No 2025-01 – January

# Working Paper

CEPII

# When Quality Management Helps Agri-food Firms to Export

Charlotte Emlinger & Karine Latouche

## Highlights

- The paper highlights the role of agri-food firms' "quality investment" in export performance.
- Using French administrative data at the employee and firm level, we assess the level of firms' commitment to issues related to product reliability and safety through the presence of quality management personnel.
- We show that firms with quality management employees have better market penetration, export higher volumes and have longer trade relationships, especially in markets with high standards requirements.

This work received financial support from the H2020-RIA research project BATModel, grant number 861932

## Abstract

This article examines the impact of firms' quality policies on export performance. Using French administrative data at the employee and firm level, we assess the level of firms' commitment to issues related to product reliability and safety through the presence of quality management personnel. We merge these data with French customs data, which provide the value and quantity of exports for each firm by product and destination. We show that firms with quality management employees have better market penetration, export higher volumes and have longer trade relationships, especially in markets with high standards requirements (higher number of sanitary and phytosanitary or technical measures). Overall, our paper highlights the role of agri-food firms' "quality investment" in export performance and emphasizes that product quality is not limited to product differentiation perceived by the final consumer. Product traceability and reliability are essential factors for firms' competitiveness, especially in the context of global value chains.



## Keywords

Quality Management, Trade Margins, Trade Duration, Non-tariff-Measures.

## JEL

F14.



Working Paper

CEPII





Centre d'études prospectives
et d'informations internationales
20, avenue de Ségur
TSA 10726
75334 Paris Cedex 07

contact@cepii.fr
www.cepii.fr – @CEPII_Paris
Press contact: presse@cepii.fr



*CEPII Working Paper*
Contributing to research in international economics

CEPII (Centre d'Études Prospectives et d'Informations Internationales) is a French institute dedicated to producing independent, policy-oriented economic research helpful to understand the international economic environment and challenges in the areas of trade policy, competitiveness, macroeconomics, international finance and growth.

Editorial Director:
Antoine Bouët

Visual design and production:
Laure Boivin

ISSN 2970-491X

January 2025

To subscribe to
*The CEPII Newsletter*:
www.cepii.fr/KeepInformed






# 1 Introduction

From the Bovine Spongiform Encephalopathy outbreak in the 90's to the milk powder scandal in China in 2008, food safety incidents have led to an increasing demand for traceability and safety of food products, from both consumers and distributors. Governments have answered to this demand by strengthening public regulation on their territory (see for example the European Community Regulation 178/2002 on food traceability) or by increasing the number of Sanitary and Phytosanitary measures (SPS) and Technical barriers to trade (TBT) at the border. The private sector also implemented several certifications to facilitate the standardization of safety and traceability (HACCP, ISO standards) or to manage the buyer-supplier relationship (IFS, BRC retailers standards).[1]

Therefore, the ability to make safe products, to ensure traceability and to have it recognized through certification appears to be an essential element of the international competitiveness of agri-food companies. Even if these characteristics are not systematically observed by final consumers, they may help to access to markets with high levels of sanitary requirements or to build trusting relationship with buyers.

In this paper, we investigate the impact of firms' investments to traceability and food safety on export performance. We rely on the presence of quality management and control personnel in agri-food firms as a proxy for their commitment to product reliability and safety issues. These employees ensure that the firm's products meet quality criteria, customer expectations and regulatory requirements. We assume that firms with dedicated staff place greater emphasis on the traceability and safety of their products. Using French administrative data on employees at the firm level, merged with French customs data, we measure the effect of firms' quality management first on trade margins and second on the duration of trade relationships.

Our results show that firms with quality control and management personnel have a higher export value and probability, but that this effect is limited to destination-products where non-tariff measures are implemented. This result suggests that firms employing quality management personnel are better able to meet standards in foreign markets than other firms. Quality control and management are also found to increase the duration of trade, confirming that firms' commitment to

[1] HACCP stands for Hazard Analysis Critical Control Point. It is a method for preventing and identifying hazards associated with food hygiene practices. ISO is the International Organization for Standardization which define international standards such as ISO9000 which is a class of standards dedicated to quality management. IFS and BRC stand for International Food Standard and British Retail Consortium are both private certification required by European retailers.

traceability and food safety helps firms to maintain long relationships with buyers, either by reducing the problems they encounter, or by improving the reliability and reputation of their products. This effect is stronger in markets with non-tariff measures, again suggesting that quality management helps firms to cope with more stringent requirements. Overall, we show that traceability and safety are essential elements in the competitiveness of firms in foreign markets. This aspect is often neglected because this type of quality is not directly observable by consumers. However, having safer and more reliable products can reduce failures in foreign markets and enhance a firm's reputation.

The effect of firms' quality control and management on trade has not been studied in the literature to our knowledge. This paper is however linked to the literature on traceability and quality in the food supply chain. A first strand investigates the effect of traceability and quality management systems on firm competitiveness. Alfaro and Rábade (2009) use a case study in the Spanish vegetable industry and show that traceability systems do not only guarantee food safety, but also give quantitative and qualitative advantages along the different stage of the supply chain, which has also been highlighted by Epelbaum and Martinez (2014) and Aiello et al. (2015). A second strand of literature focuses on the valuation of food traceability systems by consumers, assessing their willingness to pay through choice experiment. Gao and Schroeder (2009), Gracia et al. (2013), and Liu et al. (2019), among others, highlight the heterogeneity of the willingness to pay for traceability information and quality certification among consumers. In this paper, we focus on the impact of quality management on firms' export margins and trade duration, to assess the effect of firms' quality commitments on international competitiveness.

Our work contributes to the extensive literature on quality and trade. In a recent work, Bonfiglioli et al. (2025) show that within a given industry, countries characterized by larger firm heterogeneity in term of quality-price ratio, export relatively more. At firm level, Verhoogen (2008), Manova and Zhang (2012) and Baldwin and Harrigan (2011), among others, show that quality is an important component of a firm's export success. This outcome is confirmed for the agri-food sector by Crozet et al. (2012) and Curzi and Olper (2012) who demonstrate that quality increases both the probability of market entry and the amount of exported values. Quality may also change the geography of trade as underlined by Fan et al. (2018) who show that quality upgrading leads Chinese firms to reorient their exports to high income countries. The majority of empirical studies on trade uses indirect measures to proxy a product's quality. Hummels and Skiba (2004), Schott (2004), Schott (2008) and Hummels and Klenow (2005) use trade unit values, assuming that higher

prices correspond to higher quality of goods. Khandelwal (2010) (developed in Amiti and Khandelwal (2013)) proposes an indirect measure of quality derived from econometric estimation and widely used in literature in recent years. Few studies use direct quality measures to assess the quality of products. A notable exception is Crozet et al. (2012) and Chen and Juvenal (2016), who use quality ranking by experts and show that quality increases firm-level price, probability of market entry and export values. Hansman et al. (2020) rely on a direct measure of fish quality in the Peruvian fishmeal industry to assess the impact of organizational structure on quality upgrading. R&D and innovation are also used as a proxy for quality of products at the firm level, as in Curzi and Olper (2012) or Kugler and Verhoogen (2012). Our approach differs as we consider another dimension of quality differentiation, which is the safety and traceability of products. This component of the goods' quality may not be directly observable by final consumers but is essential. Having safer and more reliable production lines reduces risks, enhances firm's reputation with business partners and helps firms to comply with stricter sanitary standards.

Our paper also relates to the literature on standards and their effect on trade. An abundant empirical trade literature deals with NTMs which are public regulations applied at the border and within each countries. These works provide mixed evidence on NTMs effect on trade (see Santeramo and Lamonaca (2019) and Disdier and Fugazza (2020) for a summary). Peterson et al. (2013), Fontagné et al. (2015) and Murina and Nicita (2015) show that US and European SPS measures act as a trade barriers. This is confirmed by Grundke and Moser (2019), demonstrating that enforcement of US standards induce a counter-cyclical, hidden protectionist effect. On the other hand, Crivelli and Groeschl (2015) and de Frahan (2006) suggest that NTMs can positively impact trade. Xiong and Beghin (2014) confirm the ambiguous effect of NTMs on trade by showing that NTMs both enhance import demand and reduce foreign exporters' supply. Few papers deal with private standards. Anders and Caswell (2009) show that HACCP requirement for seafood products in the USA acts as a trade catalyst for developed and big exporters and as a trade barrier for developing and small exporters. This paper does not focus on the impact of standards on trade but show how quality management help firms to export, particularly on markets with NTMs.

Finally, this article also refers to the literature on the duration of trade relationships. Early studies on this topic emphasize the fragility and volatility of trade relationships (Besedeš and Prusa (2006), Eaton et al. (2007), Bernard et al. (2010)). Besedeš (2008) shows especially the important role of reliability and search costs in the duration of trade relationships. More recent works highlight the role of some other determinants of trade duration. Trade development (Fugazza and Molina,

2016), competition in the destination market (Jaghdani et al., 2023) or institutional quality (Engemann et al., 2023) are found to increase trade survival, while Sanitary and Phytosanitary (SPS) treatments increase the average hazard rate (Peterson et al., 2018). Our paper investigates whether improving quality management at the firm level allows firms to have a higher survival rate.

The paper is structured as follows. In a first section, we explain the role of quality management and control personnel in agri-food firms and discuss how they can affect firms' export activities. In a second section, we describe the firm-employee dataset we use and provide some stylised facts on quality management and French firms' exports. In a third section, we present our empirical strategy for assessing the impact of quality management on trade margins and discuss our results. In a fourth section, we examine the impact of quality personnel on the trade duration of exporting firms. The last section concludes the paper.

## 2 Quality management and control

### 2.1 An increased demand in reliability and traceability

The industrialization of agri-food production and the development of retailer-driven supply chains have led to products' standardization over the last few decades. At the same time, various food safety incidents have led to an increasing demand for traceability and safety of food products. The number of sanitary and phytosanitary measures at the border has increased (Disdier and Fugazza, 2020), while domestic regulations have become more stringent. Various private standards such as IFS or GlobalGAP are now required for products to be sold on supermarket shelves while various labels help consumers to get more information about the products they buy.

In this context, along with greater competition, the absence of traceability systems or sanitary guarantee is costly in many ways for agri-food firms. In the short term, failures due to non-compliance lead to a decline in the firm's productivity, through an increase in the number of rejections, breakdowns or temporary stoppage of production lines. These failures also have a cost in terms of after-sales service, with possible product recalls, on-site interventions, or even penalties or legal action. In the long term, this "non-quality" leads to a decline in the firm's reputation and limits its opportunities, by restricting its access to specific export markets or the retail network.

The implementation of a strict quality and traceability policy enables firms to limit the various costs of non-compliance. Measuring the intensity of firms' commitment to these issues of reliability and safety is complex. Implementing quality protocols and a traceability system entails both

fixed and variable costs: investment in machinery and information systems, training of employees, recruitment of dedicated personnel... In this paper, we proxy the firm's investment in quality and traceability by the presence of quality management and control personnel in order to study the impact of firms' quality policy on export performance.

## 2.2 Quality management and control personnel

Quality management and control personnel are the employees in charge of the firm's products quality. They ensure that goods are safe, reliable and durable, that they meet customers' expectation and that they follow regulatory requirements. According to the size and the organization of the firm, the activities of the employees in charge of quality management may be manifold. They define the quality criteria to fulfill safety and regulatory requirements and design the quality protocols. They ensure that these protocols are followed by conducting inspections and testing at the different stages of the production, processing and distribution. They also have the responsibilities to create quality documentation along the chain of production, allowing to track and trace products through traceability systems. Finally, they report feedback from customers and analyse safety issues by improving processes.

Quality managers are therefore major players in the firm's quality policy, both in preventing failure and in copying with those that do occur. They play a key role in the adoption of standards and in their maintenance. Working both with the firms' other employees and with external partners such as suppliers, customers, health inspectors or customs, they can lead to better export performance through three channels.

First, quality control and management increase the effectiveness of operations and the efficiency of supply chains, through a better optimization of the processes. This leads to a reduction in losses or product deterioration and an increase in overall productivity, which may translate into higher export values.

Second, quality specialists help to ensure compliance with standards, whether private such as those of retail companies, or public such as sanitary, phyto-sanitary or technical measures. This leads to better access to foreign markets, both because quality personnel can ensure that products comply with legal requirements and because they can demonstrate compliance through a traceability system and appropriate documentation. As a result, we expect firms with quality management to have better access to markets with non-tariff measures and to export higher values to those markets.

Finally, the increase in product safety allowed by the implementation of quality systems limits

consumer exposure to potentially hazardous foods, and reduces recalls and consumer complaints. This risk reduction, combined with improved product traceability, enhances the reputation of firms among buyers, be intermediaries, retailers or final consumers. This confidence can come from a simple perception or from various certifications (such as HACCP, IFS or ISO), the implementation of which is facilitated by the presence of qualified and specialized personnel. Firms' commitment to traceability and food safety thus leads to a differentiation of products from the buyers' point of view, potentially bringing not only greater export competitiveness but also more stable business relationships. From a theoretical point of view, Belleflamme and Peitz (2014) show that certifications (such as ISO9000) help buyers to infer useful information about the expected quality of the product.

We expect quality control and management personnel to induce better export performance. More specifically, we anticipate that quality systems will increase both intensive and extensive trade by reducing fixed and variable export costs. We also expect firms with quality control to have longer trading relationships, as it reduces the risk of failure and helps firms to build long-term trusting relationships with their trading partners. These effects are assumed to be higher for exports to destinations with NTMs.

The remainder of the paper will use French firm data to test these assumptions. Of course, firms do not need to have a dedicated staff on quality management to be able to meet standards, to implement traceability systems and to keep customer satisfied. These tasks may be undertaken by other employees, or partly by external contractors. However, we expect firms that employ specialized employees to have stronger policies and capabilities in these areas, and, consequently, better export performance.

# 3 Data and descriptive statistics

## 3.1 Data

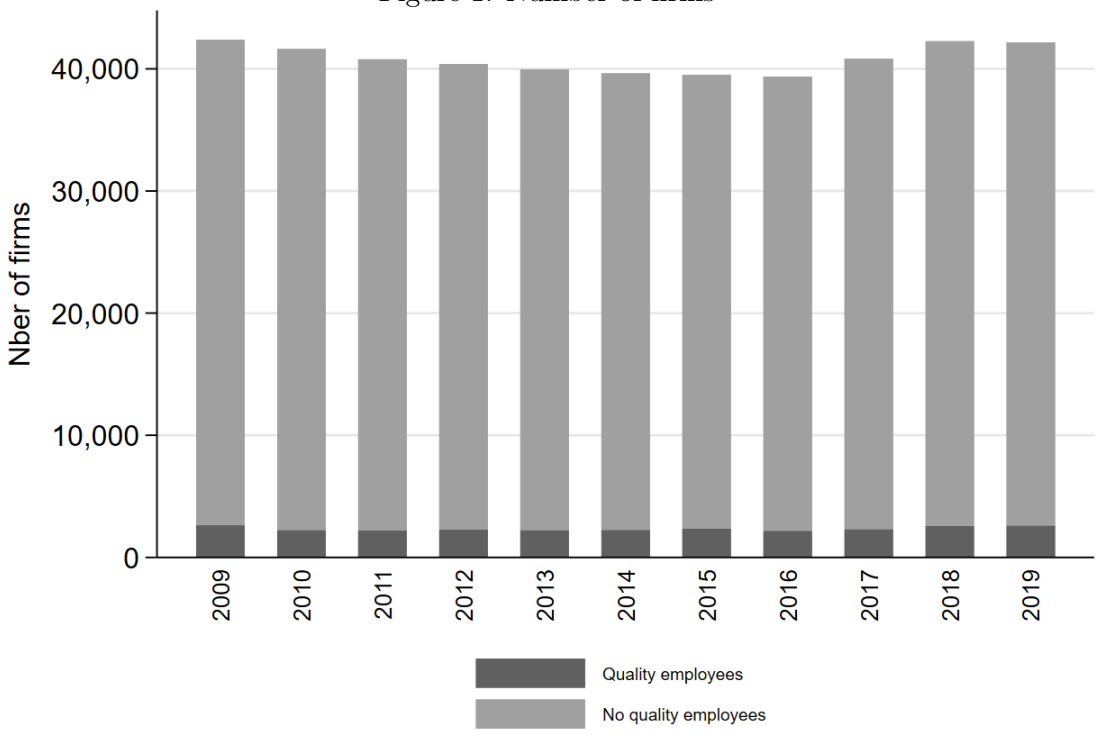
To study the impact of firms' commitment to product reliability and safety issues on trade we rely on French firm-level data on trade and employer-employee dataset from 2009 to 2019.

We assess the quality control and management commitment of firms using information from the DADS Poste dataset. The later is the compilation of annual compulsory declarations by all French private firms (excluding the self-employed) and provides for each firm the number of working hours, the total salary and the number of employees, by occupation.

From 2009 to 2019, 13,285,709 firms appear in the DADS Poste dataset, identified by a unique identifier SIREN. We restrict our sample to the 82,516 French agri-food firms (corresponding to the code 10 in the APE classification of firm's activities). This excludes not only service and manufacturing firms from our sample, but also wholesalers and retailers who may sell agri-food products but do not produce them. We only keep firms that were continuously active from 2009 to 2019 and end up with a dataset of 79,359 firms for the whole period.[2]

The occupation of each worker in the company is defined in the DADS database according to a 4-digits classification. Employees in quality control and management correspond to two occupations according to the DADS categories: "quality control manager and engineer" (387d) and "quality control technician for the processing industries" (475b). Figure 1 displays the number of agri-food firms from 2009 to 2019 with and without quality control and management employees. It appears that 7% of agri-food firms employ workers in quality control and management positions, which is much higher than the 0.5% obtained when considering all the firms present in the DADS. This proportion has not changed over the period.

Figure 1: Number of firms




[2]We keep firms that appeared during the period or who stopped their activities, but drop those that have several entries and exits from the dataset

The information on quality control and management from the DADS poste are merged with data on French firm-level trade on the same period. These data come from the French Customs and provide for each firm the quantity and value of exports, by destination, product (at the 6-digits level of the Harmonised System) and year. Only 6% of our agri-food firms in the DADS dataset export so if we reduce our sample to exporting firms, our sample has only 2,501 distinct firms.

### 3.2 Descriptive statistics : trade values

Figure 2 shows the number of exporting firms with and without quality control and management employees from 2009 to 2019. The comparison with figure 1 suggests that exporting firms tend to employ more staff dedicated to quality control and management than non exporting ones. 52% of agri-food exporting firms have quality employees in the DADS poste.

Figure 3 shows total French exports by agri-food firms. It distinguishes between trade by firms with quality management and control staff and trade by other firms. It appears that firms with quality personnel export more than firms without quality control and management since they account for more than 95% of trade, while they represent only half of the exporting firms as seen above.

This observation is confirmed by figure 4 which shows the kernel density of the export values and quantities by firm, destination, product and year. Firms with quality control and management personnel generate more flows with higher values or quantities than the other firms.

### 3.3 Descriptive statistics : trade duration

Employing staff dedicated to quality may impact not only trade values, but also the persistence of trade relationship between firms and their partners. To explore this issue, we define a spell $s$ as a period during which a firm $f$ exports a product $k$ to a destination $j$ without interruption. A given firm-destination-product trade relationship may correspond to several spells in our dataset if the firm starts exporting product $k$ to destination $j$, pauses for a while, and then starts exporting again. If the firm in our dataset exports without interruption, the firm-destination-product relationship corresponds to only one spell in the period 2009-2019.

Table 1 shows the distribution of the number of spells among the 229,651 firm-destination-product trade relationships in our sample. 81.98% of $(fjk)$ trade relationships have only one spell in the period 2009-2019, while 3% have 3 spells or more.

The average duration of spells for the whole sample is 2.73 years, which is rather low. This

Figure 2: Number of exporting firms

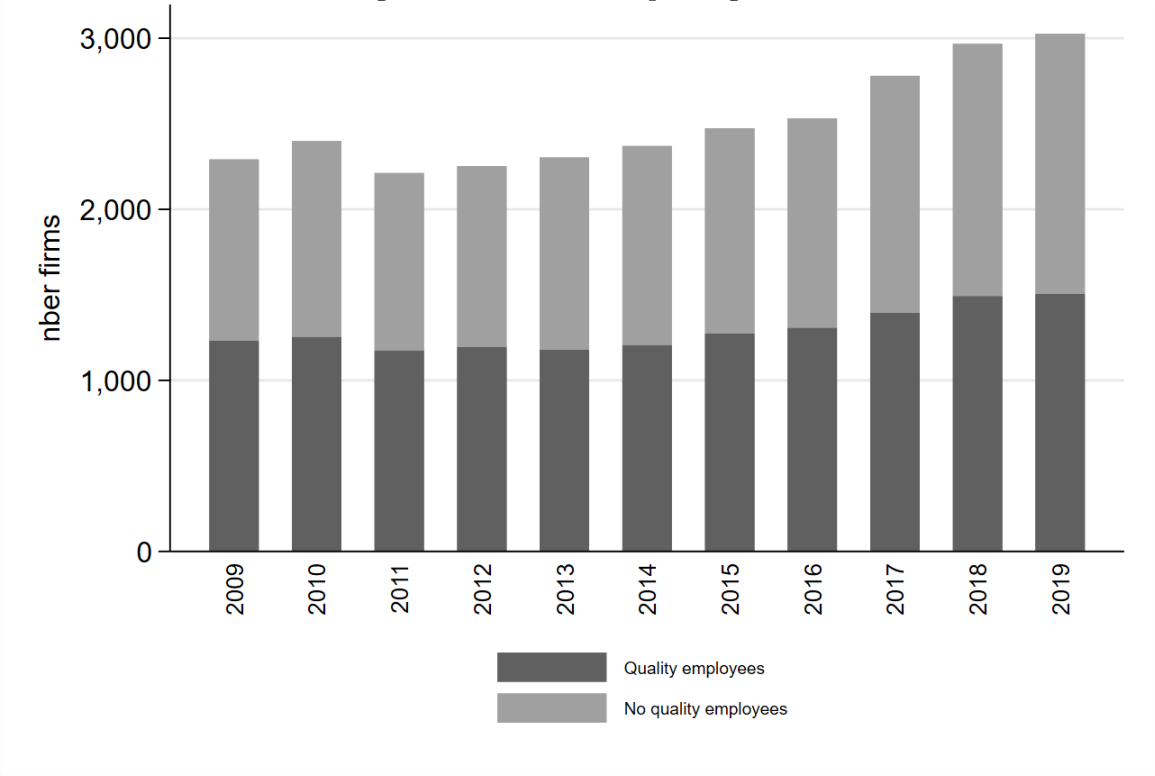


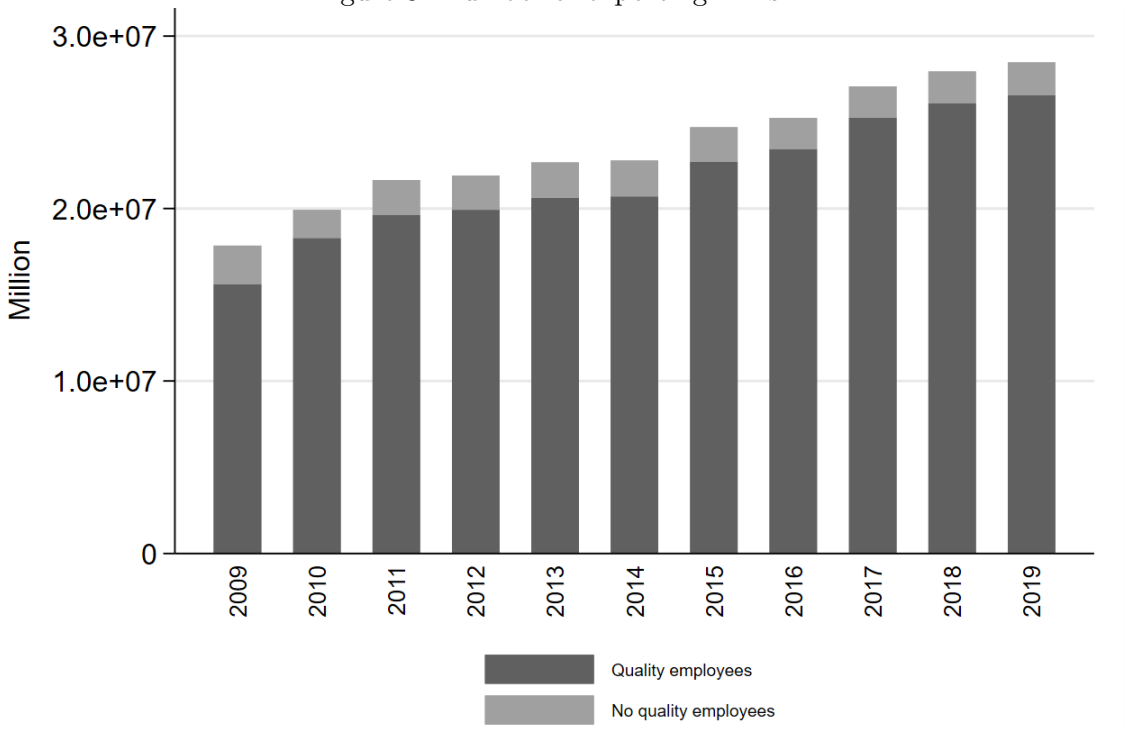

Table 1: Distribution of number of spells across firm-product-destination relationships

| Nb spells | Frequency | % |
|---|---|---|
| 1 | 188,261 | 81.98 |
| 2 | 33,959 | 14.79 |
| 3 | 6,538 | 2.85 |
| 4 | 850 | 0.37 |
| 5 | 42 | 0.02 |
| 6 | 1 | 0 |
| Total | 229,651 | 100 |

is in line with previous works on the duration of trade, such as Besedeš and Prusa (2006). The duration of spells is on average longer when firms have quality staff during the spell (2.96 years) than when firms do not have any (1.86, significant difference). French firms tend to have longer trade relationships with European partners (3.26 years on average) than with non-European partners (2.39 years significant difference).

Table 2 compares the distribution of spell duration for firms with and without quality management personnel. First, we can see that more than half of all spells last only one year, regardless of the type of firm. This result is in line with the literature describing the fragility of trade rela-

Figure 3: Number of exporting firms




tionships. For example, Bernard et al. (2010) show that trade relationships in US manufacturing are short-lived and product switching is high. Similar patterns have been found for the EU (Hess and Persson, 2012), Germany (Nitsch, 2009) or African countries (Cadot et al., 2013). Second, we observe that firms with quality management appear to have longer spells than the others. More than 18% of the spells of firms with quality staff last 5 years or more, while this is the case for only 10.6% of the spells of other firms. 5% of the spells of firms with quality management persist for the whole period (2009-2019), but only 2.56% of the spells of other firms survive the 11 years.

Descriptive statistics combining data on occupations and trade of French firms suggest that firms employing quality control and management personnel tend to export more than others and have longer trade relationships. The remainder of the paper analyzes in more detail the impact of quality management on export performance using an empirical model.

Figure 4: Number of exporting firms

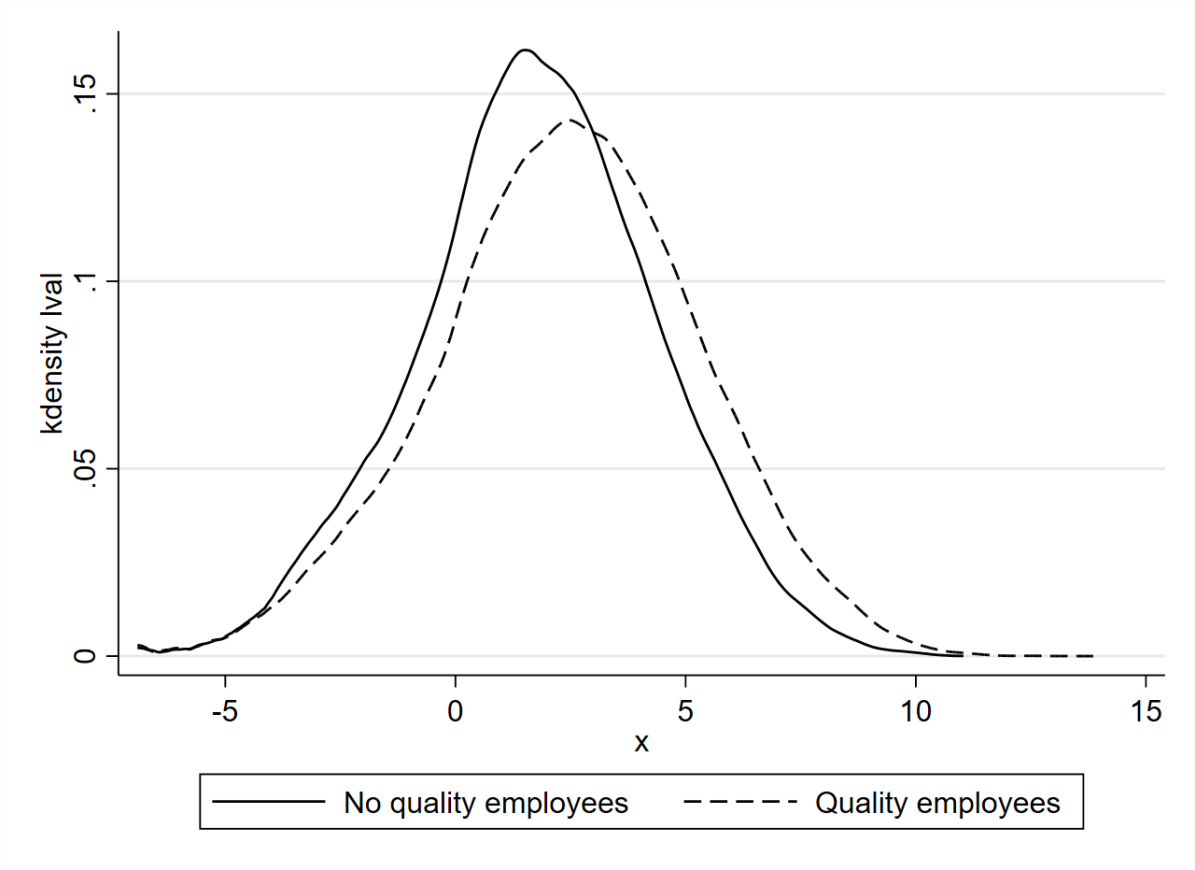



Table 2: Distribution of duration of spells relative to quality management personnel

| | Firms with no quality management personnel | | Firms with quality management personnel | |
|---|---|---|---|---|
| Nb year(s) | Frequency | % | Frequency | % |
| 1 | 38459 | 64.73 | 104621 | 47.56 |
| 2 | 10619 | 17.87 | 36988 | 16.81 |
| 3 | 4260 | 7.17 | 20552 | 9.34 |
| 4 | 1965 | 3.31 | 12507 | 5.69 |
| 5 | 1232 | 2.07 | 9807 | 4.46 |
| 6 | 764 | 1.29 | 6783 | 3.08 |
| 7 | 499 | 0.84 | 5156 | 2.34 |
| 8 | 421 | 0.71 | 4750 | 2.16 |
| 9 | 241 | 0.41 | 3099 | 1.41 |
| 10 | 144 | 0.24 | 3220 | 1.46 |
| 11 | 815 | 1.37 | 12507 | 5.69 |
| Total | 59419 | 100 | 219990 | 100 |

# 4 Quality management and the margins of trade

## 4.1 Empirical specification

Our empirical analysis assesses the impact of quality control and management employees on firm's export performance. We investigate both the extensive margin of trade (probability of export of the firm $f$ of product $k$ to destination $j$ the year $t$) and the intensive margin of trade (exported value). We estimate the following equation:

$$Exp_{fjkt} = \alpha_1 Quality_{ft} + \beta \Pi_{ft} + \xi_{jkt} + + \varepsilon_{fjkt} \quad (1)$$

where $Quality_{ft}$ is a dummy indicating whether firm $f$ has quality management the year $t$, $\Pi_{ft}$ a set of firm characteristics variables (such as productivity and size) and $\xi_{jkt}$ destination-product-time fixed effects controlling for market characteristics of country $j$ and good $k$ the year $t$. These fixed effects allow us to compare firms with and without quality management personnel in a given market (product-destination-year), controlling for firm characteristics. In a second exercise, we replace these destination-product-year fixed effects with firm-destination-product fixed effects. Our identification changes and we then estimate the effect, for a firm exporting a given product to a given destination, of hiring quality personnel (from $Quality_{ft}$= 0 to $Quality_{ft}$= 1).

In the intensive margin estimation the dependent variable $Exp_{fjkt}$ is $lv_{fjkt}$, the logarithm of the export values of firm $f$ to destination $j$ for the product $k$ at time $t$. In the extensive margin estimation, the dependent variable $Exp_{fjkt}$ is $X_{fjkt}$, a binary variable equal to 1 if there is a flow for the firm $f$ and the product $k$ for the destination $j$ at time $t$.

The firm's decision to invest in quality management staff may be driven by various factors : the need to differentiate products in a highly competitive market, previous safety or sanitary issues, evolution of domestic regulation, changes in the product portfolio... The will to expand activities worldwide or to export to a specific destination could also be one of the reasons why a given firm hires some employees dedicated to sanitary and traceability, which raises an endogeneity issue in our estimation. In order to deal with this potential reverse causality, we use an instrumental approach, using the share of firms in the same sector (APE) and department with quality management personnel as the first IV, and the share of exported products with NTM on the European market, considering that a firm will be more likely to hire quality management staff if it produces products subject to specific regulations on the European market and therefore on the French market. Since

our endogeneous variable is a dummy variable, we use a two-stage approach. First we predict $\widehat{Quality}_{ft}$ from a linear probability model including our two instruments. Second, this prediction is used as an instrument in the 2SLS estimation.

### 4.2 Results

Table 3 lists the estimates of the equation 1 that compares the trade of firms with quality management employees with the trade of other firms, for a given market product-destination-year. Columns (1) to (3) focus on the intensive margin of trade (trade values), while columns (4) to (6) present the results on the extensive margin of trade (probability of trade). The variable $Quality_{ft}$ exhibits a positive and significant coefficient in column (1), suggesting that firms with quality control and management personnel export more in value terms than the other firms. This finding is all the more important as our analysis underestimates the impact of quality management issues : firms do not need to have dedicated quality management staff to comply with standards, implement traceability systems and ensure customer satisfaction. Other employees or external contractors can also carry out these tasks.

This result remains when we restrict our sample to firms that do not change their status between 2009 and 2019 (i.e. that have or don't have quality management for the whole period, without any change) in column (2). The coefficient is still significant and positive, in column (3) using an instrumental variable approach.[3] The results confirm the endogeneity of the variable $Quality_{ft}$. Accounting for endogeneity increases the effect of $Quality_{ft}$ on the export value.

The same pattern is observed at the extensive margin. The quality variable attracts positive and significant coefficients in all columns, showing that firms with quality control and management not only have a higher value of exports, but also a higher probability of trade. Again, the difference between firms with personnel dedicated to traceability and safety and others is higher when endogeneity is taken into account. In all columns, the control variables have the expected signs. Productivity increases trade values and the probability of exporting and the larger the size of the firm, the higher its intensive and extensive trade margin.

In table 4, we slightly modify the equation 1 by adding a firm-destination-product fixed effect which allows us to control for all unobservable and time-invariant firm characteristics. The identification of the effect of quality management on trade is now within time for a given firm.

[3]The value of the Kleibergen and Paap Wald F statistic of the first-order estimation (test for weak identification) suggests that our instrument is not weak. The validity of our instruments is also supported by the rejection of underidentification (a Kleibergen-Paap rk LM statistic significant at 1 percent).

Table 3: Effect of quality management on trade margins, across firm estimation

| | ln $v_{fjkt}$ | | | $X_{fjkt}$ | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | All | $\Delta Quality_{ft}$=0 | All | All | $\Delta Quality_{ft}$=0 | All |
| | OLS | OLS | IV | OLS | OLS | IV |
| Quality$_{ft}$ | 0.183*** | 0.239*** | 0.865*** | 0.008*** | 0.014*** | 0.003** |
| | (0.010) | (0.018) | (0.030) | (0.000) | (0.001) | (0.001) |
| Productivity$_{ft}$ | 0.408*** | 0.458*** | 0.382*** | 0.014*** | 0.015*** | 0.014*** |
| | (0.006) | (0.009) | (0.007) | (0.000) | (0.000) | (0.000) |
| Size 2$_{ft}$ | 0.484*** | 0.531*** | 0.281*** | 0.024*** | 0.019*** | 0.025*** |
| | (0.012) | (0.019) | (0.015) | (0.001) | (0.001) | (0.001) |
| Size 3$_{ft}$ | 0.710*** | 0.832*** | 0.381*** | 0.038*** | 0.028*** | 0.041*** |
| | (0.014) | (0.023) | (0.020) | (0.001) | (0.001) | (0.001) |
| Size 4$_{ft}$ | 1.455*** | 1.545*** | 1.010*** | 0.061*** | 0.054*** | 0.065*** |
| | (0.013) | (0.021) | (0.024) | (0.001) | (0.001) | (0.001) |
| Destination-product-year | yes | yes | yes | yes | yes | yes |
| N | 639,419 | 421,836 | 639,419 | 11,127,999 | 7,209,619 | 11,127,999 |
| r2 | 0.367 | 0.385 | 0.077 | 0.129 | 0.132 | 0.017 |
| Underidentification stat. | | | 79100.358 | | | 410167.198 |
| F stat for weak id | | | 16213.453 | | | 5834.111 |
| Weak id. p-value | | | 0.000 | | | 0.000 |
| Endogeneity test stat | | | 595.017 | | | 24.508 |
| p-value endogeneity test | | | 0.000 | | | 0.000 |

Notes: destination-product-year fixed effects included. Firm productivity is equal to total firms sales divided by the number of employees. Size 2 groups together firms with 10 to 50 employees, size 3 groups together firms with 51 to 100 employees and size 4 groups together firms with more than 100 employees. Firms with less than 10 employees are the reference group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The coefficient on $Quality_{ft}$ is positive and significant in column (1), suggesting that a firm that hires quality management personnel during the period (moving from $Quality_{ft}$=0 to $Quality_{ft}$=1) increases the value of its trade. The 2SLS estimation in column (2) shows that the hiring of quality management personnel is not endogenous in the intensive margin estimates (the Hausman test rejects the endogeneity hypothesis).

Columns (3) and (4) in Table 4 follow the same specification as columns (1) and (2), but on the extensive margin. If the variable $Quality_{ft}$ has a positive coefficient in OLS (column (3)), this is not the case in column (4), while our instruments appear to be valid and not weak, and the Hausman test confirms the endogeneity. This suggests that the effect of hiring quality management on the probability of exporting is not robust when we control for the endogeneity of quality management.

In the Table 5, we further investigate the effect of quality management on trade patterns by examining firm's expenditures on quality management, in addition to the simple hiring or not of personnel dedicated to quality. More precisely, we follow the specification of the Table 4 and interact the variable $Quality_{ft}$ with the log of the total salary paid by the firm to quality control and management employees. The results in column (1) confirm that the presence of quality staff

Table 4: Effect of quality management on trade margins - within firm estimation

| | $\ln v_{fjkt}$ | | $X_{fjkt}$ | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | OLS | IV | OLS | IV |
| $\text{Quality}_{ft}$ | 0.026*** | 0.043** | 0.002*** | -0.002*** |
| | (0.007) | (0.022) | (0.000) | (0.001) |
| $\text{Productivity}_{ft}$ | 0.054*** | 0.054*** | 0.001*** | 0.001*** |
| | (0.006) | (0.006) | (0.000) | (0.000) |
| Size $2_{ft}$ | 0.144*** | 0.142*** | 0.010*** | 0.010*** |
| | (0.015) | (0.015) | (0.001) | (0.001) |
| Size $3_{ft}$ | 0.287*** | 0.284*** | 0.020*** | 0.020*** |
| | (0.019) | (0.019) | (0.001) | (0.001) |
| Size $4_{ft}$ | 0.497*** | 0.493*** | 0.031*** | 0.032*** |
| | (0.024) | (0.024) | (0.001) | (0.001) |
| Firm-destination-product | yes | yes | yes | yes |
| Year | yes | yes | yes | yes |
| N | 653,718 | 653,718 | 9,527,449 | 9,527,449 |
| r2 | 0.863 | 0.001 | 0.738 | 0.000 |
| Underidentification stat. | | 41120.336 | | 303465.966 |
| F stat for weak id | | 14891.704 | | 4311.094 |
| Weak id. p-value | | 0.000 | | 0.000 |
| Endogeneity test stat | | 0.888 | | 30.977 |
| p-value endogeneity test | | 0.346 | | 0.000 |

Notes: destination-product-year fixed effects included. Firm productivity is equal to total firms sales divided by the number of employees. Size 2 groups together firms with 10 to 50 employees, size 3 groups together firms with 51 to 100 employees and size 4 groups together firms with more than 100 employees. Firms with less than 10 employees are the reference group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

increases the value of exports, but that this effect is only observed above a certain salary threshold. The threshold of salary (take in log) above which the quality staff has a positive effect on trade is 10.07 (i.e. 0.413/0.041). In our sample of firms with quality personnel, the mean of the total salaries (in log) paid to quality management staff is 11.19 and the median is 11.32. 2458 firms (out of 2730) are above the threshold and have their trade positively affected by quality management personnel. For these firms, the higher the "investment in quality", the higher is the positive impact on trade.

In column (2) we restrict our sample to firms with quality management personnel. The results confirm that the amount paid for quality management personnel increases values of export.

Table 5: Effect of quality management expenditures on the intensive trade margin

| | (1) | (2) |
|---|---|---|
| | all firms | $\text{Quality}_{ft}$=1 |
| $\text{Quality}_{ft}$ | -0.413*** | |
| | (0.040) | |
| $\text{Quality}_{ft} \times \text{Salary}_{ft}$ | 0.041*** | 0.068*** |
| | (0.004) | (0.005) |
| $\text{productivity}_{ft}$ | 0.055*** | 0.057*** |
| | (0.006) | (0.008) |
| Size $2_{ft}$ | 0.141*** | 0.146*** |
| | (0.015) | (0.037) |
| Size $3_{ft}$ | 0.279*** | 0.337*** |
| | (0.019) | (0.041) |
| Size $4_{ft}$ | 0.475*** | 0.572*** |
| | (0.024) | (0.045) |
| Firm-destination-product | yes | yes |
| Year | yes | yes |
| N | 653,718 | 404,578 |
| r2 | 0.8630 | 0.8614 |

Notes: destination-product-year fixed effects included. Firm productivity is equal to total firms sales divided by the number of employees. Size 2 groups together firms with 10 to 50 employees, size 3 groups together firms with 51 to 100 employees and size 4 groups together firms with more than 100 employees. Firms with less than 10 employees are the reference group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In table 6, we investigate the heterogeneity of the effect of quality control and management on firms' exports, across destination markets. We estimate the impact of quality management on trade, distinguishing destination-product pairs with Non-tariff-Measures from those without, using two interacted variables $\text{Quality}_{ft} \times \text{NTM}_{jk}$ and $\text{Quality}_{ft} \times \text{noNTM}_{jk}$ with $\text{NTM}_{jk}$ a dummy variable equal to one whether the destination $j$ implements a NTM for the product $k$, and zero otherwise, and $\text{noNTM}_{jk}$ a dummy variable equal to one if the destination $j$ does not implement a NTM for the product $k$, and zero otherwise. The data on the presence of NTM come from the UNCTAD database, cover 80 countries and have no time dimension.

Quality variable coefficients $\text{Quality}_{ft} \times \text{NTM}_{jk}$ and $\text{Quality}_{ft} \times \text{noNTM}_{jk}$ are positive and significant regardless of the destination market, with or without NTM, in column (1). This result holds in column (2) when we restrict our sample to European destinations. In both cases, the coefficient on $\text{Quality}_{ft} \times \text{NTM}_{jk}$ is not significantly different from the coefficient for $\text{Quality}_{ft} \times \text{noNTM}_{jk}$. Hiring quality management staff is not particularly beneficial for coping with NTMs in the European market. This result is explained by the fact that NTMs applied by EU countries are the same than NTMs applied in France, i.e. on the domestic market. French firms already have to comply with these standards to sell on their own market, so they do not represent an additional barrier.

The pattern is different in column (3) where the sample is restricted to non-European destinations. The positive impact of quality control and management employees on trade shown above is now positive and significant only on markets with Non-Tariff Measures. This result argues for a compliance effect induced by quality control and management personnel. Having personnel dedicated to these specific issues helps firms to export higher values to destinations with higher requirements in terms of safety and traceability. These personnel are better able to understand the different requirements in non-EU markets, to possibly adapt products and to set up the necessary controls and tests. This result suggests that hiring management and quality control personnel is a major export advantage for French firms, particularly when it comes to dealing with MTNs.

# 5 Quality management and the duration of trade

In this section, we assess the effect of quality management on the duration of trade relationships. We know from Besedeš (2008) that reliability is an important determinant of this duration. Since the presence of quality management staff employed by the firm is a way to increase reliability and ensure product compliance, it may also determine the risk of trade relationship failure. We expect that the presence of quality management staff should reduce the risk of failure or, in other words, increase the duration of trade relationships.

## 5.1 Empirical specification

To measure the extent to which quality management personnel affects the risk of failure of a trade relationship, we use a discrete-time hazard model. We use the same data set as for the analysis of the intensive margin of trade. We consider all exports by firm $f$ to destination $j$ of product $k$ in

Table 6: Effect of quality management on the intensive trade margin with NTM

| | (1) All | (2) $EU_{ft}$=1 | (3) $EU_{ft}$=0 |
|---|---|---|---|
| Quality$_{ft} \times NTM_{jk}$ | 0.026*** | 0.022** | 0.038** |
| | (0.009) | (0.011) | (0.016) |
| Quality$_{ft} \times noNTM_{jk}$ | 0.069* | 0.091* | 0.026 |
| | (0.038) | (0.048) | (0.060) |
| productivity$_{ft}$ | 0.061*** | 0.085*** | 0.024* |
| | (0.008) | (0.009) | (0.013) |
| Size 2$_{ft}$ | 0.162*** | 0.207*** | 0.083** |
| | (0.019) | (0.023) | (0.033) |
| Size 3$_{ft}$ | 0.307*** | 0.398*** | 0.122*** |
| | (0.024) | (0.028) | (0.045) |
| Size 4$_{ft}$ | 0.537*** | 0.684*** | 0.226*** |
| | (0.031) | (0.037) | (0.055) |
| Firm-destination-product | yes | yes | yes |
| Year | yes | yes | yes |
| N | 552,022 | 360,665 | 191,357 |
| r2 | 0.86 | 0.89 | 0.81 |

Notes: destination-product-year fixed effects included. Firm productivity is equal to total firms sales divided by the number of employees. Size 2 groups together firms with 10 to 50 employees, size 3 groups together firms with 51 to 100 employees and size 4 groups together firms with more than 100 employees. Firms with less than 10 employees are the reference group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

year $t$. As in Section 3.3, we define a spell $s$ as a period during which a firm $f$ exports a product $k$ to a destination $j$ without interruption. The total duration of the trade relationship is its length (in years). We consider discrete model because we work with annual observations of the trade relation for a given firm-product-destination (Luo and Bano, 2020; Peterson et al., 2018). In such models, the hazard rate is defined as the probability of a trade relation surviving to a given point in time based on its survival in the previous year. Following the framework of Luo and Bano (2020), Hess and Persson (2012) and Peterson et al. (2018), we let $h_{sd}$ be the discrete time hazard rate. The probability of failure conditional on its survival in the previous year, given the covariates included in the regression model, can be defined as:

$$\mathrm{h}_{sd} = P(D_s < d + 1 / D_s \geq d, x_{st}) \tag{2}$$

$$= G(\beta x_{st} + \gamma_d) \tag{3}$$

Equation 2 above forms the conditional probability that a given spell will end in a set of discrete-time intervals between $d = 1$ and $d = 11$ (i.e., the maximum duration in our sample, since we have data from year 2009 to 2019). $D_s$ refers to a non-negative, continuous random variable

that measures the survival time of the $s^{th}$ spell or trade relationship. The subscript $s$ here denotes separate sequences of trade relationships (firm-product-destination), $s = (1, \ldots, n)$. $x_{st}$ is a set of time-varying covariates (where time is the year of the trade relationship) and $\beta$ are regression coefficients. $G()$ refers to an appropriate distribution function that ensures $0 \leq h_{sd} \leq 1$ for all $s$ and $d$.

Following Luo and Bano (2020) and Peterson et al. (2018), $y_{sd}$ is a binary variable that takes the value one if the relationship $s$ is observed to end in the time interval $d$, and zero otherwise. In other words, $y_{sd}$ takes the value one the last year of the trade relationship (i.e. the year after, the trade relation has stopped and there is no observation in the dataset). Therefore, the log-likelihood function for the observed observations is specified as below

$$LL = \sum_{s=1}^{n} \sum_{d=1}^{d_s} [y_{sd} \log(h_{sd}) + (1 - y_{sd}) \log(1 - h_{sd})] \tag{4}$$

The specification of $h_{sd}$ in Equation (3) allow us to measure the impact of our key variables on the probability of failure. We include different types of variables in $x_{st}$. First, we control for the characteristics of the spell by including important variables to describe it: i) the length of the $Duration_{st}$ of the spell $s$ in year $t$, ii) the dummy $Left\_censored_s$ which indicates whether the trade relationship $s$ existed at the beginning of the period (i.e. in 2009 in our case), iii) the dummy $First\_year_s$ which indicates the first year of the spell $s$, as we saw in the descriptive statistics that many spells were very short (only 1 year), iv) the dummy $Multi_s$ if the trade relation $s$ has multiple sequences, and v) the initial value ($Init_Val_s$) of the trade at the beginning of the spell $s$. Second, we include information on the destination country involved in the spell. This includes the classical gravity type variables to characterize the destination country (contiguity, distance, common language, former colony), EU member states and some destination time variables (the GDP per capita and belonging to at the same regional trade agreement). Finally, we include information about the firm involved in the spell. We include the productivity ($productivity_{ft}$) and the $Size_{ft}$ (in categories) of the firm, which are key variables for export behaviour (and similar to the previous analyses of the margins of trade). We also include our variables of interest. In the first specification, we introduce the the dummy variable $Quality_{ft}$, which indicates whether the firms

hire quality personnel during the period. [4] In the second specification, we introduce the variables $Quality_{ft} \times NTM_{jk}$ and $Quality_{ft} \times noNTM_{jk}$, which interacts information about the presence of quality personnel and the presence of NTMs in the destination market $j$.

The variables listed above control for observed heterogeneity. However, we also need to control for unobserved heterogeneity. This unobserved heterogeneity may be due to the fact that there may be some groups in which spells are more similar in their survival than spells in other groups. The effect of the unobserved heterogeneity in duration data models is referred to as frailty (Jenkins, 2017). [5]

### 5.2 Result

Table 7 shows the results of the estimations. The results show how the different variables affect the risk of failure of a trade relationship. The binary variable $y_{sd}$ is 1 if the trade relation ends and 0 if it continues. This means that a positive coefficient increases the probability of the hazard, while a negative value decreases this probability. Column (1) shows the results for the entire sample. $Quality_{ft}$ has a negative and significant sign, which means that firms with quality employees have a lower probability of hazard. This result was expected and confirms that quality personnel enable firm to provide reliable goods and to reduce the risk of failure.

The results show that a higher productivity of firm also reduces the probability of failure. The different categories of firm size have a positive effect. The reference is the category of small firms, which suggests that large firms have a higher risk of failure than small firms. These results seem to be consistent with the results obtained by Bernard et al. (2005) who shows that large firms, which are multi-product firms, export several products with a high switching rate at the firm-destination-product level.

The spell characteristics have the expected sign and are consistent with the results obtained in previous studies. The duration of the spell ($Duration_{st}$) increases the probability of being at risk. This is consistent with the value of the mean duration of spell, which is only 2.73 years for the entire sample. The hazard rate is even higher in the first year of the trade relationship ($First\_year_s$). As expected, the rate of hazard increases in the case of multiple spells ($Multi_s$) and decreases with

[4] It is important to note that, for example, a firm with two spells may have $Quality_{ft}$=0 in the first trade relationship and $Quality_{ft}$=1 in the second one. This would mean that the firm has hired quality employees between the two trade relationships.

[5] Several discrete-time hazard models with frailty are available in Stata. In this study, and following Luo and Bano (2020), we use the discrete-time cloglog model with gamma heterogeneity using Jenkins' pgmhaz8 program in Stata Jenkins (2004).

the value traded in the first year ($Init_Val_s$).

In columns (2) and (3) we estimate the same model as in column (1) but on different samples. In column (2) we focus on trade relations with EU members and in column (3) with non-EU members. $Quality_{ft}$ has a negative and significant sign in columns (2) and (3). For the other variables, the results obtained in column (1) are confirmed.

Columns (4) to (6) follow the same specifications than columns (1) to (3) same estimation, but with two additional variables: $Quality_{ft} * NTM_{jk}$ and $Quality_{ft} * noNTM_{jk}$. These variables have negative and significant signs in all columns. As before, column (4) refers to the full sample, while column (5) refers to the EU markets and column (6) refers to non-EU markets. In column (4), the coefficient of $Quality_{ft} * NTM_{jk}$ is significantly different from the coefficient of $Quality_{ft} * noNTM_{jk}$ at 1%. In the EU markets (column(5)), the difference between these coefficients is only 10%. This result was expected, since the regulation in the French market is the same as in the EU single market. The personnel in quality management makes only a small difference in the trade relationship. In column (6), on non-EU markets, the coefficients are significantly different with less than 1%. This confirms the key role of quality management staff in the export of products subject to NTMs in non-EU markets. The presence of NTMs reinforces the need for compliance and the importance of production reliability. The quality management staff employed by the firm avoids potential failures or border rejections, thus increasing the duration of trade relationships of the firms. The likelihood ratio test in the last row of the table suggests a statistically significant frailty, which confirms the presence of unobserved heterogeneity in the sample.

# 6 Conclusion

We assess the impact of agri-food firms' "investment in quality" on their export performance. Using French firm-level data, we proxy firms' commitment to traceability and reliability issues by the presence of employees dedicated to quality control and management within the firm. We show that firms with employees dedicated to quality export higher values and are more likely to export, but only to markets with non-tariff measures. This suggests that having staff dedicated to quality control and management helps firms meet the stringer requirements of destination markets, either by adapting their products to meet these requirements or by being able to demonstrate compliance. We also show that firms with quality management have a higher survival rate in foreign markets, suggesting that quality policies help firms to build trusting relationships with their trading partners

Table 7: estimation hazard function

| | (1) All | (2) $EU_{ft}$=1 | (3) $EU_{ft}$=0 | (4) All | (5) $EU_{ft}$=1 | (6) $EU_{ft}$=0 |
|---|---|---|---|---|---|---|
| *Firm characteristics* | | | | | | |
| Quality$_{ft}$ | -0.567*** | -0.631*** | -0.456*** | | | |
| | (0.009) | (0.012) | (0.014) | | | |
| Quality$_{ft} \times NTM_{jk}$ | | | | -0.580*** | -0.629*** | -0.461*** |
| | | | | (0.009) | (0.012) | (0.014) |
| Quality$_{ft} \times noNTM_{jk}$ | | | | -0.503*** | -0.656*** | -0.399*** |
| | | | | (0.011) | (0.018) | (0.021) |
| Productivity$_{ft}$ | -0.104*** | -0.102*** | -0.088*** | -0.104*** | -0.102*** | -0.088*** |
| | (0.004) | (0.006) | (0.006) | (0.004) | (0.006) | (0.006) |
| Size 2$_{ft}$ | 0.051*** | 0.005 | 0.105*** | 0.050*** | 0.005 | 0.104*** |
| | (0.009) | (0.013) | (0.015) | (0.009) | (0.013) | (0.015) |
| Size 3$_{ft}$ | 0.131*** | 0.117*** | 0.145*** | 0.128*** | 0.118*** | 0.144*** |
| | (0.010) | (0.014) | (0.017) | (0.010) | (0.014) | (0.017) |
| Size 4$_{ft}$ | 0.095*** | 0.167*** | 0.017 | 0.092*** | 0.167*** | 0.017 |
| | (0.009) | (0.013) | (0.015) | (0.009) | (0.013) | (0.015) |
| *Spell characteristics* | | | | | | |
| Duration$_{st}$ | 0.177*** | 0.179*** | 0.158*** | 0.177*** | 0.179*** | 0.158*** |
| | (0.002) | (0.003) | (0.004) | (0.002) | (0.003) | (0.004) |
| First_year$_s$ | 0.590*** | 0.564*** | 0.608*** | 0.591*** | 0.563*** | 0.608*** |
| | (0.008) | (0.010) | (0.014) | (0.008) | (0.010) | (0.014) |
| Left_censored$_s$ | -0.990*** | -0.886*** | -1.149*** | -0.983*** | -0.890*** | -1.145*** |
| | (0.009) | (0.011) | (0.017) | (0.009) | (0.011) | (0.017) |
| Multi$_s$ | 0.359*** | 0.503*** | 0.212*** | 0.362*** | 0.501*** | 0.214*** |
| | (0.006) | (0.008) | (0.009) | (0.006) | (0.008) | (0.009) |
| Init_Val$_s$ | -0.130*** | -0.119*** | -0.142*** | -0.130*** | -0.119*** | -0.142*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.002) | (0.002) |
| *Destination characteristics* | yes | yes | yes | yes | yes | yes |
| N | 683665 | 389750 | 226511 | 683665 | 389750 | 226511 |
| gammav | 0.28 | 0.22 | 0.30 | 0.28 | 0.22 | 0.30 |
| lltest_p | 0 | 0 | 0 | 0 | 0 | 0 |

Notes: destination-product-year fixed effects included. Firm productivity is equal to total firms sales divided by the number of employees. Size 2 groups together firms with 10 to 50 employees, size 3 groups together firms with 51 to 100 employees and size 4 groups together firms with more than 100 employees. Firms with less than 10 employees are the reference group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

through their ability to provide reliable products and perhaps also to have fewer failures.

Overall, our work underlines that product quality is not limited to product differentiation as perceived by the final consumer. Product traceability, safety and reliability are essential factors for the competitiveness of firms, especially in the perspective of the global value chains.

Other avenues of research could be considered to further explore these issues. Analyzing the impact of certain standards, such as the ISO 26000 standard on social responsibility, which introduces a new, more social and environmental dimension, could be particularly interesting for understanding the differentiation strategies of firms in international markets.

**Acknowledgments**

*This work received financial support from the H2020-RIA research project BATModel, grant number 861932*

## References

Aiello, G., Enea, M., and Muriana, C. (2015). The expected value of the traceability information. *European Journal of Operational Research*, 244(1):176–186.

Alfaro, J. A. and Rábade, L. A. (2009). Traceability as a strategic tool to improve inventory management: A case study in the food industry. *International Journal of Production Economics*, 118(1):104–110.

Amiti, M. and Khandelwal, A. K. (2013). Import Competition and Quality Upgrading. *The Review of Economics and Statistics*, 95(2):476–490.

Anders, S. M. and Caswell, J. A. (2009). Standards as barriers versus standards as catalysts: Assessing the impact of HACCP implementation on u.s. seafood imports. *American Journal of Agricultural Economics*, 91(2):310–321.

Baldwin, R. and Harrigan, J. (2011). Zeros, Quality, and Space: Trade Theory and Trade Evidence. *American Economic Journal: Microeconomics*, 3(2):60–88.

Belleflamme, P. and Peitz, M. (2014). Asymmetric information and overinvestment in quality. *European Economic Review*, 66:127–143.

Bernard, A. B., Redding, S., and Schott, P. K. (2005). Multi-product firms and the dynamics of product mix.

Bernard, A. B., Redding, S. J., and Schott, P. K. (2010). Multiple-product firms and product switching. *American Economic Review*, 100(1):70–97.

Besedeš, T. (2008). A search cost perspective on formation and duration of trade. *Review of International Economics*, 16(5):835–849.

Besedeš, T. and Prusa, T. J. (2006). Ins, outs, and the duration of trade. *Canadian Journal of Economics/Revue canadienne d'économique*, 39(1):266–295.

Bonfiglioli, A., Crinò, R., and Gancia, G. (2025). Firms and economic performance: A view from trade. *European Economic Review*, 172:104912.

Cadot, O., Iacovone, L., Pierola, M. D., and Rauch, F. (2013). Success and failure of african exporters. *Journal of Development Economics*, 101:284–296.

Chen, N. and Juvenal, L. (2016). Quality, trade, and exchange rate pass-through. *Journal of International Economics*, 100:61–80.

Crivelli, P. and Groeschl, J. (2015). The impact of sanitary and phytosanitary measures on market entry and trade flows. *The World Economy*, 39(3):444–473.

Crozet, M., Head, K., and Mayer, T. (2012). Quality Sorting and Trade: Firm-level Evidence for French Wine. *Review of Economic Studies*, 79(2):609–644.

Curzi, D. and Olper, A. (2012). Export behavior of Italian food firms: Does product quality matter? *Food Policy*, 37(5):493–503.

de Frahan, B. H. (2006). Harmonisation of food regulations and trade in the single market: evidence from disaggregated data. *European Review of Agricultural Economics*, 33(3):337–360.

Disdier, A.-C. and Fugazza, M. (2020). *A Practical Guide to the Economic Analysis of Non-Tariff Measures*. UN.

Eaton, J., Eslava, M., Kugler, M., and Tybout, J. (2007). Export dynamics in colombia: Firm-level evidence. NBER Working Papers 13531.

Engemann, H., Jafari, Y., and Heckelei, T. (2023). Institutional quality and the duration of agri-food trade flows. *Journal of Agricultural Economics*, 74(1):135–154.

Epelbaum, F. M. B. and Martinez, M. G. (2014). The technological evolution of food traceability systems and their impact on firm sustainable performance: A RBV approach. *International Journal of Production Economics*, 150:215–224.

Fan, H., Li, Y. A., and Yeaple, S. R. (2018). On the relationship between quality and productivity: Evidence from china's accession to the wto. *Journal of International Economics*, 110:28–49.

Fontagné, L., Orefice, G., Piermartini, R., and Rocha, N. (2015). Product standards and margins of trade: Firm-level evidence. *Journal of International Economics*, 97(1):29–44.

Fugazza, M. and Molina, A. C. (2016). On the determinants of exports survival. *Canadian Journal of Development Studies / Revue canadienne d'études du développement*, 37(2):159–177.

Gao, Z. and Schroeder, T. C. (2009). Effects of label information on consumer willingness-to-pay for food attributes. *American Journal of Agricultural Economics*, 91(3):795–809.

Gracia, A., Barreiro-Hurlé, J., and López-Galán, B. (2013). Are local and organic claims complements or substitutes? a consumer preferences study for eggs. *Journal of Agricultural Economics*, 65(1):49–67.

Grundke, R. and Moser, C. (2019). Hidden protectionism? evidence from non-tariff barriers to trade in the united states. *Journal of International Economics*, 117:143–157.

Hansman, C., Hjort, J., León-Ciliotta, G., and Teachout, M. (2020). Vertical integration, supplier behavior, and quality upgrading among exporters. *Journal of Political Economy*, 128(9):3570–3625.

Hess, W. and Persson, M. (2012). The duration of trade revisited. *Empirical Economics*, 43(3):1083–1107.

Hummels, D. and Klenow, P. J. (2005). The Variety and Quality of a Nation's Exports. *American Economic Review*, 95(3):704–723.

Hummels, D. and Skiba, A. (2004). Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture. *Journal of Political Economy*, 112(6):1384–1402.

Jaghdani, T. J., Johansen, U., Thakur, M., and Glauben, T. (2023). Salmon trade duration: The application of firm-level trade transaction data from the norwegian salmon industry. *Agribusiness*, n/a(n/a).

Jenkins, S. (2004). pgmhaz8: Stata module to estimate discrete time (grouped data) proportional hazards models. statistical software components s438501, department of economics, boston college.

Jenkins, S. P. (2017). Lesson 7. unobserved heterogeneity (frailty). *Essex Summer*.

Khandelwal, A. (2010). The Long and Short (of) Quality Ladders. *Review of Economic Studies*, 77(4):1450–1476.

Kugler, M. and Verhoogen, E. (2012). Prices, plant size, and product quality. *Review of Economic Studies*, 79(1):307–339.

Liu, R., Gao, Z., Nayga, R. M., Snell, H. A., and Ma, H. (2019). Consumers' valuation for food traceability in china: Does trust matter? *Food Policy*, 88:101768.

Luo, Y. and Bano, S. (2020). Modelling new zealand dairy products: Evidence on export survival and duration. *Australian Journal of Agricultural and Resource Economics*, 64(3):605–631.

Manova, K. and Zhang, Z. (2012). Export Prices Across Firms and Destinations. *The Quarterly Journal of Economics*, 127(1):379–436.

Murina, M. and Nicita, A. (2015). Trading with conditions: The effect of sanitary and phytosanitary measures on the agricultural exports from low-income countries. *The World Economy*, 40(1):168–181.

Nitsch, V. (2009). Die another day: duration in german import trade. *Review of World Economics (Weltwirtschaftliches Archiv)*, 145(1):133–154.

Peterson, E., Grant, J., Roberts, D., and Karov, V. (2013). Evaluating the trade restrictiveness of phytosanitary measures on u.s. fresh fruit and vegetable imports. *American Journal of Agricultural Economics*, 95(4):842–858.

Peterson, E. B., Grant, J. H., and Rudi-Polloshka, J. (2018). Survival of the fittest: Export duration and failure into united states fresh fruit and vegetable markets. *American Journal of Agricultural Economics*, 100(1):23–45.

Santeramo, F. G. and Lamonaca, E. (2019). The effects of non-tariff measures on agri-food trade: A review and meta-analysis of empirical evidence. *Journal of Agricultural Economics*.

Schott, P. K. (2004). Across-Product Versus Within-Product Specialization in International Trade. *The Quarterly Journal of Economics*, 119(2):647–678.

Schott, P. K. (2008). The relative sophistication of Chinese exports. *Economic Policy*, 23:5–49.

Verhoogen, E. A. (2008). Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector. *The Quarterly Journal of Economics*, 123(2):489–530.

Xiong, B. and Beghin, J. (2014). Disentangling Demand-Enhancing And Trade-Cost Effects Of Maximum Residue Regulations. *Economic Inquiry*, 52(3):1190–1203.