Local Product Space and Firm Level Churning in Exported Products

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Abstract

This paper explores the determinants of changes in the range of exports at the firm level with a particular interest in the role played by the locality via product relatedness. To this aim, we introduce a multi-regional setting to the theoretical framework proposed by Bernard et al. (2010), which explains multiple product firms and product switching. We test the propositions of the extended framework using French micro-data that covers information on mono-regional firms operating primarily in manufacturing industry over the period 2002-2007. Our main finding is that the local product space matters in the decisions firms make. Specifically, firms tend to modify their mix of exported products such that their production and export capabilities get more aligned with capabilities that lie beneath core capabilities of the region. Our results also suggest that once firms alter their range of exports, among all new products they start exporting, they enjoy greater export revenues in those that are more related to the core capabilities of the locality.

Keywords: Local Product Space, Product Relatedness, Firm Export Churning, France

JEL code: L25, F14, C49

1 Introduction

Recent empirical evidence point out to intense product churning at the firm level and its contributions to growth of aggregate output. Iacovone and Javorcik (2010) report that in Mexico, over the period 1994-2003, export

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variety creation constitutes annually on the average 19% of all varieties exported while export variety destruction accounts for 11%. Bernard et al. (2010) find for US manufacturing firms over the period 1987-1997 that the gross contributions of product churning within firms to aggregate manufacturing output is as large as that of firm entry and exit. Such changes in the product scope of firms are also key to understand the dynamics of comparative advantage at the country level. Hanson et al. (2015) studies 135 industries in 90 countries between 1962 and 2007 and show that 60% of the products that account for the top 5% of a country's absolute-advantage industries in a given year, have not been in the top 5% two decades earlier. Hence, what determines the changes in the range of products that a firm exports and whether these changes have a pattern or show some path dependency are important issues to investigate.

Nevertheless the determinants of product churning within firms has been overlooked for a long time as the theory of international trade has mainly developed on the simplifying assumption of mono-product firms. Both the traditional theory of comparative advantage and the new trade theory, which introduces product differentiation (Krugman, 1979; Ethier, 1982) and firm efficiency heterogeneity (Melitz, 2003), rely on the monopolistic competition framework of Dixit-Stiglitz, where firms are intrinsically mono-product. The mono-product assumption underlays also seminal models in industry dynamics (Hopenhayn, 1992; Melitz, 2003) except a recent extension by Bernard et al. (2010). Bernard et al. (2010) provides a theoretical model, distinguishing firm entry and exit from product market entry and exit. Their model explains firms' product market entry decisions by means of evolving firm and firm-market specific factors, namely productivity and consumer tastes. While this simple setting of the model enables explaining key characteristics of observed phenomenon, it excludes two aspects: agglomeration economies and interdependencies among products in terms of demand and production capabilities.

A developing literature, however, considers product relatedness and its consequences on competitiveness not at the firm level but at more aggregate levels. Hausmann and Hidalgo (2011) have developed a theory of *product relatedness* explaining diversfication into new goods and creation of new growth paths at the country level. According to this theory, products are related to each other concerning common input factors, the level of technological sophistication, overlaps in product value chains, or requisite institutions, etc. Hence, diversification of countries into new goods does not follow a random pattern but proceeds step-by-step by jumping to related goods (Hidalgo et al., 2007). Boschma et al. (2012b) shift the focus from national scale to regional scale arguing that *"the mechanisms, through which capabilities are transferred between new and existing industries, operate mainly (although not exclusively) at the regional scale"*. Evidence at the regional level corroborates the findings at the national level and suggest that new

growth paths at the regional level also depend on region's current capabilities (Boschma et al., 2012b; Neffke et al., 2011). The microdynamics behind these macro results, however, remains yet to be explored.

While the arguments in these two strands of literature have not yet been brought together in a single theoretical framework, several attempts have been made empirically. Among these, Lo Turco and Maggioni (2014) study the effect of product relatedness on product innovation using Turkish manufacturing data. They examine the role of product relatedness along two axis: within the firm (internal) and within a locality referring to products produced in a spatial unit. They suggest that relatedness of both internal and local capabilities play a positive role on product innovations, while the former being more relevant. Breschi et al. (2003) investigate the effect of technology relatedness on diversification of innovative activities and confirm a positive relationship. Poncet and Starosta de Waldemar (2015) focuses on exports but instead of diversification they investigate the link between export performance of firms in a given product and relatedness of the product to the local product space. Based on data on Chinese manufacturing firms, they show that firms producing goods that are closely related to the goods, in which their locality is specialized, enjoy higher levels of export revenues in the following period. All in all, these studies provide initial evidence on that the congruence of capabilities of a firm with capabilities in its locality matters for firms. However, they extensively focus on product innovations (Lo Turco and Maggioni, 2014; Breschi et al., 2003), and the impact on changes in the range of products that are exported to foreign markets remains still to be addressed.

Our paper aims at filling this gap by focusing on the changes in the range of exported goods at the firm level and by trying to elucidate the role played by the locality via product relatedness in those changes. We first offer a theoretical framework, which is suitable to capture the essence of the relationship between the characteristics of local product spaces and the dynamics of firm product churning. This theoretical framework is built as an an extension of the industrial dynamics model proposed by Bernard et al. (2010) on multiple product firms and product switching. We extend this model to a multi-regional setting and introduce the local dimension via urbanization economies common to all firms in the locality, and demand and export externalities that firms enjoy depending on the degree that their products are related to the products exported by the locality.

On the empirical side, we base our investigations on a rich data set on French mono-regional manufacturing firms that export both in 2002 and 2007. We use the density measure proposed by Hidalgo et al. (2007) to quantify product relatedness and investigate two main questions. The first one refers to whether firms randomly add and drop new products to their export portfolio or whether these choices are impacted by the structure of the local product space. The second investigates given that a firms starts

exporting new products, whether each has an equal share in terms of revenue generation or the structure of the local product space affects growth in each product-market.

The contribution of this empirical work encompasses at least three aspects. First, at the firm level the study suggests empirical evidence on that the changes in the range of exported products are impacted by production and export capabilities in the locality. The findings underline the need for a comprehensive theory that would relax mono-product exporters assumption and allow for interdependencies among demand and production or export capabilities. Second, existing studies provide evidence on the impact of spillovers arising from co-location of exporters on decision to start exporting or intensive margins of trade (Greenaway and Kneller, 2008; Koenig, 2009; Koenig et al., 2010). By focusing on product relatedness, this study elaborates how spillovers ocur among co-located exporters. Third, the results provide preliminary evidence on the microdynamics of regional comparative advantage. Although firm entry and exit are not addressed in this study, the pattern of changes in the incumbents' product range still sheds light on how changes in regional comparative advantege occur.

Finally, the rest of the paper is organized in four sections. In the next section, the theoretical framework will be explained and econometric models will be specified. Afterwards, in Section 3 the empirical set up will be explained by providing details on data sources, sample selection, and variable definitions. Then, results will be presented and discussed. Lastly, conclusive comments will be provided.

2   The Theoretical Framework

We base our study on the model proposed by Bernard et al. (2010) on multiple product firms and product switching, which we call the BRS Framework onwards. In the sequel, first we will introduce the BRS framework. Then, we will show how this framework can be extended to address the role of local interdependencies in changes in the range of exported products at the firm level. The BRS model, envisaged through this spatial lense, is what allow us to derive the key testable propositions of our empirical analysis.

2.1   The BRS Framework

Bernard et al. (2010) extends existing theories in industrial dynamics by providing a model that explains how a firm chooses in which product markets it will operate. In former models, this question has been the same as firm entry and exit as these models assume a single-product firm. In the model developed by Bernard et al. (2010), firms choose to produce an endogenous range of products as a result of evolving firm and firm-product level characteristics.

The model assumes that firm entry entails a sunk entry cost. Once this cost is incurred, firms observe their initial productivity, which is specific to the firm and common to all of its products, and the consumer taste for each of their products. There is also a fixed production cost for each product. Productivity and consumer tastes are assumed to evolve stochastically over time, to be serially auto-correlated, but to be uncorrelated with each other. Finally, labor is assumed to be the only production factor and in inelastic supply.

Under these assumptions, Bernard et al. (2010) define *Zero-profit consumer taste cut-off* $(\lambda_k^*(\varphi))$, which shows the level of consumer taste, below which production of product k is not profitable for a firm with productivity φ.

$$\pi_k(\varphi, \lambda_k^*(\varphi)) = \frac{R_k(\rho P_k \varphi \lambda^*(\varphi))^{\sigma-1}}{\sigma} - f_{pk} = 0 \qquad (1)$$

where $\pi_k(\varphi, \lambda_k)$ is the equilibrium profits that a firm with productivity φ and consumer taste λ_k obtains from a variety of product k. R_k is the aggregate product k revenue, P_k is the price index for product k, σ is the elasticity of substitution across varieties within products. In this framework, σ equals $1/(1-\rho)$ where ρ is a parameter that takes values between 0 and 1 and enters in the representative consumer utility function [1].

According to Equation 1 firms with higher productivity (φ) face a lower zero-profit consumer taste cut-off $(\lambda_k^*(\varphi))$. Then, the probability that these firms have a consumer taste for their variety of product k higher than $\lambda_k^*(\varphi)$ is higher, meaning that it is more likely that producing product k is profitable for them. Productivity, increasing the probability of producing a product, implies that more productive firms have a larger product range.

Yet, this proposition of the model rests on the assumption that consumer tastes are independent within a firm, across its products. Bernard et al. (2010) recognize that products might have common features that are valued by customers in different product markets. In this regard, they highlight demand and production interdependencies across products within each firm as a direction to extend the model. However, as a matter of fact these interdependencies are not necessarily confined within firm boundaries.

2.2 The BRS Framework through a Spatial Lense

The model proposed by BRS captures the essence of product selection by firms but it is totally silent on the role of firm interactions and agglomeration economies. In order to investigate whether spatial factors affect how firms determine their product switching strategies, we extend the BRS framework to a multi-regional setting and we relax the simplifying assumption that

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[1] See (Bernard et al., 2010) and its attached online technical appendix for all details.

there is no spatial interdependencies across products and firms. However, we model those spatial interdependencies as the simplest ones necessary for useful data analysis while keeping as much as the simplifying features of the original BRS framework. Also, because we observe only the portfolio of *exported* products in our data (and not the full range of products produced by our firms), we focus on the type of spatial interdependencies across firms that are of primary importance for international sales.

In the extension to a multi-regional setting, we consider that the profitability of a(n) (exported) product for a given firm has not only a firm and a firm-product component as in the original BRS framework, but also a location and a product-location component. While introducing location to the analysis we make the simplifying assumtion that firm location is exogenous and fixed over time. Hence, we only study how a firm, once born, can optimize its product mix in a context, where its profitability in each product line is jointly determined by firm, firm-product, location and location-product specific random shocks [2]. Compared to BRS, our framework is then more complex because it entails that the firm choice is impacted by the spatial interdependencies across firms.

Formally, we assume that new firms are randomly given birth in a given location[3]. Then, we follow BRS by assuming that each of those randomly and locally born firms has to incur a (common to all locations) sunk entry cost of $f_e > 0$ units of labor in order to observe its intrinsic productivity $\varphi \in [\underline{\varphi}, \bar{\varphi}]$ and its intrinsic product qualities for the characteristics embodied in its blueprint for every product, $\lambda_k \in [\underline{\lambda}, \bar{\lambda}]$.

However, we depart from BRS by assuming that agglomeration economies prevail in our economy. Those agglomeration economies take two different forms: urbanization economies, which are available to all firms established in a given locality, and localization economies, which are available only to the firms which produce similar or related products in a given locality. The first type of agglomeration economies arises when all the firms in a given locality, whatever their products portfolio, can enjoy some competitive advantage. This advantage can be due to common (transportation) infrastructure, social

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[2]In reality, the location of a firm is the result of an optimization strategy in a context of uncertainty and random shocks (as for instance the location preference of the entrepreneur). Also, in reality, the firm can decide to relocate when its spatially dependant profit opportunities change. In this model, we abstract from this margin of adjustment and force firms to optimize their profit by changing their product mix, not their location or location mix. Obviously, one interesting extension of the present research would be to relax these restrictions.

[3]We would like to note that this assumption on spatial distribution of birth is not central to the phenomenon we study. Alternatively, we could assume that at birth firms optimize their location despite some random factors being in play. Nevertheless, as time passes locational factors will no longer be those that optimized the firm choice initially. Hence, the firm will face two options: either to change location or modify product-mix. In this work, we assume that in the short-to-medium run relocation is not possible and hence profits can be optimzed by only changing the product-mix.

interactions and institutions facilitating exports, or knoweldge externalities in general. In the BRS framework, we model this form of agglomeration economies as a shifter, which lowers the fixed cost of production/export of all products in a given locality. Specifically denotes f_{pkl} the fixed cost of production of product k in location l. We assume that f_{pkl} has two distinct components: a product-specific component as originally modeled by BRS, f_{pk}, and a location specific component f_{pl} that only depends on the location characteristics and not on the product ones. We then assume that f_{pl} is lower in a more urbanized locality.

The second type of agglomeration economies depend on the specificities of the product space of the locality. Basically, we assume that the benefices from knowledge externalities, cheaper intermediate goods, common export facilities, or social interactions can be stronger if the products exported from a given region are closely related to each other. This type of agglomeration economies arise from the co-location of a specific set of industries and are referred, in the literature, as Marshall-Arrow-Romer (MAR) and Jacobian externalities. More specifically, the MAR externalities comprise knowledge externalities fostered by specialization, labor market pooling and savings in transportation costs (Glaeser et al., 1992). On the other hand, Jacobs externalities emphasize complementarity of knowledge and cross-fertilization opportunities across a diverse spectrum of knowledge (Jacobs, 1969). Frenken et al. (2007) distinguish further that diversity might have two different forms, i.e. related and unrelated variety, and argue that related industries have correlated emand shocks and related variety fosters Jacobs externalities. Unlike urbanisation externalities, in both MAR and Jacobs externalities the benefits that a firm can experience depends on the degree of its similarity to the rest of the firms in its location.

For simplicity, we model this later form of agglomeration economies economies as arising only on the demand side and as concerning primarily exported products[4]. Specifically, a given firm can benefit from a high effective consumer taste for a given product sold on foreign markets thanks to complementarities that exists across local firms. For instance, firms can benefit from the fact that foreign consumers are already familiar with product k originated from location l and are more willing to buy a product k from this provenance. Also, we can assume that exporting firms can benefit from specific distribution channels that exist at the regional level for product k.

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[4]For sure, agglomerations economies can work through much richer and diverse channels impacting altogether the firm marginal costs (i.e. productivity) and the firm intrinsic product characteristics as a firm can benefit from very diverse knowledge externalities. By restricting the modelled interactions to the demand-side, and even more narrowly to export distribution facilities, we can easily rely on the original BRS framework by keeping the distributions of the individual ϕ's and λ's as exogenous while still considering social interactions across firms. A richer modelisation of those interactions would nonetheless require endogenous distributions.

We additionally assume that those demand complementarities are stronger for products that are exported with comparative advantage in a locality. Say it differently, local demand externalities primarily prevail across the "core exported products" in any given locality, where core products refer to the products exported with comparative advantage by the locality.

Therefore, in our framework, contrary to what happens in the BRS framework, the firm's intrinsic product characteristics are no longer the only determinant of the (foreign) consumer tastes for its variety of products. The characteristics of the local product space also matters because of the prevalence of demand complementarities in exporting activities. Based on these assumptions, the effective consumer taste for a given firm-product is no longer independent of the firm location. In other words, two firms which would draw a same intrinsic quality for their varieties of a given product k, could nonetheless face very different effective consumer tastes for those varieties depending on how product k is embedded in the local environment of the firm. At one extreme, a firm located in a region, where product k or products closely related to k, are already exported with comparative advantage by many other local firms would benefit from an effective consumer taste much higher than its intrinsic consumer taste. At the other extreme, a firm located in a location where product k or products closely related to k are not previously exported, would suffer from the fact that it cannot rely on existing exporting facilities and knowledge externalities and its effective consumer taste for this product could be lower.

Formally, the assumption that demand complementarities arise across firms producing closely related products in a given locality, can be introduced in the BRS framework by making the λ_ks being a combination of two components: a purely random component, whose distribution shares the same property that the one originally modelled by BRS, and a deterministic spatially dependant component, which depends on how product k is congruent with the product space in the locality of the firm (Ω_l).

All in all, taking into account both the generic urbanization economies and the MAR and Jacobian economies, which depend on the product-space of the locality, leads us to introduce two shifters to equation 2.

$$\pi_k(\varphi, l, \lambda_k^*(\varphi, \Omega_l)) = \frac{R_k(\rho P_k \varphi \lambda_k^*(\varphi, \Omega_l)))^{\sigma-1}}{\sigma} - (f_{pk} + f_{pl}) = 0 \qquad (2)$$

From Equation 2, we can derive a number of propositions, which concern both the spatial determinants of firm product churning strategies and the relationship between those microeconomic determinants and the dynamics of regional (local) competitiveness. Considering first, firm churning strategies, Equation 2 has direct implications on both the probability for a firm to switch products and on the direction of the portfolio changes. More precisely, it can be expected that all else equal, for a given idiosyncratic productivity,

a firm will be be able to produce a larger set of products in a more urbanized area because of the fixed production cost advantages it enjoyes there. Also, this firm is more likely to add new products that are more related to the core products of the locality because of the demand complementarities that prevail across neighborhood firms. Finally, all else equal, this firm is more likely to drop a product k if this product is less congruent with the local core products. From these implications, we derive our first testable proposition about the direction of firm product churning:

Testable proposition 1: For a given idiosyncratic productivity and a given location, firm i is more likely to add (drop) product k to (from) its export portfolio if product k is more (less) congruent with locality l's product space.

A second set of implications of our extended BRS framework concerns firm sale dynamics. Basically, as equilibrium profits for related products are higher in our framework, those products can be expected to be the new paths through which firms grow. From this implication, we derive a second testable proposition.

Testable proposition 2: Given its location and product-market entry decisions, among new product-markets that the firm starts to serve share of export revenues from product k will be larger the more congruent product k is with the local product space.

In the sequel, we test these propositions empirically using specifications that are going to be presented in the next section.

2.3   Econometric Specifications

To study the first proposition, we make use of two logit models specified in Equations 3 and 4 below. The former corresponds to the part of the proposition on product-market entry, which states that controlling for firm productivity and spatial disparities in urbanization externalities, a firm will be more likely to diversify into products that are more congruent with the product space in its locality. Hence, in Equation 3, the dependent variable y_{ik}^{1a} is a binary variable, which takes a value of 1 if firm i diversifies in product k at time t. β_0 is the constant term. α_m represents the effect of the initial product mix m of firm i (in the empirical analysis initial product mix refers to the product range in $t-5$[5]). The effect of initial product mix comprises existing resources, skills, knowledge bases, or institutions in the firm and captures average relatedness of these products to all potential products that the firm might diversify in. $Productivity_i$ stands for initial $(t-5)$ productivity of firm i and β_1 is the associated coefficient. As theoretically

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[5]Entering into a new product market may involve idea generation, product development, tests and trials, adjustment of production lines, paperwork to start exporting etc. Five year lag is assumed to allow for these pre-phases and it conforms with earlier studies (Boschma and Capone, 2014; Poncet and Starosta de Waldemar, 2015).

and empirically shown by Bernard et al. (2010), productivity is positively related to product scope; hence, β_1 is expected to take a positive value. $Relatedness_k^l$ denotes proximity of product k to products, in which firm i's locality (l) has a competitive advantage. β_2 is the coefficient associated with the relatedness variable. Existing empirical studies provide statistical evidence on a positive relationship between relatedness and new product introduction (Lo Turco and Maggioni, 2014), and export performance (Poncet and Starosta de Waldemar, 2015). Hence, β_2 is also expected to take a positive value. RCA_{lk} is a dummy variable to control for products that are already exported by the region with comparative advantage and β_3 is the related coefficient. β_3 is also expected to be positive as consumer tastes that a firm observes for a product that is already being exported by the locality with comparative advantage would be higher. Whereas, δ_l stands for locality fixed effects and captures urbanization economies that are common to all firms in locality l regardless of what they produce. Finally, ϵ_{ik} is the error term.

$$y_{ik}^{1a} = \beta_0 + \alpha_m + \beta_1 * Productivity_i + \beta_2 * Relatedness_k^l + \beta_3 * RCA_{lk} + \delta_l + \epsilon_{ik} \tag{3}$$

Equation 4 refers to the latter part of the first proposition, which states that everything else being equal firms will be more likely to drop products that are less congruent with the product space in their locality. Equation 4 differs from Equation 3 only in terms of the definition of the dependent variable. y_{ik}^{1b} is also a binary variable, but it takes a value of 1 if firm i drops product k at time t, where k belongs to its initial product mix m in $t - 5$.

$$y_{ik}^{1b} = \theta_0 + \alpha_m + \theta_1 * Productivity_i + \theta_2 * Relatedness_k^l + \theta_3 * RCA_{lk} + \delta_l + \epsilon_{ik} \tag{4}$$

We study the second proposition by means of Equation 5 below. The second proposition states that, once a firm diversifies it grows more in the product-market which is more congruent with the product space in its locality. Hence, in Equation 5 the dependent variable (y_{ik}^{2a}) is defined as the ratio of export revenues that firm i obtains from a new product k to its total export revenues from all new products. ψ_0 is the constant variable. α_m, $Relatedness_k^l$, and RCA_{lk} are defined same as above. ψ_1, which is the coefficient associated with $Relatedness_k^l$ is expected to take a positive value since firms are more likely to enjoy high consumer tastes for products that are related with the core products in the locality due to demand interdependencies. This would in turn cause equilibrium profits to be higher for such products, leading the firm to grow more in that product line as compared to other products that it introduced during the same period. In the same line of reasoning ψ_2, which is the coefficient associated with RCA_{lk}, is also expected to be positive. OTH_{ik} is a variable that is introduced to

control for other new products of the firm for two main reasons. First, there is a mechanical relationship between the number of new products and the value of y_{ik}^{2a} on the average: the higher the former, the lower will be the latter. Second, how much a firm can grow in a given product-market is not independent on which other product-markets it has also entered in and how much these products are coherent with the local product space. Therefore, ψ_3 is expected to have a negative sign, indicating that the relative growth in k^{th} product market will be lower if the firm enters in many product-markets that are highly related with the local product space. Finally, $Past_{ik}$ controls for the fact that, new products that we observe at the end of the (five-year) time-window, might have been introduced at any point in the time-window spanning $t-5$ to t. The earlier the firm enters in a product-market, the more time it will have to develop distribution channels and penetrate in the market. Hence, ψ_4 is expected to have a positive sign.

$$y_{ik}^2 = \psi_0 + \alpha_m + \psi_1 * Relatedness_k^l + \psi_2 * RCA_{lk} + \psi_3 * OTH_{ik} + \psi_4 * Past_{ik} + \epsilon_{ik} \tag{5}$$

3 Data Sources, Sample Selection and Variable Definitions

For the empirical analysis, we bring together information from three different sources and build an original data set comprising French manufacturing exporters that can be traced both in 2002 and 2007 and the products that they exported. One of the data sources that we rely on is the French Customs Statistical Office, which provided us with information on quantity and value of firm level exports at the product level by destination. The second source is the French National Institute of Statistics and Economic Analyses (INSEE). Via INSEE we accessed FICUS database, which brings balance sheet and financial information on individual enterprises. Finally, we made use of the BACI[6] database maintained by CEPII[7] research center. BACI (Gaulier and Zignago, 2010) provides information on values and quantities of bilateral world trade flows at the Harmonized System (HS) 6-digit product disaggregation for more than 240 countries and 5,039 products since 1994.

We use the first two data sources to determine the sample of firms, their characteristics (such as productivity, location, export revenues, etc.) and products. Whereas, we use CEPII database to quantify bilateral product proximity, which enables building the relatedness variable, and to identify core products of localities. In the sequel, sample selection and definition of variables are explained in greater detail.

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[6]BACI - Base pour l'Analyse du Commerce International.

[7]CEPII - Centre d'Etudes Prospectives et d'Informations Internationales. Accession date: 01/09/2015

3.1 Data Sources and Sample

To build the sample, first we use French Customs data to determine the set of exporters that we can trace both in 2002 and 2007 to study firm level churning in exported products. In 2002, more than 119 thousand French firms export and make a revenue of 3200 billion Euros. In 2007, the number of exporters decrease to approximately 108 thousand and export revenues worth 3900 billion Euros. Those firms that export both in 2002 and 2007 are almost 60 thousand, constituting roughly half of all exporters in 2002 (or in 2007). However, in terms of export revenues these persistent exporters constitute approximately 90% of export revenues in 2002 (or in 2007).

We, then, use FICUS to geo-localize these firms and to identify those, of which principal economic activity (APE code) is manufacturing. In terms of location, FICUS includes two types of information: the region, where the headquarters of the enterprise is located, and the extent that its employees are spatially concentrated. Regarding spatial concentration of employees, firms are classified into three: multi-regional enterprises (not more than 80% of their employees are in the same region), quasi mono-regional enterprises (80% to 100% of their employees are in the same region), mono-regional enterprises (100% of their employees are in the same region). For multi-regional and quasi mono-regional enterprises, FICUS enables us to geo-localize only the headquarters although they have multiple establishments in different regions. This means that for these firms it is not possible to geo-localize precisely which products are produced and exported by which production site, and thus from which region.

Table 1: Firms exporting both in 2002 and 2007: by primary economic activity and spatial dispersion

	All Firms	Manufacturing Firms	Monoregional Firms	Monoregional Manuf. Firms
Number of Exporters (count)	51 606	23 077	42 578	18 730
Number of Exporters (in %)	100,0	44,7	82,5	36,3
Export Revenues in 2007 (billion Euros)	314,7	243,4	119,4	73,4
Export Revenues in 2007 (in %)	100,0	77,3	37,9	23,3
Change in Export Revenues 2002-2007 (as % 2002)	18	12	43	27

As shown in Table 1, the number of all firms that we can trace both in 2002 and 2007 and characterize location and principal economic activity is about 52 thousand. Firms primarily engaged in manufacturing activities

make up 45% of these firms and generate 77% of the export revenues. On the contrary, firms that are established in a single region constitute 83% of these firms and make up 38% of the export revenues. From the table we observe also that most manufacturing firms are mono-regional. However, the export revenue generated by mono-regional manufacturing firms is smaller than that generated by multi-regional manufacturing firms.

In the econometric analysis we focus on mono-regional manufacturing firms. Over the course of five years, we observe from the table that aggregate export revenues generated by these firms increase by 27%. This aggregate growth, however, is created via different processes taking place within firms: revenue losses due to dropping some products from the export basket, increase or decrease in export revenues obtained from goods preserved in the export basket, generation of additional export revenues by adding new goods to the export basket.

Table 2: Brakedown of Mono-Regional Manufacturing Firms by Type of Change in the Export Basket from 2002 to 2007

	Count	Share (%)
Only Adding	1,684	12.37
Both Adding and Dropping	7,936	58.27
No Change	1,891	13.89
Only Dropping	2,108	15.48
TOTAL*	**13,619**	**100.00**

According to Table 2, from 2002 to 2007 only 14% of mono-regional manufacturing firms [8] maintain the range of products that they export as it is. More than half of the firms (58%) modify their export basket by adding at least one product and dropping at least one product. The econometric analysis presented in the next section tries to explain the determinants of these changes.

3.1.1 Quantifying Product Relatedness

Product relatedness, or proximity[9], might stem from a number of dimensions as they may require similar or complementary set of resources, skills,

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[8] The total number of mono-regional manufacturing firms reported in 2 is the size of the final sample we work with and it less than the number reported in 1. The difference stems from two facts. First, some firms become multi-regional or quasi-monoregional over the period and hence we exclude them from the analysis. Second, we drop firms for which we do not have reliable data on firm productivity and some other control variables.

[9] We use the term product proximity and relatedness interchangeably throughout the manuscript.

knowledge bases, or institutions. Quantifying each of these dimensions, assigning them weights, and building up a composite indicator of relatedness is not an easy task. Hidalgo et al. (2007) propose adopting an output-based approach instead to quantify relatedness. They argue that as a consequence of relatedness, countries having a competitive edge in one good could have or develop advantage in the other good. Hence, they measure similarity between two products by means of the conditional probability of having a revealed comparative advantage in one of these products given that the country has a comparative advantage in the other. So far, their measure has widely been used to investigate structural transformation and economic development in a number of countries [10].

As a matter of fact, co-occurrence of two products in a country's export basket might stem from not only overlaps in underlying production processes (like common production factors, input-output relations, common skills, common knowledge base, etc.) but also overlaps in institutions or social and business networks facilitating the export process. Therefore, the term relatedness here extends beyond a mere connotation of similarity in terms of sophistication of goods or product features but embraces the material and immaterial setting of the production and export process.

Country j is said to have a revealed comparative advantage (RCA) in product k at a given point in time if the share of product k in country j's export basket is larger than its share in the worldwide export basket. In other words, a country having a RCA in a good means that it is a *significant exporter* (Hidalgo and Hausmann, 2009) of that good. Following (Balassa, 1965), $RCA_{j,k}$ can be expressed formally as follows:

$$
RCA_{jk} = \begin{cases} 1 & if \frac{a_{jk}}{\sum_k a_{jk}} / \frac{\sum_j a_{jk}}{\sum_j \sum_k a_{jk}} > R^* \\ 0 & otherwise \end{cases} \tag{6}
$$

where a_{jk} is the value of product k exported by country j, and generally $R^* = 1$. The conditional probability $P(k \mid m)$ that a country has RCA in product k given that it has RCA in product m is given by the ratio of the number of countries with RCA in both products over the number of countries with RCA in only product m. Then, Hidalgo et al. (2007) define relatedness between two products k and m (ϕ_{km}) as follows:

$$
\phi_{km} = min\{P(k \mid m), P(m \mid k)\} \tag{7}
$$

They explain that taking the minimum of these conditional probabilities helps to symmetrize the proximity matrix and avoids that the conditional

probability gets a value of one if a country is the sole exporter of a good.

To estimate the relatedness between each pair of products, we calculate ϕ by making use of BACI database provided by CEPII. BACI harmonizes importer and exporter information and it is available with versions 1992, 1996, 2002 and 2007 of the HS classification and it is updated every year. In this study we work with version 1992 of the HS product classification. To compute $\phi_{k,m}$ we only keep manufacturing products at HS 4-digit and 217 countries[11] in 2002. Table 3 reports bilateral proximities between selected HS-4 digit products[12]

Table 3: Bilateral Product Proximities For Selected HS-4 Digit Products

Product Name*	HS-4 Code	Rice	T-Shirt	TV	Computer	Cars
Oil	2709	0.13	0.11	0.03	0.08	0.03
Rice	1006		0.22	0.04	0.04	0.04
T-shirt	6109			0.12	0.05	0.03
TV	8528				0.39	0.27
Computer	8471					0.23

*Full names of each HS-4 category are as follows: 2709 - crude oil from petroleum and bituminous minerals; 1006 - rice; 6109 - t-shirts, singlets, tank tops etc, knit or crochet; 8528 - television receivers (incl monitors & proj receivers); 8471 - automatic data process machines, magn reader, etc. computer hardwares; 8703 - motor cars & vehicles for transporting persons.

Then we define $Relatedness_k^l$ as the density measure, which is proposed by Hidalgo et al. (2007) and used in a number of empirical studies (Poncet and Starosta de Waldemar, 2015; Boschma et al., 2012b). The density measure focuses on the products that the locality exports with comparative advantage. If a product is proximate to these core products, it is said to be densely connected to the local product structure (Poncet and Starosta de Waldemar, 2015).

Let $Relatedness_k^l$ denote the density of product k in its locality l at a given point in time. Let N be the number of all products, and RCA_{ln} be a binary variable indicating whether locality l has revealed comparative advantage in product n, as defined in Equation 6. Then $Relatedness_k^l$ could be defined formally as follows:

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[11]We drop territories like East Europe, Neutral Zone, Rest of America, Free Zones or Special Categories, etc. because we only focus on individual exporters.

[12]For comparability, we used the same set of products as Poncet and Starosta de Waldemar (2015); while they report bilateral proximities at HS-6 digit, we report bilateral proximities at the HS-4 digit.

$$Relatedness_k^l = \frac{\sum\limits_{n=1,n\neq k}^{N} RCA_{ln}\, \phi_{kn}}{\sum\limits_{n=1,n\neq k}^{N} \phi_{kn}} \qquad (8)$$

In this analysis, we define a locality at the NUTS[13] - 2 l, i.e; regions. As shown in Table 4, relatedness of a given product might take different values in different regions as each region has a different set of core products. For instance, from the Table we observe that the congruence of capabilities that are necessary to produce and export computers with core local capabilities is the highest in Rhone Alpes and the lowest in Corse.

Table 4: Summary Statistics for Relatedness of Selected HS-4 Digit Products

Product Name*	HS-4 Code	Mean	Min	Max
Oil	2709	0.153	0.038 (Corse)	0.261 (Prov. Alpes Cote d'Azur)
Rice	1006	0.179	0.047 (Corse)	0.278 (Prov. Alpes Cote d'Azur)
T-shirt	6109	0.177	0.057 (Corse)	0.300 (Ile-de-France)
TV	8528	0.169	0.037 (Corse)	0.303 (Rhone Alpes)
Computer	8471	0.160	0.036 (Corse)	0.300 (Rhone Alpes)
Cars	8703	0.160	0.046 (Corse)	0.340 (Rhone Alpes)

3.1.2 Other Variables

The dependent variable (y_{ik}^{1a}) is defined as a binary variable, which gets a value of 1 if product k is not exported by firm i at the beginning of the time window we observe (i.e; 2002) but being exported at the end of the time window (i.e; 2007), and 0 otherwise. In contrast, y_{ik}^{1b} is a binary variable, which gets a value of 1 if product k is exported by firm i at the beginning of the time window we observe (i.e; 2002) but not exported at the end of the time window (i.e;2007), and 0 otherwise. Whereas, y_{ik}^{2} is defined as a continuous variable expressed as the ratio of export revenues that firm i obtains from product k in 2007 over total export revenues that firm i obtains from all new products. α_m is a dummy variable indicating firms, whose product mix in 2002 is the same. We define initial product mix at HS-2 level although in our product level estimations a product signifies an HS-4 class. The reason behind this is that the finer the product definition the higher the number of unique product mixes. Since α_m enters into the estimation as a factor variable, all unique product mixes are dropped from the sample. Productivity ($Productivity_i$) is defined as the labor productivity and calculated by dividing the value added (before taxes) by average effective

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[13]Nomenclature of Territorial Units for Statistics.

number of employees in 2002 and expressed in logarithms. Both value added and labor are harmonized using deflators at the third level of the summary economic classification (INSEE 1994-2007)[14]. Table 5 presents summary statistics for firm productivity and some other control variables.

Table 5: Summary Statistics for Firm Level Variables

	Obs	Mean	Std. Dev.
Productivity	13619	0.037	0.032
Size (Assets)*	13619	7398.0	30252.3
Age	13619	20.4	12.4
Group	13619	0.471	0.499

* In thousand Euros

Other control variables that we introduced are firm size, firm age, appartenence to a group. Firm size ($Size_i$) is proxied by the value of total assets of firm i in 2002 and expressed in logarithms. Age_i refers to the logarithm of the age of firm i in 2002. $Group_i$ is a dummy variable, which takes a value of 1 if firm i is affiliated to a foreign or French corporate group as of 2002.

4 Estimation Results

Table 6 presents estimation results for Equation 3. Column (a) gives the estimation of the original equation, whereas columns (b) and (c) displays the results for specifications that are extensions of the baseline specification with control variables on other firm characteristics. While all specifications corroborate the expectations and yield statistically significant and positive coefficients for both productivity and relatedness variables, Tukey's link test and Hosmer-Lemeshow test indicate that as we move from column (a) to (c) omitted variables bias and the prediction power of the model are improved, respectively.

Hence, referring to the coefficient estimates provided in column (c) one can conclude that for a given product market, firms that enter into that product market are those having a higher productivity. The theoretical model presented in Section 2 explains the mechanics of this result by the fact that higher firm productivity levels decrease the zero-profit consumer taste cut-off and make the likelihood of the firm to enter into a given product-market higher. Beside productivity, firm size is found to be affecting firms'

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[14]Nomenclature Economique de Synthèse (NES) with 114 positions.

Table 6: Parameter Estimates for the Binary Choice Model of Product-Market Entry Decisions

	(a)	(b)	(c)
$Productivity_i$	0.051***	-0.089***	0.286***
	(0.019)	(0.020)	(0.088)
$Size_i$		0.239***	0.079**
		(0.009)	(0.038)
$Productivity_i * Size_i$			-0.048***
			0.011
Age_i		-0.065***	-0.067***
		(0.015)	(0.015)
$Group_i$		0.079***	0.079***
		(0.022)	(0.022)
$Relatedness_k^l$	4.960***	4.991***	4.991***
	(0.112)	(0.112)	(0.112)
RCA_k^l	0.908***	0.908***	0.908***
	(0.019)	(0.019)	(0.019)
Constant	0.133	-1.981***	-0.709**
	(0.180)	(0.197)	(0.350)
Observations	9,601,281	9,601,281	9,601,281
Region Dummies	Yes	Yes	Yes
Product-mix Dummies	Yes	Yes	Yes
Tukey's Link Test (hatsq)	-0.019	-0.012	-0.010
p-value	0.019	0.107	0.144
Hosmer-Lemeshow $\chi^2(8)$	16.31	11.86	6.95
Prob ¿ χ^2	0.038	0.158	0.542

Standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

product-market entry decisions positively. Firm size can act as an independent determinant of the firm's ability to introduce new goods to its export basket, when capital market or labor market imperfections prevail and export diversification require specific external financial support (Secchi et al., 2014) or specific labor requirement. The interaction effect is found to be negative and statistically significant, meaning that the positive effect of productivity on the probability to enter into a new product-market is dampened by size. Hence, the model implies there are limits to diversification; i.e: for very large firms higher productivity does not imply further incentives for diversification. This is possibly due to coordination problems as otherwise the process would end up with giant firms exporting all types of products. Unlike productivity and size, firm age is found to be negatively related with the probability to add product k to export range, everything else being equal. One reason for this negative relationship could be that young firms, embodying more recent technologies and younger labor force, might be less locked in their existing capabilities and be more dynamic in crossfer-

tilizing complementary capabilities to serve new consumer tastes. Finally, being affiliated to a group is found to be a factor affecting the probability to enter into a new product-market positively. This binary variable could be considered as a very rough assessment of the impact of organizational ties, which may function as a conveyor of knowledge (within or across regions) and decrease fixed production cost, or impact consumer taste.

Coming to the coefficient estimates for key variables of interest, namely to $Relatedness_k^l$, results imply that firms tend to enter into product-markets that have more common and complementary capabilities with products, in which their locality has a revealed comparative advantage. This result complies with earlier findings by Lo Turco and Maggioni (2014), who conclude that new product introduction depends on availability of product specific competencies in the locality for Turkish manufacturing firms. The positive and statistically significant coefficient estimate for RCA_k^l reveals further that the probability that a firm diversifies into products that are already one of the core goods of the locality is even higher. The coefficient estimates for $Relatedness_k^l$ and RCA_k^l together suggest that among core goods of a locality the one that is the most linked to other core goods is the most likely to be added to the product range.

While Table 6 helps understanding product-market entry decisions, Table 7 presents results on determinants of product-market exit decisions as formulated in Equation 4. As in the previous table column (a) gives the estimation of the original equation, whereas column (b) displays the results for the extended specification. The table reveals that product-market exit decisions are also shaped by productivity and product relatedness as in the case of product-market entry decisions. More precisely, it tells that less productive firms tend to drop products and the choice on product to be dropped is affected by the extent of local externalities. Products that require very different capabilities than what is already available and abundant in the locality are more likely to be dropped.

The next set of results bases on Equation 5 and shifts the focus from churning decisions to intensive margins for a given product range. Hence, it complements the first part by investigating whether related diversification is sustained by related growth, which is also a conclusion that can be derived from the theoretical framework as it predicts higher operating profits for related products. The answer to this question is also essential to understand the consequences of these firm-level choices at the aggregate level on local comparative advantage.

In Table 8 column (a) presents results for the baseline specification; whereas, column (b) replicates the estimation for products maintained from 2002 to 2007. In column (a), positive and statistically significant coefficient estimates for $Relatedness_k^l$ and RCA_k^l confirm the proposition on related growth. Among new product-markets, the growth path is the product which is densely linked to the core products of the locality. The growth

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Table 7: Parameter Estimates for the Binary Choice Model of Product-Market Exit Decisions

	(a)	(b)
$Productivity_i$	-0.125***	-0.0901**
	(0.0352)	(0.0364)
$Size_i$		-0.0587***
		(0.0165)
Age_i		-0.0258
		(0.0267)
$Relatedness_k^l$	-1.014***	-1.015***
	(0.220)	(0.220)
RCA_k^l	-0.499***	-0.493***
	(0.0348)	(0.0348)
$Group_i$		-0.0217
		(0.0391)
Constant	-0.898***	-0.257
	(0.331)	(0.361)
Observations	18,931	18,931
Region Dummies	Yes	Yes
Product-mix Dummies	Yes	Yes
Tukey's Link Test (hatsq)	0.002	0.009
p-value	0.93	0.724
Hosmer-Lemeshow $\chi^2(8)$	1.37	4.97
Prob ¿ χ^2	0.9947	0.761

Standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

is fostered if the product is already one of the core products of the locality. Inter-firm differences in growth in a new product-market (relative to other new product-markets of the firm) do not only stem from differences in coherence of that product with the local product space. It also depends on how many other new product-markets that the firm has started to serve and how these products are also related to the local product space. The more product-markets that are highly related to the local product space, the smaller the growth a given product-market everthing else being equal. Finally, the positive and statistically significant coefficient estimate $Past_{ik}$ tells us that among new-product markets the ones that have a larger share in export revenues are those that are introduced earlier.

In the table, column (b) provides similar results for products that are exported both in 2002 and 2007. This estimation bases on the assumption that as of 2007, sufficient time has passed since entry, hence differences in share of export revenues resulting from differences in product-market entry have vanished. The prediction of the theoretical framework that a firm will enjoy higher operating profits for related products, is also confirmed foe

products that have long been in the range.

The findings in Table 8 could be interpreted as an elaboration of the conclusion of Koenig et al. (2010). Koenig et al. (2010) suggest for French exporters that co-location impacts export performance positively. This analysis opens-up the notion of "'co-location"' and tells us that interdependencies among products (common and complemantary capabilities) in a given location fosters external economies and causes export revenues to increase in certain directions.

Table 8: Parameter Estimates for the Model Explaining Intensive Margin

	(a)	(b)
$Relatedness_k^l$	0.596***	0.607***
	(0.0429)	(0.0484)
RCA_k^l	0.0167***	0.0437***
	(0.00611)	(0.00710)
OTH_{ik}	-0.138***	-0.527***
	(0.00328)	(0.0129)
$Past_{ik}$	0.0282***	
	(0.00195)	
Constant	0.241***	0.546***
	(0.0256)	(0.0379)
Observations	13,049	10,289
R-squared	0.315	0.426
Product-mix Dummies	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Tables 6, 7, and 8 as a whole provide us with two explanations on the behaviour of mono-regional French exporters, whose primary activity area is manufacturing, during 2002-2007. First, firms adjust their product range such that it becomes more coherent with core capabilities of the region. During this process, the preference for products can be ordered as follows: 1) core products that share many common capabilities with other core products, 2) non-core products that are highly related to the core capabilities, 3) core-products that share (almost) no common capabilities with other core products. Hence, more firms start serving product markets that either constitute the current comparative advantage of the region or that are closely related to the current comparative advantage. Second, following diversification firms grow more in core or related product-markets. Hence, at the aggregate (regional) level these two facts would lead to path dependency in changes in the aggregate comparative advantage.

As a matter of fact, in this study we examine a single time-window and leave export starters or firms stopping exporting beyond the scope. Hence, our findings do not provide sufficient evidence and a full-fledged explanation on the evolution of the aggregate comparative advantage. Nevertheless, it

worths mentioning that the implications of our results are in the same line with findings of earlier studies explaining national and regional growth paths Hausmann and Hidalgo (2011); Boschma et al. (2012a); Neffke et al. (2011). These studies suggest that new growth paths at the national or regional level depend on current capabilities; hence next products that a nation or a region will become competent on are those related to current products in which revealed comparative advantage lies upon. Our analysis, being at the firm level, makes a preliminary step to open up the micro-dynamics of this process.

5 Conclusion

In this study we explore the determinants of changes in the range of exports at the firm level with a particular interest in the role played by the locality via product relatedness. To this aim, we introduce a multi-regional setting to the theoretical framework proposed by Bernard et al. (2010), which explains multiple product firms and product switching. We test the propositions of the extended framework using French micro-data that covers information on mono-regional firms operating primarily in manufacturing industry over the period 2002-2007.

For the cross-section of French exporters we study, our findings confirm that the local product space matters in the decisions firms make. Specifically, firms tend to modify their exported product mix such that their production and export capabilities get more aligned with capabilities that lie beneath core capabilities of the region. Hence, the changes in the firms product range do not occur randomly but in a direction associated with the core capabilities of the locality. The results also suggest that once firms alter their range of exports, among all new product export lines they enter in, they enjoy greater export revenues in those which are more related to the core capabilities of the locality.

Though these basic findings provide first key evidence that local product space matters for firm export decisions, we see avenues through which our current analysis could be extended. First, a main take-away from our empirical work is that developing a comprehensive trade theory, which not only relaxes the mono-product assumption but also allows for interdependencies among products and firms through local interactions, is still at stake. On that respect, one extension of our current theoretical framework could be to model in a riche way the demand and supply side complementarities that can rationalize the linkages between a firm product mix and its local environment. In our current framework, local interactions only act through the fixed cost of production and related export facilities. However, we could think of a richer set-up in which the distributions of the individual ϕ's and λ's are partly endogeneized.

Also, on the empirical side, several caveats remain. First, we acknowledge the necessity of a panel analysis to generalize the conclusions of our analysis. However, there are several challenges to be faced to extend this analysis to a panel setting. One challenge is the change over time in the local product space, in which the density of a given product is calculated. Another challenge is the change in bilateral product proximities over time, which would affect calculation of the density of a given product in a given product space. This implies that in time the congruence between firm's capabilities with its locality would change even if the firms product range remains unchanged. Second, our analysis as been confined at the regional level. Nevertheless, the mechanisms transferring complementary or common capabilities can operate in finer geographical levels. On the other hand, certain capabilities (infrastructures, institutions) might exist only at higher spatial scales. Hence, what roles are played by the locality at different spatial scales is yet another issue to be explored. Last but not the least, in this analysis we suggest empirical evidence on the behaviour of persistent exporters, i.e; firms we can track over time. While explanations on how they change their range of exports is necessary to understand micro-dynamics of regional or national competitivity; it is not sufficient. What determines the product-market choices of export starters or firms in which product-markets stop exporting remains as further questions to be investigated.

Acknowledgements

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