Product relatedness and firm exports in China

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Abstract

We investigate how the export performance of firms in China is influenced by how their products relate to the local comparative advantages. Using firm level data from Chinese customs for 2000-2006, we construct an indicator that captures the density of links a product has with the local product space. It hence combines information on the intrinsic relatedness of a good with information on the local pattern of specialization. Our results show that export growth is higher for products that are characterized by denser connections with the local productive structure. This finding suggests that the density of links between products gives rise to export-enhancing spillovers and plays a significant role in explaining China's stellar export performance. We however find that the positive effect of product relatedness on firms' export performance is mainly limited to ordinary trade activities and to domestic firms. More, it is stronger for most productive firms.

Keywords: product space, density, spillovers, export performance, China
JEL codes: F10, F18, Q53, Q56.

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1 Introduction

One of the most impressive dimensions of China's stellar export performance is the rapid diversification of its exports. Since the 1980s, "made in China" products have pervaded all sectors of world trade, including those that are usually considered as belonging to the area of specialization of more developed countries such as high-tech electronics and computers (Rodrik, 2006, Schott, 2008). China's rapid export upgrading is especially puzzling as production of goods requires capabilities and products that vary greatly in their knowledge requirements (Hausmann and Hidalgo, 2011). Since countries can only diversify by building on what they already have, China's rapid export diversification suggests a very efficient capacity to capitalize on its existing productive knowledge and to exploit the links between products. Recent studies focusing on the Product Space suggest that initial product specialization is key in this respect (Hidalgo et al., 2007). As developed by Hausmann and Klinger (2007a) and Hidalgo et al. (2007), the Product Space is a network that formalizes the idea of relatedness between products traded in the global economy. The main contention from this work is that all products do not have the same degree of relatedness (and hence the same position in the product space) and as a result have different potential, notably as a platform for jumping on to new economic activities. The relationship between production structure and economic performance has been confirmed by several macro-level studies. Countries specialized in products with dense connections with other goods are found to grow faster (Kali et al., 2010; Hidalgo et al., 2007). This finding suggests that density of links between products gives rise to spillovers such as knowledge externalities and economies of scale and scope.

The analysis in this paper is a micro-level study. We exploit firm level data in China to investigate whether the product space also matters at the level of individual exporters. To our knowledge it is the first study analyzing the micro-level impact of product spillovers on economic performance. Similarly to the effect it has at the level of countries, we expect the density of links between products to facilitate the firm-level upgrading as producers move through the product space by developing goods close to those they currently produce. We

focus on export growth as an indicator of economic performance and ask whether, for a given firm, export growth is faster for products characterized by a high density of links with the local productive structure.

Our analysis thus connects the macro literature on the link between productive structure and development to the micro literature on firm-level economic performance. Our study indeed follows on recent efforts to understand what drives firms' product mix (Bernard et al., 2010). Our approach is coherent with models of endogenous within-firm (between products) activity reallocation. Our contribution is to focus on the role of product spillovers in the dynamics of product-level exports. Doing so, we confirm Bernard et al. (2010) findings that within-firm allocation of export activity between products responds not only to firm-level and product-level determinants but also to factors that combine both the firm and the product dimension.

Our study also adds to the literature analyzing the existence and the nature of export spillovers. Since the pioneer article of Aitken et al. (1997), this literature focused mostly on local spillovers among exporters (Greenaway et al., 2004). The only exception we are aware of is Koenig et al. (2010). While focusing on the effect of exporters' agglomeration in the same area on the export behavior of a given firm in France, their regressions account for the number of other products exported by the firm. They find a positive and significant effect of this firm-level indicator (invariant across products of the firm in a given year) which they interpreted as evidence of scope economies across products within the firms' export portfolio. Our analysis goes further as our key indicator varies between products for a given exporter. Moreover it captures how the intrinsic product-level spillover intensity intersects with the local pattern of product specialization, hence varying across firms depending on their location. We will use sub-national trade data differentiating between processing trade and ordinary (i.e. non-processing) trade, as well as between exports by domestic and foreign-owned firms[1] to investigate whether the role of product-relatedness depends on the firm

[1]Here and in the rest of the article, we define "foreign firms" as those with some foreign capital ownership: i.e. wholly foreign-owned firms as well as joint ventures (this latter including equity and non-equity joint ventures, and joint cooperatives).

ownership or trade type.

The main contribution that the paper brings is in fact towards the literature on the link between the productive structure and economic performance (Hausmann et al., 2011). This literature shows how the products a country makes today determine which products they will be able and likely to make tomorrow. The logic behind this pattern is that products are indicative of the capabilities that the country has and will be able to develop[2]. We follow Hausmann and Klinger (2007a) and Hidalgo et al. (2007) in holding the likelihood that a product is co-exported with other products by many countries (called "proximity") as a proxy for the likelihood this product allows rapid diversification. Most of studies in this literature have aggregated information of the product space of relatedness among products to develop country-level indicators of economic complexity and assess their predictive power in terms of economic growth. Globally, they contend that the more complex a country is (as indicated by numerous products with dense connections to other products) the richer it is and the richer it should become (Hidalgo and Hausmann, 2009; Hausmann and Klinger, 2007a; Kali et al., 2010). Our analysis differs from these macro-level studies in two aspects. First, we conduct a micro analysis based on firm-level data in China. This allows identifying a mechanism through which productive structure can fuel higher growth as observed in previously cited studies. Second, we focus on export performance. As a consequence, our results will shed light on China's rapid upgrading and diversification. Third, our variable of interest measures agglomeration externalities at a very detailed (HS6) product level covering more than 5000 products. It combines the intrinsic relatedness of a good with the rest of the product space with information on the local pattern of specialization. Concretely, we use firm level export data from Chinese customs for 2000-2006 to assess whether firm level exports grow faster for goods that have denser links with those currently produced locally. We expect products that are closer to the products constituting the local export basket to benefit from larger economies of scale and scope and knowledge spillovers. They should hence be produced at

[2]The famous analogy is that a product is equivalent to a Lego model made of Lego pieces that are equivalent to capabilities (technology, capital, resources...), and a country is equivalent to a bucket of Legos. Based on the observation of products made by countries, one can infer the capabilities they have and the likelihood they will be able to develop new products in the future.

lower costs and hence be characterized by a faster export growth as firms reallocate their activity towards them. Our estimations are made controlling for unobservable characteristics of firms and of products and accounting for agglomeration effects (i.e. spillovers between nearby exporters) as well as local revealed comparative advantage. Finally, we explore the existence of potential heterogeneous impact of the product-level connections with the local productive structure depending on the ownership type of the exporting firm, the trade type (processing or ordinary) and the productivity level of the firm.

Our results are coherent with this prediction. We confirm that product spillovers play a significant role in the export performance of firms in China. We show that within a firm's export basket, export growth is systematically higher for products that are characterized by greater relatedness with the local productive structure. The results are robust to a variety of robustness checks. Our estimates display a pattern which is not confined to the most trade-oriented locations or to the most export performing firms. We find that the positive effect of product relatedness on firms' export performance is mainly limited to ordinary trade activities and to domestic firms. More, it is stronger for most productive firms. From a policy point of view, our results thus suggest to show that devices aimed at promoting exports should be concentrated on products that correspond to the local core competencies.

The rest of the paper is structured as follows. The next section presents the data and the variables construction. Section 3 presents our empirical specification and discusses our results. Section 4 concludes.

2 Indicators and Data

The goal of the paper is to test whether Chinese firms systematically display higher export performance for products characterized by higher relatedness with the local productive structure. Our estimations hence regress firm-level exports between 2000 and 2006 in China compiled by the Chinese Customs Trade Statistics (CCTS)[3] on an indicator called density

[3]It records all merchandise transactions passing through Chinese customs each year. It contains information on firm basic information (name, address, ownership, etc.), product code (8-digit), and destination

that measures for each product-locality pair the density of links with the local productive structure. It hence combines information on the intrinsic relatedness of a good with the rest of the local productive structure with information on the local pattern of specialization.

2.1 Measuring bilateral product relatedness

We compute the relatedness of each product with the other goods available in the world (Product Space) following Hidalgo et al. (2007). Product-level relatedness is based on the sum of its pairwise proximities with the rest of the Product Space. The fact that a product is co-exported with other products by many countries (called "proximity") is held as an outcome-based measure of relatedness. This builds on the idea that co-export reflects similar requirements in terms of institutions, infrastructure, resources, technology, or some combination thereof.. Bilateral proximities (for each pair of products i and j) is the minimum[4] of the pair-wise conditional probabilities of countries exporting a good given that they exports another.

$$\phi_{i,j} = min[Pr(i|j), Pr(j|i)] \tag{1}$$

with $Pr(i|j)$ being the average conditional that good i is exported when good j is exported and $Pr(j|i)$ the average conditional that good j is exported when good i is exported. These probabilities are computed as the average of bilateral co-exporting probabilities in the world. In order to exclude marginal exports, a country is said to export a product, when it exhibits a Revealed Comparative Advantage (RCA)[5] in it. Hence,

$$\Pr(i|j) = \sum^{c} \frac{RCA^c(i|j)}{RCA^c(i)} \ , \ \Pr(j|i) = \sum^{c} \frac{RCA^c(j|i)}{RCA^c(j)} \tag{2}$$

country. We collapse the data to 6-digit products for consistency with the international trade data from BACI.

[4]Considering the minimum of both conditional probabilities eliminates the problem that arises when a country is the sole exporter of a particular good: the conditional probability of exporting any other good given that one would be equal to one for all other goods exported by that country.

[5]Country c is said to have revealed comparative advantage in product i if $RCA^c(i)=\frac{exports^c(i)/\sum_i exports^c(i)}{\sum_c exports^c(i)/\sum_c \sum_i exports^c(i)}$ is larger than 1, with $export^c(i)$ denoting country c's export value of product i.

with $RCA^c(i)$ and $RCA^c(j)$ being a dummy equal to 1 when country c exports good i and j respectively with a comparative advantage and $X^c(j|i)$ being a dummy equal to 1 when country c exports both i and j with a comparative advantage.

Hence $\Pr(i|j)$ is the ratio of the number of countries that have a RCA in both i and j over the number of countries that have a RCA in i (j).

We compute the bilateral relatedness $\phi_{i,j}$ between products i and j for 5016 products, using data for 239 countries in 2000 from the BACI[6] world trade dataset. This dataset, constructed using COMTRADE original data, provides bilateral trade flows[7] at the 6-digit product level (Gaulier and Zignago, 2010). The matrix of these proximities characterizes the world product space[8].

2.2 Product density in China

Our main variable of interest in that of density that measures for each locality-product pair the density of links with the local productive structure. As in Hidalgo et al. (2007) and Kali et al. (2010), density for a given good i and locality l (Density_i^l) is based on the average of good i's bilateral proximities with the other goods that the locality l exports (with a comparative advantage):

$$Density_i^l = \frac{\sum_{j \in RCA=1, j \neq i} \phi_{i,j}}{\sum_{j \neq i} \phi_{i,j}} \tag{3}$$

The numerator is the sum of good i's proximities to products j in which the locality l has comparative advantage while the denominator is the sum of proximities to all other products that exist in the world product space. As a robustness check, we verify that results hold

[6]The BACI dataset is downloadable from http://www.cepii.fr/anglaisgraph/bdd/ baci.htm

[7]The flow dataset is constructed using an original procedure that reconciles the declarations of exporters and importers. The harmonization procedure enables to extend considerably the number of countries for which trade data are available, as compared to the original dataset.

[8]The product space framework has been used in different papers that study the implications of product space to economic development and industrial policy in developing countries (Chile (Hausmann and Klinger, 2007b), South Africa (Hausmann and Klinger, 2008), Ecuador (Hausmann and Klinger, 2010), Algeria (Hausmann et al., 2010) and the Kyrgiz Republic (Usui and Abdon, 2010)). But these series of articles are at the macroeconomic level and do not account for more disaggregated effects.

when using the China product space, that is when the RCA in the above equation based on Chinese exports as a reference when measuring the RCA denominator.

High density indicates that the product i is densely connected to the locality l's product space. It indicates that locality l has comparative advantage in numerous goods that are closely related to that product. As in Kali et al. (2010)[9] and Hidalgo et al. (2007) we hold density as a proxy of existing product spillovers and expect that it is associated with higher export growth for firms in this locality. We construct the density index at the level of Chinese prefectures[10] using the Chinese Customs Trade Statistics (CCTS) collapsed to prefectures.

3 Empirical estimations

3.1 Empirical specification

Our estimations focus on the impact of product-level density of links with the local product space on export performance of Chinese firms. We investigate whether firm-level export growth is faster for products characterized by a high density of links with the local productive structure. Our explained variable is the log of the value of exports of product k from firm f in locality l in 2006. It is regressed on its value in 2000, the initial year of our sample and the density indicator computed for the locality l and product k for that same year. Our specification is:

$$X^f_{k,2006} = \gamma X^f_{k,2000} + \beta Density^l_k + \alpha Z^l_k + \delta_f + \eta_k + \epsilon^f_k \tag{4}$$

We consider in line with Bernard et al. (2010), that there are three broad categories of determinants of product-level export performance of firms: factors that are product specific but common to all firms, factors that are specific to firms but common to products, and

[9]Our density measure has however both the location and product dimension. In Kali et al. (2010) by contrast the key indicator is a weighted average of density across products measured at the location level.

[10]As a robustness test, we check that our results remain when considering density at the province level which is the administrative unit above the prefecture.

factors that are idiosyncratic to firm-product pairings. The first category corresponds to factors that are specific to products such as changes in relative demand (i.e. evolving tastes) or relative supply (i.e. technological changes). The second category includes factors that are specific to firms such as their size, productivity, diversity of their export basket or charisma of their founder. We account for these firm- and product- characteristics through fixed effects (δ_f and η_p respectively). Since firms do not change locations, the firm-fixed effects indirectly account for location-specific features such as endowments, governance, income or export performance.

The third category of explanations into which our indicator of density falls includes firm-product characteristics. The coefficient β on this indicator is expected to capture the influence that product-level linkages with the local productive structure have on firm-level performance. Note that firm-specific or product-specific fixed effects already capture the scope economies that are common to all firms for a given product or to all products for a given firm. Hence, what our estimations focus on is the effect of the density of linkages between a product and the local specialization (that is a product-locality specific feature). Moulton (1990) showed that regressing individual variables on aggregate variables could induce a downward bias in the estimation of standard-errors. All regressions are thus clustered at the level of aggregation of the density indicator (location and product).

Our conditioning set Z is made of two categories of variables. First, following the spillovers literature, we control for the agglomeration in the same locality of exporters of the same product. Koenig et al. (2010) emphasize a positive effect of product and destination specific-exporters' agglomeration on the export behavior of individual exporters in the case of France. We include the number of exporters in the locality exporting the same product to account for these market and non-market interactions between exporting firms. Second, we control for supply side determinants by introducing proxies for local export intensity and comparative advantages. Although the firm fixed effects control for the overall export-orientation and specific conditions of their locality, they do not account for the possibility that firms in a locality l can enjoy a systematic advantage in exporting a

given product k, due to a specific ability of its locality developed over time or to specific development strategies implemented by local authorities for this product. Indeed firm fixed effects take into account these unobserved determinants of export performance if they affect firms' performance equally for all products. To control for the possibility that local endowments influence product-level exports differentially, we further introduce the log of the locality product export sales in 2000. As an alternative proxy for local specialization, we also use the Balassa index of "revealed comparative advantage" at the locality-product level, calculated as follows:

$$RCA^l(k) = \frac{exports^l(k) / \sum_k exports^l(k)}{\sum_l exports^l(k) / \sum_{l,k} exports^l(k)} \tag{5}$$

An increase of the Balassa index reflects an increased comparative advantage of locality l in product k, with respect to the rest of China. The summary statistics of all of the variables used in the regressions are displayed in Table 1 in Appendix A.

3.2 Results

3.2.1 Benchmark

Table (1) reports estimation results for Equation 4. Our benchmark regression is in Column 1, it regresses the firm-level export value in 2006 on the initial export value in 2000 and product density in 2000. Columns 2 and 3 add controls for agglomeration and comparative advantages. In column 4, we add a proxy for the performance of the firms as an exporter for a given product: the number of destinations it exports that product to. In columns 1 to 4, the density indicator is computed for each prefecture using the World Product Map, i.e. the numerator in Equation 3 only considers the products for which the prefecture has a comparative advantage with respect to the World.

In column 5, we instead rely on the China Product Map, so that prefecture-level comparative advantages are computed using China as a reference.

Table 1: Density and firm-level export value (2000-2006)

Explained variable	Firm level export value in 2006					
Model :	(1)	(2)	(3)	(4)	(5)	(6)
Initial Ln Firm export (HS6)	0.393^a	0.347^a	0.389^a	0.318^a	0.318^a	0.318^a
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln Product density (city, w/r World)	1.414^a	0.593^a	1.242^a	1.076^a		0.929^a
	(0.161)	(0.162)	(0.163)	(0.160)		(0.195)
Ln Product density (city, w/r China)					1.095^a	
					(0.129)	
Ln Product density (province, w/r World)						0.356
						(0.286)
Ln City-HS6 exports		0.183^a				
		(0.006)				
Nb of exporters (city HS6)		0.001^b	0.002^a	0.002^a	0.002^a	0.002^a
		(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
RCA index (city, w/r World)			0.000^a	0.000^a	0.000^a	0.000^a
			(0.000)	(0.000)	(0.000)	(0.000)
Firm-product level nb of countries				0.068^a	0.067^a	0.068^a
				(0.002)	(0.002)	(0.002)
	Firm fixed effects and product (HS6) fixed effects					
Observations	101691	101691	101691	101691	101691	101691
R^2	0.302	0.312	0.303	0.316	0.316	0.316

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

In column 6, we check the geographical scope of product spillovers. The product-level density of links with the productive structure of the province (the administrative unit above the prefecture) is added in parallel to the density of links with that of the prefecture.. Overall, the control variables attract coefficients with the expected signs. Initial export value has a positive and significant coefficient. Its value below 1 indicates convergence across products of the firm's export basket. This finding is in line with that of Hwang (2011). Our measure of agglomeration economies (number of exporters of the same product in the locality) enters with a positive and significant sign. Whether proxied through the local export sales or the revealed comparative advantage, local specialization has a positive and significant impact of export performance. The firm-product level proxy of export performance (the number of destinations) also enters with the expected positive and significant sign.

In all specifications, our density indicator attracts a positive coefficient, significant at the 1% level. Our results indicate that for a given firm export performance is higher for products that are characterized by denser connections with the local productive structure. Our results do not seem to depend on the reference (World or China) used to define the comparative advantages: the density variable has virtually the same coefficient in columns 4 and 5. The lack of significance of the density indicator measured at the provincial level suggests that it is adequation with the local (defined at the rather fine geographical level of prefectures) that matters for product export performance. No additional effect is measured when considering a large geographical scale.

We can interpret the magnitude of the estimated coefficients (close to unity) in Column 4, our preferred specification. Holding other factors constant, a 10% increase in product density raises the export value 6-year later by about the same magnitude.

3.2.2 Robustness checks

In Table (2) we check the robustness of our results. We first check our results hold after excluding some specific geographical zones. As emphasized in the literature on China's export performance (Amiti and Freund, 2010; Wang and Wei, 2010), a number of Chinese

localities are clearly different from the rest, in terms of location and policy particularities which have made them richer, faster-growing, and more open, and more likely to host firms with rapid export growth. Four prefectures (Beijing, Tianjin, Shanghai and Chongqing), known as the four "super cities" have been for example granted province-level status. This enhanced autonomy has allowed these locations to engaged in bolder market-oriented reforms and privatization. Column 2 of Table (2) hence confirms that our results are not affected when dropping observations from the four province-level cities. Column 3 verifies that in turn results are not driven by observations from interior provinces. The literature on China has evidenced an interior-coast divide. Interior locations are considered to be significantly different from the rest of the country. They stand up for more inward oriented economies and for their limited success in attracting foreign investment. Despite the smaller number of observations when observations from those zones are dropped, the firm-level growth elasticity of density remains significant and of the same size as before, so that the positive relationship between product relatedness to local productive structure and export growth is not driven by these locations. Column 4 reports the results after focusing on special policy zones that account for a dominant share of exports in China. As described in Wang and Wei (2010), such zones were created by the government starting in 1979 in Guangdong, to promote industrial activity, innovation and export activities. They offer low-tax regimes and faster administrative procedures to favor industrial clustering. Since special economic zones concentrate most of the export activity in China, we need to verify that our results hold for exporters in these locations. Again, our estimates are robust to restricting our sample to these most trade-oriented locations. The coefficient on product density is higher here at 1.632. In Column 5, we check the robustness of our results to the exclusion of products that have very high or very low level of relatedness to other goods. The product-level relatedness (defined at the product level from the World Product Space) is computed as the sum of bilateral relatedness defined in Equation (1). Results in Column 5 are obtained after excluding the top and bottom deciles of firm-product observations in terms of export growth between 2000 and 2006. Our estimates are robust, though significantly lower at 0.62.

Table 2: Density and firm-level export growth - Robustness checks

Explained variable	Firm level export value growth									
Model :	(1) Benchmark	(2) no 4 super city	(3) only coast	(4) only policy zones	(5) w/o top & bottom decile proximity	(6) w/o top & bottom decile growth	(7)	(8) Alternative Growth period	(9)	(10)
							2000 2005	2000 2005/06	2001 2006	2000/01 2006
Model :	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Initial Ln Firm export (HS6)	0.318^a	0.318^a	0.318^a	0.299^a	0.317^a	0.679^a	0.339^a	0.348^a	0.421^a	0.405^a
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Ln Product density	1.076^a	1.059^a	1.018^a	1.632^a	1.095^a	0.620^a	0.709^a	0.930^a	0.890^a	0.909^a
(city, w/r World)	(0.160)	(0.162)	(0.174)	(0.223)	(0.185)	(0.122)	(0.145)	(0.139)	(0.137)	(0.127)
RCA index	0.000^a	0.000^a	0.001^a	0.001^a	0.000^a	0.000^b	0.000^a	0.000^a	0.000^a	0.000^a
(city, w/r World)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters (city HS6)	0.002^a	0.002^a	0.002^a	0.001^a	0.002^a	0.001^a	0.002^a	0.002^a	0.002^a	0.002^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Firm-product level	0.068^a	0.068^a	0.066^a	0.070^a	0.068^a	0.027^a	0.068^a	0.075^a	0.075^a	0.075^a
nb of countries	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
	Firm fixed effects and product (HS6) fixed effects									
Observations	101691	100232	95000	75779	85563	80930	122746	137223	139536	158040
R^2	0.316	0.317	0.319	0.318	0.315	0.614	0.325	0.322	0.319	0.310

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

Another important question concerning the robustness of the results is on the time period of our study.

As there is lot of churning in export flows, one could say that the effect of density on export growth is only capturing a precise time event between the year of beginning and the end year of the export value. In Columns 7 to 10 we conduct sensitivity analysis by using other pairs of years. In Column 7 we keep the export value in 2000 as the beginning of the period but we look at export growth between 2000 and 2005 instead of 2006 for our benchmark. In Column 8, we use an average of 2005 and 2006 for the ending export value. In Column 9, we use 2001 as the initial year of the sample while in Column 10, we look at the export growth rate between the average value in 2000 and 2001 and the export value in 2006. As expected the sample size increases when export growth is measured using average value for either the initial year or the ending year. In all four columns however, our results (for our variable of interest and for control variables) remain similar.

In Table (3) presents additional robustness checks. The first four columns exclude observations for products with extreme values of density. In Column 1, the bottom and top percentile of density of exported products are excluded. Column 2 drops the bottom and top 5% and Column 3 eliminates the bottom and top decile of products in terms of density. The following four columns investigate the robustness of our results after excluding observations for extreme values of prefectures' exports. Column 4 excludes the top decile of exporting prefectures (in terms of exporting value in 2000) while Column 5 drops observations for both the bottom and top deciles of exporting prefectures. Columns 6 and 7 rely on the looser threshold of 5%: observations for the top 5% and for the bottom and top 5% exporting prefectures are respectively excluded. The last four columns of Table (3) check that our results hold after eliminating observations for extreme observations of exporting firms. Column 8 excludes the top decile of exporting firms (in terms of exporting value in 2000) while Column 9 further excludes the bottom decile of exporting firms. The last two columns of the table applies the threshold of 5% instead of 10%.

Table 3: Robustness checks

Explained variable:	Firm Export value of product k in 2006										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Exclusion	Product density			City exports				Firm exports			
	>1&<99%	>5&<95%	>10&<90%	<90%	>10&<90%	<95%	>5&<95%	<90%	>10&<90%	<95%	>5&<95%
Initial Ln Firm	0.317^a	0.320^a	0.321^a	0.318^a	0.318^a	0.305^a	0.305^a	0.360^a	0.360^a	0.348^a	0.348^a
export (HS6)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Ln Product density	1.000^a	1.344^a	1.732^a	1.073^a	1.073^a	0.610^b	0.608^b	0.678^b	0.674^b	0.609^b	0.600^b
(city, w/r World)	(0.166)	(0.188)	(0.219)	(0.160)	(0.160)	(0.253)	(0.253)	(0.298)	(0.298)	(0.240)	(0.240)
RCA index	0.001^d	0.001^d	0.002^d	0.000^d	0.000^d	0.000^d	0.000^d	0.000^c	0.000^c	0.000^c	0.000^c
(city, w/r World)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters	0.002^a	0.001^a	0.001^a	0.002^a	0.002^a	0.019^a	0.019^a	0.001^a	0.001^a	0.001^a	0.001^a
(city HS6)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
Firm-product level	0.067^a	0.065^a	0.065^a	0.068^a	0.068^a	0.067^a	0.067^a	0.092^a	0.092^a	0.081^a	0.081^a
nb of countries	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)
	Firm fixed effects and product (HS6) fixed effects										
Observations	99662	91552	81341	101685	101685	32270	32267	38015	37794	49924	49878
R^2	0.317	0.318	0.319	0.316	0.316	0.352	0.352	0.349	0.350	0.333	0.333

Note: Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

As can be seen throughout the table, the positive impact of product density remains, confirming that it is not limited to extreme values of product density, exporting locations and high performance exporting firms. Indeed, despite the sharp reduction in the number of observations, our main finding of a positive and significant effect of product relatedness on firms' export performance is confirmed.

3.2.3 Firm ownership type and trade type heterogeneity

In this section we assess whether the relationship between product relatedness and export growth depends on the ownership type (domestic or foreign) of exporting firms and trade regime (processing or ordinary). An interesting feature of the customs dataset is that it allows to identify whether export flows emanate from domestic or foreign firms[11], and correspond to processing trade or ordinary trade.[12] Processing trade includes all trade flows by firms operating in the assembly sector, that is, importing inputs to process them in China and to re-export the final products (these producers benefit from a preferential tax regime on imported inputs). In 2007, 54% of Chinese exports were in the processing trade sector. Processing trade activities are also dominated by foreign entities: in 2007, 82% of processing-trade exports. We can imagine that firms engaged in this kind of activity are less embedded in their local environment, and consequently that the export performance relates less to the adequation between their products with the local productive structure.

Table (4) study separately export performance for domestic firms (even columns) and foreign firms (odd columns). While Columns 1 and 2 report the results for the benchmark period (2000-2006), the following two columns use the average export flow for 2005 and 2006 to compute the final year of export growth. Columns 5 and 6 use the average for 2000 and 2001 to compute the initial export value and the last two columns compute export growth between the average of 2000 and 2001 and 2005 and 2006.

[11]The data are separately reported by firm type, including foreign-owned enterprises, Sino-foreign joint ventures, collective enterprises, private enterprises and state-owned enterprises. We consider the first two categories as foreign and the three later as domestic.

[12]The data also refer to a third (Others) category that groups other flows such as aid, border trade and consignment. This represents overall less than 1% of total trade value in each year. When we consider the processing/ordinary trade distinction, this category is dropped.

Table 4: Density and firm-level export growth: ownership heterogeneity

Explained variable	Firm level export value in 2006							
Time period	2000-2006		2000-2005/06		2000/01-2006		2000/01-2005/06	
Firm ownership type	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Model :	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial Ln Firm export (HS6)	0.258^a	0.405^a	0.284^a	0.446^a	0.345^a	0.477^a	0.379^a	0.523^a
	(0.005)	(0.009)	(0.005)	(0.007)	(0.005)	(0.008)	(0.005)	(0.007)
Ln Product density (city, w/r World)	1.333^a	0.243	1.076^a	0.398	1.177^a	0.298	0.924^a	0.375
	(0.180)	(0.383)	(0.152)	(0.342)	(0.174)	(0.367)	(0.146)	(0.323)
RCA index (city, w/r World)	0.000^a	0.000	0.000^a	0.000	0.000^a	0.000	0.000^a	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters (city HS6)	0.003^a	0.001^a	0.003^a	0.001^a	0.003^a	0.001^a	0.003^a	0.001^a
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Firm-product level	0.070^a	0.077^a	0.078^a	0.082^a	0.058^a	0.065^a	0.063^a	0.068^a
nb of countries	(0.002)	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)	(0.002)	(0.004)
	Firm fixed effects and product (HS6) fixed effects							
Observations	68421	36165	92220	45003	68431	36166	92231	45004
R^2	0.317	0.416	0.316	0.426	0.345	0.450	0.350	0.466

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

As can be seen, whatever the time span, the results are robust and indicate that positive and significant effect of product density is found only for domestic firms. Hence export spillovers between products mainly apply to export activities of domestic firms. Only in that case, does the product-level density of links with the local productive structure matter for subsequent export performance.

Since a great proportion of foreign entities trade is made of processing trade, the insignificance of product density may simply reflect the fact that foreign firms' export value growth relates more to the value and quality of imported inputs and to strategies of international division of the production process than to the product-level spillovers from the local productive structure. Indeed, since firms engaged in processing trade "simply" import inputs and re-export a transformed product, we can imagine that they are less embedded in their direct environment and consequently do not respond to product-level externalities.

Table (5) distinguishes exports by assembly/ordinary type. Columns 1 and 2 apply to all firms and study ordinary (ODT) export and processing (PCS) export flows respectively, while Columns 2 and 3 focus on foreign firms and Columns 5 and 6 cover only domestic firms. The results consistently show that the positive effect of product density on export growth mainly applies to ordinary export activities of domestic firms. No export value growth premium seems to be generated in the case of processing (PCS) trade flows: the coefficient estimates are either insignificant (for all firms or for foreign firms) or only significant at the 10% confidence level when restricting the sample to domestic firms. By contrast the density of links between the exported product and the local productive structure is associated to faster export growth in the whole sample. When decomposing between foreign and domestic firms, this average export premium seems to be restricted to domestic firms: the effect is significant at the 1% confidence level in the case of domestic firms while only at the 10% level for foreign firms.

Our results are in line with the idea that ordinary trade is related to activities that are more embedded in the Chinese industrial context. They are consistent with studies urging to distinguish the extent of assembly trade and foreign entities from ordinary trade

Table 5: Density and firm-level export growth - Trade type heterogeneity

Explained variable	Firm level export value in 2006					
Firm ownership type	all firms		Foreign firms		Domestic firms	
Trade type	ODT	PCS	ODT	PCS	ODT	PCS
Model :	(1)	(2)	(3)	(4)	(5)	(6)
Initial Ln Firm export (HS6)	0.242^a	0.404^a	0.341^a	0.392^a	0.213^a	0.382^a
	(0.005)	(0.009)	(0.014)	(0.012)	(0.005)	(0.015)
Ln Product density (city, w/r World)	0.858^a	0.405	1.016^c	0.314	0.952^a	0.846^c
	(0.193)	(0.375)	(0.605)	(0.580)	(0.210)	(0.499)
RCA index (city, w/r World)	0.000^b	0.000	0.000	0.000^b	0.000^a	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters (city HS6)	0.004^a	0.002^a	0.002^b	0.001^a	0.004^a	0.003^a
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Firm-product level nb of countries	0.075^a	0.049^a	0.082^a	0.069^a	0.076^a	0.034^a
	(0.002)	(0.003)	(0.008)	(0.007)	(0.002)	(0.003)
	Firm fixed effects and product (HS6) fixed effects					
Observations	73313	29764	15590	20035	57723	9729
R^2	0.295	0.420	0.422	0.394	0.302	0.552

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

and domestic exporters when investigating the structure, determinants and consequences of export performance of China (Schott, 2008; Jarreau and Poncet 2011). More concretely it points at the distinctive functioning of export-platform activities by foreign firms compared to ordinary exports operated by domestic firms.

3.2.4 Conditionality depending on firm level efficiency

We now investigate the potential heterogeneity of product density depending on the productivity of the exporting firm. This is an important issue. Since foreign firms are shown to be much more productive than domestic firms in China, an alternative interpretation of the lack of significance of product density in the case of foreign firms (and of processing trade that is dominated by foreign firms) is that the adequation with the local productive structure does not matter for export performance for the most productive firms. Hence, it is key to verify this line of argumentation by contrasting our results for high-productivity

and low-productivity firms. We rely on three alternative proxies for firm-level productivity computed from the customs dataset. We in turn use the number of product-country pairs that the firm's exports cover, the number of products the firm exports and the the number of countries the firm reaches by exporting. These indicators are computed for the initial year of our sample (2000).

We check whether product density plays a similar role for export performance depending on the initial productivity of the exporter by splitting our sample between low and high productivity. In Table (6), we use two alternative cut-offs: the median and the median respectively. Even columns that look at the effect for high-productivity exporters always display a higher coefficient estimate than the odd columns that focus on firms with productivity below the threshold. Hence, our results suggest that product-level spillovers related to adequation with the local productive structure is especially important for high-productivity exporters.

Table (7) reproduces Table (6) only looking at domestic firms. The cut-offs have been recomputed to cover only domestic firms. Consistent results are obtained. The coefficient estimates are roughly four times higher in the case of high-productivity firms. In the Appendix, Table (9) provides the results when focusing on foreign-owned firms.[13] They confirm the absence of significance on the product density variable whatever the productivity of the exporting firms. Hence the conditional effect of product density depending on the initial productivity of exporters is specific to the group of domestic firms.

[13]Firms are split into high and low productivity using cut-offs computed based only on foreign firms.

Table 6: Split according to productivity of firm: all firms

Explained variable:	Firm Export value of product k in 2006												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Benchmark	Nb product/country				Nb products				Nb of countries			
		Median		Mean		Median		Mean		Median		Mean	
		$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$
Initial Ln Firm	0.318^a	0.376^a	0.237^a	0.347^a	0.235^a	0.378^a	0.236^a	0.348^a	0.230^a	0.368^a	0.237^a	0.365^a	0.231^a
export (HS6)	(0.004)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Ln Product density	1.076^a	0.749^a	1.492^a	0.500^b	2.228^a	0.736^a	1.497^a	$0 .497^b$	2.199^a	0.607^b	1.631^a	0.689^a	1.550^a
(city, w/r World)	(0.160)	(0.249)	(0.216)	(0.210)	(0.255)	(0.256)	(0.211)	(0.208)	(0.260)	(0.253)	(0.217)	(0.237)	(0.228)
RCA index	0.000^a	0.000^a	0.001^a	0.000^a	0.001^a	0.000^a	0.001^a	0.000^a	0.002^a	0.000^a	0.001^a	0.000^b	0.001^a
(city, w/r World)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters	0.002^a	0.001^a	0.004^a	0.001^a	0.004^a	0.001^a	0.003^a	0.001^a	0.004^a	0.001^a	0.003^a	0.001^a	0.003^a
(city HS6)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Firm-product level	0.068^a	0.082^a	0.069^a	0.077^a	0.065^a	0.074^a	0.069^a	$0.0 74^a$	0.064^a	0.103^a	0.070^a	0.096^a	0.070^a
nb of countries	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)	(0.005)	(0.002)	(0.004)	(0.002)
	Firm fixed effects and product (HS6) fixed effects												
Observations	101691	50792	50899	64916	36775	50738	50953	66007	35684	50520	51171	54168	47523
R^2	0.316	0.369	0.331	0.335	0.359	0.377	0.325	0.338	0.354	0.359	0.338	0.357	0.339

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

Table 7: Split according to productivity of firm: Domestic firms

Explained variable:	Firm Export value of product k in 2006												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Benchmark	Nb product/country				Nb products				Nb of countries			
		Median		Mean		Median		Mean		Median		Mean	
		$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$
Initial Ln Firm	0.258^a	0.266^a	0.233^a	0.251^a	0.240^a	0.267^a	0.230^a	0.263^a	0.228^a	0.271^a	0.227^a	0.271^a	0.227^a
export (HS6)	(0.005)	(0.007)	(0.007)	(0.006)	(0.010)	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
Ln Product density	1.333^a	0.603^b	2.220^a	0.821^a	3.124^a	0.641^b	2.200^a	0 $.743^a$	2.570^a	1.045^a	1.789^a	1.045^a	1.789^a
(city, w/r World)	(0.179)	(0.253)	(0.266)	(0.206)	(0.404)	(0.254)	(0.266)	(0.229)	(0.307)	(0.250)	(0.262)	(0.250)	(0.262)
RCA index	0.000^a	0.000^a	0.002^a	0.000^a	0.004^b	0.000^a	0.002^a	0.000^a	0.003^a	0.000^a	0.001^a	0.000^a	0.001^a
(city, w/r World)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters	0.003^a	0.002^a	0.004^a	0.002^a	0.006^a	0.002^a	0.005^a	0.002^a	0.005^a	0.003^a	0.004^a	0.003^a	0.004^a
(city HS6)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Firm-product level	0.070^a	0.081^a	0.064^a	0.078^a	0.057^a	0.078^a	0.063^a	0.0 76^a	0.061^a	0.086^a	0.066^a	0.086^a	0.066^a
nb of countries	(0.002)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)
	Firm fixed effects and product (HS6) fixed effects												
Observations	67539	33656	33883	48488	19051	33591	33948	41714	25825	33095	34444	33095	34444
R^2	0.315	0.324	0.365	0.304	0.435	0.328	0.360	0.313	0.394	0.327	0.362	0.327	0.362

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.

4 Conclusion

We have here brought the recent developed framework of product space (Hidalgo et al., 2007) to the micro level. Using a measure of product-level density with the local productive structure, we test the importance of product spillovers for the export performance of Chinese firms.

We find that, firm level exports grow faster for goods that have denser links with those currently produced locally. We hence confirm that products that are closer to the products constituting the local export basket benefit from larger economies of scale and scope and knowledge spillovers. Interestingly the positive impact of product relatedness is stronger for most productive firms. From a policy point of view, our results thus suggest to show that devices aimed at promoting exports should be concentrated on products that correspond to the local core competencies. We however find that the positive effect of product relatedness on firms' export performance is mainly limited to domestic firms and to ordinary trade activities. This finding is consistent with the fact that firms (mostly foreign) engaged in processing trade activity are less embedded in their local environment, and consequently that the export performance relates less to the adequation between their products with the local productive structure.

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Appendix

Table 8: Summary statistics Nb=101691

Variable	Mean	Std. Dev.	Min.	Max.
Export value 2006	1258406	2.06e+07	1	4.28e+09
Export value 2000	664206	5185249	1	5.17e+08
Density (product-locality) 2000	0.1998	0.0763	0.0022	0.4588
RCA index (product-locality) 2000	34.20	645.67	4.97e-07	87900
# exporters (product-locality) 2000	40.38	64.81	1	754

Table 9: Split according to productivity of firm: Foreign firms

Explained variable:	Firm Export value of product k in 2006												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Benchmark	Nb product/country				Nb products				Nb of countries			
		Median		Mean		Median		Mean		Median		Mean	
		$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$	$<$	$\geq$
Initial Ln Firm	0.405^a	0.442^a	0.351^a	0.413^a	0.346^a	0.460^a	0.350^a	0.450^a	0.314^a	0.396^a	0.397^a	0.379^a	0.408^a
export (HS6)	(0.008)	(0.013)	(0.011)	(0.010)	(0.015)	(0.013)	(0.011)	(0.011)	(0.013)	(0.012)	(0.012)	(0.010)	(0.017)
Ln Product density	0.243	0.376	0.245	0.463	-0.133	0.222	0.104	0.382	1.130	0.983	0.263	0.465	0.033
(city, w/r World)	(0.372)	(0.582)	(0.523)	(0.454)	(0.671)	(0.554)	(0.552)	(0.457)	(0.700)	(0.642)	(0.482)	(0.477)	(0.658)
RCA index	0.000	0.000	0.000^b	0.000	0.000	0.000	0.000^b	0.000	0.000	0.000	0.000^a	0.000	0.001^a
(city, w/r World)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb of exporters	0.001^a	0.001^c	0.001^a	0.001^b	0.001^a	0.001	0.002^a	0.000	0.002^a	0.002^a	0.001^b	0.002^a	0.000
(city HS6)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Firm-product level	0.077^a	0.111^a	0.086^a	0.104^a	0.084^a	0.062^a	0.094^a	$0.0\ 64^a$	0.110^a	0.068	0.078^a	0.220^a	0.070^a
nb of countries	(0.005)	(0.018)	(0.006)	(0.010)	(0.006)	(0.007)	(0.007)	(0.006)	(0.009)	(0.071)	(0.006)	(0.027)	(0.006)
	Firm fixed effects and product (HS6) fixed effects												
Observations	34152	17076	17076	23620	10532	16889	17263	22478	11674	15279	18873	23452	10700
R^2	0.414	0.467	0.446	0.435	0.485	0.515	0.406	0.476	0.411	0.404	0.470	0.381	0.541

Note:Heteroskedasticity-robust standard errors are shown in parentheses: ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Regressions are corrected for clustering at product and locality level.