	0.669 *	1.007 ***	0.415	
	(0.758)	(0.326)	(0.486)		(0.336)	(0.391)	(0.366)	(0.339)	(0.483)	
Same col ever				-0.970 ***		0.223				0.204
				(0.237)		(0.246)				(0.329)
Time diff	-0.004	0.032 *	0.048 *	-0.030		0.091 ***	0.048 **	0.036 **		
	(0.020)	(0.019)	(0.027)	(0.018)		(0.029)	(0.019)	(0.015)		
CF PTA	-1.107 ***	-0.146	-0.193	-0.463 ***	-0.137	-0.743 ***	-0.652 ***	-0.357 **	-0.035	-0.591 ***
	(0.155)	(0.147)	(0.150)	(0.159)	(0.159)	(0.185)	(0.188)	(0.154)	(0.334)	(0.216)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

Variable	Pharma	Plastics	Mineral	Metal	Metal pr	El Comp	El Eq	Machine	Trans	Auto
CF PTA Tech	0.548 ***	-0.293 ***	-0.373 ***	0.338 *	-0.089	-0.533 ***	-0.052	-0.066	-0.141	0.064
	(0.186)	(0.108)	(0.129)	(0.190)	(0.122)	(0.191)	(0.140)	(0.119)	(0.263)	(0.215)

All models include 11,025 observations. All models include importer and exporter fixed effects. Bootstrapped standard errors in parentheses (500 replications). ***, **, and * denote significance at the 1%-, 5%-, and 10%-level, respectively. Xsh/Msh: predicted exporter/importer share.

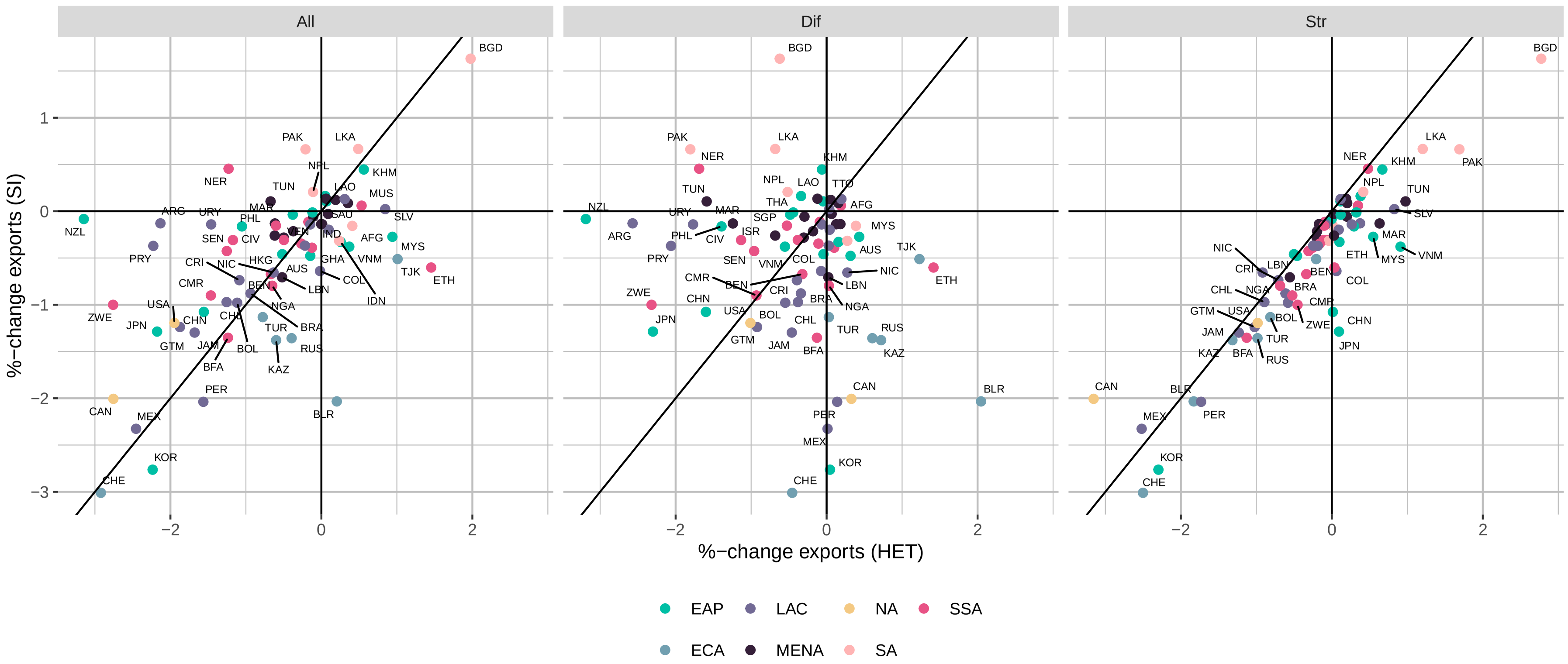

Figure 11: Changes in exports by income (in %): HET vs. SI
Changes in exports on x-axis for all, bilateral and stringency-related trade cost changes (All, Dif, Str) based on the heterogeneous effect (HET) model. Changes in exports for stringency-related trade cost changes based on the single indicator (SI) model on the y-axis.

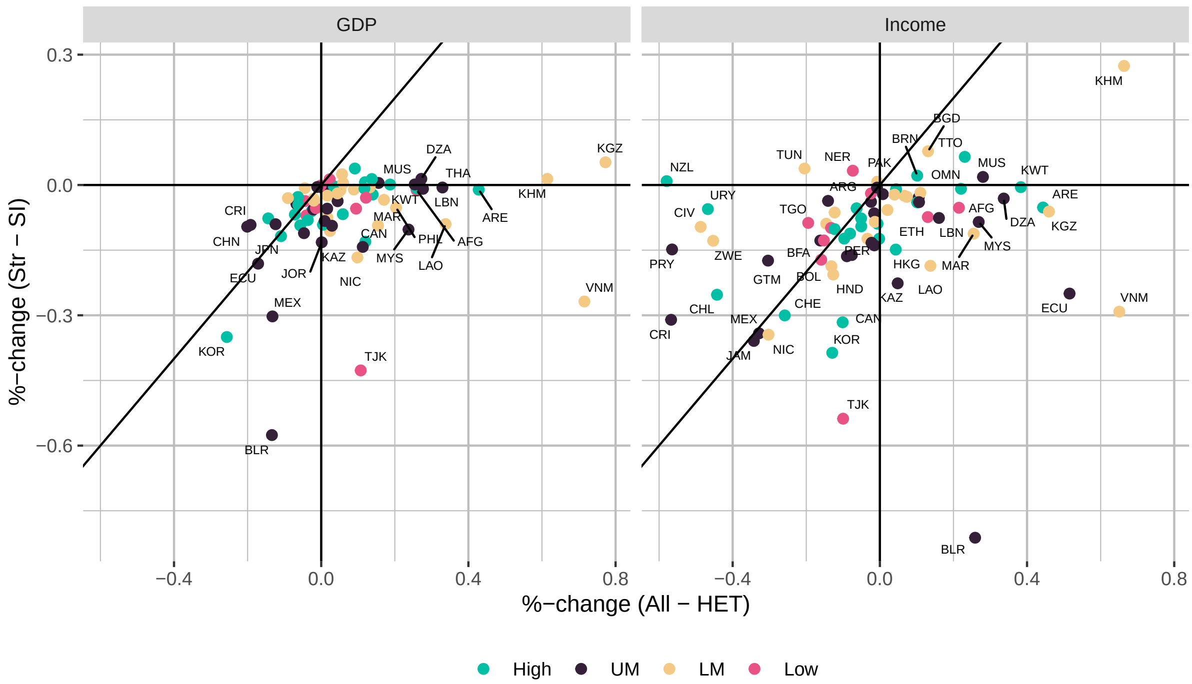

Figure 12: Changes in real GDP and income (in %)
x-axis: Real GDP and income changes based on the heterogeneous effect (HET) model. *y*-axis: Real GDP and income changes based on regulatory stringency in the single indicator (SI) model. BEN removed for exposition. Full country-level real income results in Table 24 in Appendix F.

G.2 Alternative trade cost channels

Next, we study the effect of modeling trade costs as changes in iceberg costs (our benchmark modeling option), import tariffs or export taxes. In Table 27 we list changes in real income by region and income group for different NTM trade cost dimensions, and test the sensitivity of income effects with respect to modeling trade costs changes as trade taxes and/or iceberg trade costs. Overall, the choice of the modeling approach does not significantly affect the patterns of real income effects across regions and income groups. However, modeling regulatory changes as iceberg trade costs results in larger income effects, which is consistent with efficiency gains and losses and the corresponding expansion effect associated with changes in iceberg trade costs. Modeling changes in NTM trade costs as import tariffs vs. export taxes does not lead to significantly different results.

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
All												
$\tilde{t}^{s,\tau}$	-0.05	-0.11	0.08	-0.04	-0.10	-0.02	-0.13	0.14	-0.07	0.06	-0.05	-0.06
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	-0.02	-0.07	0.02	-0.08	-0.05	0.01	-0.15	0.05	-0.04	0.04	-0.12	-0.03
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	-0.02	-0.09	0.05	-0.07	-0.08	0.02	-0.08	0.08	-0.05	0.06	-0.06	-0.03
Structure												
- Difference												
$\tilde{t}^{s,\tau}$	-0.01	-0.11	0.06	-0.02	-0.10	0.01	-0.04	0.15	-0.02	0.05	-0.03	-0.03
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	-0.01	-0.07	0.00	-0.05	-0.06	0.00	-0.08	0.07	-0.01	0.01	-0.08	-0.02
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	0.00	-0.09	0.03	-0.03	-0.09	0.01	-0.01	0.10	-0.02	0.03	-0.03	-0.02
- Divergence												
$\tilde{t}^{s,\tau}$	-0.15	-0.40	-0.13	-0.33	-0.46	-0.12	-0.20	-0.06	-0.11	-0.02	-0.14	-0.22
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	-0.10	-0.29	-0.10	-0.25	-0.32	-0.07	-0.20	-0.05	-0.06	-0.03	-0.16	-0.15
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	-0.09	-0.31	-0.07	-0.26	-0.36	-0.06	-0.10	-0.04	-0.06	0.00	-0.10	-0.15
- Harmonization												
$\tilde{t}^{s,\tau}$	0.15	0.31	0.20	0.34	0.38	0.13	0.17	0.22	0.09	0.07	0.12	0.19
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	0.09	0.22	0.11	0.20	0.27	0.07	0.12	0.13	0.05	0.04	0.08	0.13
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$	0.09	0.22	0.11	0.23	0.27	0.08	0.10	0.15	0.05	0.04	0.08	0.13
Stringency – HET												
$\tilde{t}^{s,\tau}$	-0.04	-0.01	0.02	-0.02	0.00	-0.03	-0.09	-0.01	-0.05	0.02	-0.02	-0.03
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	-0.01	0.00	0.02	-0.04	0.01	0.01	-0.07	-0.02	-0.03	0.03	-0.03	-0.01
Stringency – SI												
$\tilde{t}^{s,\tau}$	-0.10	-0.13	-0.04	-0.11	-0.13	-0.11	-0.14	-0.05	-0.07	-0.01	-0.06	-0.10
$\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$	-0.04	-0.10	-0.02	-0.10	-0.09	-0.03	-0.10	-0.06	-0.05	0.00	-0.07	-0.06
All – Impute												
$\tilde{t}^{s,\tau}$	-0.07	-0.15	-0.03	-0.06	-0.16	0.00	-0.15	0.09	-0.10	-0.04	-0.05	-0.09
All – Org												
$\tilde{t}^{s,\tau}$	-0.01	-0.34	0.11	-0.18	-0.27	0.06	-0.23	0.19	-0.05	0.10	-0.12	-0.09

Table 27: Sensitivity analysis: Change in real income by scenario (in %)
NTM shock: 100% iceberg cost ($\tilde{t}^{s,\tau}$); 50% iceberg cost, 50% rents on importer side only ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}$); and 50% iceberg cost, 50% rents with harmonization rents equally split between importer and exporter, and stringency- and divergence-related rents accrue to importer ($\tilde{t}^{s,\tau}, \tilde{t}^{s,\text{imp}}, \tilde{t}^{s,\text{exp}}$). Full country-level real income results in Table 24 in Appendix F. See Appendix A for a detailed listing of country groups.

G.3 Original NTM data scenario

We test the sensitivity of our results with respect to outlier correction described in detail in Appendix C. We simulate changes in regulatory trade costs based on the original data without correcting for outliers in regulatory changes (original-data scenario) to illustrate the impact of outlier corrections on trade and macroeconomic results. Thus, we use regulatory changes as implied by entry into force dates of measures in NTMTRAINS. Table 28 is analogous to the presentation of changes in trade flows presented in Table 4 in the main text, and Figure 13 compares macroeconomic outcomes (real GDP and income) of the original-data scenario with vs. main scenario (with outlier correction).

Trade costs in the original-data scenario increase relatively less than in the main scenario—0.05% vs. 0.19%. This difference is driven by lower import costs of upper-middle income countries in East-Asia & Pacific, and lower export costs for low income countries in Sub-Saharan Africa and Latin American & Caribbean countries. By contrast, import costs increase relatively more for the Middle East & Northern Africa and South Asia, while the same holds true for exports costs of East Asia & Pacific.

Despite an overall lower trade cost increase, total trade decreases about 0.9 percentage points more under trade cost changes not corrected for outliers relative to the main scenario (-2.29% vs. -1.43%). This difference is primarily caused by significantly lower imports and exports of middle income countries in East-Asia & Pacific and Latin America & Caribbean countries compared to the main scenario.

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
High	-0.23	-5.79	-0.10	0.48	-3.45	-0.94	-5.23	0.44	-0.70	2.27	-0.96	-2.00
UM	-4.27	-0.39	-2.24	-2.63	-7.54	2.21	-1.18	-1.76	-4.41	-3.67	-2.78	-3.26
LM	-1.16	-1.96	4.48	1.46	-2.51	-1.57	-1.85	1.75	0.97	4.96	2.68	-0.74
Low	0.81	-3.60	-1.57	-4.06	-5.90	-0.57	-2.50	4.29	-1.22	0.29	-2.48	-0.74
EAP	-0.89	-9.38	-2.78	-4.23	-8.69	3.32	-2.87	-2.99	2.78	-0.95	-4.08	-3.57
ECA	-1.45	1.78	1.44	1.49	1.87	-2.62	-4.05	0.62	0.70	2.17	-0.60	-0.26
LAC	-4.44	-3.30	4.87	-2.71	-4.78	0.30	-0.53	2.73	-5.91	3.03	3.53	-3.62
MENA	-2.17	2.26	0.73	0.54	-0.14	-1.69	-3.16	1.17	-3.91	0.51	0.45	-0.80
NA	-2.45	-4.18	2.71	3.37	1.52	0.73	-5.73	2.21	-8.80	1.90	2.10	-2.66
SA	0.13	-3.45	7.21	1.43	-0.33	-0.09	-1.82	0.60	-0.49	4.83	2.81	0.16
SSA	-1.70	-2.92	-1.03	-0.10	-5.11	-1.30	-4.29	2.64	-5.34	1.33	0.80	-1.67
Total	-1.69	-4.29	-0.50	-0.42	-4.50	0.13	-3.99	0.07	-1.89	0.70	-1.13	-2.29

Table 28: Changes in trade between regions and income level (original scenario, in %)
Trade flow changes based on the heterogeneous effect (HET) model. See Appendix A for a detailed listing of country groups.

Real GDP effects in the original-data scenario are relatively similar to our main scenario with the exception of notable outliers (e.g. Kyrgyzstan, Nicaragua, Vietnam, Korea). Real income effects are less negative for most countries in the main scenario, while for those countries for which we find positive real income effects original trade cost changes tend to lead to relatively more positive outcomes.

The results are qualitatively very similar across income groups and regions and only change sign for Europe & Central Asia for the original-data scenario. Real income effects of the original and main scenario are highly correlated (correlation coefficient of 0.7). Furthermore, the correction of outlier regulatory changes prevents unrealistic macroeconomic results such as the real income effects found for Nicaragua, Kyrgyzstan, and Belarus in the original-data scenario. The overall pattern between the two scenarios is relatively similar, and without Nicaragua, Kyrgyzstan, and Belarus real income effects between the two scenarios correlate with a coefficient of 0.9, which makes us confident that outlier corrections do not change the overall nature of results.

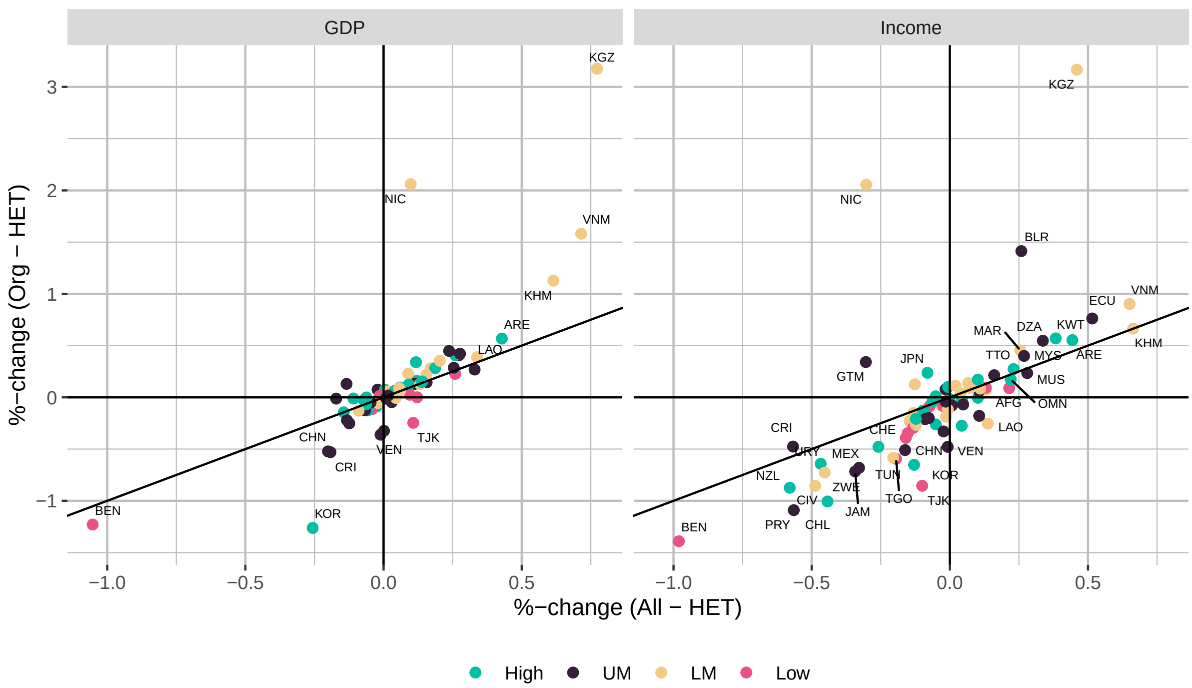

Figure 13: GDP and real income: Main scenario vs. original scenario (in %)
Real GDP and income changes based on the heterogeneous effect (HET) model. x-axis: Real GDP and income changes based on benchmark regulatory changes. y-axis: Real GDP and income changes based on regulatory changes that are not corrected for outliers.

G.4 Imputation NTM data scenario

We test the sensitivity of our results with respect to potential misreporting of regulatory changes by the design of the NTMTRAINS database—i.e. false positive (overreporting) and false negative (omission). We estimate the impact of regulatory activity that is potentially not captured by NTMTRAINS by using benchmark regulatory change $N^i_{\Delta B}$ (see Appendix C) to compute AVE trade cost changes. Table 29 is analogous to the presentation of changes in trade flows presented in Table 4 in the main text, and Figure 14 compares macroeconomic outcomes (real GDP and income) of the imputed scenario and the main scenario.

For total trade, we find that trade costs increase relatively more in the imputed scenario than in the main scenario—0.28% vs. 0.19%. The difference is driven by relatively higher import costs of lower-middle and high income countries in East-Asia & Pacific, North America, and South Asia, as well as higher export costs for low and middle income in Latin American & Caribbean countries and Sub-Saharan Africa.

Correspondingly, total trade decreases 0.25 percentage points more under imputed trade cost changes compared to the main scenario (-1.68% vs. -1.43%). Particularly, imports from middle income countries and exports of lower-middle income countries decrease relatively more, while on the regional level, trade of North America and South Asia is more negatively affected.

Real income decreases more in the imputed scenario than in the main scenario (-0.09% vs. -0.06%) reflecting the relatively larger trade cost increases. Nevertheless, real GDP and income effects are highly correlated with the main scenario. The correlation coefficient of real income

	High	UM	LM	Low	EAP	ECA	LAC	MENA	NA	SA	SSA	Total
High	-2.18	-2.05	-0.99	0.31	-1.67	-1.39	-2.18	0.30	-4.11	-0.88	-0.56	-2.02
UM	-1.81	-0.27	-0.18	0.05	-1.34	-1.45	-1.91	-0.67	-1.25	-0.45	-0.90	-1.31
LM	-0.31	-1.46	-0.22	-1.09	-1.90	0.41	-2.65	-1.98	1.14	0.15	0.02	-0.59
Low	0.20	-0.37	-1.04	0.14	0.44	-0.18	-0.70	0.77	-0.13	-1.70	-1.59	-0.15
EAP	-1.06	-2.10	-1.24	-1.25	-2.23	-1.55	-2.62	-0.69	1.11	-0.92	-1.32	-1.38
ECA	-1.29	-1.50	0.35	2.89	-1.30	-1.29	-1.36	1.01	-2.13	-0.15	0.12	-1.22
LAC	-2.47	-0.43	1.79	-0.08	-0.86	0.10	-0.08	1.15	-3.37	0.30	0.40	-1.71
MENA	-1.27	2.40	-0.37	-1.67	1.04	-0.78	-0.56	-1.77	-2.52	-0.70	-0.55	-0.39
NA	-4.42	-2.08	-0.47	0.80	-1.06	-1.43	-2.72	-0.64	-9.26	-0.55	-0.41	-3.55
SA	-0.33	-1.43	-0.69	-1.82	-0.15	0.01	-6.69	-2.19	0.25	-1.01	-1.01	-0.59
SSA	-1.18	-0.77	-0.08	-0.63	-0.67	-1.29	-1.32	0.25	-1.80	0.10	-0.76	-0.87
Total	-1.89	-1.60	-0.62	-0.12	-1.60	-1.24	-2.13	-0.15	-2.72	-0.62	-0.61	-1.68

Table 29: Changes in trade between regions and income level (imputed scenario, in %)
Trade flow changes based on the heterogeneous effect (HET) model. See Appendix A for a detailed listing of country groups.

changes is 0.8. The high correlation is highlighted by countries being located near the 45-degree line in Figure 14. Moreover, most countries are located in the upper-right and lower-left quadrant, which shows that the sign of real income effects is mostly the same in both scenarios.

Overall, assuming that the imputed regulatory changes are a suitable proxy for regulatory activities, the high correlation of results increases our confidence that the potential misreporting of regulatory activities by design of the NTMTRAINS database does not have significant impact on the quality of our findings. In particular, if the NTMTRAINS database suffers from omission of regulatory activities, the main scenario presented in the text likely underestimates negative effects of regulatory divergence trends, and presents a lower bound estimate in terms of magnitude.

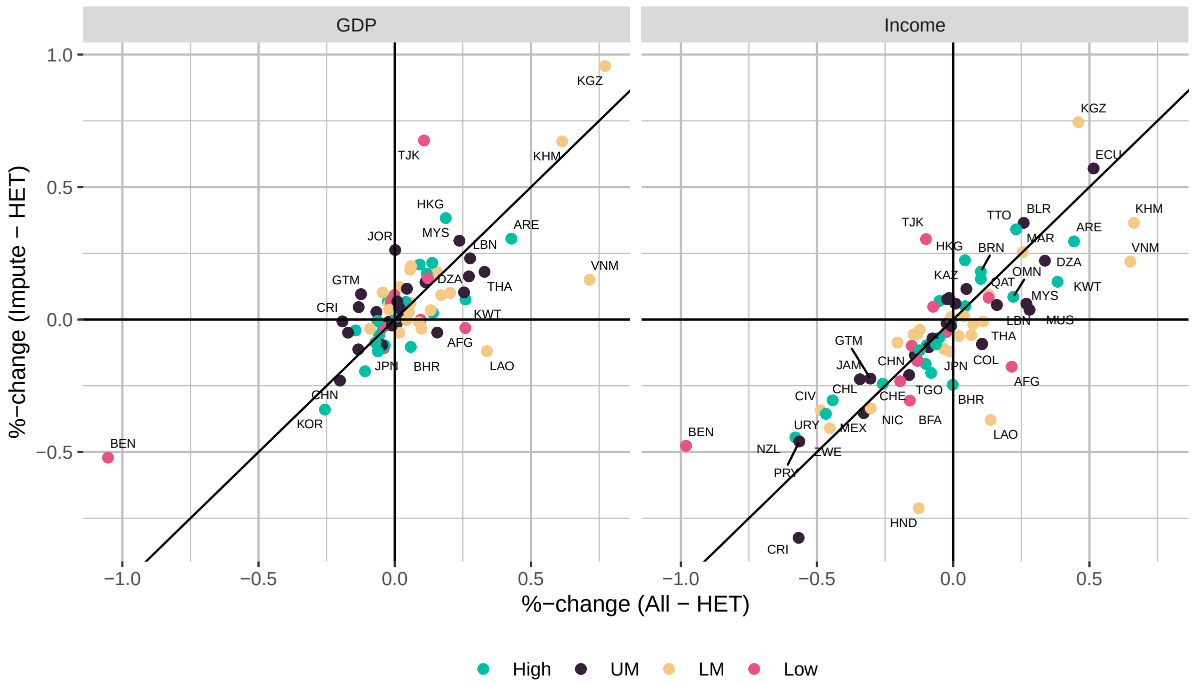

Figure 14: GDP and real income: Main scenario vs. imputed scenario (in %)
Real GDP and income changes based on the heterogeneous effect (HET) model. x-axis: Real GDP and income changes based on benchmark regulatory changes. y-axis: Real GDP and income changes based on imputed regulatory changes.