Trade Margins, Price, and Product Quality Adjustments to Non-Tariff Measures: Evidence from French Firms*

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Abstract

The paper tests whether the "quality"-focused non-tariff measures, such as technical barriers to trade (TBT) measure or sanitary and phytosanitary (SPS) measures, are trade-distorting and quality-improving. We first develop a firm-based trade model with information asymmetry on product quality. We show that the enforcement of a minimum quality standard intended to solve the asymmetric information problems induces the exit of low-quality and low-productivity firms. However, it also causes the exit of some high-quality firms because of a reallocation of demand from low-productivity to high-productivity low-quality firms. Thus, the effect of stricter quality standards on average quality of products is ambiguous. Then, using French data at the firm-product level, we study the impact of SPS and TBT measures on export decisions of firms (participation, export values and price) and average quality of products. We find that both SPS and TBT measures force low-productivity firms to exit. We also show that more SPS measures (resp. TBT measures) raise the market share of high-productivity firms at the expense of low-productivity incumbents and average quality of products in the food industry (resp., in the manufacturing industries).

JEL Codes: D21, D22, F12, F14, Q17
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1 Introduction

We study the impact of non-tariff measures (NTMs) on export decisions of firms (participation, export values and price) and average quality of products. Globalization has increased interdependencies between countries and therefore the need for effective regulation. The enforcement of minimum quality standards such as SPS and TBT measures allows governments to guarantee the absence of negative externalities (to protect, for example, human health, human safety, and environment). By enforcing these measures, governments specify requirements for both the production process ("process standards") and the final good ("product standards"). For example, national governments set minimum energy efficiency standards for many household appliances, or a maximum amount of pesticide residues that is acceptable for food products, or require that motor vehicles be equipped with airbags and anti-lock braking systems. As they must be fulfilled by all products marketed in a country whether of national or foreign origin, standards do not discriminate *ex-ante*. However, they may discriminate *ex-post*.

While NTMs that are "quality"-focused can be viewed as welfare-improving tools by addressing market failures such as information asymmetry on product quality (Leland, 1979; Ronnen, 1991; Crampes and Hollander, 1995), they may also induce distortions, being regarded as non-tariff barriers (Das and Donnenfeld, 1989). Consumers may be worse off as a result of the introduction of a public standard because their favorite varieties have been excluded from the market or the prices of the remaining varieties have gone up (Gaigné and Larue, 2016).

The impact of public standards on trade has received considerable attention and, in most cases, it has been shown that they negatively affect trade (Andriamananjara et al., 2004; Disdier et al., 2008; Hoekman and Nicita, 2011; etc.). Nevertheless, the bulk of evidence comes from macroeconomic trade models, based on aggregate trade flows. Although very informative, these studies fail to capture microeconomic effects and disregard the quality effects. In contrast, relatively little attention has been paid to the impact of SPS and TBT measures on individual producers and on the distribution of market share, price, and product quality.

In this paper we develop a firm-based trade model to study the effects of minimum quality standards on both the extensive (i.e. presence on the export market) and the intensive (i.e. export values, prices, the distribution of exports due to changes in public standards) margins of trade. Then, we test our predictions empirically.

The model incorporates the following major ingredients. First, we assume information asymmetry on product quality, meaning that producers know exactly the quality of their products, whereas consumers only know the average quality of products available in the market ("lemons problem" popularized by Akerlof, 1970). Second, firms are characterized by their productivity and the quality of their product, which are both exogenous and sell varieties which are horizontally and vertically differentiated. Third, in order to correct market failures associated with information asymmetry, governments impose minimum quality standards that have to be met by all products marketed in the domestic market, whether they are manufactured domestically or abroad.

More specifically, in our model, firms produce under monopolistic competition and, as already mentioned, they are featured by their productivity and the quality of their variety, both exogenously drawn from a bivariate distribution. Firms' variable cost of production increases with quality for a given productivity and decreases with productivity for a given quality. To be able to diffuse their products, firms are confronted with fixed and variable distribution costs which are destination-specific. Fixed distribution costs also increase with quality, since firms need to invest in new equipment, train labor and make adjustments in their production process before producing a single unit of a higher-quality good. Variable distribution costs increase with quality and trade costs and decrease with firm productivity. As a consequence, the marginal cost and, therefore, the price set by a firm for each market also increase with quality and trade costs and decrease with firm productivity.

It follows that the profit and the sales of a firm increase with productivity and the average quality prevailing in the destination market. However, the sales of high-productivity firms increase with average quality more than the sales of low-productivity firms. In this asymmetric information setting, consumers do not know the exact quality of a product, but only the average quality. Therefore, the sales of a firm selling high-quality products are lower than they would be under no asymmetric information and there is a maximum quality for a given productivity above which it is not profitable to serve the destination market. As a consequence, some high-quality products are withdrawn from the market. In this setting, the enforcement of a minimum quality standard by the government is meant to correct the market failure induced by information asymmetry. If a minimum quality standard is adopted, all products marketed in a country, whether domestic or foreign, must comply with it. Consumers know the minimum quality of products present on the market and make their choices accordingly.

Our model leads to theoretical predictions concerning the effect of public quality standards on both the extensive and the intensive margins of trade. First, we show that the enforcement of a minimum quality standard by the government may force some low-quality firms out of the market, as they are not able to keep up with the new regulations. More precisely, standards will induce the exit of both low-productivity and high-productivity low-quality firms. However, high-quality high-productivity firms cease also to serve the country with a stricter minimum standard. Hence, we document a negative impact of minimum quality standards on the extensive margin of trade and an ambiguous effect on average quality of products delivered by firms. The intuition is the following. By exiting low-quality firms from the domestic market, a stricter minimum quality standard makes competition tougher among incumbent firms and induces a reallocation of demand from low-productivity to high-productivity ones supplying a quality just above the minimum quality. For a given productivity, the incumbent firms providing the lowest quality have the highest market shares because they set the lowest price (due to lowest marginal costs) and the consumers make their choice based on average quality. We document a positive effect of standards on incumbent firms' export sales and, even more so, for the most productive firms. The adoption of a minimum quality standard raises prices if the average quality of products available in the market increases. When firm productivity is taken into account, we expect prices to decrease for high-productivity firms.

Next, we proceed to the empirical assessment of the main predictions derived from our model. We consider two databases. We first focus on the food industry because SPS and TBT measures play a prominent role in this industry as food products may often be affected by epizootics, bacterial contamination and because food standards have become important dimensions of trade agreements.[1] We then consider the manufacturing industries where TBT measures play a tremendous role (while SPS measures concern mainly the food industry).

Relying on the most recent and comprehensive dataset, we analyze both types of public quality standards: SPS measures and TBTs. As the motivation behind the use of each category of standards is different, it may induce different trade effects. For instance, SPS measures are meant to protect human, animal or plant life or health. Thus, consumers may show a greater appreciation for products affected by SPS measures even though they lead to an increase in price. On the other hand, TBT measures mainly refer to packaging regulations, labeling requirements, and technical specifications. Consumers are less sensitive to these motivations, that is why they might negatively react to an increase in price induced by these measures. Taking into account these aspects, we consider the two categories of public quality standards separately.

This dataset on public quality standards is matched with product/firm-level export data and other firm-level characteristics for France. We then conduct estimations to assess the effect of SPS and TBT measures on both the extensive and the intensive margins of trade for individual French exporters. We also analyze the reallocation effect from less productive to more productive firms. We control for other traditional trade policy instruments and tariffs imposed in the destination markets, as they may also impact the exports of the French firms. By introducing different combinations of fixed effects at the firm, product and firm level, we take into account all the other unobservable factors with a potential effect on the exports of French firms. As predicted by

[1] In addition, our theoretical setting fits well with the characteristics of the food industry. First, the food industry encompasses a large number of firms which operate under imperfect competition. Second, firms differ in terms of their productivity and supply vertically differentiated products.

the model, we find a negative effect of SPS and TBT measures on the extensive margin of trade. Thus, the presence of a firm into a certain product-destination market pair is discouraged by public quality standards such as SPS and TBT measures. However, the high-productivity firms have a higher participation into a certain product-destination market pair with SPS and TBT measures. As for the intensive margin, we show that the export value of incumbent French firms increases with SPS measures, as predicted by the theoretical model. The previous result is not confirmed for TBT measures. This highlights the importance of analyzing SPS and TBT measures separately. We also show empirically that export sales increase more for highly-productive French firms, due to a reallocation of demand from the less productive firms towards them. When it comes to prices, we focus on quality-adjusted prices and on average quality of products delivered by firms set up in France. We show that SPS measures induce a positive effect on average quality of products and quality-adjusted prices in the food industry while TBT measures have the same effects in the manufacturing industry. However, the price effects of SPS and TBT measures are lower for the more productive firms.

Literature Review

This paper contributes to the literature on the relationship between quality and trade at the firm level by considering information asymmetry between buyers and sellers as in Akerlof (1970). Building on Melitz (2003) framework, several models have considered vertical differentiation to explain the quality-sorting found in international trade. Baldwin and Harrigan (2011) introduce a taste for quality in a typical Melitz (2003) model where the competitiveness of firms is determined by their quality-adjusted prices. Then, the higher quality products are more costly and profitable, being able to enter more distant markets. Therefore, high quality firms are the ones that are the most competitive, heterogeneous quality increasing with firms' heterogeneous cost. Kugler and Verhoogen (2012) introduce in the typical Melitz (2003) framework an intermediate input sector which is assumed perfectly competitive, but quality differentiated. The model implies endogenous choice of input and output quality. The authors show that larger and more productive firms buy higher-quality and higher-price inputs and sell higher-quality products, charging higher prices. In a nutshell, these papers show that under no asymmetric information and endogenous product quality, the more productive firms specialize in higher quality products. In contrast, our paper assumes an exogenous draw of the firm productivity and the product quality from a bivariate distribution, like in Hallak and Sivadasan (2013). Hence, a high-productivity firm can produce a low-quality product or a high-quality product. In addition, we consider asymmetric information on product quality. Consumers cannot perfectly judge product quality even after consumption.

This paper is also related to both the theoretical and empirical literature on public quality standards and trade at the firm level. On the theoretical side, our paper is close to Gaigné and Larue (2016). They introduce vertical differentiation in an international trade model à la Melitz (2003) to study the effects of minimum quality standards. In this framework exporters need to fulfill the standards imposed in the destination market. In order to comply with standards, they need to pay two fixed costs, but also a variable cost which is assumed to increase with the quality of products. In their setting, there is no asymmetric information and product quality is endogenous. Compared to their study, we introduce information asymmetry and exogenous product quality. Under information asymmetry, the effect of a stricter minimum quality standard on average quality is ambiguous and the winners are high-productivity firms supplying a variety with a quality just above the minimum quality.

On the empirical side, several papers have explored the effect of public quality standards on the individual firms. Chen et al. (2008) analyze how complying with TBT measures imposed by the foreign countries affects firms' export performance in developing countries. They document a negative effect of standards and technical regulations on firms' export propensity. The value of exports is reduced by these measures. Standards and technical regulations also have a negative effect on the diversification of markets by a firm, meaning that the likelihood to export to a large number of markets is reduced. Reyes (2011) focuses on the effect of standards harmonization on individual firms rather than on the effect of product standard heterogeneity at the firm level.

He shows that product harmonization in the electronic sector between the European Union and the United States induces an increase in the US exports to the EU. This effect is due to an increase in the number of firms that penetrate the European market. These firms are already exporters to other destinations and are smaller and less productive than the incumbent firms in the European market. Fontagné et al. (2015) analyze the effect of restrictive SPS measures (proxied through specific trade concerns) on the exports of French firms. They show that SPS concerns dampen the presence of French exporters in the SPS-imposing destinations. They also find a negative effect of SPS concerns on the intensive margin of trade, namely the value of exports. However, these negative effects dissipate for larger firms. Fernandes et al. (2015) explore the effect of pesticide standards on firms' export decisions in several developing countries. When standards are more restrictive in the importing compared to the exporting country, both the probability of exporting and the export values and quantities are reduced. Smaller exporters appear to be more affected in their exporting decisions, compared to the larger ones. All these studies focus on a single type of public quality standards: either SPS, TBT or a sub-category of SPS or TBT measures. In contrast, our study considers both categories of standards, since their effect on heterogeneous exporters may be different, as previously mentioned. Consumers may show higher levels of appreciation for products affected by SPS measures compared to products affected by TBT measures, which may translate differently into the exports of French firms. Further, we study the price effects and quality effects of these non-tariff measures. Moreover, we rely on the most recent and comprehensive dataset on NTMs which includes both quality measures and more traditional trade policy instruments. A limit of the database is linked to the fact that it presents the landscape of NTMs at a particular point in time. Therefore, we are not able to exploit the time dimension and we conduct a cross-section analysis.

2 Theory

We develop in this section a trade model with heterogeneous firms and information asymmetry on product quality. We consider a single period of production, but we can easily extend our framework to multiple periods by assuming an exogenous probability about the survival of firms as in Melitz (2003). The objective of this section is to provide the microeconomic foundations of the impact of minimum quality standards on trade, prices and average quality of products delivered by firms when consumers cannot identify the quality of each product whereas sellers have specific information about their product. Hence, as in the classic asymmetric-information setting (Akerlof (1970)'s market for lemons), we study the properties of market outcomes in the presence of adverse selection in a global economy.

2.1 General Assumptions and Results

We consider an imperfectly competitive sector producing (horizontally and vertically) differentiated products under increasing returns. In our setting, information asymmetry occurs because the potential producers know the quality of their products while product quality is undistinguishable beforehand by the buyer. The consumers just know the distribution of quality. Due to the asymmetry of information, incentives exist for the seller to pass off low-quality goods as higher-quality ones. The buyer, however, takes into consideration this incentive, and considers the quality of the goods as uncertain. Only the average quality of the goods will be considered. As a result, goods that are above average in terms of quality may be driven out of the market. In our framework, there is no potential for screening or signaling. However, we will see that a trade equilibrium is reached under information asymmetry as products are also horizontally differentiated and consumers have a preference for diversity.

Demand. Let us consider $q_{ij}(\bar{\theta}_{ij}, p_{ij}, .)$ the demand in country j for variety v produced in country i where $\bar{\theta}_{ij}$ is the average quality for the set of varieties available in country j imported from country i and p_{ij} is the price of variety-v. Potential buyers do not know the quality of each product but only know the average quality of products. Product quality captures all attributes of a product other than price that consumers value. The consumer's behavior is such that

$$\varepsilon_{q,p} \equiv -\frac{\partial q_{ij}}{\partial p_{ij}}\frac{p_{ij}}{q_{ij}} > 0 \quad \text{and} \quad \zeta_{q,\bar{\theta}} \equiv \frac{\partial q_{ij}}{\partial \bar{\theta}_{ij}}\frac{\bar{\theta}_{ij}}{q_{ij}} > 0$$

where $\varepsilon_{q,p}$ is the price-elasticity of demand and $\zeta_{q,\bar{\theta}}$ is the quality-elasticity of demand which are perfectly observed by the producers.

Technology and profit. We assume that each firm is featured by its level of productivity φ and the quality of its variety θ (as in Hallak and Sivadasan, 2013). Both are exogenously drawn from a bivariate distribution $\mathbf{b}(\varphi, \theta)$ with support $[0, \varphi^+] \times [0, \theta^+]$. The variable production cost increases with product quality for a given productivity and it decreases with productivity for a given quality. As in firm-based trade theory, we also consider that the distribution of products implies fixed distribution costs ϕ_{ij} and variable costs τ_{ij} which are specific to each destination. However, fixed distribution costs are increasing with product quality ($\phi_{ij}(\theta)$). Firms have to train labor and make other adjustments in their production process before producing a single unit of a higher-quality product. For example, firms selling perishable products like fresh fruits and vegetables may have to invest in better storage facilities to meet a quality standard over an extended period.[2]

The profit of a firm producing variety v located in country i and exporting to country j is given by

$$\pi_{ij}(\nu) \equiv p_{ij}(\nu)q_{ij}[\bar{\theta}_{ij}, p_{ij}(\nu)] - c_{ij}[\theta, \tau_{ij}, \varphi]q_{ij}[\bar{\theta}_{ij}, p_{ij}(\nu)] - \phi_{ij}(\theta) \tag{1}$$

where $c_{ij}(\theta_{ij}, \varphi, \tau_{ij})$ is the *marginal* cost of production which is independent from quantity whereas it increases with product quality and variable trade costs and decreases with firm's productivity. We consider that product markets are internationally seg-

[2]Animal welfare is also a growing concern and many farms and processing firms have invested in new equipment and facilities, in some cases to meet new stricter public regulations or as a mean to differentiate their products.

mented. This means that each firm can set a price which is specific to the country in which it sells its output. To ease the notational burden, the variety index is dropped in what follows.

Firms select their prices to maximize their profit (1) where the demand is given by $q_{ij}(\bar{\theta}, p_{ij}, .)$. From the first order condition with respect to price, we obtain:

$$p_{ij} = (1 - \varepsilon_{q,p}^{-1})^{-1} c_{ij} \tag{2}$$

where $\varepsilon_{q,p} > 1$ to ensure that the equilibrium is not lower than the marginal cost. The price is equal to a constant mark-up times a marginal cost which depends not only on the firm's productivity, but also on its own quality (through c_{ij}). The price is increasing with product quality and trade costs, but decreasing in the productivity of firms. Hence, the profit of a firm producing in country i and serving market j evaluated at equilibrium prices and quality is:

$$\pi_{ij}(\varphi, \theta) = \frac{p_{ij}(\varphi, \tau_{ij}, \theta) q_{ij}(\varphi, \tau_{ij}, \theta, \bar{\theta}_{ij})}{\varepsilon_{q,p}} - \phi_{ij}(\theta)$$

with $p_{ij}(\varphi, \tau_{ij}, \theta) q_{ij}(\varphi, \tau_{ij}, \theta, \bar{\theta}_{ij}) \equiv r_{ij}$ is the export sales of the firm (associated with a specific destination). For simplicity, without loss of generality, we assume that demand elasticities are constant. It follows that

$$\frac{\partial r_{ij}}{\partial \varphi} = q_{ij}(.) \varepsilon_{q,p} \left(-\frac{\partial c_{ij}}{\partial \varphi} \right) > 0, \quad \frac{\partial r_{ij}}{\partial \bar{\theta}_{ij}} > 0 \quad \text{and} \quad \frac{\partial r_{ij}}{\partial \bar{\theta}_j \partial \varphi} > 0$$

As expected, the profit and income are increasing with productivity and average quality prevailing in the destination country. Note that the sales of high-productivity firms increase with average quality more than the sales of firms with a lower productivity. In other words, a higher average product quality reallocates market shares towards more productive firms.

As the consumers do not know the quality of products and distribution/production costs increase with product quality, the profit and sales associated with market j are lower for firms selling a higher product quality. Formally, we have

$$\frac{\partial r_{ij}}{\partial \theta} = -\frac{r_{ij}(\varepsilon_{q,p} - 1)\zeta_{c,\theta}}{\theta} < 0 \quad \text{and} \quad \frac{\partial \pi_{ij}}{\partial \theta} = \frac{1}{\epsilon_{q,p}} \frac{\partial r_{ij}}{\partial \theta} - \frac{\phi_{ij}}{\theta} \zeta_{\phi,\theta} < 0$$

with

$$\zeta_{c,\theta} \equiv \frac{\partial c_{ij}}{\partial \theta} \frac{\theta}{c_{ij}} > 0 \quad \text{and} \quad \zeta_{\phi,\theta} \equiv \frac{\partial \phi_{ij}}{\partial \theta} \frac{\theta}{\phi_{ij}} > 0.$$

where $\zeta_{c,\theta}$ and $\zeta_{\phi,\theta}$ are the quality-elasticity of marginal cost and distribution cost, respectively. It is worth stressing that, for firms selling a product with above-average quality, the sales of high-quality firms are less than they would under perfect information. Since potential buyers only know the average quality of products, then demand will tend to be lower than the true value of the top-quality products. Producers of the top-quality products will tend to withhold their products from sale. As the Akerlof's Lemons Principle (*"The bad drives out the good until no market is left"*), the high quality products are driven out of the market by the low-quality products. Hence, information asymmetry may lead to the under-provision of high-quality products although such products are preferred by consumers (market failure).

Since fixed cost are assumed to be non negative with product quality and $\partial r_{ij}/\partial \theta < 0$ for a given productivity, there exists a maximum quality for a given productivity $\hat{\theta}_j(\varphi)$ above which it is not profitable to serve the destination market. Formally, $\hat{\theta}(\varphi)$ (named as *cutoff-quality curve*) is such that $\pi_{ij}(\varphi, \hat{\theta}_{ij}) = 0$. Using the implicit function theorem, it is straightforward to check that

$$\frac{\partial \hat{\theta}_{ij}}{\partial \varphi} = \frac{-\partial \pi_{ij}(\varphi, \hat{\theta}_{ij})/\partial \varphi}{\partial \pi_{ij}/\partial \hat{\theta}_{ij}} > 0.$$

Hence, the market failure associated with information asymmetry hurts mainly the low-productivity, high-quality firms. The high productivity firms are the only firms able to profitably export high-quality products under information asymmetry. Figure 1 displays the curve $\hat{\theta}(\varphi)$ in which each firm is represented by a single point, *i.e.* a (φ, θ) combination. Firms below this threshold earn non-negative profits while firms above the curve $\hat{\theta}(\varphi)$ exit the market. Firms along the curve have equal revenue and profits).

The positive slope of the curve $\hat{\theta}(\varphi)$ highlights firms exhibiting a high productivity are more likely to export.

Insert Figure 1 here

In addition, firms supplying a high-quality variety can profitability export provided that its productivity is high enough. It is worth stressing that, under no asymmetric information and endogenous product quality, more productive firms specialize in higher quality products (Baldwin and Harrigan, 2011; Kugler and Verhoogen, 2012; Gaigné and Larue, 2016). From different mechanisms at work, we show that the high-quality firms are more likely to be the high-productive firms. High-quality firms entering a market when the MQS becomes stricter are more likely to be high-productivity firms. This is due to a mechanism of *adverse selection* which varies according to the firm' productivity.

Minimum quality standards. Let us assume now that each country introduces a standard which sets a minimum quality $\underline{\theta}_j$ which is specific to each country. By enforcing public standards, governments specify requirements with which the characteristics of the production process ('process standard') and the final product ('product standard') must comply. This guarantees that any product marketed in country j do not fail to meet the minimum threshold. When governments choose a standard, it is applied to all products marketed in the domestic market whether they are manufactured by foreign or by domestic firms. Hence, the public standard, unlike a tariff, does not directly discriminate.

Minimum quality standards MQS can solve "lemons" type problems in markets with asymmetric information by rising the average quality of products (Leland, 1979; Ronnen, 1991). In our case, the effects are more complex due mostly to the assumptions about the heterogeneity of firms and the preference for variety (products are also horizontally differentiated). We capture two competing effects. For an unchanged cutoff-quality curve ($\hat{\theta}(\varphi)$), a stricter MQS raises the average quality of products delivered by exporters and forces low-quality firms to exit, regardless of their productivity. However, the cutoff-quality curve ($\hat{\theta}(\varphi)$) shifts as well because of a reallocation of market share. Indeed, firms are heterogeneously impacted by an MQS (and, in turn, the average quality of products consumed in the country) with respect to their productivity. Indeed, we have seen above that a higher average product quality yields a reallocation of sales from low-productivity firms to high-productivity firms as $\frac{\partial r_{ij}}{\partial \bar{\theta}_{ij} \partial \varphi} > 0$ (for a given quality). In addition, it is straightforward to check that

$$\frac{\partial r_{ij}}{\partial \theta \partial \bar{\theta}_{ij}} = \frac{\zeta_{q_{ij},\bar{\theta}_{ij}}}{\bar{\theta}_{ij}} \frac{1}{\epsilon_{q,p}} \frac{\partial r_{ij}}{\partial \theta_j} < 0$$

It follows that, for an unchanged cutoff-quality curve *a stricter* MQS *implies a demand reallocation from low-productivity high-quality firms to high-productivity low-quality firms*. As the demand of firms supplying a product with a level of quality just below maximum quality curve declines while their fixed costs are unchanged, those firms exit the market with a stricter MQS. In other words, the cutoff-quality curve shifts downward. Hence, a stricter MQS drives low-quality sellers and high-quality sellers away from the market and, in turn, has an ambiguous effect on average quality of products consumed in the country.

2.2 From theory to the empirical model

We now need to define preferences, technology and market structure to deliver estimable equations and clear predictions on the impact of public standards on export decisions, the reallocation of market shares, and the average quality of products delivered by incumbent firms.

Preferences and Demand. Consumers have identical Cobb-Douglas preferences over differentiated products and a homogeneous aggregate good. We posit a CES sub-utility function for the differentiated products:

$$U_j = \left[\sum_k \int_{\Omega_{kj}} \left[\overline{\theta}_{kj} q(v) \right]^{\frac{\varepsilon-1}{\varepsilon}} \mathrm{d}v \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{3}$$

where $q(v)$ is the quantity purchased for each variety, Ω_{kj} is the set of varieties available in country j and produced in country k with $k = 1, \ldots, i, j, \ldots\ K$, $\varepsilon > 1$ is the substitution elasticity between varieties and $\overline{\theta}_{kj}$ is the average quality perceived by consumers living in country j for varieties imported from country k. Consumers value (vertical) quality and make choices under incomplete information. In Appendix A, we show that the equilibrium demand for a variety produced in country i and exported to country j is such that:

$$p_{ij} q_{ij} = \overline{\theta}_{ij}^{\varepsilon-1} E_j P_j^{\varepsilon-1} p_{ij}^{1-\varepsilon} \tag{4}$$

where E_j is the amount of income allocated to the differentiated product sector and P_j is the price index in country j, defined as:

$$P_j = \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\varepsilon-1} [p(v)]^{1-\varepsilon} \mathrm{d}v \right]^{\frac{-1}{\varepsilon-1}}$$

Note that the price index reacts negatively in response to an increase in average quality of products. Hence, the demand for varieties produced in a country is also conditioned by the average quality adopted by the firms located in the other countries through the price index. More precisely, when the average quality of products imported from the other countries increases, the price index declines inducing a lower demand faced by firms located in the country in which the average quality is unchanged.

Market Structure, sales and profit. Firms produce under monopolistic competition. They supply a single variety and each variety is provided by a single producer. Labor is the only input. We assume that $\phi_{ij} = f_{ij} \theta(v)^{\eta}$ where η is common to all firms and f_{ij} is specific to the destination country and $c_{ij} = \theta^{\alpha} \tau_{ij} / \varphi$ where τ_{ij} represent trade costs for products shipped from country i to country j and θ^{α} with $\alpha \geq 0$ can be interpreted as a cost shifter due to product quality. Higher marginal costs can be caused by a higher quality because of a more thorough selection of ingredients and/or additional production tasks. It follows that $\zeta_{c,\theta} = \alpha$. Note that we fall back on the "standard" firm-based theory when $\eta = 0$ and $\alpha = 0$.

The profit of the firm producing variety v located in country i is given by:

$$\pi_i = \sum_j \pi_{ij}(\varphi,\theta) \quad \text{with } \pi_{ij} = \frac{r_{ij}(\varphi,\theta,\overline{\theta}_{ij})}{\varepsilon} - f_{ij}\theta^{\eta} \quad \text{and} \quad p_{ij} = \frac{\varepsilon}{\varepsilon-1}\frac{\tau_{ij}}{\varphi}\theta^{\alpha} \tag{5}$$

where the sales of a (φ,θ)-firm from each market (or operating profits up to a constant $1/\varepsilon$):

$$r_{ij}(\varphi,\theta,\overline{\theta}_{ij}) = \overline{\theta}_{ij}^{\varepsilon-1} P_j^{\varepsilon-1} E_j \left(\frac{\varepsilon}{\varepsilon-1}\tau_{ij}\right)^{-(\varepsilon-1)} \varphi^{\varepsilon-1}\theta^{-\alpha(\varepsilon-1)} \tag{6}$$

with

$$P_j = \left[\frac{\varepsilon}{\varepsilon-1}\sum_k \overline{\theta}_{kj}^{\varepsilon-1}\tau_{ij}^{-(\varepsilon-1)} \int_{\varphi_{ij}}^{\varphi^+} \int_{\underline{\theta}_j}^{\widehat{\theta}_{ij}} \varphi^{\varepsilon-1}\theta^{-\alpha(\varepsilon-1)} \mathrm{d}\theta \mathrm{d}\varphi\right]^{\frac{-1}{\varepsilon-1}} \tag{7}$$

where φ_{ij} the productivity cutoff to serve country j regardless of the level of quality (defined below) and $\widehat{\theta}_{ij}$ is the highest quality which can be exported for a given productivity (defined below). For a given average quality, the sales are decreasing with product quality of the firm and trade costs due to higher prices, but increasing with market size and the firm's productivity. The sales equation also captures an externality: higher average quality of products exported (from i to j) boosts the exports of firms. Hence, a stricter MQS yields more export sales for incumbent firms. This response is more pronounced for more productive firms and for firms supplying a level of quality just above the minimum quality.

However, a stricter MQS may favor the exit of firms supplying high-quality products, depending on their level of productivity. We now analyze the impact of public standards on the process of entry/exit.

Exit/entry. The productivity cutoff to serve country j regardless of the level of quality φ_{ij} is defined such that $\pi_{ij}(\varphi_{ij}, \underline{\theta}_j) = 0$ or, equivalently,

$$\varphi_{ij} = (\varepsilon f_{ij})^{\frac{1}{\varepsilon-1}} \underline{\theta}_j^{\frac{1}{\rho}} \overline{\theta}_{ij}^{-1} P_j^{-1} E_j^{\frac{-1}{\varepsilon-1}} \frac{\varepsilon}{\varepsilon-1} \tau_{ij} \quad \text{with } \rho \equiv \frac{\varepsilon - 1}{\eta + \alpha(\varepsilon-1)} \tag{8}$$

We further determine the highest quality $\widehat{\theta}_{ij}$ which can be exported for a given productivity (the profit becomes negative above this threshold). Remember that the relationship between maximum quality and productivity is positive. The marginal firm which is indifferent between exporting and exiting that has a profit equal to zero in market j ($\pi_{ij}(\varphi, \widehat{\theta}_{ij})$) has the following quality (implicitely given):

$$\widehat{\theta}_{ij}(\varphi) = \underline{\theta}_j \left(\frac{\varphi}{\varphi_{ij}}\right)^{\rho}$$

which is the highest quality in market j supplied by a φ-firm based in country i. Using (8), it follows that a lower fixed distribution cost and a lower bilateral trade cost increase the highest quality selected by the marginal firm in country i and, in turn, average quality. Hence, trade liberalization encourages quality upgrading, an outcome reported in Amiti and Khandelwal (2013) from a different mechanism.

Note that moving along the cutoff-quality curve ($\widehat{\theta}_{ij}(\varphi)$), the profit is null. However, we do not know how price react along this curve as it depends negatively on productivity and positively on quality. The iso-price and iso-revenue curves (for serving a country) is given by $(\partial p_{ij}/\partial\varphi)\mathrm{d}\varphi + (\partial p_{ij}/\partial\theta)\mathrm{d}\theta = 0$ and $(\partial r_{ij}/\partial\varphi)\mathrm{d}\varphi + (\partial r_{ij}/\partial\theta)\mathrm{d}\theta = 0$ which imply

$$\left.\frac{\mathrm{d}\theta}{\mathrm{d}\varphi}\right|_{\mathrm{d}p=0} = \left.\frac{\mathrm{d}\theta}{\mathrm{d}\varphi}\right|_{\mathrm{d}r=0} = \frac{1}{\alpha}\frac{\theta}{\varphi}$$

while we have $\partial\widehat{\theta}_{ij}/\partial\varphi = \rho\widehat{\theta}_{ij}/\varphi$. As $\rho < 1/\alpha$, prices decrease and export sales increase moving up along the cutoff-quality curve ($\widehat{\theta}_{ij}(\varphi)$).

We now determine the impact of a stricter minimum standard on both the productivity and the quality cutoffs. The effect of a stricter MQS on the quality cutoff is unclear a priori. On the one hand, the quality cutoff increases when the productivity cutoff is unchanged (direct effect). On the other hand, using (8), low-productivity firms may exit the market/country when the MQS increases inducing a lower quality cutoff. Plugging (8) into (6), the export sales are given by:

$$r_{ij}(\varphi, \theta, \underline{\theta}_j) = f_{ij}\theta^{\eta}\varepsilon \left[\left(\frac{\underline{\theta}_j}{\theta} \right)^{1/\rho} \frac{\varphi}{\varphi_{ij}} \right]^{\varepsilon - 1}.$$

For a given productivity cutoff, a stricter public standard implies higher sales for incumbent firms because the average quality delivered by firms tends to be higher. However, the rise in sales is higher for the firm with a higher productivity and supplying a low-quality product when a stricter MQS is applied. Indeed, we have

$$\frac{\partial r_{ij}(\varphi, \theta)}{\partial \varphi \partial \theta} < 0, \; \frac{\partial r_{ij}(\varphi, \theta)}{\partial \varphi \partial \underline{\theta}_j} > 0, \text{ and } \frac{\partial r_{ij}(\varphi, \theta)}{\partial \theta \partial \underline{\theta}_j} < 0$$

As market size E_j is fixed, the sales of firms with a productivity just above the productivity cutoff or just below the quality cutoff decrease when the market share of high-productivity low-quality firms increases. Hence, the productivity cutoff φ_{ij} increases and the quality cutoff $\widehat{\theta}_{ij}(\varphi)$ decreases when the MQS is higher. A higher minimum standard makes competition tougher (captured by a lower price index) because low-productivity firms exit from the market. For a given productivity, the firms providing high-quality varieties experience a lower market share because of a reallocation of demand from high-quality firms to low-quality incumbents when the MQS increases. Clearly, there are winners and losers among firms when the MQS is strict. Stricter MQS does not help small domestic firms, rather it makes high-productivity firms supplying a quality product just above the minimum standardmore profitable. Hence, a stricter MQS does not allow high-productivity firms to export high-quality products.

Finally, whether a stricter MQS yields less varieties in the country (as φ_{ij} increases and $\widehat{\theta}_{ij}(\varphi)$ decreases), its impact on average quality is ambiguous because both low-quality products and high-quality product exit the market. Similarly, the effect of a stricter MQS on welfare is ambiguous. On the one hand, public standards can be viewed as welfare-improving tools by reducing information asymmetries (e.g. Leland, 1979). On the other hand, public standards create distortions in entry decisions (Gaigné and Larue, 2016). Indeed, consumers may be worse off as a result of the introduction of a public standard because their favorite varieties are excluded from the market or the prices of the remaining varieties have gone up.

3 Empirical analysis

3.1 Data

NTMs data

Our empirical study relies on the TRAINS NTMs database released in July 2016 by the UNCTAD and made publicly available through the I-TIP portal.[3] It is currently the most comprehensive NTMs database, providing all the measures in force by country, product and type of instruments at the time of data collection (between 2012 and 2015 depending on countries). The database covers 56 countries, with EU27 countries aggregated into the EU (see Table 1).

Insert Table 1 here

The information available in the TRAINS NTMs database covers a broad range of policy instruments. It encompasses measures with well-identified trade objectives (e.g. quotas or price controls) but also regulatory and technical instruments aiming at protecting the human health and environment (e.g. SPS and TBTs). Even without trade objectives, these regulatory and technical measures may impact international flows. Overall, the dataset includes about 38,000 measures, which are broken up into 16 chapters (from A to P), depending on their scope and/or design (see Table 2). The decomposition follows the International Classification of NTMs. Each chapter is further differentiated into subgroups to allow a finer classification of the measures.[4] For

[3] TRAINS stands for TRade Analysis Information System. During its fourteenth Ministerial Conference (July 2016), the United Nations Conference on Trade and Development (UNCTAD) launched the database. TRAINS NTMs data are available here: `http://i-tip.unctad.org/`.

[4] See UNCTAD (2015) for a detailed description of the classification. For example, chapter A on SPS measures is further decomposed into nine subchapters. Among them, subchapter A1 includes measures

our analysis, we retain the 15 first chapters (from A to O), which deal with the importing countries' requirements on their imports, and exclude the last chapter (P) covering exporting countries' requirements on their exports. Furthermore, we classify NTMs into three categories: i) SPS, ii) TBT and iii) all other import-related NTMs. As previously mentioned, our study focuses on the impact of quality measures (e.g. SPS and TBTs) on French firms' agri-food exports. However, as other NTMs may also affect firms' export flows, we include them as control variables in our estimations.

Insert Table 2 here

For each country, NTMs measures are available at the tariff line level. To match the NTMs data with French firm exports data, we aggregate them at the 6-digit level of the Harmonized System (HS) classification. With very few exceptions, all tariff lines within a given HS6 product are covered by NTMs. Therefore, this aggregation at the HS6 digit level does not bias our analysis. Finally, we count the number of SPS, TBT and other NTMs imposed by each importing country on a given HS6 product,[5] so that we obtain the number of SPS, TBT and other import-related NTMs faced by French exporters in each destination country and for each agri-food product. Unfortunately, the TRAINS NTMs database lists existing NTMs but does not provide information on their restrictiveness. However, the number of measures imposed by an importing country on a given HS6 product can be seen as a proxy for their restrictiveness. Indeed, it is likely to be more costly, and therefore more difficult, for an exporter to enter a product-destination market with a high number of NTMs.

For each country included in the TRAINS NTMs database, Table 3 reports the share of HS6 agri-food products subject to at least one SPS, one TBT, and one other NTM,

related to "Prohibitions/restrictions of imports for SPS reasons". This subchapter is then broken up into six subgroups (A11 "Temporary geographic prohibitions for SPS reasons"; A12 Geographical restrictions on eligibility; etc.). In our analysis, if more than one measure belong to the same subgroup and affect the same product in the same country, we group them (for example, two A11 measures on product k in country j are aggregated into a single measure). Indeed, these measures usually have the same purpose and are strongly connected – the most recent measure renewing with possible slight changes an older one – and cannot be seen as two different measures.

[5]We consider only unilateral NTMs (i.e. NTMs imposed by importing countries on all exporting countries – including France –) and exclude bilateral NTMs notified specifically against European or French products. However, this approach does not bias our study because for almost all bilateral measures targeting French or European products, a unilateral counterpart measure is also in force.

as well as the average number of measures in force on each product. The shares are simply obtained by dividing the number of HS6 agri-food products subject to SPS, TBT, and other NTMs by the total number of HS6 agri-food products (i.e. 664 after the conversion between different versions of the HS classification). To compute the average numbers of SPS, TBT, and other NTMs per HS6 agri-food product, we consider only products subject to at least one measure. Products without NTMs are not included in the calculation. On average in our sample, 88.2% of HS6 agri-food products are subject to at least one SPS. For TBTs and other NTMs, the shares are slightly lower (respectively 72.6% and 66.9%). Besides, each agri-food product faces on average 6.7 SPS, 3.2 TBT and 2.8 other NTMs.

Insert Table 3 here

French firm-level data

In addition to NTMs data, we use French firm-level data. French customs provide exports data by firm, HS6 product and destination country. We refer to 2012 exports. Indeed as above mentioned, the TRAINS NTMs database displays all NTMs in force in each destination country at the time of data collection (between 2012 and 2015 depending on countries). Working on the annual flows of newly adopted NTMs does not make much sense. The time-variation in the notifications of measures by countries is rather low and most of the variation in NTMs occurs across countries and across products.[6] We therefore use the French firms' exports in 2012 and perform a cross-section analysis using the stock of SPS, TBT and other NTMs in force in each destination country and on each agri-food product and potentially affecting these exports. For each firm located on French metropolitan territory, French customs data report the volume (in tons) and value (in thousands of euros) of exports for each product-destination pair. Using the official firm identifier, we merge the customs data with the BRN (Bénéfices réels normaux) dataset from the French Statistical Institute, which provides firm balance-sheet data, e.g., value added, total sales, and employment.

[6]Furthermore in the TRAINS NTMs database, a date is associated to each measure. However, no explanation is provided and it does not seem to be related to the date of the notification of the measure.

Table 4 presents the number of agri-food products exported by French firms to each destination country included in the TRAINS NTMs database, as well as the share of products affected by at least one NTM (SPS, TBT, or other NTMs) in that destination, and the average number of measures on each product. The last column of the table reports the share of French agri-food exports (in value) not subject to SPS and/or TBT measures in the destination country. Four main facts can be highlighted. First, a small number of agri-food products is effectively exported by French firms. On average in our sample, only 152.2 products are exported to each destination. After merging the customs data with firm characteristics and NTMs, our dataset includes 661 different HS6 agri-food products. For only five destinations (Cote d'Ivoire, European Union,[7] Japan, Senegal, and the US), more than half of the product basket (i.e. more than 330 products) is exported. Second, the comparison between Tables 3 and 4 suggests that on average the share of French products effectively affected by at least one measure in the destination market is higher than what would have been observed if all products would be exported by French firms to all destinations (89.7 vs. 88.2 for SPS; 77.9 vs. 72.6 for TBT; 70.7 vs. 66.9 for other NTMs). Thus, the presence of NTMs does not necessarily hamper French firms' exports. Third, French firms tend to export agri-food products affected by a low number of NTMs. Indeed, the average numbers of SPS, TBT and other NTMs per product are lower in Table 4 compared to the ones reported in Table 3 (6.0 vs. 6.7 for SPS; 2.9 vs. 3.2 for TBT; 2.4 vs. 2.8 for other NTMs). Fourth, almost all French agri-food exports are subject to SPS and/or TBTs in the destination market. On average, only 6.5% of exports (in value) are not subject to such measures, and this share exceeds 10% in only 7 countries.

Insert Table 4 here

Tariffs data

Finally, our empirical analysis controls for tariffs. Tariffs barriers may of course impact French firms' exports. In their absence, one cannot distinguish the effect of

[7] This holds true for all individual EU countries, except for Bulgaria, Cyprus, Estonia, Latvia, Malta, and Slovakia. However, French firms export at least 213 HS6 agri-food products to these destinations.

NTMs on exports from that of tariffs. To avoid this bias, we include a bilateral measure of market access. Data come from the Market Access Map (MAcMap) database jointly developed by the International Trade Centre (UNCTAD-WTO) and the CEPII.[8] It incorporates not only the applied tariff but also specific duties, tariff quotas and anti-dumping duties. All these barriers are converted into an ad valorem equivalent and summarized in one measure. This measure is computed at the HS 6-digit level. Tariff data are for the year 2010, which is currently the last available year in the MAcMap database.[9] Tariffs are not available for Liberia and Thailand, which are dropped from our analysis. For French firms' exports to other EU countries, tariffs are naturally set to zero.

All in all, our final sample includes 14,443 French firms exporting 661 HS6 agri-food products to 78 destination countries (with EU27 disaggregated).[10] On average, a firm export 2.7 HS6 agri-food products per destination and serve 2.8 destinations per HS6 agri-food products. 42.1% of firms serve only one destination (mono-destination firms) and 57.6% export only one product (mono-product firms). In terms of destinations, 53.5% of French firms export only to non-EU countries, while 28.2% serve only EU27 markets. 18.3% of firms serve both EU and non-EU destinations.

Taking into account the core principle of mutual recognition within the EU, further explanations are necessary regarding the manner in which we treat public quality standards and other import-related NTMs for the EU destinations. First, as far as public quality standards are concerned, we consider that French firms have to comply with the domestic regulations in order to be able to export to EU destinations. Therefore, the number of public quality standards is not set to 0. Second, in order to have a unified definition, we also consider that the number of the other-import related NTMs is not null.

[8]CEPII stands for Centre d'Etudes Prospectives et d'Informations Internationales. http://www.cepii.fr/anglaisgraph/bdd/macmap.htm.

[9]As for NTMs, most of the variation in tariffs is observed across products and countries rather than over time.

[10]Belgium and Luxembourg are aggregated in our analysis.

3.2 Estimations and results

In this section, we test for the theoretical predictions on the impact of quality standards on firms' exports derived from our model. We perform the estimations at the extensive and intensive margins of trade. We also investigate the reallocation across least and most productive firms and add different combinations of fixed effects in our estimations to capture unobservable characteristics at the firm, product and destination levels.

Extensive margin of trade

We first study the presence[11] of a French exporter on a given product-destination market. Our dependent variable (y_{fkj}) is the probability that firm f exports the HS6 agri-food product k to destination j in 2012. Our counterfactual scenario considers the firms that do not export in the same product-destination pair kj in 2012. This choice model can be written in the latent variable representation, with y^*_{fkj} being the latent variable that determines whether a strictly positive export flow is observed for firm f in a product-destination pair. Our estimated equation is therefore as follows:

$$Pr(y_{fkj}) = \begin{cases} 1 & \text{if} \quad y^*_{fkj} > 0, \\ 0 & \text{if} \quad y^*_{fkj} \leq 0, \end{cases} \tag{9}$$

with

$$\begin{aligned} y^*_{fkj} \quad = \quad & \alpha_1 \ln(1 + \text{nb. NTM}_{kj}) + \alpha_2 \ln(1 + \text{nb. NTM}_{kj}) \times \text{Productivity}_f \\ & + \alpha_3 \ln(1 + \text{Tariff}_{kj}) + \alpha_4 \text{Product rank}_{fk} + \mathbf{FE} + \varepsilon_{fkj}, \end{aligned}$$

where nb. NTM_{kj} is the number of NTMs applied by destination country j on HS6 product k. We consider separately the respective number of SPS, TBT and other NTMs. The interaction term between the number of NTMs and exporting firm's productivity (Productivity_f) aims to capture possible reallocation effect across exporters. Our esti-

[11]With cross-section data, we cannot test for the entry/exit of firms.

mation also controls for the protection applied in destination j on product k (Tariff_{kj}), as well as for the product rank in the firm's exports (Product rank_{fk}). The product rank is computed as follows. We sum a firm's exports of a product across all destinations. We then sort the different export values obtained for each product in descending order. The first rank is assigned to the product with the highest export value. The product with the lowest export value is assigned the last rank. We divide the product rank by 10, in order to be able to easily interpret the coefficients. Finally, **FE** represents various combinations of fixed effects, and ε_{fkj} is the error term.

We estimate the export equation using a linear probability model. The inclusion of fixed effects in a probit model would give rise to the incidental parameter problem. The linear probability model avoids this issue. In addition, we account for the correlation of errors by clustering at the HS6 product-destination level. Furthermore, our estimations retain only groups with more than one observation. Indeed as shown by Correia (2014), the inclusion of singleton groups in linear regressions where fixed effects are nested within clusters might lead to incorrect inferences. Therefore, the number of observations differs across estimations.[12]

Table 5 presents the results. We classify public quality standards into three categories. First, we consider the number of SPS measures if product k in destination j is only affected by this type of standards. Second, we consider the number of TBT measures if product k in destination j is only subject to this type of NTMs. Finally, we compute the total number of SPS and TBT measures if product k in destination j is simultaneously affected by both types of standards. We estimate the effects of these three categories of standards as described above (i.e. only SPS measures, only TBT measures, both SPS and TBT measures on product k in destination j) on firms' exports across products and destinations.

In columns 1 and 2, we introduce firm-destination and HS6 product fixed effects (FE_{fj} and FE_k). Our coefficients of interest on standards are therefore identified in the product dimension. In other words, regarding the probability of exports, we compare

[12]Estimations use the Stata package REGHDFE (Correia, 2014). The inclusion of singleton groups in the estimations leads to similar results (results are available from the authors upon request).

firms in a given destination j exporting product k versus those that are not. Column 2 differs from column 1 in that it introduces interaction terms between each category of quality standards and firm productivity. In column 1, we show that the first category of standards does not significantly affect a firm's decision to participate in the export market, whereas the second and the third categories have a negative and significant influence. These results are confirmed in column 2. However, when we analyze the coefficients of interest, on the interaction terms, we find different results. We document an insignificant effect of the first and the second categories of standards on the most productive firms' export participation decisions. When it comes to the third category, we show that it positively impacts the probability to export for the most productive firms. More precisely, a 10% increase in the total number of SPS and TBT measures on product k in destination j increases the export participation of the most productive firms by 1 percentage point. We document a positive and significant effect of the other import-related NTMs on the probability of a firm to participate in the export market. As expected, tariffs negatively influence firms' export decisions, but their effect is only significant in column 2. We also show that the lower the product rank, the lower the export participation.

In columns 3 and 4, we include firm-product and destination fixed effects (FE_{fk} and FE_j). Our coefficients of interest on quality standards are now identified in the destination dimension. We compare firms exporting a given product k entering destination j versus those that are not. In contrast with column 3, column 4 introduces interaction terms between each category of standards and firm productivity. In column 3, none of the three categories of quality standards appears to significantly influence firms' export participation decisions. This is not the case in column 4, where the coefficients on the three categories of standards are negative and significant. Thus, a 10% increase in the number of standards within the first, the second or the third category reduces the probability that a firm exports product k to market j by, respectively, 10, 24 or 5 percentage points. The coefficients on the interaction terms are, as expected, positive and significant. We show that a 10% increase in the number of measures falling within the first, the second or the third category increases the probability of exporting for the most productive firms by 3, 6 or 1 percentage points, respectively. As in columns 1 and 2, we document a positive and significant effect of the other import-related NTMs on the probability of a firm to participate in the export market. Tariffs have a negative influence on the probability of exporting, which is significant only in column 4. The product rank is directly captured through the fixed effects.

Overall, we show that public quality standards decrease the likelihood to participate in the export market. However, the most productive firms benefit from a higher export participation compared to the least productive firms, which are negatively affected. These findings support the predictions derived from our theoretical model. Moreover, our empirical findings point to reallocation effects across both destinations and products in terms of export decisions, especially for the third category of standards (i.e. both SPS and TBT measures affect product k in destination j). When we focus on the first and the second categories of standards, we find a reallocation effect in terms of export decisions only across destinations.

Insert Table 5 here

Intensive margin of trade - Value of imports

We now analyze the effect of quality standards on the intensive margin of trade. We first focus on the value of exports and estimate the following specification:

$$\begin{aligned} v_{fkj} \quad = \quad & \beta_1 \ln(1 + \text{nb. NTM}_{kj}) + \beta_2 \ln(1 + \text{nb. NTM}_{kj}) \times \text{Productivity}_f \\ & + \beta_3 \ln(1 + \text{Tariff}_{kj}) + \beta_4 \text{Product rank}_{fk} + \beta_5 \text{Past presence}_{fkj} + \mathbf{FE} + \varepsilon_{fkj}, \end{aligned} \tag{10}$$

where v_{fkj} is the value of product k exported by firm f to destination j. As previously described, nb. NTM_{kj} is the number of NTMs applied by destination country j on HS6 product k. We distinguish between the number of SPS, TBT and other

NTMs. The interaction term between the number of NTMs and exporter's productivity (Productivity_f) captures the reallocation effects across exporting firms. We also control for the applied protection (Tariff_{kj}), product rank in the firm's export basket (Product rank_{fk}) and whether the firm was already serving the product-destination (kj) pair in the previous year ($t-1$) or two years before ($t-2$). **FE** is a vector of different combinations of fixed effects. The standard errors are clustered at the HS6 product-destination level. ε_{fkj} is the error term.

The results are reported in Table 6. Columns 1 and 2 investigate the effect of quality standards on firms' exports across products, while columns 3 and 4 study the relationship across destination markets. The specifications follow the same logic as in Table 5.

In column 1, we show that the first category of standards positively affects firm-level exports, whereas the second and the third categories do not have a significant effect. In column 2, we introduce interaction terms between each category of standards and firm productivity. We highlight a reallocation effect in terms of export sales from the least productive towards the most productive firms for products only affected by a high number of SPS measures or that are subject to a high number of SPS and TBT measures at the same time. A 1% increase in the number of standards from the first and the third categories leads to an increase in the firm-level exports by 28 and 13 percentage points, respectively. The second category of standards does not influence firm-level exports. The other import-related NTMs do not have a significant influence on the export value. Tariffs negatively impact the export sales of a firm. The lower the product rank, the lower the export value at the firm level. The past presence of a firm with product k in market j positively influences its exports.

In column 3, we illustrate that the first and the second categories of standards have a positive and significant effect on export sales of a firm, whereas the second category does not significantly influence exports. In column 4, we control for firm heterogeneity in terms of productivity. We highlight a reallocation of demand from the least productive towards the most productive firms in presence of a high number of public quality standards falling within all the three categories. A 1% increase in the number of measures falling within the first, the second and the third categories increase export sales for the most productive firms by 16.3, 20.3 and 18.4 points, respectively. The other import-related NTMs do not have a significant influence on the firm-level exports. Tariffs negatively impact the export value of a firm. The product rank is captured through the fixed effects. The past presence of a firm-product combination in a given market increases exports towards that destination.

These results are in line with the theoretical predictions. First, as some firms are forced to exit the market, there is an increase in the export value of incumbents firms, highlighted in columns 1 and 3. However, when we control for firm heterogeneity we show that demand shifts towards the most productive firms, at the expense of the least productive firms. Overall, these findings depict reallocation in terms of export value across products and destinations. As before, reallocation across destinations takes place for all the three categories of standards. The reallocation across products occurs only for a high number of SPS measures or a high number of both SPS and TBT measures.

Insert Table 6 here

Intensive margin of trade - Quality-adjusted prices

Note: There is a disconnection between the theoretical and the empirical part with regard to prices. According to the theoretical model, if we estimate quality from the demand side, we should rely on the average quality and compute average quality-adjusted prices. Here we estimate quality at the firm level for each product sold in a given destination and then compute quality-adjusted prices. We are currently working to fix this issue.

We now investigate the impact of standards on the quality-adjusted prices set by exporting firms. Many papers in the literature use the unit values as a measure of the products' prices. However, these unit values mix two components: the products' quality and their prices. Compared to this literature, we go one step further and study the effects of standards on both components separately.

In a first step, we estimate the quality and quality-adjusted prices. We estimate quality from the demand side. Using the methodology developed in Khandelwal et al. (2013), the quality for each firm-product-destination observation can be estimated as the residual from the following OLS regression:

$$\log q_{fkj} + \varepsilon \log p_{fkj} = \mathbf{FE}_j + \mathbf{FE}_k + \mu_{fkj} \tag{11}$$

where the destination fixed effects include the destination country's income and price index, while the product fixed effects capture the fact that prices and quantities are not necessarily comparable across product categories. As in Khandelwal et al. (2013), we assume $\varepsilon = 4$.

Estimated quality is $\ln \hat{\theta}_{fkj} = \hat{\mu}_{fkj}/(\varepsilon - 1)$. The quality-adjusted price $\widetilde{p}_{fkj}$ is given by $\widetilde{p}_{fkj} = p_{fkj}/\hat{\theta}_{fkj}$ where:

$$\ln \left[\frac{p_{fkj}}{\hat{\theta}_{fkj}} \right] = \ln p_{fkj} - \frac{\hat{\mu}_{fkj}}{\varepsilon - 1}$$

In the second step, we estimate the effects of standards on the quality-adjusted prices set by firms on each product-destination market. The estimated equation is as follows:

$$\begin{aligned} \ln \widetilde{p}_{fkj} \; = \; & \gamma_1 \ln(1 + \text{nb. NTM}_{kj}) + \gamma_2 \ln(1 + \text{nb. NTM}_{kj}) \times \text{Productivity}_f \\ & + \gamma_3 \ln(1 + \text{Tariff}_{kj}) + \gamma_4 \text{Product rank}_{fk} + \gamma_5 \text{Past presence}_{fkj} + \mathbf{FE} + \varepsilon_{fkj}, \end{aligned} \tag{12}$$

We pursue the same specifications as before. Columns 1 and 2 investigate the effect of quality standards on firms' quality-adjusted prices across products, while columns 3 and 4 study the relationship across destination markets. Table 7 presents the results. In column 1 we show that the first category of standards negatively affects a firm's quality-adjusted prices. In column 2, we illustrate that the first and the second categories of standards positively affect these prices. However, we highlight a negative effect on prices of these two categories for the most productive firms. In fact, standards accrue costs and translate into higher prices. Nevertheless, the most productive firms are more able to cover these costs and charge lower prices.

In column 3, we show that the first and the third categories of standards negatively influence quality-adjusted prices. In column 4, we illustrate that all categories of standards positively affect quality-adjusted prices. However, the most productive firms are able to charge lower prices when confronted to a high number of standards falling within each of the three categories.

The other import-related NTMs do not significantly affect quality-adjusted prices, whereas tariffs accrue them across the four specifications. The higher the product rank, the higher the price adjusted for quality. The past presence in a given market decreases the quality-adjusted price of a firm.

All in all, our results point to reallocation effects across products and destinations.

Insert Table 7 here

Average quality

We now turn to study the effect of public quality standards on the average quality of a product in a given market. We estimate the average quality as in equation (11), by aggregating the data at the product-country level (i.e. without considering the firm dimension). Then we regress the different categories of NTMs and tariffs on the estimated average quality:

$$\ln \hat{\hat{\theta}}_{kj} \quad = \quad \delta_1 \ln(1 + \text{nb. NTM}_{kj}) + \delta_2 \ln(1 + \text{Tariff}_{kj}) + \mathbf{FE} + \varepsilon_{kj}, \tag{13}$$

We introduce product and destination fixed effects to control for product- and destination-specific factors. Table 8 presents the results. We show that only standards from the first category have a significant and positive influence on the average quality of a product in a given market. This result is intuitive since the focus of our analysis is on the agri-food sector. In this sector, SPS measures are prevalent and designed to protect human life and health. TBT measures in agri-food industries are mainly labeling requirements. Hence, they do not precisely translate into higher quality. As expected, tariffs negatively affect the average quality of a product in a given market.

Insert Table 8 here

3.3 Robustness checks

We proceed to two robustness checks, in order to verify the validity of our analysis. First, we replicate our baseline estimations without including the EU destinations in the analysis. As already mentioned, French firms benefit from the principle of mutual recognition inside the EU. Therefore, we exclude the EU destinations to investigate how our results are modified.

Table 9 presents the results. Estimations are conducted for both the extensive and the intensive margins of trade, defined as in the baseline scenario. For each margin where the analysis is run at the firm level (i.e. the extensive margin and the intensive margin defined through the value of exports and the quality-adjusted prices), we introduce two sets of fixed effects. The first set of fixed effects studies the reallocation across products, whereas the second set of fixed effects investigates the reallocation across destination. As far as the average quality is concerned, the analysis is conducted for each product-destination combination, without considering the firm dimension. In this case, we only introduce product and destination fixed effects.

First, we focus on the extensive margin. Our results show that, outside the EU, there is no reallocation across products in terms of firms' export participation decisions. However, when we analyze the reallocation across destinations, we note that effects are pretty much similar to those obtained for the case where we keep the EU destinations in our analysis. Public quality standards decrease the probability of participation into the export market, but this does not hold true for the most productive firms , which see their export participation increase. Second, as far as the export value is concerned, we note a reallocation effect across products only for the first category of standards. On the other hand, we have a reallocation effect across destinations for all categories of standards. In both cases we are able to highlight the idea that the most productive firms are the ones that benefit the most from the imposition of public quality standards, as they see their market share increase at the expense of the least productive firms. Third, when we focus on the quality-adjusted prices, we show that, across products, only the first category of standards plays a role, whereas across destinations, both SPS and TBT measures play a role when they simultaneously affect a product in a given destination. Finally, when it comes to the average quality, none of the three categories of standards has a significant influence, even though the coefficients of interest are positive.

The second robustness check extends our analysis to all HS6 products. We seek to investigate whether our results are specific to the agri-food sectors and how they change when we consider all HS6 products. Compared to our previous results, we should obtain more powerful results for TBT measures, since we include all manufacturing industries where TBT standards play a tremendous role. They are not just labeling requirements as in the case of agri-food sectors. In this case, SPS measures are expected to have a less important role in explaining the different margins of trade, than in the previous case.

Insert Table 9 here

Table 10 presents the results. Specifications follow the same pattern as in Table 9. First, we focus on the extensive margin. The reallocation effect in terms of firms' export decisions occurs both across products and destinations. We show that each category of standards reduces firm participation into the export market. As expected, in both cases, the effect is more important for the second and the third categories. We also show that the most productive firms experience a higher probability to export when confronted to standards falling within all the three categories. Second, we analyze the intensive margin defined through the value of exports. In this case, results are consistent in terms of sign and significance across products and destinations. We show that the first category of standards does not significantly affect firm-level exports, as expected. In contrast, TBT measures seem to play an important role. We notice that the second and the third categories of standards have a significant effect on exports. We also document a demand reallocation effect from the least productive towards the most productive firms for these categories of standards. These results also hold for the quality-adjusted prices, except for the fact that the signs are reversed, as expected. Finally, all categories of standards increase average quality, compared to only SPS measures in the case of agri-food products.

Insert Table 10 here

4 Conclusion

This paper has studied the effect of public quality standards on the extensive and intensive margins of trade at the firm level, focusing on the French agri-food sector. All in all, our results show that public quality standards decrease export participation. However, these effects are attenuated for the most productive firms. Also, public quality standards increase the export sales of incumbent firms, but there is a reallocation effect towards the most productive firms at the expense of the least productive ones. Standards positively impact firms' prices, but this does not hold true for the most productive firms which charge lower prices. The average quality of products in a market increases due to the imposition of public quality standards. These results are robust to several specifications.

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Appendix

Appendix A. Quality and Demand

Maximizing (3) subject to the budget constraint $E_j = \int_{\Omega_j} p(v)q(v)\mathrm{d}v$ where Ω_j is the set of varieties available in country j leads to the following demand for a variety produced in country i:

$$q_{ij}(v) = \overline{\theta}_{ij}^{\varepsilon-1} \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\frac{\varepsilon-1}{\varepsilon}} [q(v)]^{\frac{\varepsilon-1}{\varepsilon}} \mathrm{d}v \right]^{\frac{\varepsilon}{\varepsilon-1}} [p_{ij}(v)]^{-\varepsilon} / \lambda^{\varepsilon}$$

where λ is the Lagrange multiplier and Ω_{kj} is the set of varieties produced in country i available in country j. Therefore, the expenditures for a variety are

$$p_{ij}(v)q_{ij}(v) = \overline{\theta}_{ij}^{\varepsilon-1} \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\frac{\varepsilon-1}{\varepsilon}} [q(v)]^{\frac{\varepsilon-1}{\varepsilon}} \mathrm{d}v \right]^{\frac{\varepsilon}{\varepsilon-1}} [p_{ij}(v)]^{1-\varepsilon} / \lambda^{\varepsilon} \tag{14}$$

Plugging (A.1) in the budget constraint yields

$$E_j = \lambda^{-\varepsilon} \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\frac{\varepsilon-1}{\varepsilon}} [q(v)]^{\frac{\varepsilon-1}{\varepsilon}} \mathrm{d}v \right]^{\frac{\varepsilon}{\varepsilon-1}} \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\frac{\varepsilon-1}{\varepsilon}} [p_{ij}(v)]^{1-\varepsilon} \mathrm{d}v \right] \tag{15}$$

Using (A.1) and (A.2), we get (4)

$$p_{ij}(v)q_{ij}(v) = \overline{\theta}_{ij}^{\varepsilon-1} E_j P_j^{\varepsilon-1} [p_{ij}(v)]^{-(\varepsilon-1)}$$

with

$$P_j = \left[\sum_k \int_{\Omega_{kj}} \overline{\theta}_{kj}^{\varepsilon-1} [p(v)]^{-(\varepsilon-1)} \mathrm{d}v \right]^{\frac{-1}{\varepsilon-1}}.$$

Figure 1. Cutoff-quality curve

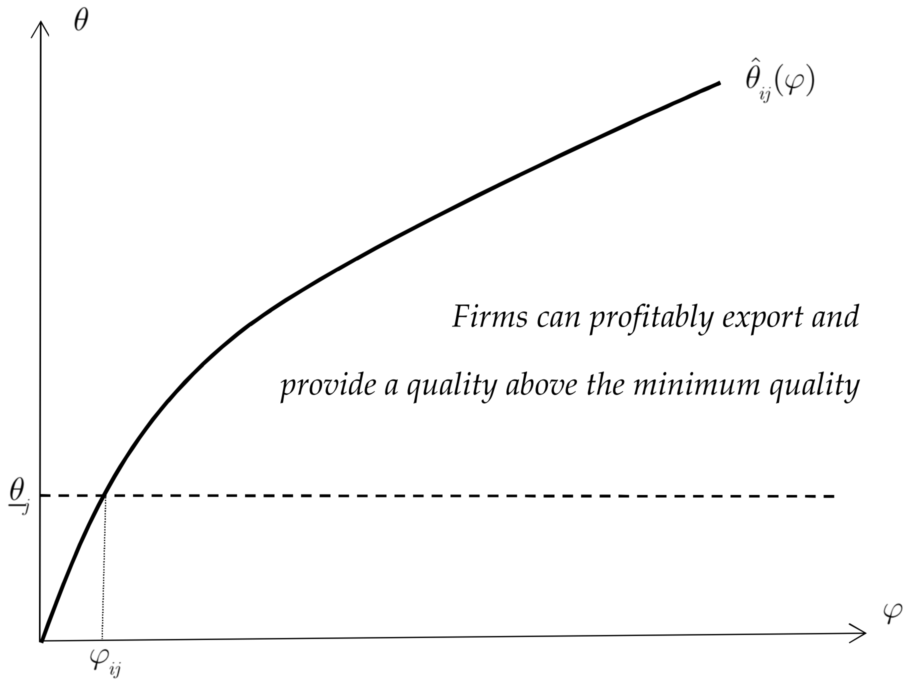

Table 1: Countries included in the TRAINS NTMs database

Afghanistan	Japan
Argentina	Kazakhstan
Australia	Lao PDR
Benin	Liberia
Bolivia	Malaysia
Brazil	Mali
Brunei Darussalam	Mexico
Burkina Faso	Myanmar
Cambodia	Nepal
Canada	New Zealand
Cape Verde	Nicaragua
Chile	Niger
China	Nigeria
Colombia	Pakistan
Costa Rica	Panama
Cote d'Ivoire	Paraguay
Cuba	Peru
Ecuador	Philippines
El Salvador	Senegal
Ethiopia	Singapore
European Union	Sri Lanka
Gambia	Tajikistan
Ghana	Thailand
Guatemala	Togo
Guinea	United States
Honduras	Uruguay
India	Venezuela
Indonesia	Vietnam

Source: UNCTAD (http://i-tip.unctad.org/).

Table 2: NTMs classification, by chapter

Chapter	Description
A	Sanitary and phytosanitary measures
B	Technical barriers to trade
C	Pre-shipment inspection and other formalities
D	Contigent trade-protective measures
E	Non-automatic licensing, quotas, prohibitions and quantity-control measures (other than for SPS/TBT reasons)
F	Price-control measures, including additional taxes and charges
G	Finance measures
H	Measures affecting competition
I	Trade-related investment measures
J	Distribution restrictions
K	Restrictions on post-sales services
L	Subsidies (excluding export subsidies under P7)
M	Government procurement restrictions
N	Intellectual property
O	Rules of origin
P	Export-related measures

Source: UNCTAD (2015).

Table 3: Share (%) of agri-food products subject to NTMs and average number of NTMs per agri-food products, by country

Country	Share of HS6 agri-food products with at least			Avge. nb. (per HS6 agri-food product) of		
	one SPS	one TBT	one other NTM	SPS	TBT	other NTMs
Mean	*88.2*	*72.6*	*66.9*	*6.7*	*3.2*	*2.8*
Afghanistan	42.5	12.8	42.5	3.3	3.0	1.7
Argentina	99.8	99.2	100	7.9	2.8	3.3
Australia	100	100	100	12.6	6.2	3.2
Benin	83.9	50.2	100	9.4	2.4	8.7
Bolivia	100	100	8.6	4.5	4.6	1.7
Brazil	99.5	99.8	43.4	7.8	8.2	1.2
Brunei	96.4	86.6	88.6	5.9	3.0	1.5
Burkina Faso	99.1	16.0	100	2.8	1.0	2.5
Cambodia	88.6	97.4	100	6.4	4.5	2.8
Canada	95.3	100	100	8.9	8.3	2.2
Cape Verde	83.7	82.8	100	7.3	3.1	7.2
Chile	99.1	92.6	9.3	6.5	2.4	1.0
China	96.5	80.3	12.5	8.3	2.3	1.5
Colombia	98.8	100	99.5	5.6	5.3	1.9
Costa Rica	63.7	66.6	6.9	4.7	4.3	1.1
Cote d'Ivoire	23.3	1.5	100	1.5	1.0	1.8
Cuba	41.3	86.1	86.1	3.1	1.0	1.0
Ecuador	57.7	57.5	44.3	6.8	4.1	1.5
El Salvador	78.8	66.0	0.3	3.4	2.1	2.0
Ethiopia	89.2	89.0	100	8.0	3.4	9.6
European Union	95.0	98.5	13.6	12.7	3.4	1.8
Gambia	82.5	80.3	99.8	10.2	5.0	2.3
Ghana	95.2	84.8	100	5.7	5.7	4.1
Guatemala	98.6	87.3	5.1	10.3	1.9	1.1
Guinea	98.6	98.6	98.6	2.2	2.3	9.3
Honduras	94.6	22.3	1.5	7.6	2.7	1.0
India	94.7	97.6	100	9.3	3.2	3.2
Indonesia	94.3	61.3	69.6	7.3	2.6	1.5
Japan	96.2	97.4	57.5	11.2	2.6	1.7
Kazakhstan	94.9	38.4	59.3	3.2	1.1	1.1
Lao	96.7	24.5	100	5.0	1.5	4.3
Liberia	100	81.9	17.3	9.9	1.3	1.2
Malaysia	94.9	99.2	47.4	5.6	3.0	2.3
Mali	99.1	12.3	100	3.9	1.5	8.5
Mexico	97.0	97.0	43.2	5.6	3.5	1.2
Myanmar	97.9	85.7	88.4	7.0	2.5	2.1
Nepal	83.4	100	100	1.3	2.2	6.0
New Zealand	95.0	90.2	100	11.8	3.5	3.1
Nicaragua	93.5	74.7	25.8	8.6	3.1	1.2
Niger	92.0	7.1	100	2.7	3.1	6.5
Nigeria	80.1	38.1	37.5	9.8	1.1	1.2
Pakistan	77.4	4.5	100	1.3	1.0	2.1
Panama	94.0	20.6	91.9	6.5	2.2	1.1
Paraguay	98.5	93.4	9.0	3.5	3.1	1.1
Peru	95.2	98.3	8.6	7.0	5.1	1.1
Philippines	98.8	95.0	100	11.6	3.4	8.5
Senegal	94.4	13.6	18.5	3.1	1.0	1.3
Singapore	88.6	100	91.4	7.4	2.8	1.2
Sri Lanka	85.2	88.3	100	4.1	4.8	4.6
Tajikistan	95.9	30.6	4.5	2.4	1.1	1.0
Thailand	83.7	88.7	86.4	10.1	3.1	1.1
Togo	20.0	79.1	100	2.9	4.0	4.0
United States	100	98.5	100	14.0	7.7	1.9
Uruguay	94.6	95.0	28.3	4.6	4.0	1.1
Venezuela	100	100	100	7.1	4.9	2.9
Vietnam	100	100	100	12.7	2.9	3.1

Note: The shares are computed by dividing the number of HS6 agri-food products subject to SPS, TBT, and other NTMs by the total number of HS6 agri-food products (i.e. 664 after the conversion between different versions of the HS classification). The average numbers of SPS, TBT, and other NTMs per HS6 agri-food product are computed using only products subject to at least one measure. Products without NTMs are not included in the calculation.

Table 4: Agri-food products exported by France and subject to NTMs in the destination country

Country	Nb. of agri-food pducts. exported by France	Share (%) of HS6 agri-food products with at least one SPS	one TBT	one other NTM	Avge. number (per HS6 agri-food product) of SPS	TBT	other NTMs	Share (%) of French agri-food exports not subject to SPS/TBT
Mean	*152.2*	*89.7*	*77.9*	*70.7*	*6.0*	*2.9*	*2.4*	*6.5*
Afghanistan	66	19.7	10.6	27.3	1.2	0.8	1.0	97.3
Argentina	106	100	100	100	7.7	2.7	2.9	0.0
Australia	242	100	100	100	13.1	6.4	3.3	0.0
Benin	319	97.2	47.6	100	8.9	1.4	9.3	0.5
Bolivia	23	100	100	30.4	4.3	4.8	0.7	0.0
Brazil	217	99.1	100	37.8	7.4	8.6	0.4	0.0
Brunei	7	100	100	100	6.1	1.9	1.3	0.0
Burkina Faso	200	100	7.0	100	2.9	0.1	2.6	0.0
Cambodia	133	94.7	100	100	4.2	3.9	1.8	0.0
Canada	329	97.0	99.7	99.7	7.5	8.6	2.3	0.0
Cape Verde	25	96.0	84.0	100	6.4	2.5	7.6	0.4
Chile	148	100	95.3	20.3	6.2	2.5	0.2	0.0
China	299	97.7	82.6	12.4	7.8	2.1	0.2	1.6
Colombia	135	100	100	100	5.8	6.1	1.9	0.0
Costa Rica	40	60.0	92.5	35.0	2.2	3.6	0.4	1.7
Cote d'Ivoire	393	27.2	2.5	100	0.4	0.0	1.9	43.6
Cuba	47	46.8	91.5	91.5	1.5	1.0	1.0	90.0
Ecuador	58	48.3	46.6	29.3	6.3	3.9	1.0	29.0
El Salvador	25	88.0	88.0	0.0	3.0	2.0	0.0	5.6
Ethiopia	48	91.7	91.7	100	7.0	3.0	10.2	0.0
European Union	659	95.0	98.3	13.5	12.2	3.4	0.2	0.3
Gambia	46	95.7	95.7	100	7.7	3.1	2.2	0.7
Ghana	152	98.0	91.4	100	5.7	5.6	4.1	0.1
Guatemala	54	94.4	87.0	22.2	9.5	2.6	0.2	1.1
Guinea	162	98.8	98.8	98.8	2.3	2.2	9.4	2.6
Honduras	27	92.6	63.0	18.5	5.4	1.7	0.2	0.0
India	189	93.7	98.4	100	8.9	3.1	3.2	0.4
Indonesia	165	93.3	75.2	66.1	5.0	2.7	1.2	0.8
Japan	382	97.1	98.2	54.5	10.7	2.6	1.0	0.2
Kazakhstan	99	98.0	64.6	75.8	3.2	0.8	1.0	0.0
Lao	77	100	68.8	100	5.5	0.8	4.4	0.0
Liberia	125	100	97.6	14.4	11.1	1.5	0.2	0.0
Malaysia	200	98.5	98.5	35.0	5.3	2.7	0.6	0.0
Mali	181	100	9.9	100	3.8	0.1	8.7	0.0
Mexico	163	94.5	98.8	34.4	5.6	3.6	0.4	0.0
Myanmar	21	95.2	81.0	81.0	5.7	1.8	1.2	0.9
Nepal	17	94.1	100	100	1.1	2.1	6.0	0.0
New Zealand	153	100	94.8	100	11.5	3.8	3.2	0.0
Nicaragua	12	91.7	75.0	41.7	6.9	2.7	0.6	0.0
Niger	190	94.2	1.6	100	2.4	0.0	6.4	1.5
Nigeria	180	91.7	63.9	29.4	9.0	0.7	0.4	22.2
Pakistan	89	79.8	10.1	100	1.0	0.1	2.1	8.7
Panama	61	96.7	18.0	86.9	6.2	0.6	1.0	0.1
Paraguay	29	96.6	100	51.7	2.5	3.0	0.6	0.0
Peru	74	95.9	100	36.5	6.7	5.0	0.4	0.0
Philippines	180	99.4	98.3	100	10.2	3.8	7.7	0.0
Senegal	336	93.8	5.7	17.6	2.9	0.1	0.2	18.4
Singapore	291	96.2	100	97.6	7.4	3.1	1.1	0.0
Sri Lanka	61	82.0	88.5	100	3.1	4.1	4.7	0.5
Tajikistan	65	100	63.1	15.4	2.4	0.7	0.2	0.0
Thailand	246	92.3	94.7	91.5	10.1	3.1	1.2	6.8
Togo	221	13.6	87.8	100	0.4	3.5	4.0	30.2
United States	366	99.7	97.5	99.7	13.8	7.4	1.6	0.0
Uruguay	97	95.9	95.9	22.7	4.1	4.1	0.3	0.6
Venezuela	65	100	100	100	6.4	5.2	3.2	0.0
Vietnam	226	100	100	100	12.9	2.6	3.1	0.0

Note: In columns (2)-(4), shares are computed by dividing the number of HS6 agri-food products subject to at least one NTM (SPS, TBT or other NTMs) and the total number of HS6 agri-food products exported by France to each destination. The statistics on the average number of NTMs (SPS, TBT, other NTMs) per HS6 agri-food product are computed only on products subject to at least one NTM (SPS, TBT or other NTMs). Products without NTMs are not included in the calculation. In the last column, the agri-food exports in value are used for the computation of the share.

Table 5: Extensive margin: probability of export

	Probability of export (Prob(y_{fkj}=1))			
	(1)	(2)	(3)	(4)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	0.000	-0.002	0.002	-0.010[a]
	(0.000)	(0.002)	(0.001)	(0.002)
Ln (1 + nb. SPS_{kj}) × $Productivity_f$		0.000		0.003[a]
		(0.000)		(0.000)
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	-0.002[a]	-0.007[b]	-0.001	-0.024[a]
	(0.001)	(0.004)	(0.001)	(0.004)
Ln (1 + nb. TBT_{kj}) × $Productivity_f$		0.001		0.006[a]
		(0.001)		(0.001)
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	-0.001[a]	-0.005[a]	0.000	-0.005[a]
	(0.000)	(0.001)	(0.001)	(0.001)
Ln (1 + nb. SPS & TBT_{kj}) × $Productivity_f$		0.001[a]		0.001[a]
		(0.000)		(0.000)
Ln (1 + other $NTMs)_{kj}$	0.004[a]	0.004[a]	0.013[a]	0.003
	(0.001)	(0.001)	(0.003)	(0.002)
Ln(1 + $Tariff)_{kj}$	-0.003	-0.005[c]	-0.008	-0.011[b]
	(0.002)	(0.002)	(0.007)	(0.005)
Product $rank_{fk}$	-0.002[a]	-0.002[a]		
	(0.000)	(0.000)		
Observations	4062240	3125382	4709484	3298620
R^2	0.541	0.528	0.191	0.224
Fixed effects:				
$Firm-Destination_{fj}$ & $Product_k$	Yes	Yes	-	-
$Firm-Product_{fk}$ & $Destination_j$	-	-	Yes	Yes

Note: The dependent variable is the probability for firm f to export product k to destination j in 2012. Robust standard errors in parentheses, clustered by HS6 product-destination level, with [a], [b] and [c] denoting significance at the 1%, 5% and 10% level respectively.

Table 6: Intensive margin: value of exports

	Value of exports (V_{fkj})			
	(1)	(2)	(3)	(4)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	0.139[b]	-1.175[a]	0.192[a]	-0.501[c]
	(0.060)	(0.313)	(0.063)	(0.290)
Ln (1 + nb. SPS_{kj}) × $Productivity_f$		0.280[a]		0.163[a]
		(0.070)		(0.063)
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	-0.046	0.221	0.128	-0.777[c]
	(0.093)	(0.537)	(0.084)	(0.403)
Ln (1 + nb. TBT_{kj}) × $Productivity_f$		-0.032		0.203[b]
		(0.115)		(0.086)
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	0.035	-0.587[a]	0.098[b]	-0.741[a]
	(0.049)	(0.221)	(0.048)	(0.161)
Ln (1 + nb. SPS & TBT_{kj}) × $Productivity_f$		0.130[a]		0.184[a]
		(0.048)		(0.033)
Ln (1 + other $NTMs)_{kj}$	0.028	-0.017	0.006	0.007
	(0.047)	(0.050)	(0.059)	(0.065)
Ln(1 + $Tariff)_{kj}$	-0.581[a]	-0.378[c]	-0.467[b]	-0.576[a]
	(0.207)	(0.224)	(0.185)	(0.210)
Product $rank_{fk}$	-0.214[a]	-0.255[a]		
	(0.003)	(0.004)		
Firm already present in that hs6 & iso3 in t-1	1.115[a]	1.113[a]	1.057[a]	1.083[a]
	(0.019)	(0.021)	(0.020)	(0.021)
Firm already present in that hs6 & iso3 in t-2	1.016[a]	1.028[a]	0.929[a]	0.954[a]
	(0.019)	(0.020)	(0.019)	(0.021)
Observations	128279	103649	136333	104327
R^2	0.698	0.698	0.698	0.697
Fixed effects:				
$Firm\text{-}Destination_{fj}$& $Product_k$	Yes	Yes	-	-
$Firm\text{-}Product_{fk}$& $Destination_j$	-	-	Yes	Yes

Note: The dependent variable is the value of exports by firm f of product k to destination j in 2012. Robust standard errors in parentheses, clustered by HS6 product-destination level, with [a], [b] and [c] denoting significance at the 1%, 5% and 10% level respectively.

Table 7: Intensive margin: quality-adjusted prices

	Quality-adjusted prices ($\tilde{p}_{fkj}$)			
	(1)	(2)	(3)	(4)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	-0.044^{b}	0.390^{a}	-0.061^{a}	0.109
	(0.020)	(0.106)	(0.022)	(0.094)
Ln (1 + nb. SPS_{kj}) × Productivity_f		-0.093^{a}		-0.041^{b}
		(0.024)		(0.021)
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	0.014	-0.052	-0.039	0.247^{c}
	(0.031)	(0.186)	(0.028)	(0.135)
Ln (1 + nb. TBT_{kj}) × Productivity_f		0.005		-0.064^{b}
		(0.040)		(0.029)
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	-0.011	0.224^{a}	-0.034^{b}	0.243^{a}
	(0.017)	(0.077)	(0.017)	(0.054)
Ln (1 + nb. SPS & TBT_{kj}) × Productivity_f		-0.050^{a}		-0.061^{a}
		(0.017)		(0.011)
Ln (1 + other $\text{NTMs})_{kj}$	-0.009	0.005	0.000	-0.001
	(0.016)	(0.017)	(0.020)	(0.022)
$\text{Ln(1 + Tariff)}_{kj}$	0.201^{a}	0.134^{c}	0.168^{a}	0.200^{a}
	(0.069)	(0.074)	(0.062)	(0.071)
Product rank_{fk}	0.072^{a}	0.085^{a}		
	(0.001)	(0.001)		
Firm already present in that hs6 & iso3 in t-1	-0.372^{a}	-0.370^{a}	-0.350^{a}	-0.358^{a}
	(0.006)	(0.007)	(0.007)	(0.007)
Firm already present in that hs6 & iso3 in t-2	-0.338^{a}	-0.342^{a}	-0.308^{a}	-0.318^{a}
	(0.006)	(0.007)	(0.006)	(0.007)
Observations	125772	102098	133330	102626
R^2	0.818	0.815	0.823	0.814
Fixed effects:				
$\text{Firm-Destination}_{fj}$& Product_k	Yes	Yes	-	-
Firm-Product_{fk}& Destination_j	-	-	Yes	Yes

Note: The dependent variable is the quality-adjusted prices of product k sold by firm f in destination j in 2012. Robust standard errors in parentheses, clustered by HS6 product-destination level, with ^{a}, ^{b} and ^{c} denoting significance at the 1%, 5% and 10% level respectively.

Table 8: Intensive margin: average quality

	Average quality
	(1)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	0.246^b
	(0.121)
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	-0.066
	(0.173)
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	0.116
	(0.089)
Ln (1 + other $NTMs)_{kj}$	0.020
	(0.093)
Ln(1 + $Tariff)_{kj}$	-2.203^a
	(0.375)
Observations	18415
R^2	0.004
$Destination_j$ & $Product_k$	Yes

Note: The dependent variable is the average quality of product k in destination j in 2012. Robust standard errors in parentheses, with ^{a}, ^{b} and ^{c} denoting significance at the 1%, 5% and 10% level respectively.

Table 9: Robustness check: EU destinations excluded

	EUdestinationsexcluded						
	EM		IM Value		IM Qual.-Adj. Prices		IM Avg. Qual.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	0.001	-0.000	-0.931[c]	-0.292	0.287[c]	0.027	0.177
	(0.002)	(0.002)	(0.488)	(0.268)	(0.164)	(0.084)	(0.135)
Ln (1 + nb. SPS_{kj}) × $Productivity_f$	-0.000	0.001[a]	0.238[b]	0.120[b]	-0.074[b]	-0.025	
	(0.000)	(0.000)	(0.108)	(0.058)	(0.036)	(0.018)	
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	-0.000	-0.015[a]	-0.862	-0.524	0.301	0.160	0.022
	(0.003)	(0.004)	(0.889)	(0.426)	(0.303)	(0.137)	(0.236)
Ln (1 + nb. TBT_{kj}) × $Productivity_f$	0.000	0.004[a]	0.216	0.140	-0.075	-0.042	
	(0.001)	(0.001)	(0.190)	(0.090)	(0.065)	(0.029)	
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	-0.001	0.004[a]	-0.435	-0.495[a]	0.147	0.153[a]	0.127
	(0.001)	(0.001)	(0.472)	(0.159)	(0.158)	(0.052)	(0.109)
Ln (1 + nb. SPS & TBT_{kj}) × $Productivity_f$	0.000	-0.001[b]	0.112	0.137[a]	-0.038	-0.044[a]	
	(0.000)	(0.000)	(0.104)	(0.032)	(0.035)	(0.010)	
Ln (1 + other $NTMs)_{kj}$	-0.000	0.000	-0.111	-0.016	0.039	0.005	-0.134
	(0.001)	(0.002)	(0.113)	(0.081)	(0.038)	(0.028)	(0.144)
Ln(1 + $Tariff)_{kj}$	-0.001	-0.015[a]	-0.317	-0.395[c]	0.105	0.136[c]	-1.644[a]
	(0.002)	(0.005)	(0.313)	(0.232)	(0.104)	(0.079)	(0.375)
Product $rank_{fk}$	-0.001[a]		-0.179[a]		0.060[a]		
	(0.000)		(0.007)		(0.002)		
Firm already present in that hs6 & iso3 in t-1			1.187[a]	1.091[a]	-0.390[a]	-0.354[a]	
			(0.050)	(0.045)	(0.017)	(0.014)	
Firm already present in that hs6 & iso3 in t-2			1.095[a]	0.897[a]	-0.363[a]	-0.299[a]	
			(0.048)	(0.043)	(0.016)	(0.014)	
Observations	2123657	2241370	18273	19935	17857	19478	7241
R^2	0.441	0.136	0.693	0.655	0.812	0.800	0.122
Fixed effects:							
$Firm\text{-}Destination_{fj}$& $Product_k$	Yes	-	Yes	-	Yes	-	-
$Firm\text{-}Product_{fk}$& $Destination_j$	-	Yes	-	Yes	-	Yes	-
$Destination_j$ & $Product_k$	-	-	-	-	-	-	Yes

Note: The dependent variable is the value of exports by firm f of product k to destination j in 2012. Robust standard errors in parentheses, clustered by HS6 product-destination level, with [a], [b] and [c] denoting significance at the 1%, 5% and 10% level respectively.

Table 10: Robustness check: All HS6 products

	All products						
	EM		IM Value		IM Qual.-Adj.Prices		IM Avg. Qual.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln (1 + nb. SPS_{kj}) if $NTMs_{kj}$=SPS_{kj}	-0.002^{b}	-0.008^{a}	0.062	-0.018	-0.032	0.002	0.185^{a}
	(0.001)	(0.001)	(0.110)	(0.134)	(0.037)	(0.044)	(0.059)
Ln (1 + nb. SPS_{kj}) × $Productivity_f$	0.001^{a}	0.003^{a}	-0.023	-0.030	0.010	0.011	
	(0.000)	(0.000)	(0.024)	(0.030)	(0.008)	(0.010)	
Ln (1 + nb. TBT_{kj}) if $NTMs_{kj}$=TBT_{kj}	-0.004^{a}	-0.015^{a}	-0.074^{b}	-0.151^{a}	0.019^{c}	0.061^{a}	0.139^{a}
	(0.001)	(0.001)	(0.032)	(0.041)	(0.011)	(0.014)	(0.026)
Ln (1 + nb. TBT_{kj}) × $Productivity_f$	0.001^{a}	0.004^{a}	0.019^{b}	0.021^{b}	-0.006^{b}	-0.010^{a}	
	(0.000)	(0.000)	(0.007)	(0.009)	(0.002)	(0.003)	
Ln (1 + nb. SPS & TBT_{kj}) if $NTMs_{kj}$=SPS_{kj} & TBT_{kj}	-0.009^{a}	-0.007^{a}	-0.292^{a}	-0.116^{a}	0.097^{a}	0.055^{a}	0.061^{b}
	(0.001)	(0.001)	(0.034)	(0.040)	(0.011)	(0.014)	(0.027)
Ln (1 + nb. SPS & TBT_{kj}) × $Productivity_f$	0.002^{a}	0.002^{a}	0.063^{a}	0.018^{b}	-0.021^{a}	-0.009^{a}	
	(0.000)	(0.000)	(0.007)	(0.009)	(0.003)	(0.003)	
Ln (1 + other $NTMs)_{kj}$	-0.001^{c}	0.001	0.033^{c}	0.011	-0.002	-0.001	-0.021
	(0.000)	(0.001)	(0.017)	(0.023)	(0.006)	(0.008)	(0.043)
Ln(1 + $Tariff)_{kj}$	-0.029^{a}	-0.073^{a}	-0.336^{a}	-0.495^{a}	0.112^{a}	0.159^{a}	-3.833^{a}
	(0.001)	(0.003)	(0.113)	(0.150)	(0.038)	(0.051)	(0.251)
Product $rank_{fk}$	-0.003^{a}		-0.164^{a}		0.055^{a}		
	(0.000)		(0.001)		(0.000)		
Firm already present in that hs6 & iso3 in t-1			0.893^{a}	-0.319^{a}	-0.319^{a}	-0.291^{a}	
			(0.006)	(0.006)	(0.002)	(0.002)	
Firm already present in that hs6 & iso3 in t-2			0.774^{a}	-0.296^{a}	-0.296^{a}	-0.255^{a}	
			(0.006)	(0.006)	(0.002)	(0.002)	
Observations	27947790	28793388	1070311	978545	1039987	952101	148362
R^2	0.439	0.202	0.639	0.710	0.859	0.885	0.003
Fixed effects:							
$Firm\text{-}Destination_{fj}$& $Product_k$	Yes	-	Yes	-	Yes	-	-
$Firm\text{-}Product_{fk}$& $Destination_j$	-	Yes	-	Yes	-	Yes	-
$Destination_j$ & $Product_k$	-	-	-	-	-	-	Yes

Note: The dependent variable is the value of exports by firm f of product k to destination j in 2012. Robust standard errors in parentheses, clustered by HS6 product-destination level, with ^{a}, ^{b} and ^{c} denoting significance at the 1%, 5% and 10% level respectively.