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The Role of Private Standards for Manufactured Food Exports from Developing Countries

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Abstract

The effect of food standards on agricultural trade flows remains unclear. We contribute to the debate with a unique dataset that contains the number of food processing firms of 88 countries from 2008 to 2013 that are certified with the International Featured Standard (IFS). Based on a theoretical framework that combines Melitz-type firm heterogeneity with quality upgrading, we estimate a gravity-model using the one-year lag of IFS as well as modern grocery distribution as an instrument to address potential endogeneity. We find that IFS increases *c.p.* bilateral exports on average of seven agricultural product categories in both specifications. However, the effect remains only for upper- and middle-income countries once we separate by income and turns even negative for low income countries in the IV-specification. Hence, whereas IFS increases exports on average, it has a trade-impeding effect for low-income countries. Therefore, private standards are not a sufficient development policy tool to integrate low-income countries to the world trading system without being accompanied by other measures.

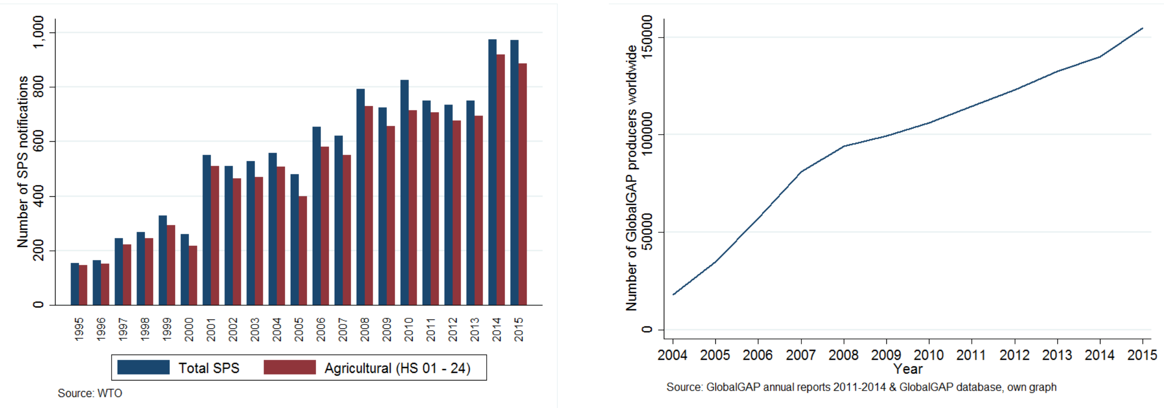
Keywords: Agricultural trade, private food standards, manufactured food, gravity model

JEL Classification: F14, F18, F19

1 Introduction

Significant tariff reductions during previous decades belong to the most successful tools to reduce poverty (Dollar and Kraay, 2004). Many South-East Asian countries integrated themselves into the world trade system and achieved tremendous increases in per capita income. However, not all countries benefit from the world trade system in the same way despite tariff reductions which were achieved via multilateral as well as via regional negotiation rounds. Moreover, as the relevance of tariffs as trade barriers declines, non-tariff barriers (NTBs) to trade gain in quantitative as well as in qualitative importance. For example, the total amount of sanitary and phytosanitary (SPS) notifications to the World Trade Organization (WTO) as a proxy for public food safety standards increased from less than 200 in 1995 to almost 1,000 in 2015, see Figure 1. Moreover, the number of GlobalGAP producers as an important private standard increased from below 20,000 in 2004 to more than 150,000 in 2015 (Swinnen et al., 2015). Therefore, the effect of NTBs and standards in particular on trade is of deep interest for economists and policy makers that are concerned about the integration of developing countries into the world trade system (Otsuki et al., 1999).

Figure 1: The raising relevance of standards



(a) **Public:** SPS notifications

(b) **Private:** Number of GlobalGAP producers

A debate entitled as "standards-as-catalyst vs. standards-as-barriers to trade" (Jaffee and Henson, 2004) emerged which - as a result - accumulated a large set of studies. Depending on the motives of policy makers, standards can either protect consumers or domestic producers. Whereas scientific justified consumer protectionism by the provision of safe food is covered by the WTO SPS agreement, the second motive of domestic producers support is a form of non-tariff protectionism.

Independent of this political economy perspective, standards can either enhance or reduce trade flows. On the one hand, standards are likely to reduce trade because of high fixed costs of compliance which affect small scale producers in particular (Herzfeld et al., 2011). For example, Czubala et al. (2009) find that average compliance costs with product standards as percentage of firm sales exceed 100%. Other non-financial obstacles like financial literacy are also found to constraint farmers to adopt standards (Müller and Theuvsen, 2015). On the other hand, food standards can enhance trade by reducing information asymmetries. The westernization of diets as well as the increasing awareness of modern consumers regarding food safety makes transparent and safe food production processes quasi-mandatory for producers. Furthermore, food standards allow producers of developing countries to enter high value chains. Private food standards in particular allow them to signal and prove high product quality. Thus, standards potentially reduce market failures due to information asymmetries which are more relevant for developing countries (Jaffee and Henson, 2004). If private food standards are found to increase exports of developing countries as well, this would have important policy implications. Since trade is not only welfare-enhancing via lower consumer prices, export sectors are on average also the most competitive sectors in a country. Thus, exporting firms earn on average higher profits, employ a larger number of workers, and pay higher wages than non-exporting firms worldwide (Mayer and Ottaviano, 2007). For example Colen et al. (2012) provide empirical support that this pattern occurs in developing countries as well. In the context of GlobalGAP certification in Senegal, the authors show that exporting firms are important drivers for job creation and productivity spillovers which underlines the potential of private food standards as a development policy tool.

Empirical research results highly depend on the corresponding context like the set of analyzed products, the set of countries, empirical method, and the type of food standard. For example, maximum residue limits (MRLs) as an important public food standard are more often - but not exclusively - found to be trade reducing than other standards (Otsuki et al., 2001; Li and Beghin, 2012). The relevance of the chosen method is also highlighted by Ferro et al. (2015) who create a restrictiveness index of MRLs for 61 importing countries. By applying the two-step Heckman procedure as illustrated by Helpman et al. (2008), the authors find evidence in the first stage that more stringent MRLs reduce the probability to export due to higher fixed costs. However, once the sample selection bias and the share of exporting firms are controlled for, standards have no effect on trade flows. In addition, the first-stage effect is stronger for the BRIC-countries than for non-BRIC countries. Exports from low income countries are more negatively affected by product standards than those from higher income countries. Ceteris paribus, countries export to destination markets which have the lowest fixed costs, i.e. less restrictive MRL standards. The effect of food safety standards on China's exports is also analyzed by Chen (2008) who find a statistically significant negative effect. According to their estimates, the effect is even stronger than imposing tariffs. Further evidence for trade-reducing effects due to more restrictive standards is - among others - also provided by Chen et al. (2006); Yue et al. (2010); Drogué and DeMaria (2012); Melo et al. (2014) who all focus on the effects of MRLs on exports. Wilson et al. (2003) also find that standards affect trade flows negatively, and the authors provide further evidence that the harmonization of standards enhances trade. The article that - among others - continues this debate was written by Anders and Caswell (2009). They argue that the introduction of the Hazard Analysis Critical Control Points (HACCP) food safety standard increases trade exports of leading exporters of seafood and reduces exports of countries with lower exports of seafood. Moreover, developing countries are more likely to experience lower exports as a response to stricter standards than developed countries.

Whereas public standards are set by public authorities and are usually mandatory and legally enforceable, private standards are set by the private sector with a wider scope than only food safety (Schuster and Maertens, 2015). As a result, the effect of private standards on trade is likely to differ from the effect of public standards. Whereas public standards are usually mandatory, private standards are *de-jure* voluntary but often *de-facto* mandatory (Henson and Humphrey, 2010). However, integrating small scale farmers of developing countries into global food export markets requires them to meet private food standards as well which are - like the International Featured Standard (IFS) - often set by large retailers in developed countries. This makes private food standards quasi-mandatory and therefore, an important subject to analyze.

Because of the private nature, data for private standards are more difficult to obtain than for public standards which are often publicly available. As a result, private standards are less frequently analyzed. Using firm-level data of the Peruvian asparagus sector Schuster and Maertens (2015) cannot confirm that BRC, IFS, and other private standards act as catalyst to trade. Although private standards are on average more stringent than public standards (Fulponi, 2006), these have the potential to increase agricultural trade nevertheless. Masood and Brümmer (2014) find that GlobalGAP certification increases banana imports of the European Union. The trade enhancing effect of GlobalGAP certification is also found by Colen et al. (2012) for mango and bean producers in Senegal which have larger export market shares and larger export volumes than non-certified firms. The differential effect of voluntary private standards compared to public standards on trade is also emphasized by Shepherd and Wilson (2013) who find that EU harmonized standards, that are equivalent to ISO norms, can even enhance trade. Eventually, Mangelsdorf et al. (2012) estimate the effect of Chinese public and private standards and also find a trade-enhancing effect which was most pronounced for internationally harmonized standards.

Overall, few studies exist that analyze the effect of private food standards on agricultural trade.

Moreover, studies use either cross-sectional data (Latouche and Chevassus-Lozza, 2015) or are based on data which are limited to specific cases. This certainly questions external validity as emphasized by Beghin et al. (2015). The main challenges are first, the quantification of private standards and hence, data availability. Most studies do not allow to draw general conclusions because they are based on very few products and countries. Second, endogeneity arises as a result of reverse causality. A correct identification of the causal impact requires to distinguish whether it is certification that enhances trade or whether trade increases the likelihood of certification. And thirdly, a correct specification of the empirical framework requires to account for recent developments in the field of gravity modeling which became the workhorse model in empirical trade analysis (Head and Mayer, 2014).

We address these shortcomings with a unique dataset which was obtained via the IFS auditing database. In contrast to previous studies on private standards and trade, the dataset is rich in all dimensions: It contains more than 50,000 audits from about 12,000 companies in 88 countries for seven agricultural product categories including a time-span of six years from 2008 to 2013. Second, we apply a novel instrumental variable approach which we consider to be superior compared to the standard method of taking a one-year lag which is not appropriate if the errors are autocorrelated. Thirdly, we estimate a gravity model via poisson-pseudo-maximum likelihood (PPML) which accounts for high share of zeros and heteroskedasticity (Santos Silva and Tenreyro, 2006, 2011). Furthermore, we apply the Baier-Bergstrand method to address multilateral resistance (Baier and Bergstrand, 2010; Anderson and van Wincoop, 2003). This approach allows us to contribute to the debate whether standards act as barriers or catalyst to trade.

We find that IFS certification as a private standard increases bilateral trade flows in general which illustrates the trade increasing potential of IFS. However, the effect remains only for high- and middle-income countries once we distinguish between income groups. Low income and lower-middle income countries are not found to experience higher exports because of IFS certification. Instead, the effect becomes even negative in the IV-specification. This finding has important policy implications. Although IFS certification does not reduce trade on average, it increases exports from high- and middle-income countries only and does not support - or even harm - the integration of low-income countries into the world trade system.

The remainder of the paper is structured as follows: Section 2 provides a theoretical framework in which we model compliance costs as the major reason for the trade barrier view and - at the same time - standards as a form of quality upgrading which we argue is the channel for the trade catalyst view. Section 3 introduces the IFS as the unique part of our dataset as well as the remaining gravity variables. Section 4 explains the PPML-estimation and the instrumental variable approach in particular including the control-function approach. Section 5 shows the results and Section 6 concludes.

2 When does the barriers- and when the catalyst-story predominates? A theoretical framework

As highlighted by the set of cited articles above, whether standards enhance or reduce trade is highly context-specific. Hence, a theoretical framework is needed which demonstrates when the barriers-to-trade channel and when the catalyst-to-trade channel predominates.

2.1 The Melitz-model

The essential role of fixed costs for production and exports has been emphasized in the "New-trade-theory" as well as in the "New-new-trade theory". Whereas the former is mostly motivated to explain intra-industry trade by implementing product differentiation in a monopolistic competition framework, the latter relaxes the assumption of firm homogeneity by arguing that exporting firms have fundamentally different characteristics than non-exporting firms in terms of productivity, wages, production volumes, and profits (Mayer and Ottaviano, 2007; Colen et al., 2012). We shall use elements of the "New-new-trade theory" of the Melitz model to demonstrate the effect of stricter food standards on bilateral exports (Melitz, 2003).

Melitz introduces firm heterogeneity via the productivity parameter φ. Firms need to pay sunk entry costs f_E to draw their productivity level from a cumulative Pareto distribution $G(\varphi)$. This productivity level determines whether the firm exits the market, serves the domestic market only, or even exports to foreign markets. Production requires fixed costs f_{ii} for serving the domestic market i and incorporates market access costs and fixed production costs. Export costs from country i to country j are denoted by f_{ij}. Hence, profits are given by Equation 1:

$$\pi_{ij}(\varphi) = B_j \tau_{ij}^{1-\sigma} \varphi_{ij}^{\sigma-1} - f_{ij} \tag{1}$$

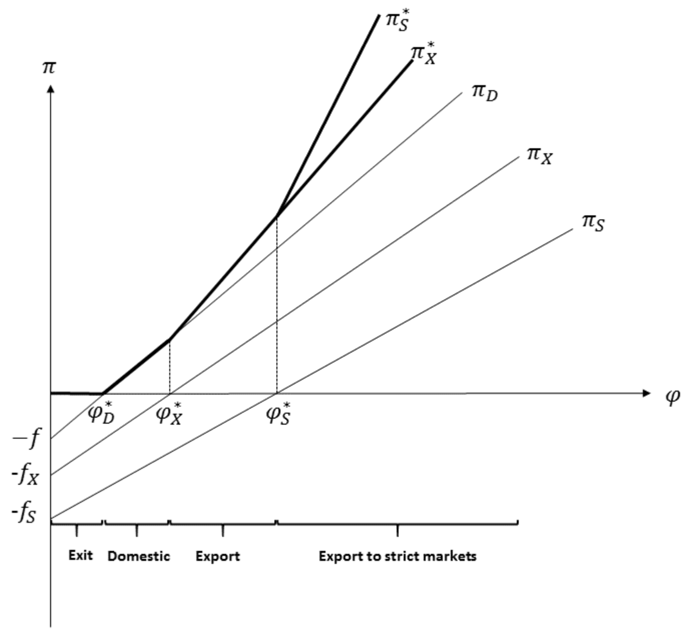
B_j is a demand parameter of the destination market j, τ represents iceberg-type trade costs, and φ is the drawn productivity parameter. σ denotes the constant elasticity of substitution which is assumed to be greater than one. Thus, the zero-profit cutoff condition for exporting from market i to market j yields the cutoff productivity level φ_{ij}^* at which profits are zero, see Equation 2.

$$\pi_{ij}(\varphi_{ij}^*) = 0$$

$$\iff \quad B_j(\tau_{ij})^{1-\sigma}(\varphi_{ij}^*)^{\sigma-1} = f_{ij} \tag{2}$$

In equilibrium, higher fixed costs f_{ij} are associated with higher demand, lower trade costs, or higher productivity for $\sigma > 1$. Figure 2 depicts the relation between fixed costs and various cutoff productivity levels. If the drawn productivity level is below φ_D^*, the firm exits the market; if $\varphi_D^* < \varphi < \varphi_X^*$, the firm produces for the domestic market only but does not export. Once the productivity level exceeds φ_X^*, the firm exports. Note that the slope of the corresponding profit curve π_X is smaller than for π_D due to variable trade costs. Profits for exporting firms are jointly determined by π_D and π_X and given by the bold curve π_X^*.

Figure 2: Profits, productivity, and standards in the Melitz framework.



2.2 New-new-trade theory and food standards

As argued in the introduction, compliance with food standards requires additional fixed costs. Melitz already defines fixed costs broadly as "market access" costs. Therefore, the stricter food standards in the destination market become, the larger are market access costs. Although compliance with food standards might also increase variable costs, e.g. due to more intensive auditing, the implied fixed costs because of investment in modern production technologies are considered as potential barriers to trade. Therefore, we add a firm-specific quality upgrading fixed cost term $f(q_i)$ where q_i is a firm-specific quality parameter for differentiated goods.

However, we implement food standards not only via increased fixed costs of exporting at the supply side but also as a strategy to address preferences of modern consumers at the demand side and hence, as a form of quality upgrading (Ferguson, 2009). Thus, profits also increase in q_i. The zero-profit cutoff condition 2 then changes to:

$$\underbrace{\max}_{q_i} \quad \left[q_i B_j \left(\tau_{ij}\right)^{1-\sigma} \varphi^{\sigma-1} - f(q_i) - f_{ij}\right] \tag{3}$$

We assume that the firm-specific quality upgrading fixed costs $f(q_i)$ are continuously differentiable. That implies that the conformance with a specific quality-level, and hence with specific standard-requirements, is not a binary decision. Instead, an optimal standard can be chosen from a broad continuum of standards. Following Ferguson (2009), we need to specify the functional form of $f(q_i)$. We assume that meeting relatively low levels of standards is a low hanging fruit. However, costs are expected to increase exponentially since it becomes increasingly difficult to meet high levels of standards. Thus, we assume that quality upgrading fixed costs are convex and increase in q_i. Hence, the partial derivative of $f(q_i)$ with respect to q_i increases in q_i.

To be more explicit, we assume the following functional form of $f(q_i)$:

$$f(q) = q^{1/\theta} \quad \text{with} \quad \theta\, \varepsilon\, [0,1] \tag{4}$$

The shape-parameter θ indicates the "ease" of quality upgrading (Ferguson, 2009, p.10). The larger θ is, the easier a firm can address preferences of consumers that demand high-quality products; i.e. products that meet relatively strict standards. Hence, if firms are able to implement standards easily, they will benefit from a lower increase in associated costs which - eventually - require lower levels of demand. Using this specific functional form of the costs of quality-upgrading, the optimal quality-level is then given by:

$$q^* = \left(\theta B_j \tau_{ij}^{1-\sigma} \varphi^{\sigma-1}\right)^{\frac{\theta}{1-\theta}} \tag{5}$$

Keeping B_j, τ_{ij}, and φ constant, higher values of θ increase the optimal level of quality. Thus, if a standard is particularly capable to address consumers' preferences - i.e. high values of θ - producers can earn higher profits by investing in stricter - i.e. high-quality - standards. In this scenario, we would expect standards to increase profits and therefore, increase trade flows at the aggregate level. Contrary, if a particular standard is less capable to address consumers' preferences - θ is close to zero - the quality level remains low and producers are less likely to invest in the standard.

Therefore, it is the nature of θ that determines whether firms comply with standards of importing countries or not. Thus, θ captures the characteristics of the specific standard, which in-turn determine whether trade flows increase or decline in the corresponding context.

In Figure 2, we include fixed costs due to stricter standards as an increase of f_X to f_S. In order to export to markets with relatively strict standards, firms need to draw a productivity level higher or equal to φ_S^*. Hence, stricter food standards in the destination market will result in larger corresponding fixed costs f_S and a higher cutoff productivity level φ_S^*. Figure 2 illustrates that firms which meet strict standards earn higher profits π_S^* than others which reflect the catalyst-perspective. Thus, high-quality products imply higher fixed costs but also higher profits as predicted by Equation 3.

3 Data description

3.1 International featured standard

The increasing complexity of agricultural value chains due to fragmentation and specialization increases the necessity for high transparency within value chains. Retailers need to guarantee the quality and food safety of the products that they sell but which they do not produce themselves. Moreover, to ensure the enforcement of legal contracts it is crucial to have transparent responsibilities at every stage within a value chain. Therefore, the association of the German retail sector HDE[1] found together with the French counterpart FCD[2] the initially named International Food Standard in 2003. The IFS is applicable at every stage of a value chain apart from agricultural raw products. This private standard - today the International Featured Standard - avoids that each retailer is required to test whether their suppliers meet the imposed standards or not. Instead, retailers agreed on the same standards. These standards are continuously modified in collaboration with the retail sector. Hereby, most regulations go beyond usual food safety standards (International featured standard, 2016). The overall objectives are twofold: first, IFS ensures the comparability, transparency, and quality for the consumer within a complete value chain. Second, it aims to reduce costs for the retail sector and their suppliers by harmonizing standards. Apart from the UK, where the British Retail Consortium (BRC) is the most relevant food standard certification body, all major retailers within Europe are member of the IFS.[3] IFS also certifies in other fields like logistics for example.

IFS does not certify products and food manufactures directly but rather via third party certification bodies which take place on average once a year. All retailers that accept the IFS have access to these audit reports of their suppliers via an online data base. In addition, all certified producers have access as well. But apart, access to the data base and information concerning audit reports and other confidential data is not possible.

Moreover, it is not only the availability of IFS data that makes our analysis distinct from previously studies. As a post-farm gate standard, which needs to be distinguished from pre-farm gate standards like GlobalGAP that certify agricultural raw products, IFS certifies processed food. These manufactured food products yield a higher value-added than non-processed food products. Hence, certification with IFS is expected to generate even larger profits gains than other standards (Colen et al., 2012).

Therefore, we consider our data set as unique since it contains the number of certificates per country and product from 2008 to 2013. The number of certification is an indicator for the relevance of IFS within a country. The about 12,000 food manufacturing companies are based in 88 countries including 53 developing countries.[4] The total number of certificates increased from about 4,000 in 2008 to almost 12,000 certificates in 2013. Europe is the major hub of IFS certification, see Figure 3. Numbers increased in Asia and Europe in 2013 in particular. The unequal distribution of IFS with Europe being the most relevant region is displayed in the world map in Figure 6 in Section 4 as well.

Moreover, Figure 4 underlines some regional patterns regarding the correlation with exports and income. Countries with more IFS certification tend to have higher exports with central European countries leading both IFS and exports. Similarly, richer countries have more certified producers on average. Both patterns naturally reflect the dominance of central European countries.

[1]Hauptverband des Deutschen Einzelhandels

[2]Fédération des Entreprises du Commerce et de la Distribution

[3]Metro Group, Edeka, Rewe Group, Aldi, Lidl, Kaufland, Kaiser's Tengelmann, Auchan, Carre-four Group, EMC – Groupe Casino, Leclerc, Monoprix, Picard, Surgelés, Provera (Cora and Supermachés Match), Système U, COOP, CONAD und Unes.

[4]All countries and products including HS classification are listed in the Appendix.

Figure 3: Number of certificates per continent

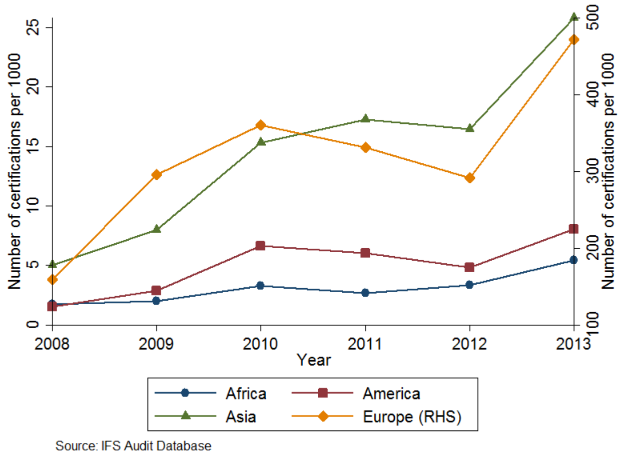
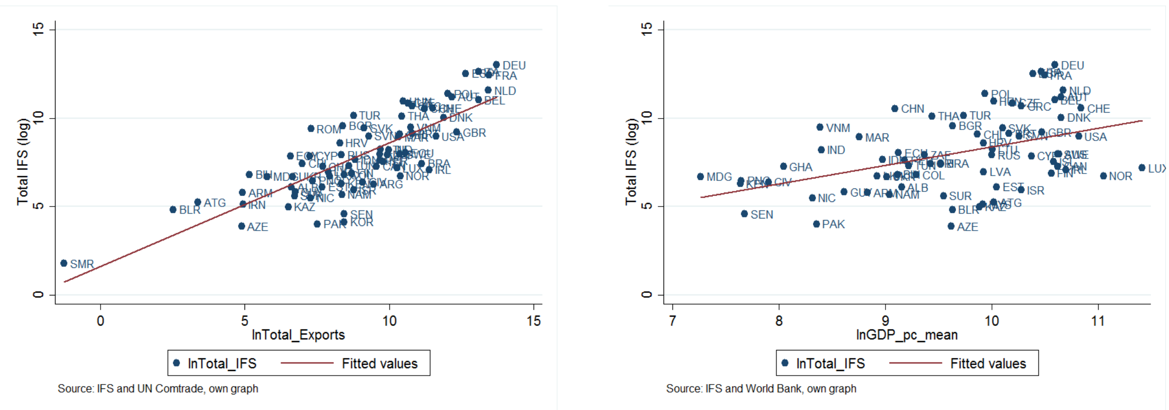


Figure 4: Regional aspects of IFS



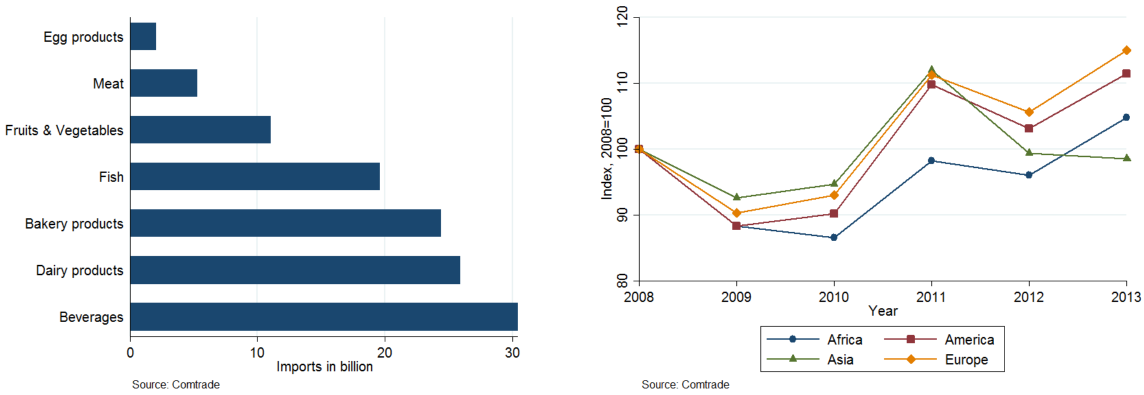
(a) IFS and Exports (b) IFS and per capita income

3.2 Gravity data

Since we are predominantly interested in the effect of IFS as an important private standard on bilateral trade flows, IFS is our main variable of interest. As highlighted by Head and Mayer (2014), the gravity model became the "workhorse model" in empirical trade analysis (see Section 4). The required variables are explained briefly:

Bilateral trade in current US Dollar from UN Comtrade is the dependent variable for seven different product categories: egg products, meat, fruits and vegetables, bakery products, dairy products, and beverages. In addition to total export values per product, Figure 5 also displays the export performance per continent. Hereby, we use an index equal to 100 for the year 2008. Exports declined for all four continents until 2009 due to the economic and financial crisis, peaked in 2011 and mostly increased again for 2013. Asia is the only continent that performed worse in 2013 compared to 2011. Exports overall increased by 11% and Europe is the best performing continent with increasing exports of 15%.

Figure 5: Exports per product and continent



(a) Exports in 2013 per product categories (b) Export performance (2008=100)

The remaining variables are of standard gravity nature: we include the logarithm of GDP in current US-Dollar from the World Bank as proxies for the economic mass of both trading partners. Proxies for trade costs like distance, language, and colony are obtained from CEPII whereas ad-valorem tariffs come from the ITC. Descriptive statistics are provided in Table 1. In total, we use 146,091 observations from which 58% of the deflated export observations are equal to zero.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP_Exporter (WDI, current US-D, logs)	146,091	25.207	1.967	20.563	30.305
GDP_Importer (WDI, current US-D, logs)	148,131	27.520	.843	26.491	28.758
Distance (CEPII, logs)	148,131	8.044	1.085	4.088	9.740
Exports (UN Comtrade)	148,131	4,324.555	29,524.54	0	1,343,673
Exports (UN Comtrade, deflated)	146,091	37.519	263.816	0	12509.41
RTA (CEPII)	148131	.2424611	.4285731	0	1
Language (CEPII)	148131	.0847291	.278479	0	1
Colony (CEPII)	148131	.0332	.180	0	1
Tariff (ITC, logs)	148131	.052	.136	0	1.643
IFS certification (IFS Audit database)	148,131	13.829	52.373	0	694
MGD (planetretail.com %)	136,899	41.067	30.394	0	96.17

4 Model specification

Since IFS was particularly designed of modern retailers and therefore, for high value chains, we expect IFS to have high values of θ - the “ease” to address preferences of modern consumers. Thus, compliance with IFS allows producers to sell their products at high-value markets. We expect IFS to allow producers to make their products distinct from others. This is a crucial difference to public mandatory standards like MRLs since these need to be met in any case. Based on this argumentation, we expect IFS to increase trade. However, compliance costs might still be too high such that developing countries might not be able to benefit from IFS as a an opportunity to gain access to high-value markets. Hence, we expect differential effects of IFS on trade depending on the income level of the country of origin.

4.1 The benchmark specification

The estimation strategy of gravity models in international trade needs to address several empirical challenges. The model needs to account for multilateral resistance (Anderson and van Wincoop, 2003), high share of zeros (Helpman et al., 2008), and heteroskedasticity (Santos Silva and Tenreyro, 2006, 2011) in particular. Country-year fixed effects are frequently used to account for multilateral resistance. However, this approach becomes computationally difficult the larger the data set becomes in terms of countries and years included. Alternatively, Baier and Bergstrand (2010) propose a different method which adjusts all trade cost proxies in such a way that multilateral resistance does not differ across countries. We chose country-, year-, and product fixed effects as our baseline specification as well as the Baier-Bergstrand method. Mainly because country-year fixed effects are computationally difficult but also because multilateral resistance is less likely to change over time during the relatively short time period of five years, we expect country- and year fixed effects to capture multilateral resistance well. Moreover, we estimate a multiplicative gravity model with the Poisson-pseudo-maximum-likelihood (ppml) (Santos Silva and Tenreyro, 2006) which does not require to take logs of the dependent variable and therefore, does not drop zeros. In addition, it is robust to heteroskedasticity which is usually present in trade data. The final model is defined as follows:

$$\begin{aligned} X_{ijpt} =& \exp(\beta_0 + \beta_1 \text{IFS}_{ipt-1} + \beta_2 \text{lnGDP}_{it} + \beta_3 \text{lnGDP}_{jt} + \beta_4 \text{lnDist}_{ij} + \beta_5 \text{lnTariff}_{ijpt} \\ &+ \beta_6 \text{Language}_{ij} + \beta_7 \text{Colony}_{ij} + \beta_8 \text{Contiguity}_{ij} + \beta_9 \text{RTA}_{ijt} + \mu_i + \nu_j + \lambda_t + \upsilon_p)\eta_{ijpt} \end{aligned} \tag{6}$$

X_{ijpt} denotes deflated exports from country i to country j of product p in year t. IFS represents the number of certifications in the exporting country and is the main variable of interest. However, IFS is likely to be endogenous because of reverse causality. Certification might not only increase trade flows due to the beforehand explained reasons. Vice versa, products might be more likely to be certified if trade flows are high. Therefore, in the benchmark specification IFS is introduced as a one-year lag to address partially endogeneity due to reverse causality.

4.2 An instrumental variable approach

Because of the above mentioned reverse causality, we expect IFS to be endogenous. The lag of IFS as an instrument for IFS does not solve the endogoneity problem if the errors are autocorrelated.

$$E\left(\text{IFS}_{ipt}\eta_{ijpt}\right) \neq 0$$

If the one-year lag of IFS was exogenous, it should not be correlated with the error term:

$$E\left(\text{IFS}_{ipt-1}\eta_{ijpt}\right) = 0$$

This argument is based on the assumption that IFS itself is correlated over time but the errors are not. However, in the presence of autocorrelation the one-year lag is not a valid IV:

$$\eta_{ijpt} = \rho_1 \eta_{ijpt-1} + \iota_{ijpt}$$

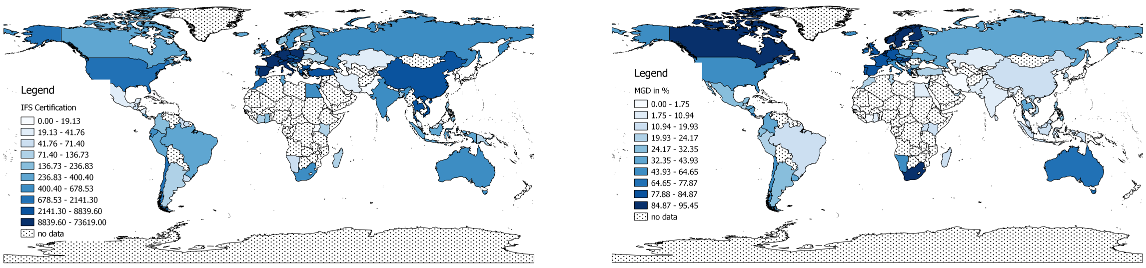
If $\hat{\rho}_1$ is significantly different from zero, the error terms are autocorrelated and the exogeneity assumption of IFS_{ijpt-1} does not hold. If IFS is correlated with the current error term, it is also correlated with it's lag if the errors are autocorrelated. The Wooldridge test for autocorrelation rejects the null hypothesis of no autocorrelation for all usual significance levels. Therefore, an additional identification strategy is required.

Modern grocery distribution

As explained in Section 3.1, IFS were primarily introduced by the retail sector at the end of the food supply chain. This feature makes IFS distinct from other standards like GlobalGAP or Fairtrade. Since retailers were the most dominant drivers of IFS, we assume and observe a correlation between IFS and the relevance of modern food retail companies within a country. If supermarkets play a minor role as a purchasing location for food, incentives for producers to pay for IFS certification are assumed to be weaker compared to countries in which the prevalence of supermarkets is higher. Non-supermarket food-selling institutions like local markets and small stores usually do not require their suppliers to sell certified products. In other words, the more people purchase food products in supermarkets the more products are certified by IFS. We chose modern grocery distribution (MGD) market share as a proxy for the relevance of supermarkets within a country and therefore, as an instrument for IFS.

The correlation between IFS and MGD is equal to 0.29 which indicates that MGD might be a relevant IV for IFS. Figure 6 shows the global distribution of IFS certification and of MGD. IFS is mostly centered in Middle- and Southern-Europe, USA, Chile, and South-East Asia. Data are not available for most African countries. The right-hand side of Figure 6 displays a similar pattern: MGD is higher in Middle- and Norther-Europe and North-America. However, supermarkets seem to be less relevant in South-East Asia and China in particular, but highly relevant in South Africa. Figure 7 underlines the distinct correlation between IFS and MGD as well.[5] Middle- and Souther-European countries are located at the top-right corner indicating the high presence of IFS certification as well as a high relevance of supermarkets compared to other food purchase locations.

Figure 6: Worldwide distribution of IFS and MGD



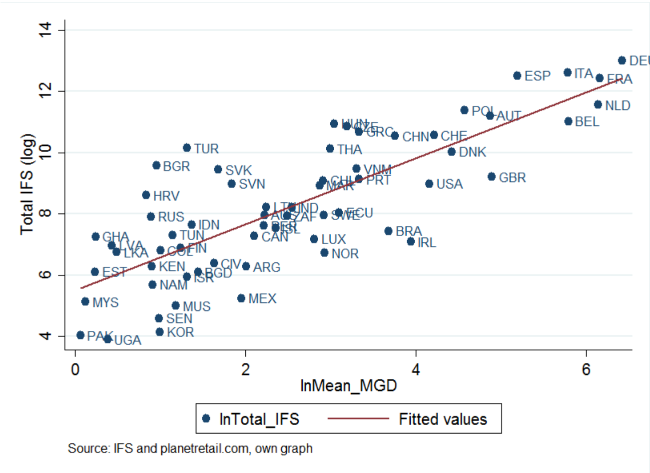
(a) Distribution of IFS

(b) Modern grocery distribution

At the same time, we expect reverse causality between exports and MGD to be absent. We cannot think of a plausible explanation why agricultural exports of country i should increase the domestic relevance of supermarkets. Although the major trading hubs of agricultural exports are North America and Europe, many countries (e.g. Brazil and India) export significant volumes of agricultural products without having high prevalence of supermarkets. Eventually, the exclusion restriction needs to be fulfilled to justify MGD to be a valid IV for IFS. That implies that MGD affects agricultural exports *only* via IFS certification. However, MGD might for example affect exports via income. In fact, MGD and per capita income of the exporting country are correlated by 64% and, by definition of gravity, income as a proxy for the economic size of a country increases exports. Nevertheless, we consider MGD to be a good instrument by keeping its weakness in mind.

[5]Note that we took the log of IFS and of the mean of MGD. We dropped observations of MGD below one percent since the logarithm would be negative for those.

Figure 7: Strong correlation between IFS and MGD



The control-function approach

We modify our estimation strategy of Section 4.1 by including an instrumental variable via the "control function approach" as proposed by Wooldridge (2010) and Martinez-Zarzoso (2015).

IFS is the endogenous variable whereas the vector Z denotes all exogenous variables from which Z_1 is a sub-vector. These are the standard gravity variables like GDP, distance and other trade cost proxies

$$X_{ijpt} = \mathbf{Z}_1\delta_1 + \alpha_1 \mathrm{IFS}_{ipt} + u_{ijpt} \tag{7}$$

The exogeneity assumption can be expressed as follows:

$$E(Z_1'u) = 0 \tag{8}$$

Consequently, the reduced form for IFS is:

$$\mathrm{IFS}_{ijpt} = \mathbf{Z}\pi_2 + \epsilon_{ijpt} \tag{9}$$

where Z includes Z_1 as well as MGD as an instrument. The residuals $\hat{\epsilon}_{ijpt}$ of this first stage regression are needed for the linear projection of the residuals of Equation 7 u_{ijpt} on these residuals of the first stage ϵ_{ijpt}.

$$u_{ijpt} = \rho_2\epsilon_{ijpt} + \phi_{ijpt} \tag{10}$$

Ultimately, we plug Equation 10 into Equation 7 to obtain the final control function:

$$X_{ijpt} = \mathbf{Z}_1\delta_1 + \alpha_1 \mathrm{IFS}_{ijpt} + \rho_2\epsilon_{ijpt} + \phi_{ijpt} \tag{11}$$

If the estimate $\hat{\rho}_2$ is significantly different from zero, we can conclude that IFS is actually endogenous. If IFS was exogenous, there would not be any variation within the reduced form residuals that explain variation of exports in the control function because variation of IFS is completely explained by the vector of exogenous variables Z.

5 Results

This section present estimation results of three different models: first the ppml-estimation in columns one and two in Table 2 based on Equation 6. Second, we estimate the IV-model and present results in columns three, four, and five in Table 2. Table 3 presents IV estimation results which are based on subsets separated by income.

The results of the first two columns only differ in the way how multilateral resistance is controlled for. The first column uses country-, year-, and product fixed effects whereas results of the second column are based on the Baier-Bergstrand approach combined with product fixed effects. Both use the one-year lag of IFS certification. Overall, IFS increases exports on average *c.p.* by 64.38% and 76.4% respectively[6]. GDP increases trade on average *c.p.* in the second specification. The magnitudes smaller than unity are in-line with the ppml-literature in which estimates for GDP are smaller and not close to unity as it is often the case for linear estimation techniques. However, GDP estimates are not statistically significant which might reflect the imperfect way of controlling for multilateral resistance.[7] This might also explain the high magnitude of tariffs in the first specification. Other estimates are as expected and similar for both specifications: same language, colonial history, common border, and regional trade agreements increase bilateral trade *c.p.* on average.

Column three contains results of Equation 7 and column four of the first-stage Equation 9. IFS increases now in magnitude and remains statistical significant. Estimates of GDP and distance are similar to the non-IV specification. The first stage reveals that MGD is indeed relevant for IFS since the coefficient is positive and statistical significant. However, it remains relatively small. Column five contains the estimate ρ_2 of the control function of Equation 10. A statistical significant estimate indicates that IFS is indeed endogenous.

We now turn to the results of Table 3 which distinguishes country groups by income. Countries are grouped according to the World Bank income categories high income, low income, lower middle income, and upper middle income. As discussed previously, the effect of standards on trade is often found to depend on income of the exporting country because meeting strict standards of the importing country requires to pay high costs of compliance. Therefore, we expect the positive effect of IFS on trade to remain for the high income group, but to reverse for the low income group.

Columns one, four, seven, and ten contain estimates of the standard ppml-specification with the one-year lag of IFS. Hereby, the Baier-Bergstrand approach was used to control for multilateral resistance. The coefficient of interest is strictly positive and statistical significant for all three higher income categories. However, it loses its statistical significance for the low income group. Thus, either low income countries are not expected to export more on average *c.p.* if they increase certification or the effect is due to the reduced number of observations from more than 32,000 to about 2,000. Similarly, IV estimates for the highest three income groups in columns two, eight, and eleven are large in magnitude, statistical significant, and strictly positive. The size of the coefficient is about half as high as for the lower middle income group than for the high income and the upper middle income group. Interestingly, the sign of the coefficient switches from positive to negative for the low income group. In other words, whereas IFS is not statistical significant in this group in the non-IV specification, it becomes statistical significant *and* negative in the IV model. The first-stage columns three, six, nine, and twelve reveal that MGD is always a relevant IV.

[6] The effect is computed as $e^{(\beta-1)*100}$ where β is the coefficient of interest.

[7] Ideally, country-year fixed effects are used instead of separate country- and year-fixed effects. However, the `ppml` and `poi2hdfe` estimation did not converge because of too many fixed effects. Moreover, we expect multilateral resistance to be constant over the relatively short time period.

Table 2: Results of ppml estimation

VARIABLES	(1) ppml - no IV	(2) ppml - no IV	(3) IV	(4) First stage	(5) c_IFS
IFS_lag	0.497***	0.568***			
	(0.026)	(0.014)			
lnGDP_Importer	-0.747	0.731***	0.836***	-0.019***	
	(1.362)	(0.023)	(0.025)	(0.006)	
lnGDP_Exporter	-0.666	0.385***	0.319***	0.367***	
	(0.559)	(0.014)	(0.034)	(0.003)	
lnDist	-0.361***	-0.861***	-0.873***	0.009	
	(0.056)	(0.054)	(0.044)	(0.021)	
lnTariff	-1.364***	-0.741***	0.444	-0.440***	
	(0.188)	(0.149)	(0.441)	(0.050)	
Language	0.837***	0.735***	0.048	-0.024	
	(0.070)	(0.066)	(0.099)	(0.035)	
Colony	0.387***	0.208**	0.592***	0.002	
	(0.099)	(0.095)	(0.096)	(0.032)	
Contiguity	0.387***	0.251***	0.757***	0.019	
	(0.073)	(0.068)	(0.070)	(0.032)	
RTA	0.081	1.400***	0.576***	-0.007	
	(0.103)	(0.112)	(0.071)	(0.030)	
D_Bakery	0.279***	0.249***	-0.269***	0.038	
	(0.057)	(0.059)	(0.091)	(0.033)	
D_Beverages	0.630***	0.554***	0.944***	-0.667***	
	(0.062)	(0.063)	(0.100)	(0.032)	
D_Dairy	0.951***	1.006***	0.643***	-0.074**	
	(0.065)	(0.067)	(0.099)	(0.035)	
D_Egg	0.379**	0.530***	0.782***	-0.790***	
	(0.155)	(0.151)	(0.162)	(0.040)	
D_F&V	-0.602***	-0.673***	-0.521***	-0.036	
	(0.057)	(0.060)	(0.098)	(0.033)	
D_Fish	0.219***	0.371***	1.195***	-0.148***	
	(0.063)	(0.059)	(0.102)	(0.032)	
IFS			1.132***		
			(0.065)		
MGD				0.015***	
				(0.000)	
Constant	36.128	-28.450***	-30.974***	-7.779***	-0.602***
	(37.217)	(0.761)	(0.916)	(0.196)	(0.062)
Observations	59,458	59,458	69,741	69,741	69,741
R-squared	0.267	0.230			
Country FE	Yes	No	No	No	No
Year FE	Yes	No	No	No	No
Product FE	Yes	Yes	Yes	Yes	Yes
Baier-Bergstrand	No	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: PPML results with and without IV by income group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	High Income			Low Income			Lower Middle Income			Upper Middle Income		
VARIABLES	No IV	IV	1^{st} stage	No IV	IV	1^{st} stage	No IV	IV	1^{st} stage	No IV	IV	1^{st} stage
IFS_lag	0.513***			-0.522			0.445***			0.242***		
	(0.0155)			(0.440)			(0.0387)			(0.0762)		
lnGDP_Importer	0.726***	0.889***	-0.0308***	0.530***	2.030***	0.00134	0.825***	0.833***	0.00114	0.680***	1.048***	0.000163
	(0.0256)	(0.0514)	(0.0104)	(0.151)	(0.207)	(0.0121)	(0.0542)	(0.0711)	(0.0126)	(0.0885)	(0.0957)	(0.0105)
lnGDP_Exporter	0.417***	-1.610***	0.519***	1.222***	2.021***	-0.240***	0.196***	-0.0441	0.277***	0.405***	0.0524	0.0958***
	(0.0146)	(0.268)	(0.00617)	(0.296)	(0.466)	(0.0118)	(0.0343)	(0.0606)	(0.00577)	(0.0635)	(0.195)	(0.00442)
lnDist	-0.835***	-0.927***	0.0144	3.659*	8.639***	0.0109	-1.388***	-2.016***	-0.00416	-0.627***	-2.073***	-0.000132
	(0.0533)	(0.101)	(0.0218)	(2.013)	(2.023)	(0.113)	(0.354)	(0.574)	(0.0466)	(0.241)	(0.465)	(0.0509)
lnTariff	-1.139***	-0.549	-0.289***	2.134	1.282	-0.865***	0.152	2.776***	-0.679***	2.420***	4.800***	-0.423***
	(0.193)	(0.392)	(0.0704)	(3.906)	(2.278)	(0.160)	(0.417)	(1.005)	(0.0847)	(0.707)	(1.573)	(0.0752)
Comlang_ethno	0.741***	0.288	-0.0342	-3.470*	1.862***	-0.0246	-0.301	0.427*	-0.00668	-0.365	-0.508	0.00448
	(0.0658)	(0.182)	(0.0412)	(2.088)	(0.614)	(0.0339)	(0.402)	(0.255)	(0.0479)	(1.538)	(0.685)	(0.0891)
Colony	0.0907	0.255	-0.00477	3.622	1.702***	0.0238	0.439***	0.949***	0.00183	1.143***	0.454	-0.000567
	(0.103)	(0.216)	(0.0492)	(2.257)	(0.543)	(0.0464)	(0.155)	(0.171)	(0.0435)	(0.341)	(0.325)	(0.0431)
Contig	0.241***	0.551***	0.0295	7.526	57.87***	0.0386	7.658***	12.71***	0.0105	3.899	11.95***	-0.0164
	(0.0679)	(0.145)	(0.0314)	(4.760)	(6.659)	(0.362)	(2.580)	(2.097)	(0.401)	(3.200)	(2.688)	(0.339)
RTA	1.369***	0.657***	0.0255	-11.07***	-7.624***	-0.0921	-3.010***	-3.000***	-0.144	-1.132***	-1.709**	-0.0358
	(0.114)	(0.151)	(0.0325)	(1.996)	(1.507)	(0.0943)	(0.580)	(0.569)	(0.107)	(0.199)	(0.722)	(0.0653)
D_Bakery	0.330***	-0.192	0.0607				-1.406***	0.140	-0.498***	-2.597***	-1.306***	0.00772
	(0.0595)	(0.204)	(0.0461)				(0.220)	(0.304)	(0.0479)	(0.260)	(0.325)	(0.0526)
D_Beverage	0.563***	3.714***	-0.757***	-2.207***	-3.430***	-0.122***	-1.561***	0.184	-0.693***	0.0879	4.123***	-0.605***
	(0.0643)	(0.436)	(0.0452)	(0.453)	(0.431)	(0.0192)	(0.260)	(0.323)	(0.0506)	(0.247)	(1.194)	(0.0461)
D_Dairy	1.022***	1.331***	-0.122***				-7.855***	-5.076***	-0.717***	-2.190***	2.276***	-0.273***
	(0.0679)	(0.222)	(0.0461)				(0.454)	(0.674)	(0.0507)	(0.519)	(0.655)	(0.0556)
D_Egg	0.451***	5.016***	-1.086***							-1.892***	-16.76	-1.243***
	(0.153)	(0.602)	(0.0486)							(0.432)	(0)	(0.0458)
D_F&V	-0.594***	0.211	-0.245***	-0.458	-1.984***	0.00837	-0.966***	-1.195***	0.552***	-1.614***	0.231	-0.138***
	(0.0625)	(0.259)	(0.0474)	(0.408)	(0.309)	(0.0182)	(0.228)	(0.252)	(0.0498)	(0.258)	(0.395)	(0.0488)
D_Fish	0.275***	3.472***	-0.659***				0.632***	0.374	0.738***	-0.135	1.154***	0.00171
	(0.0657)	(0.390)	(0.0442)				(0.229)	(0.253)	(0.0490)	(0.238)	(0.294)	(0.0468)
IFS		4.649***			-4.809***			2.312***			5.525***	
		(0.497)			(1.761)			(0.212)			(1.971)	
MGD			0.00454***			-0.0116***			0.0244***			0.00127***
			(0.000498)			(0.00139)			(0.000797)			(0.000243)
Constant	-28.91***	8.538	-10.43***	-42.27***	-100.3***	6.168***	-25.71***	-22.85***	-6.553***	-26.69***	-35.02***	-1.365***
	(0.825)	(5.445)	(0.326)	(8.337)	(13.62)	(0.438)	(1.696)	(2.243)	(0.384)	(2.222)	(3.800)	(0.313)
Observations	32,382	39,039	39,039	2,142	2,436	2,436	10,605	12,523	12,523	14,329	15,743	15,743
R-squared	0.221			0.072			0.111			0.029		

Robust standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

6 Conclusion

The analysis contributes to the debate of "standards-as-catalyst vs. standards-as-barriers to trade" by first, embedding the gravity approach with an innovative instrument into a theoretical framework that addresses key elements of the debate. Second, we use a data set that contains unique data of the private standard IFS.

Most studies in the field of food standards and agricultural trade are either based on public standards or on a specific case. Analyses using data of private standards are relatively rare and are often case-specific as well.

Based on the Melitz-idea we model the barriers-view by including additional fixed costs of compliance depending on the type of the standard. We combine this approach with parts of the quality-upgrading literature and argue that compliance with private standards like IFS increases the demand for this particular product due to higher quality which reflects the catalyst-view. Eventually, we derive the optimal level of quality which mainly depends on a standard-specific parameter θ which denotes the "ease" of addressing preferences of modern consumers.

We estimate two different empirical specification both the ppml-estimator and the Baier-Bergstrand method to control for multilateral resistance: the first uses the one-year lag of IFS to address reverse causality and the second uses modern grocery distribution as an instrument for IFS. For both models, we find a positive as well as statistical and economic significant effect of IFS on exports. However, once we separate the dataset by income, the effect only remains for high- and middle-income countries and even turns negative in the IV-specification for low-income countries.

Overall, in contrast to most studies about the effect of *public* standards on trade these results underline the potential of trade-enhancing effects of *private* standards. However, standards as such are not a sufficient development tool to integrate low-income countries into the world trade system unless these are accompanied by additional measures like reducing compliance costs.

Future research is required to complement these results of the country-perspective with those at the food-processing firm level in low-income countries. Moreover, the type of compliance costs needs to be addressed since these might consist of a financial as well as of a non-financial component.

Appendix

Table 4: Products

Product group	HS Code	HS Description
Bakery products	1704	Sugar confection
	1806	Chocolate & other food products containing cocoa
	1901	Malt extract, food preparations of flour etc.
	1902	Pasta, prepared or not, couscous
	1903	Tapioca and substitutes from starch in flakes, etc.
	1904	Foods prep by swell cereal, cereal n.e.s.o.i.
	1905	Bread, pastry cakes etc.
Beverages	2009	Fruit juices (& grape must), vegtables juice, no spirit
	2201	Water, natural etc., not sweetened etc., ice & snow
	2202	Water, sweetened & other non-alcoholic beverages n.e.s.o.i.
	2203	Beer made from malt
	2204	Wine of fresh grapes, grape must n.e.s.o.i.
	2205	Vermouth & other wine of fresh grapes with specific flavor
	2206	Fermented beverages n.e.s.o.i. (cider, berry, mead)
	2207	ethyl alcohol, un-denatured, n/un 80% alcohol, alcohol, denatured
	2208	ethyl alcohol, un-denatured, 80% alcohol, spirit beverages etc.
Dairy products	401	Milk and cream, not concentrated or sweetened
	402	Milk and cream, concentrated or sweetened
	403	Buttermilk, yogurt, kephir etc.
	404	Whey & milk products n.e.s.o.i.
	405	Butter and other fats and oils derived from milk
	406	Cheese and curd
Egg products	407	Birds' eggs, in the shell, fresh preserved or cooked
	408	Birds' eggs, not in shell &yolks, fresh dry, etc.
Fruits and vegetables products	2001	Vegetable, fruits, nuts, etc.
	2002	Tomatoes prepared or preserved n.e.s.o.i.
	2003	Mushrooms & truffles prepared or preserved n.e.s.o.i.
	2004	Vegetables n.e.s.o.i. prepared or preserved, frozen
	2005	Vegetables n.e.s.o.i. prepared or preserved, not frozen
	2006	Fruit/nuts/fruit-peel etc., preserved by sugar
	2007	Jams, fruit jellies, marmalade etc., cooked
	2008	Fruit, nuts etc., prepared or preserved n.e.s.o.i.
Fish products	303	Fish, frozen (no fillets)
	304	Fish fillets, other fish, fresh, chill or frozen
	305	Fish, dried, salted etc., smoked
	306	Crustaceans, live, fresh, cooked
	307	Mollusks, aquatic invertebrates n.e.s.o.i.
	1604	Prepared or preserved fish, caviar & caviar substitutes
	1605	Crustaceans and mollusks prepared or preserved
Meat products	1601	Sausages, similar prepared meat
	1602	Prepared or preserved meat, meat offal & blood n.e.s.o.i.

Table 5: Importing and exporting countries

Importing countries									
Austria		Belgium		France		Germany		Italy	
Netherlands		Switzerland							
Exporting countries									
Europe				**Africa**		**America**		**Asia**	
Albania	2	Latvia	1	Ivory Coast	3	Antigua and Barbuda	2	Armenia	3
Austria	1	Lithuania	2	Egypt	3	Argentina	2	Australia	1
Belarus	2	Luxembourg	1	Ghana	4	Brazil	2	Azerbaijan	2
Belgium	1	Macedonia	2	Kenya	4	Canada	1	Bangladesh	4
Bosnia Herzegovina	2	Netherlands	1	Madagascar	4	Chile	2	China	3
Bulgaria	1	Norway	1	Mauritius	2	Colombia	2	India	3
Croatia	1	Poland	1	Morocco	3	Costa Rica	2	Indonesia	3
Cyprus	1	Romania	2	Namibia	2	Ecuador	3	Iran	2
Czech Republic	1	San Marino	1	Senegal	3	Guatemala	3	Israel	1
Denmark	1	Slovakia	1	Seychelles	2	Guyana	3	Kazakhstan	2
Estonia	1	Slovenia	1	South Africa	2	Honduras	3	South Korea	1
Faeroe Island	1	Spain	1	Tunisia	3	Mexico	2	Malaysia	2
Finland	1	Sweden	1	Uganda	4	Nicaragua	3	Pakistan	3
France	1	Switzerland	1	Peru	2			Papua New Guinea	3
Germany	1	Turkey	2	Suriname	2			Philippines	3
Greece	1	Ukraine	3	United States	1			Russia	2
Hungary	1	United Kingdom	1	Uruguay	2			Sri Lanka	3
Iceland	1							Thailand	3
Ireland	1							United Arab Emirates	1
Italy	1							Vietnam	3

Notes: numbers after country-names refer to income groups of the World Bank: (1) High income, (2) Upper middle income, (3) Lower middle income, (4) Low income

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