Product Relatedness and Firm Exports in China[1]

Sandra Poncet and Felipe Starosta de Waldemar[2]

We propose the first evaluation using micro-level data of the gains from the consistency of activities with a local comparative advantage. Using firm-level data from Chinese customs over the 2000–6 period, we investigate the relationship between the export performance of firms and how their products relate to local comparative advantage. Our key indicator measures the density of the links between a product and the local product space. Hence, it combines information on the intrinsic relatedness of a good with information on the local pattern of specialization. Our results indicate that exports grow faster for goods that have denser links with those currently produced in the firm's locality. The density of links between products seems to yield export-enhancing spillovers. However, we show that this positive effect of product relatedness on export performance is mainly limited to ordinary trade activities and domestic firms. It is also stronger for more productive firms, suggesting that spillover diffusion may be hindered by insufficient absorptive capacity. JEL codes: F10, F14, O14

One of the most impressive dimensions of China's stellar export performance is the rapid diversification of the exports of its products. Since the 1980s, products "Made in China" have pervaded all sectors of world trade, including those that are typically considered to belong to the specialization areas of more developed countries, such as high-tech electronics and computers (Rodrik 2006; Schott 2008). China's rapid export upgrading is especially puzzling because the production of goods requires capabilities and products that vary considerably in their knowledge requirements (Hausmann and Hidalgo 2011). Because countries can only diversify by building on what they already have, China's export diversification suggests a particularly efficient ability to capitalize on its existing productive knowledge and to exploit the links between products. Recent work has argued

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2. Sandra Poncet (corresponding author) is a professor at the Paris School of Economics (University of Paris 1) and a scientific advisor at CEPII; her email address is sandra.poncet@univ-paris1.fr. Felipe Starosta de Waldemar is an assistant professor at the Paris-Sud University; his email address is felipe.starosta-de-waldemar@u-psud.fr. This paper benefited from the financial support of the FERDI (Fondation pour les Etudes et Recherches sur le Développement International) and the program "Investissement d'Avenir" (reference ANR-10-LABX- 14-01) of the French government. A supplemental appendix to this article is available at http://wber.oxfordjournals.org/. Any remaining errors are ours.

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that the main factor behind successful upgrading is the consistency of the new industries with the country's latent (and evolving) comparative advantages (Lin 2012).

We empirically test this proposition using export data for more than 100,000 Chinese exporters over the 2000–6 period to investigate the link between export performance and the consistency of products with the local productive structure. The density of links between a product and the local product space is calculated by combining information on the local pattern of specialization and the intrinsic relatedness of the product. We thus contribute to the recent revival of literature on the role of structural transformation as an engine of economic growth (McMillan and Rodrik 2011). The main argument is that not all products have the same degree of relatedness (and, hence, the same position in the product space); as a result, products have different potential, notably as platforms for jumping up to new economic activities (Hausmann and Klinger 2007a; Hidalgo et al. 2007). Greater link density between products is predicted to yield positive spillovers, such as knowledge externalities and economies of scale and scope. This relationship between production structure and economic performance has been found in a number of macro-level pieces of work: countries that specialize in products with dense connections to other goods grow faster (Kali et al. 2013; Hidalgo et al. 2007).

The analysis we propose here is micro level. We exploit Chinese firm-level data to determine whether the product space also matters at the level of individual exporters. To the best of our knowledge, this is the first analysis of the efficiency gains from product spillovers on firm export performance. Analogously to the country-level effect, we expect link density between products to give rise to a greater export performance for products that are close to those in the local export basket. The underlying idea is that they will share similar requirements in terms of institutions, infrastructure, resources, technology, or some combination thereof. The exports of products with denser connections to the local productive structure should grow faster because they can capitalize on existing local capabilities.

We focus on export growth to measure economic performance. Our analysis thus connects the macro literature on the links between productive structure and development to the micro literature on firm-level export performance. Our work follows recent efforts to understand the drivers of firm product mix (Bernard et al. 2010) and is consistent with models of endogenous within-firm (between products) activity reallocation. We focus on the role of product spillovers in the dynamics of product-level exports. By doing so, we confirm the findings of Bernard et al. (2010) that the within-firm allocation of export activity between products reflects not only firm- and product-level determinants but also factors combining these firm and product dimensions.

Our analysis differs from the existing cross-country work in a number of dimensions. First, we conduct a micro-level analysis based on firm-level export data and propose a mechanism through which the productive structure can fuel greater per capita GDP growth. Second, we analyze China to shed light on the country's export performance and rapid upgrading. Our work helps us understand the increasing specialization of China's exports (Amiti and Freund 2010) and highlights the role of product consistency with the local productive structure. Our empirical results suggest that products that are closer to the local export basket have an advantage in firm export bundles. This finding is consistent with economies of scale and scope and knowledge spillovers from product-level relatedness. Product spillovers produce export upgrading as producers move through the product space by reallocating their activity toward these connected goods.

Third, we consider potential heterogeneity in the impact of product-level connections with the local productive structure according to firm ownership (foreign or domestic)[3], trade type (processing or ordinary), and firm productivity. We thus contribute to the recent literature on the particularities of processing trade (Manova and Yu 2012; Dai et al. 2011). A number of studies have emphasized the lack of connection between ordinary activities and those based on imported technology and foreign affiliates (Lemoine and Unal-Kesenci 2004; Hale and Long 2011; Blonigen and Ma 2010). This lack of connection may explain the disappointing results obtained in terms of technological diffusion from processing and foreign activities in China. Fewer spillover gains may emanate from processing and foreign activities because they are less embedded in the local economy. In addition, the distinct functioning of foreign firms, which are mainly engaged in export-platform activities using imported inputs, may limit the spillovers that they generate and from which they can benefit. We further investigate whether the gains from product consistency with the local structure are contingent on firm productivity. Potential spillovers may not be realized if firms do not undertake the appropriate technological effort or have limited absorptive capacity (Crespo and Fontoura 2007). In the context of China, Li (2011) shows that firms more easily absorb domestic technological knowledge than knowledge from foreign technology and identifies a complementarity between in-house and imported technology. We check these relationships in the density-performance nexus to determine whether the benefits from product relatedness depend on firm ownership and firm productivity. This analysis allows us to determine whether there are firm-level prerequisites for growth-enhancing spillovers from product specialization. Our results also establish the appropriate reference group in terms of the local productive structure for the consistency of specialization to maximize spillovers.

We confirm that product-level relatedness with the local productive structure plays a significant role in the export performance of Chinese firms. We show that within a firm's export basket, export growth is systematically higher for products characterized by greater consistency with local capabilities. The estimated

3. 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; the latter includes equity and non-equity joint ventures and joint cooperatives).

impact is not confined to the most trade-oriented locations or to the firms that are the most export-oriented. Endogeneity issues are carefully addressed by introducing firm and product fixed effects and relevant controls for agglomeration effects as well as local revealed comparative advantage in the benchmark regression. The results resist a variety of checks that control for potential remaining reverse causality. The positive effect of product relatedness on firm export performance is mainly limited to ordinary trade activities and domestic firms. Hence, our results suggest that the export good basket of domestic firms is the key indicator for capabilities and spillover potential at the local level. We further suggest that the export benefits from consistency with local comparative advantage are greater for high-productivity firms. This suggestion is consistent with impediments to spillovers related to the limited absorption capacity of firms. Hence, product spillovers are no substitute for insufficient productivity.

The remainder of the paper is structured as follows. The next section presents the data and variable construction. Section 2 presents our empirical specification and discusses the issues of endogeneity and causality. Section 3 presents the results and discusses robustness checks and alternative indicators. Section 4 investigates whether the relationship between product relatedness and exports depends on the trade regime (processing or ordinary), the ownership type (domestic or foreign), and the efficiency of exporting firms. Finally, Section 5 concludes.

I. Indicators and Data

Our objective is to quantify the relatedness between products that are traded in the global economy and to analyze the role of this relationship in the reshaping of the structure of production in the particular case of China. Hence, we compute the bilateral relatedness between products and link this to the productive structure of Chinese cities.

Product Relatedness

To calculate the intrinsic relatedness between products, we appeal to the Product Space representation developed by Hausmann and Klinger (2007a) and Hidalgo et al. (2007). The Product Space is a network that formalizes the notion of relatedness between products traded in the global economy.

We use the Hidalgo et al. (2007) indicator of proximity based on co-exporting probabilities in the world. A product that is co-exported with another product by many countries is considered an outcome-based measure of relatedness. This understanding reflects the idea that co-exporting has similar requirements in terms of institutions, infrastructure, resources, technology, or some combination thereof. For example, producing and exporting computers is expected to require competencies, technology, inputs, and production factors that are similar to those used to produce televisions. Hence, most countries should export both computers and televisions, yielding considerable proximity between the two products. Alternatively, because the necessary requirements for the production and export of products such as cheese or natural gas are very different from those for computers, the proximity value between these two products and computers is likely to be low.

Bilateral proximity (for each pair of products i and j) is calculated based on the probability that countries with comparative advantage in one of the goods (i or j) also have comparative advantage in the other. Following Hidalgo et al. (2007), revealed comparative advantages (RCAs) are defined using the index in Balassa (1965). A country is said to export a good with comparative advantage when the ratio of the export share of that product in the country's export basket to the analogous worldwide export share is greater than 1. We define Pr $(i|j)$ as the ratio of the number of countries with RCA in both i and j over the number of countries with RCA in i and Pr $(j|i)$ as the ratio of the number of countries with RCA in both i and j over the number of countries with RCA in j. We calculate proximity as the minimum of those two pairwise conditional probabilities:[4]

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

This bilateral relatedness $\phi_{i,j}$ between products i and j is calculated for 5,016 products using data for 239 countries in 2000 from the BACI[5] world trade dataset (Gaulier and Zignago 2010).[6] The matrix of these proximities characterizes the world product space.[7]

Table 1 provides summary statistics of particular HS-2 product categories, and Table 2 presents the proximity measures for some particular product pairs, providing illustrative examples of how products are related to each other.

Digital computers have a proximity value of 0.02 with oil. For the entire sample of countries exporting computers or oil with RCA, only 2% export the other product with RCA at the same time. This low value clearly indicates the distinct requirements needed for the export of the two products. On the contrary, computers have relatively high proximity (0.32) to cars, suggesting that the requirements for computer and car export are quite similar.

Although the Balassa index on which Hidalgo et al. (2007) relies is commonly used to measure countries' sectorial specialization, it suffers from some empirical

4. Taking the minimum of the conditional probabilities eliminates the problem that arises when a country is the sole exporter of one particular good; the conditional probability of exporting any other good given this one equals 1 for all of the other goods exported by that country.

5. This dataset, constructed using original COMTRADE data, provides bilateral trade flows. The BACI dataset is downloadable from http://www.cepii.fr/anglaisgraph/bdd/baci.htm

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

7. The product-space framework has been used in different papers on industrial policy and economic development in developing countries. The countries covered include 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).

TABLE 1. Summary Statistics on Proximity

Benchmark indicator based on Balassa RCAs							
	HS-2	Obs. nb	Mean	Median	Std Dev.	Bottom 10%	Top 10%
Whole sample		25,155,240	0.14	0.13	0.10	0.03	0.27
Fish	03	436,305	0.10	0.09	0.07	0	0.2
Coffee	09	165,495	0.10	0.09	0.08	0	0.21
Ores	26	170,510	0.10	0.09	0.08	0	0.22
Chemicals	29	1,489,455	0.14	0.13	0.10	0	0.27
Plastics	39	616,845	0.16	0.15	0.10	0.04	0.3
Cotton	52	636,905	0.16	0.15	0.10	0.04	0.29
Apparel	61-62	1,168,495	0.15	0.12	0.11	0.03	0.29
Electrical machinery	84	2,497,470	0.16	0.15	0.10	0.04	0.3
Alternative indicator based on Costinot et al.'s (2012) RCAs							
	HS-2	Obs. nb	Mean	Median	Std Dev.	Bottom 10%	Top 10%
Whole sample		25,155,240	0.22	0.21	0.10	0.03	0.46

Note: The correlation between the two proximity indicators is 0.34 over the whole sample.

Source: Authors' calculations based on the BACI world trade dataset.

TABLE 2. Bilateral Proximity: Selected Pairs

	HS code	Rice	Cotton T-shirt	Color TV	Digital computer	Cars, spark ignition engine <1000 cc
Oil	270900	0.15	0.08	0.07	0.02	0.02
Rice	100610		0.09	0.04	0	0.09
Cotton T-shirt	610910			0.12	0.06	0.08
Colour TV	852810				0.03	0.4
Digital Computer	847120					0.32

Note: The HS code for cars is 870321.

Source: Authors' calculations based on the BACI world trade dataset.

distribution weaknesses (Leromain and Orifice 2013; Hinloopen and Van Marrewijk 2001).[8] To ensure that our results are reasonably robust to changes in the definition of RCA, we also compute Hidalgo et al.'s (2007) indicator of proximity using a new RCA index that is based on an econometric estimation procedure recently suggested by Costinot et al. (2012). Their approach relies on pairwise comparisons across exporters and industries instead of aggregate exports. The "revealed" measures of productivity at the country and industry level correspond to fixed effects for a country-sector (*ck*) pair estimated from the following export regression, $\ln export^k_{cd} = \delta_{cd} + \delta^k_d + \delta^k_c + \varepsilon^k_{cd}$, where δ_{cd}, δ^k_d and δ^k_c are exporter-importer, importer-industry, and exporter-industry fixed effects, respectively. Although the Balassa indicator for country *c* and product *k* assesses whether *c* is good at producing *k* compared to an intuitive but ad hoc benchmark based on the world, this alternative indicator (corresponding to the δ^k_c fixed effects) aims to determine whether *c* is relatively better than other individual countries at producing *k* compared to other goods.[9]

We apply Costinot et al.'s (2012) econometric estimation procedure on data from BACI in 2000 and estimate the δ^k_c fixed effects for each exporter-hs6 product pair. We recompute the pairwise proximity index for two goods (Equation 1) when defining a country *c* as exporting a good *k* with RCA if $\delta^k_c > 0$.

Product Density

Our main variable of interest is density, which measures, for each locality-product pair, the density of links to the local productive structure. As indicated

8. We thank an anonymous referee for suggesting various alternative approaches to measure RCAs.

9. In the subsection "Robustness checks and alternative indicators", we discuss the results reported in the online appendix (available at http://wber.oxfordjournals.org/), in which we use alternative methods to compute RCA. First, we define a measure called "no deficit RCA" according to which a country cannot have an RCA in a product for which it is running a trade deficit. Second, we define a measure called "no outlier product" RCA, which is computed by relying on countries for which no single product weighs more than the upper quartile value (46%) of the distribution of product-level weights in the country's export basket. Third, we define a measure called "restricted sample" RCA, which is computed by relying on the 60 countries for which the share in world exports is higher than the upper quartile value (0.17%) of the distribution of export shares.

by Hidalgo et al. (2007) and Kali et al. (2013), density for good i and locality l (Density_i^l) is calculated as the average of good i's bilateral proximities with the other goods that locality l exports with comparative advantage. The indicator is calculated using the Chinese customs data aggregated to the city level:

$$Density_i^l = \frac{\sum\limits_{j \in RCA^l = 1, j \neq i} \phi_{i,j}}{\sum\limits_{j \neq i} \phi_{i,j}} \tag{2}$$

The numerator above is the sum of good i's proximities to the products j in which locality l has RCA ($RCA^1 = 1$), whereas the denominator is the sum of proximities to all of the other products that exist in the world product space. For robustness, we check that the results continue to hold when we use the Chinese instead of the world product space as the reference to calculate the local RCAs.

High density values indicate that locality l has a comparative advantage in many goods that are closely related to product i. This product is thus densely connected to its locality's product structure. As indicated by Kali et al. (2013)[10] and Hidalgo et al. (2007), density is considered a proxy for product spillovers emanating from consistent specialization, such as knowledge externalities and economies of scale and scope spillovers.

II. Empirical Strategy

Empirical Specification

Our specifications focus on the impact of product-level density of links to the local product space on the export performance of Chinese firms between 2000 and 2006 compiled by the Chinese Customs Trade Statistics (CCTS).[11]

Our dependent variable is the log of the export value of product k from firm f in locality l in 2006.[12] This is regressed on the 2000 value of the same variable, the first year in our sample, and the density indicator for locality l and product k in 2000, as presented in Section 2. Our specification is

$$\ln X_{k,2006}^f = \alpha \ln X_{k,2000}^f + \beta \ln Density_{k,2000}^l + \gamma Z_{k,2000}^l + \delta_f + \eta_k + \varepsilon_k^f. \tag{3}$$

10. According to Kali et al. (2013), the key indicator is a weighted average of density across products measured at the location level. This differs from our density measure, which has both location and product dimensions.

11. The CCTS records all merchandise transactions passing through Chinese customs and contains basic firm information (e.g., name, address, ownership), product code (8-digit), and destination country. We collapse the data to 6-digit products for consistency with the international trade data from BACI.

12. In the subsection titled "Robustness checks and alternative indicators", we verify that our main results are robust to the exclusion of trading firms, identified following Ahn et al.'s (2011) approach.

We consider, in line with Bernard et al. (2010), three broad determinants of firm product-level export performance: factors that are specific to products but common to all firms; factors that are specific to firms but common to products; and factors that are idiosyncratic to firm-product pairings. The first product-specific category corresponds to factors such as changes in relative demand (i.e., evolving tastes) or relative supply (i.e., technological changes). The second firm-specific category includes factors such as firm size, productivity, diversity of the export basket, or the charisma of the founder. We account for these firm and product characteristics via fixed effects (δ_f and η_k respectively). Because firms do not change locations, the firm fixed effects indirectly account for any location-specific features, such as endowments, governance, income, or export performance.

The third category of explanations, into which our density indicator falls, includes firm-product characteristics. The coefficient β on the density indicator captures the influence of product-level linkages with the local productive structure on firm-level performance. Our specifications thus focus on the density of the linkages between a product and the local specialization (which is a product-locality specific feature). Moulton (1990) showed that a regression of individual variables on aggregate variables may produce a downward bias in the estimated standard errors. All of our regressions are thus clustered at the level of aggregation of the density indicator (locality-product).

Our final sample covers 107,663 product observations for 11,458 firms located in 294 cities.[13]

The Issue of Endogeneity and Reverse Causality

Omitted Variables. An important concern involves the endogeneity between the product relatedness variable and the export performance. As explained above, to exclude the possibility that unobserved characteristics of products and firms create the observed relationship between the export performance of firms and how their products relate to local comparative advantage, our regressions include firm fixed effects and product fixed effects. These capture any scope economies that are common to all firms for a given product or to all products for a given firm. An abundant body of empirical literature on export spillovers (Aitken et al. 1997; Greenaway et al. 2004) shows the positive impact of the number of surrounding exporters and foreign firms on firm-level export performance. These dimensions are captured in the firm fixed effects. The firm dummies also capture the impact of the typical proxies for scope economies in the firm export basket, such as the number of products the firm exports and its total export volume.

13. The sample of firms used in the analysis is a highly selective subset of the data because, given the firm and product fixed effects, firms can only be included in the final regression if they had positive exports in both 2000 and 2006 for at least 2 products. We computed that roughly 17% of exporting firms in 2006 also exported in 2000. Two-thirds of these firms were pluri-product exporters in both years. We verified that the distribution of export value and number of exported products are nevertheless similar when considering the full or the restricted sample. The main difference is that pluri-product firms and surviving firms export slightly more, on average.

Endogeneity issues are carefully addressed in our conditioning set Z, which accounts for the issue of omitted variables through the introduction of the many possible channels through which firm-product export value can affect density at the locality-product. It consists of two categories of variables. We first include proxies for product-specific export spillovers and scope economies in the firm export bundle. Koenig et al. (2010) suggest that agglomeration effects are product specific. Swenson (2008) and Mayneris and Poncet (2015) confirm the presence of export spillovers in the specific context of China. We include the number of exporters in the locality that export the same product to account for market and non-market interactions between exporting firms. We also want to account for the externalities occurring in the firm export basket for a given product. These can emerge from cost-sharing devices or information transfers between the various destinations of the firm's exports. We introduce the number of countries to which a firm exports the product under consideration.

Second, we control for supply-side determinants by introducing proxies for local export intensity and comparative advantage. Although the firm fixed effects control for overall export orientation and the particular conditions of the firms' locality, they do not account for the possibility that firms in locality l enjoy a systematic advantage in exporting a given product k due to a specific ability that the locality developed over time or specific development strategies implemented by local authorities for this product. Firm fixed effects only take into account these unobserved factors if they affect firms' export 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 use the Balassa index of revealed comparative advantage at the locality-product level, computed as the ratio of the export share of that product in the locality's export basket to the analogous worldwide export share.

The summary statistics of all of the variables used in the regressions appear in Table A1 in the Appendix.[14]

REVERSE CAUSALITY. The issue of reverse causality is limited by the way in which the density index is computed. First, the density index is measured at the city and product level in 2000, whereas exports arefor the product in 2006. The use of lagged right-hand side variables helps make up for the potential simultaneity problem. Second, as indicated in Equation 2, the density variable (for a given city l and product i) is computed as the sum of bilateral proximities ($\phi_{i,j}$). The bilateral proximities are determined at the worldwide level and hence cannot be suspected of endogeneity. The sum is of products j and excludes product i for which city l has an RCA so it does not incorporate any information on export flows for product i. Direct reverse causality can be safely excluded because the

14. Aggregate indicators (at the locality and product level), such as density or RCA, are computed using all of the information from customs.

explained variable (the export value of product *i* by firm *f*) does not enter into the computation of density. It remains that the city-product RCA dummies incorporate information on the export structure of firms in the locality. Hence, technically, the export performance of a given firm (exporting good *i*) in 2006 can affect the indicator of local density if it is able to influence the comparative advantages of its locality in terms of the other goods (*j*) in 2000. Such a scenario would be unusual, but it cannot be completely excluded for large (multi-product) firms. Concretely, concern may remainthat more dynamic firms with high export growth of a given product are able to "create" spillovers in their location and hence induce a large local density of links for that product. We address this eventuality in our regressions and ensure that our results are not driven by some outstanding firms in terms of export value, export value growth,and density, for which the potential for reverse causality is the greatest. We also account for the possibility that reverse causality emanates from firms that produce many products that generate economies of scope. We show that the association between the local density of links and export performance resists the inclusion of a measure of product-level scope economies computed as the firm-level average proximity between the good *i* under consideration and the other goods *j* exported by the firm. Below, the empirical results are shown to hold when excluding the top half of firms that are exceptional in terms of the number of products.

Two final tests ensure that our results do not simply reflect a reverse causality story. First, we recompute the density measure at the city-product level to eliminate the possibility that it is influenced by the performance of any given firm under consideration in our regressions. To do so, we revise the numerator of Equation 2 and exclude products *j*, for which the RCA dummy at the city level is converted from 1 to 0 when excluding any given firm in our final sample. Hence, we ensure that the local RCA is orthogonal to the performance of each of the local firms (including the one for which the export export performance is explained). The observed association between product density and export performance remains, suggesting that it is not driven by reverse causality.[15] Second, we further control for the lead density (computed in 2006).[16] We find that the lead density fails to be significant, suggesting that the positive association between density in 2000 and export performance does not simply reflect a simultaneity effect.

III. Results

Benchmark

Table 3 shows the estimates for Equation 3. In Column 1, we regress the firm-level export value in 2006 on the initial export value in 2000 and product

15. Roughly 27% of the city-hs6 RCA dummies turn out to be dependent (are converted from 1 into 0 by excluding the export information of a firm in our final sample). The revised density variable is strongly correlated to our benchmark density indicator: the correlation coefficient is 0.87.

16. We thank the editor for this suggestion.

TABLE 3. Density and Firm-Level Exports (2000–6)

Dependent variable	Ln Firm-product level export value in 2006							
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial Ln Firm-product export	0.394[a]	0.319[a]	0.320[a]	0.320[a]	0.319[a]	0.319[a]	0.320[a]	0.316[a]
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln Product density	1.446[a]	1.123[a]		0.830[a]			1.056[a]	0.650[a]
(city, w/r World)	(0.155)	(0.155)		(0.283)			(0.157)	(0.159)
Ln Product density					1.179[a]			
(city, w/r China)					(0.125)			
Ln Product density[i]						2.660[a]		
(bilateral RCA)						(0.300)		
Ln Product density			0.526[a]					
(no firm-level influence)			(0.087)					
Ln Product density (lead, 2006)				0.353				
				(0.285)				
Ln city-product export	0.182[a]							
	(0.008)							
RCA index (city-product)		0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]
		(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
No. of exporters (city-product)		0.002[a]	0.001[a]	0.001[a]	0.001[a]	0.002[a]	0.002[a]	0.002[a]
		(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0004)
No. of countries (firm-product)		0.066[a]	0.066[a]	0.066[a]	0.066[a]	0.066[a]	0.066[a]	0.065[a]
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Av. density (firm-other products)							-0.671[a]	
							(0.229)	
Av. proximity								0.819[a]
(firm-other products)								(0.058)
Fixed effects	Firm fixed effects and product (HS6) fixed effects							
R^2	0.31	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Observations	107,663		107,541		107,173		107,663	

Note: [i] instead of the benchmark RCA method, which is calculated by comparing a country's export share with global export shares (Balassa, 1965), the bilateral RCA uses data on relative bilateral exports following Costinot et al. (2012) and looks at whether a country is relatively better than other individual countries at producing a given good rather than other goods.

Source: Authors' calculations based on Chinese customs and other data described in the text.

Heteroskedasticity-robust standard errors are shown in parentheses; [a], [b], and [c], respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at product-locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

density in 2000. Our benchmark regression is in Column 2, where we add controls for agglomeration and comparative advantage. The values of all explanatory variables refer to those in the first year of our data (2000).

Overall, the coefficients on the control variables have the expected signs. The sign on initial export value is positive and significant with a value below 1, indicating convergence across products in the firm's export basket. This finding is in line with the finding of Hwang (2007). Our measure of agglomeration economies (number of exporters of the same product in the locality) enters with a positive and significant coefficient. Whether proxied by local export sales or RCA, local specialization positively and significantly affects export performance. The number of destinations to which the firm exports the product helps account for scope economies (across destinations) and acts as a proxy for the firm's export performance for a given product. It enters with the expected positive and significant sign.

In all of the specifications, the coefficient on the density indicator is positive and significant at the 1% level. This indicates that for a given firm, export performance is higher for products with denser connections to the local productive structure.[17] In column 3, we verify that similar findings are obtained when the numerator in Equation 2 excludes products j for which the RCA of locality l can be reversely influenced by the export performance of a firm of our final sample; that is, the RCA dummy for product j turns from 1 to 0 when we exclude the export of product j of one of the firms in our sample. As explained above, this strategy helps preclude the issue of reverse causality between the export performance of firms and our density indicator. In column 4, we check that our results remain similar when further controlling for the lead density (computed using RCAs in 2006). The results indicate some autocorrelation in density over time, which calls for caution in interpreting correlations. Nevertheless, findings of a positive and significant effect for the lagged density, but not for the lead density, suggest that the positive association between density in 2000 and that export performance does not simply reflect a simultaneity effect.

In columns 1 to 4, the density indicator is computed for each prefecture using the World Product Map; the numerator in Equation 2 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 prefecture-level comparative advantage is calculated using China as the reference. There is a strong and significant positive correlation (0.56) between the city-level RCA index measured with respect to the global export flows and the index measured with respect to the Chinese export flows in our sample of city-product pairs. Nevertheless, the two measures do not fully overlap: approximately 11% of the cases where a city is found to have an RCA based on the world reference are identified as a non-RCA

17. Table S.1 in the online appendix verifies that our estimates are unaffected by the selectivity of our dataset, referred to in endnote 11. The results are rather similar when keeping all firm-product pairs that are active in 2006, regardless of whether they report positive export flows in 2000.

cases when the China reference is used. Furthermore, close to 30% of the cases where a city is found to have an RCA based on the China reference are identified as a non-RCA cases when the world reference is used. Our results do not seem to depend on the reference (the world or China) chosen to define comparative advantage; the density variable has virtually the same coefficient in columns 2 and 5. We can interpret the magnitude of the estimated coefficients. Using the results of column 2 as our preferred specification, we compute that, holding other factors constant, an increase of half a standard deviation over the mean in the average product relatedness (leading to an increase of 36% [(0.10/0.14)/2] in product density) raises the export value six years later by 40%.

In column 6, we check that our results are robust when using a bilateral measure of RCA following Costinot et al. (2012) in the computation of the product relatedness indicators. As explained in the earlier section, instead of comparing a country's export share with global export shares, Costinot et al.'s (2012) index considers whether a country is relatively better than other individual countries at producing a given good rather than other goods. The point estimates on density roughly double compared to our benchmark in column 2. However, the orders of magnitude in terms of economic significance are not dissimilar because the mean of proximity using this alternative RCA measure is one and a half times greater than our benchmark (see Table A1 in the Appendix). An increase of half a standard deviation over the mean in the average product relatedness would correspond to 23% [(0.10/0.21)/2]. Holding the other factors constant, the resulting increase in the density indicator would raise the export value six years later by approximately 60%.

In column 7, we further include the firm-specific weighted average of the density of the other products to account for potential scope economies across products within the firm.[18] This enters with a significant negative coefficient, suggesting that competition, rather than positive feedback, prevails between products in the firm's export basket. This new variable does not alter the size and significance of the density indicator. In column 8, we control for the average proximity between the good i under consideration and the other goods j exported by the firm. It is computed as the average of bilateral proximities $\phi_{i,j}$, as defined in Equation 1. This measure of product-level scope economies enters with the expected positive sign, indicating that greater proximity between a product and the rest of the firm export bundle yields export growth gains. These benefits, however, exist in parallel to the positive effect of the density of links with the local structure.

Robustness Checks and Alternative Indicators

In Table 4, we check the robustness of our results. We first determine whether our results hold after excluding some particular geographic zones.

As emphasized in the literature on Chinese export performance (Amiti and Freund 2010; Wang and Wei 2010), a number of Chinese localities are clearly

18. The weights for each product correspond to its share in the firm's residual exports.

TABLE 4. Density and Firm-Level Exports - Robustness Checks

Dependent variable	Ln Firm-product level export value in 2006										
	No 4 super cities	No interior cities	No policy zones	W/o top & bottom 1% exporting cities	W/o cities with average density in top & bottom decile	only cities with no. of exporters >2	W/o firms in top & bottom 1% in export	W/o firms in top & bottom 1% in terms of exports growth	W/o firms with average density in top & bottom decile	No agric. or mining	Period 2000-01 to 2005-06
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Initial Ln	0.32[a]	0.32[a]	0.30[a]	0.30[a]	0.33[a]	0.31[a]	0.32[a]	0.32[a]	0.32[a]	0.32[a]	0.41[a]
Firm export	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Ln Product	1.11[a]	1.09[a]	1.62[a]	0.65[a]	1.32[a]	1.39[a]	0.65[a]	1.23[a]	1.50[a]	1.14[a]	0.83[a]
density	(0.16)	(0.17)	(0.22)	(0.18)	(0.19)	(0.19)	(0.10)	(0.16)	(0.18)	(0.16)	(0.13)
RCA index	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]	0.01[a]
exporters	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.07[a]	0.06[a]
countries	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Firm fixed effects and product (HS6) fixed effects										
R^2	0.32	0.32	0.32	0.32	0.34	0.32	0.32	0.33	0.33	0.32	0.37
Observations	104530	100336	79675	89342	81640	95732	79495	101142	86117	104746	143113

Notes: Heteroskedasticity-robust standard errors are shown in parentheses; [a], [b], and [c], respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at the product-locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

Source: Authors' calculations based on Chinese customs and other data described in the text.

different from the others in terms of location and policy particularities, which have made them richer, faster-growing, more open, and more likely to host firms with rapid export growth. For example, four prefectures (Beijing, Tianjin, Shanghai, and Chongqing), known as the four "super cities", have been granted province-level status. In column 1 of Table 4, we verify that our results continue to hold when excluding those locations that are characterized by enhanced political autonomy and smaller size. Column 2 verifies that the results are not driven by observations from interior provinces. The literature on China has underlined an interior-coast divide. Interior locations are considered to be significantly different from the rest of the country; they have more inward-oriented economies and limited success in attracting foreign investment.

Despite the smaller number of firms when observations from those zones are dropped, the firm-level growth elasticity of density remains significant and of the same size as before, so the relationship between product relatedness to local productive structure and export growth is not driven by these particular locations.

Column 3 reports the results after focusing on special policy zones thataccount for a dominant share of exports in China. As described by Wang and Wei (2010), such zones were created by the government, starting in 1979 in Guangdong, to promote industrial activity, innovation, and exports.[19] They offer low-tax regimes and faster administrative procedures to favor industrial clustering. Because special policy zones contain most Chinese export activity, we should verify that our results hold for exporters in these locations. Our estimates are again robust to restricting the sample to these trade-oriented locations. The coefficient on product density is higher here, at 1.62. In the following three columns, we exclude cities according to different criteria to determine whether extreme values are behind our results. In column 4, the criterion is the level of total exports in 2000 (excluding the top and bottom percentiles of exporting cities), and in column 5, the criterion is average density (excluding observations in the top and bottom deciles).[20] In column 6, we exclude observations when fewer than three firms export the product considered in the city. Our results are robust to these tests. We also consider robustness with respect to excluding outlying firms. Column 7 deletes observations from the top and bottom percentile exporting firms in 2000. In column 8, the criterion is the growth in the firm's exports between 2000 and 2006. In column 9, we drop observations in the top and bottom deciles of the average density at the firm level.[21] Our density variable remains positive and significant throughout, attesting to the robust association between export growth and consistency with local

19. We use the list established by Wang and Wei (2010). It includes the four types of policy zones established by the Chinese government: special economic zones (SEZs), Economic and Technological Development Areas (ETDAs), Hi-Technology Industry Development Areas (HTIDA), and Export Processing Zones (EPZs).

20. The average density in a given location is computed as the weighted average of the product density in the city's export basket, with the weights being the product's export share.

21. The firm's average density is computed as the weighted average of the product density in the firm's export basket in 2000, with the weights being the product's export share.

comparative advantage. In column 10, we delete observations for agricultural and mining products. The point estimate of the coefficient on the density variable is unchanged, indicating that our results do not simply reflect local natural endowments. The final column of Table 4 addresses the issue of zero export flows. As has been well documented, there is a great deal of churning in firms' export activities (Eaton et al. 2008). Our regressions consider only firm-product pairs for which the export value was positive in 2000 and 2006. We find that 6.3% of the firm-product pairs reporting positive exports in 2000 but zero exports in 2006 had non-zero exports in 2005. The figure is 3.1% for firms exporting in 2006 that reported zero exports in 2000 but strictly positive exports in 2001. We want to confirm that our finding of a significant effect of density on export growth does not only capture a particular time event between 2000 and 2006. In column 11, we look at the export growth rate between the average value in 2000 and 2001 and the average export value in 2005 and 2006. As expected, the sample size increases, but our results (for our variable of interest and the control variables) remain similar. Overall, our results are consistent with the idea that products that are closer to those constituting the local export basket have an advantage within a firm's export bundle; they are characterized by faster export growth as firms reallocate their activities toward them.[22]

In Table S.2 in the online appendix, we reproduce our main results after excluding intermediary firms. We follow Ahn et al.'s (2011) approach to identify these firms based on Chinese characters that have the English-equivalent meaning of "importer", "exporter", and/or "trading" in the firm's name. Although this restriction sharply reduces the sample size (from 107,663 to 58,454 observations), it leaves the results relatively unchanged.

To ensure that our results are not dependent on a specific definition of RCAs, we perform several robustness checks in which alternative definitions of the RCA are used to build our proximity and density indicators. Table S.3 in the online appendix reports the results obtained using the alternative measures of density referred to as "No deficit", "No outlier product", and "Restricted sample". The "No deficit" measure attempts to correct the fact that the Balassa index is solely based on exports, with no accounting for imports. Hence, a country might be running a large trade deficit in a certain product and still be assigned an RCA in it. The "No deficit" RCA dummy is thus set to 1 when the ratio of the export share of a product in the country's export basket to the analogous worldwide export share is greater than 1 and when the net export of that product for the country is strictly positive. The "No outlier" product RCA addresses the issue that a country that has vast exports in one product will, by construction, have only an RCA in that product, but in nothing else. We compute it as a Balassa index, restricting our sample to countries for which no single product weighs more than 46%, which corresponds to the upper quartile in the distribution of the share that a given

22. In the unreported results, which are available upon request, we check that our main message holds when defining products at the 4-digit level of the harmonized system instead of the 6-digit level.

product weighs in the country's export basket. The "Restricted sample" RCA is a Balassa index computed by relying on the 60 countries for which the share in world exports is higher than the upper quartile value (0.17%) of the distribution of export shares. The objective is to ensure that the use of the full sample of countries from BACI, which includes many economically marginal countries, does not influence the results. The point estimates of the relationship between the local density of links and firm export performance are found to be markedly consistent across definitions of RCAs.

IV. Conditionality of the Relationship Between Product Relatedness and Exports

Firm-Ownership Type and Trade Type Heterogeneity

We now assess whether the relationship between product relatedness and exports depends on the ownership type (domestic or foreign) of exporting firms and the trade regime (processing or ordinary). One interesting feature of the customs dataset is that it allows us to identify whether the export flows emanate from domestic or foreign firms,[23] and correspond to processing or ordinary trade.[24] Processing trade includes all trade from firms operating in the assembly sector that import inputs to process them in China and re-export the final products (these producers benefit from a preferential tax regime on imported inputs). In 2006, 53% of Chinese exports were from the processing-trade sector. The processing trade is dominated by foreign entities; in 2006, these accounted for roughly 80% of processing-trade exports.

A number of studies have emphasized the disconnection between ordinary activities and those based on imported technology and foreign affiliates (Lemoine and Unal-Kesenci 2004; Hale and Long 2006; Blonigen and Ma 2010). We suspect that firms engaged in the latter activity are less embedded in their local environment and, consequently, that their export performance relates less to how well their products conform to the local production structure.

Table 5 distinguishes between domestic firms and foreign firms when considering product spillovers and exports. In columns 1 and 2, we calculate two density indices according to whether the city's domestic or foreign export bundle is used as the reference to identify the revealed comparative advantage in Equation 2. We continue to find a positive (although weaker) association between density and export performance when the former is calculated using the specialization pattern

23. The data are reported separately by firm type, including foreign-owned firms, Sino-foreign joint ventures, collective firms, private firms, and state-owned firms. We consider the first two categories foreign and the other three domestic.

24. The data also refer to a third ("Others") category that covers other flows, such as aid, border trade, and consignment. Overall, this representsless than 1% of the total trade value. When we consider the processing/ordinary trade distinction, this category is dropped.

TABLE 5. Density and Firm-Level Exports: Ownership Heterogeneity

Dependent variable	Ln Firm-product level export value									
Time period	2000–6									
Firm ownership type	All		Domestic				Foreign			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Initial Ln Firm-product export	0.32^a	0.32^a	0.26^a	0.26^a	0.26^a	0.26^a	0.40^a	0.40^a	0.40^a	0.40^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Ln Product density			1.38^a				0.16			
			(0.17)				(0.36)			
Ln Product density - Domestic	0.04^c			0.43^a		0.43^a		-0.01		-0.01
	(0.03)			(0.11)		(0.11)		(0.03)		(0.03)
Ln Product density- Foreign		-0.08^a			-0.07^a	-0.07^a			0.25	0.25
		(0.01)			(0.01)	(0.01)			(0.16)	(0.16)
RCA index	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a		0.01^a	0.01^a	0.01^a	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	
RCA index - Domestic						0.01				0.01
						(0.01)				(0.01)
RCA index - Foreign						0.01				0.01
						(0.01)				(0.01)
No. of exporters (city-product)	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a	0.01^a
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of countries (firm-product)	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a	0.07^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Firm fixed effects and product (HS6) fixed effects									
R^2	0.32	0.32	0.32	0.32	0.32	0.32	0.42	0.42	0.42	0.42
Observations	107663	107663	71642	71642	71642	71642	35468	35468	35468	35468

Notes: Heteroskedasticity-robust standard errors are shown in parentheses; ^{a}, ^{b}, and ^{c}, respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at the product-locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

Source: Authors' calculations based on Chinese customs and other data described in the text.

of domestic firms. By way of contrast, the impact is negative when we use foreign firms as the reference.

The following columns in Table 5 consider the association between product density and export performance separately for domestic (columns 3 to 6) and foreign (columns 7 to 10) firms. The results suggest that how well the firm's products conform to the local productive structure enhances exports only for domestic firms. Using the results of column 3, we compute that, holding other factors constant, an increase of half a standard deviation over the mean in the average product relatedness raises the domestic export value six years later by 49%. Our findings of a negative association between firm-product export growth and the degree to which the product is linked through the density measure to those produced by foreign firms seem to go against expectations of positive export spillovers from FDI. As in the pioneer work of Aitken et al. (1997), proximity to multinational exporters is expected to give rise to various positive market and non-market (information and technology) externalities that could boost the export performance of domestic firms. However, the results in the literature show mixed evidence of the existence of export spillovers. In some cases, FDI is found to crowd out domestic investors (Agosin and Machado 2005; Ruane and Sutherland 2005). The explanations relate to the fact that foreign investors give rise to higher competition and can bring about adverse knowledge spillovers if they start recruiting domestic entrepreneurs and skilled workers away from domestic firms.

However, as with the benchmark indicator, when restricting the sample to foreign firms, the coefficient on product density becomes insignificant. The lack of association between density and export performance may then simply reflect that the growth in the value of foreign-firm exports relates mainly to the value and quality of their imported inputs and to strategies used in the international division of production. Because firms engaged in processing trade "simply" import inputs and re-export the transformed product, we can imagine that they are less embedded in their direct environment and consequently do not react to product-level externalities.

Table 6 distinguishes exports by type. Columns 1 and 2 cover all firms and refer to ordinary (ODT) and processing (PCS) export flows, respectively, whereas columns 3 and 4 focus on domestic firms and columns 5 and 6 focus on foreign firms.

Table S.2 in the online appendix confirms that the message remains when excluding intermediaries from the sample of firms and when using the alternative measures of density. Table S.3 reports several robustness checks in which alternative definitions of the RCA exchange rate are used to build our density indicator: Costinot et al.'s (2012) bilateral index, No deficit, No outlier product, and Restricted sample, as explained above. The results consistently show that the positive effect of product density on export growth is mainly found for the ordinary export activities of domestic firms. There is seemingly no export value growth advantage for processing (PCS) trade flows. The estimated coefficients are either

TABLE 6. Density and Firm-Level Exports - Trade Type Heterogeneity

Dependent variable	Ln Firm-product level export value in 2006					
Firm ownership type	All firms		Domestic firms		Foreign firms	
Trade type	ODT	PCS	ODT	PCS	ODT	PCS
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Initial Ln Firm-product export	0.245[a]	0.404[a]	0.216[a]	0.390[a]	0.345[a]	0.391[a]
	(0.005)	(0.009)	(0.005)	(0.014)	(0.014)	(0.011)
Ln Product density (city, w/r World)	0.889[a]	0.469	0.969[a]	0.874[c]	1.004	0.365
	(0.188)	(0.354)	(0.202)	(0.486)	(0.615)	(0.542)
RCA index (city, w/r World)	0.001[a]	0.001	0.001[a]	0.001	0.001	0.001[b]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of exporters (city-product)	0.004[a]	0.002[a]	0.004[a]	0.003[a]	0.002[b]	0.001[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of countries (firm-product)	0.075[a]	0.045[a]	0.075[a]	0.033[a]	0.078[a]	0.052[a]
	(0.002)	(0.003)	(0.002)	(0.003)	(0.007)	(0.007)
	Firm fixed effects and product (HS6) fixed effects					
Observations	78087	31205	61904	10131	16183	21074
R^2	0.299	0.427	0.307	0.557	0.423	0.398

Notes: Heteroskedasticity-robust standard errors are shown in parentheses; [a], [b], and [c], respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at product-locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

Source: Authors' calculations based on Chinese customs and other data described in the text.

insignificant (for all firms or for foreign firms) or only significant at the 10% confidence level when restricting the sample to domestic firms. In contrast, the density of links between the exported product and the local productive structure is linked to faster export growth for ordinary transactions. The decomposition by firm type shows that the average export advantage is only relevant for domestic firms. Our results are consistent with ordinary trade activities being more embedded in the Chinese industrial context. Thus, they support work recommending that assembly trade and foreign entities be distinguished from ordinary trade and domestic exporters for the analysis of the structure, determinants, and consequences of Chinese export performance (Schott 2008; Jarreau and Poncet 2012). More concretely, our findings underline the distinctive functioning of the export-platform activities of foreign firms compared to the ordinary exports of domestic firms. From a policy perspective, they suggest that export promotion should concentrate on products that correspond to local domestic core competencies.

The Role of Firm-Level Efficiency

We now investigate heterogeneity in the effect of product density as a function of the exporting firm's productivity. This is an important issue. Because foreign firms have been shown to be much more productive than domestic firms in

TABLE 7. Heterogeneity by Firm Productivity: All Firms

Dependent variable:	Ln Firm Export value of product *k* in 2006												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		No. of product/country pairs				No. of products				No. of countries			
		Mean		Median		Mean		Median		Mean		Median	
	col. 2 Tab. 3	<	≥	<	≥	<	≥	<	≥	<	≥	<	≥
Initial Ln Firm export (product)	0.320[a]	0.338[a]	0.232[a]	0.375[a]	0.243[a]	0.340[a]	0.234[a]	0.379[a]	0.240[a]	0.367[a]	0.236[a]	0.370[a]	0.242[a]
	(0.004)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Ln product density	1.123[a]	0.658[a]	2.665[a]	0.735[a]	1.598[a]	0.670[a]	2.302[a]	0.755[a]	1.610[a]	0.589[a]	1.737[a]	0.487[a]	1.831[a]
(city, w/r World)	(0.155)	(0.185)	(0.294)	(0.240)	(0.208)	(0.189)	(0.279)	(0.247)	(0.204)	(0.228)	(0.219)	(0.242)	(0.209)
RCA index (city, w/r World)	0.001[a]	0.001[a]	0.004[a]	0.001[a]	0.001[a]	0.001[a]	0.003[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of exporters (city-product)	0.002[a]	0.002[a]	0.004[a]	0.001[a]	0.004[a]	0.002[a]	0.005[a]	0.001[a]	0.003[a]	0.002[a]	0.003[a]	0.001[a]	0.003[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of countries (firm-product)	0.066[a]	0.073[a]	0.059[a]	0.078[a]	0.067[a]	0.071[a]	0.060[a]	0.071[a]	0.067[a]	0.090[a]	0.068[a]	0.096[a]	0.068[a]
(firm-product)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)
Observations	107663	78879	28784	53821	53842	78042	29621	53771	53892	57159	50504	53821	53842
R^2	0.321	0.328	0.397	0.370	0.337	0.333	0.385	0.380	0.331	0.360	0.345	0.361	0.345

Notes: Heteroskedasticity-robust standard errors are shown in parentheses; [a], [b], and [c], respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at product-locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

Source: Authors' calculations based on Chinese customs and other data described in the text.

TABLE 8. Heterogeneity by Firm Productivity: Domestic Firms

Dependent variable:	Ln Firm Export value of product k in 2006												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		No. of product/country pairs				No. of products				No. of countries			
		Mean		Median		Mean		Median		Mean		Median	
		<	≥	<	≥	<	≥	<	≥	<	≥	<	≥
Initial Ln Firm export (product)	0.26^a	0.255^a	0.251	0.270^a	0.238^a	0.267^a	0.233^a	0.271^a	0.235^a	0.274^a	0.232^a	0.276^a	0.231^a
	(0.01)	(0.006)	(0.009)	(0.007)	(0.007)	(0.006)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Ln product density	1.38^a	0.822^a	3.267^a	0.550^b	2.359^a	0.778^a	2.635^a	0.583^b	2.388^a	1.010^a	1.931^a	0.994^a	1.915^a
(city, w/r World)	(0.17)	(0.199)	(0.379)	(0.243)	(0.256)	(0.218)	(0.302)	(0.243)	(0.256)	(0.239)	(0.255)	(0.240)	(0.255)
RCA index (city, w/r World)	0.01^a	0.001^a	0.004^a	0.001^a	0.002^a	0.001^a	0.004^a	0.001^a	0.002^a	0.001^a	0.001^a	0.001^a	0.001^a
	(0.01)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of exporters (city-product)	0.01^a	0.003^a	0.005^a	0.003^a	0.004^a	0.003^a	0.005^a	0.002^a	0.005^a	0.003^a	0.004^a	0.003^a	0.004^a
	(0.01)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of countries (firm-product)	0.07^a	0.076^a	0.056^a	0.080^a	0.063^a	0.075^a	0.060^a	0.078^a	0.062^a	0.086^a	0.064^a	0.086^a	0.065^a
(firm-product)	(0.01)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)
Observations	71642	51023	20867	35869	36021	44526	27364	35867	36023	35435	36455	34 668	37222
R^2	0.32	0.308	0.436	0.328	0.368	0.318	0.395	0.334	0.362	0.330	0.366	0. 331	0.364

Notes: Heteroskedasticity-robust standard errors are shown in parentheses; ^{a}, ^{b}, and ^{c}, respectively denote significance at the 1%, 5% and 10% levels; the regressions are corrected for clustering at product and locality level. The values of all explanatory variables refer to those in the first year of our data (2000).

Source: Authors' calculations based on Chinese customs and other data described in the text.

China, an alternative interpretation of the weak effect of product density for foreign firms (and in processing trade, which is dominated by foreign firms) is that how well their products conform to the local production structure is unimportant for the export performance of the most productive firms. We can test this argument by comparing high- and low-productivity firms. Another rationale for this test relates to absorptive capacity. A number of studies have identified limited absorptive capacity and the absence of appropriate technological effort as undermining spillovers (Crespo and Fontoura 2007).

Because absorptive capacity is likely to be proportional to productivity, we expect the link between density and export performance to rise with firm efficiency. We consider three alternative proxies for firm-level efficiency in the customs dataset: the number of product-country pairs covered by the firm's exports; the number of products the firm exports; and the number of countries to which the firm exports.[25] These are calculated for the year 2000.

Table 7 splits the sample by initial exporter productivity. We use two alternative cut-offs: the mean and the median. The estimated coefficient in the odd columns (high-productivity exporters) is always higher than that in the even columns (low-productivity exporters).[26]

The product-level spillovers related to how well a product conforms to the local production structure are thus especially important for high-productivity exporters.[27]

Table 8 reproduces Table 7 for domestic firms only, where the respective cut-offs now also refer only to domestic firms. The results are unchanged, with the estimated coefficient being roughly four times higher for high-productivity firms. In unreported results, we considered heterogeneity for foreign-owned firms.[28] These findings confirm the insignificance of product density for foreign firms regardless of the productivity level. The conditional effect of product density by initial exporter productivity is thus particular to domestic firms. Our findings therefore suggest that spillover diffusion can indeed be hindered by insufficient absorptive capacity.

V. Conclusion

We propose the first evaluation using micro-level data on the gains from the consistency of activities with local comparative advantage. Using firm-level data

25. We do not make any attempt to determine which of the firm characteristics (productivity, product diversification, or market diversification) is more important. Our sole purpose is to use the three measures as alternative proxies of the firm-level productivity to check the robustness of our results.

26. We verified that we obtain a similar result when splitting our sample into quartiles.

27. Following a request by an anonymous referee, we investigated the existence of heterogeneous effects across products. We used the degree of differentiation defined by Rauch (1999) and the sophistication level following Hausmann et al. (2007). Our results, which are available upon request, suggest that these two product characteristics do not affect the degree of spillovers.

28. Firms are here split into high and low productivity using the cut-offs calculated using only foreign firms.

from Chinese customs for 2000–6, we investigate the relationship between the export performance of firms and how their products relate to local comparative advantage. Our key indicator measures the density of the links between a product and 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 indicate that exports grow faster for goods that have denser links with those currently produced in the firm's locality. This finding is consistent with the density of links between products giving rise to export-enhancing spillovers. However, we find that this positive export effect is mainly limited to domestic firms and ordinary trade activities. This is consistent with the finding that firms (mostly foreign) that are engaged in processing trade activity are less embedded in their local environment; consequently, their export performance is less related to how well their products conform to the local production structure. Moreover, this relationship is stronger for more productive firms, indicating that spillover diffusion is contingent upon sufficient absorptive capacity.

Appendix

Table A1. Summary Statistics N = 107663

Variable	Mean	Std. Dev.	Min.	Max.
Firm-product export value 2006 (million $)	1.4	25.7	0.1	4,480
Firm-product export value 2000 (million $)	0.7	5.41	0.1	517
RCA index (city-product)	33.84	628.10	0.1	87,589
City-product export value (million $)	18	105	0.1	338
Density (city-product)	0.198	0.076	0.002	0.46
Density (city-product) - Domestic	0.207	0.077	0.002	0.44
Density (city-product) - Foreign	0.112	0.044	0.001	0.28
No. exporters (city-product)	39.33	63.39	1	754
No. countries (firm-product)	3.56	5.41	1	91

Source: Authors' calculations based on Chinese customs and other data described in the text.

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