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Abstract

This paper analyses the relationship between innovation and export performance. More specifically, we highlight the effect of the introduction of new products on the quality and prices charged by firms in international markets. Based on Hallak and Sivadasan (2013)'s theoretical work, we develop a model to explain the mechanism underlying the relationship between innovation and product quality. Using a unique database of new product launches combined with data on production and trade in the French dairy industry, we tested this mechanism in several ways. Our results show that the export prices charged by the firms increase after the introduction of a new product in a given market. We also show that the projected quality of the new product increases after its introduction in a given market. This confirms the quality-upgrading effect of innovation at product level. These results are highly robust econometrically.

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1 Introduction

In modern economies, innovation is widely considered as the major driving force behind economic growth (Romer, 1990). As a result, the promotion of innovation is increasingly at the core of public policies. In the European Union, the promotion of innovation increased with the EU2020 Strategy. For instance, the largest research and innovation-funding programme in Europe, H2020, encourages participation by small and medium-sized firms and promotes cooperation between industry and academia to ensure the fruit of research is transformed into new products. Lastly in the European Green Deal, the European research and innovation policy (Horizon Europe), coupled with the Farm to Fork strategy, is designed to support sustainable, healthy, inclusive food systems. This leads to innovative solutions to address global challenges, including new products, tools, technologies and approaches to social, governance and institutional innovation, and new business models (European Commission, 2020). The main assumption underlying this policy is that research and innovation is linked to European competitiveness, and especially to that of European firms. In an increasingly globalised world, an important question for public authorities is whether innovation actually increases firms' competitiveness on foreign markets.

In this article, we examine the extent to which innovation helps firms increase their competitiveness on foreign markets. We focus in particular on the link between innovation and the quality of the goods that firms export. The link is important because high-quality products are often viewed as the main source of firm competitiveness on foreign markets. The role of innovation as a determinant of firm competitiveness in international trade is not new in the literature. Indeed, at least since the seminal work of Posner (1961), a school of thought has argued that one of the main sources of a country's advantage is its relative technological position vis-à-vis its competitors in a given sector. This theory has been refined in technology-gap theories of international trade (See, Freeman, Young, and Fuller, 1963; Hirsch, 1965; Vernon, 1966; Cimoli, 1988). In his influential work, Vernon (1966) proposed the product life cycle theory which hypothesises a natural evolution from innovation in the domestic market to exports. At the early stage of a product's life cycle, it is important to be close to the demand (i.e. on the local market) in order to be able to adapt the characteristics of the product to this demand. After strengthening their domestic market power, firms begin to export the innovation, as, at this stage, products are still highly differentiated. Finally, as product characteristics become more standardised, more firms enter production and competition, and focus on manufacturing efficiency rather than on developing new product characteristics. Firms start to locate their plants in low-wage regions and end up exporting their production to their domestic market. According to this product life-cycle theory, product innovation is closely linked to a firm's decision to start exporting. Other authors (for instance Fagerberg, 1988; Dosi, Pavitt, and Soete, 1990) reported robust results on the dominant role of technological conditions as determinants of trade flows. [1]

More recently, theoretical attention has shifted to considering firm productivity as the key driver of participation in export markets. Melitz (2003) developed a model of industry dynamics involving heterogeneous firms (i.e., firms with different productivity levels). In this model, only the most productive firms self-select into exporting, since only firms whose productivity is above a certain threshold are able to overcome the fixed costs associated with entry into the export market. However, Melitz (2003) considered firm productivity to be drawn from a random distribution. In contrast, the endogenous growth theory emphasises innovation as a major source of productivity growth (Romer, 1990; Aghion and Howitt, 1992). Based on this endogenous growth model, some theoretical papers (for instance, Yeaple, 2005; Costantini and Melitz, 2007; Atkeson and Burstein, 2010; Bustos, 2011) consider the role of innovation as productivity enhancer. Costantini and Melitz (2007) and Atkeson and Burstein (2010) show that in anticipation of trade liberalisation, firms invest in technology upgrading in order to improve their productivity and enter export markets.

Based on these developments, several authors have explored the relationship between innovation and export performance using firm-level data. An examination of empirical works that analyse the direct effect of innovation on a firm's decision to export reveals

[1] Dosi, Grazzi, and Moschella (2015) present a useful overview of this literature ranging from country level models and empirics, to more recent sectoral and firm level analyses.

mixed evidence.[2] For example, Caldera (2010) investigates the relationship between innovation and the export behaviour of Spanish firms using data from a panel covering 1991-2002. Results show a positive effect of firms' innovation on the likelihood of their participating in export markets. In contrast, in Slovenian firms, Damijan, Kostevc, and Polanec (2010) fail to find any significant evidence of the effects of the firms' innovation strategy on their propensity to export. Although empirical works on direct effect of innovation on participation in export markets are inconclusive, there is ample evidence that innovation indirectly affects a firm's decision to export through a positive effect on productivity growth.

In this article, we analyse the relation between innovation and quality at the firm-product-destination level. This level of disaggregation allows us to account for product heterogeneity, which was not possible with firm-level data. Product heterogenity is important for several reasons. First, the quality of is not the same. This implies that demand from a given destination vary across firms. Firms can also modify the quality of product depending on the destination, which results in demand heterogeneity across countries within a firm. Second, consumers across foreign countries may have different tastes, which amplifies demand heterogeneity. Third, a large body of economics and management literature considers that product innovation is essentially user-oriented, particularly in fast moving consumer goods, such as dairy products (see among others, Ottum and Moore, 1997; Hart, Tzokas, and Saren, 1999; Grunert and Valli, 2001; Kok, Hillebrand, and Biemans, 2003; Kleef, Trijp, and Luning, 2005; Søndergaard and Harmsen, 2007). For instance, Grunert et al. (2010) consider product innovation in the food and personal products industries as *a process towards the development of a new product or service in which an integrated analysis and understanding of consumers' wants, needs and preference formation play a key role.* Moreover, Dainelli et al. (2008) show that product innovation in fast moving consumer goods corresponds to general consumer expectations: pleasure,

[2] A (non-exhaustive) list of papers that seek to identify the effects of innovation on export decision at firm-level, include: Lefebvre, Lefebvre, and Bourgault (1998), Wakelin (1998), Ebling and Janz (1999), Becchetti and Rossi (2000), Bleaney and Wakelin (2002), Roper and Love (2002), Bernard and Jensen (2004), Gourlay and Seaton (2004), Gourlay, Seaton, and Suppakitjarak (2005), Aw, Roberts, and Winston (2007), Cassiman and Martinez-Ros (2007), Caldera (2010), Van Beveren and Vandenbussche (2010), Ganotakis and Love (2011), Eickelpasch and Vogel (2011), Becker and Egger (2013).

health, convenience and ethics. Hence, if consumer preferences are heterogeneous across countries as suggested by recent trade models (see for instance, Kugler and Verhoogen, 2012; Hallak and Sivadasan, 2013; Gaigné and Larue, 2016), the product innovation of exporting firms may differ across countries. We focussed on the French diary industry and used the *Global New Products Database* which allowed us to identify new products launches in 64 countries. Based on this dataset, we were able to construct a new measure of innovation at firm-product-destination level.

First, we document two stylized facts concerning the relationship between the introduction of a new product and export prices. We show that after the introduction of a new product, the export price increases, and this relation appears to depend on the destination country. Prices charged by French exporting firms tend to rise after the introduction of a new product on markets with a high GDP per capita. Based on these facts, we propose a simple model of firm quality choice based on the model proposed by Hallak and Sivadasan (2013). In their model, firms have two heterogeneous attributes: *productivity* which is a firm's ability to produce a given output at low marginal cost; and *expertise*, which is defined as the ability of a firm to achieve a given level of quality in a given country at lower fixed costs. Assuming that firms invest to increase their expertise as in Yeaple (2005) and Bustos (2011), we derive testable predictions that link the introduction of new products with perceived quality and prices. Further, we develop an identification strategy based on a combination of the propensity score reweighting and difference-in-differences approaches to tests these predictions. We measure perceived quality using the well-known Khandelwal, Schott, and Wei (2013) methodology. We define product quality as the sum of all the factors which, conditional on price, generate higher market shares: this is the quality that is perceived by the consumers, since it is derived from a demand function. Our results confirm the main predictions of our model. The quality perceived by the consumers and the prices charged by the firms are higher for new products. Our results are highly robust econometrically.

Our work is related to works that aim to shed some light on the export behaviour of innovators focusing on product export sales. De Rassenfosse et al. (2022) investigate the relationship between innovation and the export behaviour of firms. These authors consider granted patents obtained by the firms on specific products as the expression of firms' superior capabilities. Their analysis exploits the heterogeneity of patent coverage within firm–product–destination using data from a panel of French firms covering the period 2002–2011. They found a positive effect of innovation on the quantities of product exported by the firms and a negative effect of their export prices. Using a panel of Greek firms and the period 2006-2011, Chalioti et al. (2020) show that patent applicants export more per product than non-applicants. The higher export values are primarily driven by higher export volumes rather than by higher prices. To explain their results, the authors built a horizontally differentiated product model of trade in which an innovative firm competes for a market share against many non-innovative rivals. They show that the innovative firms export more to distant markets than their non-innovative rivals as competition between exporters of non-innovative products gets tougher.

This present work also builds on the literature that seeks to highlight the role of quality in international trade. Concerning the relation between quality and trade, several authors analyse the role of vertical differentiation in trade models based on Melitz (2003)'s model (for more detail, see Gaigné and Gouel, 2022). For instance, Kugler and Verhoogen (2012) explain why larger firms specialise in higher-quality products and pay higher prices for inputs. Crozet, Head, and Mayer (2012) argue that the firms which produce Champagne with better scores in wine guides - a direct measure of quality - charge higher prices, export to more destinations, and sell larger quantities in each market. As shown by Emlinger and Lamani (2020), the same holds for Cognac producers.

The remainder of this article is organised as follows. Section 2 presents the data and documents the stylised facts. To explain the stylised facts, Section 3 presents a trade model with heterogeneous firms featuring endogenous product quality and introduces the strategy we used for our empirical analysis. Section 4 presents the main results and some robustness checks. Section 5 concludes.

2 Data overview

2.1 Data construction and descriptive statistics

In this section, we briefly introduce our data sets and some descriptive statistics. Our analysis of the effect of the introduction of new products on export quality relies on three sources of data: data on firms' characteristics, on exports and on innovation.

Firm data. Firm-level accounting data cam from DGFIP-Insee. First, this dataset allowed us to only include exporting firms that belong to the dairy industry in our sample. To do so, we used the main activity code of the firm to select the dairy industry.[3] This means that the firms actually produce the goods they export. In other words, we excluded trade intermediaries and wholesalers from our analysis. Second, the dataset provided us with information on the characteristics (e.g., value-added, employment, tangible and intangible fixed assets...) of the firms that will be useful for empirical analysis.[4]

Export data. Detailed data on French exports classified according to the product and country of destination are available for each French firm from the French customs office (Direction Générale des Douanes et des Droits Indirects, DGDDI). The data we used cover the period 2010-2017. For each firm, this dataset contains the value and quantity of all export flows according to the destination and the product category. Unit values are computed by dividing the value of a shipment by the physical quantity shipped and are our proxies for export prices. Panel A in Table 1 describes export data as a function of time. Observations are defined at firm-product-destination-year level: for example, the 2016 cross-section of exporters contains 9,288 observations corresponding to different transactions at firm–product–destination level. These transactions were carried out by 176 firms that export 28 dairy product categories to 92 destinations.

Prodcom data. This dataset report production values and quantities at the firm-product level. The data also cover the period 2010-2017. This dataset is important

[3]The firm's main activity is represented by a 5-digit code (APE code) provided by INSEE. It is built using a top-down approach: it identifies the 1-digit section with the highest value added, within which it identifies the 2-digit division with the largest value added share, and so on up to the most detailed 5-digit APE code. See https://www.insee.fr/fr/information/2399243: Last accessed 27^{th} January 2023. Firms that manufacture dairy products are those with the APE codes 1051A, 1051B, 1051C and 1051D.

[4]Descriptive statistics are provided in appendix B.2

because (*i*) for a given firm, it allowed us to drop products that are exported but not produced by the firm; (*ii*) it provides information on the firm's core product, which is defined as the product with the highest value for a given firm. This information was important for our empirical analysis

Data on innovation. We developed a new measure of innovation based on an exhaustive list of new product launches. Information on the launches of products came from the Global New Product Database (GNPD), a database developed by Mintel.[5] GNPD collects information on dairy product launches in more than 80 countries (see Appendix B.1 for a detailed description on GNPD). For each product recorded in the GNPD, the following information is available: a detailed description of the product, the country in which the product was launched, the product launch date, the EC identification, and other information such as ingredients, nutritional composition or product claims (Solis, 2016; Chemo Dzukou, 2021). GNPD lists more than 149,000 dairy products launched in 62 countries during the period 2010-2017. In the GNPD, the products are recorded under five types of launches:[6] new product, range extension, new packaging, reformulation and relaunch. We focus on "new product" category in this article. In so doing, we follow Verhoogen (2021) who defines product innovation (or the expansion of product scope) as the production of a good not previously offered by the firm. We consider that the other types of launches are less linked to product innovation. Based on the terminology of the Oslo Manual, range extension, new packaging, reformulation and relaunch are marketing related innovations.

Linking product launch data with other data sources. Linking French administrative data, i.e., firm characteristics and export data, is straightforward. The firm identifier (*siren* number) makes it possible to merge the two data-sets at firm-year level.

Conversely, linking export and innovation data is not straightforward. To link the two datasets, we needed to observe the innovation data at the same level as export data, i.e., at firm-product-destination-year level. To this end, we proceeded in several steps. First, for each product in the GNPD data set, we needed to identify whether it was

[5]Mintel is a global, privately owned market research firm.
[6]See Appendix B.1 for a detailed description of each type of launch.

manufactured by a French firm, and when that was the case, we needed to find the *siren* number of the firm concerned. The main steps undertaken for this purpose are detailed in appendix B.4. Second, for each product, we needed to identify the product category to which it belongs. In the customs data set, the product category is identified by the PC8 nomenclature.[7] We manually assigned each product in the GNPD dataset to a product category in the PC8 nomenclature.[8] Two remarks are important here: (*i*) if a firm launches a new product that belongs to one PC8 code, we consider that all products included in this given PC8 code are concerned by the innovation [9]; (*ii*) in the following, for the sake of simplification, we sometimes use the term "product" instead of product category. Finally, we identified the market on which the new product is sold which is stated in the GNPD.

At the end of this process, we were able to transform the product launch data, GNPD, into a new dataset which describes innovation at firm-product-destination-year level. Each observation in this new dataset means that a firm has introduced a new product (PC8 code) in a given country and a given year. Panel B in Table 1 presents the innovation data available for the period 2010-2017: for example, the 2016 cross-section of exporters contains 1144 observations at firm–product–destination level. The transactions concerning new products were made by 43 firms for 15 products exported to 55 destinations.

Table 1 about here

Table 2 provides some summary statistics after the merging procedure. This table

[7]PC8 nomenclature is an extension of the NACE Rev.2 classification at the product level. See appendix prodcom-product-level-nomenclature for more details

[8]The PC8 nomenclature is regularly updated to track changes in product characteristics. We needed to account for these changes to maintain a coherent set of product categories over time. To do so, we followed the procedure of Van Beveren, Bernard, and Vandenbussche (2012) which allowed us to obtain consistent product categories from 2010 to 2017.

[9]This is the standard procedure used in empirical works. For instance in De Rassenfosse et al. (2022), granted patents are assigned to their corresponding HS6 category. All products included in this category and exported by the firm are considered to benefit from the patent. In our case, we use PC8 categories which are more detailed.

gives a first overview of 7 PC8 codes (out or 28 in our full sample). For example, the PC8 code "low-fat milk in immediate packaging, net content not exceeding two litres" (PC8:10511142) is exported to 78 countries by 32 French firms of which 42% introduced a new product.

Table 2 about here

2.2 Stylised facts on product innovation and prices

In this section, we highlight the relationship between innovation and export prices. We examine changes in export prices by incumbent exporting firms before and after the introduction of a new product. Export prices are unit values, computed by dividing deflated export values by the physical quantity.[10] It should be noted that both the introduction of a new product and export prices are observed at firm-product-destination level. Table 3 presents the median and mean before and after the introduction of a new product. For this exercise, we only used firm-product-destinations for which prices were available before and after the introduction of a new product.

Table 3 shows that, on average, the price levels after the introduction of a new product are higher than the price levels before. This suggests that export prices rise after the introduction of a new product (+1.41%).

Table 3 about here

[10]To compute unit values of Chinese exports, Fan, Li, and Yeaple (2015) deflate the export value using industry-specific output deflators from Brandt, Van Biesebroeck, and Zhang (2012). De Loecker et al. (2016) also deflate all nominal values for their analysis, and unit values are deflated by sector-specific wholesale price indexes. Unfortunately, our data do not contain such information, but we are nevertheless able to compute a price index because our data contain values and quantities exported. More formally,

$$P_{h,t} = \sum_{ct} \delta_{c,t} P_{cht}, \text{ where } P_{cht} = \frac{\sum_{cht} Q_{icht} \times V_{icht}}{\sum_{cht} Q_{icht}}, \text{ and } \delta_{c,t} = \frac{\sum_{cht} V_{icht}}{\sum_{ht} \sum_{cht} V_{icht}}$$

where Q_{icht} and V_{icht} are the quantity and value of a product h exported to country c by firm i, respectively.

The cumulative distributions of export prices are plotted in Figure 1 to highlight the shifting pattern of export prices before and after the introduction of a new product. We include only firm-product-destinations whose prices are available both before and after the introduction of a new product. We compare the prices over time by regressing them on product-destination-year fixed effects and then plotting the residuals, but first we removed outliers in the bottom and top percentiles to ensure our results are not affected by extreme values.

Figure 1 about here

Figure 1 shows that the distributions of export prices shift to the right after the introduction of a new product. Thus, we summarise the first stylised fact as follows:

Stylised fact 1. Firms' export prices tend to increase after the introduction of a new product.

Second to consider whether the effect of the introduction of a new product on price depends on product differentiation, we divide the export destinations according to their GDP per capita. The intuition behind this is that consumers in rich countries value quality differentiation more than consumers in poor countries. In our preliminary approach, we consider that the GDP per capita at country level is a good proxy of the capacity of consumers in that country to buy expensive products. We assume that countries with higher GDP per capita value quality differentiation more and have more scope for quality differentiation.[11] We divide our sample into two groups: countries with high GDP per capita and countries with low GDP per capita. These two groups enable us to identify income levels and hence to distinguish between representative rich and poor consumers

[11] Balassa and Bauwens (1988), Helpman (1981), Krugman (1979) and Lancaster (1980) consider that both the demand and supply of differentiated commodities are positively associated with income. This suggests that the scope for product differentiation is a positive function of the income level, measured by GDP per capita.

as a first approach. Based on these two groups, we explore whether the introduction of a new product has the same effect on prices in the two types of countries. If upgrading-quality explains the increase in export prices reported in Table 3 and Figure 1, then the observed effect of product innovation on prices should be stronger where consumers value quality differentiation, i.e. in countries with higher GDP per capita.

In Table 4, we use the bottom (respectively top) 33^{rd} percentile as proxies for the group of countries with limited (respectively large) scope for quality differentiation. We then compute the change in export prices for the two groups of countries. Table 4 shows that the change in prices in countries with large scope for quality differentiation is significantly larger than the change in the whole sample, whereas in countries with limited scope for quality differentiation, the change in export prices is smaller than the change observed in the whole sample.

Table 4 about here

Figure 2 presents the differential effect of product differentiation on cumulative price distribution: the export price in countries with large scope for quality differentiation rises after the introduction of a new product (see Figure 2b), while the export prices in countries with limited scope for quality differentiation remain unchanged (see Figure 2a).

Figure 2 about here

We summarise this stylised fact as follows:

Stylised fact 2. The change in export prices tends to increase significantly after the introduction of new products in markets where the scope for quality differentiation is large, while export prices tend to remain unchanged after the introduction of new products in markets where the scope for quality differentiation is limited.

3 Identification strategy

3.1 Theoretical Framework

3.1.1 Demand and supply sides

We start by presenting a basic economic framework to support our analysis. The model develops testable predictions on the relationship between the introduction of a new product on a market and the quality of the exported product.

Consider a market (a product-country pair) where preference across varieties within this market are CES with an elasticity of substitution, σ_j. This gives rise to the following demand function,

$$x_{ij} = q_{ij}^{\eta_j} p_{ij}^{-\sigma_j} E_j P_j^{\sigma_j - 1} \tag{1}$$

where x_{ij}, p_{ij} and q_{ij} are the quantity, the price and the quality purchased of each firm's variety i sold in market j; P_j is the price index in market j that is exogenous from the point of view of individual firms; and E_j is the expenditure optimally allocated to market j. Following the recent literature on international trade (e.g., Kugler and Verhoogen, 2012; Hallak and Sivadasan, 2013; Gaigné and Larue, 2016), we consider that products are also vertically differentiated, and an increase in η_j signals greater appreciation for vertically differentiated products in market j.

On the supply side, we follow Hallak and Sivadasan (2013) and assume that firms are characterized by two heterogeneous attributes: productivity, ϕ_i, which is the ability of a firm to produce a given output at low marginal cost; expertise, ξ_{ij}, defined as the ability of a firm to achieve a given level of quality for a given market at a lower fixed costs.[12] In line with the interpretation of ξ_{ij}, we allow firm's expertise to vary across markets.[13]

[12] In IO and international trade literature, assuming that the production of quality requires fixed costs is standard procedure, see for instance Shaked and Sutton (1983), Motta (1993), Sutton (2007) Kugler and Verhoogen (2012), Hallak and Sivadasan (2013), Fan, Li, and Yeaple (2015) and Gaigné and Larue (2016).

[13] Hallak and Sivadasan (2013) p. 56 state that *"A high-ξ firm, for example, may be one with an R&D department that is effective in generating and implementing innovative ideas for new products,*[...]*, or one with a work environment that fosters design creativity or that can rapidly translate evolving consumer tastes into designs that meet those tastes."* Since in our model, consumer preferences are heterogeneous across markets, we also assume that a firm's ability to adapt to these changing preferences is not the same across markets.

Moreover, we assume that exporting to market j implies a fixed distribution cost, f_j, which is specific to each destination. Firms also have to pay additional fixed and variable costs, both of which increase with product quality. Firms have to make adjustments to their production process before producing a single unit of a higher-quality product.[14] The fixed costs are represented by the following function,

$$F_j = \frac{f q_{ij}^{\beta_j}}{\xi_{ij}} \tag{2}$$

where f is a constant and $\beta_j > 0$ is the quality-elasticity of fixed costs. A high β_j means that the product differentiation needed to reach market j is costly.

We also assume that, for a given product, serving market j causes a shift in marginal costs because firms have to adapt their product to each market. We assume that labor is the only input with a constant price, w_H. The marginal cost is thus defined as

$$c_{ij} = \tau_j \frac{w_H q_{ij}^{\alpha_j}}{\phi_i} \tag{3}$$

where $\tau_j > 1$ represents iceberg trade costs for products shipped from the home country to market j; $0 \leq \alpha_j < 1$ is the quality-elasticity of marginal costs.[15] A high α_j implies that a higher quality variety requires more physical labour to achieve the same output as a lower quality variety. We assume that firms produce under monopolistic competition. The price charged by a firm is equal to a constant markup over the marginal costs:

$$p_{ij}(\phi_i) = \frac{\sigma_j}{\sigma_j - 1} \frac{\tau_j w_H q_{ij}^{\alpha_j}}{\phi_i} \tag{4}$$

The profit from serving market j is

$$\pi_{ij} = (p_{ij} - c_{ij})\, x_{ij} - F_j - f_j \tag{5}$$

[14] The Chinese milk scandal in 2008 prompted authorities to introduce new, stricter food hygiene and safety regulations and veterinary inspection of dairy products. These new regulations have pushed firms wishing to enter the Chinese market to be more careful about the quality of their products.

[15] In Hallak and Sivadasan (2013), the iceberg transport costs are assumed to decrease with an increase in quality. In the presence of per-unit charges, transport costs represent a smaller proportion of the price of high quality products. This is the well-known Alchian–Allen effect. Although this effect is not formally modelled in Eq.(3), it is at least partly captured by α_j.

The firm chooses its quality, q_{ij}, to maximise its profit from exports to market j. To obtain an interior solution, we impose the parameter restrictions $\beta_j - \eta_j + \alpha(\sigma_j - 1) > 0$ so that the firm will choose a quality level that is strictly positive but finite.[16] The first-order conditions enable us to solve for the optimal quality, which is given by

$$q_{ij}\left(\xi_{ij},\phi_i\right) = \left[\frac{\xi_{ij}}{\beta_j f}\left(\frac{\sigma_j - 1}{\sigma_j}\right)^{\sigma_j - 1}\left(\frac{\phi_i}{\tau_j}\right)^{\sigma_j - 1} P_j^{\sigma_j - 1} E_j\right]^{\frac{1}{\beta_j - \eta_j'}} \tag{6}$$

where $\eta_j' = \beta_j - \eta_j + \alpha(\sigma_j - 1) > 0$. This means that the quality q_{ij} is positively linked to the ξ_{ij} parameter. An increase in expertise in market j increases the quality of the product exported to this market. The following section deals with the way innovation can improve expertise and quality.

3.1.2 Choosing to innovate and its implications

We assume that ξ_{ij} is linked to the stock of knowledge of firm i with respect to market j, noted k_{ij}. For example, k_{ij} may reflect the level of knowledge of the firm i concerning consumer preferences in market j. Consider the possible case where expertise, ξ_{ij}, is proportional to k_{ij}, $\xi_{ij} = \gamma k_{ij}$.[17] Gaining new knowledge (i.e. in our case, better knowledge of consumers' needs leading to innovation) is costly, and we assume that the cost of increasing the stock of knowledge k_{ij}, $c(k_{ij}) = \psi k_{ij}^a$, where ψ determines average innovation costs to adapt the products to consumers in market j and a determines how these costs rise with knowledge. The firm then chooses the optimal k_{ij} that maximises their net profit, $\pi_{ij} - c(k_{ij})$. In Appendix A, we show that the profit maximisation is satisfied when $a\left(\beta_j - \eta_j'\right) - \eta_j' > 0$, and the optimal stock of knowledge, k_{ij}, is

$$k_{ij}(\phi_i) = \boldsymbol{A_j}\left(\frac{\phi_i}{\tau_j}\right)^{\frac{\beta_j(\sigma_j - 1)}{a\left(\beta_j - \eta_j'\right) - \eta_j'}} \tag{7}$$

[16]The second order condition for profit maximisation is satisfied when $\beta_j - \eta_j + \alpha_j(\sigma_j - 1) > 0$

[17]Innovations in the food industry are mainly user-oriented (Dainelli et al., 2008; Grunert et al., 2010; Tudoran et al., 2012). According to Dainelli et al. (2008), consumers' needs and expectations are the main drivers of innovation. These authors show that innovation corresponds to general consumer expectations: pleasure, health,convenience and ethics. Given the interlinkages between innovation and consumer appeal, the ability of a firm to create innovation in response to changing consumers preferences is crucial to its survival.

where $\boldsymbol{A_j}$ is a constant term that varies across markets.[18] Assuming that the firm chooses the optimal stock of knowledge, $k_{ij}(\phi_i)$, the optimal quality a in market j takes the following form,

$$q_{ij}\left(k_{ij},\phi_i\right)=\left[\frac{\gamma k_{ij}}{\beta_j f}\left(\frac{\sigma_j-1}{\sigma_j}\right)^{\sigma_j-1}\left(\frac{\phi_i}{\tau_j}\right)^{\sigma_j-1}P_j^{\sigma_j-1}E_j\right]^{\frac{1}{\beta_j-\eta_j'}} \tag{8}$$

Using Eqs.(4) and (8), the optimal price with respect to the stock of knowledge can be expressed as:

$$p_{ij}\left(k_{ij},\phi_i\right)=\frac{\sigma_j}{\sigma_j-1}\frac{\tau_j w_H}{\phi_i}\left[\frac{\gamma k_{ij}}{\beta_j f}\left(\frac{\sigma_j-1}{\sigma_j}\right)^{\sigma_j-1}\left(\frac{\phi_i}{\tau_j}\right)^{\sigma_j-1}P_j^{\sigma_j-1}E_j\right]^{\frac{\alpha_j}{\beta_j-\eta_j'}} \tag{9}$$

From this theoretical model, we can formulate the following proposition:

Proposition 1. *An increase in a firm's stock of knowledge with respect to market j has a positive effect on product quality.*

This proposition is intuitive: an increase in k_{ij} increases the level of expertise, ξ_{ij} and hence lowers the fixed costs F_j for any given quality level. The reduction in fixed costs would encourage the firm to reach a new quality optimum. Using Eq.(8), we obtain that the elasticity of q_{ij} with respect to k_{ij} is $\varepsilon^j_{q/k}=(\beta_j-\eta_j')^{-1}$. From proposition 1, we can deliver two corollaries.

Corollary 1. *An increase in a firm's stock of knowledge with respect to market j has a positive effect on price.*

This corollary is obtained using Proposition 1. The stock of knowledge, k_{ij}, affects the price charged by the firm i in market j indirectly through their product quality, and the elasticity of p_{ij} with respect to k_{ij} is $\varepsilon^j_{p/k}=\alpha_j/(\beta_j-\eta_j')$.

Corollary 2. *An increase in a firm's stock of knowledge with respect to market j has a negative effect on the quality-adjusted price, defined as* $\tilde{p}_{ij}=\frac{p_{ij}}{q_{ij}}$.

This second corollary is obtained since $\varepsilon^j_{\tilde{p}/k}=(\alpha_j-1)/(\beta_j-\eta_j')$ and $\alpha_j<1$.

[18] See Appendix A, for the expression of $\boldsymbol{A_j}$.

3.2 Empirical Methodology

In this section, we build an empirical methodology to test Corollaries 1 and 2 based on proposition 1. We evaluate the effect of introducing a new product (our proxy for a stock of knowledge) on the outcomes (quality and price) based on a matching procedure. Such a procedure ensures the statistical causality of the effect as suggested by Heckman, Ichimura, and Todd (1997). The method consists of building a counterfactual which allows us to examine how quality and price would have evolved if the firm had not introduced a new product. Our main problem is that we are unable to observe the counterfactual and we need to match the treated firm with a control group of similar firms that do not receive the treatment.

3.2.1 Treated firms and the construction of a set of control firms

Let's start with a graphical representation to enable us to visualize variations in the introduction of new products (i.e. the treatment we are interested in) across firms and over time. This gives an intuition about the identification of the desired causal effects. Figure 3 shows the distribution of the introduction of new product for a selection of four markets (destination-pc8 pair).[19] In a given market (panel 3a, 3b, 3c or 3d), each rectangle (red, blue or white) represents a firm-year pair. All the rectangles are the same length since we observe firms in a given market each year throughout the period 2010-2017. The width of the area may vary according to the market as it depends on the number of firms in that market. The more firms there are in a market, the smaller the width of the rectangles. For example, there are 23 firms in market DEU-10513030 from 2010 to 2017 (panel 3b); while there are only 14 firms in market CHN-10513030 (panel 3d) during the same period. The first column on the left in Table 5 shows the number of firms included in each panel of Figure 3; it also shows the number of firms exporting to 6 other markets among the 2,326 markets included in our analysis. In a given market, each line represents a variation in the behaviour (i.e. treatment) of a given firm over time. The red areas represent the

[19]We have used markets with only a few firms to facilitate visualization. We used the `PanelMatch` package in `R` developed by Imai, Kim, and Wang (2021).

year the firm introduced a new product ($m_{ij}^t = 1$).[20] The blue area represents the year the firm did not introduce a new product ($m_{ij}^t = 0$). The white area represents the years the firm did not export to that particular market (m_{ij}^t is not defined; $m_{ij}^t = .$).

Figure 3 about here

Table 5 about here

The definition of the treatment effect is crucial in our analysis. A firm will be considered as treated for a given market if three conditions hold: (*i*) the first and most obvious is that the firm must have introduced a new product at least once during the analysis period; (*ii*) firm i in market j introduces a new product for the first time during the period to ensure that the effect we measure is not due to previous introduction; (*iii*) firm i must have operated in market j for at least one year before the introduction of a new product. According to these conditions, and referring back to Figure 3, we consider three firms as *treated* in market GBR-10515241: firms O, G and R in 2011, 2014 and 2013, respectively. In contrast, firm P is not considered as treated in 2010 as it does not fulfil condition (*iii*): our sample period begins in 2010; so we have no information before then. Neither is it considered as treated in 2012, 2013 nor 2014 as it does not fulfil condition (*ii*): it introduced a new product before 2012. Under the same conditions, we consider one firm as *treated* in the market DEU-10513030 (J), one firm in the market USA-10513030 (R) and one firm in the market CHN-10513030 (G). Therefore, we can define a treatment variable, d_{ij}^t, such as $d_{ij}^t = \mathbb{1}\left(m_{ij}^t = 1,\, m_{ij}^{t-1} = 0,\; \{m_{ij}^{t-\ell}\}_{\ell=2}^{L_i} = \{0;.\} \text{ for all } \ell = t-2, \ldots, t-L_i\right)$, where L_i is the number of lags for firm i between 2010 and before it introduced a new product for the first time, $m_{ij}^{t-\ell} = 0$ means that the firm did not introduce a new product in year $t-\ell$ and $m_{ij}^{t-\ell} = .$ means that the firm did not export at all. For example, for the treated firm G in market GBR-10515241, the number of lags is four; and for the treated firm J in market DEU-10513030, the number of lags is also four. The information on

[20] m_{ij}^t is an indicator variable which takes the value of 1 if firm i introduced a new product in market j at time t and 0 if not.

the number of treated firms per market is summarised in the second column in table 5. Once we have defined the treatment, we follow the micro-econometric evaluation literature (Heckman, Ichimura, and Todd, 1997) and define the Average Treatment effects on the Treated (ATT) on the outcome, y_{ij}^t, as

$$\begin{aligned} ATT &= \mathbb{E}\left\{y_{ij}^t\left(d_{ij}^t=1\right)-y_{ij}^t\left(d_{ij}^t=0\right)\mid d_{ij}^t=1\right\} \\ &= \mathbb{E}\left\{y_{ij}^t\left(d_{ij}^t=1\right)\mid d_{ij}^t=1\right\}-\mathbb{E}\left\{y_{ij}^t\left(d_{ij}^t=0\right)\mid d_{ij}^t=1\right\} \end{aligned} \tag{10}$$

The key difficulty is identifying a counterfactual for the last term in Eq.(10). In order to identify this group, we start with the identification of a *matched set* of control firms for each treated firm. Control and treated firms share an identical history in market j from year $t-L_i$ to $t-1$. In other words, we adjust for time-specific unobserved confounders. We choose exact matching because past experience is one of the most important confounders. It likely affects both the treatment (introduction of a new product) and the outcomes (quality and price). More formally, the *matched set* of control firms associated with the treated firm i in market j at t is defined as,

$$\boldsymbol{M}_j^t(i)=\left\{i':i,i'\in j,i'\neq i,m_{i'j}^t=0,m_{i'j}^{t-1}=0,\left\{m_{i'j}^{t-\ell}\right\}_{\ell=2}^{L_i}=\left\{m_{ij}^{t-\ell}\right\}_{\ell=2}^{L_i}\right\}. \tag{11}$$

Referring back to Figure 3, the matched sets for treated firms in market GBR-10515241 (Panel 3a) are: $\boldsymbol{M}(O)=\{G,R,Q,M,L,F\}$, $\boldsymbol{M}(G)=\{Q,L,M\}$, $\boldsymbol{M}(R)=\{G,Q,L,M\}$. In market DEU-10513030 (Panel 3b), the matched set of the treated firm J is $\boldsymbol{M}(J)=\{\varnothing\}$. This means that this last market is not accounted for in the analysis.

3.3 Refining the matched sets

As mentioned above, the matched sets defined in Eq.(11) are adjusted for past experience. We also need to adjust for other cofounders. [21] We choose to apply re-weighting

[21] Under the unconfoundedness assumption (Rubin, 1978; Rosenbaum and Rubin, 1983), various methods have been proposed to deal with observable confounders. Some rely on estimating the conditional regression function of the outcomes of given covariates (Robins, Rotnitzky, and Zhao, 1995; Robins and Rotnitzky, 1995; Hahn, 1998; Heckman, Ichimura, and Todd, 1997; Heckman, Ichimura, and Todd, 1998). Others use the propensity score (Rosenbaum and Rubin, 1983; Rosenbaum and Rubin, 1984) in

methods that make additional adjustments by further refining the matched sets. The aim is to construct a weight for each control firm within a matched set such that greater weight is assigned to the most similar control firm(s). The aim of these weights is to balance the distribution of the covariates between a treated firm and its control group. Under *unconfoundedness* and *overlap* assumptions (see, Rosenbaum and Rubin, 1983), Hirano, Imbens, and Ridder (2003) use the propensity score and construct the weights $w^t_{i'j}$ computed from $\frac{\hat{e}^t_{i'j}}{1-\hat{e}^t_{i'j}}$ such that $\sum_{i'\in \boldsymbol{M}^t_j(i)} w^t_{i'j} = 1$, and where $\hat{e}^t_{i'j}$ is the estimated propensity score defined as the probability of assignment to the treatment group given the set of covariates. To precise what the propensity score and confounding factors are in our case, we use Eq.(7). Taking the log. of this equation, gives,

$$\ln(k_{ij}) = \beta' \ln(\phi_i) + \boldsymbol{A'_j}$$

where $\beta' = \frac{\beta_j(\sigma_j-1)}{a\left(\beta_j-\eta'_j\right)-\eta'_j}$ and $\boldsymbol{A'_j} = \ln(\boldsymbol{A_j}) - \frac{\beta_j(\sigma_j-1)}{a\left(\beta_j-\eta'_j\right)-\eta'_j}\ln(\tau_j)$; and k_{ij} is the stock of knowledge of firm i in market j. As noted above, k_{ij} is unobserved in our data, but we do have information on m_{ij} which is a dummy indicating whether or not a firm has introduced a new product in a given market. We assume that firm i is able to introduce a new product in market j only if its stock of knowledge, k_{ij}, is above a certain threshold, $\tilde{k}_j$. This leads to the following binary choice model (omitting the t exponent for the sake of simplicity) ,

$$\begin{aligned} d_{ij} &= \begin{cases} 1 & \text{if } \ln(k_{ij}) > \ln(\tilde{k}_j) \\ 0 & \text{otherwise} \end{cases} \\ \ln(k_{ij}) &= \beta' \ln(\phi_i) + \boldsymbol{A'_j} + \varepsilon_{ij} \end{aligned}$$

matching procedures or in regression adjustment. Hirano, Imbens, and Ridder (2003) propose a Horvitz-Thompson type estimator based on weighting by the inverse of the assignment probabilities, with the assignment probabilities estimated non-parametrically.

Using a logistic function, the propensity score can be written as :

$$e_{ij} = \Pr(d_{ij} = 1 \mid \phi_i, \boldsymbol{A'_j}) = \frac{1}{1 + \exp\left(-\beta' \ln(\phi_i) - \boldsymbol{A'_j}\right)} \tag{12}$$

This specification shows that the main confounding variables are firm efficiency, ϕ_i, and market characteristics, $\boldsymbol{A'_j}$. In our estimation, we use firm characteristics such as the number of employees, the capital intensity, the TFP (total factor productivity), investment in innovation as a proxy for the efficiency of the firm and we consider $\boldsymbol{A'_j}$ as market-specific unobserved heterogeneity.[22] [23]

Based on estimation of the propensity score, we estimate the ATT of the introduction of a new product defined in Eq.(10). For each treated firm, we estimate the counterfactual outcomes using the weighted average of the control firms in the matched set. We then compute the Difference-in-Differences, DiD, estimate of the ATT for each treated observation and then average it across all treated observations and markets.[24] More formally, our ATT estimator is given by,

$$A\hat{T}T = \frac{\sum_j w_j A\hat{T}T_j}{\sum_j w_j} \tag{13}$$

where,

$$A\hat{T}T_j = \frac{1}{N_j} \sum_{i \in j} \left\{ \Delta y_{ij}^t - \sum_{i' \in \boldsymbol{M}_j^t(i)} w_{it}^{i'} \Delta y_{ij}^t \right\}, \tag{14}$$

$w_j = \sum_{i \in j} \hat{e}_{it}$ and N_j is the number of treated firms in market j, and where $\Delta y_{ij}^t = y_{ij}^t - y_{ij}^{t-1}$.

Overall, our data consist of 2,326 markets: 744 markets with treated and control firms (the sample used for our analysis), 1,419 markets with no treated firms and 163 markets with treated firms, but no control firms. Table 5 gives information on treated and control firms for some markets.

[22] see Table 13 in Appendix E for the definition of the variables.

[23] Table 15 in Appendix E shows the results of the estimation using a random-effects logit model; the balancing tests are given in Appendix C.

[24] According to Blundell and Costa Dias (2000) a combination of matching techniques and difference-in-differences can improve the quality of matching results because initial differences between treated and control firms are removed.

4 Results

In this section, we report the extent to which new products introduced on a market have higher prices and quality, using the empirical methodology described in section 3.2. Further, we consider two subsamples with different scope for quality differentiation and show that the ATTs of new product introduction on price and quality differ substantially across the type of markets. Finally, we show that our results are robust to other econometric techniques and assess the robustness of our interpretation compared to that of alternative explanations.

4.1 New product introduction and export prices

Table 6 shows the results of the estimation of the ATTs of new product introduction on export prices. The different columns correspond to the evaluation of ATTs at different time periods after the introduction of a new product. In column (I), we show a positive and statistically significant coefficient, indicating that the introduction of a new product is associated with higher export prices. This result is consistent with corollary 1. New products introduced in year t also have higher prices (+0.7%) in the same year, on average, compared to the prices charged by identical firms which did not introduce new products on the same market.

Table 6 about here

The higher prices of new products fade away two years after the introduction of the new product. Introducing a new product in year t leads firms to have higher export prices (+0.6%) one year after the new product introduction. It becomes non significant two and three years after the introduction.

4.2 New product introduction and quality

To test whether higher export prices reflect improvement in quality, we need to estimate the ATTs of the introduction of a new product on the quality of the exported products. Unfortunately, quality cannot be observed directly in our data. We thus estimate quality using the approach proposed by Khandelwal, Schott, and Wei (2013). We define quality as unobserved attributes of a variety that make consumers willing to purchase large quantities of the variety despite high prices. In other words, when, for a given price, the variety is purchased in larger quantities by consumers than the other varieties, it is considered to be of higher quality (see Appendix D for more details).

Table 7 shows our estimation of the ATT of introduction of a new product on estimated quality. The columns correspond to the evaluation of the ATT at different times. We present various specifications reflecting different values of elasticity of substitution in the estimation of quality. Note that the estimated ATT in column (`I`) is significantly positive. It supports the prediction of Proposition 1 that the introduction of a new product is associated with higher product quality (+16.3% to +21.2%) the same year.

Table 7 about here

Columns (`II`)-(`IV`) in Table 7 present the estimated ATT of the introduction of a new product in year t on quality evaluated in year $t+1$, $t+2$ and $t+3$ after the introduction of the new product. Our estimations show that new products introduced in year t are of higher quality in subsequent periods. These results suggest that the introduction of a new product has a long-term effect on the quality of the product, compared to the same product exported by firms that did not innovate for this product.

Moreover, the results in Tables 6 and 7 are consistent with Corollary 2. Indeed, the introduction of a new product affects quality much more than it affects price. This suggests that the quality-adjusted prices decrease. Newly introduced products have higher prices and quality and lower quality-adjusted prices.

4.3 The role of scope in quality differentiation

In this subsection, we test whether the ATTs of the introduction of a new product on price and quality are heterogeneous across destinations. As we want to test whether the scope for quality differentiation on a given market matters, we use quality dispersion to create two separate samples. For each market (product-destination pair), we estimate the variance of the quality. This measures the scope for quality differentiation on a given market. We use the median of quality variances of all markets to distinguish markets with highly-dispersed quality (market with large scope for quality differentiation) and less-dispersed quality (market with small scope for quality differentiation). Table 8 lists the summary statistics for quality dispersion, which is the variance of product quality in a given market, which as Table 8 shows that, is rather high. Indeed, the coefficient of variation is around 1.06. This means that the scope for quality differentiation is highly dispersed across markets.

Table 8 about here

Table 9 lists the estimated results for these two groups. Column `(I)` lists the estimated results when we use the sub-sample of markets with large scope for quality differentiation; column `(II)` lists the estimated results when we use the sub-sample of markets with limited scope for quality differentiation.

Table 9 about here

Panel (d) in table 9 reveals a substantial difference in ATT estimates depending on quality differentiation. When quality differentiation is limited, new products tend to have lower export prices after the introduction of a new product; however, the resulting ATT is not significant. Conversely, in markets where the scope for quality differentiation is large, newly introduced products have higher export prices. This is in accordance with Corollary 2. Panel (e) – Panel (g) in Table 9 show that the ATT in markets with large scope for quality differentiation is much larger than the ATT in markets with limited scope for quality differentiation.

4.4 Robustness check

In this subsection we check the robustness of our results to alternative econometric methods and other mechanisms.

4.4.1 Alternative estimation strategy

As stated above, unobserved demand shocks may drive quality, price and innovation. This raises an endogeneity problem when we assess the effect of innovation on quality and price. To address this problem, we developed an empirical approach that allows us to control these unobserved confounding factors, simultaneously using propensity score and DiD techniques. In the following, we use an instrumental variable approach. We have to idenitfy relevant instruments, i.e. variables exogenous to the introduction of a new product and which only have an impact on quality and price. The empirical literature on innovation suggests that several variables can play this role (R&D-related or other variables like those in Caldera, 2010; Van Beveren and Vandenbussche, 2010; Hombert and Matray, 2018; Cassiman and Martinez-Ros, 2007; Harris and Li, 2009). However, these instruments are not suitable in our case as our innovation measure is product specific. The R&D-related variables are firm specific and may affect quality and price through other types of innovation. For example, firms may invest in R&D to generate new process (process innovation) that can improve the quality of their products.

In this paper, we exploit the wide coverage of the data at our disposal to construct an instrument for d_{ij}^t. We account for the firm's exports in the same product category to different destinations. We define our instrument as,

$$\bar{d}_{ij}^t = \frac{\sum_{j' \neq j} d_{ij'}^t * \omega_{ij'}^t}{\sum_{j' \neq j} \omega_{ij'}^t} \tag{15}$$

where $\omega^t_{ij'}$ corresponds to the share of exports on market j' in terms of value over the total export value of the firm. Our instruments build on the insights of Hausman-type instruments, which are used extensively in the Industrial Organisation literature (see for instance, Hausman, Leonard, and Zona, 1994; Nevo, 2001; Jäkel, 2019). These instruments can be considered as valid under the assumptions that (*i*) firm *i*'s innovation in market *j* can be expressed at firm level by a common factor (ϕ_i is the common factor in our case, as shown in Eq.(7); (*ii*) the unobserved demand shocks are uncorrelated across destinations.[25]

The corresponding 2SLS model we estimate is given by

$$\ln(y^t_{ij}) = \alpha_1 d^t_{ij} + \pi_1 \ln(\phi^t_i) + \theta_{1,ij} + \theta_{1,t} + \epsilon^t_{ij} \quad (16)$$

$$d^t_{ij} = \alpha_2 \bar{d}^t_{ij} + \pi_2 \ln(\phi^t_i) + \theta_{2,ij} + \theta_{2,t} + v^t_{ij} \quad (17)$$

where Eq.(16) is obtained using the log. of the Eqs.(8) and (9); where $\theta_{1,ij}$ and $\theta_{2,ij}$ are the firm-market fixed effects, and $\theta_{1,t}$ and $\theta_{2,t}$ are the year fixed effects. In Eq.(16), we exploit variations in the outcome (quality or price) and the introduction of a new product within a firm–market over time through the firm–market fixed effects. We also control for confounding factors and for macroeconomic fluctuations through firm efficiency (firm characteristics) and year fixed effects.

Table 10 lists the results of our estimation. The estimation of Eq.(17) using OLS shows that the estimated effects of the introduction of a new product on price and quality are rather large in magnitude (panel *h*). This result is consistent since OLS do not control for unobserved demand shocks which would increase both the likelihood of introducing a new product and the outcomes (quality and price). This specification is the reference point to assess the impact of our instrumentation on the estimates. Turning to the 2SLS estimation and using an instrumental variable, panel (*i*) reports a lower estimates in

[25] Although this hypothesis seems to be strong, we did conduct some analyses suggesting that unobserved demand shocks are uncorrelated across destination. In particular, we checked that the markets were not exposed to global shocks which would contradict the hypothesis of independent demand shocks across countries.

magnitude. This confirms that, as expected, the instrument does correct for endogeneity. Panel (j) shows the first-stage relations that underlie our 2SLS estimates. The F -statistic (162.5) is above the thresholds usually used to detect weak instruments (see Staiger and Stock, 1997). This result validates our instrument and reveals its considerable influence on d^t_{ij}. This approach validates the main predictions of our model which state that introducing a new product leads to higher export prices and higher product quality. We also validate the hypothesis that introducing a new product affects quality much more than price, meaning it reduces quality-adjusted prices.

4.4.2 Alternative explanations

Given the assumptions of our theoretical model, we did not consider an alternative mechanism that could explain our results. Indeed, the positive effects of the introduction of a new product on quality and prices could be driven by variable markups.[26] If the introduction of a new product leads firms to increase their markups, this would also increase our estimated quality (residual demand) and prices.

To address this possible mechanism, we estimate the ATT of the introduction of a new product on the markup-corrected prices. We follow Fan, Li, and Yeaple (2015) and subtract the change in the market share from the variation in price to obtain the change in the price corrected for markup. As shown by Amiti, Itskhoki, and Konings (2014), this controls for variations in markups because a firm's markups tend to increase with the firm's market share. Then we define the markup-corrected prices as:[27]

$$\Delta \ln p' = \Delta \ln p - \frac{1}{\sigma - 1}\Delta s \qquad (18)$$

[26] In our set-up, variable markups could be obtained by relaxing the monopolistic competition assumption and assuming an oligopolistic competition.

[27] As in Fan, Li, and Yeaple (2015), we consider that the firm profit function is given by $(p_i - c_i)\frac{Ep_i^{-\sigma}q_i^{\eta}}{\sum_j p_j^{1-\sigma}q_j^{\eta}}$ where E is the expenditure on the good category and quality q_i has been included for the sake of completeness. Using first order conditions and taking logarithms we have $\ln p_i = \ln c_i + \ln\left(1 + \frac{1}{(\sigma-1)(1-s_i)}\right)$, where $s_i \equiv \frac{p_i^{1-\sigma}q_i^{\eta}}{\sum_j p_j^{1-\sigma}q_j^{\eta}}$ is the market share of firm i. Taking the difference in log price and using a first-order Taylor approximation of the log markup, we can derive that $\Delta \ln p_i = \Delta \ln c_i + \frac{1}{\sigma-1}\Delta s_i$.

where s is the market share of a firm in a given market. This exercise should alleviate the concern that our results reflect variation in markups rather than upgraded quality.

Table 11 shows ATT estimates of the introduction of a new product on markup-corrected prices. The markup corrected price is estimated using different values of elasticity of substitution, σ, following the previous sections. The resulting ATTs are positive and still significant, whatever the value of the elasticity of substitution. In addition, the ATTs obtained in panels (k) and (l) are similar to those obtained in Table 6, showing that the effect of the introduction of a new product on markups is insignificant. This exercise confirms that our results are not primarily driven by changes in markups.

Table 11 about here

5 Conclusion

This article evaluates the role of product innovation in key attributes of exported products: price and quality. Although this role has already been analysed, the aggregated nature of the data at firm level was failed to produce a clear picture of the mechanisms involved at product level.

The `GNPD` database enabled us to build a unique dataset containing information on the introduction of a new product at firm-product-destination level. We propose a theoretical framework which allows a firm to invest in product innovation according to the characteristics of that market. This is important in industries like the dairy industry, where the presence of market-specific taste is important and where firms consequently need to adjust the quality of their product.

We used a re-weighting sampling technique to construct a counterfactual control group to test whether the introduction of new products is associated with higher export prices and quality. We estimate that after the introduction of a new product, export prices and product quality increase by an average of 0.7% and 16%, respectively. We also show that quality remains higher for several years following the introduction of a new product. Finally, we show that the magnitude of the increases depends on the scope for quality differentiation in the destination markets. In markets where the scope for quality differentiation is large, we estimate that export prices and product quality increase by an average of, respectively, 1% and 27% after the introduction of a new product. On the other hand, in markets where the scope for quality differentiation is limited, we estimate that product quality is 12% higher on average after the introduction of the new products, and we found no effects on export prices. As in De Rassenfosse et al. (2022) and Dosi, Grazzi, and Moschella (2015), these results are the expression of superior capabilities (linked to technological factors) of firms that export new products to some markets. These capabilities lead to higher export prices and improved quality on international markets. As our analysis concerns a particular industry, we recommend caution before generalising our findings to other industries. However, we believe that the detailed information on the launching of new products allow us to unpack the changes occurring within firms and is a relevant contribution to the literature on firms' export behaviour. From a policy point of view, our results show that firms' ability to improve their knowledge of a given market is an important competitiveness factor at product level. This highlights the key role of existing programmes in France, such as the "V.I.E. French international internship".[28] This programme helps firms hire young people and send them abroad for an internship. This type of scheme, together with involvement in European innovation strategies, should enhance firms' international competitiveness by enabling a more precise match between foreign consumers' expectation and product innovation by firms.

[28]See https://mon-vie-via.businessfrance.fr/en/what-is-the-vie-french-international-internship-program for more information on this program

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A The Optimal Knowledge Stock

The firm chooses the optimal k_{ij} that maximises the net profit in market j, $\pi_{ij} - c(k_{ij})$, i.e.,

$$\pi_{ij} = \max_{\xi_{ij}} \left((p_{ij} - c_{ij})\, x_{ij} - F_j - f_j - \psi k_{ij}^{a} \right)$$

The first order condition gives

$$\frac{\eta'_j}{\beta_j - \eta'_j} k_{ij}^{\frac{2\eta'_j - \beta_j}{\beta_j - \eta'_j}} \boldsymbol{A'_j} \left(\frac{\phi_i}{\tau_j}\right)^{\frac{\beta_j}{\beta_j - \eta'_j}} = a\psi k_{ij}^{a-1}$$

$$k_{ij}(\phi_i) = \boldsymbol{A_j} \left(\frac{\phi_i}{\tau_j}\right)^{\frac{\beta_j(\sigma_j - 1)}{a\left(\beta_j - \eta'_j\right) - \eta'_j}}$$

where $\boldsymbol{A'_j} = \left(\frac{\beta_j - \eta'_j}{\beta_j}\right) \left(\frac{E_j}{\sigma_j}\left(\frac{(\sigma_j - 1)P_j}{\sigma_j}\right)^{\sigma_j - 1}\right)^{\frac{\beta_j}{\beta_j - \eta'_j}} \left(\frac{\gamma\eta'_j}{f\beta_j}\right)^{\frac{\eta'_j}{\beta_j - \eta'_j}}$, $\eta'_j = \eta_j - \alpha(\sigma_j - 1)$ and $\boldsymbol{A_j} = \left(\frac{\eta'_j}{a\psi\beta_j}\right)^{\frac{\beta_j - \eta'_j}{a\left(\beta_j - \eta'_j\right) - \eta'_j}} \left(\frac{\gamma\eta'_j}{f\beta_j}\right)^{\frac{\eta'_j}{a\left(\beta_j - \eta'_j\right) - \eta'_j}} \left(\frac{E_j}{\sigma_j}\left(\frac{(\sigma_j - 1)P_j}{\sigma_j}\right)^{\sigma_j - 1}\right)^{\frac{\beta_j}{a\left(\beta_j - \eta'_j\right) - \eta'_j}}$

The second order condition is, for the optimal k_{ij} is,

$$\frac{\eta'_j}{\beta_j - \eta'_j} \frac{2\eta'_j - \beta_j}{\beta_j - \eta'_j} k_{ij}^{\frac{3\eta'_j - 2\beta_j}{\beta_j - \eta'_j}} \boldsymbol{A'_j} \left(\frac{\phi_i}{\tau_j}\right)^{\frac{\beta_j}{\beta_j - \eta'_j}} - a(a-1)\psi k_{ij}^{a-2} < 0$$

$$\frac{2\eta'_j - \beta_j}{\beta_j - \eta'_j} k_{ij}^{\frac{3\eta'_j - 2\beta_j}{\beta_j - \eta'_j} + \frac{a\left(\beta_j - \eta'_j\right) - \eta'_j}{\beta_j - \eta'_j}} - (a-1) k_{ij}^{a-2} < 0$$

$$\left(\frac{2\eta'_j - \beta_j}{\beta_j - \eta'_j} - (a-1)\right) k_{ij}^{a-2} < 0$$

Then there is an interior solution if $a\left(\beta_j - \eta'_j\right) > \eta'_j$.

B Data

The originality of our study lies in our innovation data. We built a dataset that allows us to identify innovation at firm-product-destination level. We also developed a procedure to merge our new dataset with existing administrative data sets, such as `CUSTOMS` and `FARE`. Here, we present the Global New Product Database (`GNPD`) in detail, together with the procedures we applied.

B.1 Global New Product Database

The Mintel Global New Products Database (GNPD) contains information on "new product" launches, especially product descriptions and information on ingredients and brands. It highlights trends in new products in global markets such as food markets (Solis 2016). Mintel mainly uses primary information sources to enrich `GNPD`. The primary source of information is shoppers who receive a list of stores they need to visit weekly to find new products. Secondary information sources such as trade shows, press releases, the media, corporate intelligence are also used. The distribution channels monitored include supermarkets, the mass market, pharmacies, health food stores, mail order and Internet sales, and some direct-to-consumer stores. When a new product is identified, it is cross-referenced with the Mintel Shopper website to limit duplication of products that have already been identified. The product is then purchased and sent to the Mintel offices. Mintel's data entry team records relevant information from the packaging, including the type of launch, EC identification, product claims, bar codes, ingredients, nutritional data, and product category. The products are then sent to be photographed. The quality of each product sheet is checked by a team of editors before publication on the site. An editor reviews the product sheet as an additional quality control measure. The products appear in `GNPD` as soon as possible after the launch date and at the latest within approximately one month after being launched.

In the period 2010-2017, `GNPD` registered more than 120,000 dairy products launched worldwide.[29] These products are listed in `GNPD` under five types of launches:

- "*New product*": This type of launch depends on the brand. It is assigned to a new range, line, or family of products;
- "*New variety/range extension*": This type of launch depends on the brand. It is used to document an extension of an existing range of products in `GNPD`;

[29] The dairy product category is one of the most common in the GNPD dataset. Over the period 2010-2015, the first three sectors concerned by product launches on the French market were "Bakery" (22%), "Prepared meal with fish or meat" (19%), and the "Dairy" sector (17%). We chose to explore innovation in the dairy sector as it is an important sector for French export competitiveness.

- "*New packaging*": This type of launch is determined by visual inspection of the product. It includes terms like "'New Look"', "'New Packaging"', or "'New Size"' written on the packaging;

- "*Reformulation*": This type of launch is used when terms such as "New Formula", "Even Better", "Tastier", "Now Lower in Fat", "New and Improved", or "Great New Taste" are indicated on the packaging;

- "*Relaunch*": This type of launch is used when "Relaunch" is specified on the packaging, via secondary source information (trade shows, public relations, websites, and the press) or when a product has been both significantly repackaged and reformulated.

The GNPD usually targets at manufacturers, retailers and suppliers who are involved in the marketing, sale, research, or innovation of new products and need to identify new trends (Solis, 2016) However, GNPD is also used as a source of information for scientific research: in (i) food and nutrition (Mitchell, 2008; Gallagher, 2009; Van Camp, Hooker, and Souza-Monteiro, 2010; Roodenburg et al., 2011; Van Camp, Hooker, and Chung-Tung, 2012; Menard et al., 2012; Slining, Ng, and Popkin, 2013; Martinez, 2013; Yangui, Costa-Font, and Gil, 2016; Souza-Monteiro and Hooker, 2017; Gilham, Hall, and Woods, 2018; Dickie, Woods, and Lawrence, 2018; Tennant and Bruyninckx, 2018), (ii) the environment (Gouin et al., 2012; Zhang et al., 2015), (iii) biotechnology (Bouwmeester et al., 2009; Jankovic et al., 2010; Lucas et al., 2015), (iv) management (Anselmsson and Johansson, 2009; Chrysochou, 2010; Barcellos, Grunert, and Scholderer, 2011; Krystallis and Chrysochou, 2011; Stanton et al., 2015; Rubera, Chandrasekaran, and Ordanini, 2016)) and (v) economics (Pofahl and Richards, 2009; Li and Hooker, 2009; Allender and Richards, 2010). In economics, GNPD is usually used to understand consumer behaviour; for example, Pofahl and Richards (2009) used GNPD to estimate the welfare effects on U.S. consumers resulting from the introduction of three bottled juice products. Allender and Richards (2010) used GNPD to estimate potential changes in California consumer surplus.

B.2 Other sources of data we used

The second source of information we used is the `CUSTOMS` dataset. This dataset is a comprehensive record of the yearly values and quantities exported by French firms collected by French customs. The data include information on the final destination country of the product exported. The product is defined at the eight-digit level for each French exporting firm. The eight-digit combined nomenclature product classificationis used (hereafter `CN8`). `CN8` classification is based on the Harmonised Commodity Description and Coding System covering all the products that can be the object of international transactions and have a physical dimension. The first six digits are those of the Harmonised System (`HS`) and the last 2 digits correspond to HS subdivisions to meet EU tariff or statistical needs.[30]. We decided to use the 8-digit Prodcom (`PC8`) product level nomenclature. [31] We converted the `CUSTOMS` dataset from `CN8` classification to (`PC8`) classification using a standard concordance table [32]

The third source of data we used, called `FARE`, contains accounting data on French firms. The data originate from mandatory firms' declarations to fiscal authorities in France. Since every firm has to report to the tax authorities every year, the data covers all French firms from 2010 to 2017 with no limiting threshold in terms of firm size or sales. However, we limited our study to the dairy manufacturing firms (four-digit NACE Rev.2: 10.51). This dataset provided us with information on TFP, employment, and capital intensity, the five-digit sector to which the firm belongs, and so on. Table 14 lists some statistics that are characteristic of the firms in our final sample.

Table 14 about here.Il faut ajouter dans le tableau le nombre total de firmes

[30]See http://www.conex.net/nc8/2017/en/04.html, for a detailed description of dairy products categories (in French).

[31]The name Prodcom refers to "'statistics on the production of manufactured goods"'. Prodcom refers to both a database that records data on the physical production of manufactured products in EU countries and a product classification used to classify the physical production of manufactured goods.`PC8` is an extension of the `NACE Rév. 2` classification at product level.

[32]This table is available on the European Union's classification metadata server i.e. the Ramon server (http://ec.europa.eu/eurostat/ramon/).

B.3 Merging procedure

Our objective was to merge our three sources of information: `GNPD`, `FARE` and `CUSTOMS` datasets. Merging administrative firm-level data from `FARE` and `CUSTOMS` data is fairly straightforward as in both datasets, a firm can be identified by its own identifier, i.e. the `SIREN` number. The main challenge was to match `FARE` and `CUSTOMS` with `GNPD`. For our analysis, we needed to match `GNPD` and `CUSTOMS` at firm-product-destination level. The only information directly available in GNPD is the destination (i.e. the country where the product was found). To enable matching, we searched for data on product characteristics to retrieve information on the manufacturer's identifier and the product category.

As `GNPD` reports characteristics that are visible on the packaging, we were able to use the `EC` identification (health marks) to identify the manufacture. `EC` identification is the oval-shaped mark found on food products of animal origin in the European Community, which is required by European Union food safety regulations. [33] It identifies the processing plant that produced the product. The identification and health marks contains the following information: (*i*) the name of the country in which the product was processed, or more frequently its two-letter `ISO` country code; (*ii*) the national approval number of the facility where the food was processed, and (*iii*) the letters EC, standing for European Community. We developed a matching algorithm to map new products launched by the corresponding French firms. The steps of the matching procedure we used are as follows:[34]

- First, we selected observations with an `ISO` country code corresponding to France, i.e. `FR`. This ensured the information referred to products manufactured in France;
- Second, we aggregated the information on the database with respect to `EC` identification and the year. This procedure allowed us to count the number of products launched by `EC` identification in a given year;
- Third, by using the file of milk and dairy products production establishments ap-

[33] See Regulation (EC) `No.853/2004` of the European parliament and of the council.

[34] See Appendix B.4 for an example

proved by the Ministry of Agriculture available here, we were able to link the EC identification with the 14-digit plant-level `SIRET` number of the manufacturing plant.[35]

- Finally, we aggregated observations from the 14-digit plant-level (`SIRET`) to the 9-digit firm-level (`SIREN`).

We assigned each product in GNPD to its PC8 product category manually. This step was time consuming, but we were then able to construct a new product dataset at firm-product-destination level.

B.4 Retrieving firm identifiers: An example

In this appendix, we provide an example of the procedure we used to retrieve firm identifiers (`SIREN`) to enable us to merge `GNPD` with other databases. Figure 4 shows an example of a product in `GNPD`. It features the image of a Camembert cheese launched in the UK in 2015. as can be seen, the EC identification for this product is `FR 14.162.001 EC`. Thanks to the list of approved milk and milk product production plants freely accessible on the Ministry of Agriculture website, it was possible to link this EC identification with the identification system number of the directory of establishments.[36] We found that the EC identification `FR 14.162.001 EC` is associated with the plant whose `SIRET` number is `50199410700016`. By retaining only the first 9-digits, we obtained the `SIREN` number, `501994107`.

Figure 4 about here

[35]The `SIRET` (système d'identification du répertoire des établissements) number identifies each firm's production plants. It is composed of 14 digits: the 9 digits of the `SIREN` number + the 5 digits corresponding to an internal classification number (French acronym `NIC`)

[36]The list of approved milk and milk product production plants is available at: https://fichiers-publics.agriculture.gouv.fr/dgal/ListesOfficielles/SSA1_LAIT.pdf

C Balancing tests

The propensity score method relies on the validity of the balancing hypothesis. In order to obtain an unbiased estimate of the average treatment effect on the treated group, we must ensure that in a given market, firms with identical propensity scores have, on average, the same distribution of covariates independently of their treatment status. We performed two of the balancing tests suggested in the literature to check whether this hypothesis holds (Dehejia, 2005; Smith and Todd, 2005). The first is the standardised difference test. It informs about the difference in means between the treated group and the re-weighted comparison group, scaled by the square root of the average of the variances of the unweighted groups.

$$\mathrm{SDIFF}(z) = \frac{1}{N_T} \sum_j N_T^j \cdot \mathrm{SDIFF}^j(z) \tag{19}$$

where

$$\mathrm{SDIFF}^j(z) = 100 \cdot \frac{\sum_{i \in j} z_i \Big/ N_T^j - \sum_{i' \in \mathscr{M}_{it}^j} w_{i't}^j z_{i'} \Big/ \sum_{i' \in \mathscr{M}_{it}^j} w_{i't}^j}{\sqrt{\frac{\mathrm{var}_{i \in j}(z_i) + \mathrm{var}_{i' \in \mathscr{M}_{it}^j}(z_{i'})}{2}}} \tag{20}$$

Despite the absence of a formal criterion, the literature recommends a value of 20% as the maximum acceptable difference between means (Rosenbaum and Rubin, 1985). We also performed the test suggested by Smith and Todd (2005). These authors regressed each covariate on the estimated propensity score, some higher order polynomials, and interaction terms between the propensity score and the treatment variable:

$$z = \gamma_0 + \sum_{k=1}^{3} \gamma_{1,k} \hat{e}^k + \sum_{k=1}^{3} \gamma_{2,k} d \cdot \hat{e}^k + \gamma_j + \eta \tag{21}$$

This test relies on the hypothesis that the treatment status is independent of the covariate, conditional on the propensity score; *i.e.*, the coefficients of interaction terms between the propensity score and the treatment variable are non-significant. Table 16 lists the results of these two balancing tests. Table 16 about here

The first two columns list the mean of the covariates used in the propensity score specification for the matched observations of the treated and control groups. A detailed examination of these differences can be made by computing the standardised differences (% bias, third column). As can be seen, all the covariates satisfied the criterion proposed by Rosenbaum and Rubin (1985), suggesting that the re-weighting procedure succeeded in eliminating most of the differences. In addition, the fourth column shows a considerable reduction in bias following the re-weighting procedure.The F-statistic and the p-value of the joint null hypothesis used for the second balancing test are listed in the last two columns in Table 16. Again, this test confirmed the balance of the covariates between the treated and control groups.

D Quality estimation

To measure the quality of a product, we followed the literature on international trade by defining quality as an unobserved attributes of a variety which increases consumers' valuation of it, i.e. quality is modeled as a utility shifter. Following Khandelwal, Schott, and Wei (2013), we estimated perceived quality via the demand equation described by the Eq.(1). Taking the logs of this demand equation, we used the residual from the following `OLS` regression to infer quality

$$\ln(x_{ij}) + \sigma_j \ln(p_{ij}) = \alpha_j + \epsilon_{ij} \tag{22}$$

The market fixed effects, α_j, include both the destination price index P_J and income E_J. The estimated perceived quality is the residual of the `OLS` regression, $\hat{\epsilon}_{ij}$. The intuition behind this approach is that, conditional on price, higher quality is attributed to a variety with a higher quantity. Then, given the value of the elasticity of substitution, we are able to estimate perceived quality from Eq.(22). Following Anderson and Van Wincoop (2004), we first consider $\sigma_j \in [5; 10]$. We use different values $\sigma_j = 5$ and $\sigma_j = 10$. Second, we allow the elasticity of substitution to vary across product category, using the estimates reported by Ossa (2015).

E Tables

Table 12 about here.

Table 13 about here.

Data availability statement

The data that support the findings of this study are available from French National Statistics Institute. Restrictions apply to the availability of these data, which were used by authorised authors. Data are available through CASD agreement and secured box (more information at https://www.casd.eu/en/). STATA codes are available upon request.

Table 1: Description of the data

Year	Obs.	# PC8 categories	# Firms	# destination
Panel A: description of export data				
2010	8,097	28	187	92
2011	8,117	28	168	92
2012	8,363	28	169	96
2013	8,358	28	166	96
2014	9,077	28	162	97
2015	9,268	28	170	95
2016	9,288	28	176	92
2017	8,880	28	174	93
Panel B: description of product launches				
2010	962	15	49	47
2011	985	14	43	50
2012	956	16	38	50
2013	986	17	32	53
2014	1,126	17	64	56
2015	1,055	13	37	52
2016	1,144	15	43	55
2017	1,160	15	48	55

Notes: Obs. is the number of firm-product-destination per year. Columns (3)–(5) report: the number of PC8 categories, the number of firms and the number of destinations.

Table 2: Descriptive statistics for 7 product categories

	#	#	(%)	Export Performance		
PC8	destination	firms	Innovator	Value	Quantity	Price
10511142	78	32	0.41	952.01	1784.88	0.89
10511230	82	45	0.44	405.98	189.56	3.05
10513030	83	60	0.58	312.43	79.39	5.69
10514030	96	97	0.15	1140.58	525.97	7.07
10514050	98	225	0.38	1035.68	191.16	9.72
10514070	88	65	0.65	1009.26	192.47	5.64
10515241	73	56	0.09	711.67	595.65	2.25

Notes: We classify firms as innovators if they introduced at least one new product at any destination in year t.

Table 3: Export prices before and after the introduction of a new product in the period 2010-2017.

	Before introduction of a new product (1)	After introduction of a new product (2)	Change from before to after (3)
Mean	1.25	1.41	1.41%
Median	1.30	1.51	0.70%

Notes: Unit values (Export prices) are defined at the firm-product-destination level, and are computed by dividing the deflated export values by the physical quantity.

Table 4: Change in export prices before and after the introduction of a new product according to its destination.

	Whole sample (1)	Countries with high GDP per capita (Top 33rd percentiles) (2)	Countries with low GDP per capita (Bot. 33rd percentiles) (3)
Mean	1.41%	2.57%	0.33%
Median	0.70%	1.55%	0.10%

Notes: Export prices are unit values, computed by dividing deflated export values by the physical quantity. Prices are defined at firm-product-destination level. Prices are in natural logarithm.

Table 5: Treated and Control firms per market

Market	#Firms	#Treated Firms	#Control Firms
Panel A: Markets described in fig3			
GBR-10515241	18	3	6
DEU-10513030[1]	23	1	0
USA-10513030	17	1	2
CHN-10513030	14	1	2
Panel B: A slice sample of other markets included in our analysis			
GBR-10514050	80	5	60
DEU-10514050	113	24	63
USA-10514050	83	12	73
CHE-10514050	86	5	67
ESP-10514050	98	11	61
DNK-10514050	63	7	47
Panel C: The whole sample			
Total	29,434	3,719	10,203

Notes: Our sample is based on 744 markets. We use the term "firm" to describe a firm-product pair. #Firms refers to the number of firms; #Treated Firms refers to the number of treated firms; and #Control Firms refers to the number of firms used as control. [1]Not included in our analysis since the treated firm has no control.

Table 6: Estimated ATT of introducing a new product on export prices

	(I)	(II)	(III)	(IV)
	0 year...	One year...	Two years...	Three years...
	... after the introduction of a new product			
ATT	0.007***	0.006***	0.004	-0.013
S.E.	(0.002)	(0.002)	(0.014)	(0.018)
#Treated	3,719	3,204	2,611	2,041
#Controls	10,203	9,990	9,697	9,218

Notes: ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E. refers to standard errors obtained by bootstrapping. The dependant variable is the change in unit value at firm-market level.

Table 7: Estimated ATT of introducing a new product on quality

	(I)	(II)	(III)	(IV)
	0 year...	One year...	Two years...	Three years...
	... after the introduction of a new product			
Panel (a): Quality estimated using $\sigma = \sigma_h$				
ATT	0.163***	0.208***	0.255***	0.346***
S.E.	(0.031)	(0.050)	(0.066)	(0.098)
Panel (b): Quality estimated using $\sigma = 5$				
ATT	0.185***	0.252***	0.364***	0.346***
S.E.	(0.037)	(0.057)	(0.077)	(0.098)
Panel (c): Quality estimated using $\sigma = 10$				
ATT	0.212***	0.279***	0.410***	0.331*
S.E.	(0.060)	(0.095)	(0.135)	(0.174)
#Treated	3,719	3,204	2,611	2,041
#Controls	10,203	9,990	9,697	9,218

Notes: ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E. refers to standard errors obtained by bootstrapping. The dependent variable is the change in the estimated quality at the firm-product-destination level, given the value of the elasticity of substitution. In panel (a), we estimate quality using $\sigma = \sigma_j$; in Panel (b), we use $\sigma = 5$; in Panel (c), we use $\sigma = 10$.

Table 8: Summary statistics for quality dispersion

	Mean	S.D.	25^{th} percentile	Median	75^{th} percentile
Quality dispersion	8.462	9.008	2.846	6.232	11.331

Notes: S.D.: standard deviation. We compute quality dispersion by using the estimated quality to compute a quality variance for each market (product-destination pair).

Table 9: The influence of differentiation on the ATT of the introduction of a new product on export prices and quality

	(I) Market with large...		(II) Market with small...	
	...quality differentiation			
	ATT	S.E.	ATT	S.E.
Panel (*d*): Export prices (Unit value)				
	0.010***	(0.002)	-0.006	(0.010)
Panel (*e*): Quality estimated using $\sigma = \sigma_j$				
	0.277***	(0.050)	0.122***	(0.038)
Panel (*f*): Quality estimated using $\sigma = 5$				
	0.201***	(0.045)	0.149**	(0.062)
Panel (*g*): Quality estimated using $\sigma = 10$				
	0.268***	(0.073)	0.084	(0.104)

Notes: ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E.: standard errors. We compute quality dispersion by using the estimated quality to compute a quality variance for each market (product-destination pair). We use the median of quality variances of all markets to distinguish markets with highly dispersed quality (market with large quality differentiation) and less-dispersed quality (market with small quality differentiation).

Table 10: Robustness check: OLS and 2SLS estimations

	$\ln p$	$\ln q$		
		$\sigma = \sigma_j$	$\sigma = 5$	$\sigma = 10$
Panel (h): OLS estimation				
Introduction of a new product	0.148***	0.354***	0.381***	0.495***
S.E.	(0.005)	(0.074)	(0.081)	(0.093)
Panel (i): 2SLS Estimation: second stage				
Introduction of a new product	0.021**	0.194**	0.215**	0.237**
S.E.	(0.010)	(0.095)	(0.106)	(0.119)
F-statistics		162.481		
Panel (j): 2SLS Estimation: first stage				
Instrument		0.751***		
S.E.		(0.073)		

Notes: ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E.: standard errors. All regressions include firm-level controls (TFP, capital intensity, investment in innovation and the number of employees), firm-market fixed effects and year dummies.

Table 11: ATT estimates of the introduction of a new product on markup corrected prices

	(I)	(II)	(III)	(IV)
	0 year...	One year...	Two years...	Three years...
	... after the introduction of a new product			
Panel (k): Estimating markup corrected prices using $\sigma = \sigma_j$				
ATT	0.007***	0.006***	0.002	-0.011
S.E.	(0.003)	(0.002)	(0.014)	(0.019)
Panel (l): Estimating markup corrected prices using $\sigma = 5$				
ATT	0.008***	0.005**	0.003	-0.008
S.E.	(0.002)	(0.002)	(0.014)	(0.019)
Panel (m): Estimating markup corrected prices using $\sigma = 10$				
ATT	0.019***	0.026***	0.027**	0.015
S.E.	(0.006)	(0.010)	(0.013)	(0.019)

Notes: ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E.:standard errors obtained by bootstrapping. Markup corrected prices are defined in Eq.(18).

Table 12: Prodcom product level nomenclature

PC8	Definition
	Processed liquid milk
10511133	Milk and cream of a fat content by weight of $\leq 1\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content $\leq 2l$
10511137	Milk and cream of a fat content by weight of $\leq 1\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content $> 2l$
10511142	Milk and cream of a fat content by weight of $> 1\%$ but $\leq 6\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content $\leq 2l$
10511148	Milk and cream of a fat content by weight of $> 1\%$ but $\leq 6\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content $> 2l$
	Milk and cream of >6% fat, not concentrated or sweetened
10511210	Milk and cream of a fat content by weight of $> 6\%$ but $\leq 21\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of $\leq 2l$
10511220	Milk and cream of a fat content by weight of $> 6\%$ but $\leq 21\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of $> 2l$
10511230	Milk and cream of a fat content by weight of $> 21\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of $\leq 2l$

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Table 12 – continued from previous page

PC8	Definition
10511240	Milk and cream of a fat content by weight of $> 21\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of $> 2l$
10511240	Milk and cream of a fat content by weight of $> 21\%$, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of $> 2l$
	Skimmed milk powder
10512130	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of $\leq 1.5\%$), in immediate packings of $\leq 2.5kg$
10512160	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of $\leq 1.5\%$), in immediate packings of $> 2.5kg$
	Whole milk powder
10512230	Whole milk powder or full cream powder (milk and cream in solid forms, of a fat content by weight of $> 1.5\%$), in immediate packings of $\leq 2.5kg$
10512260	Whole milk powder or full cream powder (milk and cream in solid forms, of a fat content by weight of $> 1.5\%$), in immediate packings of $> 2.5kg$
	Butter and dairy spreads
10513030	Butter of a fat content by weight $\leq 85\%$
10513050	Butter of a fat content by weight $> 85\%$ and other fats and oils derived from milk (excluding dairy spreads of a fat content by weight $< 80\%$)
10513070	Dairy spreads of a fat content by weight $< 80\%$
	Cheese and curd
10514030	Unripened or uncured cheese (fresh cheese) (including whey cheese and curd)

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Table 12 – continued from previous page

PC8	Definition
10514050	Grated, powdered, blue-veined and other non-processed cheese (excluding fresh cheese, whey cheese and curd)
10514070	Processed cheese (excluding grated or powdered)
	Milk and cream, concentrated or containing added sugar or other sweetening matter, other than in solid forms
10515104	Condensed or evaporated milk, unsweetened
10515108	Condensed or evaporated milk, sweetened
	Yoghurt and other fermented or acidified milk or cream
10515241	Curdled milk, cream, yogurt and other fermented products
10515145	Flavoured liquid yoghurt or acidified milk (curdled milk; cream; yoghurt and other fermented products flavoured or containing added fruit; nuts or cocoa)
10515163	Buttermilk powder
10515165	Buttermilk
	Casein
10515300	Casein and caseinates
	Lactose and lactose syrup
10515400	Lactose and lactose syrup (including chemically pure lactose)
	Whey
10515530	Whey and modified whey in powder, granules or other solid forms, whether or not concentrated or containing added sweetening matter

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Table 12 – continued from previous page

PC8	Definition
10515560	Whey and modified whey in liquid or paste forms; whether or not concentrated or containing added sweetening matter
	Dairy products n.e.c.
10515600	Products consisting of natural milk constituents, n.e.c.

Table 13: Definition of variables

Variables	Definition
Number of employees	Number of employees in full time equivalent
Capital intensity	Tangible assets per employee
TFP	Total Factor Productivity
Investment in innovation	Firm invests in intangible assets
Foreign firm	Firm is a subsidiary of a foreign multinational company
Belonging to a group	Firm is a subsidiary of a French multinational company
Core product	Product h is the core product of the firm

Table 14: Firm-level characteristics

Firm-level characteristics	Mean	Standard Deviation	Min	Max
Turnover	10.051	1.779	5.530	14.334
Value added	8.158	1.612	3.338	12.702
Capital	9.013	1.912	2.384	13.444
Number of employees	4.032	1.507	-0.105	7.831
Labour productivity	4.127	0.521	1.138	7.444
TFP	-0.406	0.418	-1.739	1.067

Notes: Firm characteristics are in log. Employment is measured in full time equivalent. Labour productivity is measured as the value added per employee. Monetary values are deflated. Turnover, value-added and labor productivity are deflated using the gross product output deflators from OECDSTAN. Capital is deflated using the gross fixed capital formation deflator from EUROSTAT.

Table 15: results of propensity score estimation

Variables	Coef.	S.E.
Number of employees	0.341***	(0.061)
Capital intensity	0.382***	(0.085)
Total factor productivity (TFP)	0.319**	(0.147)
Investment in innovation	0.124***	(0.041)
Foreign firm	0.698***	(0.201)
Belonging to a group	0.687*	(0.184)
Core product	0.587***	(0.084)
# Observations	13,922	

Notes: For the estimation, we use pre-treatment firm characteristics. ***, ** and * indicate significance at the 1%, 5%, and 10% level. S.E. corresponds to standard errors.

Table 16: Balancing tests from the re-weighting procedure

	Mean		% Bias abs.	% Bias	Regression based test	
	Treated	Control	value	reduction	F-stat	p-value
Number of employees	5.831	5.691	9.203	82.941	0.92	0.431
Capital intensity	5.468	5.472	0.413	101.156	1.06	0.366
TFP	-0.328	-0.330	0.348	98.206	0.00	1.000
Invest. inn.	0.234	0.244	2.386	87.259	1.28	0.280
Foreign firm	0.053	0.046	0.099	96.573	1.27	0.284
Belonging to a group	0.832	0.841	2.492	154.621	0.19	0.903
Core product	0.658	0.301	0.422	53.621	0.98	0.401

Notes: The balancing tests are performed for the ATT estimate computed over the full sample using a re-weighting procedure and matched within the same market. The first two columns show the mean of the covariate in the treated and control group, respectively. The next two columns show the bias and the percentage bias reduction. The last two columns show the F-statistic and the p-value of the regression-based test.