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INFORMATION EXTERNALITIES AND EXPORT TRADE DURATION AT THE FIRM LEVEL

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Information Externalities and Export Duration at the Firm Level.

Evidence for Colombia[1]

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Abstract

Recent empirical work emphasizes the importance of the extensive margin of trade (new exporters, new export activities) for long run export growth. In this context, understanding the determinants of duration of new exporters is key for underpinning the dynamics of exports growth. As new exporters tend to show low survival rates, identifying the determinants of export duration is highly relevant for academic and policy purposes. In this paper, we explore whether information externalities arising from different levels of spatial interaction allow new exporters to increase the duration of their trade activities. For this, we use transaction level data on Colombian exports between 2004 and 2011. Results show that export networks, understood as the agglomeration of exporting firms at different spatial levels, reduce the risk of dropping out from exporting and that this effect is stronger the more similar are export activities carried out by firms.

Key words: information externalities, export duration, export dynamics, duration analysis, survival of trade.

JEL: F14, C41.

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[1]The views expressed herein are those of the authors and do not reflect the views of the institutions they belong to.

1. Introduction.

Recent empirical work on trade dynamics has shown that the main channel for long term export growth is new firm entrance and survival (Eaton et al 2007, Bernard et al 2009, Lawless 2009, Amador 2008, Iacovone and Javorcik 2010). According to Arkolakis (2010) and Arlbornoz (2012), the presence of fixed costs of exporting and firms lack of knowledge about their productivity, lead firms to sequential exporting by which they first get into international markets with small exports and once they manage to survive, rapidly increase their exports levels showing growth rates above those of incumbent firms. From this, it follows that the importance of new exporters is scant for export growth in the short run, but it considerably increases as new comers survive and grow.

The link between firm entry to the export market and long term export growth is firm survival. Export duration was relatively neglected as a research topic until heterogeneous firms models came into play, as former trade models assumed that once a trade relationship was started it will last forever (Fugazza and Molina 2009). The literature examining export duration finds short spans of export activity (between one and two years) either at the product (Besedes and Blyde 2010, Hess and Persson 2011) or at the firm level (Lawless et al 2009, Arlbornoz et al 2012, Amador et al 2008 and Eaton et al 2007), and significant differences between developed and developing countries, the latter showing shorter spans.[2]

Even though growing as a research theme, there is still scant evidence on the determinants of export duration at the firm level. This literature can be divided in three main streams, according to the relationship they explore: export diversification, market heterogeneity, and networks. This research belongs to the last type, under the perspective of information externalities, a variant of agglomeration externalities, by which it is posited that spatial closeness to export firms operating in the same markets or exporting the same products allows them to improve their survival rate.

We analyze transaction level data for Colombian exports between 2004 and 2011 to explore this issue. Results show that with an increasing number of export activities within the same spatial unit (*municipio*) export duration at the firm level increases. This result is robust to different econometric specifications and to the inclusion of control variables at the location (*municipio*), firm, and international trade levels. Estimations for alternative definitions of export activities (general to the firm, product-specific, market-specific, and product-and-market-specific) indicate that the more specific they are the higher export duration is at the firm level.

The paper is organized in seven sections besides this introduction. In the second we carry out a literature review at both the theoretical and empirical levels. Definition of our proxy of network as well as the econometric technique used are presented in the third section. In the fourth section we present the data and discuss the way they are organized. Duration patterns and information networks, as they arise from the data, are presented in section five. In sections six and seven we discuss results and present robustness tests, and in section eight we conclude.

[2] Eaton et al (2007) finds that for the case of Colombia, less than 40% of firms exporting for the first time will export the following year.

2. Literature Review: from who exports? To why they survive?

In order to explore a wide branch of stylized facts, trade theory and empirical trade work has moved from countries and industries to firms and products (Bernard et al, 2012). Heterogeneous firms models provide an explanation for several stylized facts in trade data, such as that only a small fraction of firms export, that exporting firms are more productive, more capital intensive, and pay higher salaries than non exporting firms. In general, these theories state that entry into export markets is dictated by self selection with no role for learning by exporting. Bernard at el (2003) and Eaton and Kortum (2002) introduce productivity shocks in the Ricardian model where firms compete in international markets to be the lowest cost supplier to a specific market. In contrast, Melitz (2003) and Melitz and Ottaviano (2005) avoid firm competition by adopting the monopolistic competition framework of one-sector intra-industry trade models of the "New Trade Theory".

Testable implications drawing on these theories have lead to examined other predictions arising from the models and uncovered new dimensions of trade behavior not yet captured by theoretical developments. Some of these include multiproduct firms, offshoring, intrafirm trade, and firm export market dynamics (Bernard et al, 2012). Empirical work on firm export dynamics have to some extent been hindered by data requirements, since transaction level information is needed and a panel data structure is wanted at the firm level. For this reason, this is an area in which there is more availability of theoretical than empirical work.

Among the empirical studies on firm export dynamics, Eaton et al (2007), using data on Colombia arrive to three stylized facts: i) almost half of the exporting firms in a given year are new exporters and a high proportion of them will not export the following year; ii) new exporters represent a negligible share of total exports and, as a consequence, have no bear on short term export growth; iii) new exporters that are able to survive, expand rapidly both in terms of destination markets and export volume, and account for a significant share of export growth in the long term. Studies by Bernard et al (2009), Lawless (2009), Amador (2008), and Iacovone and Javorcik (2010), confirm these findings for other countries.

Given their long term significance for exports growth, the study of new export firms survival is highly relevant from both the academic and policy perspectives. Low survival rates among new exporters runs afoul some heterogeneous firm models. For instance, in the Melitz (2003) model once a firm discovers its productivity and incurs in the fixed cost of exporting, there is no reason for expecting that it will withdraw from the export market. Facing the empirical reality of low survival rates, two theory strands have been developed. The first suggests that the decision of entering the export market is not a binary one, since there may be different entry costs associated with the volume of operation. The second argues that firms decide their entry to export markets under uncertainty about their productivity levels and therefore tend to minimize this risk starting with low export values.

According to Arkolakis (2010), firms incur in a fixed cost to sell to a unique buyer in a destination market; hence, with an increasing number of buyers the export fixed cost increases. In this sense, firms face a continuum of decisions as to what extent they seek to enlarge their exports, giving rise to a variety of behaviors. The more productive firms can enter markets with larger export values and also export to more destinations, while the less productive ones tend to export small values and to a single market. In Albornoz et al (2012) export firms do not know ex ante neither their productivity levels nor the benefits accruing from the exporting activity. Given they face a sunk cost of exporting, they decide to enter export markets with low export levels so as to minimize potential losses. Once they realize the outcome of the export activity, they decide whether to continue exporting (sequential exporting, that may imply increasing export levels and diversification to new markets) or withdraw.

A conceptual integration of the above theoretical findings would indicate that the interaction between productivity (and productivity discovery) and sunk export costs not only explains entry to international markets but also export duration. From this point of view, the concept of productivity could be viewed not only as referring to productive efficiency but also as covering product distribution and marketing efficiency. This way, the most productive firms would produce and trade more efficiently (i.e. would have lower production, transportation, buyer identification, advertising, and, general logistic costs) and the latter dimension (trade or commerce) could be highly market or product specific. Therefore, having access to information on these variables could enhance export survival.

The empirical literature inquiring for the determinants of export duration is still scant. However, the results arising from this work seem to point to three main determinants: product and market diversification (Volpe and Carballo, 2008; Tovar and Martinez, 2011), export market heterogeneity (Pallardó et al, 2012) and information networks (Cadot et al, 2010; Tovar and Martinez, 2011; Fernandes and Tang, 2012). This paper belongs to the last strand of this literature.

Volpe and Carballo (2008), for Peru, and Tovar and Martinez (2011), for Colombia, explore whether export diversification has any impact on the risk rate faced by exporting firms. Both studies distinguish between market diversification and product diversification and analyze them jointly, arriving to the conclusion that even though both diversification types have a positive effect on reducing the risk rate, the impact coming from product diversification is higher. Pallardó et al (2012) study how heterogeneity in destination markets affects firms survival rates in Spain. The findings show that comparative advantage, distance, and market size have a positive relationship with survival rates when exports are destined to countries with low political risk and that political risk basically nullifies their effect.

The above three studies as well as Cadot et al (2011), for Sub-Saharan Africa, and Fernandes and Tang (2012), for China, examine the effect of firms networks on the survival rate. By using the number of exporting firms as the defining feature of network size, they all find that there is a negative relationship between network size and firms' risk rates. However, there is disparity in the way the network is defined since several alternatives exist in terms of its scope (by market of destination, by product, by product-market or all encompassing) or coverage (national, regional, local).

Networks allow firms to transmit information among themselves, either directly or indirectly, thereby decreasing uncertainty about export markets and optimizing resource use. Information transmitted through networks facilitates export logistics, decreasing sunk export costs and increasing survival rates (Eaton et al 2010; Segura-Cayuela and Vilarrubia, 2008).

In Cadot et al (2010), the network is defined as the set of firms exporting to the same market, while in Tovar and Martinez (2011) the product dimension is the defining characteristic.[3] It can be argued that taking a national perspective, the network effect that most likely is captured in their work refers to formal networks (i.e. national institutional arrangements that provide a connection among firms). While this type of network certainly exists, it probably tends to be less common that informal

[3] In Tovar and Martinez (2011) markets are aggregated according to geographic zones, assuming that sunk costs depend upon geographic region.

networks as they require relatively high density of firms (reflected in industry organizations) and, most likely, governmental intervention.

Agglomeration externalities related to formal and informal transmission of knowledge, associated to (micro) location have been empirically explored (Koenig et al, 2010) and it has been posited that export firms acquire knowledge from others either through observation or direct interaction, which implies proximity (Eaton, 2010; Krautheim, 2008). From this perspective, networks, as empirically defined in Cadot et al (2011) and Tovar and Martinez (2011) do not seem to correspond to the relevant definition from the agglomeration externalities view point. To the best of our knowledge Fernandes and Tang (2012) is the only work in which the impact of local networks on export firm survival is assessed. As mentioned, it finds a positive impact of network size on export firm survival that increases with distance to the destination market.

In this research we aim at contributing to this literature by examining the impact of local networks on export firm survival in a developing country where new exporters face a high mortality rate. As follows from above, our work differs from Tovar and Martinez (2011) in the way networks are defined, being our definition consistent with the theory of information externalities. Furthermore, we define networks in a specific manner and observe export activity in a way consistent with network definition. That is, if the network is defined as the set of local firms exporting the same product to the same market, the export activity upon which we measure survival rates is exports of the same product to the same market by new entrants (as opposed to mere export firm survival). Lastly, differently from Tovar and Martinez (2011) we use discrete duration models that allow us to control survival for duration of the firm and, in a better way, for non observed heterogeneity at the firm, product and market levels. Additionaly, we focus only on network effects and conduct robustness checks for omitted variables, simultaneity bias, and specific groups estimation.[4]

3. Definitions and Econometric Strategy

3.1 Measuring information networks and export duration

The strength of externalities accruing to new exporters depend upon the volume of information they get and the way it flows through the network. Information can be conveyed through two mechanisms: cooperation among firms and informal transmission. When there is explicit cooperation among firms, it is implied that incumbents share valuable information with potential newcomers, which is unlikely as the practice will increase competition for incumbents. With informal transmission, locational proximity is key and information spillovers are the propagating mechanism so we expect the information flow to be greater among firms within the same location than among firms in different locational units.

Even though firms want to protect their information, part of it is involuntarily transmitted since their export activities (and practices) can be observed by other firms and employees from different firms interact in diverse (including social) settings. Hence, a way of approximating the volume of information that flows through the network is the number of exporting firms located in the same place. The higher the number of firms, the most likely is that the volume of flowing information is bigger. Therefore, as in other works, we measure the size of the export network as the number of exporting firms in a locality.

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[4]Koenig et al (2010) and Fernandes and Tang (2012) delve deeper on these particularities.

However, physical proximity may not be enough. It may happen that firms export different products to different markets and that this feature renders information less valuable. For instance, export requirements in terms of product standards or administrative procedures may considerably differ from market to market, redering general information less useful.As a consequence, export activity proximity must be considered too, both in the product andmarket dimensions. . As the relationship between information specificity and export duration is unknown, we use four alternative ways of defining networks, as described in Table 1.

By denoting r_j the network size under the profile *j*, the more general definition (r_i) considers that any exporting firm located in the same location (municipality) generates positive externalities to other exporting firms, irrespective of the markets to which it exports or the product it trades. Under this definition, it is most likely to find networks with high density levels (i.e. municipalities with more than 10 exporting firms)[5]. At the other extreme, the most specific network (r_{ipd}) assumes that only firms located in the same municipality and exporting the same product to the same market can have an impact on export duration for other exporting firms.

Table 1. Network types according to specificity of information

Network type	Definition	Density levels	Information specificity
r_i	Number of firms in municipality *i* that export.	High	Low
r_{ip}	Number of firms in municipality *i* that export product *p*.	Medium	Medium
r_{id}	Number of firms in municipality *i* that export to market *d*.	Medium	Medium
r_{ipd}	Number of firms in municipality *i* that export product *p* to market *d*	Low	High

Source: authors' elaboration based on DIAN data. Note: density levels refer to the percentage of networks with more than 10 exporting firms. High: >10%, Medium: between 2% and 10%, Low: <2%

Each network type has its own assumption as to which type of information can have an impact on export duration and also on the type of export activity that is relevant. Therefore, we define export activities at a more detailed level than the firm, as illustrated in Table 2. The study examines each of the export activities within the firm (defined as all possible combinations of products and markets), so that export firm survival is just one of the possibilities. In sum, each network definition has its own export activity definition.

Measuring duration under the above four definitions is not the last step in defining the variable of interest. In duration analysis is quite common to find that the dependent variable is sensible to the possibility of being censored, since the observed duration does not correspond to the complete duration of an individual in the current state. In such a case, classical regression techniques cannot be implemented. Hence, we focus on analyzing the probability than an individual changes its current state. In our context, this means studying the impact that the size of the network has on the probability that a firm drops out of the international market.

[5] The 10-firm threshold has descriptive but no analytical value.

Table 2. Information specificity according to network type

Network type	Duration type	Definition
r_i	d_{if}	Number of consecutive years that firm *f*, located in municipality *i*, exports.
r_{ip}	d_{ifp}	Number of consecutive years of product *p* exports, performed by firm *f* located in municipality *i*.
r_{id}	d_{ifd}	Number of consecutive years of exports to market *d*, performed by firm *f* located in municipality *i*.
r_{ipd}	d_{ifpd}	Number of consecutive years of product *p* exports to market *d*, performed by firm *f* located in municipality *i*.

Source: authors' elaboration

3.2 Econometric technique

As shown by Hess and Persson (2011), the use of continuous time models with trade data entails difficulties leading to biased coefficient estimates and standard errors, besides improper control for unobserved heterogeneity and reliance in the empirically questionable assumption of proportional hazards. Therefore, we rely in the duration model proposed by Prentice and Gloeckler (1978), build upon a discrete support and reformulated by Jenkins (1995) as a complementary log-log model.

Most of the empirical literature on trade duration employs continuous time models of the Cox (1972) type.[6] According to Hess and Persson (2011), the nature of trade is discrete as not all trade transactions take place on a daily or monthly basis, a feature that leads to measuring trade duration data on an annual basis. Given this frequency, and the presence of short-lived trade activities within a year, a large number of trade spells with the same duration arise in the data (tied survival times) that continuous time models have difficulty in handling. In the case of Colombia (as must be in other countries), the discrete nature of trade data is reinforced by supply and demand seasonality (Tovar and Martinez 2011), while the existence of export sunk costs leads to few and relatively large dispatches per year (Eaton 2008).

We now describe the econometric technique, closely following Jenkins (1995). In duration models, the variable of interest, T, measures duration of export activities and is characterized by its discrete, stochastic, and non-negative nature. The unconditional probability that an export activity exits the market at time *t* is given by the following density function: $f(t) = \Pr(T = t)$, while the risk that it faces of exiting the market before time *t* is given by the cumulative distribution function: $F(t) = \Pr(T \leq t)$. Given this, the analysis focuses on two etities: survival distribution and the hazard function. The first is defined as the probability of staying in the market for at least *t* periods by means of the following expression:

$$S(t) = 1 - F(t) = \Pr(T \geq t) = 1 - \sum_{j \geq t}^{N} f(j)$$

In turn, the hazard function, $h(t)$, is defined as the probability that a firm faces of leaving the market at time *t*, given that it survived until time *t-1*. It is given by:

[6] Most empirical work on the determinants of export duration, either at the level of trade flows (Besedes and Prusa, 2007; Besedes, 2010; Nitsch, 2009, Fugazza and Molina, 2009) or firms (Bosco and Gervais, 2004; Tovar and Martinez, 2011; Volpeandy Carballo, 2008) have used the Cox model.

$$h(t) = \frac{f(t)}{S(t)} = \Pr(T = t|T \geq t)$$

The purpose of trade duration models is to estimate the relationship between the hazard function and a set of characteristics observed in the export activity that change through time, $x(t)$. Given this and the discrete nature of trade data, Prentice and Gloeckler (1978) derive a discrete version of the Cox model under the assumption of proportional hazards:

$$h(t) = 1 - \exp\{-\exp(x(t)'\beta + \gamma_t)\}$$

Where, γ_t is the baseline hazard function that represents the common risk. The Prentice and Gloeckler (1978) function can be reformulated as a complementary log-log model in the following manner:

$$\log\left[-\log\left(1 - h(t)\right)\right] = x(t)'\beta + \gamma_t$$

This model allows for controlling, in a single manner, unobserved heterogeneity, assuming that each analysis unit (export activity) has random effects. According to Hess and Person (2011), the assumptions on the distribution of these effects do not impact on the estimation of coefficients and standard errors; hence, the model not only offers a simple way of controlling for unobserved heterogeneity, but is also unaffected by the presence of tied duration times (two highly desirable characteristics for duration trade models).

As we use four types of export activity (corresponding to the four network types), lets define *k* as the vector of combinations for each network type, where $k \in \{a, p, d, pd\}$[7]. With this definition the model we estimate is:

$$\log\left[-\log\left(1 - h_{ifk}(t)\right)\right] = \delta_k r_{ik,t-1} + \beta_1' X_{ft} + \beta_2' X_{kt} + \beta_3' X_{it} + \gamma_t \qquad (1)$$

Where γ_t is the baseline hazard function that is modeled without distributional assumptions, and the expression includes dichotomous variables for each period the export activity has stayed in the market. The probability that the export activity *k* of firm *f* in municipality *i*, exits the market at time *t*, given that it has endured along the last *t-1* periods, is defined as $h_{ifk}(t)$. This hazard function depends upon the number of firms in the same network *k* that were located in the same municipality *i*, during the previous period, *t-1*, defined as $r_{ik,t-1}$. Therefore, the parameter δ_k captures the potential average impact of information network *k* on the hazard rate faced by export activities.

By defining the information network $r_{ik,t-1}$ with a lag of one year, we avoid potential endogeneity problems between the hazard rate for firm *f* in municipality *i* and the information network constituted by the other export firms in the same network. The specification also includes control variables associated with export activity survival that may at the same time explain its agglomeration in the space.

[7] Additionally, let *a* represent any poduct-market combination.

The vector X_{ft} includes variables associated with firm characteristics while the vector X_{kt} includes variables pertaining to characteristics of the export activity. In the latter case, when the network is defined with the most specificity where $\{X_{kt} = (X_{pdt})\}$ it includes controls at the product, destination market, and product-destination market levels. When export activities are defined at the product level where $\{X_{kt} = (X_{pt})\}$ the vector includes product related controls, and when they are defined at the market level where $\{X_{kt} = (X_{dt})\}$ it includes market related controls. Lastly, the vector X_{it} includes variables related to the municipality where the firm is located and that may enhance agglomeration and at the same time exert an impact on the duration of export activities.

This way, for each definition of the export activity and network, the above specification will be estimated independently in order to determine whether or not networks have an impact on export activities and, in case they have, identify if network specificity plays a role.

According to Jenkins (1995), this model can be estimated by means of the following maximum likelihood function, which has the same form than that used for discrete selection models in panel data, where the dependent variable is y_{fk}:

$$\ln \mathcal{L} = \sum_{fk=1}^{N} \sum_{t=1}^{T} \left[y_{fk}(t) \cdot \ln\left(h_{fk}(t)\right) + \left(1 - y_{fk}(t)\right) \cdot \ln\left(1 - h_{fk}(t)\right) \right]$$

If firm f does not perform export activity k in period t, the variable $y_{fk}(t)$ takes value 1 and cero otherwise. Additionally, the number of periods that the export activity k lasts in firm f is observed, allowing for a non-monotonic baseline hazard function in dichotomic variables.

4. Data: information sources, cleaning, and control variables

The information source for export activities and network sizes is the Colombian national export registry, administered by the Colombian National Tax and Customs Authority (DIAN for its acronym in Spanish) and processed by the National Statistical Office (DANE for its acronym in Spanish). The database is a census of all (legal) export activity at the transaction level between 2004 and 2011 and each observation contains information on the date the transaction was carried out, the tax identification number of the firm, the municipality where the firm is located, the product exported, the FOB value of the export activity, and the destination market. It allows identifying the duration of each export activity (product and market combinations) and the number of firms clustered in each municipality (along with their export activities). Even though the database identifies products at the national nomenclature level (10 digits), for our purposes we group trade data at the four-digit level (equivalent to the four-digit level of the Harmonized System). In Tables 3 and 4 we synthesize the main characteristics of the data.

Table 3. Number of export activities and their value during the 2005-2011 period according to their left-censoring duration situation.

Export activity	Left-censored	Observations		Value	
		Number	Share (%)	Number	Share (%)
ifpd	No	418,998	83.0	149,588	63.3
	Yes	86,041	17.0	86,774	36.7
if	No	49,303	69.2	131,880	55.8
	Yes	21,940	30.8	104,482	44.2
ifp	No	253,194	98.2	225,957	95.6
	Yes	4,763	1.8	10,405	4.4
ifd	No	200,710	98.3	234,720	99.3
	Yes	3,471	1.7	1,642	0.7

Source: authors' calculation on DIAN data. Notes: for export activities i indexes the municipality, f the firm, p the product (at the HS4 level), and d he destination country. Left- censored observations are those whose export activities initiated before 2005. The number of observations and export value refer to the 2005-2011 aggregate.

Table 4. Observations and active export networks according to network type and year.

	2005	2006	2007	2008	2009	2010	2011	**Average**	**Total**
Dimension size									
p	1,080	1,095	1,065	1,081	1,070	1,065	1,067	1,075	7,523
d	171	185	182	188	187	181	179	182	1,273
f	8,085	8,068	8,272	8,377	7,976	7,273	7,378	7,918	55,429
i	194	204	208	228	118	75	55	155	1,082
Export activities (observations)									
if	9,577	9,543	9,750	9,954	12,021	10,313	10,085	10,178	71,243
ifp	36,899	36,777	37,130	36,234	40,160	35,234	35,523	36,851	257,957
ifd	28,855	29,012	28,902	29,249	30,740	28,810	28,613	29,169	204,181
ifpd	73,824	73,438	73,213	71,756	73,652	69,078	70,078	72,148	505,039
Active networks									
i	194	204	208	228	118	75	55	155	1,082
ip	7,789	7,757	7,906	8,310	6,074	5,219	5,211	6,895	48,266
id	2,401	2,514	2,565	2,829	1,520	1,231	1,079	2,020	14,139
ipd	34,235	34,531	34,212	34,922	28,650	27,835	27,944	31,761	222,329

Source: authors' calculation on DIAN data. Nota: p the product dimension (HS4), d is the destination country dimension, f is the firm dimension, and i is the municipality dimension.

From Table 4 it follows that the number of products and countries of destination is relatively stable along the period, with 1,075 products and 182 countries in average. The number of firms decreases 12% between 2009 and 2010, due to the international crisis, and, in parallel, the number of municipalities where there is at least one exporting firm decreases. Even though, it is not our objective to explain the behavior of export activities during the crisis, its incidence will have importance for the robustness tests as we will need to check if estimated coefficients to see if they are stable before and after the crisis.

For measuring network size we use the whole database to count the number of firms that perform the same export activity at the municipality level, for each network definition. Measuring duration requires knowledge of the year in which the export activity initiated. Because we are concerned with duration of the new exporting units, export activities already present in the database for 2004 are neglected. As a consequence the set of observations we use for estimation are those with a "No" in the second column of Table 3, which are presumed to have appeared for the first time during the 2005-2011 period. These observations, according to Table 3, represent more than 70% of export activities and more than 50% of exported value.

Another dimension that has to be taken into account refers to export activities with multiple durations; that is, export activities that disappear at some moment during the observation period to reappear at some other moment. These reappearing activities have a hazard rate that differs from the corresponding to activities that enter just once. Being a reappearing activity may means that firms have previous experience which may entail a lower hazard rate; however, it may also means that they are low performance activities with a higher hazard rate. In order to control for potential differences between this type of activities and the "truly" new ones, we use a dichotomous variable to identify them.[8].

Besides the national export registry we use other information sources for gathering data on municipality characteristics, firm characteristics, and export activity characteristics, that may have an effect on duration while being, at the same time, correlated with network formation. We now briefly discuss some issues about these control variables.

As controls at the municipality level we use variables related to the duration of the export activity that may also have an effect on network formation. A variable of this type is the existence of Special Economic Zones (SEZ), whose creation had a new impetus from 2005; in this case a variable measuring the number of active SEZs in each municipality and year was used. Other, mostly structural, variables were used as controls; for instance, the logarithm of per-capita income in the municipality, the urbanization rate, the logarithm of primary and secondary routes length, the percentage of firms linked to the industrial production, the index of living quality and the index of endogenous development of the municipality (a fiscal type index measuring its capability for carrying out investment in the long term).[9]

Firm level controls were built to represent firms' productivity and export skills and were calculated using data from the national export registry.[10] These variables include the number of

[8] For constructing this variable we use data covering the period 1996 to 2011. We are precluded from employing this dataset for estimation since only from 2004 on data on municipalities are available.

[9] With the exception of the SEZs and routes length, these variables were taken from the National Planning Department (DNP, 2012), elaborated from the 2005 National Population Census. Data on the SEZs were sourced from the legislation that created each of the SEZs, while routs length was sourced from the corresponding national agency (INVIAS, 2009).

10 The matching between export firms in the national export registry and alternative sources of information at the firm level is poor, so we have to rely on firm performance indicators built form the former.

destination markets of the firm and the number of products it exports, as indicators of productivity and export capabilities of the firm, and indicator showing whether the firm has reappearing export activities (as explained above), and an indicator of the scope of the firm. The latter variable, which can be viewed as the export portfolio of the firm, changes according to the network type that is evaluated: it is the number of products exported to a given market *d*, when the network refers to duration of exports to market *d*; the number of destination markets to which a product *p* is exported, when the network refers to duration of exports of product *p* to any market; and the number of product-market combinations when the network refers to firm *f* duration. When the network refers to exports of product *p* to market *d*, the variable has no use.

Lastly, there are controls related to the export activity. For activities including the product dimension in their definition, we use controls such as the share of the industry (defined at the two-digit HS level) in total exports, so we capture comparative advantage and export supply conditions; dichotomous variables indicating the product type according to Rauch's (1999) product classification; and the world export growth rate of the product (at the four-digit HS level) for the 2005-2011 period, excluding Colombian exports (using Comtrade data). For specifications including the destination market dimension in their definition, we use two dichotomous variables, one showing if there is a Free Trade Agreement in place and other showing if there is a preferential market access provision in place (this information comes from the Colombian Ministry of Trade); additionally, we use the growth rate of total imports of each partner country, excluding imports from Colombia, as a way to control for potential market particularities (using Comtrade data). Finally, we us a dummy variable for identifying the years in which the last international crisis hit. Even though its effects can be partly captured in the behavior of imports growth rates, this variable allows to capture other relevant factors such as exporters expectations and financial markets restrictions, that may have an effect on export activity duration. When the specification of interest refers to firm survival only the dummy for the international crisis and world growth rates of trade are used as controls.

5. What the Data Say: duration and information networks in Colombia.

5.1 Export networks

Export networks must comply with certain characteristics to allow for identification of their informational impact on trade duration. In essence, it is required that there is enough variance in their size for each network type. This requirement is fulfilled in the dataset, where, even though there is relatively scant geographical density, there is a mixture of cases ranging from situations with numerous networks to just a few or no network at all (for each network definition and size).

Active networks are those in which there is at least an exporting firm for each network definition and their number of observations corresponds to the summation of the products of the number of cases for each active network type by the number of firms in each network. As can be appreciated from Table 4, for instance, the network related to the number of exporters in a municipality i has in average 155 active networks (or municipalities in this case), while the network related to the number of exporters of the same product, to the same market, located in the same municipality, *ipd*, shows 31,761 combinations in average in which there is at least a firm exporting. Hence, there is a high number of active networks from which the majority show densities bellow two firms. This fact can be appreciated in Table 5 where the density distribution of each network is described. Clearly the distribution shows a larger number of active networks with just one firm than of active networks with high density (say, more than 10 firms per network). A fact that is relatively uniform across network definitions (with the exception of the simplest network –number of exporting firms by municipality- where high density networks are more common).

Table 5. Network distribution according to number of clustered firms and network type. (2005-2011).

Number of neighboring firms	Network type (% by column)			
	ipd	*id*	*ip*	*i*
No neighbor	69.02	47.63	51.97	37.62
1	14.02	14.19	15.14	13.31
2	5.62	7.6	7.41	6.93
3	3.03	4.9	4.78	4.99
4	1.84	3.32	3.24	3.6
5	1.26	2.19	2.4	2.31
6-10	2.84	6.47	6.31	8.41
11-20	1.36	4.18	3.66	6.75
More than 20	1.02	9.55	5.1	16.08

Source: authors' calculation on DIAN data. Notes: *ipd*: export network of the same product to the same market, located in the same municipality; *ip:* export network of the same product, located in the same municipality; *id*: export network to the same market, located in the same municipality; *i*: export network of any product to any market, located in the same municipality.

Table 5 also verifies the nature of export activities in Colombia, in the sense that there is no high geographical concentration of export activities in terms of their number. Almost 70% of active networks corresponding to the more specific network definition (*ipd*) has just one exporting firm, while 14% has only two firms per municipality and only 1% of active networks shows a network density of more than 21 exporters. In the other extreme, networks defined on the basis of the number of exporters located in the same municipality (*i*), irrespective of the product exported or the destination market, almost 38% of networks has just one exporter, while a bit more than 31% of them has more than six exporters.

5.2 Duration of export activities

The main input in duration models is the number of consecutive years that an export activity has been in place. Given our time period, the maximum duration length is 7 years; however, there is no guarantee that a new export activity may be, in actuality, a reappearing one since it may have had activity before 2004. Based on duration data, we first estimate the survival distribution through the Kaplan-Meier (1958) estimator.

Table 6 shows these survival functions. According to them, the duration of exports that a firm makes of a product to a specific market is relatively short: 42% of these export activities last for more than one year and less than 25% last for at least three consecutive years. Export activities of a product p to any market show similar survival rates: 41% of them last for at least two years, while a bit more than 24% do it for more than two years. Slightly more than 50% of export activities of any product to a specific market *d* last more than one year and almost 33% more than two years. The highest survival rates are found for the more general definition of a network (exports of any product to any market by a firm): more than 52% of these export activities last more than one year, while almost 35% do it for at least two years.

Table 6. Kaplan-Meier duration estimator for each type of export activity. (2005-2011).

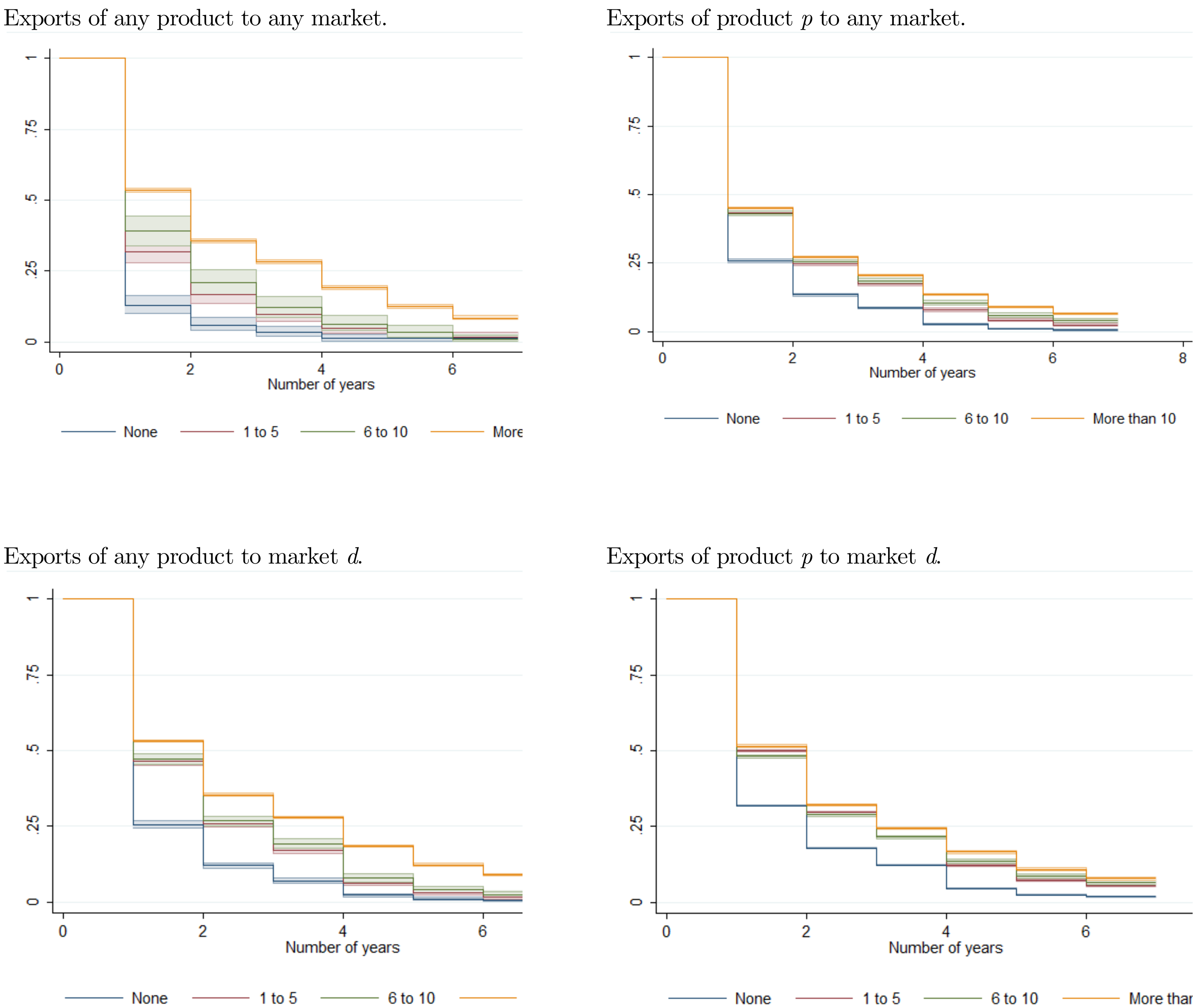
Years	Survival function	Confidence interval (95%)		Years	Survival function	Confidence interval (95%)	
		L.B.	U.B.			L.B.	U.B.
Exports of product *p* to market *d*				**Exports of product p to any market**			
1	42.0	40.2	42.4	1	41.3	41.0	41.5
2	24.1	24.9	25.2	2	24.4	24.1	24.6
3	17.3	18.1	18.5	3	17.9	17.6	18.1
4	10.0	9.8	10.2	4	10.6	10.3	10.8
5	6.2	6.0	6.4	5	6.5	6.3	6.7
6	4.6	4.4	4.7	6	4.6	4.4	4.9
7	4.6	4.4	4.7	7	4.6	4.4	4.9
Exports of any product to marketo *d*				**Exports of any product to any market**			
1	50.6	50.27	50.93	1	52.2	51.6	52.8
2	32.84	32.51	33.18	2	34.7	34.1	35.2
3	25.32	24.98	25.65	3	27.2	26.7	27.8
4	15.58	15.23	15.94	4	18.1	17.5	18.8
5	10.16	9.82	10.51	5	11.9	11.3	12.6
6	7.39	7.05	7.74	6	8.0	7.4	8.7
7	7.39	7.05	7.74	7	8.0	7.4	8.7

Source: authors' calculation on DIAN data. Note: L.B. is the lower bound and U.B. is the upper bound.

Therefore, irrespective of the type of export activity, just half or less than half of new export activities lasts for more than one year and around a third lasts for more than two years. Additionally, it is interesting that export activities belonging to a specific market tend to last longer than export activities belonging to a specific product. This means that firms tend to diversify their product portfolio to the same market more than to diversify their export destinations basket, explaining why exit rates corresponding to a specific product do not completely translate in exit rates from a specific market. The next question is how duration relates to trade network density. Graph 1 illustrates this relationship.

From Graph 1 it follows that high density networks (networks with more than 11 firms) have the highest survival rates across all network types while there is basically no difference in survival rates among networks with densities between two and six firms (1 to 5 five neighbors) and with densities between seven and 11 firms (6 to 10 neighbors) –expect in the case in which networks are defined as exports of the same product to the same market. In the latter case, there seems to be no overlapping in survival rates during the first years, an observation that reinforces the idea that the more specificly defined the export activity (and therefore, the nature of the network), the greater is the impact of the network on the survival function. Additionally, it is observed that the gap among survival rates is larger during the first and second years in all cases, which can be read as an indication about the time span along which network externalities have an impact on duration. The increase in direct learning that happens as firms export, may be the root cause for the decline in the effect of information externalities on duration.

Graph 1. Kaplan-Meier survival functions by network type and density.



Source: authors' calculation on DIAN data.

To test whether these survival functions are statistically different, we perform several test on the functions whose results are presented in Table 7. As follows from there, survival functions defined over network densities are statistically different.

Table 7. Statistical tests on survival functions defined on the basis of network density (number of neighbor firms).

Statistics\Test	Log Rank	Wilcoxon	Tarone-Ware
Any product to any market			
$X^2_{(3)}$	491.53	461.51	484.23
p-valor	0.00	0.00	0.00
Product p to any market			
$X^2_{(3)}$	3166.95	2984.48	3083.8
p-valor	0.00	0.00	0.00
Any producto t market d			
$X^2_{(3)}$	2404.8	1972.17	2154.84
p-valor	0.00	0.00	0.00
Product p to market d			
$X^2_{(3)}$	8993.28	9525.8	9591.36
p-valor	0.00	0.00	0.00

Source: authors' calculation on DIAN data. Note: survival functions are grouped according to number of neighboring firms (no neighbors, 1 to 5, 6 to 10, more than 10).

In sum, both duration of export activities and information networks distribution show desirable characteristics from the point of view of estimating the impact of information networks on trade duration. On the duration side, survival after the first year is below 50% and there is a difference in duration between export activities defined at the product and those defined at the market level. On the survival function side, survival rates are lower when export activities are specific (product *p* to market *d*) and show a relationship with survival rates at the product level, so the product portfolio of firms seems to be relatively flexible while their destination market portfolio is not –the latter being more related to firm survival. Lastly, the behavior of network density shows low frequency for high density networks (more than 10 firms located in the same municipality).

6. Results

6.1 Specificity of network impact

Estimation of the impact of information networks on export activity duration, according to equation (1) was carried out for each network type. Results from the estimations are presented in Tables 8 to 11. In all cases, column (1) presents the basic model that includes the network variable and dichotomic variables for each year of duration of the export activity. In this case, it is observed that information networks reduce the hazard rate faced by export activities.

In column (2) firm level controls are added, seeking to take into account firm ability as an exporter. If it is assumed that the more productive firms last longer in the market (Arkolakis, 2010) and that they tend to agglomerate, including these controls should decrease the effect of information networks (in absolute terms). From Tables 8 and 9 it follows that the impact arising from networks strengthens, while from Tables 10 and 11 it decreases in absolute terms. Hence, no clear cut conclusion can be reached as to which type of relationship exists between ability and agglomeration and, therefore, on the direction of the estimation bias should these controls be dropped from the estimation.

In column (3), municipality controls are added to variables in column (2). These controls seek to capture municipality characteristics that may affect both network density and duration; therefore, it is expected that they may reduce the estimated value of the effect of networks. As follows from the tables, this expectation is fulfilled in all cases.

Controls on trade characteristics are added in column (4), referring to both products or markets, according to network definition. As these variables may affect duration either in a positive or negative way, there is no clear expectation as to the way their inclusion may affect the coefficient on networks. Observation of the figures in column (4) in the tables indicates that the effect of networks on the hazard rate is negative and significant in all cases and it increases in absolute terms with respect to column (3) for all specifications.

In synthesis, the effect of information networks on export activity hazard rates is negative and significant and persists after including controls related to firm, municipality, and trade characteristics that may have an effect on firms' agglomeration and trade duration.

The specification in Table 8 refers to the more specific definition of an export activity: exports of product *p* to market *d* by firms in location *i*,[11] and the corresponding information network refers to neighboring firms exporting product *p* to market *d* during the previous year (so endogenity between the export activity and network size is avoided). Results from column (4) in the Table indicate that the size of a network of this type in time *t-1* generates information externalities that drop the hazard rate of a newcomer in 0.5%.

In Tables 9 and 10, intermediate levels of export activity and network specificity are considered. In Table 9, export activity refers to exports by firm *f* to market *d* and, according to column (4), the size of a network of this type in time *t-1* reduces the hazard rate of a newcomer in 0.03% in time *t*. Correspondingly, in Table 10 the definition of export activity is exports of product *p* by firm *f* (to any market), and results from column (4) indicate that as the size of a network in time *t-1* increases, the hazard rate for newcomers in time *t* decreases 0.09%. These results suggest that the effect of information networks is stronger for products than it is for markets, a situation that may originate in the fact that firms that share production of the same product, besides performing similar exporting activities, share similar production characteristics: technologies, labor types, and inputs. This overlap may imply broader opportunities for indirect information sharing and, consequently, informational externalities.

Lastly, Table 11 shows estimation results for the case in which export activities refer simply to export firm survival (as opposed to intra-firm survival of export activities). Results in column (4) for this case, show that export firm hazard rates decrease 0.008% as network size increases, so there is a relatively small effect on firm survival arising from having general information on the exportation process (information that lacks specificity with respect to products or markets).[12]

From the above, it follows that the more specific is the nature of the information flowing through the network, the more useful it is for newcomers for reducing their hazard rates. This result is consistent with the findings in Fernandes and Tang (2012) for China, that imply that networks at the product level have a larger impact on hazard rates than do market level networks. However, it does not explore the effect of networks combining the product and market dimensions. In Koenig et al (2010), the four definitions of networks that we use are considered for the case of France, and the results are similar to ours in terms of the order of network importance: general networks are the less important for

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[11] Hence, a firm may have several export activities during a year, as many as product-market combinations it uses.

[12] Additionally, the value for the ρ coefficient indicates that it is not possible to rule out the existence of non-observed heterogeneity in the models.

decreasing hazard rates, followed by market and product related networks, while the more specific networks (product and market related) show the higher impact.

6.2 The geography of networks' impact

Having observed the relationship between network specificity and its impact on hazard rates, it is worth examining its spatial dimension in the sense of exploring whether the impact of the networks is the outcome of highly localized phenomena, where distance (physical proximity) is key for the network to have effects, or if, on the contrary, information flowing through the network does not require proximity and could be transmitted through channels that bridge distance.

For empirically evaluating this question, we make use of two additional regressions. In the first, the network is defined as the number of firms within the region that performed the same export activity the year before. In the second, it is defined as the number of firms that performed the same export activity the year before. Results from these regressions are presented in Tables 12 through 15 in Appendix A.3. There, column (1) reproduces results from the original estimation while columns (2) and (3) correspond to the two above mentioned regressions. The definition of region correspond to the municipality level (column 1), the departmental (state) level (column 2), and the national level (column 3).

Observation of the data, as illustrated in Graphs 2 and 3 in Appendix A.2, shows that independently of the way export activities are defined, the agglomeration of exporters follows a city-region pattern. That is, places where there are more than two exporters basically locate in the country's main cities and, secondarily, in their periphery. This pattern allows exporters to benefit from services channeled through main cities, such as inputs sells, labor supply, training, etc., and justifies the use of the departmental (state) level as the basis for defining region for estimations reported in column (2) of Tables 12 to 15. This way, city-region factors as well as departmental level institutional factors are captured simultaneously.

Results reported in Table 12, indicate that the impact of information networks on export activities' hazard rates (defined as same product to same market) is stronger at the municipality level, reducing hazard rates in 0.5% as opposed to what happens at the departmental (-0.3%) and national (-0.1%) levels. Therefore the effect of municipal networks is around five times stronger than that of national networks (the definition used in Tovar and Martinez, 2011).

Table 8. Hazard rate estimation for exports of product p to market d.

	(1)	(2)	(3)	(4)
Network	-0.00330†	-0.00418†	-0.00333†	-0.00525†
Hazard function				
2	-0.521†	-0.339†	-0.406†	0.0317$^{\Delta}$
3	-1.019†	-0.738†	-0.837†	-0.0749†
4	-0.351†	0.0185	-0.119†	0.692†
5	-0.573†	-0.110†	-0.257†	0.598†
6	-1.013†	-0.471†	-0.635†	0.365†
7	-30.02	-22.45	-22.43	-24.69
Firm characteristics				
Number of destination markets		-0.0174†	-0.0177†	-0.0262†
Number of products		-0.00112†	-0.000831†	-0.00120†
Scope of export activity		-	-	-
Reappearing		-0.398†	-0.369†	-0.665†
Municipality characteristics				
Number of SEZs			-0.111†	-0.200†
Routes length (ln)			0.00970*	0.0174$^{\Delta}$
GDP per-capita			0.00341†	0.00616†
Number of firms			-0.0152†	-0.0275†
Urbanization rate			-0.000257†	-0.000514†
Political institutions			-0.000827†	-0.00130†
Poverty index			0.00927†	0.00995†
Trade characteristics				
Industry share				0.0165†
Reference price goods				-0.0668†
Heterogeneous goods				-0.235†
FTAs				-0.362†
PAs				0.0449†
Destination markets share				0.0121†
World trade growth				0.166†
International crisis				0.607†
Observations	399,114	399,114	398,669	398,669
ρ	0.00441	0.142	0.0902	0.425
Loglikelihood	-265064	-261964	-260044	-255304

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p to the same market d, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient.

Table 9. Hazard rate estimation for exports of any product to market *d*.

	(1)	(2)	(3)	(4)
Network	-0.000191†	-0.000347†	-0.000262†	-0.000346†
Hazard function				
2	-0.472†	-0.222†	-0.266†	0.0868†
3	-0.962†	-0.579†	-0.646†	0.0409
4	-0.324†	0.166†	0.0761**	0.794†
5	-0.421†	0.182†	0.0838*	0.854†
6	-0.687†	0.0259	-0.0853	0.742†
7	-27.18	-22.76	-21.94	-28.79
Firm characteristics				
Number of destination markets		-0.0438†	-0.0416†	-0.0610†
Number of products		0.00756†	0.00701†	0.00871†
Scope of export activity		-0.0790†	-0.0788†	-0.0977†
Reappearing		-0.316†	-0.302†	-0.576†
Municipality characteristics				
Number of SEZs			-0.113†	-0.191†
Routes length (ln)			0.0270†	0.0421†
GDP per-capita			0.00490†	0.00859†
Number of firms			-0.0219†	-0.0383†
Urbanization rate			-0.000376†	-0.000657†
Political institutions			-0.000909†	-0.00143†
Poverty index			0.00157	-0.00229
Trade characteristics				
FTAs				-0.324†
PAs				0.114†
Destination markets share				0.00151
World trade growth				0.547†
International crisis				0.654†
Observations	146,412	146,412	146,158	146,158
ρ	0.0244	0.190	0.152	0.468
Loglikelihood	-96228	-93346	-92732	-90704

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) exporting to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at both the export activity and the firm levels. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient.

Table 10. Hazard rate estimation for exports of product p to any market.

	(1)	(2)	(3)	(4)
Network	-0.00105†	-0.000867†	-0.000675†	-0.000973†
Hazard function				
2	-0.541†	-0.292†	-0.341†	-0.0635†
3	-1.072†	-0.674†	-0.747†	-0.239†
4	-0.534†	-0.0324	-0.143†	0.376†
5	-0.604†	-0.0219	-0.146†	0.360†
6	-0.941†	-0.291†	-0.427†	0.113*
7	-32.05	-21.51	-22.61	-23.54
Firm characteristics				
Number of destination markets		0.00387†	0.00153$^{\Delta}$	0.000952
Number of products		-0.00270†	-0.00218†	-0.00251†
Scope of export activity		-0.425†	-0.426†	-0.496†
Reappearing		-0.401†	-0.385†	-0.611†
Municipality characteristics				
Number of SEZs			-0.0866†	-0.141†
Routes length (ln)			0.0146$^{\Delta}$	0.0269†
GDP per-capita			0.00377†	0.00644†
Number of firms			-0.0168†	-0.0287†
Urbanization rate			-0.000304†	-0.000512†
Political institutions			-0.00119†	-0.00185†
Poverty index			0.00602†	0.00569*
Trade characteristics				
FTAs				-0.00238
PAs				-0.122†
Destination markets share				-0.148†
World trade growth				0.210†
International crisis				0.545†
Observations	207,221	207,221	206,813	206,813
ρ	0.000117	0.104	0.0634	0.294
Loglikelihood	-137030	-131023	-129890	-128393

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at both the export activity and the firm levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient.

Table 11. Hazard rate estimation for exports of any product to any market.

	(1)	(2)	(3)	(4)
Network	-0.0000719†	-0.0000704†	-0.0000616†	-0.0000885†
Hazard function				
2	-0.486†	-0.174†	-0.209†	0.0709$^{\Delta}$
3	-1.011†	-0.528†	-0.582†	-0.0376
4	-0.463†	0.189†	0.104*	0.640†
5	-0.406†	0.359†	0.257†	0.757†
6	-0.396†	0.409†	0.285†	0.869†
7	-34.64	-20.61	-22.57	-21.64
Firm characteristics				
Number of destination markets		-0.394†	-0.400†	-0.459†
Number of products		-0.0696†	-0.0668†	-0.0769†
Scope of export activity		0.0157$^{\Delta}$	0.0151$^{\Delta}$	0.0144*
Reappearing		-0.300†	-0.300†	-0.534†
Municipality characteristics				
Number of SEZs			-0.0732†	-0.136†
Routes length (ln)			0.0365$^{\Delta}$	0.0613†
GDP per-capita			0.00746†	0.0107†
Number of firms			-0.0333†	-0.0479†
Urbanization rate			-0.000306†	-0.000536†
Political institutions			-0.00114†	-0.00174†
Poverty index			-0.00286	-0.00744
Trade characteristics				
International crisis				0.613†
Observations	49,303	49,303	49,087	49,087
ρ	0,00005	0.155	0.118	0.371
Loglikelihood	-31873	-30038	-29742	-29346

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient.

Table 13 reports results for the case in which networks are defined as exports of firm *f* to market *d*. In this case, the impact of municipal level networks is barely above that of departmental and national level networks (-0.03%, -0.024%, and -0.023%, respectively). On the other hand, Table 14 reports results when networks are defined as exports of product *p* by firm *f* to any market. Contrary to the last case, in this one the gap between spatial levels is broad: the size of municipal level networks decreases hazard rates 0.09%, that of departmental level networks do it 0.06%, and national level networks 0.01%; hence the effect of municipal network size is a third larger than that of departmental networks and nine times that of national networks.

Given the above, it seems that when only the market dimension is considered, the spatial scope of networks lacks importance, but that when the product dimension is the focus there is a strong effect of network scope, that translates in municipal level networks having an effect about nine times higher than national networks.

Table 15 shows results when networks are defined simply as the number of exporting firms. In this case, the effect of national level networks is stronger than that of municipal or departmental networks. A possible reason for this behavior is that the number of exporting firms at the national level is also a measure of international market access and of the effect of public policies on export activities in general, factors that may not be well controlled for in the estimations (specially in the case of public policies, except for the formation of SEZs). We do not believe that this result undermines the preponderance of the effect that specific networks have on export activity duration. On one side, because the size of the effect of municipal level networks is higher than that of departmental networks, on the other due to the potential lack of a broader range of control variables acting at the national level, and, lastly, because of the relative size of the coefficients.

To partly test for the last reason given above a for the relevance of networks at the municipality level in general, we run another regression including the size of information networks excluding the municipality level ones as control. That is, when we, for instance, consider networks for exports of product *p* to market *d*, we use as control variable the number of firms that export the same product to the same market but that operate in other municipalities. The sign of this control can be positive, indicating the existence of a certain degree of interregional competition captured through the presence of similar exporters in other municipalities, or negative, indicating that useful information potentially flows beyond the municipality level. In any case, what is relevant is not the sign of these relationships but the effect that this control has on the direction and significance of the coefficient on municipality level networks. Table 16 in Appendix A.3 shows the results from this estimation. From there, it can be appreciated that the sign of information networks at the municipal level is kept and the significance of the coefficient is preserved. According to this, information networks at the municipality level are relevant in terms of their impact on hazard rates and the size of their effect is higher than the one originating in networks at other geographical levels.

7. Robustness Tests

Several robustness tests were carried out to appraise the above results. The first set of tests checks the stability of the coefficient on networks before alternative ways of defining the network. The second uses different lags to define the appropriate network. The third employs a four-year moving window in order to isolate the potential influence of a particular year for determining the results. The fourth targets coefficients estimated for different firm and network subgroups. Lastly, the fifth uses a fixed effects estimation at the firm-export activity level and at the network type-year level, to control for potential non-observed variables.

7.1 Different ways to measure networks

Results from the first set of tests are presented in Tables 17 to 20 in Appendix A.3. Results from the basic estimation are shown in column (1), while columns (2) to (4) show estimates for alternative ways of defining networks, based on Fernandes and Tang (2012) and Koenig et al (2010). Columns (5) to (7) represent estimations based on non-linear specifications for networks (on the basis of the number of firms).

Column (2) uses the density of the number of export activities, calculated as the number of firms that perform the same activity per squared kilometer of the municipality. This is an alternative way of measuring networks as it refers to the concentration level of firms and, therefore, to the probability that information flows between firms by any means. Column (3) uses the logarithm of the exported value of the set of neighboring firms instead of its number, so the size of the network here refers to trade value. Finally, column (4) measures the network as the density of export value, understood as the exported value per squared kilometer per municipality. Even though these alternatives are also useful as a measure of network size, the number of firms is the best since it is not affected by the existence of firms with high exported values, which may lead to overestimating the effect of the network, and also because it isolates the fact that firms interact at the interior of an urban zone and not at the interior of the whole surface of the municipality. In all cases, as follows from the tables, the size of the network, irrespective of the way it is measured, reduces hazard rates.

In columns (5) to (7) we report results from non-linear specifications of the networks. In column (5) the network is measured by means of categorical variables covering the following ranges: form 0 to 1 neighboring firm, between 2 and 4, between 5 and 9, between 10 and 29, and more than 30 (the first category is omitted).[13] Results suggest that there are decreasing returns for the informational effect of networks, as the decrease in hazard rates is lower for bigger groupings; for instance, in column (5) of Table 17 (where the network is defined as exports of product p to market d) moving from cero neighbors to between 2 and 4 implies a reduction of the hazard rate of 21%, while moving from cero neighbors to between 11 and 29 the reduction reaches 56%; that is, if the number of neighbors increases fivefold the effect just doubles. In column (6) a binary definition of networks is used, by means of a dichotomous variable that takes value one if the export activity had at least a neighboring firm the year before and cero otherwise. In the case of Table 17, having at least a neighbor reduces hazard rates in 28%. Lastly, in column (7) non-linear effects of the impact from networks are captured by introducing the number of firms squared as a regressor. In this case the sign of the coefficient for networks continues being negative and the coefficient on the squared term shows that there is indeed a non-linear effect that makes the impact of information networks concave. Therefore, at low density levels of the network (low number of firms) the informational effect seems to be greater than the competition effect entailed by having another exporting firm in the municipality, while at higher density levels an increase in the number of firms translates in a reduced effect from the network.

Hence, independently of the way networks are defined, results indicate that the presence of a network or its size, have a positive and significant effect in reducing hazard rates and that this effect seems to be convex.

7.2 Different lags of the informational externality

As mentioned, the second set of tests refers to the lag with which network externalities operate. The rationale for these tests is that it is possible that there is some momentum in export activities and firms cannot quickly update their portfolio of products or destinations markets, reacting to new

[13] The groupings were obtained from the networks' density function according to their distribution. Nonetheless, estimations using other groupings show similar results.

information transmitted through the network; that is, the lag between the moment the information is gathered and the firm updates its practices may vary. Tables 21 to 24 report results from this set of tests, where columns (2) and (3) show different informational lags. In column (2) it is assumed that the relevant information is gathered two years before, instead of one as assumed in the basic estimation according to equation (1), while in column (3) it is assumed that the information was gathered at the beginning of the observation period (in 2004). Results indicate that the effect from networks is, again, negative and significant.

7.3 Stability of coefficients

To explore stability of coefficients we use different observation periods to run the estimations. The rationale for this is to isolate both the effects of potential transitory factors that may impinge upon the results and of structural changes that may have occurred during the observation period. A case in mind, for instance, is the effect of the 2007-2008 international crisis, that affected Colombian export behavior during 2009 and 2010 and may have also had an effect on trade duration as there is an increase in the geographical concentration of export activities (as shown in Table 4, there is a drop in the number of municipalities with export activities from 228 in 2008 to 55 in 2011.

Tables 25 to 28 present results from this set of tests. The observation periods that are considered cover the pre-crisis period, 2005 to 2008, reported in column (2); the 2006-2009 period, reported in column (3); the 2007-2010 period, reported in column (4); and the 2008-2011 period, reported in column (5). Therefore, we use a moving time window covering the years for which the effect of the international crisis may have exerted an effect.

The effect of networks on hazard rates is negative and significant during the pre-crisis period (column 2), but its size appears to be lower than in the basic estimation (column 1). Results reported in columns (2) to (5) show that the sign and significance of the basic estimation are preserved and that the size of the effect tends to decrease as more of the crisis years enter the time window. However, in all cases the size of the effect increases for the last time period considered. In any case, what is relevant here is that the sign and significance of the effect are preserved along the set of observation periods.

7.4 Sub-groups in the data

Estimation results may be sensible to outliers and atypical data. It is a feature of the dataset, for instance, that network distribution is characterized by a large number of cases belonging to the no-neighbors category and a few number of them belonging to the higher density categories (say, more than a hundred neighbors). To take account of this particularity of the data, in Tables 29 to 32, we report results from estimations in which some network categories are excluded from the analysis. In particular, in column (2) of these tables the category no-neighbors is excluded, while in column (3) the categories including more than 10 neighbors are excluded.

This way, we expect to see if the effect from the networks is kept along the whole network distribution or if it is determined by its extremes. As follows from the tables, the impact from the networks, its sign and significance, is preserved in all cases.

Another potential issue refers to the type of exporting firm. In particular, the distinction between multiplant and monoplant firms may be of relevance. The multiplant-monoplant characteristic of firms changes from year to year in the dataset; a firm is multiplant in year t if it exports from more than a municipality in that year and is monoplant otherwise. Therefore, a multiplant firm may have a hazard function that differs from that of monoplant firms, as the former gathers information from different networks at the municipality level and may increase the value of the whole set of information it receives, in which case the value of information from any single municipality may be overstated. Another possibility is that there is a hierarchy in multiplant firms by which a particular municipality (where the firm's headquarters are located) is basically the only place from where the firm gathers information, rendering the other localities useless from the point of view of information gathering and use.

Column (4) in Tables 29 to 32 reports results for monoplant firms and column (5) for multiplant firms. As shown, the impact of information externalities is higher for monoplant firms, but is, nonetheless, negative and significant in both cases.

7.5 Un-observed heterogeneity

So far, all models are non-linear and were estimated by maximum likelihood methods. This method suffers from problems of convergence when there is high dimensionality in control variables and for this reason it was not possible to control for un-observed heterogeneity at the firm and network levels (market and/or product, as introducing these controls would have implied using more than 10,000 dummy variables). To make up for this deficiency and to test whether or not the impact of networks is preserved when there are fixed effects, we use two alternative estimations. First, using a logistic model in panel data and second using a linear probability model. While both model types allow using fixed effects, they cannot completely explain the duration of export activities and for this reason are only used for these robustness tests.

The logistic model estimates fixed effects through the sequential accumulation of conditional logistic models. However, according to Chamberlain's theorem (1980), this model only takes into account panel data where there is variation in the dependent variable, so observations that are right-censored and those with only one year of duration are excluded. In other words, using this model is equivalent to ask for duration of export activities with more than one year of existence, which leaves a high share of observations in the dataset out. Table 33 shows results from this model. From there, it follows that the effect of networks is negative and significant with independence of the type of export activity and network definition. However, it must be kept in mind that the coefficients are not comparable to those of the basic estimation given that both one-year of duration activities and right-censored observations are not taken into account (which represent something in between 50% and 60% of observations, according to the way export activities are defined).

The linear probability model has been used by several researchers to explore trade hazard rates in an unconditional way (i.e. with independence of duration). This model is lacking for forecasting and for estimating standard errors (as is common for linear models used on binary independent variables) and entails a trade-off between its capability for controlling for fixed effects and forecasting of hazard rates (conditional on duration); hence, we use it only for conducting robustness tests. In particular, we control for fixed effects at the firm level to take into account un-observed heterogeneity at the firm-municipality dimension and at the export activity-year level. The first set of fixed effects substitutes for all municipality level controls that are time invariant, while the second substitutes for all controls referred to product and market characteristics year by year.

Results from this model are presented in Table 34. They show that the effect of networks is still negative and significant but that its magnitude is severely damped. For instance, in the case of export activities defined as exports of product p to market d, the effect goes from 0.5% in the basic estimation to 0.02%, so an agglomeration of 10 firms represented a 5% reduction in the hazard rate under the original estimation and of 0.2% under the linear probability model. Furthermore, according to column (2), the impact of networks of firms exporting to the same market is no longer significant, while networks of firms exporting the same product (column 3) or simply of exporting firms (column 4) keep their significance and pecking order.

8. Conclusions

This research focuses on duration of export activities at the interior of the firm. They can be defined at four levels: exports of product *p* to market *d*, exports of any product to market *d*, exports of product *p* to any market, and exports of any product to any market, the last measuring duration of the exporting firm per se. Results show that firm survival has increased since the Eaton et al (2008) estimation, as 52.2% of firms export for more than two years during the period 2004-2011, while the share of firms exporting for more than one year in Eaton et al (2008), referred to the period 1996-2005, was lower than 40%.

Duration of export activities at the interior of the firm is lower than duration of the firm as an exporter[14] and behave asymmetrically as survival of firm-destination market combinations after the first year is close to survival of the firm in the export market (50.9%), while survival of firm-product combinations is lower (41.3%). This means that firms' export portfolio updating relays more on products and less on destination markets, a result that seems consistent with the idea that multiproduct firms have more export experience (Bernard et al 2004) and that export firms face high costs to enter new markets (Chaney 2010).

Observation of export activities location shows that there is relatively high geographical dispersion. Irrespective of the way export activities are defined, a low percentage of them locate in places where there are more than 20 firms carrying out the same export activity. For instance, trade networks defined on a product-market basis show only 1.02% of cases with network densities above 20 firms, those defined on a destination market basis show 9.5% of high density cases, and those defined on a product basis 5.1%. The broader definition of a trade network (number of exporting firms in the same municipality) shows that 37% of firms are the sole exporter in their municipality.

The main finding of this research is that the previous existence of export activities in the same municipality (the trade network) reduces the hazard rates of newcomers to the international market. This effect is robust to the inclusion of controls for the characteristics of the municipalities, international trade conditions, and characteristics of the firms, and increases, at a decreasing rate, with the size of this network. Controlling for the influence of municipal, market, and firm characteristics, assures that the effect is due to the informational content of interactions within the trade network.

Additionally, it is observed that the effect of trade networks on hazard rates is stronger when the network is narrowly defined implying that more general, cross-sectional information, on export activities, is less useful in helping newcomers survive longer in the international market once they have decided to enter. While the impact of networks defined on the basis of product-market combinations shows to be the most important, that of networks of exporters (irrespective of the products traded or destination markets) or of networks of exporters to the same destination market seem to carry the lower impacts. On the other hand, trade networks defined on a product basis appear to have the second largest impact on hazard rates. This may imply that information flows are denser when export activities share not only the export dimension but also the production process aspect. Furthermore, the spatial dimension of this effect appears to be relevant too as results show that the impact of trade networks on hazard rates decreases with the increase in geographic level.

Results are robust to several tests, including different ways of measuring trade networks, observation period, population sub-groups, and informational lags. They also have potential implications for export promotion policies design.

[14] Which can be due to firm export dynamics, as firms may adjust their export portfolio (in terms of destination markets and products) through time.

9. References.

Akhmetova, Z. (2010). Firm experimentation in new markets. University of New South Wales.

Albornoz, F., Calvo Pardo, H. F., Corcos, G., & Ornelas, E. (2012). Sequential exporting. *Journal of International Economics* , 17-31.

Álvarez, R. et al (2007). *Exports and Productivity: Comparable Evidence for 14 Countries.* Centre for Industrial Economics, Discussion papers.

Álvarez, R., Faruq, H., & López, R. A. (2007). *New Products in Export Markets: Learning from experience and learning from others.* Indiana University.

Álvarez, R., & López, R. A. (2008). Entry and Exit in International Markets: Evidence from Chilean Data. *Review of International Economics* , 692-708.

Amador, J., & Opromolla, L. D. (2013). Product and Destination Mix in Export Markets. *Review of World Economics 149 (forthcoming)* .

Antràs, P., & Helpman, E. (2008). Contractual Frictions and Global Sourcing. En E. Helpman, D. Marin, & T. Verdier, *The Organization of Firms in a Global Economy.* Cambridge MA: Harvard University Press.

Arkolakis, C. (2010). Market Penetration Costs and the New Consumers Margin in International Trade. *Journal of Political Economy* , 1151-1199.

Baltagi, B. H. (2001). *Econometric Analysis of Panel Data.* New York : John Wiley & Sons.

Bernard A. B., Redding SJ, Schott PK. (2010). Multi-product Firms and Product Switching. *American Economic Review.* 100(1): 70-97

Bernard A. B., Eaton J. B., Jensen JB, Kortum SS. (2003). Plants and Productivity in International Trade. *American Economic Review.* 93(4): 1268-90

Bernard A. B., Jensen J. B., Redding SJ, Schott PK. (2009). The Margins of U.S. Trade. *American Economic Review. Papers and Proceedings.* 99(2): 487-93

Bernard, A. B., Jensen, J. B., Redding, S., & Schott, P. K. (2012). The Empirics of Firm Heterogeneity and International Trade. *Annual Review of Economics* , Vol 4: 283-313.

Besedes, T. (2011). Export differentiation in transitioneconomies. *Economic Systems* , 25-44.

Besedes, T., & Blyde, J. (2010). *What Drives Export Survival? An Analysis of Export Duration in Latin America.* Inter-American Development Bank.

Besedes, T., & Prusa, T. J. (2007). *The Role of Extensive and Intensive Margins and Export Growth.* NBER Working Paper No 13628.

Brenton, P., Saborowksi, C., & Uexkull, E. v. (2009). *What Explains the Low Survival Rate of Developing Country Export Flows?* Policy Research. Worling Paper 4951, The Wolrd Bank.

Cadot, O., Iacovone, L., Pierola, D., & Rauch, F. (2010). *Success and Failure of African Exporters.* Working Papers Policy Research. The World Bank No 5657.

Chaney T. (2011). The Network Structure of International Trade.American Economic Review, revise and resubmit.

Cox, D. R. (1972). Regression models and life-tables (with discussion). *Journal of the Royal Statistical Society (Series B)* , Vol 34. 187-220.

Dzhumashev, R., Mishra, V., & Smyth, R. (2011). *Exporting, R&D Investment and Firm Survival.* Monash University. Department of Economics. Discussion Paper 39.

Eaton, J. & Kortum, S. (Forthcoming). *Technology in the Global Economy: A Framework for Quantitative Analysis.*

Eaton, J., Eslava, M., Krizan, C. J., Kugler, M., & Tybout, J. (2010). *A Search and Learning Model of Export Dynamics.* Penn State University, Unpublished.

Eaton, J., Eslava, M., Kugler, M., & Tybout, J. (2008). Export Dynamics in Colombia: Transactions Level Evidence. *Borradores de Economia No. 522, Banco de la Republica.*

Eaton, J., Eslava, M., Kugler, M., & Tybout, J. (2007). *Export Dynamics in Colombia: Firm-Level Evidence.* NBER Working Paper Series, 13351.

Eaton, J. & Kortum, S.(2002). Technology, Geography, and Trade, *Econometrica* 70(5):1741-1779.

Fernandes, A., & Tang, H. (2012). *Learning from Neighbors' Export Activities: Evidence from Exporters' Survival.* Centro Studi Luca d'Agliano Development Studies Working Paper No. 337.

Fugazza, M., & Molina, A. C. (2009). *On the Determinants of Exports Survival.* HEI Working Papers 05–2009, Economics Section, The Graduate Institute of International Studies.

Heckman, J. J., & Singer, B. (1984). A method for minimizing the impact of distributional assumptions in econometric models for duration data. *Econometrica* , Vol 52. 271-320.

Hess, W., & Persson, M. (2011). The Duration of Trade Revisited. Continuous-Time vs.Discrete-Time Hazards. *Empirical Economics (forthcoming)* .

Hsieh, F. Y. (1995). A cautionary note on the analysis of extreme data with Cox regression. *The American Statistical Association* , Vol 49. 226-228.

Hummels, D., & Klenow, P. (2005). The Variety and Quality of a Nation´s Exports. *American Economic Review* , Vol 95. 704-723.

Iacovone, L., & Javorcik, B. (2010). HYPERLINK "http://ideas.repec.org/a/ecj/econjl/v120y2010i544p481-499.html" Multi-Product Exporters: Product Churning, Uncertainty and Export Discoveries , Royal Economic Society, Vol 120(544). 481-499,

Isgut, A. (2001). What's Different About Exporters? Evidence from Colombian Manufacturing. *The Journal of Development Studies*, Vol. 37 (5) , 57-82.

Jenkins, S. P. (1995). Easy estimation methods for discrete-time duration models. *Oxford Bulletin of Economics and Statistics* , Vol 57. 129-137.

Kaplan, E. L.; Meier, P (1958). Nonparametric estimation from incomplete observations.. Journal American Statististic. Assn.Vol 53. 457–481.

Koenig, P., & Mayneris, F., & Poncet, S. (2010). Local export spillovers in France. *European Economic Review, Elsevier, Vol. 54(4). 622-641, May.*

Krautheim S. (2008). *Gravity and Information: Heterogenous Firms, Exporter Networks and the "Distance Puzzle"*, EUI Mimeo.

Lall, S. (2000). The technological structure and performance of developing country manufactured exports, 1995-1998, *Oxford Development Studies*, 28 (3), 337-369.

Lawless, M. (2009). Firm export dynamics and the geography of trade. *Journal of International Economics* , Vol 77. 245-254.

Máñez-Castillejo, J. A., Rochina Barrachina, M. E., Sanchis-Llopis, J. A., & Pérez, E. S. (2007). *A survival analysis of manufacturing firms in export markets.* ETSG Paper 2007.

Marshall, A. 1890. Principles of Economics: An Introductory Volume. London: MacMillan and Co.

Melitz, M. & Ottaviano, G. (2005). *Market Size, Trade, and Productivity*, NBER Working Paper 11393.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* , Vol 71. 1695-1725.

Meyer, B. D. (1990). Unemplyment insurance and unemployment spells. *Econometrica* , Vol 58. 757-782.

Newfarmer, R., Shaw, W., & Walkenhorst, P. (2009). *Breaking into New Markets.* Washington DC: The World Bank.

Nicoletti, C., & Rondinelli, C. (2010). The (mis)specification of discrete duration models with unobserved heterogeneity: A Monte Carlo study. *Journal of Econometrics* , Volume 159. 1-13.

Nitsh, V. (2009). Die another day: duration in German import trade. *Review of World Economics* , Vol 145. 133-154.

Numn, N., & Trefler, D. (2008). The Boundaries of the Multinational Firm: An Empirical Analysis. En E. Helpman, D. Marin, & T. Verdier, *The Organization of Firms in a Global Economy* (págs. 55-83). Cambridge MA: Harvard University Press.

Pallardó López, V., Requena Silvente, F., & Pérez, E. S. (2012). The duration of firm-destination export relationships: Evidence from Spain, 1997-2006. *Economic Inquiry* .

Prentice, R. L., & Gloeckler, L. A. (1978). "Regression analysis of grouped survival data with application to breast cancer data. *Biometrics* , Vol 34. 57-67.

Rauch, J. (1999), Networks versus markets in international trade. *Journal of International Economics* Vol. 48, 7-35.

Reis, J. G. (2011). *Identifying supply-side constraints to exports.* OECD Workshop on Aid for Trade Implementation.

Roberts, M., & Tybout, J. (1997). The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs. *American Economic Review*, 87 Vol 4 , 545-563.

Sabuhoro, J. B., Larue, B., & Gervais, Y. (2006). Factors Determining the Success or Failure of Canadian Establishments on Foreign Markets: A Survival Analysis Approach. *The International Trade Journal* , 33-73.

Schott, P. (2004). Across-Product versus Within-Product Specialization in International Trade. *Quaterly Journal of Economics* , Vol 119(2). 647-678.

Martínez, L. R., & TovarMartínez, J. (2011). Diversification, Networks and the Survival of Exporting Firms. *Documentos CEDE. Factuldad de Economía. Universidad de los Andes.*

Volpe Martincus, C., & Carballo, J. (2008). Survival of New Exporters in Developing Countries: Does It Matter How They Diversify? *Globalization, Competitiveness & Governability. GCG Georgetown University.* , Vol 2. N 3. 30-44.

Wagner, J. (2011). *Exports, Imports and Firm Survival: First Evidence for Manufacturing Enterprises in Germany* .IZA Discussion Paper No. 5924.

APPENDIX

A.1 Description of variables used

Firm level. Variables were obtained from the national export registry. Some come from 1996-2011 period and some from the 2004-2011 period.

Reappearing: Dichotomous variable taking value 1 if the firm has previous exporting experience, durin the observation period, and cero otherwise.
Number of products: Number of HS-four-digit products exported by the firm at time t.
Number of destination markets: Number of countries to which the firm exports at time t.
Scope of export activity: according to trade network definition, number of destination countries for exports of product p by firm f in time t; number of four-digit products that the firm exports to market d at time t; number of product-market combinations the firm exports at time t.

Municipality level. As mentioned in the text they provide from different sources:

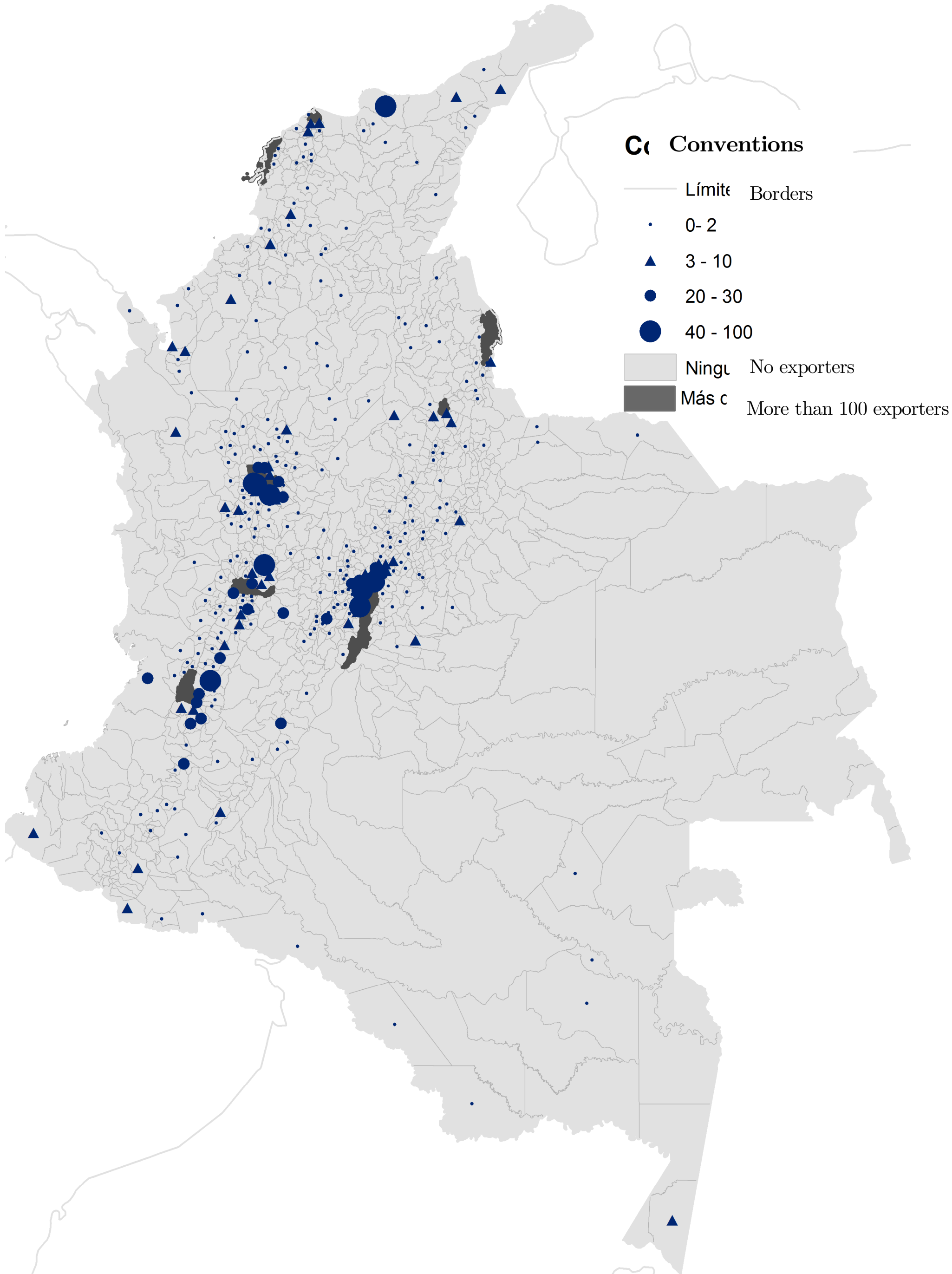
Routes length: primary and secondary routes area in squared kilometers, calculated Arcgis using INVIAS (2009) maps.
Special Economic Zones: Number of active SEZs in municipality i at time t. Source: legislation on SEZs (2011).
GDP per-capita. Estimation based on bank deposits at the municipality level during 2005-2011. Source: Colombian Financial Superintendence.
Number of firms: Share of industrial establishments on total municipal establishments (DNP 2010, based on 2005 Population Census data)
Urbanization rate: Share of urban population on total municipal population (DNP 2010, based on 2005 Population Census data)
Political institutions: A combination of an index that measures public municipal investment per capita (DDTS 2005-20010) and an index of institutional capability at the municipality level (DDTS 2005-2010). Calculation by DNP (2010, on DDTS)
Poverty index: Index of basic unsatisfied needs (2005 Population Census)

Product level. Variables calculated at the HS-four-digit level.
Industry share: Industry's share in total exports (DIAN, 2005-2011)
Types of goods: Based on Rauch's (1999) classification.

Market level. Calculated at the destination market level
Free Trade Agreements (FTAs): Dichotomous variable with value 1 if there is an FTA in place at time t with the destination country and cero otherwise.
Preferential Agreements (PAs): Dichotomous variable with value 1 if there is an PA in place at time t with the destination country and cero otherwise.
Destination markets share: Share of destination market d in total Colombian exports at time t.
World trade growth: Growth rate of world imports, excluding Colombian trade, at the products, markets, or product-market combinations.
International crisis: Dichotomous variable with value 1 for the crisis years for Colombia (2009-2010).

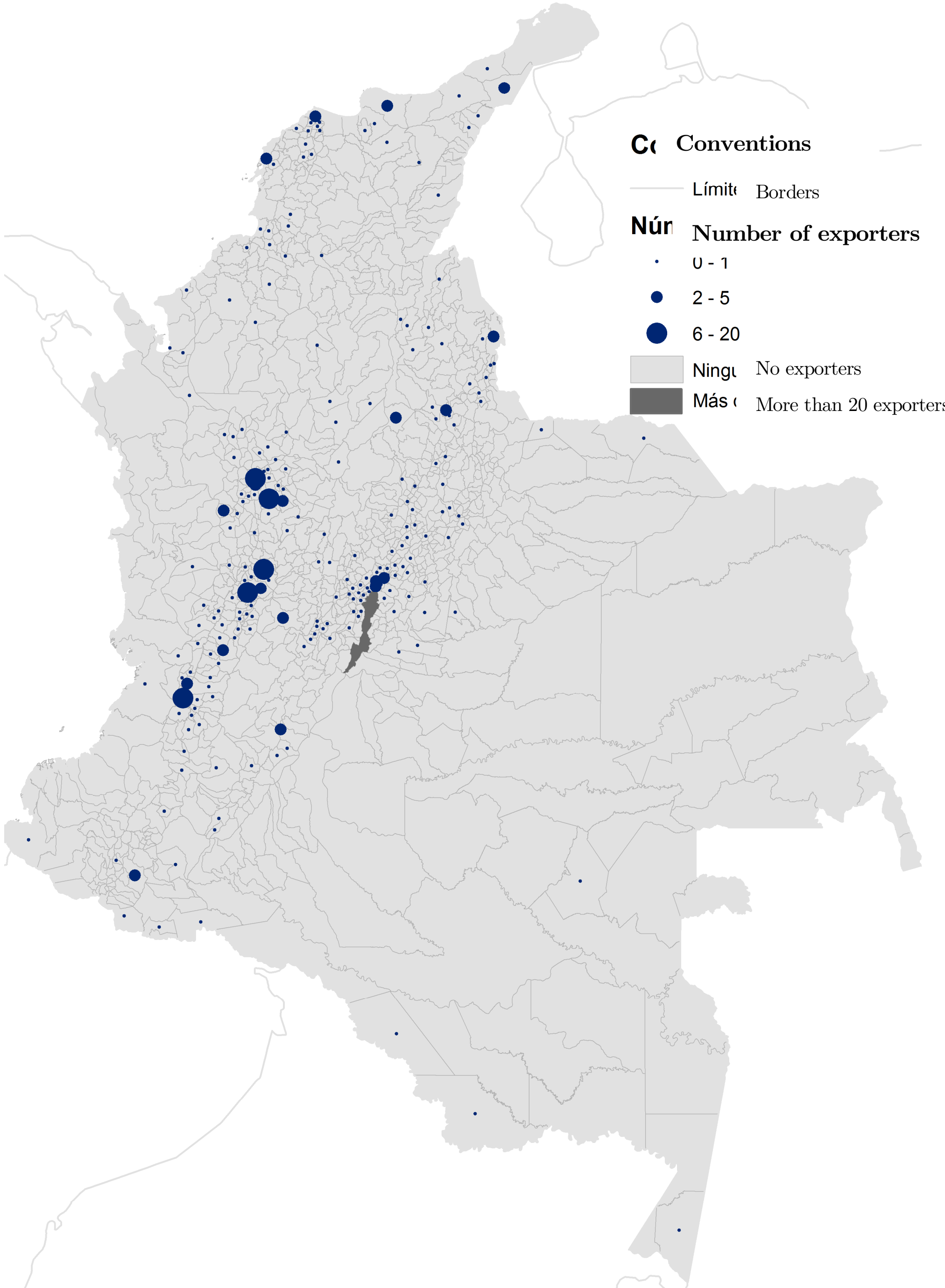
A.2 Graphs

Graph 2. Number of exporters per municipality, 2005



Source: authors' calculation on DIAN data. Maps from IGAC.

Graph 3. Number of exporters of product p to market d by municipality, 2005



Source: authors' calculation on DIAN data. Maps from IGAC.

A.3 Tables

Table 12. Hazard rate estimation for exports of product *p* to market *d*. Different geographical levels: municipality, department, national.

	(1)	(2)	(3)
Network	-0.00525†	-0.00360†	-0.00144†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	398669	398669	398669
ρ	0.425	0.100	0.0944
Loglikelihood	-255304	-258076	-258375

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export the same product p to the same market *d*, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 8, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level.

Table 13. Hazard rate estimation for exports of any product to market *d*. Different geographical levels: municipality, department, national.

	(1)	(2)	(3)
Network	-0.000346†	-0.000244†	0.000234†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	146158	146158	146158
ρ	0.468	0.193	0.196
Loglikelihood	-90704	-91827	-91884

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 9, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level.

Table 14. Hazard rate estimation for exports of product p to any market. Different geographical levels: municipality, department, national.

	(1)	(2)	(3)
Network	-0.000973†	-0.000693†	-0.000143†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	206813	206,813	206,813
ρ	0.294	0.0676	0.0639
Loglikelihood	-128393	-129858	-129959

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 10, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level.

Table 15. Hazard rate estimation for exports of any product to any market. Different geographical levels: municipality, department, national.

	(1)	(2)	(3)
Network	-0.0000885	-0.000044†	-0.00195†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	49087	49087	49087
ρ	0.371	0.117	0.149
Loglikelihood	-29346	-29759	-26786

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 11, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level.

Table 16. Hazard rate estimation for each type of export activity, including networks at a level different from the municipality.

	Product *p* to market *d*	**Any product to market *d***	**Product *p* to any market**	**Any product to any market**
Network (municipality)	-0.00471†	-0.000446†	-0.000993†	-0.000632†
Network (rest)	-0.000723†	-0.000230†	-0.000267†	-0.000155†
Hazard function	√	√	√	√
Firm characteristics	√	√	√	√
Municipality characteristics	√	√	√	√
Trade characteristics	√	√	√	√
Observations	176,364	66,199	95,973	25,165
ρ	0.151	0.489	0.229	0.412
Loglikelihood	-113675	-41708	-60533	-15358

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that carried on the same export activity, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the export activity and firm levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient.

Table 17. Hazard rate estimation for exports of product p to market d. Different ways of defining and measuring networks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Network definitions							
Network	-0.00525†	-1.661†	-0.0519†	-0.0496†		-0.284†	-0.00805†
Network squared							0.0000093†
2 to 4 neighbors					-0.213†		
5 to 9 neighbors					-0.277†		
10 to 29 neighbors					-0.370†		
More tan 30					-0.566†		
Hazard function	√	√	√	√	√	√	√
Firm characteristics	√	√	√	√	√	√	√
Municipality characteristics	√	√	√	√	√	√	√
Trade characteristics	√	√	√	√	√	√	√
Observations	398669	398669	302399	302399	398669	398669	398669
ρ	0.425	0.421	0.243	0.245	0.422	0.411	0.426
Loglikelihood	-255304	-255899	-193792	-193874	-255117	-255473	-255217

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export the same product p to the same market d, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level and export activity levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 8, column (2) corresponds to number of firms squared, column (3) to exported value, column (4) to exported value by squared kilometer, column (5) to different network densities, column (6) dummy with value 1 if the network has at least a neighbor, column (7) number of firms squared.

Table 18. Hazard rate estimation for exports of any product to market *d*. Different ways of defining and measuring networks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Network definitions							
Network	-0.00034†	-182.7†	-0.0790†	-0.0723†		-0.427†	-0.0007†
Network squared							0,000000232†
2 to 4 neighbors					-0.218†		
5 to 9 neighbors					-0.342†		
10 to 29 neighbors					-0.508†		
More tan 30					-0.925†		
Hazard function	√	√	√	√	√	√	√
Firm characteristics	√	√	√	√	√	√	√
Municipality characteristics	√	√	√	√	√	√	√
Trade characteristics	√	√	√	√	√	√	√
Observations	146158	146158	141607	141607	146158	146158	146158
ρ	0.468	0.459	0.432	0.434	0.448	0.446	0.466
Loglikelihood	-90704	-90802	-87561	-87603	-90347	-90721	-90672

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 9, column (2) corresponds to number of firms squared, column (3) to exported value, column (4) to exported value by squared kilometer, column (5) to different network densities, column (6) dummy with value 1 if the network has at least a neighbor, column (7) number of firms squared.

Table 19. Hazard rate estimation for exports of product p to any market. Different ways of defining and measuring networks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Network definitions							
Network	-0.000973†	-426.6†	-0.0287†	-0.0253†		-0.226†	-0.00112†
Network squared							0,000000356†
2 to 4 neighbors					-0.202†		
5 to 9 neighbors					-0.217†		
10 to 29 neighbors					-0.202†		
More tan 30					-0.325†		
Hazard function	√	√	√	√	√	√	√
Firm characteristics	√	√	√	√	√	√	√
Municipality characteristics	√	√	√	√	√	√	√
Trade characteristics	√	√	√	√	√	√	√
Observations	206813	206813	188668	188668	206813	206813	206813
ρ	0.294	0.292	0.244	0.244	0.289	0.284	0.295
Loglikelihood	-128393	-128481	-117143	-117178	-128321	-128392	-128393

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 10, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level. . Column (1) corresponds to column (4) in Table 10, column (2) corresponds to number of firms squared, column (3) to exported value, column (4) to exported value by squared kilometer, column (5) to different network densities, column (6) dummy with value 1 if the network has at least a neighbor, column (7) number of firms squared.

Table 20. Hazard rate estimation for exports of any product to any market. Different ways of defining and measuring networks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Network definitions							
Network	-0.0000885†	-189.0†	-0.0789†	-0.0573†		-0.510†	0.000644†
Network squared							-0.000000103†
2 to 4 neighbors					-0.00653		
5 to 9 neighbors					-0.163		
10 to 29 neighbors					-0.342†		
More tan 30					-0.878†		
Hazard function	√	√	√	√	√	√	√
Firm characteristics	√	√	√	√	√	√	√
Municipality characteristics	√	√	√	√	√	√	√
Trade characteristics	√	√	√	√	√	√	√
Observations	49087	49087	48826	48826	49087	49087	49087
ρ	0.371	0.370	0.341	0.350	0.352	0.355	0.335
Loglikelihood	-29346	-29297	-29159	-29181	-29263	-29368	-29100

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 11, column (2) corresponds to number of firms squared, column (3) to exported value, column (4) to exported value by squared kilometer, column (5) to different network densities, column (6) dummy with value 1 if the network has at least a neighbor, column (7) number of firms squared.

Table 21. Hazard rate estimation for exports of product p to market d. Different informational lags.

	(1)	(2)	(3)
Network	-0.00525†	-0.00450†	-0.00313†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	398669	398669	398669
ρ	0.425	0.0886	0.0986
Loglikelihood	-255304	-257960	-258308

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export the same product p to the same market *d*, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level and export activity levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 8, column (2) corresponds to a two-year lag, column (3) corresponds to information gathered in 2004.

Table 22. Hazard rate estimation for exports of any product to market d. Different informational lags

	(1)	(2)	(3)
Network	-0.000346†	-0.000306†	-0.0000691†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	146158	146158	146158
ρ	0.468	0.170	0.188
Loglikelihood	-90704	-91688	-91911

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 9, column (2) corresponds to a two-year lag, column (3) corresponds to information gathered in 2004.

Table 23. Hazard rate estimation for exports of product p to any market. Different informational lags

	(1)	(2)	(3)
Network	-0.000973†	-0.00118†	-0.000416†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	206813	206813	206813
ρ	0.294	0.0619	0.0630
Loglikelihood	-128393	-129655	-129910

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 10, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level. . Column (1) corresponds to column (4) in Table 10, column (2) corresponds to a two-year lag, column (3) corresponds to information gathered in 2004.

Table 24. Hazard rate estimation for exports of any product to any market. Different informational lags

	(1)	(2)	(3)
Network	-0.0000885†	-0.000111†	0.0000573†
Hazard function	√	√	√
Firm characteristics	√	√	√
Municipality characteristics	√	√	√
Trade characteristics	√	√	√
Observations	49087	49087	49087
ρ	0.371	0.0882	0.114
Loglikelihood	-29346	-29575	-29753

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 11, column (2) corresponds to a two-year lag, column (3) corresponds to information gathered in 2004.

Table 25. Hazard rate estimation for exports of product *p* to market *d*. Stability of coefficients.

	(1)	(2)	(3)	(4)	(5)
Network	-0.00525†	-0.00372†	-0.00386†	-0.00373†	-0.00812†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	398669	209831	228269	238029	245877
ρ	0.425	0.00000724	0.00000101	0.00000109	0.839
Loglikelihood	-255304	-130043	-142308	-148229	-141486

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export the same product p to the same market *d*, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level and export activity levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 8, column (2) uses 2005-2008 as observation period, column (3) uses 2006-2009, column (4) uses 2007-2010, column (5) uses 2008-2011.

Table 26. Hazard rate estimation for exports of any product to market *d*. Stability of coefficients.

	(1)	(2)	(3)	(4)	(5)
Network	-0.000346†	0.0000141	-0.0000204	-0.0000851†	-0.000692†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	146158	72507	82250	88686	94311
ρ	0.468	0.0000213	0.00000282	0.000000465	0.863
Loglikelihood	-90704	-47112	-53049	-56571	-51931

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 9, column (2) uses 2005-2008 as observation period, column (3) uses 2006-2009, column (4) uses 2007-2010, column (5) uses 2008-2011.

Table 27. Hazard rate estimation for exports of product p to any market. Stability of coefficients.

	(1)	(2)	(3)	(4)	(5)
Network	-0.000973†	-0.000786†	-0.000816†	-0.000777†	-0.00180†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	206813	107217	119507	124752	128504
ρ	0.294	6.18e-06	8.63e-07	9.31e-07	0.818
Loglikelihood	-128393	-63874	-71077	-74078	-72633

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 10, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level. . Column (1) corresponds to column (4) in Table 10, column (2) uses 2005-2008 as observation period, column (3) uses 2006-2009, column (4) uses 2007-2010, column (5) uses 2008-2011.

Table 28. Hazard rate estimation for exports of any product to any market. Stability of coefficients.

	(1)	(2)	(3)	(4)	(5)
Network	-0.0000885†	0.00003†	-0.00000674†	-0.0000228†	-0.00017†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	49087	22,436	27,537	30,700	33,229
ρ	0.371	0.0000327	0.00000165	0.000000718	0.85
Loglikelihood	-29346	-14229	-17210	-18841	-17794

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 11, column (2) uses 2005-2008 as observation period, column (3) uses 2006-2009, column (4) uses 2007-2010, column (5) uses 2008-2011.

Table 29. Hazard rate estimation for exports of product *p* to market *d*. Different population subgroups.

	(1)	(2)	(3)	(4)	(5)
Network	-0.00525†	-0.00274†	-0.0357†	-0.00359†	-0.00284†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	398669	172384	294438	309887	88782
ρ	0.425	0.0588	0.0898	0.0807	0.116
Loglikelihood	-255304	-110841	-190280	-198174	-53864

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export the same product p to the same market *d*, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level and export activity levels. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 8, column (2) excludes observations with network density equal to cero, column (3) excludes observations with network density greater than 10, column (4) only considers monoplant firms, and column (5) only considers multiplant firms.

Table 30. Hazard rate estimation for exports of any product to market *d*. Different population subgroups.

	(1)	(2)	(3)	(4)	(5)
Network	-0.000346†	-0.000393†	-0.0510†	-0.000269†	-0.000208†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	146158	132340	22706	99481	46677
ρ	0.468	0.210	0.145	0.147	0.219
Loglikelihood	-90704	-82233	-14708	-63204	-26847

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that export to the same market, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 9, column (2) excludes observations with network density equal to cero, column (3) excludes observations with network density greater than 10, column (4) only considers monoplant firms, and column (5) only considers multiplant firms.

Table 31. Hazard rate estimation for exports of product p to any market. Different population subgroups.

	(1)	(2)	(3)	(4)	(5)
Network	-0.000973†	-0.000754†	-0.0314†	-0.000666†	-0.000737†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	206813	156228	81379	144266	62547
ρ	0.294	0.0745	0.0335	0.0526	0.109
Loglikelihood	-128393	-97557	-51388	-89916	-35866

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the same product p, the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity and homogenous products. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 10, column (2) corresponds to estimates when networks are defined at the departmental level, and column (3) when defined at the national level. . Column (1) corresponds to column (4) in Table 10, column (2) excludes observations with network density equal to cero, column (3) excludes observations with network density greater than 10, column (4) only considers monoplant firms, and column (5) only considers multiplant firms.

Table 32. Hazard rate estimation for exports of any product to any market. Different population subgroups.

	(1)	(2)	(3)	(4)	(5)
Network	-0.0000885†	-0.0000919†	-0.00481†	-0.000166†	-0.0000402†
Hazard function	√	√	√	√	√
Firm characteristics	√	√	√	√	√
Municipality characteristics	√	√	√	√	√
Trade characteristics	√	√	√	√	√
Observations	49087	48180	1683	24162	24925
ρ	0.371	0.133	0.140	0.0724	0.140
Loglikelihood	-29346	-29119	-1020	-15286	-13673

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Estimations were performed by means of a complementary log-log model, with constant and random effects at the firm level. Excluded categories correspond to first year of export activity. Marginal value of the network effect is the same as the estimated coefficient. Column (1) corresponds to column (4) in Table 11, column (2) excludes observations with network density equal to cero, column (3) excludes observations with network density greater than 10, column (4) only considers monoplant firms, and column (5) only considers multiplant firms.

Table 33. Hazard rate estimation for export activities. Logistic panel estimation.

	Product *p* to market *d*		Any product to market d		Product *p* to any market		Any product to any market	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Network	-0.0069†	-0.0042†	-0.00045†	-0.0016†	-0.0014†	-0.0034†	-0.00013†	-0.00034†
Hazard function	√	√	√	√	√	√	√	√
Firm characteristics	√	√	√	√	√	√	√	√
Municipality characteristics	√	√	√	√	√	√	√	√
Trade characteristics	√	√	√	√	√	√	√	√
Observations	398669	152650	146158	62677	206813	78209	49087	20830
ρ	0.418		0.382		0.330	.	0.366	.
Loglikelihood	-255172	-21524	-90519	-9120	-128756	-11016	-29426	-2944
Random effects	Si	No	Si	No	Si	No	Si	No
Fixed effects firm-activity	No	Si	No	Si	No	Si	No	Si

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. Observation unit is the combination firm-export activity. Column (1) for each estimation uses random effects and column (2) fixed effects. All models have a constant and the excluded categories are first year of export activity and homogeneous goods. Fixed effects cannot estimate coefficients for variables with no variance within the firm-export activity combination and exclude variables where there is perfect prediction. Marginal value of the network effect is the same as the estimated coefficient.

Table 34. Hazard rate estimation for export activities. Linear probability estimation.

	Product *p* to market *d*	Any product to market d	Product *p* to any market	Any product to any market
	(1)	(2)	(3)	(4)
Network	-0.000215†	-0.00000221	-0.0000629†	-0.0000923†
Hazard function				
2	-0.0650†	0.0117†	-0.0227†	0.199†
3	-0.0750†	0.0187†	-0.00938Δ	0.234†
4	-0.0735†	0.0314†	-0.0287†	0.216†
5	-0.0569†	0.0516†	-0.00220	0.194†
6	-0.0618†	0.0871†	-0.0103	0.224†
7	-0.0677†	0.0837†	-0.0180	0.132†
International crisis	-1.019	-1.243	0.174	0.532
Scope of export activity	-0.00284†	-0.0132†	-0.0399†	0.00289†
Number of destn markets	-0.00284†	-0.0000745	0.000149	-0.0322†
Number of products	0.000978†	0.00000942	0.00247†	-0.0129†
Reappearing	-0.0899†	-0.0827†	-0.135†	-0.619†
Number of SEZs	0.0290†	0.0182Δ	0.0430†	0.0733†
Fixed effects activity-year	Si	Si	Si	Si
Fixed effects firm-municipal.	Si	Si	Si	Si
Observations	399,114	146,412	207,221	49,303
R-squared	0.009	0.013	0.039	0.290

Source: authors' calculation on DIAN data. Network is the number of neighboring firms (same municipality) that exported to the same market the year before. Estimated coefficients are significant at: 1% †, 5% Δ, and 10% *. All models have a constant and the excluded category is first year of export activity. Marginal value of the network effect is the same as the estimated coefficient.