Quality Misallocation, Trade, and Regulations*

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Abstract

Domestic regulations on product standards are a key point of contention in modern trade agreements. We study the effects of international trade on the optimal level of restrictiveness of regulations in a multi-country model of monopolistically competitive firms that are heterogeneous in quality. We model regulations as a fixed cost that any firm selling to an economy must pay, consistent with stylized facts that we present. The fixed cost improves allocative efficiency, by forcing the exit of low-quality firms and reallocating production towards high-quality firms. Furthermore, the fixed cost generates a positive externality on the rest of the world. Our main finding is that international trade and regulations are complements: a reduction in trade costs reduces the optimal restrictiveness of regulations. We estimate our model and quantify the welfare consequences of imposing the optimal regulation, the extent of the positive externalities across countries, and the reduction in trade costs required to achieve equivalent welfare gains.

Keywords: Allocative Efficiency, Regulations, Quality Standards, Variable Markups, Trade Policy.

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1 Introduction

Regulations on goods' characteristics are an important tool applied by policy makers. For example, standardization of technical requirements for products is a major priority of the European Commission growth initiative.[1] Governments choose to impose standards in the domestic economy for many legitimate reasons, e.g. standards on auto emissions to counter the negative externality of pollution, or standards in the food industry to protect consumers from disease. Although these regulations are targeted at protecting domestic constituents, product standards are hotly debated in the context of international trade (Maskus et al., 2000; Baldwin et al., 2000; Rodrik, 2018).[2] Still, the trade policy literature has focused almost exclusively on the possibility of positive optimal tariffs, with no work on non-tariff barriers as an available instrument. Domestic regulations are often viewed as a barrier on market access of foreign firms and for that reason are treated strictly as protectionist (Baldwin et al., 2000; Chen and Novy, 2011; Fontagné et al., 2015).

However, non-discriminatory regulations that require the payment of compliance costs affect all firms selling to an economy, regardless of their origin, and are *de facto* targeting the smallest firms, which cannot afford these additional costs. We focus on regulations that select out small firms, and find that they generate a reallocation of production that improves the allocative efficiency of a market. In fact, the interaction between consumers' preferences and firms' variable market power generate inefficiencies whereby small firms over-produce by charging low markups, and large firms under-produce due to high markups. We are the first to investigate in an open economy setting the welfare implications of such regulations. We find that international trade and regulations are complements: a reduction in trade costs reduces the optimal restrictiveness of regulations.

A contribution of this paper is to introduce a new avenue through which trade policy has allocative efficiency implications. The trade literature has recently dealt with the idea that trade liberalization – through a reduction in trade costs – lowers misallocation through competition (references below). However, a separate way through which policy makers can alter the selection of firms is through the imposition of regulations that require the payment of compliance costs. As our model allows for both trade and regulations, we provide a new framework to approach product regulations in the negotiation of trade agreements. This paper offers support of a dual approach for policymakers: pushing towards lower trade costs while lowering restrictiveness of quality standards.[3]

[1] https://ec.europa.eu/growth/single-market/european-standards_en

[2] In the international trade context, these regulations are labeled technical measures to trade and consist of sanitary and phythosanitary standards and technical barriers to trade (UNCTAD, 2012).

[3] The result provides a theoretical justification for the continuous efforts from the WTO of improving

Our theory applies the demand framework of Macedoni and Weinberger (2019) to a multi-country world with trade frictions. The model features firm heterogeneity and monopolistic competition. Any country can set a regulation that requires all firms selling to it the payment of a fixed cost. The ability to pay these fixed costs will depend on the ex-ante profitability of the firm, which in our model is determined by its quality draw. In requiring the compliance cost, governments select out the lowest quality firms, which for example might be firms whose products are most likely to be unsafe. Hence, the regulations we examine can be best represented as quality standards.[4] An important property of regulations is that their effects can still be heterogeneous across sourcing countries depending on their average level of quality. The same level of (non-discriminatory) fixed cost will be perceived more stringent in origin countries with a lower average quality.

We show that there exists a level of compliance costs which eliminates the lowest quality home and foreign firms and raises welfare, by improving allocative efficiency. Proper to an open economy framework, regulations also affect the relative wage, which reflects changes in the terms of trade, and it exhibits a non-monotone hump shaped relationship with the regulation of the imposing country. At low levels of restrictiveness, the relative wage increases with the standard, as low-quality firms exit. However, at higher levels of restrictiveness, workers are reallocated toward compliance activities, captured by the fixed cost, which reduces their purchasing power. In addition, stricter regulations in one country foster the entry of new (high-quality) firms from both the imposing and the foreign country. The increase in the mass of firms is driven by the larger profitability of surviving firms because the regulation raises average quality.

The optimal level of regulation interacts with the level of openness of a country. As the trade literature has highlighted with firms heterogeneous in productivity (Dhingra and Morrow, 2016; Edmond et al., 2015), a reduction in variable trade costs of exporting and importing reallocates production from small (low-quality) non-exporters to large (high-quality) exporters. Thus a reduction in trade costs generates effects that are similar to those of a regulation, thus, reducing the welfare improving ability of the regulation. In fact, we find that lower trade costs imply a smaller optimal restrictiveness of regulation. Still, trade alone is not sufficient to eliminate allocative inefficiencies and regulations are still welfare enhancing in a fully integrated world.

the Technical Barriers to Trade Agreement, which has now reached the Eighth Triennial Review. See https://www.wto.org/english/tratop_e/tbt_e/tbt_triennial_reviews_e.htm

[4]The model uses a general "quality" for the firm that encompasses any (single) dimension through which quality is determined for a product. As discussed in Macedoni and Weinberger (2019), a model with productivity heterogeneity generates similar results. We stress that our model does not necessitate any imposition of an ad-hoc negative externality, as the distortion we capture is the over/under allocation of a certain quality level. Any reduction of negative externalities would be a *further* rationale for the standard.

An important result of this paper is that regulations create additional benefits that are not internalized by the country imposing the regulation. In stark contrast to the beggar-thy-neighbor rationales that dominate much of trade policy, in this case international cooperation is motivated by a positive externality on foreign economies. As regulations in one country improve welfare in all other countries, a non-cooperative equilibrium generates too lenient regulations across countries. Cooperation across countries ensures higher welfare achieved with higher levels of regulations.

Our model also sheds some light on differences of regulations across countries, due to differences in origin characteristics. We find that larger countries, and countries with more efficient production technologies, will optimally choose to set more restrictive standards, as these countries can tolerate higher levels of fixed costs. This suggests for example that the European Union will likely set stingier standards than Mexico. This is an important result because it arises in the absence of any protectionist motives nor presence of negative consumption externalities.

We provide a quantitative exercise to estimate the restrictiveness of regulations and evaluate the welfare effects of changes in regulations across countries. First, we use data on the distribution of firm-level export sales at the country-pair level, available in the Exporter Dynamics Database (EDD). This allows us to estimate the level of restrictiveness applied by destinations on individual trade partners, and we provide an algorithm that employs these to produce a domestic restrictiveness measure. Consistent with our theoretical framework, the estimated restrictiveness acts as a fixed cost of compliance as it is negatively related with the extensive margin of exports but positively related with the intensive margin.

Second, we leverage the gravity framework produced by our model to estimate the global welfare response to a counterfactual change in regulations in either a single or all countries. As pointed out in the model, countries can raise their own welfare up to a point with a modest level of regulations, but they raise the welfare of their trade partners *always*. If all countries impose contemporaneously their own optimal standard, welfare increases by as much as 0.88% in Costa Rica, and by an average of 0.34% in all countries. Relative to the welfare gains when countries change their standards individually, the gains when *all* countries impose optimal standards is 10 times larger. More open countries, with lower optimal restrictiveness, gain the least from imposing their own optimal regulations, but gain the most from other countries imposing regulations. This highlights the large benefits available in the cooperation of countries to jointly raise their standard, a further motivation for "deep" trade agreements. As a comparison to the common case examined in the literature where countries lower their trade costs, we find that achieving the same average welfare gains requires a 4.2% reduction in trade costs, or countries becoming on average 2% "more open".

Robustness exercises are also reported that deal with several data issues.

Prior to laying out the theoretical results on optimal regulation, we introduce stylized facts that are rationalized by the model. We merge a database of product standards reported as non-tariff measures across 70 countries (NTM-MAP) with information on firm export success (EDD). Although the model-implied estimated level of restrictiveness accounts for any policies that affect the observed distribution of exporters to a destination, technical measures such as phytosanitary and sanitary (SPS) and technical barriers (TBT) represent a subset of such policies that can be quantified explicitly in the NTM-MAP data. Export outcomes, as a real measure of their restrictiveness, confirm that quality standards in trade act as a fixed cost. An origin-sector pair sends fewer exporters to destinations with higher number of regulations, although the average value per exporter is not affected. This is in contrast to the standard measures of variable trade costs the literature has examined, such as distance. Furthermore, we show that destinations with larger income and size tend to apply stingier regulations as they are more successful in restricting market access, while more open economies apply more lenient regulations. These results fit with our findings of optimal standards for countries across their income, size, and openness characteristics.

Related Literature. The idea that economic integration reduces misallocation is a focus of Edmond et al. (2015) (EMX) and Dhingra and Morrow (2016) (DM). Our setting is closer to DM as they also examine monopolistic competition, although they model integration through an increase in market size. Arkolakis et al. (2017) (ACDR) generalize DM and introduce costly trade, and capture changes in allocative efficiency as part of the total welfare gains due a reduction in trade costs. Trade raises allocative efficiency among home firms due to a rise in competition but also raises misallocation in reallocating demand to less productive foreign firms. EMX and Holmes et al. (2014) both study the effects of trade liberalization on allocative efficiency in oligopolistic competition settings and find that a rise in competition is an avenue through which misallocation is reduced as a response to freer trade. We combine the pro-competitive consequences of trade with the ability of the government to alter the selection of firms by imposing technical standards. Finally, Khandelwal et al. (2013) provide a mechanism through which the elimination of quotas in China reduces misallocation, as export licenses were not allocated efficiently. In that case, there is new entry of *productive* firms, and hence entry raises efficiency. Our study on quality standards by construction investigates regulations where the marginal firms are of *lowest* quality, although the regulation also fosters new entry of high-quality firms.

An important contribution is to provide a new rationale for regulations in an open economy framework. Quality standards could be raised to address negative externalities, such as environmental externalities (Parenti and Vannoorenberghe, 2019; Mei, 2017), to reduce oligopolists' market power (Baldwin et al., 2000), or to enhance investments in quality upgrading (Gaigne and Larue, 2016). Other reasons, yet to be explored in the context of international trade are information asymmetries or, more generally, information frictions (Schwartz and Wilde, 1985). Technical measures could also be used as murky protectionism (Baldwin and Evenett, 2009), as studied by Fischer and Serra (2000) in the context of an international duopoly. This paper acts as a complement to the existing literature on rationales for regulations in trade agreements as it is the first to explore the role of inefficient markets. As inefficient markets are a pervasive feature of international trade models, our case for regulation is immune to the criticism where an imposition of a negative consumption externality could be considered ad-hoc.[5] Also, the reduction in the misallocation distortion is a *further* benefit of a standard, even though these are typically imposed to correct more specific negative externalities.

A parallel literature investigates the role of standards in trade agreements through the positive impact that harmonization has on trade flows.[6] Our paper does not study the positive trade effects of harmonization, but instead takes as given the (fixed) costs involved with imposing standards. As harmonization allows countries to reduce the fixed costs associated with standards, the possible welfare gains from imposing the optimal standard in our framework would be even higher. However, we do analyze the role for cooperation in setting standards given the positive effect on allocative efficiency.

As argued by Costinot et al. (2016), the literature on how firm heterogeneity impacts trade policy is scant. Demidova and Rodriguez-Clare (2009), Felbermayr et al. (2013), Demidova (2017), and Costinot et al. (2016) each explore the role of optimal import taxes and subsidies in settings with imperfect competition and firm heterogeneity. Except for Demidova (2017), these studies assume that markups are constant, and in general do not focus on the way that variable markups distort the allocation of resources. Our paper adds to this literature in that it provides another potentially important mechanism through which firm heterogeneity may affect the design of optimal trade policy. Although we take trade costs (and hence tariffs) as given and study instead optimal standards that are part of a governments' policy schedule, we also provide the equivalent reduction in trade costs necessary to achieve the same welfare gains.

[5] Furthermore, negative consumption externalities are hard to quantify, which makes a welfare comparison between private solutions and a centralized government solution difficult to examine concretely.

[6] Swann et al. (1996) find that standards raise exports for UK firms. Chen and Mattoo (2008) find that trade flows increase with EU/EFTA harmonization. Shmidt and Steingress (2018) confirm the rise in export flows, at the intensive and extensive margin, across a broad set of standards and across countries. Parenti and Vannoorenberghe (2019) motivate the emergence of trade blocks through the incentive to harmonize depending on the "regulatory distance" between trade partners.

The remainder of the paper is organized as follows. Section 2 provides new stylized facts on the effects of regulations on export. Section 3 derives the main theoretical results of the paper. Section 4 shows the results from the estimation of the model and the counterfactual exercises on regulatory restrictiveness. Section 5 concludes the paper.

2 Stylized Facts on International Regulations

Regulations and Country Characteristics. In order to motivate the decision of policymakers to apply optimal product standards, we conduct a comparative analysis of current standards. We use the the NTM-MAP database provided by CEPII which measures the incidence of non-tariff measures across destination countries. We interpret standards as the application of *technical measures* (TMs), either sanitary and phytosanitary standards (SPS) or technical barriers to trade (TBT). These types of regulations fit most closely with the regulations in the theory because they restrict the level of quality that can survive in a market. Our prevalence measure counts only these reported barriers as a measure of TM. The data is cross-sectional and is provided for 71 countries, however we group the EU28 into one observation as all EU countries must harmonize their regulations. For further detail see Gourdon (2014).[7] The sample is made up of mostly middle-income and lower-income countries, with EU as the exception. The NTM data is merged with macroeconomic measures from the Penn World Table 9.0 for the year 2012.[8]

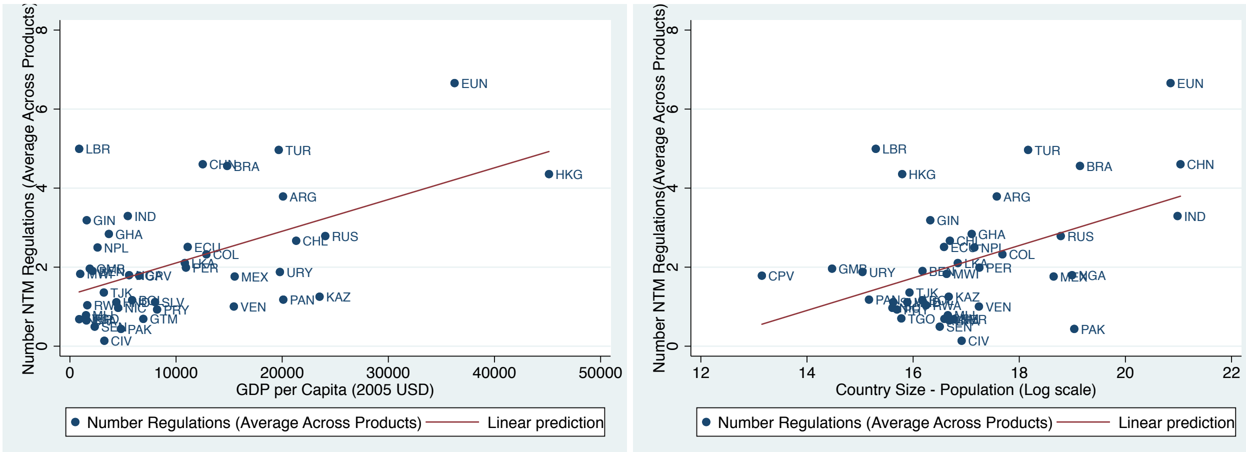
Figure 1 displays scatter plots of the TM prevalence measure, with country income and size, for 43 countries. Richer countries tend to impose more standards (left panel). The correlation between GDP per capita and the prevalence of measures is 0.54. In unreported results, we find that the correlation is (unsurprisingly) very strong with other indicators of standard of living, such as human capital, capital intensity, and TFP. In the relationship with country size, measured as population, we also observe almost the same relationship, with a correlation coefficient of 0.52.[9]. We note that the relationship is very similar with GDP, or if we restrict standards to include only SPS, which are more likely to reflect vertical norms.

[7] The data is provided at the country-HS2 product level on the CEPII website: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=28. The prevalence measure we use captures the average number of TMs which apply to a HS6 product. We take a weighted average of the HS2 products, weighting by the number of product lines in each sector. Using the coverage ratio instead of the prevalence measure would yield similar results. Finally, HS6 level data is available directly from I-TIP on their website: https://i-tip.wto.org/goods/default.aspx?language=en. We constructed a prevalence measure using this data (for both SPS and SPS+TBT) and found very similar results

[8] "EUN" represents the EU in the figures below. We aggregate its macro data as one large country.

[9] The figure uses a log scale for population in order to reduce the differences between EUN/China/India and the rest of the countries.

Figure 1: Regulations and Country Characteristics



The figure is a scatter plot of GDP per capita (left) and population (right) against the prevalence of NTM (SPS+TBT) regulations. The NTM data is provided at the country-HS2 product level by CEPII. The prevalence measure we use captures the average number of standards which apply to a HS6 product. We take a weighted average of the HS2 products, weighting by the number of product lines in each sector. Source of the national production and population data is the Penn World Table 9.0. GDP is output-side real GDP, using PPP chain-weighted prices. "EUN" is an aggregate of all EU28 countries. For the country size plot, we plot on a log scale of population due to the huge differences between EU, China, and India with the rest of the countries.

Regulations and Trade. We also provide an analysis that motivates the model in Section 3, and aims to complement the existing literature on trade standards and market access (Fontagné et al., 2015; Fernandes et al., 2015a; Ferro et al., 2015). This literature has relied on export flows to argue that exporters from a specific origin (e.g France) are less likely to sell to destinations that impose relatively more regulations.[10] Fontagné et al. (2015) show that this effect is especially strong for small exporters using firm-level data for France. A rationalization of this result is that regulations impose a fixed cost on firms that restricts mainly the extensive margin of exporting.

In the following, we bring in the Export Dynamics Database (EDD) to reproduce this result, and extend it to study the differential effect of TMs across different types of destinations. The EDD is a dataset from the World Bank that draws on the universe of exporter transactions obtained directly from customs agencies. We use the HS2 level data, which reports the number of exporters from an origin country to many destinations at this product classification.[11] We merge this with bilateral time-invariant gravity measures from CEPII (Fouquin and Hugot, 2016) and the NTM-MAP plus PWT data described above. We then run several specifications to study the effect that destination-specific regulation have on the

[10]These regulations typically include SPS and TBT. Fontagné et al. (2015) focus only on "specific trade concerns" as these are most likely to impede trade.

[11]There are 45 origins in the EDD data and 70 destinations. We can match the vast majority of destinations to our NTM data, but if we wanted a measure of the barriers imposed by the origin we would only be able to do this for less than half the countries. In this case, we split the EU into separate countries to take advantage of variation in trade flows to separate European destinations.

number of exporters and exports per exporter. These outcomes provide information on the real *restrictiveness* of regulations, improving upon simple counts of reported standards. The most basic specification is the following:

$$\#Exporters_{ijs} = \alpha_{is} + \alpha_j + TM_{js} + Gravity_{ij} + \epsilon_{ijs}, \quad (1)$$

where i represents origins, j destinations, and s 2-digit HS sectors.[12] We are interested in the market access of an origin-sector group with respect to variation in sector-destination regulations. Therefore, we include a set of origin-sector and destination fixed effects, along with gravity controls ubiquitous in the trade literature. As an alternative, the specification is also reported with an additional α_{ij} – importer-exporter interacted fixed effects.

The first column of Table 1 reports the effect of the TM prevalence measure on the number of exporters and follows exactly the specification in (1). It is clear that an origin-sector group will send fewer exporters to destinations that are more regulated, as was found in Fontagné et al. (2015). Doubling the prevalence of regulations is associated with a 1.3 percent decrease in the number of exporters.[13] The coefficients on the gravity measures confirm what is widely known – that trade barriers such as distance, no common language, and no common border will restrict the number of exporters. In the second column, we replace the gravity controls with the fullest set of fixed effects possible as we take both importer-exporter and exporter-sector controls. In this case we confirm that regulations restrict the number of exporters in a destination.

In the next three columns, we interact TMs with a destination (j) specific characteristic and include the full set of fixed effects. The effects of TMs on the extensive margin of exporters is stronger when the destination has a higher GDP per capita, and when the destination is a larger economy. Figure 1 suggests that these destinations tend to impose more regulations, but the literature has struggled with the fact that quantifying regulations this way is imperfect as not all standards are necessarily equal (nor applied equally). Columns (3) and (4) confirm that these destinations are also *more restrictive*; a regulation set by a rich/large country is *more successful* in restricting market access. Finally, column (5) reports that technical standards are *less restrictive* in more open destinations, where openness is the average of import and export shares of GDP. Although we acknowledge the potential problems with using export information on the right hand side, note that this result is

[12] We have also experimented with raising the sample size by using multiple years of EDD data, with the RHS variables fixed. Adding year interaction for all the fixed effects currently in the specification would ensure that we only use within-year variation, or a pooled cross-section. We keep the current specification for simplicity, although results are generally less noisy in the larger sample.

[13] As reference, doubling the prevalence of regulations might, for example, take an $i - j - s$ observation from the 25th percentile to the median in terms of prevalence scores.

consistent with our models' prediction that trade costs and standards are complements.

Next, we also investigate the effect of regulations on the value of exports per exporter (columns (5) and (6)). Notice the difference between trade costs such as distance and regulations: they are not equivalent barriers. TMs seem to *raise* export values, consistent with our interpretation that these only act on the *extensive* margin. With fewer exporters, the remaining exporters export more to each destination. Although the coefficient is of similar size compared to the log number of exporters, the standard error is larger. This effect is likely small, but note that if these types of restrictions were acting as marginal costs, this coefficient should be negative. Our finding that the average export value is either unaffected or increases marginally is consistent with TMs acting as a fixed cost that restricts the survival of low-quality firms. The gravity terms, most likely reflecting marginal costs, can be interpreted as lowering average exports as costs (e.g distance) increase.[14]

Table 1: Trade Margins and Regulations

	Log Number of Exporters					Log Value per Exporter	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TM Prevalence (log)	-0.013**	-0.014***	0.065	0.016*	0.015	0.015	0.018
	(0.007)	(0.005)	(0.046)	(0.010)	(0.014)	(0.014)	(0.014)
GDP/L*TM			-0.008*				
			(0.005)				
POP*TM				-0.009***			
				(0.002)			
Openness*TM					0.017**		
					(0.007)		
Distance	-0.839***						-0.766***
	(0.008)						(0.017)
Common Lang	0.872***						0.281***
	(0.016)						(0.034)
Border	0.416***						0.337***
	(0.022)						(0.041)
Fixed Effects	j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	j,i-hs2
R^2	0.77	0.86	0.86	0.86	0.86	0.60	0.56
# Observations	39930	39930	39930	39930	39930	30866	30868

In this table we study the effect that destination-specific regulation have on the number of exporters and exports per exporter. To construct the prevalence measure of regulations, we allow for SPS and TBT chapters only within NTM-MAP data. Results for only SPS are available upon request. Regulations are for the destination (j), as are the interaction terms in columns (3)-(5). GDP/L is the log of real GDP (in millions of 2005 USD) over millions of engaged persons (employed). Population is the log of the population size of the country. Openness is the average of import and export shares of GDP, as calculated by PWT. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

[14] The negative effect of distance on average exports is consistent with previous empirical findings (Lawless, 2010), but not necessarily the modeling framework. In general, the prediction for this effect depends on the distributional assumptions. In the Melitz-Chaney framework of CES preferences and Pareto distributed firms, this coefficient is zero as the intensive margin and extensive margins cancel out. Head and Mayer (2014) argue that it is negative with a log-normal distribution of firms as the intensive margin increases. We do not delve into this effect as we assume a Pareto distribution of firms and focus on the effects of regulations.

A concern with the specification above is that the choice to implement regulations is itself correlated with export behavior. It might also be the case that fixed costs, which we argue increase with regulations, are correlated with variable costs such as distance. Although it is difficult to find valid instruments for regulation of each country, we follow the strategy in Kee and Nicita (2016) and Shmidt and Steingress (2018) and use the TMs of related countries. Specifically, for each destination, we take the average number of regulations imposed in the same sectors by countries that either share a border or speak the same language. Both of these ties likely reflect similar institutions, and we add the common language requirement since contiguous countries have similar distances to export partners which might still be a problem if fixed costs are correlated with variable costs. As a further check, we also use regulations of countries with a common legal origin as instruments.

Column (1) of Table 2 replicates the second column of the previous table but with the regulations of common border and language countries as instruments, while in column (2) the common legal origin instrument is used. We do confirm that the number of exporters is lower when there are more TMs imposed, and the coefficient increases relative to the OLS specification. In both cases the F-stat is large which suggests a strong instrument. The third column reports an over-identified specification where we use both instruments, with the results mirroring the first column.[15] The last three columns repeat the specification for average exports as the LHS, and once again we find no effect of regulations on the intensive margin.

Table 2: Trade Margins and Regulations: IV

	Log Number of Exporters			Log Value per Exporter		
	(Lang/Border)	(Legal)	(OverID)	(Lang/Border)	(Legal)	(OverID)
TM Prevalence (log)	-0.050**	-0.154**	-0.047**	-0.095	0.107	-0.102
	(0.024)	(0.069)	(0.024)	(0.063)	(0.195)	(0.063)
Distance	-0.834***	-0.843***	-0.834***	-0.770***	-0.765***	-0.770***
	(0.008)	(0.008)	(0.008)	(0.017)	(0.017)	(0.017)
Common Lang	0.880***	0.876***	0.880***	0.283***	0.280***	0.283***
	(0.016)	(0.016)	(0.016)	(0.034)	(0.034)	(0.034)
Border	0.428***	0.413***	0.428***	0.338***	0.337***	0.338***
	(0.022)	(0.022)	(0.022)	(0.042)	(0.041)	(0.042)
F-stat (first stage)	1784.03	286.17	883.51	1140.29	164.86	562.75
Fixed Effects	j,i-hs2	j,i-hs2	j,i-hs2	j,i-hs2	j,i-hs2	j,i-hs2
# Observations	39267	39572	39267	30437	30638	30437

In this table we study the effect that destination-specific regulation have on the number of exporters and exports per exporter. To construct the prevalence measure of regulations, we allow for SPS and TBT chapters only within NTM-MAP data. We instrument the number regulations in each destination in two ways: i) the average number of regulations in the same sector, for countries that either share a border or have a common language with the instrumented country, ii) the average number of regulations in the same sector, for countries that have a common legal system as the instrumented country. The first-stage F-statistic is reported. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

[15] The Hansen J-Statistic suggests we cannot reject the null of valid instruments at the 5% level. We also find that an endogeneity test *cannot* reject the null that the number of regulations is exogenous.

3 Model

We build a multi-country model of international trade to study the optimal level of regulations. There are I countries indexed by i for origins and j for destinations. In each country i, L_i consumers, with per capita income y_i, enjoy the consumption of varieties of a differentiated good. The varieties are produced by a mass of single-product firms, which differ in terms of their quality z. We assume that quality z is a demand shifter: consumers exhibit a higher willingness to pay for higher quality goods. There is perfect information: consumers, firms, and the government costlessly distinguish between the quality offered in the market.

As in the Melitz (2003) model, there is a pool of potential entrants. Upon entry, firms pay a fixed cost of entry f_E in domestic labor units and discover their quality z. Quality is drawn from an unbounded Pareto distribution whose CDF and pdf are $H_i(z) = 1 - \left(\frac{b_i}{z}\right)^{\kappa}$ and $h_i(z) = \frac{\kappa b_i^{\kappa}}{z^{\kappa+1}}$, where κ and b_i are positive constants. Only a mass J_i of firms pays the fixed cost of entry. Free entry drives expected profits equal to $w_i f_E$. The market is monopolistically competitive. All firms from i produce their goods with the same marginal cost of production c_i, in labor units. There is an iceberg trade cost of delivering a good $\tau_{ij} \geq 1$ with $\tau_{ii} = 1$. Workers earn a wage w_i. These assumptions imply that size heterogeneity is linked to the exogenous quality draws. The direct mapping of quality to size might seem stark, but it is a convenient feature that is also present in Kugler and Verhoogen (2012) and finds quantitative support in the empirical findings of Hottman et al. (2016).

3.1 Consumer Problem

We adopt the Indirectly Additive (IA) case of the Generalized Translated Power (GTP) preferences proposed by Bertoletti and Etro (2018). Consumers in each country j have the following utility function:

$$U_j = \int_{\Omega_j} \left(az(\omega)\xi_j q(\omega) - \frac{\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \right) d\omega + \frac{\xi_j^{-\eta} - 1}{\eta} \tag{2}$$

where $a > 0$ and $\gamma \geq 0$ are constants, $q(\omega)$ is the quantity consumed of variety ω, $z(\omega)$ is a variety specific demand shifter, which we interpret as quality, and Ω_j is the set of varieties available for consumption. ξ_j is a quantity aggregator that is implicitly defined as:

$$\xi_j^{-\eta} = \int \left(az(\omega)\xi_j q(\omega) - (\xi_j q(\omega))^{1+\frac{1}{\gamma}} \right) d\omega \tag{3}$$

The GTP utility follows the generalized Gorman-Pollak demand system[16], and nests several preferences based on the value of the parameter $\eta \in [-1, \infty]$. We fix $\eta = -1$, to obtain IA preferences as described by Bertoletti et al. (2018).[17]

The consumer's budget constraint is:

$$\int_{\Omega_j} p(\omega) q(\omega) dz \leq y_j$$

where $p(\omega)$ is the price of variety ω. The consumer chooses $q(\omega)$, $\omega \in \Omega_j$, to maximize its utility subject to the budget constraint. Consumer's inverse demand is:

$$p(\omega) = y_j \left[az(\omega) - (\xi_j q(\omega))^{\frac{1}{\gamma}} \right] \tag{4}$$

3.2 Firm Problem

As we model government regulations as a fixed cost of compliance, which affects the production-exit decisions of firms, we can solve the problem of monopolistically competitive firms conditional on being active, and later examine the effects of regulations. The constant returns to scale assumption allows us to study the problem of a firm operating in each destination j independently. Given the quality draw z, a firm from i maximizes its profits in a destination j by choosing the quantity $q_{ij}(z)$ and taking ξ_j as given. Profits are given by:

$$\tilde{\pi}_{ij}(z) = L_j \left[y_j \left(azq_{ij}(z) - (\xi_j)^{\frac{1}{\gamma}} (q_{ij}(z))^{1+\frac{1}{\gamma}} \right) - \tau_{ij} w_i c_i q_{ij}(z) \right] \tag{5}$$

The first order condition with respect to $q_{ij}(\omega)$ equals:

$$y_j az - y_j \left(1 + \frac{1}{\gamma} \right) (\xi_j q_{ij}(z))^{\frac{1}{\gamma}} = \tau_{ij} w_i c_i$$

and setting $q_{ij}(z^*_{ij}) = 0$ yields the market determined quality cutoff:

$$z^*_{ij} = \frac{\tau_{ij} w_i c_i}{a y_j} \tag{6}$$

[16] Gorman (1972), Pollack (1972).

[17] For $\eta = 0$, preferences become homothetic with a single aggregator. For $\eta \to \infty$, preferences become directly additive (DA), and generalize the preferences used by Melitz and Ottaviano (2008). The case where $\gamma = 1$ generates linear demand as in the separable case of Melitz and Ottaviano (2008). Fally (2018) describes the regularity conditions for these preferences. We adopt IA preferences for tractability. As shown in Macedoni and Weinberger (2019), preferences other than the IA case generate markups that are a function of the number of competitors. This feature only quantitatively affect the welfare effects of standard.

For a quality level below the cutoff $z < z^*_{ij}$, a firm has zero demand. Absent any fixed costs of operation, z^*_{ij} would be the only source of selection of firms into production, export, or exit. An important property of IA preferences is that the market quality cutoff is only a function of the origin marginal costs of production, and of the destination per capita income. In particular, richer destinations have a lower quality cutoff. Furthermore, the origin quality cutoff is a constant: $z^*_{ii} = \frac{c_i}{a}$. Substituting the cutoff (6) into the first order condition yields the optimal quantity:

$$q_{ij}(z) = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma} \frac{(z^*_{ij})^{\gamma}}{\xi_j} \left(\frac{z}{z^*_{ij}} - 1\right)^{\gamma} \tag{7}$$

Substituting (7) into (4) yields the optimal pricing rule:

$$p_{ij}(z) = \frac{a y_j z^*_{ij}}{1+\gamma} \left(\frac{z}{z^*_{ij}} + \gamma\right) \tag{8}$$

Prices are increasing in per capita income of the destination, in line with the evidence from Simonovska (2015). Furthermore, prices are increasing in quality z. Such prediction receives empirical support from Bastos and Silva (2010), Martin (2012), Dingel (2015), and Manova and Zhang (2017). Firm z revenues $r_{ij}(z)$ and profits $\pi_{ij}(z)$ are given by:

$$r_{ij}(z) = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j y_j (z^*_{ij})^{1+\gamma}}{\xi_j}\right) \left(\frac{z}{z^*_{ij}} - 1\right)^{\gamma} \left(\frac{z}{z^*_{ij}} + \gamma\right) \tag{9}$$

$$\tilde{\pi}_{ij}(z) = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j y_j (z^*_{ij})^{1+\gamma}}{\xi_j}\right) \left(\frac{z}{z^*_{ij}} - 1\right)^{1+\gamma} \tag{10}$$

3.3 Fixed Costs of Compliance to Regulations

The government of each country can set a regulation that requires all firms selling to j the payment of a fixed cost in labor units. We denote such a fixed cost as f_{ij}. We will explore both the case in which the fixed cost is paid in the domestic labor units of a firm, and the case in which the fixed cost is paid in the destination labor units. The former case captures compliance tasks that are completed by the firms workers, e.g. quality controls, environmental requirements etc. The latter case captures the compliance tasks that require hiring destination country's workers, e.g. flying out inspectors.

The presence of a fixed cost of compliance forces some low-quality firms to exit relative to the market allocation. In fact, firm profits equal $\pi_{ij}(z) = \tilde{\pi}_{ij}(z) - f_{ij}$. As profits are increasing in quality z, there exists a firm with quality $\bar{z}_{ij}$ such that $\pi_{ij}(\bar{z}_{ij}) = f_{ij}$. Any firm with $z < \bar{z}_{ij}$ exits. $\bar{z}_{ij}$ is defined by as:

$$\bar{z}_{ij} = z^*_{ij} + z^*_{ij} \left[f_{ij} \left(\frac{(1+\gamma)^{1+\gamma}}{a^{1+\gamma}\gamma^\gamma} \right) \left(\frac{\xi_j}{L_j y_j (z^*_{ij})^{1+\gamma}} \right) \right]^{\frac{1}{1+\gamma}}$$

Consider $g_{ij} = \frac{\bar{z}_{ij}}{z^*_{ij}} \in [1, \infty)$ as a measure of the restrictiveness of the regulation. Absent any fixed costs, $g_{ij} = 1$. For larger levels of the fixed cost, our measure of restrictiveness increases, and even with non-discriminatory fixed costs, the restrictiveness is not equal across origins. The measure g_{ij} is related to the probability of a firm being active under the regulation, relative to the probability of being active without the regulation: $\frac{P(z \geq \bar{g} | g > 1)}{P(z \geq \bar{g} | g = 1)} = g^{-\kappa}$. Thus, g_{ij} captures a scale-free measure of the restrictiveness of the regulation. For each origin country i, g_{ij} is implicitly defined by:

$$\left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j y_j (z^*_{ij})^{1+\gamma}}{\xi_j} \right) (g_{ij} - 1)^{1+\gamma} = f_{ij} \tag{11}$$

To find a simple equation that describes the relationship between the restrictiveness of the standard for domestic firms g_{jj} and for foreign firms g_{ij}, we first take the ratio of (11) for origin j and for origin i. Then, we substitute for the market quality cutoff ratio using $\frac{z^*_{ij}}{z^*_{jj}} = \frac{\tau_{ij} w_i c_i}{y_j c_j}$ by (6). This yields:

$$g_{ij} = 1 + (g_{jj} - 1) \frac{y_j c_j}{\tau_{ij} w_i c_i} \left(\frac{f_{ij}}{f_{jj}} \right)^{\frac{1}{1+\gamma}} \tag{12}$$

The level of restrictiveness of the same regulation generally differs between domestic and foreign firms as the same regulation has a more lenient effect on source countries with higher average quality. In fact, larger costs of production and delivery impose a stronger selection of high-quality firms that are able to access the domestic economy, thus, reducing the perceived restrictiveness of regulations for foreign firms. Depending on whether the fixed cost of compliance is expressed in home labor units or domestic labor units, we obtain:

$$g_{ij} = 1 + (g_{jj} - 1) \frac{y_j c_j}{\tau_{ij} w_i c_i} \qquad \text{if } f_{ij} = w_j f_j \tag{13}$$

$$g_{ij} = 1 + (g_{jj} - 1) \frac{y_j c_j}{\tau_{ij} w_i c_i} \left(\frac{w_i}{w_j} \right)^{\frac{1}{1+\gamma}} \qquad \text{if } f_{ij} = w_i f_j \tag{14}$$

We choose to model the costs associated with compliance to regulations as a fixed costs because their effects are consistent with our stylized facts. Fixed costs of regulation generate selection of firms based on their quality, thus, they mainly affects the extensive margin of exports. Such a prediction also finds support in Fontagné et al. (2015), Fernandes et al. (2015a). Furthermore, the fixed costs generates a reallocation of production from low-quality firms that exit to high-quality firms, in line with the empirical evidence of Macedoni and Weinberger (2019). We should note that any increases in the marginal costs of production due to the regulation would be unambiguously welfare reducing.

3.4 Aggregation and Equilibrium

Although governments set the fixed cost of regulation, we can make the simplifying assumption that what is *chosen* is actually the level of restrictiveness of the regulation in the domestic economy g_{jj}. Then, g_{ij} follows from the relationships above and it is not necessary to know the (implied) fixed cost. Wages are equal to per capita income: $y_j = w_j$, a consequence of expected profits in equilibrium being equal to the fixed cost of entry.

Access to a destination j is dampened by the regulation. In fact, the mass of active firms N_{ij} from i selling to destination j equals:

$$N_{ij} = \frac{J_i b_i^\kappa}{\bar{z}_{ij}^\kappa} = \frac{J_i b_i^\kappa}{(z_{ij}^* g_{ij})^\kappa} = a^\kappa J_i b_i^\kappa (c_i w_i)^{-\kappa} w_j^\kappa (\tau_{ij} g_{ij})^{-\kappa} \tag{15}$$

This prediction is consistent with our stylized fact where we document a negative relationship between number of exporters and restrictiveness of regulations, controlling for origin and destination fixed effect, as well as for trade costs τ_{ij}. The origin fixed effect captures the aggregate mass of firms active in the origin, weighted by the costs of production: $J_i b_i^\kappa (c_i w_i)^{-\kappa}$. The destination fixed effect captures the income of the destination, which increases the extensive margin.

We leave the derivations of the aggregate variables to the appendix. Aggregate revenues of firms from i to j is given by:

$$R_{ij} = N_{ij} \int_{\bar{z}_{ij}}^{\infty} r_{ij}(z) \frac{\kappa \bar{z}_{ij}^\kappa}{z^{\kappa+1}} dz = \left(\frac{a^\kappa \gamma^\gamma}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j} \right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})$$

where $G_2(g_{ih}) = \kappa g_{ih}^\gamma \left[\frac{g_{ih}\, {}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ih}^{-1}]}{\kappa-\gamma-1} + \frac{\gamma\, {}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ih}^{-1}]}{\kappa-\gamma} \right]$, and ${}_2F_1[a, b; c, d]$ is the hypergeometric function. We can derive the gravity equation, by considering the share of of revenues of products from i to country j:

$$\lambda_{ij} = \frac{R_{ij}}{\sum_v R_{vj}} = \frac{(\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})}{\sum_v (\tau_{vj} c_v w_v)^{-\kappa+\gamma+1} J_v b_v^\kappa g_{vj}^{-\kappa} G_2(g_{vj})} \tag{16}$$

Thus bilateral trade flows are dampened by variable trade costs (with elasticity $\kappa - \gamma - 1$), and by the restrictiveness of the regulation.

Market clearing implies that

$$\sum_j \lambda_{ij} w_j L_j = w_i L_i \quad \forall i = 1, ..., I \tag{17}$$

The expected zero profit condition $E[\pi_i] = w_i f_E$ is given by:

$$E[\pi_i] = \left(\frac{a^\kappa \gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) b_i^\kappa \sum_j \left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j}\right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} \tilde{G}_1(g_{ij}) = w_i f_E$$

where $\tilde{G}_1(g_{ij}) = g_{ij}^{-\kappa}[G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma}]$ and $G_1(g_{ih}) = \kappa g_{ih}^{\gamma} \left[\frac{g_{ih}\, {}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ih}^{-1}]}{\kappa-\gamma-1} - \frac{{}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ih}^{-1}]}{\kappa-\gamma}\right]$. Combining market clearing, the gravity equation, and the zero profit condition, yields the equilibrium mass of entrants in country i:

$$J_i = \frac{1}{w_i f_E} \sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})} \quad \forall i = 1, ..., I \tag{18}$$

where $\tilde{G}_2 = g_{ij}^{-\kappa} G_2(g_{ij})$. Contrary to standard monopolistic competition model with a Pareto distribution of the underlyining firm characteristics, the mass of entrants is no longer constant, as it depends on the level of regulations and on the equilibrium wage.

Without loss of generality, we can normalize the per capita income of a country k to one and set it as the numeraire. The equilibrium in the model is a vector of wages $\{w_i\}$ for $i \neq k$ and mass of entrants $\{J_i\}$ for $i = 1, ..., I$, such that goods markets clear, trade is balanced, and expected profits equal the fixed cost of entry.

The utility of the representative consumer is given by:

$$\tilde{U}_j = U_j - 1 = a^\kappa \left(\frac{\gamma}{1+\gamma}\right)^{1+\gamma} \frac{J_j b_j^\kappa (\tau_{jj} c_j)^{-\kappa+\gamma+1}}{\lambda_{jj}} \tilde{G}_2(g_{jj}) \sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})} \tag{19}$$

3.4.1 General Effects of Regulation Changes

By use of the hat algebra as in Arkolakis et al. (2012), we can easily characterize the changes in the equilibrium values of our endogenous variables, as well as welfare, following any change in the regulatory restrictiveness of countries. Any change in the level of domestic regulation g_{jj} is reflected to changes in the restrictiveness faced by firms from i when exporting to j (g_{ij}), as described in (12). Given the changes in g_{ij} for $i, j = 1, ..., I$, and the initial levels of w_i, λ_{ij}, and g_{ij}, we can characterize the changes in trade shares, wages, and mass of entrants.

We denote with $\hat{x} = \frac{x_{new}}{x_{old}}$ the change in a variable, and apply the hat algebra to the equations (16), (17), and (18). The system of equations is as follows:

$$\hat{\lambda}_{ij} = \frac{\hat{J}_i \hat{w}_i^{-\kappa+\gamma+1} \hat{\tilde{G}}_2(g_{ij})}{\sum_v \lambda_{vj} \hat{J}_v \hat{w}_v^{-\kappa+\gamma+1} \hat{\tilde{G}}_2(g_{vj})} \qquad \forall i, j = 1, ...I \tag{20}$$

$$\hat{w}_i = \frac{\sum_j \lambda_{ij} w_j L_j \hat{\lambda}_{ij} \hat{w}_j}{\sum_j \lambda_{ij} w_j L_j} \qquad \forall i = 1, ..., I \tag{21}$$

$$\hat{J}_i = \frac{1}{\hat{w}_i} \frac{\sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})} \hat{\lambda}_{ij} \hat{w}_j \widehat{\left(\frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})}\right)}}{\sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})}} \qquad \forall i = 1, ..., I \tag{22}$$

To compute the welfare changes due to the change in regulation we consider the equivalent variation in income which leaves consumers indifferent between the new equilibrium at the new level of regulation, and the initial allocation. First, we need to compute the change in utility following a change in regulation, using (19)

$$\hat{\tilde{U}}_j = \frac{\hat{J}_j}{\hat{\lambda}_{jj}} \hat{\tilde{G}}_2(g_{jj}) \frac{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})} \frac{\hat{\lambda}_{ij} \hat{G}_1(g_{ij})}{\hat{G}_2(g_{ij})}}{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})}}$$

Then, we compute the equivalent variation in income by deriving the change in utility due to a change in income, keeping the price distribution unchanged. We leave the details to the appendix and, to preserve tractability, we use the local approximation to derive the equivalent variation in income. The welfare formula is then:

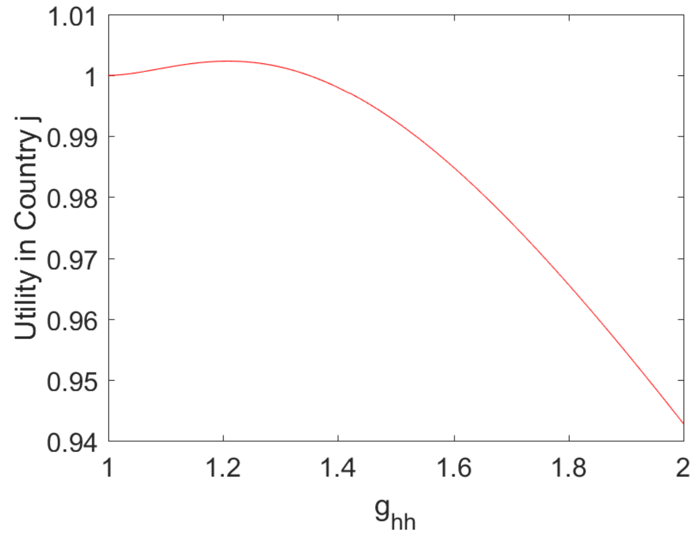
$$d \ln W_j = \frac{\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})}}{1+\gamma} (\hat{\tilde{U}} - 1) \tag{23}$$

3.5 Welfare Effects of Regulations

This section shows the main result of the paper that trade costs and regulations are complementary tools in addressing allocative inefficiency across heterogeneous firms. First, we show that regulations can improve welfare in an open economy framework. Second, we compute the optimal level of the regulation as a function of trade costs. Third, we use our model to make predictions about the level of regulations that countries of different sizes and average quality level impose optimally. Finally, we discuss the role of cooperation in setting regulations. To proceed, we consider a version of the model outlined in the previous section with only two countries, home and foreign, denoted by subscript h and f.

By examining the relationship between welfare and regulation we find that the results of Macedoni and Weinberger (2019) also hold in a trade environment. There is a non-monotone hump shaped relationship between the restrictiveness of the regulation g_{hh} and the utility of home consumers, shown in Figure 2. A small level of fixed costs of compliance to regulations can improve welfare. Such a result arises regardless of the origin of the labor required to comply to regulations: welfare improves both in the case in which firms use their domestic labor or the labor of the home economy.

Figure 2: Restrictiveness of Regulation and Home Welfare



The intuition for the result is similar to that outlined in Macedoni and Weinberger (2019) for a closed economy. Increased regulatory restrictiveness has two main effects: a composition effect, which is welfare improving as it reallocates production from low- to high-quality firms and, thus, raises average quality. The second effect is a reduction in the number of varieties available for consumption, which is welfare reducing as consumers have a love for variety.[18] For a small level of the fixed cost, the first effect dominates and welfare improves. The result hinges on misallocation of production under the market allocation: due to the business stealing bias, there is over-production by low-quality firms. The fixed costs reduces such misallocation by forcing out of the market low-quality firms.

Relative to the closed economy case, in an open economy there are two additional channels. First, changes in regulation affect the mass of foreign firms. The effects of home trade policies on the mass of foreign firms is typically a property of the trade policies of large countries: small open economies are usually assumed not to have an influence on foreign entry (Demidova and Rodríguez-Clare, 2013). Increases in g_{hh} determine a rise in the mass of

[18]Furthermore, there is potentially an anti-competitive effect, whereby surviving firms charge higher markups in response to the reduction in competition. This channel is absent here due to the assumption of IA preferences.

home and foreign firms that pay the fixed cost of entry: as only higher quality firms survive, average profits in the economy are higher. Holding constant the mass of foreign firms, the welfare effects of regulations are diminished, as smaller entry is equivalent to fewer varieties available for consumption.

The second channel through which g_{hh} affects welfare in an open economy setting is the home relative wage w_h. This is a terms of trade effect of the regulation, as changes in the relative wage reflect changes in the relative purchasing power of consumers in the two countries. Similar to the relationship between g_{hh} and U_h, there is a non-monotone hump shaped relationship between g_{hh} and the wage. As the restrictiveness of the standard increases, workers move from low-quality to high-quality firms, which increases their purchasing power as more high-quality goods are produced. However, workers additionally move to the compliance activities captured by their fixed costs, which reduces their purchasing power. In the appendix, we show the relationships between g_{hh}, J_f, and w_h.

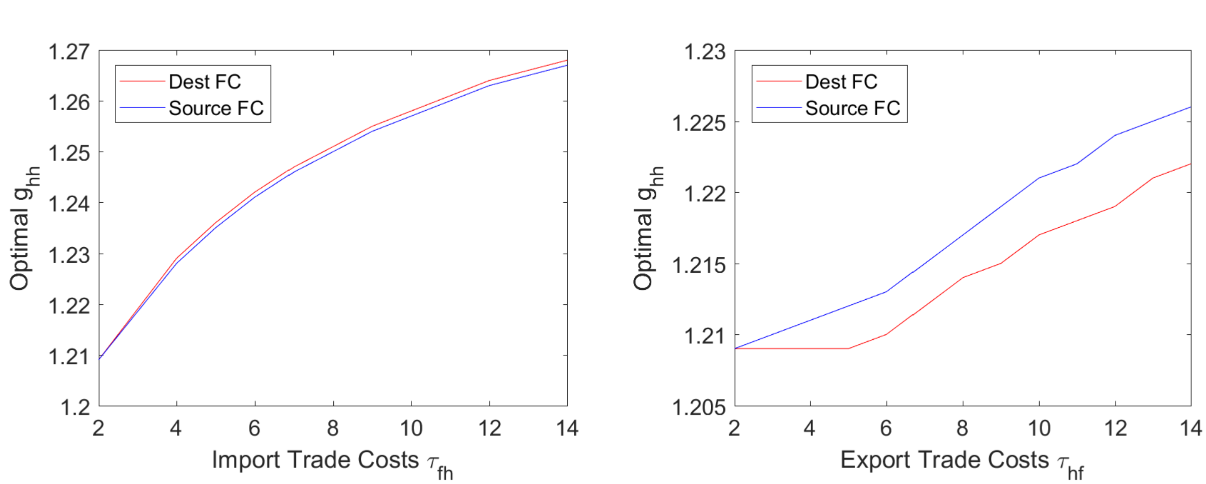
Optimal Regulation and Trade Cost. To illustrate the relationship between regulations and trade costs, we conduct a numerical exercise where we compute the welfare maximizing level of the restrictiveness of regulations g_{hh} as a function of iceberg trade costs τ_{ij}. We restrict the set of trade costs such that the set of exporters from either country is different from the set of non-exporters. In fact, if the trade costs are small, large enough values of the fixed regulation costs, can generate an unrealistic situation in which all domestic firms export. Notice that the results are not qualitatively affected by which units of labor the fixed costs are expressed in.[19]

Figure 3 shows the positive relationship between optimal restrictiveness of standards and iceberg trade costs of exporting from the home economy and to the home economy. When foreign export costs or domestic export costs decline, the optimal standard falls. A reduction in τ_{fh} reallocates consumption, hence production, from low-quality domestic varieties to (relatively) high-quality foreign varieties. Similarly, a reduction in τ_{hf} reallocates production from low-quality non-exporter to high-quality exporters. In both cases, the reallocation generated by trade costs reduces the distortion the regulations targets. Hence, trade costs and regulation are complementary.

Optimal Regulation, Size, and Technology. We use our model to compute the optimal level of g_{hh} as a function of domestic relative size L_h and domestic relative unit costs c_h. Our first result is that larger economies have larger values of optimal g_{hh} (Figure 4). To

[19]In the figures, Dest FC labels the case in which the fixed cost of compliance is expressed in labor units of the destination, and Source FC in labor units of the source country.

Figure 3: Optimal Regulation and Iceberg Trade Costs



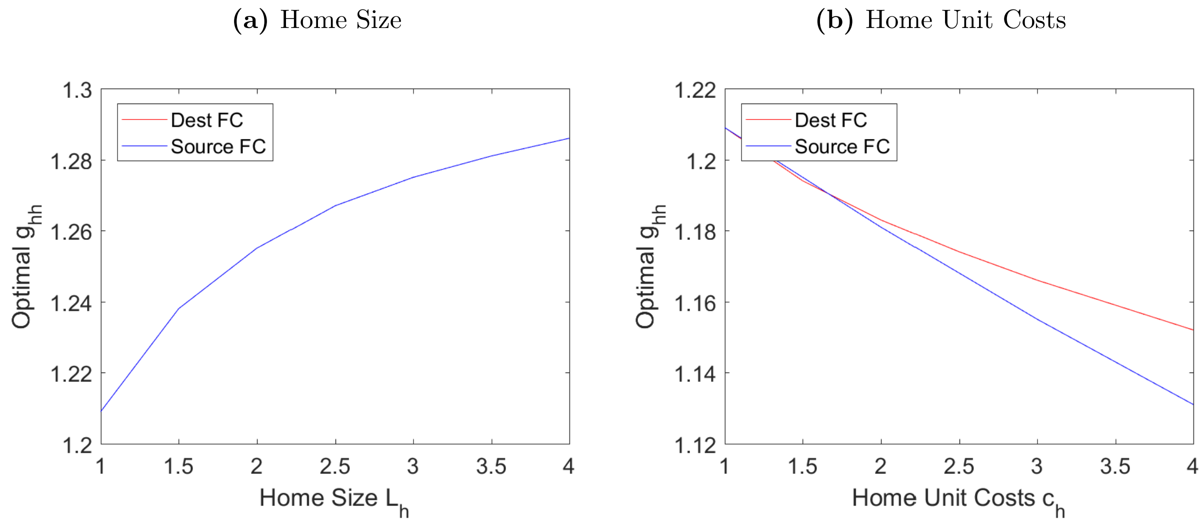
understand this, consider two economies identical in every aspect but size: one economy is twice the size of the other. An increase in the level of restrictiveness has the same qualitative effects in both economies. However, the quantitative effects are different. The larger economy experiences a slower reduction in the wage, as workers move towards compliance activities. Furthermore, the larger economy experiences a faster growth in the mass of entrants. As a result, welfare in the large economy increases more with the standard, relative to the small economy.

A similar effect occurs when considering economies that are more technologically efficient and, thus, have higher per capita income. As the home economy unit costs c_h declines, the optimal level of regulation rises. This theoretical results finds support in our empirical analysis, where we document a positive relationship between restrictiveness of TMs (in the way they affect the extensive margin) and size and per capita income of a country. Our model predicts that larger and richer economies optimally impose more restrictive regulations.

The Role of Cooperation. An important theoretical result is the positive externality of regulations in one country on the welfare of other countries. In particular, we find that when the home economy increases its level of restrictiveness of regulations, welfare in the foreign economy improves, despite the lack of change in their domestic level of the regulation. In other words, the foreing economy benefits from the reallocation of production towards high-quality firms in the home economy. Furthermore, the regulation promotes entry of new varieties in the foreign economy.

The result is important as it eliminates a beggar-thy-neighbor rational for imposing the regulation. When a country imposes a standard, welfare does not improve at the expenses of

Figure 4: Optimal Regulation, Size, and Costs



foreign economies. Despite the presence of a terms of trade channel, where the home economy can increase home purchasing power by imposing the standard, welfare in the foreign economy improves *always*. An implication of our findings is that it motivates international cooperation in imposing regulations. When countries impose a standard they do not internalize the positive externality on foreign economies, and thus the restrictiveness of the standard is below the social optimum.

In Figure 5, we compare the optimal level of regulation imposed in two scenarios. In the first scenario, only the home economy imposes the standard.[20] In the second scenario, a common standard is optimally chosen to maximize welfare in both economies. As shown in Figure 5, the optimal standard under cooperation is higher than the optimal standard chosen by countries unilaterally.

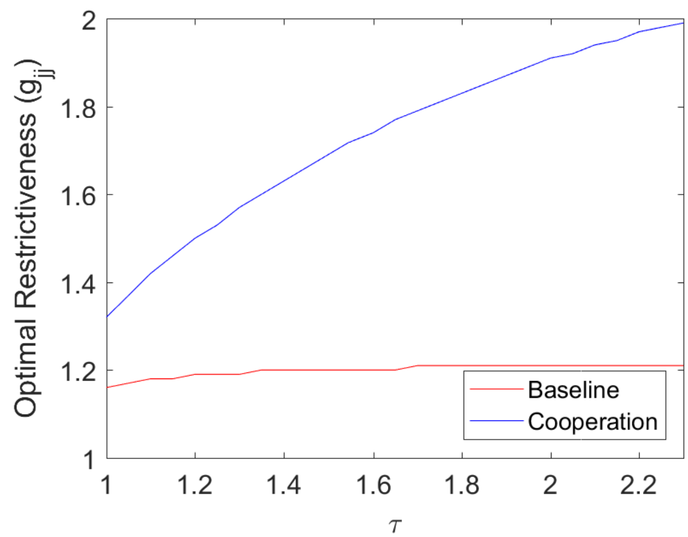
4 Quantitative Analysis

The goal of this section is to take advantage of the gravity formulation of the model in order to estimate parameters and provide a counterfactual exercise which results in the (world) welfare consequences of one country changing its regulation policy. As shown in Section 3.4, we can characterize the changes in the equilibrium values of our endogenous variables, as well as welfare, following any change in the regulatory restrictiveness of countries.

The calibration exercise generally is as follows. First, we estimate the observed level

[20]We also considered the Nash Equilibrium arising when both economies impose a standard. However, given our parametrical assumptions, the best response of one country is by and large independent of the regulations imposed by the foreign economy.

Figure 5: Optimal Regulation under Cooperation



of restrictiveness, g_{ij}, for a sample of trading partners without requiring data on explicit barriers imposed. These are found to reflect the SPS and TBT regulations investigated above, although they are a much broader measure of quality standards. Second, we provide an algorithm to compute the initial levels of trade shares and wages, as well as the parameters κ, γ, and L_j. The gravity framework outlined in the previous section allows for a counterfactual exercise that computes the general equilibrium welfare consequences of policy changes. Given the changes in g_{ij} for $i, j = 1, ..., I$, and the initial levels of w_i, λ_{ij}, and g_{ij}, we can characterize the changes in trade shares, wages, and mass of entrants through equations (20)-(22).

4.1 Estimation of Country-Pair Restrictiveness

The EDD provides several statistics from the distribution of sales for firms in origin i and destination j which we use to estimate g_{ij} for each country pair. As is argued above, the regulations not only eliminate low-quality firms but reallocate resources to higher-quality firms. Therefore, relative sales of firms selling in j across percentiles of the sales distribution are a function of g_{ij}. The EDD, with information on the distribution of exporters from an origin to multiple destinations, allows us to match moments informative of the imposition of restrictions on destination sales.

For each country pair in our sample $i - j$ we simulate draws of quality conditional on firms exporting to the destination, and compute revenues relative to the average revenue in the destination by firms from the same origin. We compute 6 moments and match them to the data using g_{ij} (taking as given γ and κ, which we return to below). The moments are: the 25th, 50th, and 75th percentiles of sales normalized by average sales, along with the export share of top 1%, 5%, and 25% of exporters. In all cases, the distribution is based on a specific $i - j$ country pair. A simulated method of moments (SMM) algorithm returns a vector of g_{ij} for each $i \neq j$.[21] However, the moments above are not useful for the *domestic* level of restrictiveness g_{jj}, since the EDD data is not informative on this front. We deal with the estimation of g_{jj} in section 4.2.

Estimated Restrictiveness and the Extensive Margin. To get a sense of the ability to estimate restrictiveness, we compare our results of the estimated restrictiveness, g_{ij}, with the NTM data used in (1). First, notice that from equation (15) we can derive the ratio of the number of exporters from i across two destinations:

$$\frac{N_{ij}}{N_{ik}} = \left(\frac{w_j \tau_{ik} g_{ik}}{w_k \tau_{ij} g_{ij}}\right)^{\kappa}. \tag{24}$$

We therefore repeat the exercise from (1), but with estimated g_{ij}. If the estimation described above is indeed picking up the restrictiveness as defined in the model, then we should once again find that the number of exporters to j decreases with restrictiveness in that destination, and that the value per exporter increases with restrictiveness (due to the selection of higher quality exporters). Furthermore, we expect this effect to be larger in richer and larger destinations, while restrictiveness should be subdued in more open destinations.

We start by estimating g_{ij} for importer-exporter-product combinations since this is available in the EDD database. Relative to Section 2, we aggregate HS products to 15 "sections" in order to observe sales distributions with more exporters, and reduce the computational cost of estimating so many restrictiveness parameters.[22] Table 3 roughly follows the specifications from Table 1. With product-level observations, we control for exporter-HS Section fixed effects, along with either only destination or importer-destination fixed effects. Either way, we capture variation in the restrictiveness of destinations for the same importer-product exports. Column (1) includes the gravity controls, and we confirm that a rise in g_{ij} reduces the number of exporters to a destination. In columns (2)-(4), we once again find that this effect is larger for richer and larger countries, while more open destinations tend to have less restrictive barriers. In this sample, the gravity variables also have the expected sign, as for example, the number of exporters is reduced with distance. In column (5), we check the *intensive margin*, or the export value per exporter. We find that a higher restrictiveness is associated with a larger amount of average exports, consistent with the selection present in

[21] For details on the SMM procedure, see Appendix 6.3. All 6 moments are not necessarily available for each pair. For each pair, we estimate g_{ij} with the available moments, as long as at least one is reported.

[22] These are a subset of the 21 HS-Sections as classified by the UN (see Appendix 6.3 for a list).

the model – regulations select for higher quality exporters.

The last 2 columns in Table 3 compare the model-implied estimated restrictiveness with the technical measures we use to proxy these in Section 2. These include importer-exporter interacted fixed effects, and therefore no gravity controls, in order to compare the most restrictive specifications. First, notice that in the model sample ("Model Estimation"), the coefficient on g_{ij} is still negative and large, although smaller than column (1). Next, we run the same regression with the TM data described in Section 2. In this sample, we still find that a higher prevalence of TMs are associated with fewer exporters to the destination.[23] In fact, destinations with more TMs have a larger estimated g_{ij}, confirming that TMs are one type of standard that we pick up in our general restrictiveness estimate.[24] The counterfactual presented in the next subsection requires a substantially restricted sample, but the results in this table serve as confirmation that our estimated restrictiveness in fact captures a reduction in entry from i to j.[25]

4.2 Counterfactual Exercise

In order to compute the welfare effects of a change in regulatory policies, we next outline the rest of the estimation procedure which follows the gravity framework outlined in Sections 3.4 and 3.4.1. With gravity data, we compute λ_{ij}, and the solution to the market clearing condition (17) provides a way to back out destination wages consistent with our gravity framework. Finally, to estimate κ and γ, we use a census of Chilean firms in 2012 provided by the Chilean statistics database (INE) and follow Macedoni and Weinberger (2019) to estimate these parameters (plus its domestic restrictiveness) with a cross-section of sales data.[26] With 2012 cross-sectional data of the firm sales distribution, our calibration results in $\kappa = 3.96$ and $\gamma = 1.88$. The next step is to use the gravity relationships in our model to estimate *domestic* level of restrictiveness, g_{jj}, which cannot be inferred from the exporter data used to estimate g_{ij}.

[23] The number of observations are smaller in this case because it requires a country to be included in the NTM-MAP dataset.

[24] We do point out that a 1% rise in the prevalence of TMs seems to have a smaller effect on the number of exporters as a 1% rise in g_{ij}, which is not surprising as the estimated restrictiveness is a broader measure.

[25] We have checked however that the negative relationship exists in the evolving samples.

[26] Details are provided in the cited paper, but we summarize the exercise in Appendix 6.3. Chile is the one country for which we have the full census for domestic sales. With those, we match moments from the *domestic* sales distribution (similar to the export moments above). The Chilean census (we use only 2012 for the present paper) can be found from the INE here: https://www.ine.cl/estadisticas/economicas/manufactura?categoria=Encuesta%20Nacional%20Industria%20Anual%20-%20ENIA. Since 2008, the INE publishes the census of manufacturing firms, but without firm indicators. We do not require a panel data.

Table 3: Estimated Restrictiveness and Extensive Margin

	Log N Exporters				Exports per Exporter	Log N Exporters	
	(1)	(2)	(3)	(4)	(5)	(Model Estimation)	(NTM Data)
Estimated g (log)	-0.553***	-0.427***	-0.516***	-0.565***	0.277***	-0.310***	
	(0.015)	(0.113)	(0.026)	(0.036)	(0.019)	(0.013)	
g*Wages		-0.013					
		(0.012)					
g*Pop			-0.014*				
			(0.008)				
g*Openness				0.107*			
				(0.064)			
NTM Prevalence (log)							-0.048***
							(0.010)
Log Dist	-0.965***	-0.963***	-0.964***	-0.945***	-0.106***		
	(0.011)	(0.011)	(0.011)	(0.012)	(0.013)		
Border	0.489***	0.475***	0.490***	0.386***	0.289***		
	(0.033)	(0.034)	(0.033)	(0.042)	(0.035)		
Common Language	0.832***	0.858***	0.833***	0.833***	-0.411***		
	(0.025)	(0.026)	(0.026)	(0.030)	(0.027)		
Colony	0.536***	0.490***	0.534***	0.360***	0.181***		
	(0.038)	(0.039)	(0.038)	(0.040)	(0.038)		
Fixed Effects	j,i-HS	j,i-HS	j,i-HS	j,i-HS	j,i-HS	i-j,i-HS	i-j,i-HS
R^2	0.760	0.764	0.759	0.800	0.724	0.887	0.897
# Observations	20965	19542	20753	13738	20313	20931	10047

In this table . $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Estimation of g_{jj} with Gravity. Our method to estimate the domestic level of restrictiveness requires a references country k. Let Chile be country k, for which we have an estimate of g_{kk} from the Macedoni and Weinberger (2019) procedure mentioned above. In that paper, we describe an algorithm to estimate the domestic level of restrictiveness along with κ and γ, which results in $g_{kk} = 1.066$.

Given an estimation of κ, γ, and g_{kk} for $k = Chile$, we next turn to information about relative trade costs. First, the ratio of the number of exporters from i across two different destinations is derived from (15). We obtain the relative iceberg trade costs $\frac{\tau_{ij}}{\tau_{ik}}$ with the following extensive margin specification:

$$\ln \frac{N_{ij}}{N_{kj}} = \ln S_i - \ln S_k - \kappa \ln \ln \frac{\tau_{ij}}{\tau_{kj}} - \kappa \ln \frac{g_{ij}}{g_{kj}} \tag{25}$$

where S_i and S_k are country i and k fixed effects (which include wages from (24 above)), $\frac{g_{ij}}{g_{kj}}$ are taken from the estimation of $i \neq j$, and the number of exporters is data from EDD. Trade costs take the following form: $\tau_{ij} = \beta_1 \ln dist_{ij} + \beta_2 contig_{ij} + \beta_3 commlang_{ij} + \beta_4 colomy_{ij}$[27],

[27] The latter three variables are indicators equal to one if the country pair shares a border, has a common

and since we know κ, we then obtain $\frac{\tau_{ij}}{\tau_{kj}}$.

Given relative trade costs, the domestic levels of restrictiveness can be backed out from the relationships in the model. The relationship between g_{ij} and g_{jj} is given by (12). For exposition purposes, suppose the fixed costs are expressed in destination labor units.[28] Our relationship becomes:

$$g_{ij} - 1 = (g_{jj} - 1)\frac{w_j c_j}{\tau_{ij} w_i c_i} \tag{26}$$

Let $a_i = w_i c_i$, and let us normalize, without loss of generality $a_k = 1$ for Chile. This implies setting its wage to one, and assuming that all marginal costs are expressed as relative to the marginal costs of country Chile. Thus, we have:

$$g_{ij} - 1 = (g_{jj} - 1)\frac{a_j}{\tau_{ij} a_i}$$

We can obtain each value of a_i simply by taking the following ratio:

$$\frac{g_{ij} - 1}{g_{kj} - 1} = \frac{\tau_{kj}}{\tau_{ij}}\frac{1}{a_i} \tag{27}$$

Since we have the estimated values of g_{ij} for each country pair and relative trade costs, $\frac{\tau_{kj}}{\tau_{ij}}$, we compute g_{jj} as the solution to:

$$\frac{g_{ij} - 1}{g_{ik} - 1} = \frac{g_{jj} - 1}{g_{kk} - 1}\frac{\tau_{ij} a_j}{\tau_{ik}} \tag{28}$$

Gravity Data. To compute welfare changes due to changes in regulations requires initial values of g_{ij}, w_i, and λ_{ij}. Above, we have estimated the first of these with the extensive margin relationships in the model. The latter correspond to gravity relationships. There are two separate ways that we could compute the initial values for λ_{ij}. One way is to take the structure of the model seriously and estimate the gravity relationship, which we describe in Appendix 6.7.[29] Instead, in the benchmark analysis, we take the alternative approach of simply using trade shares from the data. To make trade shares realistic, we add a "rest of the world" (ROW) country which makes up for all of the rest of trade done, which would not be captured within our sample. Regardless of our estimation of λ_{ij}, wages are easily backed out

language, or a colonial relationship, respectively. The first variable is the log distance between the pair in miles.

[28]This algorithm would support also the more general case where the fixed cost is expressed both in domestic and foreign labor units, bundled together in a Cobb-Douglas fashion: $f_{ij} = w_i^{\alpha} w_j^{1-\alpha}$.

[29]Given the representation of countries in our sample, this pushes up trade shares for many countries. For example, in our sample, Denmark would have a domestic share equal to 0.99, with slightly more realistic shares for countries like Chile, Peru and Bolivia.

through (18). Tables 6-8 in the Appendix report the restrictiveness and trade shares matrix, as well as the predicted wages for the sample of countries in the counterfactual. Finally, we are armed with the necessary parameters and initial values to compute (20)-(22) for a given change in regulations.

We merge the EDD data described above with gravity data from CEPII's Geography and TRADHIST databases,[30] as well as manufacturing data from the World Development Indicators (WDI) to produce employment and gross output in manufacturing.[31] First, we must eliminate all observations from the EDD where a country is not a destination for Chile.[32] To run the counterfactual described in Section 3.4.1 requires an N by N matrix, but the EDD data has more destinations that origins.[33] In order to estimate g_{jj} we further restrict the data such that we only keep country pairs in which both $i - j$ and $j - i$ exist in the EDD data. With this further restriction we are left with very few countries, only 16 origins and destinations, and these will make up our hypothetical world in estimating the global welfare effects of a rise in regulations.[34]

Counterfactual Results. We next turn to compute the optimal standards in each country implied by our model, given initial values and under the assumption that there is no reaction by other countries. For example, Chile takes the initial matrix g_{ij} as given, then maximizes its welfare by setting its optimal domestic restrictiveness, which then affects the restrictiveness perceived by its trading partners by (28). In Table 5 of the Appendix, the first three rows report the domestic trade share (λ_{jj}), restrictiveness of regulations on domestic firms (g_{jj}), and the optimal domestic standard imposed in a country. Above we found that optimal standards increase with income and size, but decrease with openness, and these relationships hold here. Colombia, with the highest domestic share, has among the highest optimal standards. The rest of the world, which is very large and has high wages relative to our sample, has the largest optimal standard. Costa Rica, which is extremely open, has the lowest optimal standard, and in fact is one of the only 4 countries where the current domestic

[30] See Head and Mayer (2014) and Fouquin and Hugot (2016).

[31] Domestic trade shares require gross output of manufacturing, which we approximate as in Fernandes et al. (2015b) by multiplying the manufacturing value added in each country (from WDI) by 4. In an alternative exercise we use reported gross output from CEPII's TradeProd database, but this is only available up to 2006 (and for many countries one must go further back).

[32] In robustness exercises below, we consider alternative strategies.

[33] There are a select number of countries for which the EDD data collects information about exporters (the origins in the data). We restrict the origins to be those that have exporters in Chile, which limits the sample somewhat. Finally, most destinations (richer countries) are not origins in this data set which is the main reason our sample decreases.

[34] This is a consequence of working with the EDD data, where the sample of exporter origins comes from mostly small developing countries. However we are not aware of any other dataset that contains the type of extensive margin information we require.

restrictiveness we estimate is above the optimal (for all other countries our model implies the level of restrictiveness is too low).

Figure 6 presents the counterfactual welfare changes under two scenarios. The horizontal axis reports welfare changes for each country when *only that particular country raised its standards to the optimal one while all other worldwide restrictions were fixed*. The vertical axis in Figure 6 reports the welfare changes when *every* country separately sets its optimal standards (taking as given the initial restrictiveness in the data).[35] Notice that there are large gains from cooperation in the sense of allowing each country to choose its optimal standard. The welfare gains in this case range from 0.18-0.88%, while countries gain very little from changing regulations themselves. Only one country, Nicaragua, gains more than 0.1%, but this is one of the few countries where the current restrictiveness is *too strict*, and they have very large gains to reducing these restrictions. For this reason, we also present the figure without Nicaragua (on the right).[36] Open countries such as Costa Rica, due to their integration with the rest of the world, gain the most from other countries imposing stricter standards. Relatively closed economies, such as Colombia, have a higher optimal restrictiveness and therefore gain more from simply imposing stricter standards even if other countries do not. A similar argument applies for rich/large countries, such as Spain.

Although these are not large numbers, an important caveat is that they are lower bounds due to the way we characterize standards as fixed costs that are paid in wages. Regulations that affect the selection of firms without the imposition of a fixed cost paid by *all* firms generate larger gains as shown by Macedoni and Weinberger (2019). However, we highlight the large benefits available to countries in *jointly* raising standards – the gains are more than 10 times higher for most countries. An important result emphasized here is countries do not internalize all the benefits from raising standards domestically, which provides a motivation to negotiate "deep" trade agreements.[37]

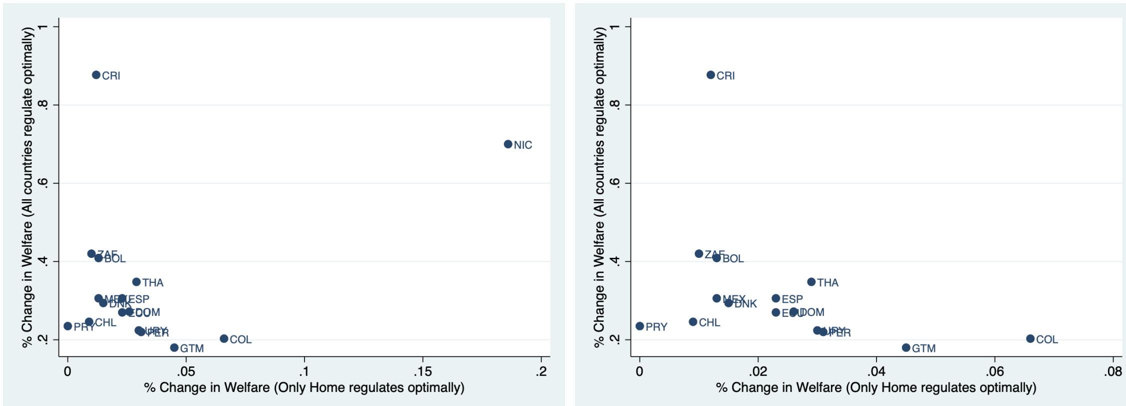
A separate perspective from which to analyze the gains from policy changes is to compare them to changes in iceberg trade costs. We do so in another counterfactual where we compute the welfare changes predicted by our model due to a reduction in trade costs across countries. Appendix 6.5 describes the system of equations that allow us to compute welfare gains due to

[35] Notice this is different than a theoretical cooperative equilibrium where countries choose regulations by jointly maximizing welfare.

[36] The last three rows of Table 5 list the welfare changes under these scenarios and the ratio of the case when all countries impose their optimal regulation relative to when only open particular country imposes their optimal regulation.

[37] We have also investigated an alternative exercise with a shift up in g_{ij}, $\forall i$, such that fixed costs increase to enter any destination. When all countries simply shift up their standards the welfare gains are bunched around 0.15%, with a few countries showing negative effects because their domestic restrictiveness is already above the optimal one.

Figure 6: % Change in Welfare for Changes in Restrictiveness: Benchmark (All countries (left) and No Nicaragua (right))



This figure displays the % change in welfare for countries in two different scenarios. The y-axis is the change in welfare when all countries impose their optimal domestic standard, along with restrictiveness to other countries using (28). The x-axis reports welfare changes for each country when only that particular country raised its standards to the optimal one while all other worldwide restrictions were fixed. In both cases, the $\hat{g_{ij}}$ is such that we take the ratio of the new restrictiveness measures imposed relative to the initial values. Then we compute $\hat{J_j}$, $\hat{w_j}$, and $\hat{\lambda_{ij}}$ as a response, which produces the equivalent variation in income according to (23).

changes in trade costs, which replace (20)-(22) and utilize the same initial values (including estimated restrictiveness). In the appendix we report the following thought experiment: each country unilaterally drops trade costs proportionally for all trade partners, which results in a corresponding drop in the domestic trade share, such that the welfare gains for that country are equal to those from the optimal regulation computed above.[38] Countries reduce their trade costs 4-8% on average, and domestic trade shares drop 1.2-5% on average. Separately, a simpler comparison is to drop by the same amount *all* trade costs proportionally ($\hat{\tau}_{ij}$ for $i \neq j$) in order to achieve *average* welfare gains of 0.34% (the average in the couterfactual above). We find that trade costs must drop by a substantial 4.2%, which is equivalent to an average decrease in the domestic trade share of 2%.

Finally, we are able to examine the interaction between gains from trade and regulations. Given the across-the-board reduction in trade costs, more restrictive countries tend to gain *less* from the same reduction in trade costs than less restrictive countries. Controlling for initial domestic trade shares, we find that raising g_{jj} by 0.1 lowers the welfare gains from the across-the-board reduction in trade costs (relative to welfare gains from optimal regulations) by 0.026 percentage points on average. The result highlights the complementarity between trade cost reduction and quality standard that is present in our model.

[38]Reducing λ_{jj} unambiguously raises welfare, though by less than the Arkolakis et al. (2012) case, mostly for the same reasons detailed in Arkolakis et al. (2017).

4.3 Robustness Exercises

The exercise above is limited by various data restrictions, and we investigate alternative exercises with differing data assumptions. We make use of the *TradeProd* database provided by CEPII which includes data on manufacturing gross output as well as a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), and an estimate of wages (the total wage bill in manufacturing divided by employment). The downside of the data is that it is only provided up until 2006, while we used 2012 data as in Section 2 above.[39] With this data we conduct two separate robustness exercises. First, we re-run the analysis above with 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW), but keep the same estimated restrictiveness produced with the 2012 EDD data. Second, we re-estimate g_{jj} with value added per worker and an estimate of the wage bill, where we rely on rely on (26) instead of (28). This means that we do not need Chile as a reference country which slightly broadens the data coverage.[40] Some details on the procedure and results are relegated to Appendix 6.6.

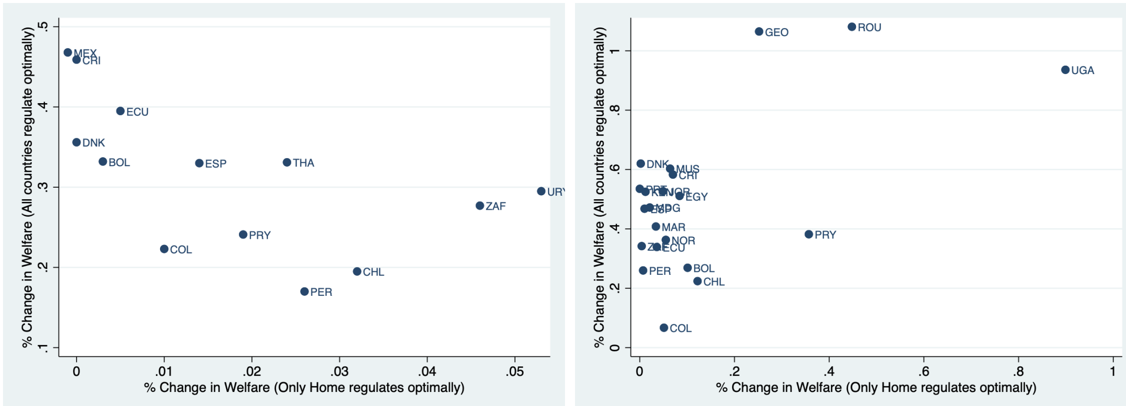
Figure 7 replicates the previous figure with the two alternative data exercises (Tables 10 and 11 in the Appendix replicate the corresponding table as well). There are some small deviations in welfare effects, mostly due to differences in the domestic consumption share. For most countries, the domestic trade share increases, which raises the optimal restrictiveness and raises the welfare gains from raising standards non-cooperatively. As a result, cooperation gains are then slightly smaller. From re-estimating the restrictiveness values in the second exercise (right panel), one conclusion is that the previous strategy tends to under-estimate domestic restrictiveness. In many more cases, we now find that initial domestic restrictiveness is *too high*, with large welfare gains from non-cooperative policy due to *lowering* restrictiveness.[41] The gains to cooperation once again exist, and are mostly of similar magnitude – although they explode for the countries in which non-cooperative gains are very small because domestic restrictiveness is already optimal. It is still the case that welfare gains cluster around 0.5% for all countries imposing optimal standards, and 0.05% for countries regulating unilaterally.

[39] In fact to get a as large a sample as possible, we go back to 2002, and must drop Dominican Republic, Guatemala, and Nicaragua which are unavailable.

[40] Here we assume costs and wages can be observed in the data to back out domestic restrictiveness given $g_{ij}, i \neq j$. In this case we re-estimate non-domestic g_{ij} with earlier EDD data. Although it is not possible to go back to 2002, for each exporter in the EDD database we take its first year of data (between 2004 and 2008). Also, since we use wage data, we do not back out wages from gravity, but instead use the *TradeProd* data for both wages and trade shares.

[41] This is not entirely shown in the figure since took out outliers where welfare changes were too large to more clearly report the rest of the countries. Iran is the most extreme case, where welfare increases by 2.6%.

Figure 7: % Change in Welfare for Changes in Restrictiveness: Alternative Data for Gross Output and Trade (left) and Alternative Data for All Initial Values (right)



Both figures display the % change in welfare for countries in the two different scenarios described in Figure 6. The y-axis is the change in welfare when all countries impose their optimal domestic standard, along with restrictiveness to other countries using (28). The x-axis reports welfare changes for each country when only that particular country raised its standards to the optimal one while all other worldwide restrictions were fixed. The left panel re-runs the benchmark analysis with 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW), but keeps the same estimated restrictiveness produced with the 2012 EDD data. For the right panel we re-estimate g_{jj} with value added per worker and an estimate of the wage bill, where we rely on rely on (26) instead of (28). This means that we do not need Chile as a reference country, and it allows for a broader sample (notice new countries included in the figure). The *TradeProd* database provided by CEPII includes data on manufacturing gross output as well as a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), and an estimate of wages (the total wage bill in manufacturing divided by employment). We detail how the restrictiveness measures are re-estimated in Appendix 6.6.1.

5 Conclusions

We have studied the effects of regulations that affect the selection of firms in an open economy framework. Regulations improve the efficiency of allocation of production across firms that are heterogeneous in quality: as low-quality firms over-produce in the market allocation, regulations that force their exit improve welfare. Our main result is that regulations and trade costs are complements: more open economies optimally impose less restrictive standards. For this reason, this paper offers support of a dual approach for policymakers: pushing towards lower trade costs while lowering unnecessary restrictiveness of quality standards.

Our framework allows us to compare the optimal degree of restrictiveness of standards that countries of different characteristics impose. We find that larger countries and countries with a higher level of average quality optimally choose more restrictive standards. This result is consistent with our evidence the large, richer, and less open economies tend to impose a larger number and more restrictive technical standards. The quantitative exercise highlights the mechanisms present in the model and provides estimates of possible welfare gains.

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6 Appendix

6.1 Model Derivations

6.1.1 Aggregation and Equilibrium

Aggregate revenues of firms from i to country j are given by:

$$\begin{aligned} R_{ij} &= N_{ij} \int_{\bar{z}_{ij}}^{\infty} r_{ij}(z) \frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}} dz = \\ &= N_{ij} \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j} \right) \int_{\bar{z}_{ij}}^{\infty} \left(\frac{z}{z_{ij}^*} - 1 \right)^{\gamma} \left(\frac{z}{z_{ij}^*} + \gamma \right) \frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}} dz \end{aligned}$$

Applying the change of variable technique, with $t = \frac{z_{ih}^*}{z}$, we obtain

$$\begin{aligned} R_{ij} &= N_{ij} \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j} \right) \int_{0}^{g_{ij}^{-1}} \left(t^{-1} - 1\right)^{\gamma} \left(t^{-1} + \gamma\right) \frac{\kappa \bar{z}_{ij}^{\kappa}}{(z_{ij}^*)^{\kappa}} t^{\kappa-1} dt = \\ &= N_{ij} \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j} \right) \kappa g_{ij}^{\kappa} \int_{0}^{g_{ij}^{-1}} (1-t)^{\gamma} (1+\gamma t) t^{\kappa-\gamma-2} dt \\ &= N_{ij} \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j} \right) G_2(g_{ij}) \\ &= \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma-\kappa}}{\xi_j g_{ij}^{\kappa}} \right) J_i b_i^{\kappa} G_2(g_{ij}) \\ &= \left(\frac{a^{\kappa}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j} \right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^{\kappa} g_{ij}^{-\kappa} G_2(g_{ij}) \end{aligned}$$

where we used the definition of quality cutoff $z_{ij}^* = \frac{\tau_{ij} c_i w_i}{a w_j}$. $G_2(g_{ij})$ is given by:

$$\begin{aligned} G_2(g_{ij}) &= \kappa g_{ij}^{\kappa} \int_{0}^{g_{ij}^{-1}} (1-t)^{\gamma} (1+\gamma t) t^{\kappa-\gamma-2} dt = \\ &= \kappa g_{ij}^{\gamma} \left[\frac{g_{ij\,2}F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ij}^{-1}]}{\kappa-\gamma-1} + \frac{\gamma_2 F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ij}^{-1}]}{\kappa-\gamma} \right] \end{aligned}$$

where ${}_2F_1[a, b; c, d]$ is the hypergeometric function.

The sum of revenues across origins to destination j is then:

$$\sum_i R_{ij} = \left(\frac{a^{\kappa}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j} \right) \sum_i (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^{\kappa} g_{ij}^{-\kappa} G_2(g_{ij}) \tag{29}$$

By market clearing $\sum_i R_{ij} = w_j L_j$. Thus, we obtain:

$$\left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j}\right) = L_j w_j \left(\frac{a^\kappa \gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)^{-1} \left[\sum_i (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})\right]^{-1} \tag{30}$$

Using the same change of variable as before, average profits from i to j are:

$$\begin{aligned}
\bar{\pi}_{ij} &= \int_{\bar{z}_{ij}}^{\infty} \pi_{ij}(z) \frac{\kappa \bar{z}_{ij}^\kappa}{z^{\kappa+1}} dz - f_{ij} \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) \int_{\bar{z}_{ij}}^{\infty} \left(\frac{z}{z_{ij}^*} - 1\right)^{1+\gamma} \frac{\kappa \bar{z}_{ij}^\kappa}{z^{\kappa+1}} dz - f_{ij} \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) \kappa g_{ij}^\kappa \int_0^{g_{ij}^{-1}} (1-t)^{1+\gamma} t^{\kappa-\gamma-2} dt = -f_{ij} \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) G_1(g_{ij}) - f_{ij} \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) \left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) (G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma})
\end{aligned}$$

where we used (11) and where $G_1(g_{ij})$ is given by:

$$\begin{aligned}
G_1(g_{ij}) &= \kappa g_{ij}^\kappa \int_0^{g_{ij}^{-1}} (1-t)^{1+\gamma} t^{\kappa-\gamma-2} dt = \\
&= \kappa g_{ij}^\gamma \left[\frac{g_{ij}\, {}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ij}^{-1}]}{\kappa-\gamma-1} - \frac{{}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ij}^{-1}]}{\kappa-\gamma}\right]
\end{aligned}$$

Let $\tilde{G}_1(g_{ij}) = g_{ij}^{-\kappa}[G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma}]$ and $\tilde{G}_2(g_{ij}) = g_{ij}^{-\kappa} G_2(g_{ij})$. The zero expected profit condition becomes:

$$\left(\frac{a^\kappa \gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right) b_i^\kappa \sum_j \left(\frac{L_j w_j^{\kappa-\gamma}}{\xi_j}\right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} \tilde{G}_1(g_{ij}) = w_i f_E$$

Using (30) yields:

$$\sum_j \frac{w_j L_j (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} b_i^\kappa \tilde{G}_1(g_{ij})}{\sum_i (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa \tilde{G}_2(g_{ij})} = w_i f_E$$

Finally, using the definition of λ_{ij} (16) we obtain:

$$\sum_j \frac{\lambda_{ij} w_j L_j \tilde{G}_1(g_{ij})}{J_i \tilde{G}_2(g_{jj})} = w_i f_E$$

$$J_i = \frac{1}{w_i f_E} \sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})} \quad \forall i = 1, ..., I \tag{31}$$

which is the expression shown in the main text.

Let us now consider the utility function. Substituting the definition of the aggregator ξ into the utility function yields:

$$U_j = \int_{\Omega_j} \left(az(\omega)\xi_j q(\omega) - \frac{\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \right) d\omega - (\xi_j - 1) = \int_{\Omega_j} \frac{(\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\gamma} d\omega + 1$$
$$= \left(\frac{a\gamma}{1+\gamma} \right)^{1+\gamma} \sum_{i=1,h} z_{ij}^{\gamma+1} N_{ij} \int_{\bar{z}_{ij}}^{\infty} \left(\frac{z}{z_{ij}^*} - 1 \right)^{1+\gamma} \frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}} dz + 1$$

Thus the utility becomes:

$$U_j = 1 + a^{\kappa} \left(\frac{\gamma}{1+\gamma} \right)^{1+\gamma} \sum_i J_i b_i^{\kappa} \left(\frac{\tau_{ij} w_i c_i}{w_j} \right)^{-\kappa+\gamma+1} g_{ij}^{-\kappa} G_1(g_{ij})$$

From our gravity equation:

$$J_i b_i^{\kappa} \left(\frac{\tau_{ij} w_i c_i}{w_j} \right)^{-\kappa+\gamma+1} g_{ij}^{-\kappa} = \frac{\lambda_{ij}}{\lambda_{jj}} J_j b_j^{\kappa} (\tau_{jj} c_j)^{-\kappa+\gamma+1} g_{jj}^{-\kappa} \frac{G_2(g_{jj})}{G_2(g_{ij})}$$

Thus, subtracting one from our utility, we obtain:

$$\tilde{U}_j = U_j - 1 = a^{\kappa} \left(\frac{\gamma}{1+\gamma} \right)^{1+\gamma} \frac{J_j b_j^{\kappa} (\tau_{jj} c_j)^{-\kappa+\gamma+1}}{\lambda_{jj}} \tilde{G}_2(g_{jj}) \sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})}$$

6.1.2 Equivalent Variation in Income

First, consider the indirect utility function written as:

$$V(W_j, \mathbf{p}) = \frac{1}{1+\gamma} \sum_i N_{ij} \int_0^{\bar{z}_{ij}} (\xi_j q_{ij}(z))^{1+\frac{1}{\gamma}} f(z) dz = \frac{1}{1+\gamma} \sum_i N_{ij} \int_0^{\bar{z}_{ij}} \left(az - \frac{p_{ij}(z)}{W_j} \right)^{1+\gamma} f(z) dz$$

where $W_j = y_j + EV_j$ and EV_j is the equivalent variation in income. Taking logs and differentiating with respect to W_j holding prices constant yields:

$$d\ln V_j = (1+\gamma)\frac{\sum_i N_{ij}\int_0^{\bar{z}_{ij}}\left(az-\frac{p_{ij}(z)}{W_j}\right)^{\gamma}\frac{p_{ij}(z)}{W_j}f(z)dz}{\sum_i N_{ij}\int_0^{\bar{z}_{ij}}\left(az-\frac{p_{ij}(z)}{W_j}\right)^{1+\gamma}f(z)dz}d\ln W_j$$

Substituting prices yields:

$$d\ln V_j = (1+\gamma)\frac{\sum_i N_{ij}(z_{ij}^*)^{1+\gamma}\int_0^{\bar{z}_{ij}}\left(\left(1+\gamma-\frac{y_j}{W_j}\right)\frac{z}{z_{ij}^*}-\gamma\frac{y_j}{W_j}\right)^{\gamma}\frac{y_j}{W_j}\left(\frac{z}{z_{ij}^*}+\gamma\right)f(z)dz}{\sum_i N_{ij}(z_{ij}^*)^{1+\gamma}\int_0^{\bar{z}_{ij}}\left(\left(1+\gamma-\frac{y_j}{W_j}\right)\frac{z}{z_{ij}^*}-\gamma\frac{y_j}{W_j}\right)^{1+\gamma}f(z)dz}d\ln W_j$$

Solving the expression generates hypergeometric functions that depend both on g_{ij} and EV_j. Integrating for $EV_j \in [0, W_j - y_j]$ yields the equivalent change in welfare. However, such an expression is quite complicated and requires numerical integration. Thus, we use the local approximation, which can be obtained by setting $y_j = W_j$. This yields:

$$\begin{aligned} d\ln V_j &= (1+\gamma)\frac{\sum_i N_{ij}(z_{ij}^*)^{1+\gamma}\int_0^{\bar{z}_{ij}}\left(\frac{z}{z_{ij}^*}-1\right)^{\gamma}\left(\frac{z}{z_{ij}^*}+\gamma\right)f(z)dz}{\sum_i N_{ij}(z_{ij}^*)^{1+\gamma}\int_0^{\bar{z}_{ij}}\left(\frac{z}{z_{ij}^*}-1\right)^{1+\gamma}f(z)dz}d\ln W_j = \\ &= (1+\gamma)\frac{\sum_i J_i b_i^{\kappa}(\tau_{ij}c_i w_i)^{1+\gamma}g_{ij}^{-\kappa}G_2(g_{ij})}{\sum_i J_i b_i^{\kappa}(\tau_{ij}c_i w_i)^{1+\gamma}g_{ij}^{-\kappa}G_1(g_{ij})}d\ln W_j = \\ &= (1+\gamma)\frac{\sum_i \lambda_{ij}}{\sum_i \lambda_{ij}\frac{G_1(g_{ij})}{G_2(g_{ij})}}d\ln W_j = \\ &= (1+\gamma)\left[\sum_i \lambda_{ij}\frac{G_1(g_{ij})}{G_2(g_{ij})}\right]^{-1}d\ln W_j \end{aligned}$$

Thus, to compute the welfare change given $\hat{\hat{U}}$, we calculate:

$$d\ln W_j = \frac{\sum_i \lambda_{ij}\frac{G_1(g_{ij})}{G_2(g_{ij})}}{1+\gamma}(\hat{\hat{U}}-1)$$

6.2 Welfare Effects of Regulations

We consider the case of two symmetric countries, where only one of them (home) is allowed to impose a regulation. We fix the size of the two countries L to one. We set $\kappa = 5$, $\gamma = 1$, and $\tau_{fh} = \tau_{hf} = 1.5$. We first consider the case in which the fixed costs of compliance are expressed in the destination (home) labor units. Namely, $f_{hh} = f_{fh} = w_h f$. Figure

8 illustrates the effects of increase in restrictiveness of the standard on several outcome variables.

Figure 8: Effects of Regulations (Fixed Cost in Destination Labor Units)

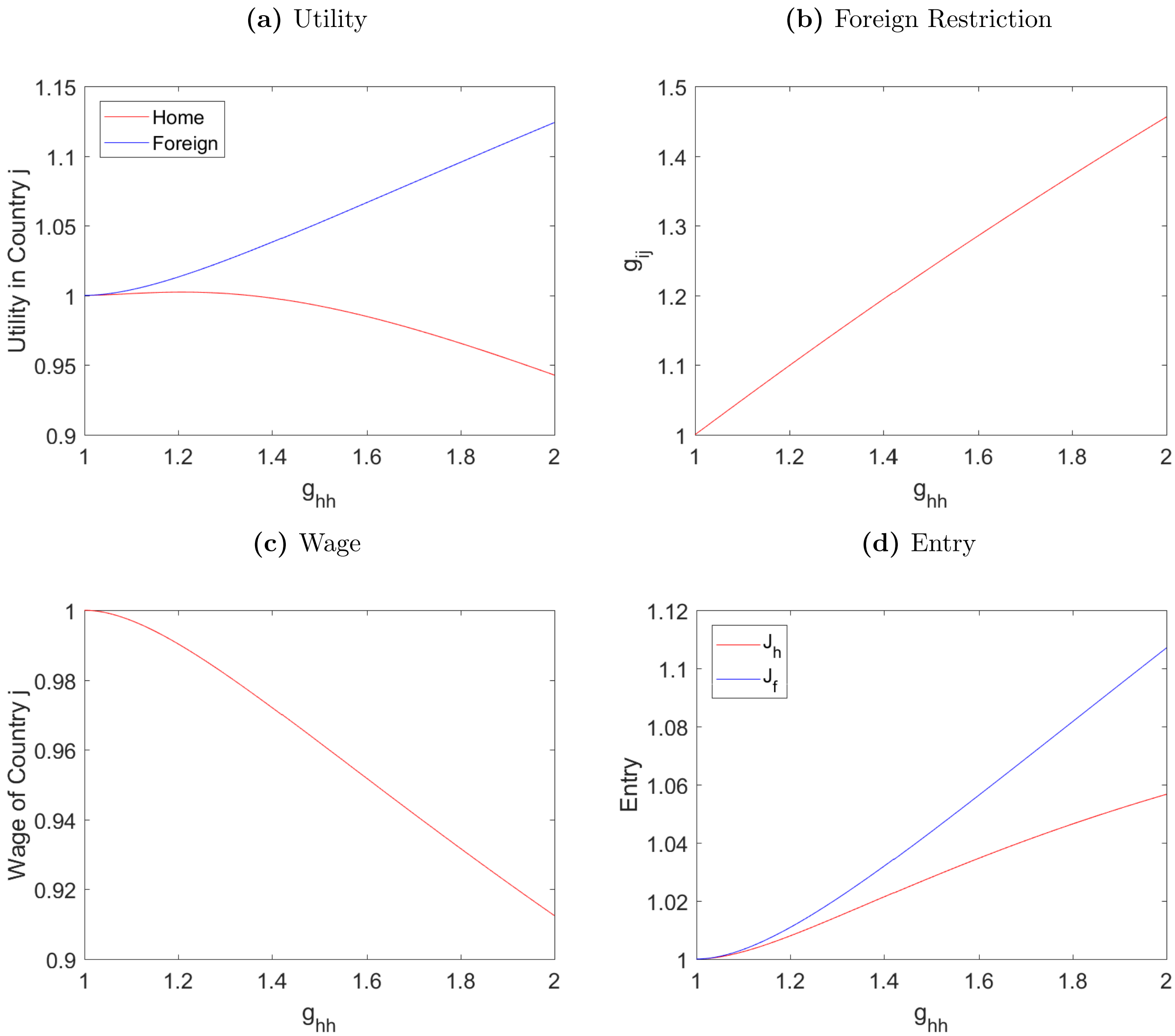


Figure 9: Effects of Regulations with a small economy (J_f constant)

(a) Utility **(b)** Foreign Restriction **(c)** Wage **(d)** Entry

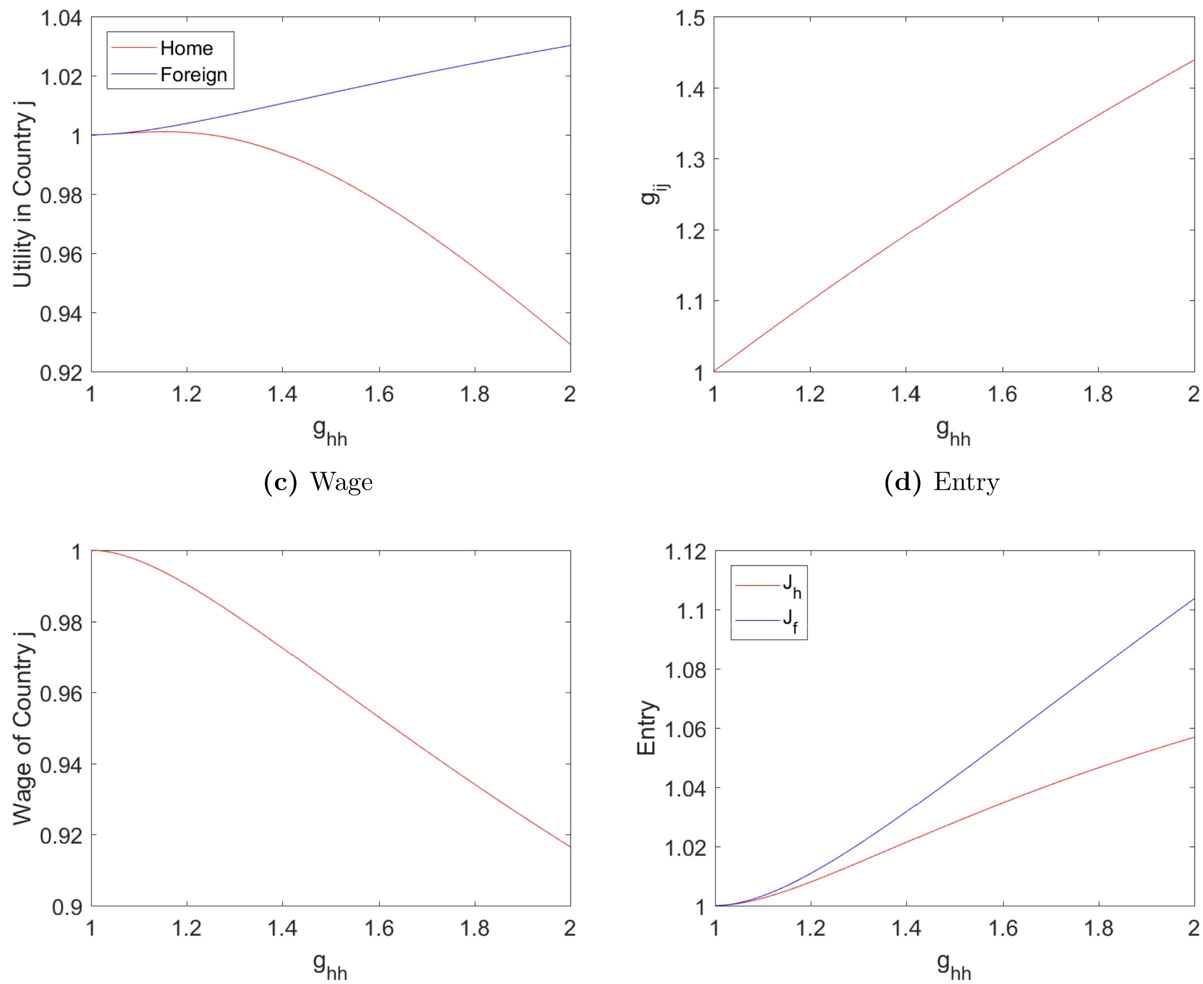


Figure 10: Effects of Regulations with a small economy (J_f and w_h constant)

(a) Utility **(b)** Foreign Restriction

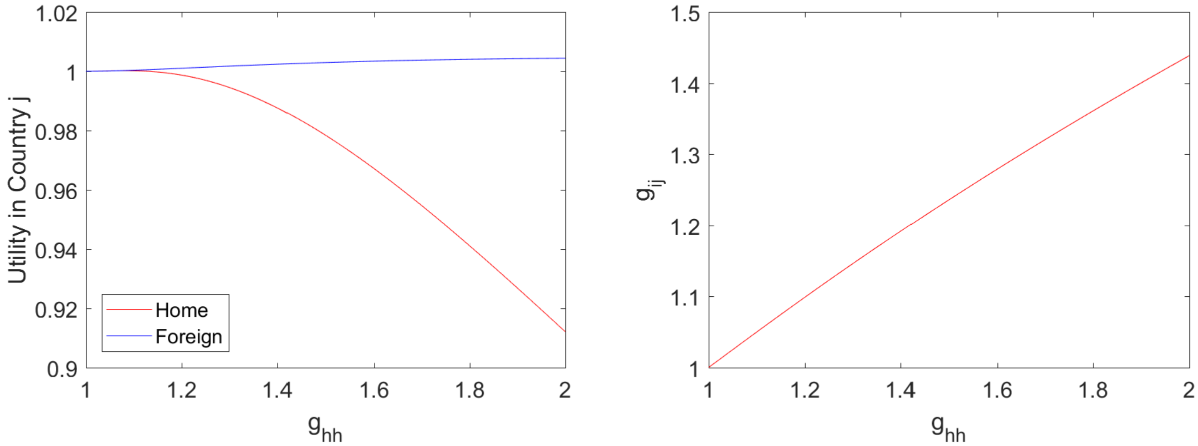
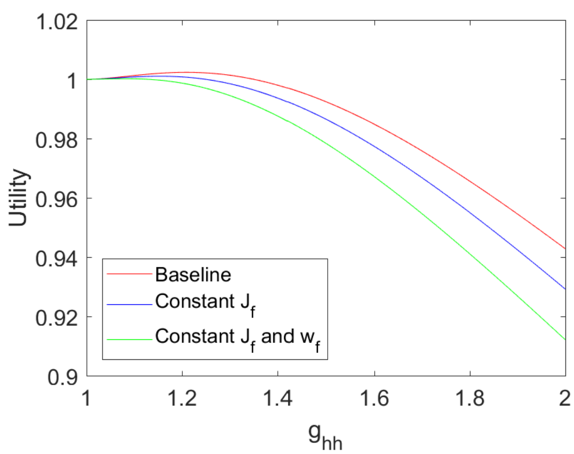


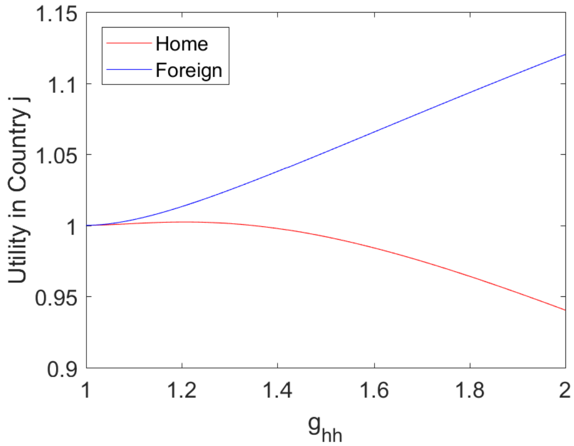
Figure 11: Effects of a Standard with a small economy (J_f and w_h constant)



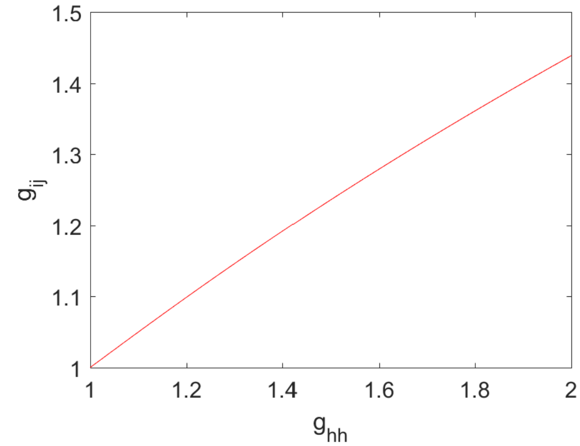
We now consider the case in which firms must pay the fixed cost of compliance in home labor units. Namely, $f_{hh} = w_h f$ and $f_{fh} = w_f f = f$. This change in the assumption does not alter the results in any relevant way. The reason for that is due to the fact that home wages change minimally in the range of regulations considered and, therefore, such a change is not enough to produce visible changes in optimal policy.

Figure 12: Effects of Regulations (Fixed Cost in Source Labor Units)

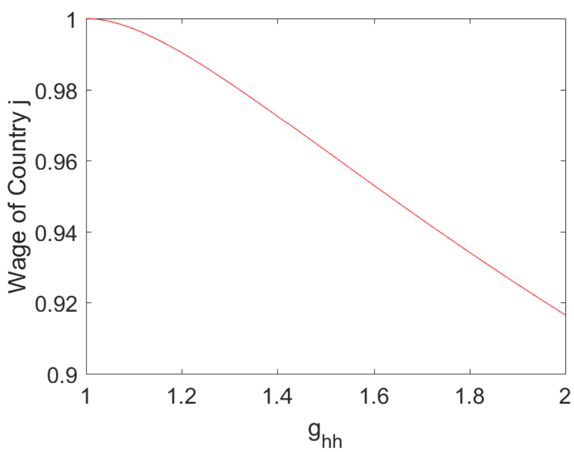
(a) Utility



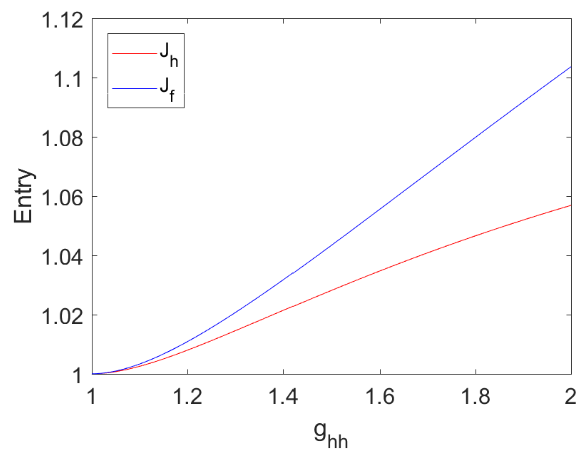
(b) Foreign Restriction



(c) Wage



(d) Entry



6.3 Quantitative Exercise: Simulated Method of Moments Algorithm

Estimation of g_{ij} with EDD Data. The exporter dynamics database provides 6 statistics about the sales distribution, which we could use to estimate g_{ij} for each country pair. In particular, the EDD has:

- Median, First Quartile, and Third Quartile for the export value per exporter distribution (moments of the pdf)
- Share of top 1%, 5%, and 25% of Exporters in total export distribution

So, for each country pair in our sample $i - j$ we simulate draws of quality conditional on firms exporting to the destination, and compute revenues relative to the average revenues: $\frac{r_{ij}(z)}{R_{ij}}$. Armed with these relative revenues for every exporter, we compute 6 moments and match them to the data (taking the values of γ and κ as given). The moments are:

- 25th, 50th, and 75th percentiles of sales normalized by average sales
- Share of top 1%, 5%, and 25% of Exporters in total export distribution

This algorithm returns a vector of g_{ij} for each $i \neq j$. Our identification consists of choosing the parameter set that minimizes the sum of the squared errors between empirical and theoretical moments:

$$\min_{g, \forall i, i \neq j} \sum_{q=1}^{6} \left(F_q^d - F_q^m(g_{ij}) \right)^2, \tag{32}$$

where q identifies each of the 6 moments listed above.

Estimation of parameters with Chilean Firm Data. The procedure below is adopted from Macedoni and Weinberger (2019). In that case, we have firm level data which allows us to produce the distribution of *domestic* sales. Domestic sales are a function of g_{jj}, just as as g_{ij} is a function of the export distribution of firms in country i that sell in j. The procedure below takes a closed economy framework where g refers to g_{jj} in the model above, where $j = Chile$.

We adopt an over-identification strategy that targets 99 moments from the empirical domestic sales distribution. Given a set of potential producers in the simulation, namely those with $z > g$, we compute firm revenues normalized by mean revenues:

$$\tilde{r}(z|z > g) = \frac{r}{\bar{r}} = (G_2(g))^{-1} \left(\frac{z}{z^*} - 1 \right)^{\gamma} \left(\frac{z}{z^*} + \gamma \right) \tag{33}$$

where $G_2(g)$ is a function that depends on the targeted parameters and $\tilde{r}$ refers to *domestic sales*.

The theoretical relative sales are matched to their counterpart in the data in order to identify the model parameters in an approach that follows Sager and Timoshenko (2017). Let $F_q^m(g, \kappa, \gamma) = \log(\tilde{r})_q$ be the q-th quantile of the simulated log domestic sales distribution. Then, let F_q^d denote the corresponding value of the empirical CDF of the log sales distribution. Our identification consists of choosing the parameter set that minimizes the sum of the squared errors between empirical and theoretical quantiles:

$$\min_{g,\kappa,\gamma} \sum_{q=1}^{99} \left(F_q^d - F_q^m(g, \kappa, \gamma)\right)^2. \tag{34}$$

The strategy to estimate the parameter set $(\hat{g}, \hat{\kappa}, \hat{\gamma})$ is based on the separate ways that each parameter is identified within the sales distribution. κ governs the shape of the quality distribution, which is proportional to the shape in the sales distribution only in special cases (Mrazova et al., 2017), which do not apply to our model. The divergence in the sales and quality distribution is due to the distribution of markups. Since firm markup levels are a function of γ (see (8)), this parameter affects the mapping from the quality to the sales distribution and is not collinear with κ.[42] Finally, the standard not only eliminates low-quality firms but reallocates resources to higher-quality firms. Therefore, relative sales across percentiles of the sales distribution are a function of g. For this reason, we use a general strategy to match sales across the firm distribution, with each parameter being identified by different parts of the distribution.

HS Sections. For the specification reported in Table 3 we aggregate the HS2 data into "sections". These sections are a subset of the 21 HS-Sections as classified by the UN, as listed along with their description in Table 4 below. We combine the 21 sections into 17 aggregate sections, and have 15 left in our data with positive number of observations.

[42] As is not the case, for example, if preferences were CES and the distribution of quality is Pareto.

Table 4: Correspondence of our Custom HS Sections to UN Classification

This Paper	HS Sec.		ISIC	HS2
1	1	Live Animals; animal products	01, 05	1 to 5
1	2	Vegetable products	15	6 to 14
1	3	Animal or vegetable fats and oils; prepared fats	15	15
2	4	Prepared foodstuffs; beverages, spririts vinegar; tobacco	15,16	16-24
3	5	Mineral products	23	25-27
4	6	Products of chemical or allied industries	24	28-38
5	7	Plastics and articles thereof; rubbers	25	39-40
6	8	Raw hids and skins; leather; handbags; articles of animal gut	18	41-43
7	9	Wood; charcoal; cork; straw; plaiting materials	20	44-46
8	10	Pulp or wood or other cellulosic material;paper or paperboard	21	47-49
9	11	textiles and textile articles	17	50-63
10	12	Footwear, headgear, umbrellas; prepared feathers; flowers, human hair	19	64-67
11	13	Articles of stone, plaster, cement, asbestos, mica, ceramic, glass, wine	26	68-70
12	14	Natural or cultured pearls, precious stones, metals, jewelry	36	71
13	15	base metals and articles of base metal	27	72-83
14	16	machinery and mechanical appliances; electrical equipment	31,28	84-85
15	17	Vehicles, aircraft, transport"	34,35	86-89
16	18	Optical photographic, cinematographic, medical and musical instruments	32,33	90-92
17	19	Arms and ammunition, parts thereof	29	93
12	20	Miscellaneous manufactured products	36	94-96
	21	Works of art, collectors pieces		97-98

6.4 Quantitative Exercise: Welfare Results

The following tables present the welfare results when all countries impose their optimal standard, under varying data samples. These correspond to the results in Figure 6.

Table 5: Counterfactual Welfare Results when All Countries Impose Optimal Standards

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
Domestic Trade Share	0.456	0.576	0.813	0.192	0.599	0.713	0.647	0.692	0.75	0.681	0.431	0.755	0.738	0.998	0.663	0.721	0.576
Domestic Restrictiveness	1.313	1.066	1.095	1.235	1.06	1.168	1.071	1.065	1.145	1.105	1.635	1.069	1.366	1	1.033	1.537	1.004
Optimal Restrictiveness	1.165	1.24	1.426	1.01	1.274	1.359	1.3	1.318	1.394	1.304	1.132	1.329	1.388	1.602	1.321	1.38	1.248
% Change W (cooperative)	0.409	0.246	0.203	0.877	0.294	0.272	0.27	0.306	0.18	0.306	0.7	0.22	0.235	0.248	0.348	0.224	0.42
% Change W (non-cooperative)	0.013	0.009	0.066	0.012	0.015	0.026	0.023	0.023	0.045	0.013	0.186	0.031	0	0.248	0.029	0.03	0.01
Cooperative Benefit Ratio	30.914	25.941	3.075	73.356	19.605	10.284	11.733	13.12	3.994	23.235	3.764	7.184	517.84	1.001	12.106	7.511	40.199

This table presents the welfare results described in Figure 6. The first three rows summarize estimated λ_{jj}, g_{jj} and g_{jj}^{opt} for each j. In the cooperation case, each j sets g_{jj}^{opt} , which determines g_{ij}'s $\forall i \neq j$ by (28), in order to maximize welfare taking the initial values of all other countries as given. The non-cooperative case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

6.4.1 Extra Tables

The following tables report the initial values for trade shares, wages and estimated restrictiveness.

Table 6: Estimated Restrictiveness Index (g_{ij}) Matrix for all i,j

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
BOL	1.31	1.13	-	-	-	-	-	-	-	-	-	1.23	-	1	-	-	-
CHL	1.07	1.07	1.04	1.14	1.03	1.23	1.11	1.15	1.12	1.04	1.44	1.03	1.13	1	1.21	1.1	1.23
COL	1.02	1	1.1	1.03	-	1.02	1.01	1.04	1.02	1	1.23	1	1.18	1	-	1.14	-
CRI	-	1.01	1.03	1.23	-	1.01	1	1.03	1	1	1.01	1.02	-	1	-	1.28	-
DNK	1.15	1.49	1.13	1.24	1.06	1.1	2.63	1.13	1.68	1.14	-	1.14	-	1	1.37	1.35	1.47
DOM	-	-	1.12	1.23	-	1.17	-	1.11	1.03	1.12	-	-	-	1	-	-	-
ECU	1.28	1.09	1.04	1.12	-	1.06	1.07	1.08	1.14	1.19	-	1.03	-	1	-	-	-
ESP	1.07	1.01	1.02	1.08	1	1.06	1.04	1.07	1.09	1	1.13	1.02	1.1	1	1.02	1.11	1
GTM	-	1.21	1.08	1	-	1	1.17	1.34	1.14	1	1	1.15	-	1	-	-	-
MEX	1	1	1	1	1	1	1.02	1	1	1.1	1	1	1.07	1	1	1.03	1.05
NIC	-	-	-	1.05	-	-	-	-	1.03	1.17	1.64	-	-	1	-	-	-
PER	1.02	1	1.01	1.05	-	1.06	1.04	1.02	1.05	1.04	1.1	1.07	1.13	1	-	1.08	-
PRY	2.13	-	-	-	-	-	-	-	-	-	-	-	1.37	1	-	1.23	-
ROW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
THA	1.09	1.01	1.03	1.02	1	1.19	1.03	1	1.07	1	1.49	1	1.06	1	1.03	1.03	1
URY	1.23	1.15	1.19	-	-	-	-	1.21	-	1.12	-	2.13	1.14	1	-	1.54	-
ZAF	-	1.09	1.02	-	1.07	-	-	1.02	-	1.06	-	1.06	-	1	1.03	-	1

This table reports estimated restrictiveness (g_{ij}) for all country pairs available in EDD. In the cases where there is no exporter information in EDD, we assume no trade between those country pairs (since we cannot estimate g_{ij} in those cases).

Table 7: Trade Shares Matrix for all i,j, taken from data

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
BOL	0.4557	0.0013	-	-	-	-	-	-	-	-	-	0.0029	-	0	-	-	-
CHL	0.0244	0.5762	0.0032	0.0138	0.0007	0.001	0.0089	0.0018	0.002	0.0013	0.0026	0.0073	0.0034	0.0001	0.0005	0.0036	0.0006
COL	0.0103	0.0121	0.8133	0.0155	-	0.0072	0.0311	0.003	0.0083	0.0008	0.0018	0.0091	0.0005	0.0001	-	0.001	-
CRI	-	0.0002	0.0002	0.1916	-	0.0039	0.0008	0.0001	0.0071	0.0029	0.0452	0.0002	-	0	-	0.0002	-
DNK	0.0006	0.0011	0.0003	0.001	0.5994	0.0012	0.0003	0.0022	0.0001	0.0004	-	0.0004	-	0.0001	0.0004	0.0023	0.0012
DOM	-	-	0.0001	0.0018	-	0.7131	-	0.0001	0.0019	0.0001	-	-	-	0	-	-	-
ECU	0.0021	0.0119	0.0035	0.0013	-	0.0008	0.6468	0.0005	0.0034	0.0001	-	0.0119	-	0	-	-	-
ESP	0.0064	0.0077	0.0026	0.009	0.0061	0.0085	0.0087	0.6915	0.0028	0.0036	0.0104	0.0047	0.002	0.0004	0.0009	0.0037	0.0051
GTM	-	0.0006	0.0002	0.0192	-	0.0018	0.0004	0.0001	0.7496	0.0005	0.0343	0.0005	-	0	-	-	-
MEX	0.0151	0.0144	0.0211	0.0551	0.0008	0.0169	0.0126	0.0066	0.0287	0.6807	0.0433	0.0098	0.0038	0.0006	0.0009	0.0074	0.003
NIC	-	-	-	0.005	-	-	-	-	0.0015	0.0001	0.4308	-	-	0	-	-	-
PER	0.0356	0.0115	0.003	0.0022	-	0.0009	0.016	0.002	0.0017	0.0004	0.0016	0.7548	0.0002	0.0001	-	0.0006	-
PRY	0.0054	-	-	-	-	-	-	-	-	-	-	-	0.7377	0	-	0.002	-
ROW	0.4375	0.3569	0.1509	0.6802	0.3906	0.2437	0.2701	0.29	0.191	0.305	0.4231	0.1943	0.2469	0.9979	0.3314	0.257	0.403
THA	0.0044	0.004	0.0011	0.0043	0.0018	0.0009	0.0044	0.0008	0.002	0.0034	0.0069	0.0026	0.0017	0.0003	0.6631	0.0008	0.0112
URY	0.0023	0.0015	0.0003	-	-	-	-	0.0001	-	0.0003	-	0.001	0.0038	0	-	0.7215	-
ZAF	-	0.0006	0.0001	-	0.0006	-	-	0.001	-	0.0005	-	0.0004	-	0.0002	0.0029	-	0.5758

This table reports trade shares, for our trade matrix. In the cases where there is no exporter information in EDD, we assume no trade between those country pairs (since we cannot estimate g_{ij} in those cases).

Table 8: Predicted Wages (Market Clearing)

BOL	0.17
CHL	1
COL	0.65
CRI	0.86
DNK	4.28
DOM	0.3
ECU	0.45
ESP	1.82
GTM	0.28
MEX	0.96
NIC	0.14
PER	0.54
PRY	0.31
ROW	9.4
THA	0.99
URY	1.07
ZAF	0.6

This table reports the estimated wages given employment data, trade shares, and the relationship given by (17). We normalize the wages in Chile equal to one.

6.5 Counterfactual: Change in Trade Costs

Let us use the hat algebra to derive the change in welfare due to any change in the iceberg trade costs τ_{ij}. The system of equation that needs solving to find the changes in wages, trade shares, and mass of entrants is:

$$\hat{\lambda}_{ij} = \frac{\hat{J}_i \hat{w}_i^{-\kappa+\gamma+1} \hat{\tau}_{ij}^{-\kappa+\gamma+1}}{\sum_v \lambda_{vj} \hat{J}_v \hat{w}_v^{-\kappa+\gamma+1} \hat{\tau}_{vj}^{-\kappa+\gamma+1}} \qquad \forall i, j = 1, ...I$$

$$\hat{w}_i = \frac{\sum_j \lambda_{ij} w_j L_j \hat{\lambda}_{ij} \hat{w}_j}{\sum_j \lambda_{ij} w_j L_j} \qquad \forall i = 1, ..., I$$

$$\hat{J}_i = \frac{1}{\hat{w}_i} \frac{\sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})} \hat{\lambda}_{ij} \hat{w}_j}{\sum_j \lambda_{ij} w_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{jj})}} \qquad \forall i = 1, ..., I$$

The change in utility is given by:

$$\hat{\hat{U}}_j = \frac{\hat{J}_j}{\hat{\lambda}_{jj}} \frac{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})} \hat{\lambda}_{ij}}{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})}}$$

And the welfare formula is identical to the case of a change in regulatory restrictiveness:

$$d \ln W_j = \frac{\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})}}{1+\gamma} (\hat{\hat{U}} - 1)$$

Table 9 reports the results when we allow for a drop in trade costs and the domestic trade share such that welfare gains are equal to those from Table 5. For each j, we allow $\tau_{ij}, \forall i \neq j$ to drop by a proportional amount. Given the drop in trade costs, we compute the corresponding in $d \ln \lambda_{jj}$. The welfare gains are computed with the assumption that other countries do *not* drop their own trade costs.

Table 9: Welfare Equivalent Changes in Trade Costs and Domestic Share

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
% Change W (cooperative)	0.41	0.25	0.2	0.88	0.29	0.27	0.27	0.31	0.18	0.31	0.7	0.22	0.23	0.25	0.35	0.22	0.42
Welfare equivalent % Drop Trade Costs	4.92	4.02	7.97	6.2	5.08	6.77	5.38	6.99	5.28	6.75	7.82	6.51	6.53	96.32	7.18	5.92	6.68
Welfare equivalent % Drop in Trade Share	2.4	1.45	1.2	5	1.73	1.61	1.59	1.8	1.07	1.8	4.1	1.3	1.4	1.46	2.04	1.36	2.45

This table reports the implied proportional drop in trade costs for all origins to j, as well as $d \ln \lambda_{jj}$, such that the change in welfare is equivalent to the change in welfare when countries impose optimal regulations given current trade costs.

6.6 Robustness Results

To check the impact of using trade and production data for 2002 instead of 2012, we re-run the analysis above with 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW), but keep the same estimated restrictiveness produced with the 2012 EDD data. Given new trades shares, wages are re-computed with the same method that leverages the market clearing condition. For the set of countries that are in both samples, we find a large correlation in tradeshares across samples, equal to 0.96. The correlation for wages is only 0.30, while the correlation for the estimated optimal restrictiveness given the two samples is 0.64.

Chile's gain from raising its standards by itself is almost twice as large. However, the cooperative gains tend to be smaller in this case (for Chile, cooperative welfare gains are 25% smaller). This is not the case for all countries, the biggest outlier being Denmark which looks much more open in this data. Denmark therefore has very small gains from raising its own standards, but large gains from other countries raising its standards.

Table 10: Counterfactual Results Welfare when All Countries Impose Optimal Standards: Alternative Data for Gross Output and Trade (Robustness)

	BOL	CHL	COL	CRI	DNK	ECU	ESP	MEX	PER	PRY	ROW	THA	URY	ZAF
Domestic Trade Share	0.564	0.688	0.692	0.469	0.363	0.51	0.637	0.485	0.782	0.51	0.967	0.643	0.646	0.722
Domestic Restrictiveness	1.313	1.066	1.095	1.235	1.06	1.071	1.065	1.105	1.069	1.366	1	1.033	1.537	1.004
Optimal Restrictiveness	1.247	1.335	1.289	1.027	1.01	1.169	1.274	1.021	1.327	1.204	1.574	1.302	1.329	1.365
% Change W (cooperative)	0.332	0.195	0.223	0.459	0.356	0.395	0.33	0.468	0.17	0.241	0.218	0.331	0.295	0.277
% Change W (non-cooperative)	0.003	0.032	0.01	0	0	0.005	0.014	0	0.026	0.019	0.214	0.024	0.053	0.046
Cooperative Benefit Ratio	103.05	6.043	21.592	-	-	83.535	24.453	-	6.467	12.844	1.019	13.973	5.57	5.98

In this table we re-run the analysis with 2002 data for gross output and trade, with the *TradeProd* database provided by CEPII. The Dominican Republic, Guatemala, and Nicaragua are not available. This table presents the welfare results described in the *left panel* of Figure 7. The first three rows summarize estimated λ_{jj}, g_{jj} and g_{jj}^{opt} for each j. In the cooperation case, each j sets g_{jj}^{opt} , which determines g_{ij}'s $\forall i \neq j$ by (28), in order to maximize welfare taking the initial values of all other countries as given. The non-cooperative case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

6.6.1 Re-estimation of g_{jj} with TradeProd Data

The *TradeProd* data also contains a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), as well as an estimate of wages (the total wage bill in manufacturing divided by employment). With these two pieces of information, consider an alternative estimate g_{jj}, that does not require using Chile as the reference country as above, but continues to rely on (26). In this case we assume that costs and wages are measured in the data with accuracy.[43] To re-estimate g_{ij} using previous years, although it is not possible

[43] Since we use wage data here, we will not back out wages from gravity, but instead use the *TradeProd* data for both wages and trade shares.

to go back to 2002, for each exporter in the EDD database we take its first year of data (between 2004 and 2008). After estimating g_{ij} using the same procedure as before, we back out g_{jj} from (26)[44], and combine these with trade shares and wage data to conduct the counterfactual of all countries imposing their optimal standards.

Table 11 reports the results, where the sample has been extended given that we don't have to drop countries that do not act as destinations for Chile. There are some differences that emerge from re-estimating the restrictiveness values. One conclusion is that the previous strategy tends to under-estimate domestic restrictiveness. In many more cases, we now find that initial domestic restrictiveness is *too high*. The welfare gains from non-cooperative policy tend to be higher in these cases, as the welfare loss of too much restrictiveness can be quite large. This is especially true in Iran (not available in our previous sample), where welfare increases by 2.6% by simply reducing its restrictiveness to the optimal value.[45] The gains to cooperation once again exist, and are mostly of similar magnitude – although they explode for the countries in which non-cooperative gains are very small because domestic restrictiveness is already optimal.

Table 11: Counterfactual Welfare Results (Robustness): Alternative Data for all Initial Values (Robustness)

	BOL	CHL	COL	CRI	DNK	ECU	EGY	ESP	GEO	IRN	JOR	KEN	MAR	MDG	MUS	NOR	PER	PRT	PRY	ROU	ROW	UGA	URY	ZAF
Domestic Trade Share	0.564	0.688	0.692	0.469	0.363	0.51	0.488	0.637	0.144	0.618	0.403	0.827	0.526	0.557	0.475	0.448	0.782	0.497	0.51	0.549	0.964	0.523	0.646	0.722
Domestic Restrictiveness	1.524	1.628	1.419	1.465	1.146	1.395	1.417	1.318	1.706	3.024	1.405	1.295	1.295	1.355	1.434	1.187	1.275	1.15	1.398	1.8	1	1.156	2.292	1.402
Optimal Restrictiveness	1.353	1.428	1.422	1.168	1.092	1.255	1.267	1.156	1.076	1.386	1.143	1.354	1.258	1.04	1.055	1.334	1.345	1.07	1.569	1.08	1.586	1.64	1.282	1.2
% Change W (cooperative)	0.269	0.224	0.067	0.583	0.62	0.339	0.511	0.468	1.065	3.44	0.527	0.525	0.408	0.472	0.603	0.363	0.26	0.535	0.382	1.081	0.224	0.936	1.631	0.342
% Change W (non-cooperative)	0.101	0.122	0.051	0.07	0.002	0.036	0.084	0.01	0.252	3.107	0.049	0.012	0.034	0.021	0.064	0.055	0.007	0	0.357	0.448	0.227	0.899	1.207	0.004
Cooperative Benefit Ratio	2.653	1.835	1.31	8.285	323.949	9.377	6.067	49.209	4.231	1.107	10.732	43.534	11.971	22.446	9.459	6.633	35.709	1081.812	1.068	2.412	0.986	1.041	1.351	77.989

In this table we re-run the analysis with 2002 data for gross output and trade, as well as domestic restrictiveness, with the *TradeProd* database provided by CEPII. Wages and the inverse of labor productivity are used to approximate w_i and c_i in (26). Furthermore, g_{ij} is re-estimated using the same procedure but earlier EDD data (in this case, we take the first year for each country in the sample, between 2004-2008). To give more weight to local costs, we set $\alpha = 1$. This table presents the welfare results described in the *right panel* of Figure 7. The first three rows summarize estimated λ_{jj}, g_{jj} and g_{jj}^{opt} for each j. In the cooperation case, each j sets g_{jj}^{opt} , which determines g_{ij}'s $\forall i \neq j$ by (28), in order to maximize welfare taking the initial values of all other countries as given. The non-cooperative case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

[44] We once again estimate trade costs using coefficients from distance, etc. and furthermore, we require an estimate of α. We have generally found that how fixed costs are paid is not important, and in this case we set $\alpha = 1$ to look at the case where they are paid with domestic wages.

[45] This is not shown in the figure. We took out outliers where welfare changes were too large to more clearly report the rest of the countries.

6.7 Other Results: Estimating Trade Shares from the Model

An alternative to using λ_{ij} from the data is to predict trade shares with the structure of the model. Although this is more theoretically consistent, it also leads to some improbable trade shares, and for that reason we stick to the data in the benchmark analysis.

$$\ln\frac{\lambda_{ij}}{\lambda_{jj}} = \underbrace{\ln\left[J_i b_i^{\kappa}(c_i w_i)^{-\kappa+\gamma+1}\right]}_{\text{Origin FE}} - \underbrace{\ln\left[J_j b_j^{\kappa}(c_j w_j)^{-\kappa+\gamma+1}\right]}_{\text{Destination FE}} - (\kappa-\gamma-1)\ln\frac{\tau_{ij}}{\tau_{jj}} + \ln\left(\frac{g_{ij}^{-\kappa}G_2(g_{ij})}{g_{jj}^{-\kappa}G_2(g_{jj})}\right), \tag{35}$$

where trade costs take an explicit form as as above (distance, etc.) plus an indicator for internal trade, and the last component is produced with estimated restrictiveness measures. Then, the measure of trade shares is the predicted value of $\frac{\lambda_{ij}}{\lambda_{jj}}$, which includes domestic shares that are produced with the approximated manufacturing gross output described above.

Table 12 displays the results for trade shares if we were to back them out after estimating the gravity equation, instead of taking them straight from data.

Table 12: Predicted Trade Shares

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	THA	URY	ZAF
BOL	0.752	0.002	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-
CHL	0.076	0.973	0.005	0.006	0.001	0.004	0.004	0.001	0.003	0.002	0.008	0.030	0.008	0.000	0.019	0.001
COL	0.022	0.003	0.948	0.022	-	0.017	0.023	0.002	0.007	0.002	0.022	0.029	0.002	-	0.004	-
CRI	-	0.000	0.001	0.870	-	0.003	0.001	0.000	0.002	0.001	0.061	0.002	-	-	0.000	-
DNK	0.004	0.000	0.001	0.002	0.990	0.003	0.001	0.002	0.000	0.001	-	0.002	-	0.000	0.001	0.001
DOM	-	-	0.001	0.001	-	0.907	-	0.000	0.001	0.000	-	-	-	-	-	-
ECU	0.004	0.001	0.010	0.006	-	0.005	0.939	0.001	0.002	0.000	-	0.018	-	-	-	-
ESP	0.025	0.005	0.007	0.013	0.004	0.016	0.006	0.980	0.005	0.004	0.029	0.013	0.006	0.001	0.010	0.005
GTM	-	0.000	0.001	0.008	-	0.004	0.001	0.000	0.907	0.003	0.035	0.001	-	-	-	-
MEX	0.045	0.006	0.015	0.049	0.002	0.035	0.013	0.008	0.067	0.983	0.163	0.023	0.007	0.001	0.016	0.004
NIC	-	-	-	0.011	-	-	-	-	0.002	0.000	0.665	-	-	-	-	-
PER	0.039	0.004	0.007	0.005	-	0.004	0.009	0.001	0.002	0.001	0.011	0.868	0.002	-	0.004	-
PRY	0.017	-	-	-	-	-	-	-	-	-	-	-	0.968	-	0.009	-
THA	0.009	0.002	0.003	0.007	0.002	0.003	0.003	0.003	0.003	0.002	0.005	0.006	0.003	0.998	0.007	0.006
URY	0.007	0.002	0.001	-	-	-	-	0.001	-	0.000	-	0.001	0.005	-	0.930	-
ZAF	-	0.001	0.001	-	0.000	-	-	0.001	-	0.000	-	0.002	-	0.000	-	0.982

This table reports λ_{ij}'s when we use the estimated relationship given by (35). The specification is run with gravity data and the restriction parameters estimated in the previous step.