Geographical indications and trade:
Firm-level evidence from the French cheese industry

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Abstract

The protection of geographical indications is now an important feature of trade agreements. In this paper, we examine whether geographical indications are valued by foreign consumers and whether they have implications for trade at firm level. We use firm-product level data from French Customs and a unique dataset of firms and products concerned by Protected Designations of Origin (PDO) in the cheese and cream sector. Our estimations show that PDO varieties are perceived by consumers as varieties of higher quality than non-PDO varieties and that the prices of PDO varieties are 11.5% higher than those of non-PDO varieties. Regarding trade margins, and especially the extensive margin, our estimations show that the exported expected value of PDO varieties would increase by 67.5% on non-EU markets if non-EU consumers valued PDO labels as highly as EU consumers.

Keywords: Geographical indication; PDO; price; product quality; trade margins

JEL: F10, F14.

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1 Introduction

Geographical indications (GIs) are a contentious issue in trade negotiations. In the past, the European GI system has twice given rise to complaints to the WTO dispute settlement body, once by the United States in 1999 and once by Australia in 2003. The protection of GIs was also very controversial in the negotiation of the Comprehensive Economic and Trade Agreement (CETA) between the European Union and Canada. These tensions arise from the significant differences in the approaches between the European Union and the US, Canada and Australia (Josling, 2006). Despite the controversy in trade negotiations, empirical evidence on the impact of GIs on import demand is lacking.

In the opinion of the EU, there is a clear link between the place of production and the quality of agricultural products, which is mainly explained by soil, weather and local know-how. The definition and protection of geographical indications is one way of informing consumers about the intrinsic quality of products while promoting rural development and securing cultural heritage. The EU's efforts to promote GIs in multilateral and bilateral negotiations conflict with the view of Anglo-Saxon countries who historically prefer to rely on trademarks. The US, Canada, Australia and South Africa are reluctant to adopt GIs and consider them as unfair trade impediments. However, Canada has made concessions to the European Union and has agreed to recognize 145 GIs in the CETA. While this agreement is still too recent to measure the impact of this recognition on trade in products with geographical indications from the European Union, it is worth investigating the impact of GIs on trade at firm level to shed light on the potential impact of such recognition.

Relatively few papers analyze the impact of geographical indications on trade. Agostino and Trivieri (2014) focused on wine from France, Spain and Italy and demonstrate that quality wines produced in specified regions (QVPSR) have higher export values. Sorgho and Larue (2014) quantified the effect of GIs on intra-community trade using a gravity model with data at country and product (defined with 2 digit codes - HS2) level. They found the effects of GIs on trade within the EU varies, according to whether or not the importing country has GI protected products. They also identified a higher border effect for GI products, due to their greater appreciation by domestic consumers. The same authors continued their work in Sorgho and Larue (2018) and show that the effect of GIs on European trade is ambiguous, due to heterogeneity in consumer preferences. Raimondi et al. (2019) use a dataset with trade flows at country and product (defined with 6 digit codes - HS6) level to estimate the effect of GIs on intra- and extra-EU trade margins. They show

that GIs positively affect trade and prices, in both European and non-European countries. The main challenge in studying GIs and trade is to identify the trade flows concerned by GIs, as this information is not recorded in trade databases. The works cited above analyze the effect of GIs at the aggregated level (country imports of HS2 or HS6 products) and use the number of existing GI per product category (HS2 or HS6) to identify flows containing potential GI varieties. To identify GI flows more precisely, one needs a more disaggregated product level (8 digit for instance) and information on the exporting firms. Indeed, for a given GI, only authorized firms are allowed to operate. In other words, the GI flows can only be properly identified in trade dataset once firm-product (8 digit) pairs are accounted for.

In this paper, we identify firm-product flows concerned with GIs and examine whether GIs impact prices and trade margins at firm level. We also test whether foreign consumers perceive GI varieties as higher quality varieties. We focus on the 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 sectors in the international GI debate (see chapter 6 by S. Frankel in Calboli and Ng-Loy (2017)). We take advantage of a unique exhaustive list of firms - product (defined with 8 digit codes - NC8 in the European 8-digit level product classification) pairs concerned by PDO in France to compare exports of PDO varieties with exports of non-PDO varieties to a given destination. In a first stage, we investigate whether PDO labels allow producers facing the same rules for a given product to charge higher prices in foreign markets. We also investigate whether PDO labels are perceived by foreign consumers as a quality signal (more tasty, safer, healthier, more sustainable etc.). In other words, we account for the heterogeneity on consumer tastes on a given market. To this end, we follow the methodology developed by Amiti and Khandelwal (2013) to estimate demand functions based on observed trade data at firm-product (NC8) level to infer relative quality. Our approach thus differs from that used in other articles on consumer valuation of GIs that measure willingness to pay for geographical labels (Menapace et al., 2011; Bonnet and Simioni, 2001), price elasticities (Hassan et al., 2011) or price premiums (see for example a meta-analysis by Deselnicu et al., 2013). In a second stage, we estimate the impact of PDO labels on the margins of trade at firm-product level: the probability of exporting and the quantity exported. European destinations are distinguished from other destinations.

Our research builds on papers that investigate 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, 2008; Hummels and

Klenow, 2005; Baldwin and Harrigan, 2011) or firm level data (Bastos and Silva, 2010; Martin, 2012). A second strand of this literature focuses on the heterogeneity of firm-level quality. Johnson (2012) shows that highly productive firms export better quality goods and charge higher prices than other firms. Manova and Zhang (2012) show that Chinese firms producing higher quality goods have a better export performance. Crozet et al. (2012) tested the Melitz model (2003) using firm heterogeneity and show that quality increases both the probability of market entry and exported values. Curzi and Olper (2012) also confirm the relationship between productivity, product quality and export performance in the food sector. Except for Crozet et al. (2012), who use quality ranking by experts, and Curzi and Olper (2012), who used R&D and innovation as a proxy for quality, the majority of these studies have used trade unit values as a proxy for the quality of the product. In this paper, we investigate the impact of another measure of quality, the label PDO. In the theoretical model, the PDO label is considered as a quality shifter for some consumers (increasing the demand for PDO varieties) but also, due to production constraints, as a marginal cost shifter for producers (increasing price and thus reducing demand). Thus the PDO label has an ambiguous effect on trade. In the empirical analysis, we show that this label has a positive impact on firm trade flows.

We find that, for a given product-destination pair, PDO varieties are perceived by consumers as products of higher quality than non-PDO varieties. This confirms the link between PDO label and quality perception by consumers. As expected this link is higher for EU consumers. If non-EU consumers valued PDO labels as highly as EU consumers, firm exports of PDO varieties would increase by an average of 11.4%. Our estimations also reveal that PDO varieties allow firms to charge higher prices (their prices are 11.5% higher than those of non-PDO varieties) and to reach a larger number of destination countries.

The paper is organized as follows. In the first section, we present the European approach to protecting GIs, highlighting how it differs from the trademark system. In the second section, we develop a theoretical framework showing the different mechanisms at work that we use as a guide for our identification strategy. In the third section, we describe our dataset and provide first evidence for differences in trade patterns between PDO and non-PDO varieties. In the fourth section, we present our empirical strategy. In the fifth section, we show our empirical results and present our conclusions in the last section.

2 The European Geographical Indications Policy

2.1 The GI component of the European quality package

In the European Union, GI protection is included in the European quality package, which was launched in 2010 and is defined in details in European regulation 1151/2012. This European quality policy aims to provide consumers with information both on the origin of the products and on traditional know-how. GIs include two quality schemes: Protected Designations of Origin (PDO) and Protected Geographical Indications (PGI).[1]

In 2019, the European Union listed 1455 food products that are registered with a GI (640 PDO, 753 PGI) and 266 products are in the process of registration among which 25 originate from countries outside the European Union. While wines are still the main GI products, the cheese sector also accounts for a large share of European GIs (see Table 1).

For a product to be registered as a PDO, applicants have to be a group of producers and/or processing firms and can apply for the name of an existing product. The application form includes the product description and the geographical area associated with the products. Details on the link between the region of origin and its causal influence on product quality or characteristics have to be provided. PDO requirements are stricter than those required for Protected Geographical Indications (PGI).

In France, GIs are managed by the INAO (*Institut National de l'Origine et de la Qualité*), which is a mixed public-private body. However, only public authorities (the Ministry of Agriculture) are authorized to examine GI specifications and to interact with the EU commission. INAO was created in 1935, but French law has recognized and associated the location with a product name since 1905. At that time, the aim of the law was to protect wine producers through the definition of AOC labels (*Appellation d'Origine Contrôlée*). The first cheese AOC, the AOC *Roquefort*, appeared in 1925. Another emblematic French cheese AOC, the AOC *Comté*, was recognized in 1958. Among the 50 French dairy PDOs, 36 existed before 1995 and 25 existed before 1980. The most recent French PDO applies to *Beurre et crème de Bresse* which was recognized in 2014.

[1] The label Traditional Specialties Guaranteed (TSG) only relies on traditional know-how without any reference to a specific location.

Table 1: Number of registered GIs in the cheese sector

	Total	PDO	PGI
European Union	243	189	47
France	54	45	9
Italy	53	50	2
Spain	28	26	2

Notes: Authors' computation using the DOOR database.

2.2 Related literature on the impacts of GIs on producers and consumers

GIs are included in the European quality policy as a welfare-improving tool because they reduce market failures associated with information asymmetry and help producers to better market their products. GIs help promote regional and rural development by securing prices at farm gate level and by protecting producers of regional food products from unfair competition from trademarked products using the same denominations. Lence et al. (2007) demonstrate that when producer organizations obtain stronger property rights to collectively manage the geographically protected products, their welfare is enhanced. Their conclusion is in agreement with that of Moschini et al. (2008) who show that GIs lead to welfare gains in a competitive market structure of quality supply. Moreover, the GI scheme reduces the cost of establishing a reputation and GIs reveal more information than do trademarks (Menapace and Moschini, 2012). The positive effects of PDO labeling have also been empirically demonstrated by the exit rate of firms. Looking at the impact of PDO on the survival of French cheese firms, Bontemps et al. (2013) find that PDO labeling mitigates the exit rate for dairy firms. Bouamra-Mechemache and Chaaban (2010b) also demonstrate that PDO are efficient from the producer's perspective. However, PDO labeling restricts quantity and increases variable costs compared to private collective certification that relies on fixed costs such as investment in R&D and joint advertising. On average, PDO producers face 40% higher costs (more labor intensive, higher prices paid for raw material) than non-PDO producers (Bouamra-Mechemache and Chaaban, 2010a). Desquilbet and Monier-Dilhan (2015) examine the heterogeneity of PDO labeling by investigating two extreme cases: (i) a denomination label, *i.e.*, the PDO only protects the product name or brand and (ii) a minimum quality standard label, where the PDO label not only protects the product name but it also includes a set of binding requirements. They show that theoretically, producers are better off in the first PDO labeling scheme.

Consumers are not always aware of the differences between PDO and non-PDO varieties. Bon-

net and Simioni (2001) found that only a small number of consumers prefer purchasing a PDO *camembert* to a non-PDO *camembert*. This author mentions that a trademark appears to provide more relevant information about the valuation of this specific product. Hassan et al. (2011) confirm this result by estimating price elasticities across various cheese products, but the finding is not widely supported in the literature. In their meta-analysis, Deselnicu et al., 2013 point out that the biggest premiums from GIs are found in the cheese, fruit and vegetable and grain sectors. They also report that PDOs with the most stringent requirements get the highest premium.

2.3 GIs versus trademarks at international level

At the multilateral level, GIs were officially introduced and defined in article 22 of the Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement of the World Trade Organization (WTO) in 1994. The TRIPS agreement is weakly prescriptive and leaves the means of GI protection to be defined by each country to account for the heterogeneity of national approaches. Whereas the US, and other countries including Australia and New Zealand, largely incorporate GI protection in trademark laws, *sui generis* systems were developed in countries with Roman law, (France,Italy and Spain) and are currently in force in the EU.

GIs and trademarks are thus the two main alternative means used by WTO members to protect products with GI provisions. They both protect products through intellectual property and grant exclusive rights to the users. They address a market failure and ensure that information is revealed to consumers to mitigate information asymmetry. However, based on stronger state intervention and involving both definition of the methods of production and facilitation of the supply chain coordination, the GI *sui generis* system differs considerably from the trademark system (Gangjee, 2017; Kireeva and O'Connor, 2010). In the *sui generis* system, when entry conditions (geographic area and adoption of GI code of rules) are met, all producers (farmers and processors) can use the associated GI. GI can be thus regarded as a collective brand shared between agricultural producers and processing firms that are authorized to use it. In that sense, in contrast to trademarks, they are not exclusionary.

The coexistence of GIs and trademarks on the same market due to international trade raises several concerns. For instance, in countries that use the trademark system, GI producers from other countries cannot prevent the misuse of their denomination unless the GI is registered as a trademark. As a consequence, GIs may not have the same impact on firms' exports depending on the destination market. We explore this issue in our empirical analysis.

3 Theoretical framework

The specification of our empirical model is driven by the firm-based trade theory. We built a model as a guide for our identification strategy. Let U_{jk} be the utility associated to consumption of product k in country j:

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

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, $\varepsilon_{jk} > 1$ 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. Standard calculations show that the equilibrium demand for variety v of product k in country j is such that:

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

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:

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

Note that the price index responds negatively to an increase in product quality. In other words, the demand for a variety decreases with an increase in the quality of products supplied by rivals. 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 from country i is not a PDO variety then the quality is given by θ_{ik}. Parameter ξ_i is a quality shifter associated with PDO labeling and η_j represents the consumer quality valuation of product k in country j. In this model, we do not quantify the quality shift induced by the PDO label. We introduce a shifter specific to consumers in country j. The more consumers value PDO (quality shift), the higher the imported quantity. 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. As in Curzi

and Olper (2012) and Crinò and Epifani (2012), the demand addressed to firm f from country i by consumers from country j for product k is higher for high quality varieties. In our model, as PDO is a potential component of quality, the demand will higher if consumers in country j value PDO varieties.

We now describe production technology and market structure. Firms produce under monopolistic competition and can be multi-product. In the empirical section, we consistently used the firm-product pair (*variety*) as the basic unit of our analysis. However, each variety is supplied 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

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

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. Following Crinò and Epifani (2012), we assume that the marginal cost of producing its variety of product k to be exported to country j, is decreasing in firms f's efficiency for product k and increasing in product quality. In our case, we add a supplementary cost shifter to account for the fact that PDO production is costly. The variable $(\theta_{ik})^{\alpha_i}$ with $\alpha_i \geq 0$ can be interpreted as a cost shifter due to product quality with no PDO label while $e^{\beta_i \text{PDO}_{fik}}$ is an additional cost shifter due to the PDO label. The parameter β_i can be interpreted as the cost elasticity of producing a PDO variety.[2] Higher marginal costs can be caused by a more thorough selection of ingredients and/or additional production tasks. Note that $\text{PDO}_{fik} = 1$ if firm f has a PDO certification for a variety of product k and $\text{PDO}_{fik} = 0$ otherwise. Hence, $\text{PDO}_{fik} = \text{PDO}_v$ 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 located in country i producing product k. We also consider that the multi-product firm has a core competence product it produces at the 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: $\varphi_{fik} = \varphi_{fi} \times \text{Rank}_{fik}^{-\gamma}$ 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.[3] Thus the marginal production

[2] In this model, we deal with the production of a PDO variety, once the firm obtained the authorization. We do not address the process to get authorized (surely involving sunk costs) as most PDO authorizations were obtained more than 20 years ago.

[3] Rank_{fik} is computed as in Eckel and Neary, (2010) and Mayer et al. (2014) where products are ranked in

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 of 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

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

Hence, as expected, firms charge a markup ($\varepsilon_{jk}/(\varepsilon_{jk} - 1)$) over the marginal cost (c_{fijk}). Note that the shift in marginal costs will induce a higher profit-maximizing price.

Our model makes explicit the ambiguous role of PDO labels in the probability of exporting (the extensive margin of trade) and the level of export quantity (the intensive margin of trade). On the one hand, consumers could be more willing to pay for a food product with a PDO label because they perceive the product to be of higher quality. The demand addressed to PDO producers will increase when consumers in a destination market value PDO varieties as quality goods (demand effect - noted ζ_{ij}in our model). On the other hand, the binding quality requirements associated with PDO labels could generate higher production costs at firm level and thus result in higher prices. PDO increase marginal costs and doing so increase the profit maximizing prices (cost effect - noted β_i). In turn, higher prices decrease the demand addressed by consumers. According to the relative importance of these two components, the global effect of PDO labels will be different. We expect it to be positive, especially on markets where PDO are perceived as quality varieties: the positive demand effect will be higher than the negative cost effect.

descending order of their total exported value at firm level

4 Data and descriptive statistics

4.1 Data

The objective of the paper is to investigate the effect of PDO label on trade patterns. Based on our theoretical model described in section 3, our empirical analysis relies on an exhaustive list of product-plants concerned by PDO labels published in 2012, provided by the INAO. This list gives for each PDO label, the list of plants authorized to operate. This bilateral link between plant and PDO name is the key point to identify PDO trade flows.

This dataset is merged with data on French firm-level trade and characteristics. Trade data from French Customs provide the value and quantity of exports, for each firm, according to the European 8-digit level product classification (NC8) and destination. Data on firm's characteristics come from the French national institute of public statistics (INSEE) and provide information on the main activity, total sales and the value added per worker of each firm. The activity code enables us to select the firms specialized in the production of cream and cheese.

The first issue we encounter when merging PDOs information and firm's characteristics is to match plant and firm identifiers. A plant is a production location and a firm may have multiple production locations. We aggregate plants into firms using the first nine numbers of the national identification code of plants (SIRET) which is the firm's identification code (SIREN).

The second challenge is to match the names of PDO (for instance *Camembert de Normandie*) from the INAO dataset with the NC8 classification of products used by French Customs (in our example 0406.90.82, which correspond to *Camembert*). We build a correspondence table (Table 7) to make the transformation, using NC8 and PDO descriptions. Although the correspondence is straightforward for several products as in the case of *Camembert*, two types of problems may arise. First, a PDO label may not have an exclusive NC8 code, as in the case of *Comté* that can be registered under the code 0406.90.15 or 0406.90.99 depending on its fat content, which is linked with the period of the year. Second, a NC8 code can stand for both PDO and non-PDO varieties, as in the case of the NC8 code 0406.90.15. This code corresponds to *Comté* but also to products with the same characteristics in terms of fat or water content but that do not benefit from the PDO label, as *Gruyère*. At the end, we obtain a list of 14 NC8 categories that are concerned by PDO labels.

Among firms that belong to the same activity code (i.e. production of cheese and cream), we limit our analysis to firms that export products that belong to the NC8 categories for which at least

one PDO label is defined.[4],[5] We only consider producing firms and exclude wholesalers from our sample to fit with our theoretical model but also because it is impossible to follow PDO varieties produced by authorized firms and exported by wholesalers or other trade intermediaries in our data.

We end up with a sample of 29 authorized and 191 non-authorized exporting firms, both kinds of firms being multi-products. It is worth noting that a PDO authorizations is specific to a given PDO, so authorized firms may export both PDO varieties in some NC8 codes but also non-PDO varieties for some other NC8 codes, as we can see in the figure 1. In this example, firms f_1, f_2 and f_3 all produce and export two products, the NC8 0406.90.82 (*Camembert*) and the NC8 0406.90.15 (hard cheese as *Gruyere* or *Comté*). The firm f_1 is authorized for *Camembert* (which correspond to the PDO *Camembert de Normandie*) but not for the hard cheese category. As a consequence, only its exports of product NC8 0406.90.82 benefits from the PDO label and is identified as a PDO *variety* in our data. Note that the firm f_1 may also export *Camembert* without the PDO label. However, as the customs services do not register for the PDO characteristic of the product, we can not distinguish between PDO and non-PDO variety for a given authorized firm-NC8 product pair. We thus consider that all the exports of authorized firms for the NC8 product benefits from the label.[6] The firm f_2 is authorized for the hard cheese category 0406.90.15 (which correspond to the PDO *comté*) but not for *Camembert*, so only its exports of NC8 0406.90.15. is recorded as a PDO *variety* in our dataset. Firm f_3 is neither authorized for the *Camembert* nor for the hard cheese category.

4.2 Descriptive statistics

Table 2 provides descriptive statistics for authorized and unauthorized firms. Authorized firms appear to be slightly more productive (computed at firm level) and, based on the number of employees, to be larger. This is consistent with the fact that complying with PDO constraints may generate higher costs that can only be covered by more productive firms. Their higher average productivity and larger size may also partly explain why authorized firms export more products (without distinguishing between PDO and non-PDO varieties), to a larger number of destinations,

[4]This concerns 14 NC8 codes among 40 different codes in the HS4 categories 0405 or 0406 for cream and cheese products

[5]We focus on the NC8 exported by firms as we do not know what products are produced by non-exporting firms.

[6]This hypothesis sounds realistic at the plant level as a plant is located in a specific geographical area; the hypothesis is stronger at the firm level (as a firm can have several plants located in different areas). This hypothesis may lead our empirical analysis to underestimate the effects of labels.

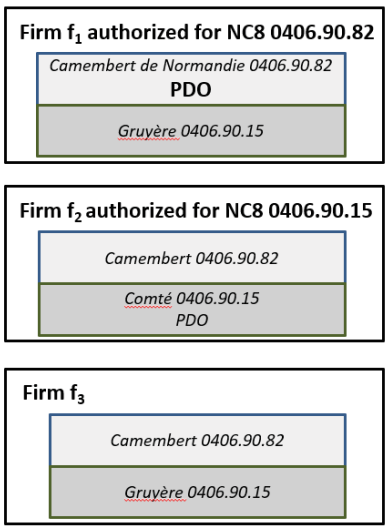


Figure 1: Firm-NC8 pairs and identification of PDO flows

and have a 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 exporters.

PDO varieties represent 23.5% of the export value of authorized firms. As a consequence, PDO varieties represent a relatively small share (5%) of French total exports of cream and cheese. As explained in section 4.1, non-labeled varieties are exported by both unauthorized firms (representing 78% of total trade) and authorized firms (representing 17%). Figure 2 presents median French cheese exports per firm-product and shows that PDO-varieties export values and quantities are higher than for non-PDO varieties. Figure 3, which shows the kernel density of the export values and quantities per firm-product pair, confirms this observation. PDO varieties generate more flows with higher value or in larger quantities than other varieties.

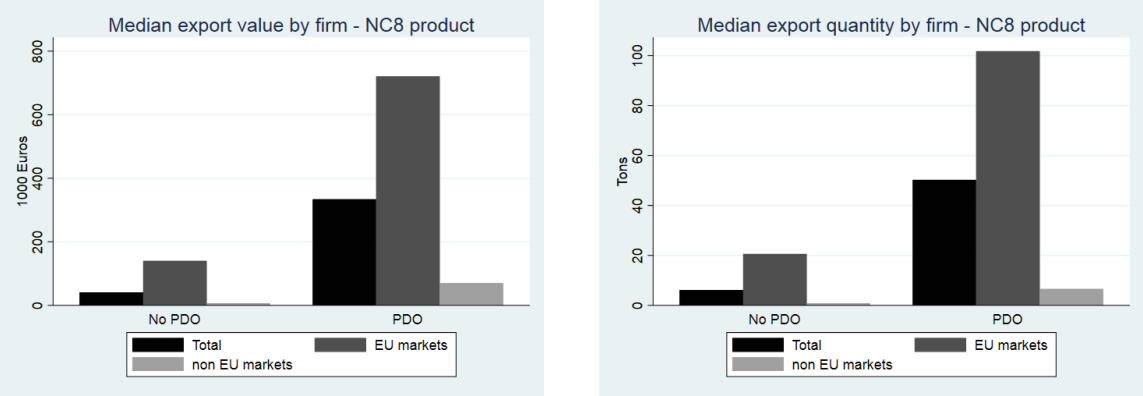
Figure 4 shows the median of trade unit value of cheese and cream products computed for PDO and non-PDO varieties. In contrast to the export values, the unit value does not differ much according to the type of variety.

So far, the descriptive statistics suggest a positive role for PDO labels in firms' export performance in the cheese and cream industry.

Table 2: Descriptive statistics on authorized and unauthorized firms

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

Notes: Authors' computation using INSEE and INAO datasets.



(a) Value (b) Quantity

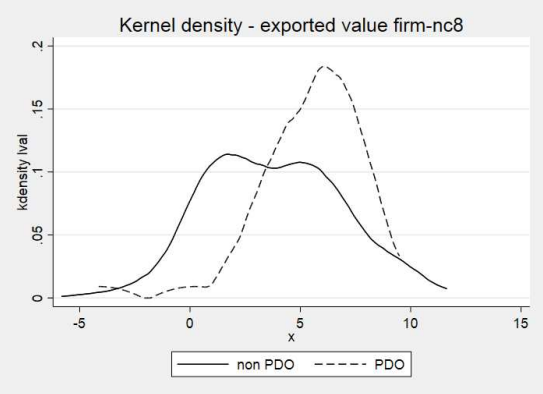
Notes: Authors' computation using French Customs and INAO datasets.

Figure 2: Export per firm and product (NC8)

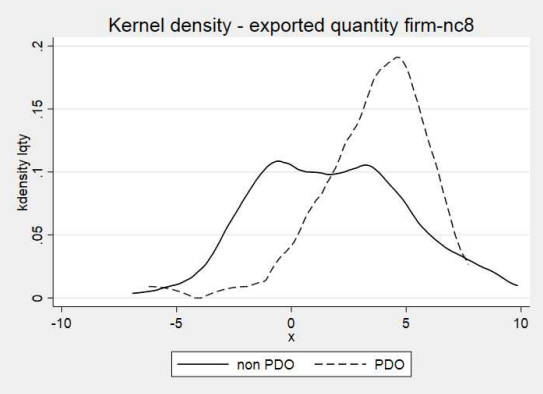
5 Empirical strategy

5.1 Identification

Ideally, we would have liked to quantify the causal effect of PDO labeling on a firm's export patterns by comparing the mean change in a firm's export performance before and after the acquisition of the PDO label relative to a control group. This is unfortunately not possible because our database does not contain information on when a firm first obtained the PDO label. Moreover, in the French cheese sector, most of the firms authorized to handle PDO are the firms that introduced the PDO label, and have consequently been involved in PDO production for many years. As already mentioned in section 2.1, most PDO cheeses and creams, especially those exported as *Comté*, *Camembert de*



(a) Value

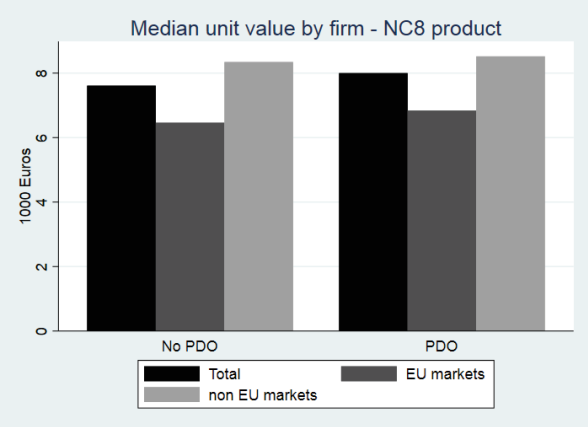


(b) Quantity

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

Figure 3: Kernel density of export

Figure 4: Exported unit value per firm and product (nc8)



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

Normandie or *Roquefort*, were created before 1995. To be able to identify the first authorization to handle PDO would thus require a very long panel dataset for which firm level trade data are not available.

Our identification of the effect of PDO label on trade patterns exploits variation across firm-product varieties, for a given destination and product NC8. To come back to the example presented in section 4.1 and as we can see in figure 5.1, we are comparing exports of firms f_1, f_2 and f_3 of product NC8 0406.90.82 in a specific destination j, *Japan* in our example. More precisely, we compare the variety [f_1-NC8 0406.90.82], which benefits from the PDO label and is thus *Camembert de Normandie* to the other varieties [f_2-NC8 0406.90.82] and [f_3-NC8 0406.90.82] that do not have the PDO label and correspond to *Camembert* on the Japanese market. This strategy allows to

control for all the characteristics of the destination-product pair (as the taste of Japanese consumers for this specific kind of cheese, transportation cost, and other Japanese market characteristics) in order to focus on the difference between PDO and non-PDO varieties.

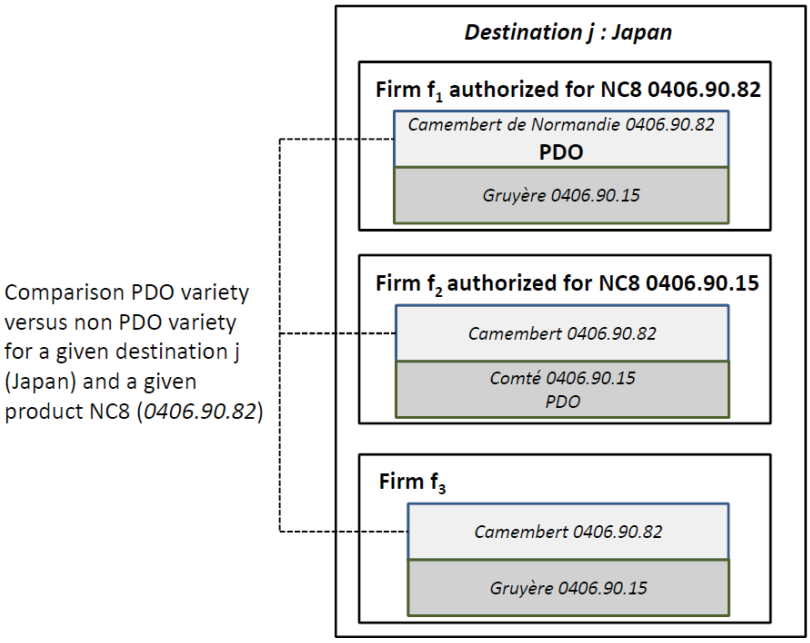


Figure 5: Firm-NC8 pairs and identification strategy

5.2 PDO labeling, price and perceived quality

Our first objective is to check whether exporters of PDO varieties can charge a price premium, compared to non-PDO varieties for a given product and a given destination market. As we have information on unit value, which is a proxy for price, for each firm-destination-product triplet, we can identify the cost elasticity of PDO labeling (β) defined in 3. 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 by 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 inclusion of destination-product fixed effect $\mathbf{FE}_{jk}$ allows us to compare PDO varieties and non-PDO varieties for a given destination-product pair. This fixed effect captures heterogeneity

in destination-product pair (consumer preferences, trade costs τ_{ijk}, markup, and foreign market structure). As our sample includes only one country of origin (France), an origin country-product fixed effect is not needed. Hence, the quality cost of non-PDO varieties $(\theta_{ik})^{\alpha_i}$ 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 products than cream or cheese).

Our interest variable is PDO_{fk}, a dummy variable equal to 1 if firm f benefits from PDO labeling for product k (defined at the NC8 level) and zero otherwise. We recall that a given firm-product pair fk corresponds to a variety: 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 groups two types of firms: the set of firms authorized to handle some PDO varieties and the others. Indeed, authorized firms can supply both PDO varieties and non-PDO varieties, while unauthorized firms only produce non-PDO varieties (as shown on figure 5.1). Including firm fixed effects FE_f avoids the biased estimates associated with price equations.

Our second objective is to check whether foreign consumers value PDO labels as quality signals for cheese products. Indeed, the purpose of the 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). This methodology does not account for label or quality signal. Indeed, the quality for each firm-destination-product observation is inferred from observed data. For a given price in a firm-destination-product triplet, a variety with a higher quantity is attributed higher quality. The variable λ_{fjk} is estimated for each firm-destination-product observation as the residual of the following OLS regression:

$$\log q_{fjk} + \varepsilon_{jk} \log p_{fjk} = \mathbf{FE}_{jk} + \xi_{fkj} \tag{9}$$

with $\mathbf{FE}_{jk} = \log \left[E_j^k (P_j^k)^{\varepsilon_{jk}-1} \right]$. We consider $\varepsilon_{jk} = 5$, which corresponds to the elasticity estimates associated with cheese products reported in Ossa (2015). Hence, estimated quality perceived by foreign consumers is $\log \hat{\lambda}_{fkj} = \hat{\xi}_{fkj}/(\varepsilon_{jk} - 1)$. Therefore, to identify whether PDO label has an effect on the quality perceived by foreign consumers as supposed in (4) and to quantify this effect, we estimate the following equation:

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

Note that we do not include the variables $Rank_{fk}$ and the destination-product fixed effect $\mathbf{FE}_{jk}$ in the regression (**??**) 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 introduce a firm fixed effect $\mathbf{FE}_f$ in order to control for the perceived quality of all the products produced by one firm (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 others.

5.3 PDO labeling and trade margins

Our objective is now to estimate the trade margins at firm level. According to our theoretical framework, the effect of PDO label on export margins is ambiguous. We first test the effect of PDO labels 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} (see section 3). 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

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

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 $\rho_1 \equiv (\varepsilon_{jk} - 1)(\zeta_j - \beta)$ and $\rho_2 \equiv -(\varepsilon_{jk} - 1)\gamma$. The term FE_{jk} is a destination-product fixed effect capturing E_{jk}, P_{jk}, ϕ_{jk} while FE_f is a firm fixed effect capturing φ_f and ω_f. As highlighted in the theoretical section, 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), relative to the cost elasticity of PDO labeling (β). Indeed, on the one hand, PDO labeling can increase product quality as perceived by consumers and, in turn, the demand for the PDO variety (demand effect). On the other hand, PDO labeling implies higher marginal costs and prices, thereby reducing the 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 EU countries where consumers are more aware of the difference in quality of PDO labeled products than anywhere else. Under 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 account for 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

$$\log q_{fjk} = \mu_1 \text{PDO}_{fk} + \mu_2 \log\text{Rank}_{fk} + \mathbf{FE}_f + \mathbf{FE}_{jk} + \epsilon_{fjk} \tag{13}$$

with $\mu_1 \equiv (\varepsilon_{jk}-1)\zeta_j - \varepsilon_{jk}\beta$ and $\mu_2 \equiv -\varepsilon\gamma$. As above, the destination-product fixed effects FE_{jk} capture the role of all types of market size, price index, taste for NC8 products and trade barriers, while the firm fixed effect (FE_f) captures all firm-specific determinants, such as productivity, size, and whether the firm is authorized to handle certain PDO varieties. Our coefficient of interest is μ_1. Like for the extensive margin, two opposing 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.

6 Results

6.1 Is there a PDO premium on foreign markets?

Table 3 lists estimations of equation 8 on unit values. As our estimations include product-country fixed effects, we compare the export unit values of PDO authorized firms with those of unauthorized firms for a given destination-(8-digit)product pair. The dummy PDO_{fk} attracts a significant and positive coefficient (the estimated parameter β from equation 8) in column (1). A PDO label allows firms to increase their price by an average of 11.5%. Column (2) disentangles the effect of PDO per destination. The positive coefficients obtained both on European and non-European markets suggest that PDO varieties benefit from a price premium, compared to non-PDO varieties, whatever the destination country. These results are in line with those of Deselnicu et al. (2013) who identify the existence of price premiums induced by PDO, but that these depend on the characteristics of the sector concerned.

Column (3) in Table 3 explores the heterogeneity of non-European countries by differentiating between countries that recognize PDO labels and countries that do not. The PDO dummy interacts with a dummy GI_j equal to one if the destination country j registered a GI in the European system or has a similar system of geographical indications.[7] The coefficient associated with PDO_{fk} listed in column (3) is not significant when it interacts with the dummy GI_j or non-EU_j, meaning that this price premium does not exist neither on markets with a similar system of geographical labels nor on other markets. The results we obtain on GI destinations remain puzzling. The consumers from these countries are not more willing to pay for PDO varieties from France. They do not differentiate PDO varieties from other imported products, and consequently do not give any additional value to imported GI products in contrast to their own GI products. It is worth noting that in 2012 only few countries are concerned by this dummy. This result should be tested several years after when several other countries are concerned and especially those that signed an agreement with the EU and explicitly recognized some French GIs.

Table 3: 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	-0.012
	(0.022)	(0.022)	(0.022)
$PDO_{fk} \times EU_j$		0.104*	0.105*
		(0.059)	(0.058)
$PDO_{fk} \times$ non-EU_j		0.133*	0.122
		(0.070)	(0.080)
$PDO_{fk} \times GI_j$			0.163
			(0.114)
Fixed effects	f, kj	f, kj	f, kj
N	2,365	2,365	2,365
r2	0.71	0.71	0.71

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 products).

Table 4 lists the results of the estimation of equation **??** on the perceived quality, estimated according to Khandelwal's methodology presented in section 5.2. The estimated parameter ζ_j which is the coefficient of the variable PDO_{fk} is positive in column (1), suggesting that PDO varieties

[7] Countries with similar system and/or for which a GI was registered under the EU system (DOOR, before 2012) are Swizerland, Japan, Vietnam, China, Turkey, Brazil, Colombia, India, Morocco.

are, on average, considered by consumers to be of higher quality than non-PDO varieties. This results holds on both European and non European markets as ζ_j^{EU} and ζ_j^{non-EU} are positive and significant in column (2), but not in countries with geographical indications in column (3). The latter result is consistent with those in table 3, suggesting that PDO labeled French cheeses do not benefit from a price premium on these markets and that the consumers in those countries do not consider them as higher quality products. We then conducted some sensitivity analyses using different values of ε_{jk} (see Table 8 in Appendix A). Our results remain valid.

Table 4: Effect of PDO on trade patterns- quality

Dependent variable	ln Qual$_{fkj}$		
	(1)	(2)	(3)
PDO$_{fk}$	0.140***		
	(0.077)		
PDO$_{fk}$ × EU$_j$		0.157**	0.157***
		(0.05)	(0.05)
PDO$_{fk}$ × non-EU$_j$		0.112**	0.113**
		(0.095)	(0.045)
PDO$_{fk}$ × GI$_j$			0.109
			(0.089)
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

6.2 Do PDO labels improve export performance?

Our results reveal that PDO labeling plays an ambiguous role because of two opposing effects; consumers perceive an increase in quality for PDO varieties but PDO labels also results in higher prices and, in turn, reduces demand. We therefore expect a positive impact of PDO varieties on the export decision at least when exporting to EU countries, where consumers are more aware of this quality scheme.

Table 5 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). It should be noted that our estimations compare the export decision of firms selling labeled varieties with that of firms selling non-labeled varieties for a given destination-product pair. For the extensive margin, the demand effect is higher than the cost effect. 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 label entails a higher probability of being exported, in agreement with the results found by Agostino and Trivieri (2014). In column (2), we distinguish the impact of labeling according to the destination, assuming that the impact of PDO may differ within the European Union, as this label is defined at the community level and benefits from legal protection in the EU. Only the interacted variable $\text{PDO}_{fk} \times \text{EU}_j$ has a positive and significant coefficient, meaning that PDO labels increase the probability of varieties being exported only towards European markets. We confirm the results found by Raimondi et al. (2019). In column (3), the PDO dummy interacts with the dummy GI_j. The coefficient of the interacted variable is positive and significant while the coefficient relating to other non-European countries remains non-significant in contrast to the results of Raimondi et al. (2019). PDO labeling favors the entry of French cheese producers on the European market and into countries with a similar policy of denomination of origin of food products, but not into other countries.

In all columns in table 5, the variable $\ln \text{Rank}_{fk}$ controls for the rank of product k in the exports of the firm f. As expected, it has a negative coefficient: the export performance of a firm is lower for products that do not correspond to its core business. Column (4) estimates the impact PDO labeling PDO_{fjk} according to the rank of product k. It shows that the positive effect of PDO labels on the probability of export occurs irrespective of the rank of the exported product within the firm in the European market, but only when the exported products ranks under 4 in the case of GI destinations. PDO labeling helps firms reach new markets that recognize geographical indicators only when the product is among the main products exported by the firm concerned.

Table 6 follows the same specification as table 5 but with the logarithm of the quantity exported as explained variable (the intensive margin of trade). This table lists 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 $\ln \text{Rank}_{fk}$) is negative and significant in all columns. The two effects of PDO labeling (demand and cost effects) offset each other at the intensive margin. Our result suggests that PDO varieties lead to better export performance in the cheese industry but only at the extensive margin. PDO labeling may favor entry on new markets in European countries and in countries with a similar system of labeling, but has no impact on the volume of trade.[8]

We use counterfactual analysis to assess the impact of PDO labeling on exports at the extensive

[8]We confirm our results at the extensive margin using the traded value (see Table **??** in Appendix A).

margin. We evaluate the expected change in export performance if consumers in non-EU countries value PDO label as highly as EU consumers (*e.g.*, $\zeta_j^{\text{non-EU}} = \hat{\zeta}_j^{\text{EU}} = 0.157$ instead of $\zeta_j^{\text{non-EU}} = 0.112$) as shown in Table 4. Using equation (12) and estimations presented in Table 5, we know that the role of PDO on the probability to export to non-EU markets (*e.g.*,$\rho_1^{\text{non-EU}}$) is 0.167 whereas it is 0.855 on EU markets. This difference is due to the difference in consumers appreciation of quality as $\rho_1^{\text{non-EU}} \equiv (\varepsilon_{jk} - 1)(\zeta_j^{\text{non-EU}} - \beta^{\text{non-EU}})$ in equation (12). If consumers in non-EU countries value PDO label as much as European consumers, then the probability to export to non-EU markets for PDO producers would increase by

$$\Delta\rho_1^{\text{counterfactual}} = \hat{\rho_1}^{\text{EU}} - \hat{\rho_1}^{\text{non-EU}} = 0.855 - 0.167 = 0.688 \tag{14}$$

It follows that the probability to export on non-EU markets will increase by 0.03 in mean (*e.g.*, $\Delta\rho_1^{\text{counterfactual}} * \Pr[\hat{q_{fjk}} > 0]$). This change in the probability to export leads to a change in the exported expected value for PDO exporters on non-EU markets (*e.g.*, the new probability to export cross the expected value estimated). Based on our calculation, the expected value would increase by 67.5%. Note that this counterfactual analysis focuses on a partial effect of PDO labels. Indeed, we disregard its effect through the price index (see equation 3) as our estimations consider a destination-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.

7 Conclusion and policy implications

This paper investigates the effect of GI on perceived quality, prices and trade margins, using firm-level data to identify trade flows concerned by PDO in the French cheese and cream industry. Our results confirm that consumers value PDO label as a quality signal, whatever the markets. In our theoretical model, we highlight the ambiguous effect of PDO labeling on the probability to access new markets and on the intensity of exporting in those markets. When foreign consumers recognize the PDO label as a quality scheme, it increases demand. However this label also implies higher production costs because of high quality ingredients or additional production tasks. Our empirical results show that the demand effect is higher than the cost effect at the extensive margin and that PDO varieties allow firms to charge higher prices than their rivals. We also highlight the role of PDO labeling in firm export competitiveness in the French cheese industry, as benefiting from labels allows firms to reach new markets. Our results show that if non-EU would appreciate the

Table 5: Effect of PDO on trade patterns - extensive margin - probability to export

Dependent variable	X_{fkj}			
	(1)	(2)	(3)	(4)
PDO_{fk}	0.539***			
	(0.113)			
ln $Rank_{fk}$	-0.950***	-0.947***	-0.950***	-0.913***
	(0.060)	(0.061)	(0.061)	(0.062)
$PDO_{fk} \times EU_j$		0.855***	0.863**	
		(0.143)	(0.144)	
$PDO_{fk} \times$ non-EU_j		0.167	-0.058	
		(0.159)	(0.171)	
$PDO_{fk} \times GI_j$			1.122***	
			(0.297)	
$PDO_{fk} \times EU_j \times Rank_{fk}^{1-3}$				1.307***
				(0.179)
$PDO_{fk} \times EU_j \times Rank_{fk}^{4-15}$				0.260
				(0.210)
$PDO_{fk} \times$ non-$EU_j \times Rank_{fk}^{1-3}$				-0.046
				(0.210)
$PDO_{fk} \times$ non-$EU_j \times Rank_{fk}^{4-15}$				0.098
				(0.267)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				1.289***
				(0.365)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				0.976
				(0.534)
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 products).

Table 6: Effect of PDO on the intensive margin - quantity

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)
$PDO_{fk} \times EU_j$		0.227	0.232	
		(0.3)	(0.299)	
$PDO_{fk} \times$ non-EU_j		-0.008	-0.197	
		(0.365)	(0.399)	
$PDO_{fk} \times GI_j$			0.531	
			(0.773)	
$PDO_{fk} \times EU_j \times Rank_{fk}^{1-3}$				0.375
				(0.340)
$PDO_{fk} \times EU_j \times Rank_{fk}^{4-15}$				-0.240
				(0.660)
$PDO_{fk} \times$ non-$EU_j \times Rank_{fk}^{1-3}$				-0.456
				(0.475)
$PDO_{fk} \times$ non-$EU_j \times Rank_{fk}^{4-15}$				0.459
				(0.619)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				0.497
				(0.906)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				0.740
				(0.954)
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 products).

quality of PDO varieties as much as EU consumers, the exported expected value of french PDO producers would increase by 67.5%.

Our work suggests that the inclusion of some GI varieties in trade agreements constitutes an opportunity for PDO producers to increase their market access. The CETA between Canada and the EU, which recognizes 145 GIs, among which 20 are PDO varieties of French cheese, or the EU-Japan FTA which includes 200 GIs, with 5 PDO varieties of french cheese, will probably allow some French PDO producers to reach those markets to which they did not have access before. *Ex post* analysis of the effect of these agreements will allow to confirm these results in the future.

It should be noted, however, that in our results the effect of PDO on trade is not significant on the volume of trade and that the effect on market access is limited to European countries and to countries with a similar policy about denomination of origin products. This results raise the need to strengthen protection and recognition of French PDO outside the community market. The identification of French PDO, and more generally European GI, by non EU consumers should be increased through general information campaigns, advertisements in media and active and structured participation in international food exhibitions.

References

Agostino, M. and Trivieri, F. (2014). Geographical indication and wine exports. an empirical investigation considering the major european producers. *Food Policy*, 46:22–36.

Amiti, M. and Khandelwal, A. K. (2013). Import competition and quality upgrading. *Review of Economics and Statistics*, 95(2):476–490.

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

Bastos, P. and Silva, J. (2010). The quality of a firm's exports: Where you export to matters. *Journal of International Economics*, 82(2):99–111.

Bonnet, C. and Simioni, M. (2001). Assessing consumer response to protected designation of origin labelling: a mixed multinomial logit approach. *European Review of Agriculture Economics*, 28(4):433–449.

Bontemps, C., Bouamra-Mechemache, Z., and Simioni, M. (2013). Quality labels and firm survival: some first empirical evidence. *European Review of Agricultural Economics*, 40(3):413–439.

Bouamra-Mechemache, Z. and Chaaban, J. (2010a). Determinants of Adoption of Protected Designation of Origin Label: Evidence from the French Brie Cheese Industry. *Journal of Agricultural Economics*, 61(2):225–239.

Bouamra-Mechemache, Z. and Chaaban, J. (2010b). Protected Designation of Origin Revisited. *Journal of Agricultural & Food Industrial Organization*, 8(1):1–29.

Calboli, I. and Ng-Loy, W. L. (2017). *Geographical Indications at the Crossroads of Trade, Development, and Culture: Focus on Asia-Pacific*. Cambridge University Press.

Crinò, R. and Epifani, P. (2012). Productivity, quality and export behaviour. *The Economic Journal*, 122(565):1206–1243.

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.

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., and McFadden, D. T. (2013). A Meta-Analysis of Geographical Indication Food Valuation Studies: What Drives the Premium for Origin-Based Labels? *Journal of Agricultural and Resource Economics*, 38(2).

Desquilbet, M. and Monier-Dilhan, S. (2015). Are geographical indications a worthy quality label? a framework with endogenous quality choice. *European Review of Agricultural Economics*, 42(1):129–150.

Gangjee, D. S. (2017). Proving provenance? geographical indications certification and its ambiguities. *World Development*, 98:12–24.

Hassan, D., Monier-Dilhan, S., and Orozco, V. (2011). Measuring Consumers' Attachment to Geographical Indications. *Journal of Agricultural & Food Industrial Organization*, 9(1):1–30.

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

Johnson, R. C. (2012). Trade and prices with heterogeneous firms. *Journal of International Economics*, 86(1):43–56.

Josling, T. (2006). The war on terroir: geographical indications as a transatlantic trade conflict. *Journal of Agricultural Economics*, 57(3):337–363.

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

Kireeva, I. and O'Connor, B. (2010). Geographical indications and the trips agreement: what protection is provided to geographical indications in wto members? *The Journal of World Intellectual Property*, 13(2):275â"303.

Lence, S. H., Marette, S., Hayes, D. J., and Foster, W. (2007). Collective marketing arrangements for geographically differentiated agricultural. *American Journal of Agricultural Economics*, 89(’):947–963.

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

Martin, J. (2012). Markups, quality, and transport costs. *European Economic Review*, 56(4):777–791.

Menapace, L., Colson, G., Grebitus, C., and Facendola, M. (2011). Consumers' preferences for geographical origin labels: evidence from the Canadian olive oil market. *European Review of Agricultural Economics*, 38(2):193–212.

Menapace, L. and Moschini, G. C. (2012). Quality certification by geographical indications, trademarks and firm reputation. *European Review of Agricultural Economics*, 39(4):539–566.

Moschini, G. C., Menapace, L., and Pick, D. (2008). Geographical indications and the competitive provision of quality in agricultural markets. *American Journal of Agricultural Economics*, 90(3):794–812.

Raimondi, V., Falco, C., Curzi, D., and Olper, A. (2019). Trade effects of geographical indication policy: The eu case. *Journal of Agricultural Economics*, (244795).

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.

Sorgho, Z. and Larue, B. (2014). Geographical indication regulation and intra trade in the European Unione. *Agricultural Economics*, 45(1):1–12.

Sorgho, Z. and Larue, B. (2018). Do geographical indications really increase trade? a conceptual framework and empirics. *Journal of Agricultural & Food Industrial Organization*, 16(1).

Appendix A. Robustness checks

Table 7: Correspondence table

NC8 code	PDO name
0406.10.20	Brocciu
0406.40.10	Roquefort
0406.40.90	Bleu d'Auvergne, Bleu de Gex, Bleu des Causses, Fourme d'Ambert, Fourme de Montbrison
0406.90.82	Camembert de Normandie
0406.90.84	Brie de Meaux, Brie de Melun
0406.90.88	Goat cheese (Chabichou du Poitou, Chevrotin, Ste Maure de Touraine); Livarot, Maroilles, Pont-l'évêque
0406.90.79	Reblochon ou Reblochon de Savoie, St Nectaire
0406.90.81	Cantal, Salers
0406.90.87	Beaufort,Ossau-Iraty
0406.90.15	Beaufort, Comté
0406.90.18	Mont d'Or / Vacherin
0406.90.69	Morbier
0406.90.86	Munster
0406.90.99	Maroilles, Munster, Comté, Reblochon/ Reblochon de Savoie

Table 8: Effect of PDO on 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)						
$\text{PDO}_{fk} \times \text{UE}_j$				0.238**	0.184***	0.141***	0.238**	0.184***	0.140***
				(0.093)	(0.064)	(0.043)	(0.093)	(0.064)	(0.043)
$\text{PDO}_{fk} \times \text{non-UE}_j$				0.168**	0.131**	0.101***	0.165**	0.135**	0.112***
				(0.083)	(0.056)	(0.039)	(0.083)	(0.055)	(0.038)
$\text{PDO}_{fk} \times \text{GI}_j$							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 products).

Table 9: Effect of PDO on the intensive margin in value

Dependent variable	ln Q_{fkj}			
	(1)	(2)	(3)	(4)
PDO_{fk}	0.325			
	(0.229)			
$Rank_{fk}$	-1.282***	-1.282***	-1.284***	-1.267***
	(0.10)	(0.10)	(0.101)	(0.098)
$PDO_{fk} \times EU_j$		0.400	0.337	
		(0.284)	(0.293)	
$PDO_{fk} \times non\text{-}EU_j$		0.189	-0.074	
		(0.326)	(0.371)	
$PDO_{fk} \times GI_j$			0.694	
			(0.784)	
$PDO_{fk} \times EU_j \times Rank_{fk}^{1-3}$				0.484
				(0.337)
$PDO_{fk} \times EU_j \times Rank_{fk}^{4-15}$				-0.143
				(0.637)
$PDO_{fk} \times non\text{-}EU_j \times Rank_{fk}^{1-3}$				-0.312
				(0.464)
$PDO_{fk} \times non\text{-}EU_j \times Rank_{fk}^{4-15}$				0.537
				(0.625)
$PDO_{fk} \times GI_j \times Rank_{fk}^{1-3}$				0.667
				(0.917)
$PDO_{fk} \times GI_j \times Rank_{fk}^{4-15}$				0.888
				(0.988)
Fixed effects	f, kj	f, kj	f, kj	f, kj
N	2796	2796	2796	2796
r2	0.65	0.65	0.65	0.66

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 products).