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Financing Time to Trade : Evidence from French firms

Pauline BOURGEON, Jean-Charles BRICONGNE, Guillaume GAULIER

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Financing Time to Trade

Evidence from French firms

Pauline Bourgeon*, Jean-Charles Bricongne**, Guillaume Gaulier**

Abstract¹

Using a very detailed set of French firms' data on trade flows and balance sheets, this paper analyses to what extent firms' financial frictions, considered as the interaction of financial dependence and financial constraints, and trading time affect their trade flows. In this empirical study the main indicator taken for firm's financial constraint, namely payment incident occurring at firm's partner is exogenous, whereas "traditional" financial indicators in other studies are not.

The notion of trading time encompasses the whole time-lag between the production of export goods and the receiving of the revenues generated by these exports (time in transit, time at borders, etc.). In estimations, we both use distance as a proxy and a precise indicator computed by adding shipping time and average time spent at borders (only available for a sub-sample of extra-EU countries).

The empirical results obtained so bring evidence that trading time amplifies the negative effect of financial restrictions on trade. By computing the marginal effect of financial constraint over bilateral trade we confirm that it represents a significant barrier to export for destinations beyond 3500 kilometers away.

Keywords: distance interaction, financial frictions, gravity equations, trade patterns, trading time

JEL codes: F02, F10

* Banque de France and PSE/Paris 1

** Banque de France

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1. Introduction

International trade induces specific risks and costs, it also requires longer time to ship goods and this time represents an extra opportunity cost since the longer trading time is, the higher working capital needs are. International trade is therefore more dependent on the financial sector than domestic transactions. Understanding better the impact of financial frictions and trading time on bilateral trade may help to identify more precisely the determinants of bilateral trade.

The idea that the financial sector directly affects the structure of international trade has arisen a pretty long time ago with the article of Bardhan & Kletzer (1987). By studying the asymmetry of specialization of the North versus the South, it finds that the financial development does play an important role. Indeed, rich countries having a more efficient financial sector offer lower credit costs and could thus specialize in capital-intensive goods which require more working capital. Other latter articles have empirically confirmed these theoretical findings.

At the firm-level, the literature on financial frictions and trade performance has emerged through the recent theoretical framework of the “new-new trade” theory. The theory of heterogeneous firms (Melitz (2003)) offers a new source of explanation for trade patterns. Indeed, according to this model, firms need to attain a productivity threshold to face the specific sunk cost of exporting. Thus, countries will export to a partner if domestic firms attain a sufficient level of productivity to export. Exploiting this theoretical framework, Chaney (2005) demonstrates that access to finance may also directly affect the firm’s export decision. So the more productive a firm is and the more access to finance it has, the more likely it is to export. Restrictive access to finance constitutes an additional obstacle to firm’s entry on foreign markets and therefore at the aggregate level influences the structure of international trade flows.

Beyond the question of productivity and financial access at the level of firms, we want to focus on the impact of trading time on bilateral trade. By trading time, we consider both time needed to ship the goods to the foreign destination and time necessary to prepare an international delivery (time to ship merchandise to the border, time to fulfill the customs statement, etc...). The recent empirical studies on financial frictions at the level of exporting firms have revealed that this issue of financial access at the level of firm is all the more essential as it concerns exports, which induce longer time lag between producing goods and receiving revenues from exports (Feenstra & al. (2011), Schmidt-Eisenlohr (2011)). As Amiti & Weinstein (2009) notice, it is usual for goods to spend nearly two months in transit. To cover this cost associated to goods produced but still in transit, exporting firms have higher liquidity needs. In our study, we want to analyze the combined effect of financial constraint and trading time on bilateral trade. To measure trading time, we will first use distance as a proxy and then a specific indicator of trading time that measures precisely the whole time lag between production and receiving revenues from the exports.

In order to capture this effect on bilateral trade, we will exploit a unique French firms dataset covering the period from 1995 to 2007. This one provides us an exogenous variable of financial constraint at the level of firm besides giving us traditional financial indicators present in the firms’ balance sheet. In this kind of empirical studies, endogeneity is a real matter since traditional measures of financial constraints are directly observed in firms’ balance sheet and a reverse causality may happen. Indeed, exporting activities may generate extra-revenues and improve firms’ financial situation.

A large body of work has already studied the link between financial constraints and trade. While they are mainly focused on the export behavior of constrained firms or on periods following major financial shocks, they do not consider trading time as an extra trade barrier for financially constrained firms. Our work aims at capturing the impact of financial frictions and trading time on the structural trade relations between exporters and their destination partners.

The rest of the paper will be organized as follows. In a second section, we expose in details our motivations by recalling the results of the related literature. Section three describes our empirical strategy. Section four details our data and exhibits some stylized facts by interpreting descriptive statistics on the French firms. Section five is an interpretation of our results and explores the robustness of these results. Finally section six concludes.

2. Motivations

International trade is associated to higher costs than domestic transactions. And these extra costs force exporting firms to hoard a higher amount of liquidity.

Indeed, export is associated to higher costs and higher risks for several reasons. First, there are several fixed costs associated to the entry on a foreign market:

- Information costs: to learn the characteristics of this new market, and getting this information abroad is usually costlier than in the home country.
- Research, development and marketing costs: often, firms need to develop a product meeting the particular standards and needs of the customers of each destination served.
- Distribution network build-up costs: to reach individual customers abroad, firms need to build a distribution network.

Second, there are some variable costs on top of the traditional variable production costs. Transportation costs and duties need to be added to the different costs faced by exporters.

Moreover, exporters experience a longer time-lag between the time of production and the time they receive revenues from their foreign sales. This time-lag is almost equivalent to what we call “trading time”. On the exporter side, there is an uncertainty over the timing of payment from the importer.

Most often, all those costs need to be paid before getting revenues from exports. It is the reason why exporters need a higher level of liquidity than non-exporters. This is ascertained by the empirical results from Campa & Shaver (2002) which use balance sheet data from Spanish manufacturing firms, and notably cash flows to measure the liquidity constraint.

Besides, export includes a higher level of risk than domestic transactions. There is a risk associated to the shipment of products; another one is associated to the enforcement of the contract. So, to meet the liquidity needs and to finance the risks associated to export, firms need to have unrestrictive access to finance.

Several empirical studies have already brought large proofs on the impact of financial frictions on trade at the firm’s level. It appears that financially constrained firms are less likely to export, to fewer destinations, fewer volumes and lower varieties (Manova & al. (2011), Muùls (2008), Minetti & Zhu (2011), Askenazy & al. (2011)). It is also clear that financial constraints could be assimilated to a determinant of the export selection and it reinforces this selection.

Another part of the literature on firms’ financial restrictions and trade concentrated on specific episodes of liquidity restrictions. The liquidity shortage resulting from aggregate financial shocks may strengthen the financial constraints at the level of firm. Several papers find an obvious transmission mechanism between the liquidity shortage and the trade collapse (Chor & Manova (2011), Amiti & Weinstein (2009), Paravisini & al. (2011)). Some other works find a significant link between the increase of financial constraints and the fall of international trade (Bricongne & al. (2011), Levchenko

& al. (2009)). In this work, we will not consider the specific case of financial crises but these results encourage us to bring new empirical evidence of the impact of financial factors on trade.

Another issue is the question of exogeneity. To be able to evaluate the impact of financial constraints over trade, financial indicators retained should be as exogenous as possible. Indeed, a reverse causality may happen, as Greenaway et al. (2007) states it: participation in export markets may well improve firms' financial health and then alleviate financial constraints. To avoid the problem of endogeneity, the best potential indicators should be related to external constraints. All the papers we mentioned above, except Minetti & Zhu (2011) may suffer from an endogenous bias. Minetti & Zhu (2011) are among the only ones to propose an exogenous indicator, based on a survey. The main indicator we use also relates to an external constraint, namely payment incidents occurring at firm's partners, which is external to the firm, but that is likely to influence its financial soundness and thus its level of financial constraint.

As we explained it in the introduction, beyond the question of firms' financial constraints as a trade barrier, we want to deeper analyze the impact of trading time as an additional barrier. As stressed in most of the literature, the time-lag between the production of export goods and the receiving of the revenues generated by these exports is a determinant of financial constraints (Amiti & Weinstein (2009), Feenstra & al. (2011), Schmidt-Eisenlohr (2011)).

Distance between the export country and the destination one is not a fully satisfying proxy of this time lag since it does not take into account the time between the firm and the domestic border or the time spent at the borders in the customs areas. To illustrate the potential disjunction between the geographical distance and the time needed to export to a destination by sea (time spent during transport and at borders) we can compare two countries. In a sample of 91 extra-EU countries, Côte d'Ivoire ranks as 18th in terms of distance and 66th in terms of sea trading time while Hong Kong ranks as 84th in terms of distance and 40th in terms of sea trading time.

Nevertheless, correlation between the two indicators (distance and trading time) is high, close to 0.9.

Even if distance is not a perfect proxy, it is still essential to consider it in our study. As Forlani (2010) states it, fixed costs associated to export are related to distance.

To the best of our knowledge, the first noticeable work doing with the impact of trading time on trade flows is Hummels (2001). It quantifies the cost of time for trade. According to this estimation each extra day spent in transport reduces the probability that the U.S will source from this country by 1 to 1.5 %. The costs associated to shipment time are from different nature. First, there are costs associated to the holding of inventories during shipment and the necessity for the importers to constitute inventories in case of the delivery delay. Delays matter because when it is about international trade, a delivery could have some days or even weeks of delay. Second, there are depreciation costs associated to the goods shipped and the amount of depreciation depends on the type of good (perishable, fashion goods, etc.) and their corresponding stage in the production chain. This article only studies the differences of shipment time between air shipment and sea shipment. It reinforces the statement that time-lag in the domestic country before international shipment, and the time-lag between the arrival in the destination country and the delivery do play a major role.

This latter is asserted by the paper from Martinez-Zarzoso & Novak-Lehmann (2006) which notices that trading time plays a more crucial role when there are only a few trade barriers. In the absence of official trade barriers, trading time represents the main restraint of international trade. As trade barriers have largely decreased over the last two decades, we can legitimately think that trading time is a significant determinant of trade patterns.

A more recent paper, Hummels (2007) demonstrates that the choice of freight mode depends on the effect on the shipment price. It seems that even if the faster transport mode is costlier, consumers will choose the fastest and most expensive transport mode if the difference on the delivery price is small. But evaluating the cost of trading time depends on the timeliness sensitivity of the shipped products. According to Evans & Harrigan (2003) timeliness sensitivity reflects the necessity for a product to be restocked several times during a selling season. So, even if trading time embodies a trade barrier, trading time affects firms with more heterogeneity than tariffs.

Of course, in a historical perspective the importance of trading time has decreased since the transportation time has continuously decreased over the last five decades thanks to technological changes.

To better approximate trading time, as Djankov & al. (2010), we decide to use a dataset from the World Bank which gives us a measure of the number of days and documents needed to prepare an international shipment. It is very important to take it into account since there is more heterogeneity across countries for this indicator than for geographical distance and more important, moving products from factory to ship could take more time than between the source country and the destination one. In their article, they estimate that an additional day of delay reduces exports at least by 1% and this is even more considerable for time sensitive products.

In the light of all those findings, we want to strengthen the analysis of financial constraints on international trade patterns by investigating the impact of trading time on these interactions. Since our indicator of trading time is only available for extra-EU export destinations, we will also use distance between two countries as a proxy to consider a larger sample of countries.

With our empirical study, we want to analyze the combined effect of financial frictions and trading time on bilateral trade, using an exogenous financial variable and an accurate measure of trading time. By doing so, we will bring new empirical evidence on the role played by financial frictions and trading time as trade barrier.

3. Empirical strategy

The gravity equations we use in order to capture the effect of financial factors and trading time on bilateral trade rely on the equations used by Schmidt-Eisenlohr (2011). As for all types of gravity equations bilateral trade is determined by the revenues and the size of the two trading partners but contrary to more traditional gravity equations, we do not consider a pair of two countries since we want to introduce a firm dimension. Thus, we consider an equation where traders are French firms and their partners are countries with which they trade.

Our goal is to measure the impact of the combined effect of financial frictions (considered as the interaction of financial dependence and financial constraints) and trading time (measured by a specific indicator or proxied by distance) on bilateral trade.

To conduct our empirical study, we estimate the following gravity equation by the following multiplicative interaction model. To estimate this model properly, we follow the recommendations from Brambor & al. (2006).

Box 1 – Baseline specification

$$\ln EX_{ijst} = \beta_1 \ln(\text{Financial Indicator}_{it}) + \beta_2 \ln(\text{itime}_{ij}) * \ln(\text{Financial Indicator}_{it}) + \beta_k X_k + \chi_i + \chi_j + \chi_t + \chi_s + \varepsilon$$

In this specification, i refers to a French firm and j to its trading partner country, t to time and s to the sector to which the French firm belongs to. The different financial indicators are detailed in the following paragraph.

The vector X_k is a vector of control variables. Since, we use firm (χ_i), country (χ_j), time (χ_t) and sector (χ_s) fixed effects we do not need to control for a large number of variables. As we know from empirical research at firms' level (Bernard & al. 2007), that size and productivity are essential determinants of export performance, we control for both. For size we consider the total amount of balance sheet and for productivity, we take the value added per employee.

Recently, Stiebale (2011) contradicts empirical findings on financial constraints and trade performance at firms' level and argues that all the previous works overestimated the effect of financial constraints on exports at the firm-level. According to this article, the overestimation comes from unobservable factors that directly influence the decision of exporting. Using an empirical specification which controls for unobserved heterogeneity, it demonstrates that the impact of financial constraints on export status disappears. Aware of this latter objection, we try to control better these unobservable factors with accurate fixed effects listed above.

Here, the variable $ttime_{ij}$ refers to our two measures of trading time. We use both distance and the specific indicator we build to estimate this baseline specification. Note that we do not include the variable $ttime_{ij}$ as an explanatory variable (outside the interaction with financial indicators). As Brambor & al. (2006) demonstrates it, we cannot rightly estimate a multiplicative interaction model without including all the constitutive terms from the interaction. Yet, in our specification we do not include $ttime_{ij}$ since it is already captured by the country fixed effect.

To assess financial conditions at the firm level, we use different indicators of financial constraints and financial dependence. The intuition is, when a firm is very dependent on the financial sector, it may face a restrictive access to future financing facilities since previous financial charges may represent a substantial burden. We use a measure of dependence to the financial sector which is computed as the ratio of the total amount of financial charges over total amount of debts net from social debt. The higher this ratio, the more dependent from the financial sector a firm is. Thus, we understand that a high level of financial charges may be assimilated to a financial constraint for a firm. We will use this indicator interacted with financial constraints indicators, and as a single proxy of financial constraint.

The second variable we use is a very accurate measure of financial constraint. It is the yearly amount of payment incident generated by a firm to its trade partners. It comes from a database from Banque de France which registers any incident of a firm failing to pay its creditors². We consider this measure as very precise one since this information is available to banks. Thus, before lending to a firm, the bank will check the creditworthiness of the firm thanks to this payment incident database. It is important to notice that this payment incident database takes into account only French transaction failures. Nevertheless, it has no consequence on our approach since the banks (potential lenders) will have access only to this available information about domestic payment incidents. They will take the decision to grant the loan based on this information. In our specification, we use these payment incidents by considering the ratio of the amount of payment incident generated by the firm over the amount of total asset. The higher the ratio is, the more financially constraint a firm is.

² More information about this variable are available in section 4.Data

The previous financial variables may present an endogenous bias since a reverse causality may happen. We still exploit the payment incident database. This kind of indicator has been used by Bricongne et al. (2011) and Aghion et al. (2010). Yet, this indicator raises some potential econometric problems, since a third variable, namely the firm's financial health, may influence both payment incidents and its behavior (trade for instance). As already suggested, by generating new revenues, export activities may relax the financial constraint. We solve this problem by considering not the payment incidents occurring with the firm itself, but with its partners. Indeed, since it concerns other firms, it should be exogenous, and if the amounts at stake are substantial, it should influence negatively the firm financial health, and thus its financial constraint. As mentioned previously, our database does not cover payment incidents from foreign partners. In other words, if a foreign partner generates a payment incident the database will miss it, but it should not induce any additional financial constraint on the French firm since French banks will not get the information about the foreign payment incident anyway. In the specification, we will consider the ratio of total amount of payment incidents from partners over the total amount of assets. The higher the ratio is, the more financially constraint a firm is.

The exogeneity of the partner's payment incident variable is confirmed by three different methods:

- We first control the lack of reverse causality by performing a Sims-like relation (Cf. Sims (1972)). We regress payment incidents on their own lagged value and on lagged values of exports, with fixed effects for firms, sectors and years. To neutralize relations that may come from size effects, we use ratios with total balance sheets as denominators. We find that coefficients of exports variables are not significant, which confirms the lack of causality from lagged values of exports.
- We use the Hausman test of variables using financial charges. The model is first estimated by instrumenting these variables with payment incidents. The model is then estimated with OLS and the Hausman test implemented. The probability test being smaller than 10%, the instruments based on payment incidents perform better in terms of exogeneity.
- We also check that the correlation of variables using incident payments with the residual of the model of column (5) is null, which is the case.

We know from our dataset, that a financial constraint is not necessarily correlated with a high level of financial dependence. We think that these alternative measures of financial constraints should be mixed with financial dependence. Indeed, the most restricting situation of financial frictions is when a firm is both financially dependent and constrained. If a firm is financially constrained and not very dependent, financial frictions should not affect it significantly.

By exploiting this unique dataset, we run the baseline specification to analyze the impact of firm's financial frictions interacted by trading time (also proxied by distance).

4. Data

We construct a dataset on French firms using several sources.

We use French individual exports of goods data which are recorded on a monthly basis by the French customs. In order to combine these variables with firms' balance sheet data, we aggregate exports on a yearly basis. Export flows are not systematically registered, the Customs apply different thresholds for the declaration of exports. Flows with non-EU countries are registered from 1,000 Euros, while exports to an EU-member state require a compulsory declaration if the yearly cumulated value of exports to the other EU member states is larger than 150,000 Euros.

Each individual firm is designated by its identification number (SIREN) which is also the registration number used in the corporate accounts dataset. We use the firms' tax returns registered by the French Tax Authority (Direction Générale des Finances Publiques). It gathers all the items of the income statement and the balance sheet of a large sample of French firms. This dataset captures 94% of the aggregate turnover.

The main indicator of financial constraint used is payment incidents occurring at firm's partners. It is taken from a database from Banque de France. Indeed, since 1992, French banks have been legally obliged to report within four business days, any incident of a firm failing to pay its creditors. These defaults on credits are called payment incidents. The Banque de France collects this information and makes it available to all credit institutions, for all the incidents of the previous 12 months. These payment incidents can be regarded as credit constraints, since they adversely affect the probability of contracting a new loan and the size of a new loan.

To approximate trading time between France and its trade partners, we build a specific indicator. First, we use a dataset from Eurostat-Comext called "EXTRA EU27 Trade Since 1999 By Transport Mode (NSTR)"³. Thanks to these data, we determine for each product the main transport mode used by country of destination for each year. We only hold the observations related to products traded by air and sea. Then we associate time transport duration to each country by transport mode. We consider that on average transporting goods by air to any destination required 1.5 day. For transport by sea, we compute the number of days spent at sea between the capital city of the destination country and Le Havre⁴ thanks to the website <http://e-ships.net/>. The same kind of indicator is used by Berman & al. 2011.

With transport time, we add up the average number of days required to import goods in a country (unloading and delivering). This indicator is provided by the World Bank and its Doing Business database. It takes into account the time required to unload a cargo, the administrative requirements to import merchandize in a country and the average time required to deliver the imported goods.

So, we combine these datasets to get information about firms' trade flows and their financial situations. We cover the period from 1999 to 2007. As we want to analyze trade flows, we need to add other determinants of trade associated to the countries we consider. We use the database Distances from the CEPII (Centre d'Études Prospectives et d'Informations Internationales) to add traditional variables used by gravity models (GDP, common language...).

³ More information is available at: <http://epp.eurostat.ec.europa.eu/newxtweb/>

⁴ Le Havre is the main French commercial harbour in the North of France.

5. Estimations and results

5.1. A first glance at the data

Before starting with a more rigorous empirical analysis, we will describe our sample thanks to summary statistics and simple correlations from the data.

From our dataset, we confirm the standard results from empirical studies that only a few numbers of firms do export. Indeed, over the period 1995-2007, from table 1 we observe that only 21% of firms export. We do not observe a significant difference between exporters and non-exporters in terms of financial dependence but in terms of payment incidents. On average, non-exporting firms fail to their creditors for a total amount representing 0.22 % of their total assets which is the same order of magnitude as for exporting firms. What is more interesting is the fact that partners' payment incident represents on average 2% of the total assets of exporters while it is only 0.67% for non-exporters. It gives a hint that exporters are more financially constrained than non-exporters.

Table 1 – Financial variables of exporters vs. non-exporters

	Exporters				Non-exporters			
	N	Mean	Median	Std.	N	Mean	Median	Std.
$Fi_dependence_{it}$	1 326 895	0.04	0.02	3.06	4 964 127	0.04	0.02	6.07
$Firm_PI_{it}$	1 326 895	0.08	0.00	2.49	4 964 127	0.22	0.00	4.01
$Partner_PI_{it}$	1 326 895	2.12	0.00	119.85	4 964 127	0.67	0.00	55.66

$Fi_dependence_{it}$: financial dependence; measured by the ratio of the total amount of financial charges over total amount of debts net from social debt

$Firm_PI_{it}$: firm's payment incident. It is the ratio of the amount of payment incident over the amount of total assets.

$Partner_PI_{it}$: payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Note: this sample excludes firms belonging to financial sector and real estate sector.

Sources: BRN (Direction Générale des Finances Publiques), DGDDI (French Customs), payment incidents database (Direction des Entreprises, Banque de France)

To confirm our intuition that measures of financial dependence and financial constraint provide completing information about financial situation at firm's level, we compute the correlations between the three indicators we consider in our estimations. Table 2 shows that correlations are positive but weak. It therefore ascertains the relevance of using different indicators of financial constraints to test empirically our theory.

Table 2 – Correlations between financial indicators

	$Fi_dependence_{it}$	$Firm_PI_{it}$	$Partner_PI_{it}$
$Fi_dependence_{it}$	1.0000	0.0158 <.0001	0.0442 <.0001
$Firm_PI_{it}$		1.0000 <.0001	0.0280 <.0001
$Partner_PI_{it}$			1.0000
Observations	3 054 608		

$Fi_dependence_{it}$: financial dependence; measured by the ratio of the total amount of financial charges over total amount of debts net from social debt

$Firm_PI_{it}$: firm's payment incident. It is the ratio of the amount of payment incident over the amount of total assets.

$Partner_PI_{it}$: payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Sources: BRN (Direction Générale des Finances Publiques), DGDDI (French Customs), payment incidents database (Direction des Entreprises, Banque de France)

To measure the financial constraint at firm's level, we exploit the payment incident variable. Since it is not a traditional measure of financial constraint, we describe it in table 3. In our sample, only 21.9% of firms fail at least once to pay their creditors and on average the yearly amount of payment incident represents 5% of their total assets. In this table, we also observe that only 2.5% of firms had to deplore payment incidents from their partners, and on average it counts for 2.5 of their total assets.

Table 3 – Payment incident variables

	N	% of obs.	Mean	Median	Std. dev.
$Firm_PI_{it}>0$	667 972	21.9	5.0	3.1	4.8
$Partner_PI_{it}>0$	76 238	2.5	2.3	1.6	2.6
Observations	3 054 608				

$Firm_PI_{it}$: firm's payment incident. It is the ratio of the amount of payment incident over the amount of total assets.

$Partner_PI_{it}$: payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Sources: BRN (Direction Générale des Finances Publiques), DGDDI (French Customs), payment incidents database (Direction des Entreprises, Banque de France)

The statistics of table 1 confirm the relevance of estimating the gravity equation previously exhibited since they confirm that financial frictions may influence bilateral trade. And as we see in tables 2 and 3, financial constraint and financial dependence might impact firm's export behavior differently.

5.2. Results

We first estimate our baseline specification by considering financial interactions (considered as the interaction of financial dependence and financial constraints) and distance. To estimate our model properly we include all the constitutive terms of the double multiplicative interaction: $Financial\ dependence_{it} * Financial\ constraint_{it} * dist_{ij}$ (cf. Brambor & al. 2006)⁵. Even if all couples of interactions and single variables are explanatory variables, we are only interested by the estimator of this double interaction (in bold in Table 4).

To measure firm's financial constraint we use both firm's payment incident variable and firm's partners' payment incident variable. As expected, we then find a negative coefficient associated to the interaction of financial frictions (financial constraint interacted by financial dependence) and distance. The instrument used, namely payment incidents with partners is significant at 1% level, whereas the variable based on the firm's own incidents is only significant at 10% level.

Nevertheless, even if these coefficients have the expected sign, they should not be interpreted directly as the marginal effect of financial frictions. In simpler estimation models, the estimator is the average effect of the explanatory variable on the dependent one. However, in this multiplicative interaction model due to the other variables added, estimator is not directly equal to the partial derivative of $\log(\text{exports})$ with respects to financial frictions. In this case, estimator is very hard to interpret.

In order to be able to interpret directly the marginal effect of financial factors, we state a more simple regression that only interacts financial constraint (or financial dependence) with distance (table 5).

⁵ Estimating a three order interaction model with variables X, Z and J requires to include all constitutive terms : X, Z, J, XZ , XJ and ZJ additional to XZJ.

Table 4

Dependent variable	<i>Exports_{ijt}</i>	
	(1)	(2)
<i>Fi_dependence_{it}</i>	0.1770** (0.0064)	0.1626*** (0.0067)
<i>Firm_PI_{it}</i>	-0.1333 (0.1365)	
<i>Partner_PI_{it}</i>		0.3230*** (0.0271)
<i>Fi_dep_{it} * Firm_PI_{it}</i>	0.0716** (0.0352)	
<i>Fi_dep_{it} * Partner_PI_{it}</i>		0.0238*** (0.0069)
<i>Fi_dep_{it} * dist_{ij}</i>	-0.0215*** (0.0008)	-0.0196*** (0.0008)
<i>Firm_PI_{it} * dist_{ij}</i>	0.0190 (0.0182)	
<i>Partner_PI_{it} * dist_{ij}</i>		-0.0411*** (0.0035)
<i>Fi_dep_{it} * Firm_PI_{it} * dist_{ij}</i>	-0.0084* (0.0046)	
<i>Fi_dep_{it} * Partner_PI_{it} * dist_{ij}</i>		-0.00282*** (0.0009)
<i>Balance sheet_{it}</i>	0.4167*** (0.0040)	0.4160*** (0.0040)
<i>Productivity_{it}</i>	0.1141*** (0.0030)	0.1147*** (0.0030)
<i>GDP_{jt}</i>	0.3671*** (0.0078)	0.3726*** (0.0078)
R ²	0.4203	0.4205
N	3 054 608	3 054 608
# firms	118 524	118 524
# countries	158	158
# sectors	28	28
# years	13	13
Fixed effects	Firm, time, country, sector	

Fi_dependence_{it} : financial dependence; measured by the ratio of the total amount of financial charges over total amount of debts net from social debt

Firm_PI_{it} : firm's payment incident. It is the ratio of the amount of payment incident over the amount of total assets.

Partner_PI_{it} : payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Note: ***: significant at 10% level **: significant at 5% level *: significant at 1% level. Standard errors are in brackets.

Sources: French customs, French Tax Authority (BRN), World Bank, CEPII

* This sample excludes all firms belonging to financial sector, real estate sector

By estimating this less complex interaction model (cf. table 5), we will be able to compute the marginal effect of financial constraint over bilateral exports.

Table 5

<i>Dependent variable</i>	<i>Exports_{ijt}</i>	
	(1)	(2)
<i>Fi_dependence_{it}</i>	0.1773*** (0.0064)	
<i>Partner_PI_{it}</i>		0.2408*** (0.0072)
<i>Fi_dep_{it} * dist_{ij}</i>	-0.0215*** (0.0008)	
<i>Partner_PI_{it} * dist_{ij}</i>		-0.0315*** (0.0009)
<i>Balance sheet_{it}</i>	0.4169*** (0.0040)	0.4116*** (0.0040)
<i>Productivity_{it}</i>	0.1146*** (0.0030)	0.1156*** (0.0030)
<i>GDP_{jt}</i>	0.3678*** (0.0078)	0.3742*** (0.0078)
R ²	0.4203	0.4204
N	3 054 608	3 054 608
# firms	118 524	118 524
# countries	158	158
# sectors	28	28
# years	13	13

Fixed effects Firm, time, country, sector

Fi_dependence_{it} : financial dependence; measured by the ratio of the total amount of financial charges over total amount of debts net from social debt
Partner_PI_{it} : payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Note: ***: significant at 10% level **: significant at 5% level *: significant at 1% level. Standard errors are in brackets.

Sources: French customs, French Tax Authority (BRN), World Bank, CEPII

* This sample excludes all firms belonging to financial sector, real estate sector

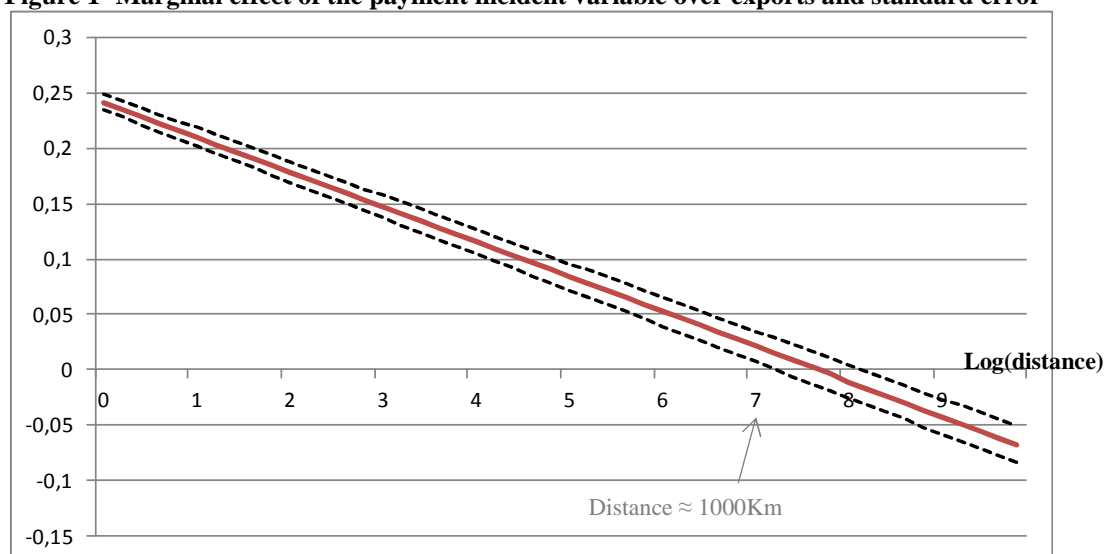
The results from table 5 prove that financial factors might be a trade barrier the further the export destination is. But even if the estimators of both (1) and (2) are negative and significant it is not sufficient to conclude on the marginal effect of financial factors over bilateral trade.

Following the method explained in Brambor & al. (2006), we can then estimate the marginal impact of the payment incident variable by calculating the partial derivative of the logarithm of exports with respect to this variable.

We then obtain the following formula, coming from the baseline specification:

$$\frac{\partial \ln EX_{ijt}}{\partial \ln(\text{Financial Indicator}_{it})} = \beta_1 + \beta_2 \ln(\text{time}_{ij})$$

Figure 1- Marginal effect of the payment incident variable over exports and standard error



Source: calculation of the authors

This equation is represented by the straight line in figure 1. To calculate the standard error which appears in dashed line on the graph, we use the following variance property. The variance of a sum of random variables is as follows:

$$Var(aX + bY) = a^2Var(X) + b^2Var(Y) + 2ab cov(X, Y)$$

We can divide the graph into three parts (the horizontal axis represents the log of distance):

- Up to around 1000 kilometers, the marginal effect is significant and positive. Yet, this distance mainly covers exchanges which are inside France and are not relevant for international trade.
- Between 1000 kilometers and around 3500 kilometers, the confidence interval (area between the dashed lines) intersects the horizontal axis and the marginal effect is thus no longer significant. It mainly includes transactions which take place with European partners.
- Over 3500 kilometers, the marginal effect is significant and negative, which confirms the negative impact of distance.

In order to use a more accurate trading time variable and also to check the robustness of results of table 5, we estimate our specification with trading time rather than distance over a sub-sample of extra-EU countries (cf. table6). We find the same conclusions, namely that trading time has a negative and significant effect. This result is robust both for the instrument of payment incidents with partners and for the financial dependence (charge of interests).

We can interpret all those results by concluding that financial frictions have heterogeneous effects. Indeed, amongst firms that are financially constrained, those that export to faraway destinations (in terms of distance and trading time) find their export activity relatively more affected.

Table 6

Dependent variable	Exports _{ijt}	
	(1)	(2)
<i>Fi_dependence</i> _{it}	0.1173*** (0.009)	
<i>Partner_PI</i> _{it}		0.0572*** (0.0208)
<i>Fi_dep</i>_{it} * <i>ttime</i>_{ij}	-0.0281*** (0.0024)	
<i>Partner_PI</i>_{it} * <i>ttime</i>_{ij}		-0.0149*** (0.0057)
<i>Balance sheet</i> _{it}	0.4205*** (0.0108)	0.4177*** (0.0107)
<i>Productivity</i> _{it}	0.0925*** (0.0085)	0.0917*** (0.0085)
<i>GDP</i> _{jt}	0.4744*** (0.0171)	0.4766*** (0.0171)
R ²	0.4894	0.4892
N	353 358	3 054 608
# firms	22 745	118 524
# countries	78	78
# sectors	26	26
# years	13	13

Fixed effects Firm, time, country, sector

*Fi_dependence*_{it} : financial dependence; measured by the ratio of the total amount of financial charges over total amount of debts net from social debt

*Firm_PI*_{it} : firm's payment incident. It is the ratio of the amount of payment incident over the amount of total assets.

*Partner_PI*_{it} : payment incident from firm's partners. It is the ratio of total amount of payment incidents from partners over the total amount of assets.

Note: ***: significant at 10% level **: significant at 5% level *: significant at 1% level. Standard errors are in brackets.

Sources: French customs, French Tax Authority (BRN), World Bank, CEPII

* This sample excludes all firms belonging to financial sector, real estate sector

6. Conclusion

We demonstrate that financial factors, at firms' level, do influence trade flows and so international trade patterns. In our main regression, exports are thus negatively influenced by financial frictions, taken as the product of exogenous financial constraint and financial dependence.

This work confirms that financial factors have a significant impact on trade, magnified by trading time. These results have two policy implications. First, it reasserts the considerable necessity for easing access to credit for firms. Second, it points out the importance of reducing trading time to promote trade. It can be done by different ways, by investing in transport infrastructure and also by easing procedures required to trade with foreign partners.

We already plan to apply the same empirical approach to bilateral imports. As exports, import activities also imply higher costs (information costs, insurance, duty fees, etc.). Thus, we will be able to capture the combined effect of financial frictions and trading time on trade flows on the other side of the trade relation.

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