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On the Competitiveness Effects of Quality Labels: Evidence from the French Cheese Industry

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Highlights

- The paper investigates the impact of Protected Designations of Origin (PDO) on French firm export competitiveness in the cheese and cream industry.
- PDO labelling positively impacts the extensive margin of trade and the trade unit value, but have no effects of the intensive margin of trade.
- PDO products are perceived as products of higher quality by consumers, whatever the destination country.

Abstract

The paper questions the impact of geographical indication labels on firm export competitiveness in the French cheese and cream industry. We use firm level data from the French custom and an original dataset of firms and products concerned by Protected Designations of Origin (PDO). Our estimations show that PDO labeling allows firms to increase their price by 11.5% on average. Moreover these products are perceived by consumers as products of better quality than non-PDO products. Regarding trade margins, while the effect on trade volume (the intensive margin of trade) is not significant, PDO labeling increases the probability of serving a foreign country (the extensive margin of trade). Our estimations show that exports of PDO products would increase by 11.4% if non-EU consumers value PDO label as much as EU consumers.

Keywords

Geographical Indication, PDO, Trade Margins, Product Quality, Price.

JEL

F10, F14.

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RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

On the competitiveness effects of quality labels: Evidence from the French cheese industry [1]

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1. Introduction

In the context of increasing globalization and growing demand for quality by consumers worldwide, quality schemes based on geographical indication (GI) gain attention. The European quality package launched in 2010, resulted in the adoption of the regulation 1151/2012 which defines three quality schemes that promote and protect names of agricultural products and foodstuffs according to their origin: the Protected Designations of Origin (PDO), the Protected Geographical Indications (PGI), and the Traditional Specialities Guaranteed (TSG). This European regulation aims at providing information to consumers on the origin of the products. More precisely, GI allows consumers to identify the food products whose their quality or other characteristics are linked to their geographical origin. The PDO label can thus be viewed as welfare-improving tool by addressing market failures associated with information asymmetry.[2] However, we lack empirical evidence on the effects of this EU quality policy on quality perception of foreign consumers and on international trade. This is surprising as GIs are increasingly central in international negotiations.

At the multilateral level, GI were officially introduced in the "Trade Related Aspects of Intellectual Property Rights" (TRIPS) Agreement of the World Trade Organization (WTO) in 1994. This agreement gives exclusive rights to any indication that identifies a good as originating in a particular place, with the idea that the nature of the geographic environment in which production takes place (climate condition, soil composition, local knowledge, traditional methods) impacts the quality attribute of the products (Marie-Vivien and Biénabe (2017) and Menapace and Moschini (2014)). The TRIPS agreement is weakly prescriptive and leaves the modalities of GI protection to be defined at the national level to account for the heterogeneity of country approaches. Whereas the US, and some other countries as Australia or New-Zealand, largely incorporates GI protection within trademark (Gangjee, 2017), *sui generis* systems were developed in countries with roman law (as France, Italy and Spain) and are currently in force in the EU. Based on stronger state intervention and implying both the definition of the methods of production and the facilitation of the supply chain coordination, the GI *sui generis* system is very different from the trademark one, which entails important debates at

[2] Their objective is also to promote territorial, local, regional and rural developments by securing prices at farm level and by protecting producers of regional food products from unfair competition of non-genuine products.

the international level. The European GI system notably generated complaints at the WTO dispute settlement body from the United States in 1999 and Australia in 2003, which led to a reform in the EU quality scheme in 2006. The GI systems remain a sensitive topic both in multilateral and bilateral trade negotiations, as shown by the recent CETA (Comprehensive Economic and Trade Agreement) negotiations between Canada and the European Union. It raises the question of the recognition of these GI systems by consumers in different countries, which has been scarcely studied in the literature.

In this paper, we focus on the trade effects of Protected Designations of Origin (PDO) scheme in the French cheese and cream industry, which is an important component of the French international reputation and one of the most contentious sector in the international GI debate (chapter 6 by S. Frankel in Calboli and Ng-Loy (2017)). Relying on an original exhaustive dataset of firms and products concerned by PDO in France, we first investigate whether PDO products allow producers to charge higher prices in foreign markets and imply a higher perceived quality by foreign consumers (i.e. more tasty, safer, healthier, more sustainable, ...) according to Khandelwal's definition of quality (Khandelwal (2010)). Second, we estimate the impact of PDO label of the probability of exporting and the exported quantity distinguishing European destinations from the other.

This paper contributes to the literature on European geographical labels concerning food products. This literature can be presented along two axes. First, papers dealing with the consumer's perception of labeled products. This perception is analyzed measuring either consumers' willingness to pay for geographical labels (Menapace et al., 2011), prices elasticities (Hassan et al., 2011) or price premiums (see for example the meta-analysis of Deselnicu et al. (2013)). These different approaches deal with different food sectors and suggest that the premium for geographical indicators vary substantially according to the nature of products or markets. A second axis of the literature focuses on the producer side. Bouamra-Mechemache and Chaaban (2010a) analyze the determinant of adoption of PDO by French producers of brie and show that the attractiveness of PDO certification depends on the cost of raw material and the size of the companies. Bouamra-Mechemache and Chaaban (2010b) use a theoretical model and show that PDO labeling is efficient for the producers as it allows them to signal their quality, but that private collective certification bring more welfare. Bontemps et al.

(2013) estimate the impact of PDO on the survival of French cheese firm and show that labeling reduces the risk for smaller firms. These different studies focus on the production aspects but do not consider the exports of the firms producing PDO. In our paper, we analyze the impact of PDO labeling on trade patterns, distinguishing its impact between European and non European markets.

Our work also relates to papers investigating the relationship between quality and trade. A first strand of this empirical literature assesses the impact of different trade costs on trade according to the quality of the products, using either country-level data (Schott (2004), Schott (2008) , Hummels and Klenow (2005), Baldwin and Harrigan (2011)) or firm level data (Bastos and Silva (2010), Martin (2012)). A second strand of the literature focus on firm-level heterogeneity in quality. Johnson (2012) shows that firms with high productivity export higher quality goods and charge higher prices than other firms. Manova and Zhang (2012) shows that Chinese firms with higher quality goods have better export performance. Crozet et al. (2012) test the Melitz model (2003) with firm heterogeneity and show that quality increases both the probability of market entry and the exported values. Curzi and Olper (2012) also confirm the relationship between productivity, product quality and export performance in the food sector. Except Crozet et al. (2012) who use use quality ranking by experts and Curzi and Olper (2012) who use R&D and innovation to proxy quality, the majority of these works use trade unit values as proxy for the quality of the product. From a panel data on trade of food products, it has been shown that GIs promote trade depending on whether GIs are produced in the exporter or importer country (see Sorgho and Larue (2014); Raimondi et al. (2016)). In this paper, we investigate the impact of another measure of quality that is the Protected Denomination of Origin and show that this label has a positive impact of trade flows.

The contribution of this article is twofold. First, using an exhaustive dataset of the firms and products concerned by PDO in the French cheese industry, we show that PDO products have on average higher unit values in foreign markets and are perceived on average as products of higher quality by foreign consumers. Second, we show that PDO labeling only impacts the probability of exporting (the extensive margin of trade) to European countries and to foreign markets with similar geographical indications. However, our results suggest exports of PDO

products would increase by 11.4% if non-EU consumers value PDO label as much as EU consumers.

Our results suggest that the EU quality policy through the promotion of geographical labels helps French producers of cheese and cream to reach new markets within the European Union and in countries with similar GI policy. This later result highlights the role of inclusion of the GI aspects in international trade agreements. The increasing number of bilateral new generation agreements (as the CETA between Canada and the EU) can thus be seen as an opportunity for EU producers to increase their market access. However, the non significant impact of PDO on other markets and on the volume of trade in general raise the issue of the need to strengthen identification and protection of PDO out of the community market.

The paper is organized as follows. In the first section, we describe our dataset and give first evidence on differences in trade patterns between PDO and non-PDO products. In the second section, we develop a theoretical framework showing that GI leads to two opposite effects on the demand as it raises the quality perceived by the consumers but entails higher marginal costs. We present our empirical strategy and compare export performance of PDO and non-PDO products. The third section presents our empirical results. The last section concludes.

2. Data and stylized facts

2.1. PDO Labeling

The European Protected Designations of Origin (PDO) scheme is precisely defined in the European regulation 1151/2012. For a product to be registered as a PDO, applicants should be a group of producers and/or processing firms and may apply for the name of a given product. The application form includes the product description (a qualification document including *cahiers des charges* or code of practices) and the geographical area associated with the products. The applicants have to provide details on the link between the region of origin and its causal influence upon the product quality or characteristics. Such a link is considered as stronger than Protected Geographical Indications (PGI) (Gangjee, 2017).

In France, the INAO (Institut National de l'Origine et de la Qualité- a mixed public-private

body) is involved in the GI management.[3] In this country, the link between the location and the name of the product has been recognized by law since 1905. The objective of the law was then to protect producers, at first in the wine sector, with the definition of the AOC label (Appellation d'Origine Contrôlée). A body dedicated to this label was also created and became in 1935 the INAO. The AOC label has also been adopted in the cheese sector. For instance the AOC Roquefort was created in 1925, the Comté in 1958. Among the 50 French dairy PDO, 36 existed before 1995 and 25 existed before 1980. The most recent French PDO are Beurre et crème de Bresse and have been recognized since 2014.

2.2. Data

We use the exhaustive list of authorized plants concerned by PDO labeling for given products in 2012, provided by the INAO to make an empirical assessment of the effect of PDO labeling on export performance. To do so, we rely on French custom data but we have to concert INAO defined products into the 8-digit product category level of the good classification of the EU statistics, that is not straightforward. First, a PDO labeled product may not have an exclusive NC8 code. Second, a NC8 may correspond to both PDO and non-PDO products. In the latter case, we assume that the PDO label applies to all the NC8 category, which implies that the effects of labels may be under-estimated in our empirical analysis. We also have to aggregate plants into firms, as trade flows are defined at the firm level. To do so, we use the first nine numbers of the national identification code of plants (the SIRET) which denote the firm's identification code (SIREN).

We merge the INAO dataset with French firm-level trade and characteristic data. Trade data from the French customs provides for each firm its exports in value and quantity by NC8 product and destination. Firms' characteristics data come from the French national institute of public statistics (INSEE) and gives information on the main activity, the total sales and the value added per worker of each firm. In order to compare firms with the same activity, we restrict our analysis to firms exporting cheese or cream (products that belong to the HS4 categories 0405 or 0406, i.e. 40 different products) and to firms from the agri-food sectors (excluding wholesalers).[4] We also exclude NC8 for which no PDO label is defined.

[3] However, only public authorities (the Ministry of Agriculture) are in charge of the examination of GI specifications and interact with the EU commission (Marie-Vivien and Biénabe, 2017)

[4] We focus on exporting firms as we do not know what are the products actually produced by non exporting

In 2012, our sample includes 29 authorized firms among 220 exporting firms that export 16 different NC8 concerned by PDO labels. As authorized firms are multiproducts, they export both PDO and non PDO products, while non authorized firms only export non PDO products.

2.3. Descriptive statistics

The combination of French Customs and INAO datasets allows us to distinguish PDO authorized firms from non-authorized firms among French exporters of cheese and cream. As said above, among the 220 firms of our dataset, 29 firms are authorized to handle PDO. Table 1 presents descriptive statistics for authorized and non authorized firms. Authorized firms appear to have a slightly higher productivity (computed at the firm level) and to be larger according to the number of employees. This is consistent with the fact that having such an authorization may induce fixed costs, that can only be covered by more productive firms. The higher average productivity and size may also partly explain why authorized firms export an higher number of products (without distinguishing PDO and non PDO products), to a larger number of destinations, and have higher total export value. At the aggregated level, authorized firms represent more than 22% of the total export value of cheese and cream whereas they only represent 13% of the number of exporters.

PDO products represents 23.5% of exports value of authorized firms. As a consequence, PDO products represent a relatively small share (5%) of French total exports of cream and cheese. Non-labeled products are exported by both non-authorized firms (for 78% of total trade) and authorized firms (for 17%). Figure 1 presents the French cheese median exports by firm and product. It shows that export values and quantities are higher for authorized firms. The difference in export is more pronounced when we consider labeled products. The level of exports by authorized firms for labeled products is more important than for non labeled products, whatever the destination market (EU or non-EU). Figure 2, which displays the kernel density of the export values and quantities by firm-product pair, confirms this observation. Authorized firms with labeled products generate more flows with high values or quantities than other firms.

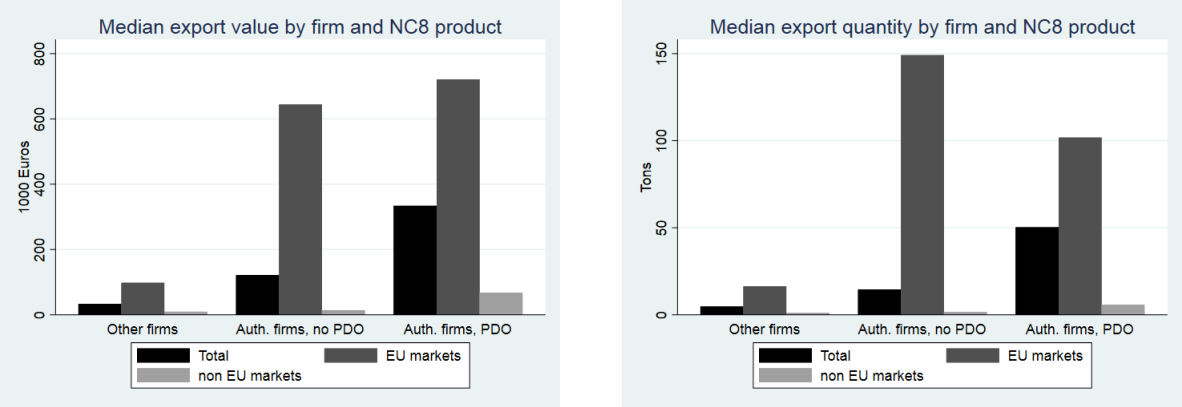
In Figure 3, we assess the extensive margin of trade by computing the median number of

firms. We are only able to identify the products exported by the firm.

Table 1 – Descriptive statistics on authorized and non authorized firms

	Type of firm	Nber of firms	Mean	Sd	Median	Min.	Max
productivity	*Authorized*	28	1,522.21	5,358	355.5	145.9	28,759.1
	Non-authorized	145	630.70	2,232	293.4	0	26,131.4
Number of Employees	*Authorized*	28	190.21	321.65	86.5	10	1512
	Non-authorized	145	148.12	313.2	35.5	1	2392
Number of products	*Authorized*	28	4.29	2.26	4	1	10
	Non-authorized	145	2.09	1.77	1	1	11
Number of destinations	*Authorized*	28	13.39	14.21	8.5	1	63
	Non-authorized	145	5.88	12.45	2	1	89
Total export value	*Authorized*	28	11,255	26,622	1,882	0.43	121,883
	Non-authorized	145	3,995	18,180	59	0.11	172,232

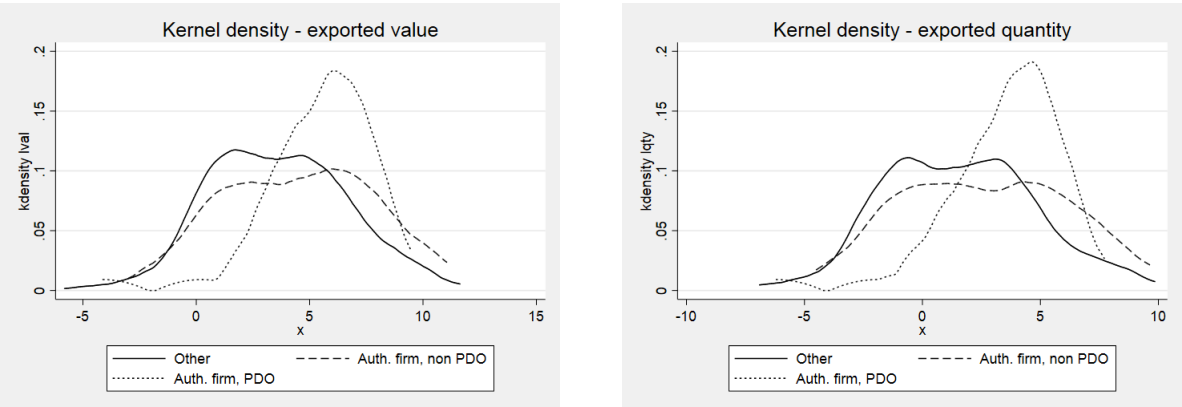
Notes: Authors' computation using INSEE and INAO datasets.



(a) Value (b) Quantity

Figure 1 – Export by firm and product (nc8)

Notes: Authors' computation using French Customs and INAO datasets.



(a) Value (b) Quantity

Figure 2 – Kernel density of export

Notes: Authors' computation using French Customs and INAO datasets.

destination countries by firm and NC8 category of product. The number of destinations is higher for authorized firms exporting PDO products. For non-PDO products, differences on the number of destinations between authorized and non-authorized firms only appear on European markets.

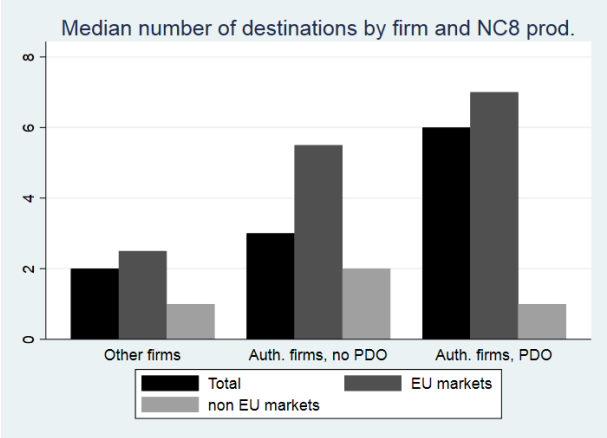


Figure 3 – Number of destinations by firm and product (nc8)

Notes: Authors' computation using French Customs and INAO datasets.

In Figure 4, we compute the median of trade unit value of cheese and cream products for the three categories of firms-product pairs. Contrary to the export values and the number of destinations, the unit value does not differ a lot according to the type of firms and products. Trade unit values of non-authorized firms are not different from those of authorized firms. Within PDO authorized firms, PDO products are exported at a higher price than non-labeled products, in particular on the non-European markets.

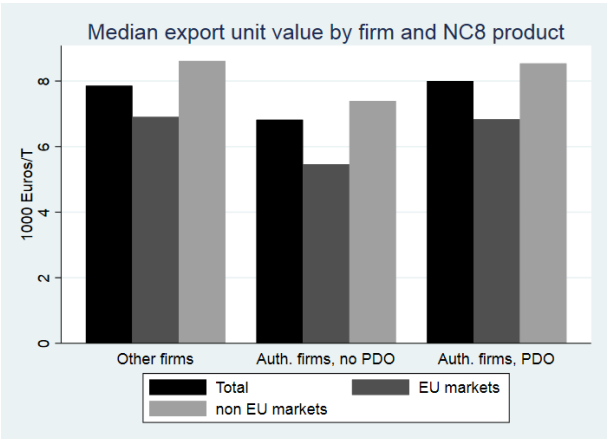


Figure 4 – Exported unit value by firm and product (nc8)

Notes: Authors' computation using French Customs and INAO datasets.

So far, the descriptive statistics suggest a positive role of PDO labeling in firms export performance in the cheese and cream industry. This impact appears both at the extensive and the

intensive margins. Moreover, we observe these differences in trade margins both within and between firms. An authorized firm export more and to more destinations than non-authorized firms especially to EU markets and the value exported by an authorized firm is higher for its labeled products than for its non-labeled products.

3. Empirical model and identification strategy

The specification of our empirical model is driven by firm-based trade theory. We develop a model as a guide for our identification strategy. It assumes that on the one hand, consumer may be more willing to pay for a food product with a PDO label because he perceives this product as a higher quality one. On the other hand, the binding quality requirements associated with PDO labeling generate higher production costs at firm level and thus induce higher prices. This theoretical framework allows us to explicit the ambiguous role of PDO labeling on the probability of exporting (the extensive margin of trade) and the level of export quantity (the intensive margin of trade).

3.1. Theoretical framework

We develop a structural gravity model based on constant elasticity of substitution (CES) expenditure structure to estimate the impact of PDO labeling on export performance at firm level. More precisely, consumers are assumed to have identical Cobb-Douglas preferences over differentiated products $U_j = \Pi_k U_{jk}^{\delta_{jk}}$ where U_j^k is a strictly increasing and strictly concave upper-tier utility function that is twice continuously differentiable in all its arguments and δ_{jk} is the standard expenditure shares with $\sum_k \delta_{jk} = 1$. The utility resulting from the consumption of each differentiated good is given by :

$$U_{jk} = \left[\sum_i \int_{\Omega_{ik}} \left[\lambda_{ijk}(v) q(v) \right]^{\frac{\varepsilon^k - 1}{\varepsilon^k}} \mathrm{d}v \right]^{\frac{\varepsilon^k}{\varepsilon^k - 1}} \tag{1}$$

where $q(v)$ is the quantity purchased for each variety of product k, Ω_{ik} is the set of varieties of product k available in country j and produced in country i, $\varepsilon^k > 1$ is the substitution elasticity between varieties and $\lambda_{ijk}(v)$ is the quality perceived by consumers living in country j for variety v of product k imported from country i. Consumers value (vertical) quality. Some standard calculations show that the equilibrium demand for variety v of product k in

country j is such that:

$$q_{ijk}(v) = [\lambda_{ijk}(v)]^{\varepsilon^k - 1} E_{jk} P_{jk}^{\varepsilon^k - 1} [p_{ijk}(v)]^{-\varepsilon^k} \tag{2}$$

where E_{jk} is the amount of income allocated to the differentiated product k in country j and P_{jk} is the price index in country j associated with product k, defined as:

$$P_{jk} = \left[\sum_{\ell} \int_{\Omega_{\ell j}} [p_{\ell jk}(v)/\lambda_{\ell jk}(v)]^{1-\varepsilon^k} \mathrm{d}v \right]^{\frac{-1}{\varepsilon^k - 1}} \tag{3}$$

Note that the price index reacts negatively in response to an increase in quality of products. In other words, the demand for a variety decreases when the quality of products supplied by the rivals increases. We assume that foreign consumers value varieties as follows

$$\lambda_{ijk}(v) = [\theta_{ik} e^{\xi_i \times \mathrm{PDO(v)}}]^{\eta_j} \tag{4}$$

where $PDO(v)$ is equal to one if variety v of product k has a PDO label. If a variety belonging to product k is not a PDO variety then the quality is given by θ_{ik} which is the quality of non-PDO product k from country i. Parameters ξ_i is a quality shifter associated with PDO labeling and η_j represents the consumer quality valuation of product k in country j. Note that $\zeta_{ij} \equiv \xi_i \times \eta_j$ is the elasticity of perceived quality by consumers living in country j to PDO labeling from country i.

We now describe production technology and market structure. Firms produce under monopolistic competition and can be multi-product. Consistently, in the empirical section, we take the firm-product pair (*variety*) as the basic unit of our analysis. However, each variety is provided by a single producer. Technology is such that the marginal cost of firm f located in country i associated with its variety of product k and exported to country j is given by

$$c_{fijk} = \omega_f i (\theta_{ik})^{\alpha_i} e^{\beta_i \mathrm{PDO}_{fik}} \tau_{ijk} / \varphi_{fik} \tag{5}$$

where $\omega_f i$ is a price index of inputs used by firm f and τ_{ijk} represents trade costs for product k shipped from country i to country j. The variable $(\theta_{ik})^{\alpha_i}$ with $\alpha_i \geq 0$ can be interpreted as a cost shifter due to product quality without PDO label while $e^{\beta_i \mathrm{PDO}_{fik}}$ is an additional cost

shifter due to PDO labeling. The parameter β_i can be interpreted as the cost elasticity of PDO labeling. Higher marginal costs can be caused by a more thorough selection of ingredients and/or additional production tasks. Note that $\mathrm{PDO}_{fik} = 1$ if firm f has a PDO certification for a variety of product k and $\mathrm{PDO}_{fik} = 0$ otherwise. Hence, $\mathrm{PDO}_{fik} = \mathrm{PDO}_v$ since each variety of product k is supplied by a single firm. In other words, the variety labeled v is defined as a product labeled k supplied by a firm labeled f.

The variable φ_{fik} is the productivity of firm f producing product k. We also consider that the multi-product firm has a core competence product which it produces at lowest cost. Adding more products incurs additional costs as it pulls a firm away from its core competency (Eckel and Neary, 2010; Mayer et al., 2014). An additional product entails a decrease in productivity as follows : $\varphi_{fik} = \varphi_{fi} \times \mathrm{Rank}_{fik}^{-\gamma}$ with $\gamma > 0$ and φ_{fi} the productivity in producing the core product and Rank_{fik} the rank of product k within the product line of firm f.[5] Thus the marginal production cost increases with the number of varieties supplied by the manufacturer. Note that we fall back on the "standard" firm-based theory when $\beta = 0$, $\alpha = 0$ and $\gamma = 0$.

As the marginal cost is assumed to be independent from output size, the profit of the firm producing variety v located in country i can be written as follows:

$$\pi_{fi} = \sum_j \sum_k \pi_{fijk} \quad \text{with } \pi_{fijk} = p_{fijk}q_{fijk} - c_{fijk}q_{fijk} - \phi_{fijk} \tag{6}$$

where ϕ_{fijk} is a fixed cost associated with exporting product k from country i to country j incurred by firm f. The profit-maximizing prices are

$$p_{fijk} = \frac{\varepsilon^k}{\varepsilon^k - 1} \frac{\omega_{fi}(\theta_{ik})^{\alpha_i} e^{\beta_i \mathrm{PDO}_{fik}} \tau_{ijk}}{\varphi_{fi} \mathrm{Rank}_{fik}^{-\gamma}} \tag{7}$$

Hence, as expected, firms charge a markup ($\varepsilon^k/(\varepsilon^k - 1)$) over its marginal cost (c_{fijk}).

3.2. PDO labeling, price and perceived quality

Our first objective is to check whether exporters of PDO products can charge a price premium, compared to non-PDO product. As we have information on unit value, a proxy for price, for

[5] Rank_{fik} is computed as in Eckel and Neary, (2010) and Mayer et al. (2014) where products are ranked according to the descending order of their total exported value at the firm level

each firm-destination-product triplet, we can identify the cost elasticity of PDO labeling (β). By using 7, we obtain the following equation to estimate

$$\log p_{fjk} = \text{constant} + \beta \text{PDO}_{fk} + \gamma \text{logRank}_{fk} + \mathbf{FE}_f + \mathbf{FE}_{jk} + \nu_{fjk} \tag{8}$$

where we drop index i as data concern exports of the firms located in France. The term $\mathbf{FE}_f$ is a firm fixed effect controlling for firm heterogeneity (productivity φ_{fi}, production factor prices ω_{fi}). The term $\mathbf{FE}_{jk}$ is a destination-by-product fixed effect capturing heterogeneity in destination-product pair (trade costs τ_{ijk}, markup, and foreign market structure). As our sample includes only one origin country (France), origin country-product fixed effects is therefore not needed. Hence, the quality cost of non-PDO products $(\theta_{ik})^{\alpha_i}$ is captured in the constant term. The variable Rank_{fk} is computed using all the products exported by the firm f (not only cream and cheese products as some firms also export other types of products which are not cream or cheese).

Our interest variable is PDO_{fk}, a dummy variable equals to 1 if the firm f benefits from PDO labeling for a product k (defined at the NC8 level) and zero otherwise. There is only a single type of variety for a given product-firm pair fk : either a PDO variety ($\text{PDO}_{fk} = 1$) or a non-PDO variety ($\text{PDO}_{fk} = 0$). It is worth noting that, when $\text{PDO}_{fk} = 0$, the control group is heterogeneous as it gathers two types of firms: the set of firms authorized to handle some PDO varieties and the others. Indeed, authorized firms can supply both PDO products and non-PDO products while non-authorized companies produce exclusively non-PDO products. Including firm fixed effects FE_f avoids the biased estimates associated with price equation.

Our second objective is to check whether foreign consumers value PDO labels as quality signals on cheese products. Indeed the purpose of PDO label is to facilitate identification of food products with certified quality. To quantify the effect of PDO on product quality perceived by foreign consumers (ζ_j), we need to compute an index of quality at the firm-destination-product level. To estimate product quality from the demand side, we use the methodology developed in Khandelwal (2010). The quality for each firm-product-destination observation can be estimated by using (2). For a given price in a firm-destination-product triplet, a variety with a higher quantity is assigned higher quality. The variable λ_{fjk} is estimated for

each firm-destination-product observation as the residual of the following OLS regression:

$$\log q_{fjk} + \varepsilon^k \log p_{fjk} = \mathbf{FE}_{jk} + \eta_{fkj} \tag{9}$$

with $\mathbf{FE}_{jk} = \log\left[\theta_{ik}^{\eta_j} E_j^k (P_j^k)^{\varepsilon^k - 1}\right]$. We consider $\varepsilon^k = 5$ which corresponds to the elasticity estimates associated with cheese product reported in Ossa (2015). Hence, estimated quality perceived by foreign consumers is $\log \hat{\lambda}_{fkj} = \hat{\eta}_{fkj}/(\varepsilon^k - 1)$. Therefore, to identify the effect of PDO labeling on the perceived quality by foreign consumers, we estimate the following equation

$$\log \hat{\lambda}_{fkj} = \text{constant} + \mathbf{FE}_f + \zeta_j PDO_{fk} + \nu_{fjk} \tag{10}$$

where we have used (4). Note that we do not include the variables $Rank_{fk}$ and the destination-by-product fixed effect $\mathbf{FE}_{jk}$ in the regression (10) as λ_{fkj} is estimated for a given price (p_{fjk}) which includes the variable $Rank_{fk}$ and for a given destination-product pair. We also introduce a firm fixed effect $\mathbf{FE}_f$ in order to control for the perceived quality of all a firm's products (the firm-specific component of quality). We expect the elasticity of perceived quality by consumers living in country j to PDO labeling $\hat{\zeta}_j$ to be positive and to be higher for EU countries than for the others.

3.3. PDO labeling and trade margins

The effect of PDO labeling on export margins is ambiguous according to our theoretical framework. Our objective is to disentangle the two opposite effects at works. Although our data allow us to identify which firms and products get the PDO label, we have no information about when a firm acquired the label PDO for the first time. We would have ideally liked to quantify the causal effect of PDO labeling on firm's export performance using a difference-in-differences approach. By comparing the mean change in firms' export performance before and after the acquisition of the PDO label relatively to a control group, we would have been able to measure the impact of PDO labeling on firms' export performance. Since we do not have a panel dataset, we instead exploit variations across firms, for a given destination and product. It is important to note that most of the firms authorized to handle PDO are the firms which have initiated the PDO label. This means that in the French case, these firms have been involved in PDO production for a long time. To be able to catch the first authorization

to handle the PDO would require to have very long panel dataset. As already mentioned in section 2.1, most of PDO cheese and creams and especially exported ones have been created before 1995.

We first test the effect of PDO labeling on the probability of exporting product k to country j. A French firm exports if its operating profits $\Pi_{fkj} \equiv (p_{fjk} - c_{fjk})q_{fjk} = \frac{p_{fkj}q_{fkj}}{\varepsilon}$ are greater than its fixed export costs ϕ_{fjk}. We assume that these fixed costs are stochastic due to firm-specific unmeasured trade frictions ν_{fjk} with $\phi_{fjk} = \phi_{jk}e^{-\nu_{fjk}}$. Hence, the conditional probability that firm f producing product k exports to country j is

$$\text{Pr}[q_{fjk} > 0] = \text{Pr}[\log(\Pi_{fkj}/\phi_{jk}) > -\nu_{fjk}] \tag{11}$$

Using (7), (4) and (2), we obtain the following equation to estimate :

$$\log\Pi_{fkj}/\phi_{jk} = \rho_1 \text{PDO}_{fk} + \rho_2 \log\text{Rank}_{fk} + \mathbf{FE}_f + \mathbf{FE}_{jk} \tag{12}$$

with $\rho_1 \equiv (\varepsilon^k - 1)(\zeta_j - \beta)$ and $\rho_2 \equiv -(\varepsilon^k - 1)\gamma$. The term FE_{jk} is a destination-by-product fixed effect capturing E_{jk}, P_{jk}, ϕ_{jk} while FE_f is a firm fixed effect capturing φ_f and ω_f. The impact of PDO labeling on the probability of serving a foreign country j depends on the foreign consumers' attitudes towards the EU label (ζ_j), relatively to cost elasticity of PDO labeling (β). Indeed, on the one hand, PDO labeling can increase the product quality perceived by the consumers and, in turn, the demand for the PDO variety (demand effect). On the other hand, PDO labeling implies higher marginal costs and prices leading to a lower demand for the PDO variety (cost effect). This leads to an ambiguous role of PDO labeling. We expect a positive impact of PDO labeling on the export decision at least when exporting to the EU countries where consumers are more aware of quality differentiation induced by PDO than anywhere else. Under the standard assumptions, the unknown parameters could be estimated up to scale using a probit model. However, as the inclusion of fixed effects in a probit model would give rise to the incidental parameter problem, we use the conditional (fixed effects) logit model to take into account the binary nature of the dependent variable.

Second, we test the effect of PDO on intensive margins. Using (2), (4), and (7), the logarithm of quantity exported of product k for firm f located in France to country j to be estimated

is given by

$$\log q_{fjk} = \mu_1 \mathrm{PDO}_{fk} + \mu_2 \log \mathrm{Rank}_{fk} + \mathbf{FE}_f + \mathbf{FE}_{jk} + \epsilon_{fjk} \quad (13)$$

with $\mu_1 \equiv (\varepsilon^k - 1)\zeta_j - \varepsilon^k \beta$ and $\mu_2 \equiv -\varepsilon\gamma$. As above, the destination-by-product fixed effects FE_{jk} capture the role of all types of market size, price index, taste for NC8 products, trade barriers while the firm fixed effect (FE_f) capture all firm-specific determinants, such as productivity, size, and whether the firm is authorized to handle some PDO varieties. Our coefficient of interest is μ_1. As for the extensive margin, the two opposite effects (demand effect *versus* cost effect) are at work. However the relative weight of the cost effect is higher in the intensive margin than in the extensive margin.

4. Results

4.1. Is there a PDO premium?

Table 2 displays estimations on unit values from the equation 8. As our estimations include product-country fixed effects, we compare the unit values of firms exporting labeled products to firms providing non-labeled products for a given destination-(8-digit)product pair. The dummy PDO_{fk} attracts a significant and positive coefficient (the estimated parameter β from the equation 8) in column (1). PDO labeling allows firms to increase on average their price by 11.5%. Column (2) disentangles the effect of PDO by destination. The positive coefficients obtained both on European and non-European markets suggest that PDO products benefit from a price premium, as compared to non-PDO products, whatever the destination country.

Column (3) in Table 2 explores the heterogeneity of non-European countries by differentiating countries recognizing PDO labels from the others. The PDO dummy is interacted with an dummy GI_j equal to one whether the destination country j recognizes European PDO label or has similar system of geographical indications.[6] The coefficient associated with PDO_{fk} reported in column (3) is not significant when interacted with the dummy GI_j, meaning that this price premium does not exist on markets with similar system of geographical labels. These results are in line with Deselnicu et al. (2013) who identify the existence of price premiums induced by PDO, but depending on the characteristics of sectors. The results we obtain on

[6] Algeria, Bosnie-Herzegovine, Bulgaria, Burkina Faso, Congo, Costa Rica, Cuba, Macedonia, Gabon, Georgia, Haiti, Hungary, Iran , Israel, Mexico, Montenegro, Nicaragua, Peru, Moldova, Korea, Serbia, Togo, Tunisia

GI destinations remain puzzling.

Table 2 – Effect of PDO on trade patterns- trade unit values

Dependent variable	ln uv_{fkj}		
	(1)	(2)	(3)
PDO_{fk}	0.115**		
	(0.052)		
ln $Rank_{fk}$	-0.012	-0.012	-0.011
	(0.022)	(0.022)	(0.022)
$PDO_{fk} \times UE_j$		0.104*	0.104*
		(0.059)	(0.059)
$PDO_{fk} \times$ non-UE_j		0.133*	0.164**
		(0.070)	(0.080)
$PDO_{fk} \times GI_j$			0.008
			(0.092)
Fixed effects	f, kj	f, kj	f, kj
N	2,365	2,365	2,365
r2	0.71	0.71	0.72

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors are clustered at the destination-8-digit-product level

$Rank_{fk}$ are computed using all the products exported by the firm f (not only cream and cheese product).

Table 3 show the results of the estimation of the equation 10 on the perceived quality, estimated following the Khandelwal's methodology presented in section 3.2. The estimated parameter ζ_j which is the coefficient of the variable PDO_{fk} is positive in column (1), suggesting that PDO products are, on average, considered as a product of higher quality by consumers, as compared to non PDO products. This results holds both on European and non European markets as ζ_j^{UE} and ζ_j^{non-UE} are positive and significant in column (2), but not on countries with geographical indications in column (3). This latter result is consistent with those of table 2, suggesting that PDO labeled French cheeses do not benefit from price premium on these markets. We do some sensitivity analysis by using different values of ε^k (see Table .1 in Appendix A). Our results remain valid.

4.2. Does PDO labeling improve export performance?

Our results highlight an ambiguous role of PDO labeling because of two opposite effects; consumers can perceive an increase in quality for PDO labeling products but the PDO labeling also implies higher price and, in turn, lower demand. We therefore expect a positive impact of PDO labeling on the export decision at least when exporting to the EU countries where

Table 3 – Effect of PDO on trade patterns- quality

Dependent variable	ln Qual$_{fkj}$		
	(1)	(2)	(3)
PDO$_{fk}$	0.140***		
	(0.077)		
PDO$_{fk}$ × UE$_j$		0.157**	0.157**
		(0.05)	(0.05)
PDO$_{fk}$ × non-UE$_j$		0.112**	0.121***
		(0.095)	(0.094)
PDO$_{fk}$ × GI$_j$			0.074
			(0.125)
Fixed effects	f	f	f
N	2,365	2,365	2,365
r2	0.19	0.19	0.19

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors are clustered at the destination-8-digit-product level

consumers are more aware of this quality scheme.

Table 4 reports our estimates of equation 12. The dependent variable is the decision to export (i.e. a dummy indicating whether the firm exports a given product to a given destination). Remember that our estimations compare export decision of firms selling labeled products to firms providing non-labeled products for a given destination-product pair. For the extensive margin, we find that the demand effect is higher than the cost one. The dummy PDO_{fk} exhibits a positive coefficient in column (1). This result means that for a given product-destination pair, benefiting from a PDO labeling entails a higher probability to be exported. In column (2), we distinguish the impact of labeling according to the destination, assuming that the impact of PDO may be different within the European Union, as this label is defined at the community level and benefits from a legal protection in this area. Only the interacted variable PDO$_{fk}$ × UE$_j$ has a positive and significant coefficient, meaning that PDO labels increase the probability of products to be exported only towards European markets. In column (3), the PDO dummy is interacted with the dummy GI$_j$. The coefficient of the interacted variable is positive and significative while the coefficient relating to other non-European countries remains non significant. PDO labeling favors the entry of French cheese producers on the European market and on countries with a similar policy of denomination of origin of food products, but not on the other countries.

In all columns of table 4, the variable ln Rank$_{fk}$ controls for the rank of the product k in the exports of the firm f. It has a negative coefficient, as expected : the export performance of a firm is lower for products that do not corresponds to its core business. Column (4) estimates the impact PDO labeling PDO_{fjk} according to the rank of the product k. It shows that the positive effect of PDO labels on the probability of export occurs whatever the rank of the exported product within the firm in the case of the European market, but only when the exported products has a rank under 4 in the case of GI destinations. PDO labeling help firms to reach new markets recognizing geographical indicators, only when the product is among the main products exported by the firm.

The table 5 follows the same specification than table 4 but with the logarithm of the quantity exported as explained variable (the intensive margin of trade). This table reports the estimated parameters $\hat{\mu}_1$ and $\hat{\mu}_2$ from equation 13. The estimated parameter $\hat{\mu}_1$ (the coefficient of the PDO dummy) is not significant in any specification whereas the estimated parameter $\hat{\mu}_2$ (the coefficient of the variable ln Rank$_{fk}$) is negative and significant in all columns. The two effects of PDO labeling (demand and cost effects) are offsetting each other at the intensive margin. Our result suggests that PDO products entail better export performance in the cheese industry but only at the extensive margin. PDO labeling may favor the entry on new markets on European markets and on countries with similar system of labeling, but do not have any impact on the volume of trade.[7]

We consider a counterfactual analysis to assess the impact of PDO labeling on exports at the intensive margin for a given price. We evaluate the expected change in export if consumers of non-EU countries value PDO label as much as EU consumers (*e.g.*, $\zeta_j^{\text{non-EU}} = \hat{\zeta}_j^{\text{EU}} = 0.157$ instead of $\zeta_j^{\text{non-EU}} = 0.121$) Using (2) and (4) as well as our estimates, if consumers of non-EU countries value PDO label as much as European consumers , then the export quantity of firms supplying a PDO product would increase by

$$\frac{q_{fjk}(\zeta_j^{\text{non-EU}} = \hat{\zeta}_j^{\text{EU}})}{q_{fjk}(\zeta_j^{\text{non-EU}} = \hat{\zeta}_j^{\text{non-EU}})} - 1 = \frac{e^{(\varepsilon^k - 1)\hat{\zeta}_j^{\text{EU}}\text{PDO}_{fk}}}{e^{(\varepsilon^k - 1)\hat{\zeta}_j^{\text{non-EU}}\text{PDO}_{fk}}} - 1 \cong 0,114 \tag{14}$$

It follows that PDO cheese exports at the intensive margin would increase by 11.4% if non-EU consumers value PDO label as much as EU consumers. Note that this counterfact ual analysis

[7] Using a PPML model, we confirm our results at the extensive margin (see Table .2 in Appendix A).

focuses on partial effect of PDO labeling. Indeed, we neglect its effect through the price index (see 3) as our estimations consider a destination-by-product fixed effect (for a given price index). However, the mass of products with a PDO label is very low in each foreign county so that general equilibrium effects can be disregarded.

Table 4 – Effect of PDO on trade patterns - extensive margin - clogit model

Dependent variable	X_{fkj}			
	(1)	(2)	(3)	(4)
PDO_{fk}	0.539***			
	(0.113)			
ln $Rank_{fk}$	-0.950***	-0.947***	-0.949***	-0.911***
	(0.060)	(0.061)	(0.061)	(0.062)
$PDO_{fk} \times UE_j$		0.855***	0.867***	
		(0.143)	(0.144)	
$PDO_{fk} \times$ non-UE_j		0.167	-0.019	
		(0.159)	(0.167)	
$PDO_{fk} \times GI_j$			1.447***	
			(0.369)	
$PDO_{fk} \times UE_j \times Rank_{fk}^{1-3}$				1.316***
				(0.180)
$PDO_{fk} \times UE_j \times Rank_{fk}^{4-15}$				0.259
				(0.215)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{1-3}$				0.008
				(0.205)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{4-15}$				0.103
				(0.268)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				1.641***
				(0.425)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				1.305*
				(0.682)
N	26317	26317	26317	26317

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors are clustered at the destination-8-digit-product level

$Rank_{fk}$ are computed using all the products exported by the firm f (not only cream and cheese product).

5. Conclusion

Our results confirm that consumers value PDO label as a quality signal, whatever the markets. PDO products can charge higher prices. Our estimations also highlight the export competitiveness role of PDO labeling in the French cheese industry as benefiting from labels allows firms to reach new markets (in particular inside the EU). The increasing number of bilateral

Table 5 – Effect of PDO on trade patterns- intensive margin

Dependent variable	ln Q_{fkj}			
	(1)	(2)	(3)	(4)
PDO_{fk}	0.141			
	(0.247)			
$Rank_{fk}$	-1.387***	-1.387***	-1.391***	-1.382***
	(0.12)	(0.12)	(0.121)	(0.118)
$PDO_{fk} \times UE_j$		0.227	0.23	
		(0.3)	(0.299)	
$PDO_{fk} \times$ non-UE_j		-0.008	-0.189	
		(0.365)	(0.376)	
$PDO_{fk} \times GI_j$			0.73	
			(1.016)	
$PDO_{fk} \times UE_j \times Rank_{fk}^{1-3}$				0.374
				(0.340)
$PDO_{fk} \times UE_j \times Rank_{fk}^{4-15}$				-0.242
				(0.660)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{1-3}$				-0.420
				(0.475)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{4-15}$				0.466
				(0.619)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				0.734
				(1.246)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				0.795
				(0.969)
Fixed effects	f, kj	f, kj	f, kj	f, kj
N	2365	2365	2365	2365
r2	0.67	0.67	0.67	0.67

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors are clustered at the destination-8-digit-product level

$Rank_{fk}$ are computed using all the products exported by the firm f (not only cream and cheese product).

new generation agreements (as the CETA between Canada and the EU or the Japan-EU FTA) can thus be seen as an opportunity for EU producers to increase their market access. However, the non significant impact of PDO on other markets and on the volume of trade in general raise the issue of the need to strengthen identification and protection of PDO out of the community market.

Our work argues in favor of the inclusion of GI aspects in international trade agreements. The recognition of lists of PDO products by Canada and Japan in the framework of the CETA and the EU-Japan FTA will offer interesting case studies to evaluate the impact of such agreement.

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Appendix

Appendix A. Robustness checks

Table .1 – Effect of PDO on trade patterns- quality - robustness checks for $\varepsilon^k = 2, 3, 5$

	(1) $\varepsilon^k = 2$	(2) $\varepsilon^k = 3$	(3) $\varepsilon^k = 5$	(4) $\varepsilon^k = 2$	(5) $\varepsilon^k = 3$	(6) $\varepsilon^k = 5$	(7) $\varepsilon^k = 2$	(8) $\varepsilon^k = 3$	(9) $\varepsilon^k = 5$
PDO_{fk}	0.212***	0.164***	0.126***						
	(0.073)	(0.050)	(0.035)						
$PDO_{fk} \times UE_j$				0.238**	0.184***	0.141***	0.238**	0.184***	0.140***
				(0.093)	(0.064)	(0.043)	(0.093)	(0.064)	(0.043)
$PDO_{fk} \times$ non-UE_j				0.168**	0.131**	0.101***	0.165**	0.135**	0.112***
				(0.083)	(0.056)	(0.039)	(0.083)	(0.055)	(0.038)
$PDO_{fk} \times GI_j$							0.180	0.109	0.053
							(0.240)	(0.162)	(0.104)
Fixed effects	f	f	f	f	f	f	f	f	f
N	2365	2365	2365	2365	2365	2365	2365	2365	2365
r2	0.19	0.18	0.20	0.19	0.18	0.20	0.19	0.18	0.20

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors are clustered at the destination-8-digit-product level

$Rank_{fk}$ are computed using all the products exported by the firm f (not only cream and cheese product).

Table .2 – Effect of PDO on trade patterns - PPML

Dependent variable	ln V_{fkj}			
	(1)	(2)	(3)	(4)
PDO_{fk}	0.309***			
	(0.070)			
ln $Rank_{fk}$	-0.662***	-0.659***	-0.659***	-0.646***
	(0.031)	(0.031)	(0.031)	(0.032)
$PDO_{fk} \times UE_j$		0.480***	0.480***	
		(0.082)	(0.082)	
$PDO_{fk} \times$ non-UE_j		0.033	-0.093	
		(0.106)	(0.114)	
$PDO_{fk} \times GI_j$			0.720***	
			(0.243)	
$PDO_{fk} \times UE_j \times Rank_{fk}^{1-3}$ E				0.594***
				(0.102)
$PDO_{fk} \times UE_j \times Rank_{fk}^{4-15}$				0.238*
				(0.139)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{1-3}$				-0.042
				(0.131)
$PDO_{fk} \times$ non-$UE_j \times Rank_{fk}^{4-15}$				-0.175
				(0.221)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				0.707**
				(0.293)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				0.884**
				(0.413)
Fixed effects				
N	26321	26321	26321	26321
r2	0.33	0.33	0.33	0.33

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors are clustered at the destination-8-digit-product level

$Rank_{fk}$ are computed using all the products exported by the firm f (not only cream and cheese product).