Time is Money:
Cash-Flow Risk and Product Market Behavior

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Abstract

Do long payment delays in the domestic market represent a financial barrier to international trade? Introducing cash-flow risk management in a dynamic contracting environment, I analyze the role of payment delays in export market decisions. The model yields simple predictions that I test exploiting an exogenous variation in payment delays triggered by a 2009 French reform. The empirical framework relies on the disaggregated nature of export data to introduce market fixed-effects so as to control for unobserved shocks. Moreover, I use the ex ante heterogeneity in sectoral exposure to the reform as an instrument for the variation in payment delays. The estimations strongly support the empirical predictions: an exogenous decrease in payment delays of 10 days in the domestic market lowers the probability to exit an export market by 7.2 percentage points and raises the probability of entry by 0.4 percentage points. These effects are robust to a range of alternative specifications; estimations on sub-samples suggest that the source of identification comes from cash-poor firms and firms operating in sectors relying on external finance.

JEL codes: *C26, C73, F14, G31.*

"Remember that Time is Money. [...] Money, more or less, is always welcome; and your Creditor had rather be at the Trouble of receiving Ten Pounds voluntarily brought him, tho' at ten different Times or Payments, than be oblig'd to go ten Times to demand it before he can receive it in a Lump."
Benjamin Franklin, "Advice to a Young Tradesman" (1748).

In the light of the recent evolutions of the factoring industry, Benjamin Franklin's advice (see above) seems more relevant than ever: according to the World Factoring Yearbook (2014), the global

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factoring volume (*i.e.*, the volume of account receivables sold in exchange of an immediate cash payments) increased by 72% between 2007 and 2013 to reach 2 230 billions euros (around 3% of global 2013 GDP). In France in which the empirical investigation takes place, the volume of credits taken over by factoring firms rose in a similar fashion by more than 65% during the same time period (ASF, 2014). Strikingly, while firms seem to attach growing importance on getting paid quickly, empirical evidence on the real effects of payment delays is limited. Yet, if firms do not fully hedge and if the supply of external finance is not perfectly elastic, payment delays should affect firms' decisions (Froot, Scharfstein and Stein, 1993).

The choice to serve or not an export market is perhaps the real outcome that is the most likely to be impacted by payment delays (*PD*). Since export transactions are paid in the vast majority after reception of the product (Schmidt-Eisenlohr, 2013), exporting firms are granting *de facto* a payment period that is equal to the transportation time, which is generally longer than for domestic operations. Firms's activity in international markets might therefore be affected by the prevailing payment conditions in the domestic market: given the payment conditions that the firm face operating in the domestic market, firms might be more or less prone to enter remote export markets with high *PD*.

As an illustration, Atradius (2016)[1] shows that payment conditions vary widely across European countries with average payment delays between domestic firms amounting to 32 days in Denmark but reaching 82 days in Italy. Suppose that both a Danish and an Italian firm contemplate exporting in a fictional market where transportation time entail payment delays of 90 days. How is the entry decision affected by the magnitude of domestic *PD*? On the one hand, compared to Danish firms, Italian firms might enter less easily in the export market as they encounter more difficulties to maintain a healthy cash-flow operating only in their domestic market. To use Hummels and Schaur's (2013) words, long payment delays in the domestic market may in this respect make *"time act as a trade barrier"*. On the other hand, exporting represent a lower risk for Italian firms in relative terms, as entering the export market would only make a difference of 8 days compared to operating only in the domestic market (*"relative risk effect"*).

To analyse the role of payment delays in product market decisions, I consider a dynamic contracting environment based on Philippon and Sannikov (2007) in which the manager of a firm (the agent) must contract with a bank (the principal) to get financed. While the volume of cash-flows is deterministic and publicly known, the timing of payment is random and follows a Poisson process. At every period, the agent has the option to pay an entry cost to enter in a new market, which raises future cash-flows but potentially lengthens the average gap between payments.

Since cash-flow payments are assumed to be independent, it would be optimal to enter immediately in the absence of information asymmetry. I assume however that it is costly for the agent to get paid quickly and that effort is unobservable. In a competitive setting, offering flexible payment terms to clients may indeed be necessary to attract and keep clients (Lee and Stowe, 1993); requiring clients to pay quicker thus comes at the expense to a deterioration of the relation of the firm with its customer base, which might be costly for the manager. This prediction is empirically confirmed by Murfin and Njoroge (2015) who show that exogenous restrictions on payment delays sever supplier-

[1] Atradius is a factoring firm which conducts a yearly survey on payment practices on approximately 3000 companies across Western Europe from which I report these estimations of average payment delays.

buyer links.

Dynamic contract techniques developed in DeMarzo and Sannikov (2006) and Biais et al. (2007) show that a simple implementation of the contract makes the exercise of the firm's entry and exit options entirely conditional on the level of cash holdings. If the level of cash holdings reaches an optimally determined threshold, the firm will enter the new market; if it is too low, the contract will terminate. Importantly, in absence of cash-flow payments, cash holdings decrease continuously: hence, the manager of the firm is incentivized to always exert high effort so as to maintain payment occurrences at their optimal level. In particular, since the principal's profit function is endogenously concave, the bank acts as the creditor in Franklin's emphasized quotation and therefore prefers frequent payments of small amounts to large payments in a lump sum.

This framework yields clear-cut empirical predictions on the role of payment delays: in the model, the *"time as trade barrier effect"* always dominates the *"relative risk effect"*, leading to a negative role of domestic *PD* in the probability of entry in a new market and a positive one in the probability of exit. When cash holdings approach the entry threshold, however, the two effects cancel each other and the effects of *PD* on entry fade out. Similarly, an increase in average *PD* or a decrease in future profitability in the new market always unequivocally lowers the probability of entry.

To test the predictions of the model, I exploit a large-scale variation in contractual payment delays following the enactment in 2009 of a French reform ("Loi de Modernisation de l'Economie" or LME) aiming at reducing excessive payment delays. This reform extended the 2006 law presented and studied by Barrot (2016) by prohibiting payment contracts between *domestic* firms operating in any sectors to stipulate payment delays longer than sixty days. Although public authorities considered at the time that the reform was globally successfully applied (ODDP, 2010), a precise examination of the effects of this law is particularly challenging since *(a)* there is no natural control group to which the econometrician might refer and *(b)* the reform was voted in mid-2008 and but took only effect at the beginning in 2009, i.e. precisely during the peak of the global financial crisis.

I tackle these identification issues by building an econometric framework based on three pillars. First, I exploit rich fiscal and survey data sets provided by the French statistical institute (Insee) to estimate payment delays at the firm-level. The measure is based on the observation made by Ng, Smith and Smith (1999) that since most of trade credit determinants (*e.g.,* intensity of competition, quality uncertainty) hold at the industry-level, payment delays are relatively stable within an sector. Payment delays on the clients side are therefore estimated at the industry-level (defined as a 5-digits SIC equivalent) as the mean of the accounts receivables over sales ratio. I proceed similarly to measure *PD* on the suppliers side, which allows us to quantify payment delays *in net terms, i.e.* to compare how long it takes for a firm to be paid by its clients to the amount of time that is needed for this firm to pay its suppliers. I then use information on the breakdown of firms' sales by sector to define payment delays at the firm-level as the weighted average of sectoral net payment delays (*NPD*). According to this measure, a firm that operates in sectors that exhibit high *NPD* will experience long payment delays irrespectively of the firm's own tax reports.

Second, I use the sixty-days-rule defined by the law to estimate the firm's *exposure to the reform prior to its enactment* as the sales-weighted average of the sectoral changes in *NPD* that would be needed for the reform to be perfectly enforced. Broadly speaking, this variable measures the distance in days to the situation in which the sixty-days-rule is perfectly enforced in all the sectors in which the firm operates. This distance is then included as an instrument for the actual variation in *NPD*. This instrument strategy has two main advantages: first, it allows to overcome the absence of control group by exploiting the *ex ante* variation in exposure to the reform. Second, it enables to only capture the part of the variation in *NPD* that can be explained by the enactment of the reform, thereby leaving aside the potential effects of confounding aggregate shocks (*e.g.*, the financial crisis).

Third, I rely on the disaggregate nature of export data to introduce a whole set of market fixed effects as in Paravisini et al. (2014). The estimates are thus based on the comparison between firms differently affected by the reform of export outcomes *in a given industry and a given destination* (which I define to be an export market). This procedure allows first to control for any market-level shock that might have affected exports by shifting the supply (*e.g.*, input shocks) or the demand curve (*e.g.*, real estate crisis). Moreover, the presence of market dummies removes the effects of specialization patterns: if firms that export in markets particularly hit by the crisis are also on average more exposed to the reform, an estimation without fixed effects might lead to inappropriately conclude to a causal effect of the variation in *NPD* on export outcomes.

[Insert figure 1 here]

In line of the empirical predictions, the estimates point to a significant effect of the variation in *NPD* in the French market on the decisions to enter and to exit export markets. An increase in net payment delays by 10 days is found to raise the probability to exit an export market by 7.2 percentage points (compared to a 24.3% unconditional probability of exit) and to lower the probability of entry by 0.4 percentage points (1.0%), indicating a sizeable role of payment conditions on the participation to international trade. I find no role of payment delays at the intensive margin. Overall, the results corroborates Manova's (2013) finding of a specific effect of financial frictions on international trade.

The results prove robust to a battery of reliability checks. I investigate whether these effects still hold using alternative measures of payment delays. If the magnitudes of the effects vary with the estimations, all my results point to an economically significant role of payment delays in export market decisions. When restricting the estimations to sub-samples of the data set, I find that consistently with theory, the effects of the variation in *NPD* are stronger for cash-poor firms or for sectors that are dependent on external finance.

The emphasis on the effects of payment delays on export market decisions is justified by the particular characteristics of export transactions. As stressed by Amiti and Weinstein (2011), export transactions differ from domestic transactions as they entail *longer payment delays* and *higher customer risk*. On the basis of survey evidence, Schmidt-Eisenlohr (2013) finds that in 78% of export transactions, the importer pays after reception of the product. This means that shipping time comes in addition to the payment delays that prevail in the domestic market: Amiti and Weinstein (2011) estimate that the median transportation time can be estimated to two months. Figure 1 shows that a positive correlation between exporting activity and payment delays can be observed in the data: as firms export more in volume, they have on average higher net payment delays (clients *PD* minus suppliers *PD*).

Higher customer risk then results from the difficulty to settle a dispute in an international setting and on the differences in quality of institutions between countries. Courts may in particular function more or less effectively: studying duration of legal procedures in 103 countries, Djankov et al. (2003) estimate that it takes approximately one month and a half for a court in Singapore to collect a bounced check, while more than three years are needed in Poland.

Since export transactions generate more frictions than domestic ones, Feenstra, Li and Yu (2014) argue that exporters are more likely to be financially constrained that domestic producers, a prediction that they confirm using financial data on Chinese firms. In this respect, the optimal portfolio of export markets may not only be determined by profit considerations (Mélitz, 2003), but also by whether the payment delays that hold in those markets allow the firm to maintain a cash flow that is sustainable given its financing conditions. In the presence of a variation in domestic liquidity risk such as that triggered by the 2009 French reform, firms might have to readjust their product market portfolio, a prediction that the empirical results strongly support.

This work contributes to a recent strand of literature that investigates the role of working capital risk management in international trade. In an influential paper, Antràs and Foley (2015) shows that the negotiation of financing terms is key in building and maintaining trade relationships, and that the way customer risk is managed shapes the impact of crises on supplier-customer links. Using data on U.S. banks' trade finance claims by country, Schmidt-Eisenlohr and Niepmann (2016) estimate that a one standard deviation negative shock to a country' trade insurance supply lowers export by U.S. firms to that country by 1.5% (see also Aubouin and Engemann (2014)). More broadly, this article relates to another group of publications (Manova (2013) ; Feenstra, Li and Yu (2014) ; Paravisini et al. (2014)) that look at the role of credit supply in international trade[2]. In contrast with the theories put forward by this literature, my model provides a contractual framework in which debt plays only an indirect role in the decision to entry or exit an export market: in a dynamic framework, only the level of cash matters to ensure that the entry in a new export market is sustainable in terms of working capital management.

This article then falls within the wide array of articles that study the interactions between structural characteristics of product markets and capital structure policies, and more specifically on the role of cash holdings in entry patterns[3]. Boutin et al. (2013) find evidence that entry is negatively correlated to the cash hoarded by incumbent affiliated groups and positively associated with the level of entrant groups' cash. Frésard (2010) then shows that large cash reserves act as a comparative advantage in product markets as they lead to systematic future market share gains at the expense of industry incumbents. In comparison, the results of this article suggest that firms operating in countries where payment delays are low benefit from a comparative advantage on their international rivals.

The closest paper to this article is presumably Barrot (2016): studying an early implementation of the 2009 reform on the trucking sector, Barrot finds using differences-in-differences that corporate defaults fell following the reform and that the decrease in payment delays triggered the entry of small

[2]Note that Chaney (2016), which was the first article to analyse the role of financial constraints in firm-level exports, emphasized the role of *liquidity* constraints and is thus closer to an analysis in terms of working capital management than of credit constraints.

[3]A major part of this literature is devoted to the examination of the role of leverage in product market decisions. Chevalier (1995) famously shows that LBO supermarkets charge higher prices following LBO when market rivals are also highly leveraged; Khanna and Tice (2000) find evidence that highly levered supermarkets responded less aggressively to the entry of Wal-Mart in their local markets. See Parsons and Titman (2008) for a survey.

firms in the trucking industry. This article extends Barrot's work on three points: first, I bring a theoretical model that allows to understand precisely the effects of payment delays on product market decisions. In contrast with the creation of a new firm, the decision of entry depends indeed not only on the payment delays in the new market but also on the *PD* that prevail in the markets in which the firm is already operating. Second, since the setting of the LME reform does not lend itself well to a differences-in-differences estimation, I deviate from Barrot's methodology by relying on the heterogeneity of the exposure to the reform to instrument the variation in payment delays. Third, thanks to the quantitative measure of payment delays, I am able to to take both the effects of the variations of clients *PD* and of suppliers *PD* into account by computing payment delays in net terms.

Barrot and Nanda (2016) further investigate the role of payment delays in firm decisions by exploiting a 2011 US reform that restricted payments delays of government contractors to small businesses. They estimate that at the aggregate level, each "accelerated" dollar resulted in a 10 cents increase in total payroll between 2011 and 2014, indicating a significant effect of *PD* on employment. Using information on payment delays in buyer-supplier relationships, Breza and Liberman (2016) show that long payment delays are associated with reduction in capital expenditures for the firms who bear the working capital costs.

This article eventually contributes to a burgeoning strand of theoretical papers devoted to the study of real options in presence of financing constraints. Three different lines of articles can be distinguished: a first series of studies investigate how the exercise of real options is affected by exogenous financing costs resulting from debt overhang issues or uncertainty on capital supply (Sundaresan, Wang and Yang (2015); Bolton, Wang and Yang (2014); Hugonnier, Malamud and Morellec (2015)). "Real option signalling" models then show that in presence of asymmetric information, the timing of the exercise of the real option can be used as a signal to the principal on the quality of the project or on the financial strength of the agent (Grenadier and Malenko (2011); Morellec and Schürhoff (2011); Bustamante (2012); Bouvard (2014)). A last strand of models (Philippon and Sannikov (2007); Biais et al. (2010); Gryglewicz and Hartman-Glaser (2015)) allows the agent to affect the stochastic process of the real option's underlying in a moral hazard setting. This paper builds on the setting of Philippon and Sannikov (2007) by replacing Brownian motions by Poisson processes (as in Sannikov (2005)) and allowing the exercise of the real option to affect the volatility of the cash-flow process as well as its instantaneous expected value.

The remainder of the paper is organized as follows. Section 1 specifies the theoretical model and the empirical predictions that it yields. The details of the LME reform and the data sets used are described in section 2. In section 3, I present in detail the identification strategy. Empirical results are displayed in section 4; in section 5 I investigate how the results are affected by firm- and market-level heterogeneity. Results are discussed in section 6. Section 7 concludes.

1 Cash-flow risk and product market decisions

1.1 Theoretical framework

How does cash-flow risk affect firms' decision to enter or leave a product market? I address this question using a model building on the dynamic real option setting presented in Philippon and Sannikov (2007). Brownian motions are in particular replaced by Poisson processes which, by their discrete nature, are naturally more suited to the study of the timing of cash-flows payments. Second, I add the possibility that the exercise of the real option affects the volatility of the cash-flow process: this allows payment delays to vary with the level of export activity, as figure 1 suggests.

The resolution of the optimal contract is based on martingale techniques developed in a Brownian framework in DeMarzo and Sannikov (2006) and adapted to point processes in Biais et al. (2010) and Sannikov (2005). A brief sketch of the proofs initially presented in Philippon and Sannikov (2007) is displayed in a separate technical appendix ; new results using the concavity of the principal functions are derived and presented in detail in section 1.3 and appendix B.

1.1.1 General setup

A cash-constrained entrepreneur (the agent) seeks outside financing F to have her firm started. She contracts with a bank (the principal) to fund the set-up costs and to cover the losses of her project. Both the entrepreneur and the bank are risk-neutral[4] and discount future cash flows at the market interest rate r. Time is continuous.

At time $t = 0$, the project starts at the "initial" state I ; then, at every instant $t \geq 0$, the entrepreneur has the option to pay an entry cost K and to start entering in a new export market (state E)[5]. Denoting the timing of the export option exercise by τ_E, I write by a slight abuse of notation $I = [0, \tau_E]$ and $E = [\tau_E, \infty[$. The annual expected sales of the firm are given by $\Pi_t \in \{\Pi_I, \Pi_E\}$; the occurrence of cash-flows arrivals cash-flows is modeled by a point process $N = \{N_t\}_{t \geq 0}$. N is assumed to follow a Poisson process of intensity $\lambda_t \in \{\lambda_I, \lambda_E\}$: the average time between payments at time t, the measure of the average payment delays, is therefore given by $1/\lambda_t$.

Entering a new export market is posited to simultaneously change annual sales from Π_I to Π_E and the average number of payments from λ_I to λ_E (E stands for "export"). In line with standard international trade models (Mélitz, 2003), it would be optimal in the absence of information asymmetries to start exporting immediately as long as the option to export is profitable : $\Pi_E - \Pi_I > rK$ (1); the condition (1) is assumed to hold in the following. Moreover, figure 1 suggests to impose $\lambda_I \geq \lambda_E$ such that the average payment delays increases with export activity.

Since the focus of this paper is to investigate the effects of the volatility induced by the *uncertainty over the timing of payments*, the following analysis abstracts from the role of the *uncertainty over the amount of cash-flows* by assuming that the volume of cash-flows is deterministic (it only depends on whether the firm exports or not) and that cash-flows are evenly distributed over the year: $X_t = \Pi_t/\lambda_t$.

[4] Gryglewicz and Hartman-Glaser (2015) investigate the role of the agent's risk aversion in a dynamic model of real option with agency. They find that risk aversion has an ambiguous effect as it could lead to earlier as well as later exercise of the real option.

[5] Note that the firm might already be exporting in state I.

Instantaneous change in cash-flows are therefore given by $dY_t = X_t dN_t$ and

$$E_t[dY_t] = \lambda_t X_t = \lambda_t \Pi_t / \lambda_t = \Pi_t \tag{2}$$

Note however that for a given Π_t, the variance of X_t is decreasing in λ_t:

$$Var_t[dY_t] = \lambda_t (X_t)^2 = \lambda_t (\Pi_t / \lambda_t)^2 = \Pi_t^2 / \lambda_t \tag{3}$$

Information frictions arise as it is assumed that the entrepreneur must exert an effort to maintain a high rate of cash-flow arrivals. Previous research tends to show that the collection of account receivables is a costly process: using mandatory pension contributions as an exogenous shock on cash, Bakke and Whited (2012) show that firms recover receivables when facing a liquidity shock, suggesting that firms balance out the cost of collecting commercial debt with their liquidity needs to determine the optimal level of receivables collection (a result later confirmed in another context by Amberg et al. (2016)).

In presence of uncertainty on the quality of the product, trade credit might indeed be the optimal way for firms with no reputation to provide their clients with a warranty clause (Lee and Stowe, 1993): the buyer chooses to delay the payment so as to check whether the the product meets his requirements. Collecting receivables might thus deter clients from coming back to make future purchases, which is costly for the manager.

Formally, the presence of moral hazard in this model is introduced for all $t \geq 0$ by allowing the agent to reduce the intensity of the Poisson process from λ_t to $\theta_t \lambda_t$ (with $\theta_t \in [0,1]$) in exchange for a private benefit $(1-\theta_t)\lambda_t$ per cash-flow unit[6] ; the effort process $\theta = \{\theta_t\}_{t\geq 0}$ is unobservable by the principal. Importantly, shirking reduces the rate of cash-flows but does not modify their volume, thereby reducing the expected instantaneous profitability of the firm. For all $t \geq 0$, the instantaneous flows of private benefits dY_t^B and realized profits dY_t^R are then equal to $dY_t^B = (1-\theta_t)\lambda_t X_t$ and $dY_t^R = dY_t - dY_t^B$.

The agent is not allowed to save money [7] so that her consumption process is defined by:

$$dc_t = dY_t^B + di_t \tag{4}$$

where $dc_t \geq 0$ is her increase in consumption and $di_t \geq 0$ is her increase in income paid by the principal. $c = \{c_t\}_{t\geq 0}$ and $i = \{i_t\}_{t\geq 0}$ are assumed to be right continuous with left limits. The principal has complete control over the agent's retribution i, over the timing of the export option exercise τ_E and over the termination date τ_L of the contract. The present value of future payment to the agent is in particular assumed to be finite: $\int_0^{\tau_E \wedge \tau_L} e^{-rt} i_t dt < \infty$ (5). The principal's set of admissible controls is denoted by P. On her side, the agent determines the effort intensity $\theta = \{\theta_t\}_{t\geq 0}$. Given i, τ_E and τ_L, the agent's admissible set is given by $A(i, \tau_E, \tau_L)$.

[6]The intensity of the moral hazard problem could be modulated through an additional parameter $\kappa > 0$ such that the private benefits equal $\kappa(1-\theta_t)\lambda_t$. Setting $\kappa = 1$ does not change the main properties of the model but simplifies significantly the proofs.

[7]DeMarzo and Sannikov (2006) shows that if the private saving rate of the agent is strictly inferior to the market interest rate, it is optimal for the agent never to save money. For simplicity, I exclude here the possibility of private savings and take the case where the agent and the principal share the same discount factor.

In case of termination of the contract, the principal gets his liquidation value $L_t \in \{L_I, L_E\}$ and the agent gets her outside option value $R_t \in \{R_I, R_E\}$. I discuss in section 1.2.3 how to make these values endogenous. Termination of the contract is assumed to be socially inefficient, which imposes the inequalities $L_t + R_t < \Pi_t / r$ for $t \in \{I, E\}$ (6).

Two additional conditions are necessary: first,

$$\lambda_I > \lambda_E > r \tag{7}$$

is assumed. This assumption is in fact rather weak: remember that λ can be interpreted as the average number of payments received by the firm during the year, while standard calibrations of r are generally inferior to 5% (Philippon and Sannikov (2007) chooses 2%). The second constraint imposes that the outside option of the entrepreneur is strictly superior to the value of an additional cash-flow:

$$R_t > X_t \text{ for } t \in \{I, E\} \tag{8}$$

This inequality is likely to hold for most of the firms: when annual cash-flows do not depend on a particular customer, an additional cash-flow payment is generally inferior to the liquidation value of the firm. However, for firms with a very high operational leverage (e.g., in the aircraft or boat industry), this assumption might be violated. Section 1.3 discusses the consequences of this constraint.

1.1.2 Optimization problem

The agent's problem is to maximize her expected discounted utility W_0 :

$$W_0 = \max_{\theta \in A(i, \tau_E, \tau_L)} E^{\theta} \left[\int_0^{\tau_L} e^{-rt} dc_t + R_{\tau_L \wedge \tau_E} e^{-r(\tau_L \wedge \tau_E)} \right] \tag{9}$$

where E^{θ} denotes the expectation operator under the probability $\mathbf{P}^{\theta}$ given by θ. It is also assumed that for every strategy θ, her continuation utility W_t^{θ} must exceed the value of her outside option at every time t:

$$W_t^{\theta} = E^{\theta} \left[\int_t^{\tau_L} e^{-r(s-t)} dc_s + R_{\tau_L \wedge \tau_E} e^{-r(\tau_L \wedge \tau_E)} | \mathscr{F}_t^N \right] \geq R_t. \tag{10}$$

where $\mathscr{F}^N = \{\mathscr{F}_t^N\}_{t \geq 0}$ is the filtration generated by N. The principal's problem is to maximize its expected discounted profit; using the continuation utility of the agent as a state variable (see for instance Spear and Srivastava (1987)), the principal's profit $b^I(W_0)$ for a given starting value W_0 can be expressed as:

$$b^I(W_0) = \max_{(i, \tau_E, \tau_L) \in P} \max_{\theta \in A(i, \tau_E, \tau_L)} E^{\theta} \left[\int_0^{\tau_L \wedge \tau_E} e^{-rt} (dY_t^R - di_t) - 1_{\tau_E < \tau_L} K + L_{\tau_L \wedge \tau_E} e^{-r(\tau_L \wedge \tau_E)} \right] \tag{11}$$

subject to (10) and to make the contract incentive-compatible for the agent. Similarly to (11), consider eventually for a given starting value W_0 the function $b^E(W_0)$ giving the profit of principal if the firm is already exporting:

$$b^E(W_0) = \max_{(i, \tau_L) \in P} \max_{\theta \in A(i, \tau_L)} E^{\theta} \left[\int_0^{\tau_L} e^{-rt} (dY_t^R - di_t) + L_E e^{-r\tau_L} \right] \tag{12}$$

1.2 Resolution of the optimal contract

Martingale techniques show that incentive compatibility impose to make the continuation utility of the agent W_t evolve according to

$$dW_t = rW_t dt + X_t(dN_t - \lambda_t dt) - di_t \tag{13}$$

Intuitively, by setting the sensibility of the agent's continuation utility to the cash-flow process equal to 1, the principal makes the agent indifferent between shirking ($\theta_t < 1$) and exerting high effort ($\theta_t = 1$). In the regions where $di_t = 0$, the principal's profit functions follow the following differential equation:

$$rb(W_t) = \Pi_t + (rW_t - \Pi_t)b'(W_t) + \lambda_t(b(W_t + X_t) - b(W_t)) \tag{14}$$

Proceeding by backward induction, the optimal contract can be fully characterized after exporting and before exporting by the equation (14) with the appropriate border conditions.

1.2.1 Optimal contract after exporting

After paying the entry cost K, the cash-flows process of the firm is characterized by $X_t = X_E$, $\lambda_t = \lambda_E$ and $\Pi_t = \Pi_E$. The optimal contract is given by the following proposition:

Proposition 1. *(Sannikov 2005) In the optimal contract, the continuation value W_t evolves according to* (13) *starting with value W_0. When $W_t \in [R_E, R^*[$, with $R^* = \Pi_E/r$ the agent receives no payment: $di_t = 0$. When W_t reaches R^*, payments di_t cause W_t to reflect at R^*. The profit function b^E follows* (14) *on the interval $[R_E, R^*]$ with the boundary conditions $b^E(R_E) = L_E$ and $b^E(R^* + \omega) = -\omega$ for all $\omega \geq 0$. The principal gets the liquidation value L_E at time τ_L when W_t reaches R_E.*

The upper threshold R^* corresponds to the private benefit the agent would get if she chooses to shirk forever: $\theta_t = 0$ for all $t \geq 0$. When $W_t \geq R^*$, the moral hazard problem disappears: the agent gets all the proceeds of the cash-flows as if she was the sole owner of the project.

1.2.2 Optimal contract before exporting

In the initial stage of the game, the cash-flows process of the firm is characterized by $X_t = X_I$, $\lambda_t = \lambda_I$ and $\Pi_t = \Pi_I$.

Proposition 2. *(Philippon and Sannikov 2007) In the optimal contract, the continuation value $W_t \in [R_I, W_E[$ evolves according to* (13) *starting with value W_0 with $di_t = 0$ for all $t \geq 0$. The profit function b_I follows* (14) *on the interval $[R_I, W_E]$ with the boundary conditions $b^I(R_I) = L_I$ and $b^I(W_E + \omega) = b^E(W_E + \omega) - K$ for all $\omega \geq 0$. If W_t reaches W_E before R_I at time τ_E, the firm starts exporting and the optimal contract is given by Proposition 1. If W_t reaches R_I first at time τ_L, the principal gets the liquidation value L_I.*

In contrast with the perfect information case, it is optimal for the agent and the principal to wait that W_t reaches the threshold W_E to start exporting. Note that unlike standard real option models (e.g. McDonald and Siegel (1986)), waiting does not provide any additional information on the profitability of the firm: by assumption, cash-flows are *iid*. The value of waiting in this model stems from the moral hazard problem: by making entry conditional on the continuation value of the agent passing a given threshold, the contract gives incentives to the agent to maintain a high rate of cash-flow arrival and thus allows to decrease the risk of liquidating the firm, which is costly for the principal.

1.2.3 Endogenous termination values: intensive and extensive margins

The result that the firm is liquidated if its cash holdings fall below a given threshold raises the question of the possibility of a renegotiation. Indeed, it is legitimate to think that neither the bank nor the entrepreneur would find optimal to liquidate the firm if another option was available to them. Instead of liquidating the firm, a manager facing low levels of cash due to late payments might rather choose to temporarily forego profitable sales opportunities while rebuilding her cash reserves: in this case, the firm adjusts at the intensive margin by reducing the volume of sales.

This possibility can be introduced in the model by making the termination values endogenous: suppose that in addition to the liquidation of the firm, the principal has the option to wait during an interval of time Δ and to reset the contract at $W_t = W_0$. In this case, the liquidation value becomes $L_I^* = \max(L_I, e^{-r\Delta} b_I(W_0))$ and $R_I^* = R_I$ if the contract is terminated or $R_I^* = e^{-r\Delta} W_0$ if the contract is relaunched.

The set of outside options available to the manager is even richer when the firm is present in several markets (state E in our model). In addition to liquidating the firm or to reduce the volume of sales, the manager can decide in this case to reduce the number of markets in which the firm operates (adjustment at the extensive margin). I make the simplifying assumption that it is always preferable to adjust in state E at the intensive or extensive margin than by liquidating the firm: in this setting, the liquidation value is given by $L_E^* = \max(b_I(W_0), e^{-r\Delta} b_E(W_E))$ and $R_E^* = W_0$ if the exporter reduces her export sales at the extensive margin or $R_E^* = e^{-r\Delta} W_E$ if export sales are reduced at the intensive margin.

Though difficult to handle in general, this modelization is useful when trying to understand the respective effects of the reform on the extensive and intensive margins. As will be seen in proposition 5, reducing export sales at the intensive margin when *PD* increase is optimal in particular when entry in new export markets is costly.

1.3 Predictions of the model

1.3.1 Implementation of the optimal contract

The optimal contract has a natural implementation with cash reserves and debt (see Biais et al. (2007)). Defining the stock of cash C_t by $C_t = W_t - R_I$, the optimal contract can be implemented as following:

- The entrepreneur begins with a reserve of cash $C_0 = W_0 - R_I$. At every instant, she pays back a coupon $\lambda_I dt$ to the bank. New cash-flow payments are immediately deposited on the bank account of the manager. Cash holdings therefore evolves according to $dC_t = rC_t dt + X_t(dN_t - \lambda_I dt)$. Note that cash reserves decrease in absence of cash-flows arrival.

- If her cash reserves reach $C_E = W_E - R_I$, the agent enters in a new export market. If she runs out of cash first, the bank and the manager gets their (potentially optimally chosen) termination values.
- After starting to export, the agent is paid every time the level of cash goes above $C^* = R^* - R_I$. The bank and the manager gets their termination values as soon as C_t goes below $R_E - R_I$.

The initial level of cash reserves C_0 is determined by the respective bargaining powers of the agent and the principal. In particular, if the bank is a monopoly, $W_0 = C_0 + R_I$ is defined by the condition $b_I'(W_0) = 0$. On the opposite, if the agent has all the bargaining power, W_0 is pinned down by the conditions $b_I(W_0) = I$ and $b_I'(W_0) < 0$. The face value of the debt with coupon payments λ_k and coupon rate r is equal to $D_k = \lambda_k / r$ for $k \in \{I, E\}$.

The threshold C_E is given by an arbitrage for the bank between the value of exercising the entry option and the value of waiting that the agent builds cash reserves (which lowers the chances of a costly liquidation). It is revealing to see how the result of this arbitrage evolves with the payment delays after and before exporting:

Proposition 3. *The amount of cash required to enter in a new export market C_E decreases with $1/\lambda_I$ (the average PD before exporting) and Π_E (the profitability after exporting) and increases with $1/\lambda_E$ (the average PD after exporting), Π_I (the profitability before exporting) and K (the cost of entry).*

All other things equal, if the initial conditions of the firm improve, exporting becomes more risky in relative terms, which induces it to raise the required amount of cash. Proposition 3 leads therefore to seemingly paradoxical conclusions: a deterioration of the payment conditions might lead firms with high levels of cash to enter the export market as differences in *PD* between exporting and not exporting fade out.

1.3.2 Testable predictions

This implementation is extremely useful since it allows us to make testable predictions about observable outcomes.

Proposition 4. *The probability to enter in a new export market decreases with the average PD before exporting $1/\lambda_I$ and increases with the profitability Π_I. Similarly, the probability to exit or to reduce the sales in an new export market increases with the average PD after exporting $1/\lambda_E$ and increases with the profitability Π_E.*

A decrease in average *PD* before exporting has two opposite effects: it increases the cash threshold C_E and it increases the future prospects of the firm by lowering the probability of liquidation. Proposition 4 shows that all other things equal, the first effect is always weakly dominated by the second one. When C_t approaches C_E, however, the proof of the proposition shows that the two effects perfectly cancels out: payment delays should therefore not affect the rate of entry of cash-rich firms that are close to exporting.

The proposition might not hold in general if I relax condition 8 by allowing very large cash-flow payments: for low levels of cash $C \in [0, X_I - R_I]$, the probability of entry might in this case increase with average *PD*. The intuition is that for a firm that is liquidity-distressed, an increase in average payment delays makes the principal expect longer intervals between cash-flow arrivals and thus tempers the stringency of the requirement of an immediate important payment, which reduces the probability of an immediate liquidation and thus increases the probability of exporting.

Proposition 5 eventually analyses whether we should expect firms to adjust at the intensive or the extensive margin following a modification in payment delays:

Proposition 5. *It becomes optimal to reduce export sales at the intensive margin rather than at the extensive margin as the cost of entry K increases.*

Intuitively, as the cost of entry increases, reducing export sales at the extensive margin becomes more costly: we should therefore observe that firms choose more often to reduce sales at the intensive margin in markets that are more difficult to access. I turn to the empirical tests of these predictions in the following sections.

2 Background and data description

2.1 Payment delays reform

The 2009 payment delays reform is the outcome of a long-term process of reflections and negotiations on the regulation of payment delays in France. Since 2000, the regulation of late payment practices has been on the European agenda (Barrot, 2016): based on the notion that *"heavy administrative and financial burdens are placed on businesses, particularly small and medium-sized ones, as a result of excessive payment periods and late payment"*, the directive 2000/35/EC allowed firms to demand interest payments to their debtors in case of excessive payment delays (30 days). In France where *PD* were in average higher than in the other members of the European Union (ODDP, 2007), the government took up this issue by fostering negotiations between professional organisations representing clients and suppliers of a given sector. This resulted in 2006 in a reform limiting contractual payment delays to thirty days in the trucking sector, and in 2007 in a agreement to limit contactual *PD* to ninety days in the automobile sector.

The 2009 reform extended these reforms by generalizing as of January, 1. 2009 the limit of contractual payment delays to sixty days in any transactions involving French firms, regardless of the sectors they are operating in. More precisely, the limit was set to sixty days after sending the invoice or forty-five days after the end of the month in which the invoice has been sent. Excess payment delays are to be reported to public authorities by firms' accounting auditors: sanctions resulting from a violation of the contractual limits can reach a maximum of 2 millions euros. These rules appear to be enforced in practice: in 2015, a major telecom group had to settle a fine of 750 000 euros (around 845 000 $) following several complaints of excessive payment delays[8].

The 2009 law featured several major exceptions to the sixty-days-rule. First, in some sectors of activity involving the production or the sale of perishable products contractual payment delays were restricted to be shorter (e.g. thirty days for transactions involving frozen food products). Second,

[8] See TelecomPaper.com (2015).

some sectors whose activity is highly seasonal (e.g. the toy industry) or where the immediate enforcement of the sixty-day-rules appeared to be problematic could benefit from longer contractual payment delays; however, these derogations scheduled a progressive normalization of the contractual payment delays limit to the general sixty-days-rule before 2012 at the latest. The list of derogations is displayed in appendix C. Third, the reform put only a ceiling on *contractual PD* and not on *actual PD*, which might differ in practice. Eventually, the scope of the 2009 reform included only *domestic* transactions, thereby leaving aside import and export transactions: this point is crucial as it allows us to investigate the effect of payment delays in the domestic market on decisions made in foreign product markets.

Overall, several specificities of this reform that makes it particularly challenging to use for causal inference have motivated the empirical strategy described in section 3:

(a): Absence of a natural control group Unlike Barrot (2016) or Barrot and Nanda (2016), no natural control group emerges as this reform affects all sectors[9]. Discontinuities induced by the derogations to the reform cannot be exploited as they are clearly endogeneous (derogations would be granted to some professional organisations representing a given sector provided they could justify that the sixty-days-rule would affect them more than other sectors).

(b): 2008-09 financial crisis The 2009 reform was voted on August 4. 2008, that is only a few weeks before the Lehman Brothers collapse. French export transactions were greatly affected by the ensuing global financial crisis: Bricongne et al. (2012) find that exports dropped by -16.2% between September 2008 and April 2009, the contribution of the intensive margin being four times higher in magnitude than the extensive margin one. Should this effect not be properly accounted for, any inference in this period would be subject to the risk of being contaminated by the confounding presence of the 2008 financial crisis.

(c): Presence of derogations The 2009 law allowed some sectors to deviate from the sixty-days-rule because of particular difficulties (seasonal activity, particular payment usages...) to implement it as of 2009. If those difficulties are correlated to firms' export market behavior, the measured variation in payment delays might be endogenous.

(d): Anticipation Eventually, since the law was voted in mid-2008, firms might have been anticipating the enactment of the law and begun to adjust their payment contracts as of 2008. This possibility has been studied by the public instance responsible for the follow-up of the enactment of the reform (ODDP, 2008). It found that out of of a sample of nearly 200 credit managers of large industrial firms, 47% tried to renegotiate their payment contracts as of 2008; however, some credit managers report that these negotiations proved difficult to succeed, since the different firms involved would wait for all their main clients and customers to agree to modify their delays as well so as not to bear alone the working capital costs.

[9] Unfortunately, if the 2006 reform proved well-suited for a difference-in-difference setting, firms in the trucking sector do virtually no exporting (which makes it likewise impossible to use the trucking sector as a control group for this reform). Similarly, the 2007 agreement may seem promising at first glance since the automobile sector is one the main French exporting industries; however, the non-binding nature of the agreement casts some doubt on the actual enforcement of the payment delays limits (ODDP, 2008). In fact, this report suggests that it is because of the very difficulties faced by the government to enforce the 2007 agreement that public authorities decided to move from an approach based on interprofessional negotiations to a general law that incorporated all sectors.

2.2 Firm data

Balance sheet data comes from BRN-RSI tax returns collected by the French fiscal administration[10]. This data set gives accounting information for the whole universe of French firms in the private sector, excluding the financial and agricultural sectors between 2006 and 2011. In addition of balance sheet information, a common identifier among all French firm data (SIREN number) and a 4-digits sector classification are provided. Since the focus is on the effects of *PD* on the export markets behaviour, only firms belonging to the manufacturing and wholesale sectors (the two main French exporting sectors) are retained.

To identify precisely in which sectors firms are operating, I rely on an extensive yearly survey conducted by the Ministry of Industry (Enquête Annuelle des Entreprises, "EAE"). The survey is exhaustive for French firms with more than 20 workers or whose sales exceed 5 millions euros (smaller firms are surveyed according to a stratified sample design) and contains the amounts of sales realized by each surveyed firms in each 5-digits sector.

Information on group ownership is eventually added using the LIFI ("Liaisons financières") survey; exhaustive on the set of firms that employ more than 500 employees, that generate more than 60 millions euros in revenues or that hold more than 1.2 million euros of traded shares, the LIFI survey is completed by data coming from Bureau Van Dijk (Diane-Amadeus data set) so as to cover the whole universe of French corporate groups. This data set allows us to identify the set of firms that belong to the same corporate group and to determine whether a given group can be classified as a SME according to the French legislation. According to the French classification, a group (which can be composed of several firms) is considered as a SME if (1) it employs less than 250 workers and (2) it generates less than 60 millions euros in revenues or possesses less than 43 millions euros in total assets. In order to avoid a potential contamination of the results by the presence of active internal capital markets in large groups (see Boutin et al. (2013) for the role of internal capital markets in entry in product markets), I focus on firms that belong to SMEs (19 000 firms) in the following and come back to the firms that belong to large groups as a robustness test.

2.3 International trade data

International trade data comes from the French customs (DGDDI). For each firm identified by its SIREN number, this data set gives the (free on board) value of exports and imports by country and by product ; products are identified by a 6-digit number (CPF6) easily comparable to the French activity nomenclature. A firm operating in the French metropolitan territory must report detailed information to French customs if it exports more than 1 000 euros outside the European Union. To facilitate intra-EU trade, however, firms are not required to provide information at the product-level if its total exports to the European Union for a given year are inferior to 150 000 euros and therefore do not appear in the data.

A lot of observations are excluded as export information is added since a firm must export at least once between 2008 and 2009 to appear in the resulting data set: from 19 000, the number of

[10]See Bertrand, Schoar and Thesmar (2007), Garicano, Lelarge and Van Reenen (2016) or Boutin et al. (2013) for other uses of this data set.

firms present in 2009 drops to approximately 14 000. Exports are then clustered at the firm-country-industry level by summing all export flows from a f to the country c in the same 2-digits product classification i ("industry"). A pair (c, i) is called a market m.

To have a sharp distinction between the intensive and extensive margins, a firm is considered to be *active* in a market if $Exports_{fm09}$ is at least equal to 5 000 euros. The export behavior at the *intensive margin* can then be observed by defining $\Delta Exports_{fm09} = \log(Exports_{fm09}) - \log(Exports_{fm08})$ if firm f is active in market m in 2008 and 2009. As in Paravisini et al. (2014), the export behavior at the *extensive margin* is treated differently depending if the firm enters or exits a given market. If firm f is active in market m in 2008, I set $Exit_{fm09} = 1$ if f does not export in m in 2009 and 0 otherwise.

Entries are more tricky as one must define the set of potential markets in which firm f might enter[11]. To that end, I first compute the top 25 export destinations for French firms in 2007; the set of potential export markets in 2009 of firm f is then defined as the product of the countries included in the top 25 with the industries in which f is exporting (or selling in the domestic market if f does not export in 2008). If firm f is not present in market m in 2008, I set $Entry_{fm09} = 1$ if f is active in 2009 in m and 0 otherwise. Since I observe very few entries in 2009 for small exporters and non-exporting firms, I focus for the analysis of the probability of entry on firms that export at least 50 000 euros in 2008 (approximately 10 000 firms); even with this restriction, the unconditional entry probability remains low (1.0%).

2.4 Measurement of payment delays

Traditional firm-level data sets such as tax returns databases do not feature information on contractual payment delays[12]. However, a natural measure of the actual client payment delays (used for instance in ODDP (2010) or Barrot and Sauvagnat (2015)) might be derived from standard balance sheet data by defining for a firm g

$$Client_g = \frac{Account\ receivables_g}{Sales_g} * 365$$

The ratio gives the amount of sales that is owed to firm g by its clients; it is multiplied by 365 so as to be readily interpretable in terms of days. $Client_g$ can be thought as the average payment delays between firm g and its client for a given fiscal year. This measure corresponds to $1/\lambda$ in the model, i.e. the average gap between cash-flow payments.

Since the reform affected suppliers as well as clients payment delays, it is necessary to find an estimation of the variation in payment delays that takes both sides of trade credit into account. Suppliers' *PD* are therefore symmetrically computed as

$$Supplier_g = \frac{Account\ payables_g}{Purchases_g} * 365$$

[11] In the absence of such restrictions, the set of potential market is composed of approximately 25 industries * 200 countries = 5000 markets, which generates very low entry probabilities. To facilitate the estimation of linear probability models, I focus here on the "most reasonable" entry markets which I define as the product of the industries in which firms are already present and the top 25 export destinations for French firms.

[12] See Antràs and Foley (2015) for a recent example of a data set including such information.

A definition of payment delays in "net" terms must take into account differences in sourcing strategy: a firm that produces all its intermediate inputs will not be affected the same way by suppliers' *PD* than a firm that heavily relies on outsourcing. To that end, I define net payment delays NPD_g as

$$
\begin{aligned}
NPD_g &= Client_g - \frac{Purchases_g}{Sales_g} * Supplier_g \\
&= \frac{Account\ receivables_g - Purchases_g}{Sales_g} * 365
\end{aligned}
$$

Notwithstanding their simplicity and ease of interpretation, there are several reasons to believe that these direct measures of *PD* might not be appropriate for the analysis. First, as noted by Barrot (2016), these estimations are subject to measurement error as they compare the amount of sales generated in the whole fiscal year to the amount of trade credit recorded at the time of the tax report. If firm g's sales fall at the time of the tax report, clients trade credit will fall more than total sales, thereby leading to underestimate $Client_g$. Similarly, if firm g sells all its account receivables to a factoring firm, estimated *PD* will be zero while effective *PD* will stay strictly positive.

Second, these estimations measures *actual PD*, which may differ from *contractual PD*; yet, the reform only restricts contractual payment delays. This measurement problem can be overcome by noting that if contractual *PD* widely vary across industries, they are quite stable within a given sector (Ng, Smith and Smith (1999) and Costello (2013)). This finding is consistent with the fact that most of the trade credit determinants emphasized in existing trade credit theories[13] are homogeneous at the sector-level.

These observations suggests that taking sectoral means of payment delays instead of firm-level observations might (1) alleviate the measurement error problem due to accounting issues (2) yield estimates that are closer to contractual *PD* as they provide information on the *PD* that are observed on average in a given sector. Another advantage of this methodology is that it allows to identify disentangle domestic and international *PD*: by computing the sectoral means on the set of firms that only operate in the French territory or whose exports represent less than 20% of total sales, I am able to build a measure of the payment delays that prevail on the French territory.

Using the BRN-RSI data set on the whole universe of French firms, I remove for the computation of the means the observations that are superior (resp. inferior) to the median plus (resp. minus) three times the gap between the 5th and the 95th percentile in each sector so as to limit the effects of outliers. Moreover, I discard sectors with less than 10 firms operating mainly in the domestic market. The sectoral average are denoted by $\overline{Client_s}$ and $\overline{Supplier_s}$ in a given sector s.

[Insert table 1 here]

Table 1 displays the sectors with the highest and lowest values of $\overline{Client_s}$ and $\overline{Supplier_s}$. Several patterns emerge from table 1. First, highest $\overline{Client_s}$ and $\overline{Supplier_s}$ appear mostly in heavy industry, while lowest $\overline{Client_s}$ and $\overline{Supplier_s}$ are mostly to be seen in the agri-food sector. This is consistent with

[13] Among them one can mention the degree of product market competition (Brennan, Maksimovic and Zechner, 1988), the degree of uncertainty on the quality of the product (Long, Malitz and Ravid (1993) and Lee and Stowe (1993)) and the information advantage of suppliers over banks to observe product quality or to enforce high effort (Smith (1987), Biais and Gollier (1997), Burkart and Ellingsen (2004) or Cunat (2007)).

the theoretical prediction of Long, Malitz and Ravid (1993) that the durability of the product should be positively correlated to payment delays. However, there is no direct mapping between the sectoral rank of $\overline{Client}_s$ and of $\overline{Supplier}_s$: in 2007, the correlation between the two is only of 46%.

Once $\overline{Client}_s$ and $\overline{Supplier}_s$ are estimated, I use the information of the sales by sector given in the EAE dataset; denoting by $\omega_{fs08} = Sales_{fs08}/Sales_{f08}$ the ratio of firm f's sales in sector s to total sales in 2008, contractual clients and suppliers PD are computed as

$$\overline{Client}_{ft} = \sum_s \omega_{fs08}\overline{Client}_{st} \text{ and } \overline{Supplier}_{ft} = \sum_s \omega_{fs08}\overline{Supplier}_{st}$$

This measure of PD is therefore a sales-weighted sum of the PD might have to agree to through its presence in an industry. Net payment delays are similarly computed as

$$\overline{NPD}_{ft} = \overline{Client}_{ft} - \frac{Purchases_{f08}}{Sales_{f08}}\overline{Supplier}_{ft}$$

Eventually, the change in net payment delays between 2008 and 2009 is computed as

$$\Delta\overline{NPD}_{f09} = \overline{NPD}_{f09} - \overline{NPD}_{f08}$$

The sectoral weights and the purchases to sales ratio are held constant at their 2008 values in the computation of $\Delta\overline{NPD}_{f09}$ so as to abstract from potential endogenous firm-level adjustments due to the payment level reform (variation in the sourcing strategy or in the sectoral repartition of sales).

3 Empirical strategy

3.1 PD variation and export market behavior

This section describes the approach to identifying the causal effects of payment delays on export market decisions. In order to disentangle the effects of the 2009 reform from the presence of the financial crisis (point (b) in section 2.1), I first rely on the disaggregated nature of export data by bringing the analysis to the market level and introducing industry-country fixed effects (Paravisini et al., 2014). By comparing export outcomes within an industry-country pair, I am able to remove any market-level shock that hit demand (*e.g.*, household over-indebtness) or supply (*e.g.*, variation in input prices) between 2008 and 2009 in a given market. Instead of comparing total export variations, the estimations will therefore be based on the comparison of export outcomes in a industry-country pair between firms that were differently affected by the reform.

Market fixed effects additionally allow to take into account a possible correlation between the exposure to the reform and the presence in certain markets. Suppose for instance that because of their position in the input-output network, firms that were exporting plastics and rubber products to the US experienced a strong fall in NPD following the reform. A "naive" estimation might erroneously conclude to a significant positive effect of the variation in payment delays to the drop in exports to that market even in the absence of actual causation. Removing average trends at the market level ensures that the estimations are not prone to such potential bias.

The introduction of fixed effects will however not yield unbiased estimates if the impact of the crisis is heterogeneous among firms exporting in the same market. I first rely on accounting data to assess the impact of the crisis at the firm-level; I use in particular the firm-level variation of the operational margin Δ*Operational margin*$_{f09}$ to control for changes in profitability and the variation in the cash-to-assets ratio Δ*Cash holdings*$_{f09}$ to control for the evolution of the level of liquidity of the firm (a description of the construction of these variables is given in Table 2). Note that the introduction of Δ*Cash holdings*$_{f09}$ is all the more necessary to test the empirical predictions presented in section 1.3 than proposition 4 predicts that a change in *PD* should affect export decisions *holding constant the level of cash*.

Firms might also try to respond to a variation in payment delays by adjusting the speed at which they repay their fiscal debts. This concern is particularly acute during our time frame as French administrations were told to be tolerant for delayed payments during the financial crisis as a way to support small firms' cash flows. (French Ministry of Finance, 2009): bearing this information in mind, I include the variation in tax debts between 2008 and 2009 Δ*Tax debts*$_{f09}$ as a control variable. The lag of leverage *Leverage*$_{f08}$ is also added in the set of explanatory variables to account for differences in debt capacity.

Since Bricongne et al. (2012) find that French exporters' reaction to the crisis varied a lot with firm's size[14], I include the lag of the logarithm of total assets *Size*$_{f08}$ in the estimations; similarly, a dummy *Group*$_{f,t\text{-}1}$ is added to control for heterogeneity in financing conditions due to the affiliation to a business group.

Another potential concern with this approach is that the methodology designed to compute $\Delta\overline{NPD}_{f09}$ might make it inappropriately capture sectoral variations of factors correlated to payment delays. In order to control for such correlations, I use the same methodology to build $\Delta\overline{Sales}_{f09}$ and *Var Inv*$_{ft}$ (see table 2 for the details of the computation): this allows us to take explicitly into account the effects of the crisis as experimented by firm f through the sales-weighted mean of the variation in sectoral sales (which I interpret as a measure of the impact of the crisis on the supply-demand equilibrium at the sectoral level) and investment (which captures the changes in expectations on future profitability and possibly the effects of the tightening of credit conditions). $\Delta\overline{NPD}_{f09}$ might also simply reflect firm f's exposure to financial constraints through its presence on sectors with varying dependence on external finance (Rajan and Zingales, 1998): I take this eventuality into account by introducing the sales-weighted average of sectoral financial dependence, $\overline{ExtFin}_{f,07}$, where financial dependence is defined as the average share of capital expenditures that is not financed by operating cash-flows[15]. This measure has been in particular previously used in previous work on the links

[14] Bricongne et al. (2012) find that while all firms have been evenly affected by the crisis, large firms did mainly adjust through the intensive margin and by reducing the portfolio of products offered in each destination served while smaller exporters have been instead forced to reduce the range of destinations served or to stop exporting altogether.

[15] Rajan and Zingales (1998) recommend to use the average values taken for the US economy, as they advocate that the US financial system is the most developed one and that the values of *ExtFin* computed for the US economy would therefore capture variation in financial dependence due only to industrial factors (degree of uncertainty, of redeployability of the assets...) and not to variation in development of the financial system. I use here the values taken for the French economy since (1) the identification does not depend on cross-country variations (2) the French financial system is arguably developed enough for *ExtFin* to mostly capture variation in demand-originated variation in financial dependence.

between finance and international trade such as Manova (2013) or Paravisini et al. (2014).

For $Z_{fm09} \in \{\Delta Exports_{fm09}, Exit_{fm09}, Entry_{fm09}\}$, the baseline regression is therefore specified as

$$Z_{fm09} = \alpha_m + \beta \Delta \overline{NPD}_{f09} + \gamma X_{f09} + \epsilon_{fm09} \tag{15}$$

where α_m is the industry-country fixed effects and X_{f09} the set of firm-level control variables. Several features in equation 15 are worth emphasizing: first, since the left-hand variable is observed at the firm-country-industry-level and right-hand sides variables only at the firm-level, error delays ϵ_{fm09} will be correlated for a given firm f. Bertrand, Duflo and Mullainathan (2004) and Petersen (2009) show with Monte-Carlo simulations that this will lead to underestimate standard errors and thus to under-reject the null hypothesis of non significance. I follow the econometric literature on that subject and cluster standard errors by firm to allow for arbitrary patterns of cross-correlation. Second, for $Z_{fmt} \in \{Exit_{fm09}, Entry_{fm09}\}$, equation 15 boils down to a linear probability model. The choice of a linear estimator over nonlinear ones can be understood by the necessity for the estimator to handle a large number of fixed effects, which the probit estimator appears to struggle with (see Greene (2004)). This suggests the use of logit models ; however, this strand of nonlinear econometric models does not easily deal with endogeneity issues[16], a problem I now turn to.

3.2 Description of the IV strategy

There are indeed several reasons to believe that $\Delta\overline{NPD}_{f09}$ might be endogenous. As previously noted in point (c), derogations to the 2009 might cause the variation in PD to be driven by export-related factors and thus create a form of simultaneity in equation 15. More importantly, if there are omitted variables (such as aggregate factors due to the financial crisis) that drive $\Delta\overline{NPD}_{f09}$ even in the presence of control variables, the estimated coefficient $\hat{\beta}$ will be biased. Ideally, $\Delta\overline{NPD}_{f09}$ should only reflect the effect of the reform. A natural way to isolate the effect of the reform is to rely on the sixty-day-rule: since the reform gave a clear ceiling to contractual payment delays, it is possible to determine to which extent sectors were likely to be affected by the reform. For a given sector s, I define to that end excessive clients and suppliers PD at the sectoral level as the mean for all firms g in s of

$$Excess\ Client\ PD_g = \max(0, Client_g - 60) \text{ and } Excess\ Supplier\ PD_g = \max(0, Supplier_g - 60)$$

The firm-level variable $Excess\ \overline{NPD}_{f07}$ is then computed as

$$Excess\ \overline{NPD}_{f07} = \sum_s \omega_{fs08} \left(Excess\ Client\ PD_{s08} - \frac{Purchases_{f08}}{Sales_{f08}} Excess\ Supplier\ PD_{s08} \right)$$

$Excess\ \overline{NPD}_{f07}$ can be interpreted as a measures of the net change in PD needed in 2007 to reach the setting where the reform is perfectly enforced: if $Client_f$ and $Supplier_f$ were always inferior to sixty days in sector s, then $Excess\ \overline{NPD}_{f07}$ would equal zero. Similarly, if suppliers excessive PD were about

[16] Recent developments (Wooldridge, 2014) suggest that quasi-maximum likelihood techniques can be developed to get consistent estimators in logit models with a continuous endogenous regressor.

as high than clients excessive *PD*, the needed change in *PD* would be zero in net terms. In general, a high value of $\overline{ENPD}_s$ means that clients *PD* are on average higher than sixty days and that suppliers *PD* are relatively low. This variable is used as in instrument for $\Delta\overline{NPD}_{f09}$:

$$\Delta\overline{NPD}_{f09} = \eta_{ci} + \xi Excess\,\overline{NPD}_{f07} + \rho X_{ft} + \nu_{fmt} \text{ for } t = 2009 \tag{16}$$

I expect a negative significant coefficient ξ: the variation in net payment delays subsequent to the reform should correct for previous excessive *PD*.

The identification assumption behind the IV strategy is that factors other than payment delays that affect export outcomes of firms present *in a given market* are not correlated to the exposure to the reform. This assumption might be violated if firms with more market power were more likely to be affected by the reform than other. Since one of the main goal of the reform was to put an end to abusive practices resulting (in particular) from dominant positions in supplier-customer relationships, this might create some bias in the estimations since export decisions are presumably correlated with market power. This potential concern is however alleviated by the fact that I focus on SMEs whose market power is presumably limited.

This instrumentation strategy has several advantages in this context: first, in the absence of a control group (point (a)), it allows to turn a *qualitative* assignment (treatment versus control group) into a *quantitative* one (to what extent is firm f exposed to the reform?). Second, the instrument is designed so as not to take into account derogations (point (c)). The first-stage estimation thus only captures the variation of net *PD* that can be explained by the sixty-days-rule and should leave aside the effects of derogations; in the end, derogations should only bring down the coefficient $\hat{\xi}$ but should leave $\hat{\beta}$ unaffected. In other terms, the IV estimator captures the *local average treatment effect* (LATE) by relying on the effects of the reform only in the sectors that applied the sixty-days rule (*compliers*).

3.3 Descriptive statistics

To obtain the final data set, I eventually remove outliers by dropping observations that are superior (resp. inferior) to the median plus (resp. minus) three times the gap between the 95$^{\text{th}}$ and 5$^{\text{th}}$ percentile; I only keep firms with non missing observations for all variables. The final data set is composed of 13 829 firms. A majority of firms belong to the manufacturing sector (71 %) and they are on average relatively mature (the median age is 23 years). Panel B of table 2 shows moreover that average total assets is around 5 millions euros, and that 52 % of the firms in the data set belong to a business group, which is in line with the importance of business groups in the French economy (Boutin et al., 2013).

[Insert table 2 here]

The effects of the crisis are clearly visible in the summary statistics. The operating margin dropped on average by -3%, while sectoral sales (as measured by $\Delta\overline{Sales}_{f09}$) decreased by 19%. On the export side, I observe an exit probability from a market m between 2008 and 2009 of 24%; when firms were active in 2009 and 2009 in a market, they decreased the volume of exports by 16% on average. Net payment delays increased by 0.96 days on average, but a closer look to the distribution shows that they decreased for half of firms, which makes explicitly appear that the renegotiation of *PD* produced both winners and losers.

Median excessive payment delays were about -10.8 days prior to the reform, which means that the majority of firms were located in sectors where most of the excessive payment delays were to be found on the suppliers side. This is partly due to the presence of wholesale firms in the data set; the wholesale sector was indeed perceived as one of the sectors who benefitted the most from important suppliers *PD* (ODDP, 2010). When I restrict the data set to manufacturing firms, median $Excess\,\overline{NPD}_{f07}$ increases to -6.3 days, indicating that clients and suppliers *PD* were more balanced in the manufacturing sector.

4 Results

4.1 Variation in net payment delays

Figure 2 shows the result of a local polynomial regression of $\Delta\overline{NPD}_{f09}$ on $Excess\,\overline{NPD}_{f07}$: the relation seems to negative and reasonably approximated by a linear function. As expected, the reform seems to correct past excessive payment delays.

[Insert figure 2 here]

Columns 1 to 4 of table 3 displays the results of the estimations of equation 16; standard errors are clustered by industry (2 digits activity nomenclature). This exercise allows to understand as a first step the impacts of the sixty-days-rule on net payment delays. The effect of $Excess\,\overline{NPD}_{f07}$ is negative and significant; on average, estimations indicate that every 10 days of $Excess\,\overline{NPD}_{f07}$ was followed by a decrease of 0.97 day in $\Delta\overline{Sales}_{f09}$. This effect is robust to the addition of control variables; in particular, the effects of $\Delta\overline{Sales}_{f09}$ and $\Delta\overline{Inv}_{f09}$ is found to be non-significant, which alleviates the concern that the significance of the $\Delta\overline{NPD}_{f09}$ coefficient might be driven by aggregate shocks due to the crisis. Similarly, $\Delta\overline{NPD}_{f09}$ does not seem to be correlated with the sales-weighted average of sectoral financial dependence $\overline{ExtFin}_{f,07}$. Interestingly, I find a positive correlation of $Leverage_{f08}$ on the variation in net *PD*, which suggests that the firms that operate in sectors in which net payment delays increased between 2008 and 2009 are more leveraged on average.

[Insert table 3 here]

Column 5 displays the results of the same estimations replacing $\Delta\overline{NPD}_{f08\text{-}09}$ by $\Delta\overline{NPD}_{f08\text{-}09}$ so as to test for the possibility of an anticipation of the reform. The elasticity increases to -0.47 from -0.10, which suggests that firm may indeed have started changing their payment behavior as of 2008. I take this finding into account in the robustness tests performed in section 5. I eventually perform a placebo equation by testing equation 16 for $t = 2010$ and find no effect of a correction of excessive net payment delays after the implementation of the reform.

4.2 Extensive margin

Table 4 shows the results of the estimations of equation 15 for $Z_{fm09} = Exit_{fm09}$ (panel A) and $Z_{fm09} = Entry_{fm09}$ (panel B). Column 1 and 2 of panel A show that direct OLS estimations yields no significant association between probability of exit and $\Delta\overline{NPD}_{f09}$. However, it can be observed that the exit probability is lower for mature, large firms and that a deterioration in the operational margin or the cash-to-assets ratio is associated with higher exit rates. Firms present in sectors that fared better during the crisis exited less between 2008 and 2009 ($\Delta\overline{Sales}_{f09}$); interestingly, increases in tax debts are associated with less exits, suggesting that firms might have used this margin of adjustment to finance their cash flows.

[Insert table 4 here]

Consistently with the results from the first-stage estimations, the Kleibergen-Paap statistics presented in columns 3 to 5 go in favour of a rejection the hypothesis of a weak instrumentation; moreover, when $\Delta\overline{NPD}_{f09}$ is instrumented with $Excess\ \overline{NPD}_{f07}$, the coefficient on $\Delta\overline{NPD}_{f09}$ becomes positive and highly significant. This result is very intuitive: columns 3-5 indicate that longer payment delays had a positive effect on the probability of exit. The magnitude of the effect is sizeable: according to the estimations, an increase in net payment delays of 10 days increases the probability of exit by 7.2 percentage points (column 4).

The fact that simple OLS do not allow to pin down this effect suggests the presence of confounding aggregate factors leading direct estimations to yield biased estimates. By capturing the part of the variation in net payment delays that can be explained by the exposure to the reform, I am able to isolate the causal effect of $\Delta\overline{NPD}_{f09}$ on firms' exit decisions.

Panel B displays the results of the regressions on the probability of entry for the subpopulation of firms that already export in 2008. The estimates do not substantially change if I also include non-exporters (last column in appendix A). In a very coherent way, the results shows that $\Delta\overline{NPD}_{f09}$ had a positive and highly significant effect on $Entry_{fm09}$. On average, an increase in $NPD_{f,t}$ by 10 days leads to a 0.4% decrease of the probability of entry. When compared to the unconditional probability of entry (1.0%), such a decrease in NPD would cause a 39% rise in the probability of entry.

Furthermore, it appears that size and increase in operational margins are positively associated with the entry rate. By contrast, age and sectoral sales growth are negatively correlated to entry, which can be explained that mature firms operating in performing sectors might have already entered in their preferred export market as of 2008. A small positive correlation between the level of debt and the probability of entry can eventually be observed.

4.3 Intensive margin

Table 5 shows the result of the estimations of equation 15 for $Z_{fm09} = \Delta Exports_{fm09}$. I find a positive correlation between $\Delta Exports_{fm09}$ and the variation in operating margin $\Delta Operational\ margin_{f09}$, $\Delta Cash\ holdings_{f09}$ and $\Delta Tax\ debts_{f09}$.

[Insert table 5 here]

OLS estimations yields an imprecise but significant positive relation between the variation in net payment delays and in export volumes. However, the effect of $\Delta\overline{NPD}_{f09}$ becomes non significantly different from zero in all IV specifications, indicating that payment delays did not affect exports at the intensive margin.

4.4 *Alternative specifications*

To assess the robustness of my results, I reestimate equation 16 using several alternative specifications. I first take the presence of derogations to the sixty-days rules into account in the construction of the instrument (see appendix C for a list of the derogations). The results are displayed in the *Derogations* column and show that the $\Delta\overline{NPD}_{f09}$ coefficients are nearly unchanged compared to the baseline estimations.

[Insert table 6 here]

In the *Anticipation* column, the estimation is performed for $\Delta\overline{NPD}_{f,07,09}$ instead of $\Delta\overline{NPD}_{f,08,09}$. The respective signs of the coefficients stay unchanged but their magnitudes drop by a factor five, which is partly explained by a greater standard deviation of $\Delta\overline{NPD}_{f,08,09}$ (2.2 times higher than for $\Delta\overline{NPD}_{f,08,09}$).

The next two columns display results of the estimations using alternative classifications of the French nomenclatures of activities and products: in the *Market* column, a market (c, i) is defined at a finer level as the product of a country and of a product defined at a 3-digits level (instead of 2 digits) ; remarkably, while the number of observations increase by nearly 34% in the *Entry* estimation, the elasticity remains very close to the one obtained in the baseline specification. The other *NPD* elasticities remain stable as well. In the *Sector* column, payment delays are averaged at a grosser level of the French classification of activity (3 digits instead of 5), yielding a coarser measure of *PD* but at the same time making it less sensitive to potential extreme values; the magnitudes of the effects are similar to the baseline results. Overall, these tests indicate that the effects are fairly robust while giving a range of estimates to assert their magnitudes.

5 Heterogeneity of the effects of payment delays

5.1 *Heterogeneity in cash holdings*

In the model, the decision to enter or to exit an export market is entirely driven by the position of the firm's cash holdings relative to an optimally chosen upper threshold. In stage I, for instance, the firm enters the export market if and only its cash holdings reach C_E (C^* is state E). Moreover, the analysis suggests that the effects of a variation in *PD* should disappear for firms whose cash holdings are close to the entry threshold. Intuitively, it is reasonable to expect cash-poor firms to be more affected by a variation in cash-flow risk as only a slight increase in *PD* might jeopardize the financial sustainability of the firm.

[Insert figure 3 here]

It is therefore interesting to try to ascertain the variation of the intensity of the *PD* effects with the level of cash holdings. However, as liquidity holdings are endogenously chosen by the firm, a simple classification of firms according to their level of cash might be misleading. Low cash holdings might for instance not reveal a fragile financial structure but on the contrary reflect the fact that the firm has access to other sources of external financing. In the wording of the model, firm's actual cash holdings C_t are observable but the optimal upper threshold C_E is not.

Building on this insight, I estimate the potential level of cash that firm could hold given its observable characteristics: this "cash capacity", that I interpret as a proxy for C_E, allows me to identify whether a firm is cash-poor or not *by comparison to the amount of cash that it could possibly hold*. I draw to this end on Edmans, Goldstein and Jiang (2012) and estimate a quantile regression of cash holdings on total assets, age, volume of exports, leverage, operational margin and payment delays in 2008 and also include a set of industry (2-digits) fixed effects. In order to limit the effects of outliers while capturing the variations of the distribution of cash holdings, I focus on the 9th decile of cash holdings; the results are however robust to other specifications of the quantile regression.

I get that the firms that are bigger, older, more profitable and export more have a bigger cash capacity; by contrast, group affiliation is negatively associated with cash capacity, suggesting that internal capital markets might act as substitute for liquidity holdings. Similarly, leverage is negatively associated to cash capacity; the payment delays coefficient is non-significantly different from zero. Using the result of the estimation, I predict a firm-level cash capacity C_f^*: with this methodology, for a given level of cash holdings, a firm that belongs to a group will be attributed a bigger value of $C_f - C_f^*$ than an independent firm as we expect the group-affiliated firm to have lower cash holdings at equilibrium. I sort firms in five quintiles of $C_f - C_f^*$ and reestimate equation 16 on the different subgroups.

The results are graphically represented in figure 3. Strikingly, the effects of the variation in payment delays on the entry probability appear to be concentrated in the first quintile of $C_f - C_f^*$, indicating that the variations of *PD* primarily affected cash-poor firms; by contrast, the entry rate of cash-rich firms do not appear to be affected by the variation in payment delays. The role of cash holdings in the sensitivity of the exit rate to $\Delta\overline{NPD}_{f09}$ is less clear as the coefficient is significant at 10% in all quintiles but the first. The effects of the variation of net *PD* on the intensive margin of exports stays not significant for all quintiles.

5.2 *Other firm-level sources of heterogeneity*

In this section, I analyse the role of alternative sources of firm-level heterogeneity in the sensitivity to *PD* variation. This exercise serves two main purposes: first, it allows that to check that in line with the economic theory, the effects should be greater for certain types of firms and lower for others; moreover, this verification incidentally highlights the source of identification of the different estimations. Second, systematic unobserved variations between groups differently affected by the reform might lead us to erroneously conclude to a causal effects of $\Delta\overline{NPD}_{f09}$ on export outcomes (Bakke and Whited, 2012). By performing the regressions on groups of firms that are supposedly more homogeneous, this exercise directly addresses this concern.

[Insert table 7 here]

I first rerun the estimations on the subsets of manufacturing and wholesale firms: the suspicion of a confounding role of unobserved heterogeneity between these two groups is high since (1) they were unequally affected by the reform (see section 3.3) (2) they gather firms with presumably very different unobserved characteristics which might have affected their export decisions. Table 7 shows that if the results hold for manufacturing firms but not for the wholesale sector. Predictably, the coefficient are less precisely estimated: since the manufacturing and the wholesale sectors were differently affected by the reform (see section 3.3), the regression on the subgroups removes part of the variation upon which the identification strategy hinges.

The asymmetry between the manufacturing and the wholesale sector might point to a role of financial constraints which may be more of a concern for manufacturing industries due to their greater needs for external finance. This explanation is supported by columns 4-5 in which I split the sample between *financially independent* (first half of $\overline{ExtFin}_{f,07}$) and *financially dependent* firms (second half): I find that the variation in net payment delays have causal effects only for financially dependent firms. I then look at the effects of variations in *NPD* on firms belonging to large groups: only the rate of entry seems to be affected by the variation in payment delays, but the coefficient is imprecisely estimated. The entry probability appears to be unaffected by $\Delta\overline{NPD}_{f09}$, which is again consistent with the notion that financial constraints are necessary for payments delays to have an impact on real outcomes.

The effects of *NPD* are identified by the exogenous restriction on payment delays on the domestic market. Firms that operates in majority outside of the domestic market should therefore be less exposed to the effects of the reform: I denote to that end firms as *insulated* if their exports to total sales and imports to total purchases ratios are superior to 50%. The $\Delta\overline{NPD}_{f09}$ coefficients are non-significant for all the margins of adjustment, which shows that the effects of the reform are only observed for firms that maintains sufficient activity in the domestic market.

5.3 *Market-level sources of heterogeneity*

The sample is eventually divided in different geographic zones to investigate the role of unobserved heterogeneity between export markets. Interestingly, the effects of the variation in payment delays on the probability of entry becomes not significant when the sample is restricted to markets within the EU, which could be interpreted as liquidity risk playing less a role in the decision of entry as these markets are presumably easier to access. The effect on the entry rate stays however positive and significantly different from zero. The effects of *PD* persists outside the European Union (Europe outside the EU, Africa, America) except for Asia, where neither the entry nor the exit rates seem to be affected by $\Delta\overline{NPD}_{f09}$.

[Insert table 8 here]

Importantly, firms appear to adjust their sales following a variation in payment delays only at the extensive margin, and this irrespective of the localization of the export markets. Proposition 5 would suggest that this indicates that firms perceive the costs of reentering export markets to be rather low.

This finding could be rationalized if the costs of entry mostly covers networking or marketing costs to reach foreign buyers (à la Arkolakis (2010)), which are presumably lower when the firm wants to reenter in a market in which it has already had access to.

6 Discussion of the results

The results are consistent with the empirical predictions presented in section 1.3: when faced with higher domestic liquidity risk, firms adjust their market portfolio so as to be less exposed to foreign liquidity risk. It is important in this sense that the estimations include the changes in cash holdings as control variable: the estimation of the $\Delta\overline{NPD}_{f09}$ coefficient thus cast aside the impacts of the variation in payment delays on firms' cash holdings to only capture the effects of the modification of firms' anticipations on their ability to maintain a sustainable cash flow in export markets.

These results are in stark contrast with Paravisini et al. (2014) who find that credit supply only affects the intensive margin of exports through the variable cost of exporting. Yet, this apparent contradiction can easily be overcome by noting that the two studies look at the export effects of financing shocks of a very different nature: while Paravisini et al. (2014) look at the impacts of a temporary fall in debt supply, I investigate the role of a permanent shift in liquidity risk[17]. In face of a short-lived credit crisis, it may be optimal to temporarily adjust through shifting towards more expensive sources of financing such as factoring; though raising the variable cost of exporting, this solution allows to keep exporting in the same markets (albeit at a lower rate through the impact on prices) which avoids a costly exit for the firm.

Eventually, it is important to recall that these effects might be influenced by the coincident presence of the financial crisis. Theory in this respect does not provide clear guidance on whether the financial crisis tends to go for or against the effects of the reform. On the one hand, since financial constraints were presumably very high during this period, the real effects of payment delays should have been magnified. On the other hand, precautionary motives might have made firms hoarding cash instead of readjusting their portfolio of export markets. Further research on other regulations on payment delays such as the Federal Quickpay Initiative in 2011 in the US or the Directive 2011/7/EU that generalizes the French reform to the whole European Union might show whether the results still hold with more standard financing conditions.

7 Conclusion

The results point to a significant effect of the variation in domestic payment delays on the decisions to enter or to exit an export market for small firms operating in sectors relying on external finance. This finding is of particular interest to the study of export barriers in developing countries: while trade credit is a very important source of financing for firms operating in developing countries (Fisman, 2001), excessive payment delays remain a pervasive source of concern while performing

[17]The reform might have had an effect on firms' decisions both through (1) permanent changes in liquidity risk and (2) a temporary impact on cash holdings as firms adjust to their new payment contracts. Since I control for Δ*Cash holdings*$_{f09}$, the regressions should mostly capture the effects of (1) and leave aside (2).

day-to-day operations in those markets (ACCA, 2015). In this way, policies aiming at reducing payment delays (such as simplifying customs procedure, see Hummels (2007)) or fostering the development of factoring firms might allow small firms in developing countries to access international markets.

The theoretical model then suggests a role of operational leverage (that is, how total sales depend on a single customer) in the effects of payment delays on firm decisions. In this line of reasoning, using client-level export data might generate interesting results on how firms adjust their portfolio of clients following a shock on liquidity risk (see Kramarz, Martin and Mejean (2014) for a study of the propagation of individual shocks in exporter-importer networks).

Payment delays might also affect other individual outcomes. In particular, it seems legitimate given the results to believe that *PD* might affect labor decisions (Barrot and Nanda, 2016) since unlike input purchases, wage payment can not generally be delayed; it is possible that in presence of financial constraints, recurrent late payments might deter from hiring since firms fear being unable to meet the additional payroll expenses. Structural estimations might eventually be useful to understand and to estimate the aggregate effects of payment delays on the real economy.

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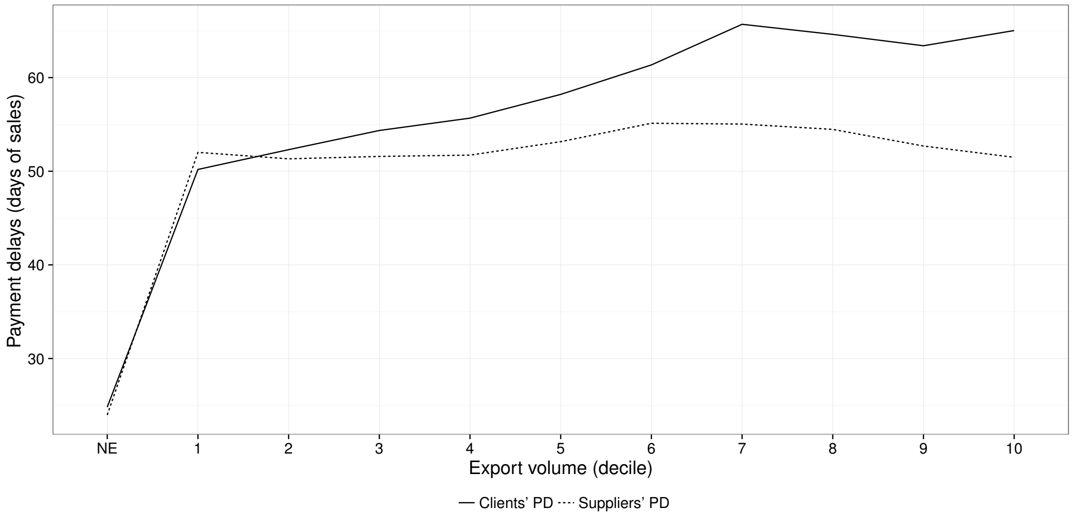
Appendix A Tables and figures

Figure 1: Payment delays and export activity



Source: BRN-RSI tax returns, customs data (2013). *Field:* manufacturing and wholesale firms. *Lecture:* This figure plots clients and suppliers estimated payment delays as a function of export activity: "NE" stands for "not exporting", and the numbers denote the corresponding deciles of total exports. For a given decile of export activity, clients (resp. suppliers) *PD* are estimated as the mean of the account receivables over sales (resp. account payables over sales) ratio multiplied by 365 to be expressed in days of sales. The growing gap between clients *PD* and suppliers *PD* means that in the cross-section, firms get paid later in net terms as they export more.

Table 1: Top and bottom 5 sectors for $\overline{Client_s}$ and $\overline{Supplier_s}$ (2007)

$\overline{Client_s}$		$\overline{Supplier_s}$	
Manufacture of non-metallic mineral products	145.1	Replication of recordings	168.7
Manufacture of industrial gases	120.1	Manufacture of magnetic and optical media	154.3
Manufacture of locomotives	119.7	Manufacture of cider and other fruit wines	146.0
Manufacture of steam generators	118.1	Manufacture of ships	144.5
Manufacture of cement	112.6	Manufacture of machinery for metallurgy	143.3
Processing and preserving of potatoes	8.2	Wholesale of waste and scrap	54.3
Confectionery shop	6.7	Wholesale of fuel	46.8
Delicatessen	6.4	Delicatessen	45.5
Bakery	6.1	Manufacture of grease and oil	38.1
Industrial bakery	5.0	Wholesale of live animals	32.3

Source: BRN-RSI tax returns. *Field:* manufacturing and wholesale firms.
Lecture: This table displays the NAF-4 digits sectors in the manufacturing or wholesale sector with the highest and lowest values of average clients *PD* ($\overline{Client_s}$) and suppliers *PD* ($\overline{Supplier_s}$). The values are given in days. A value of 100 for $\overline{Client_s}$ means that the average gap between cash-flow payments for firms in sector *s* is of 100 days.

Table 2: Descriptive statistics

This table summarizes the main variables used (Panel A) and presents summary statistics (Panel B).

Panel A: Data Definitions

Dependent variables	
$\Delta Exports_{fm09}$	$\Delta \log(Exports_{fm9})$ if firm f exports more than 5000 euros in market m in 2008 and 2009. *Source: Customs.*
$Exit_{fm09}$	$Exit_{fm09} = 1$ if firm f exports more than 5000 euros in market m in 2008 and zero in 2009 (0 otherwise). *Source: Customs.*
$Entry_{fm09}$	$Entry_{fm09} = 1$ if firm f does not export in market m in 2008 and exports more than 5000 euros in 2009 (0 otherwise). *Source: Customs.*
Independent variables	
$\Delta \overline{NPD}_{f09}$	Variation in the logarithm of the sales-weighted average of sectoral net payment delays (see section 2.4. *Source: EAE, BRN-RSI.*
$\Delta \overline{Sales}_{f09}$	Sales-weighted average of sectoral sales growth rates between 2008 and 2009. *Source: EAE, BRN-RSI.*
$\Delta \overline{Inv}_{f09}$	Sales-weighted average of sectoral investment growth rates between 2008 and 2009. *Source: EAE, BRN-RSI.*
$\overline{ExtFin}_{f,07}$	Sales-weighted average of the sectoral mean of the share of capital expenditures that is not financed by operating cash-flows (computed in 2007). *Source: EAE, BRN-RSI.*
$\Delta Operational\ margin_{f09}$	Variation in the EBIT over sales ratio. *Source: BRN-RSI.*
$\Delta Cash\ holdings_{f09}$	Variation in cash holdings, standardized by the lag of total assets. Cash holdings are computed in "net" terms, that is by removing bank overdrafts. *Source: BRN-RSI.*
$\Delta Tax\ debts_{f09}$	Variation in tax debts, standardized by the lag of total assets. *Source: BRN-RSI.*
$Leverage_{f08}$	Lag of the ratio of long-term debt to total assets. *Source: BRN-RSI.*
$Group_{f08}$	Dummy indicating the affiliation to a business group. *Source: LIFI.*
$Size_{f08}$	Lag of the logarithm of total assets. *Source: BRN-RSI.*
Instrument	
$Excess\ \overline{NPD}_{f07}$	Sales-weighted average of sectoral excessive net payment delays computed in 2007 (see section 3.2). *Source: EAE, BRN-RSI.*

Panel B: Summary Statistics

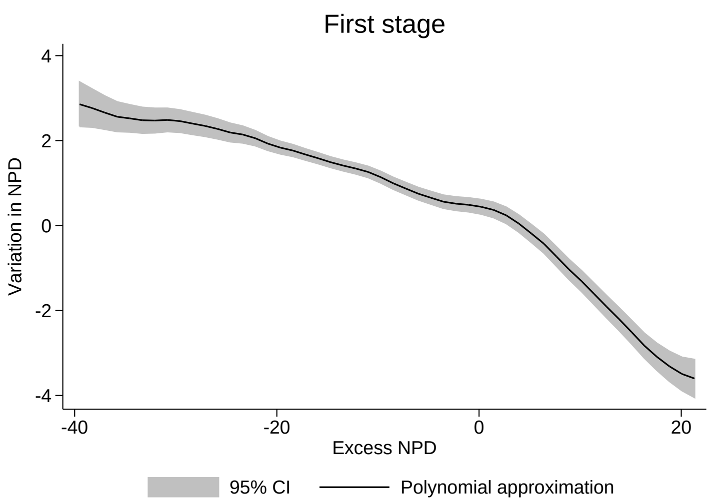
Name	# Obs.	Mean	Std. Dev.	Percentiles 5^{th}	25^{th}	50^{th}	75^{th}	95^{th}
$\Delta Exports_{fm09}$	64 986	-0.16	1.01	-1.79	-0.64	-0.15	0.30	1.46
$Exit_{fm09}$	108 479	0.24	0.43	0.00	0.00	0.00	0.00	1.00
$Entry_{fm09}$	557 500	0.01	0.11	0.00	0.00	0.00	0.00	0.00
$\Delta \overline{NPD}_{f09}$	13 829	0.95	4.56	-5.93	-1.28	1.20	2.87	7.53
$Excess\ \overline{NPD}_{f07}$	13 829	-10.77	15.20	-36.56	-19.19	-11.15	-0.78	13.71
$\Delta \overline{Sales}_{f09}$	13 829	-0.19	0.16	-0.46	-0.26	-0.18	-0.11	-0.02
$\Delta \overline{Inv}_{f09}$	13 829	-0.35	0.44	-1.07	-0.51	-0.36	-0.13	0.26
$\overline{ExtFin}_{f,07}$	13 829	-7.33	2.95	-12.38	-8.88	-7.30	-5.65	-2.27
$\Delta Operational\ margin_{f09}$	13 829	-0.03	0.10	-0.18	-0.05	-0.01	0.01	0.07
$\Delta Cash\ holdings_{f09}$	13 829	0.01	0.08	-0.10	-0.02	0.00	0.04	0.14
$\Delta Tax\ debts_{f09}$	13 829	-0.00	0.03	-0.03	-0.01	-0.00	0.01	0.03
$log(Total\ Assets)_{f08}$	13 829	8.52	1.11	6.62	7.84	8.57	9.27	10.29
$Leverage_{f08}$	13 829	0.04	0.07	0.00	0.00	0.02	0.06	0.18
Age_{f09}	13 829	27.53	18.81	6.00	15.00	23.00	36.00	53.00
$Group_{f08}$	13 829	0.52	0.50	0.00	0.00	1.00	1.00	1.00

Table 3: Variation in net payment delays

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
		$\Delta\overline{NPD}_{f,08\text{-}09}$			$\Delta\overline{NPD}_{f,07\text{-}09}$	$\Delta\overline{NPD}_{f,09\text{-}10}$
Excess $\overline{NPD}_{f,t}$	-0.097^{***}	-0.096^{***}	-0.095^{***}	-0.098^{***}	-0.474^{***}	0.024
	(0.021)	(0.021)	(0.021)	(0.019)	(0.046)	(0.019)
Δ*Operational margin*$_{f,t}$		1.177^{*}	1.192^{*}	1.111^{*}	-3.362^{***}	0.231
		(0.594)	(0.580)	(0.565)	(1.103)	(0.623)
Δ*Cash holdings*$_{f,t}$		-0.278	-0.250	-0.350	-0.203	-0.658
		(0.570)	(0.581)	(0.581)	(0.467)	(0.543)
Leverage$_{f,t\text{-}1}$		2.218^{**}	2.034^{**}	2.509^{**}	2.214	0.762
		(1.006)	(0.945)	(0.929)	(1.539)	(1.254)
log(Total Assets)$_{f,t-1}$		0.086	0.126	0.125	-0.388^{*}	-0.235
		(0.073)	(0.077)	(0.083)	(0.191)	(0.142)
Group$_{f,t\text{-}1}$			-0.067	-0.095	0.259^{*}	0.114
			(0.092)	(0.082)	(0.142)	(0.090)
Age$_{f,t}$			-0.196^{**}	-0.180^{*}	0.040	0.292^{*}
			(0.094)	(0.089)	(0.134)	(0.152)
Δ*Tax debts*$_{f,t}$			-0.722	-0.469		
			(1.748)	(1.658)		
$\Delta\overline{Sales}_{f,t}$				0.170		
				(2.009)		
$\Delta\overline{Inv}_{f,t}$				0.007		
				(0.479)		
$\overline{ExtFin}_{f,07}$				-0.100		
				(0.071)		
Observations	13829	13823	13823	13823	14404	14034
R^2	0.105	0.107	0.108	0.112	0.527	0.008

All standard errors are clustered at the sector (NAF 2-digits) level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. $\Delta\overline{NPD}_{f,r,t}$ is given by $\overline{NPD}_{ft} - \overline{NPD}_{fr}$.

Figure 2



Source: BRN-RSI tax returns. *Field:* manufacturing and wholesale firms.
Lecture: Figure 2 displays the result of a kernel-weighted local polynomial regression of $\Delta\overline{NPD}_{f09}$ on *Excess* $\overline{NPD}_{f07}$; the grey area gives the 95% range around the polynomial approximation. The computations of the variation in net payment delays and of excess net payment delays are presented in sections 2.4 and 3.2.

Table 4: Effects of $\Delta\overline{NPD}_{f09}$ at the extensive margin

Panel A: Exit

	OLS (1)	OLS (2)	IV 2SLS (1)	IV 2SLS(2)	IV 2SLS (3)	First stage
			$Exit_{fm09}$			$\Delta\overline{NPD}_{f09}$
$\Delta\overline{NPD}_{f09}$ (×100)	0.011	0.023	0.572***	0.718***	0.713***	
	(0.041)	(0.040)	(0.178)	(0.177)	(0.170)	
Δ*Operational margin*$_{f09}$	−0.093***	−0.090***		−0.092***	−0.088***	−0.015
	(0.031)	(0.031)		(0.031)	(0.032)	(0.011)
Δ*Cash holdings*$_{f09}$	−0.105***	−0.091***		−0.110***	−0.095***	0.012
	(0.030)	(0.031)		(0.031)	(0.032)	(0.009)
log(Total Assets)$_{f08}$	−0.031***	−0.032***		−0.033***	−0.033***	0.001
	(0.002)	(0.002)		(0.002)	(0.002)	(0.001)
Age$_{f09}$	−0.009***	−0.009***		−0.006*	−0.006*	−0.002*
	(0.003)	(0.003)		(0.003)	(0.003)	(0.001)
Group$_{f08}$	−0.003	−0.003		−0.003	−0.002	−0.001
	(0.005)	(0.005)		(0.005)	(0.005)	(0.002)
$\Delta\overline{Sales}_{f09}$		−0.047***			−0.063***	0.026***
		(0.013)			(0.016)	(0.009)
Leverage$_{f08}$		0.023			−0.005	0.048***
		(0.036)			(0.038)	(0.014)
Δ*Tax debts*$_{f09}$		−0.366***			−0.383***	−0.004
		(0.127)			(0.128)	(0.032)
Excess $\overline{NPD}_{f07}$ (×100)						−0.095***
						(0.006)
Observations	108479	108479	108479	108479	108479	108479
Firms	12350	12350	12350	12350	12350	12350
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.121	0.122	-	-	-	0.160
Weak identification (KP stat)	-	-	166.1	162.9	179.8	-

Panel B: Entry

	OLS (1)	OLS (2)	IV 2SLS (1)	IV 2SLS(2)	IV 2SLS (3)	First stage
			$Entry_{fm09}$			$\Delta\overline{NPD}_{f09}$
$\Delta\overline{NPD}_{f09}$ (×100)	−0.001	−0.001	−0.027*	−0.042***	−0.039***	
	(0.004)	(0.004)	(0.014)	(0.015)	(0.015)	
Δ*Operational margin*$_{f09}$	0.005***	0.005***		0.006***	0.006***	−0.000
	(0.002)	(0.002)		(0.002)	(0.002)	(0.008)
Δ*Cash holdings*$_{f09}$	0.001	0.001		0.001	0.001	0.002
	(0.003)	(0.003)		(0.003)	(0.003)	(0.007)
log(Total Assets)$_{f08}$	0.002***	0.002***		0.002***	0.002***	0.001*
	(0.000)	(0.000)		(0.000)	(0.000)	(0.001)
Age$_{f09}$	−0.001**	−0.001**		−0.001***	−0.001***	−0.002**
	(0.000)	(0.000)		(0.000)	(0.000)	(0.001)
Group$_{f08}$	0.000	0.001		0.000	0.001	−0.000
	(0.000)	(0.000)		(0.000)	(0.000)	(0.001)
$\Delta\overline{Sales}_{f09}$		−0.004***			−0.003**	0.003
		(0.001)			(0.001)	(0.006)
Leverage$_{f08}$		0.008*			0.008*	0.005
		(0.004)			(0.004)	(0.010)
Δ*Tax debts*$_{f09}$		0.001			0.003	0.019
		(0.010)			(0.010)	(0.023)
Excess $\overline{NPD}_{f07}$ (×100)						−0.094***
						(0.007)
Observations	557500	557500	557500	557500	557500	557500
Firms	9537	9537	9537	9537	9537	9537
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.005	0.005	-	-	-	0.099
Weak identification (KP stat)	-	-	224.2	214.2	208.3	-

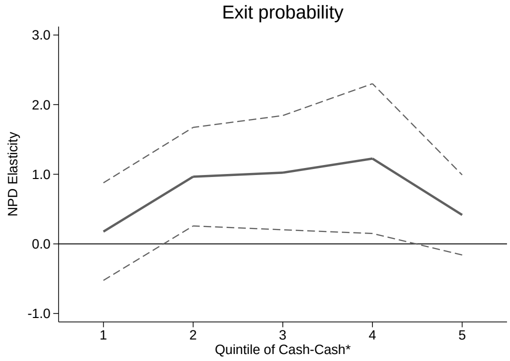
All standard errors are clustered at the firm level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. The Kleibergen-Paap statistic (KP stat) tests for the presence of a weak instrument in presence of heteroscedasticity (high values suggest to reject the null hypothesis of weak identification).

Table 5: Effects of $\Delta\overline{NPD}_{f09}$ at the intensive margin.

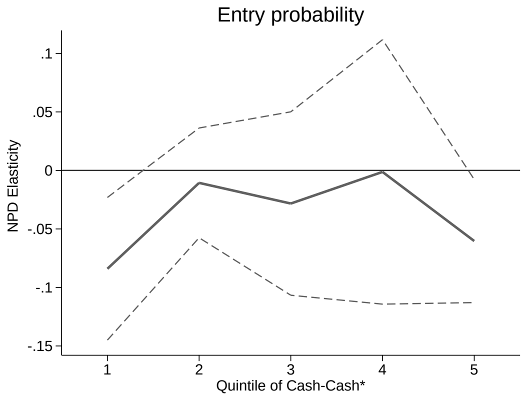
	OLS (1)	OLS (2)	IV 2SLS (1)	IV 2SLS(2)	IV 2SLS (3)	First stage
	$\Delta Exports_{fm09}$					$\Delta\overline{NPD}_{f09}$
$\Delta\overline{NPD}_{f09}$ (×100)	0.180*	0.174*	0.260	−0.086	−0.134	
	(0.098)	(0.098)	(0.386)	(0.386)	(0.376)	
Δ*Operational margin*$_{f09}$	0.516***	0.510***		0.517***	0.511***	−0.011
	(0.068)	(0.068)		(0.069)	(0.069)	(0.013)
Δ*Cash holdings*$_{f09}$	0.300***	0.270***		0.301***	0.271***	0.009
	(0.074)	(0.074)		(0.074)	(0.074)	(0.010)
log(Total Assets)$_{f08}$	−0.003	−0.003		−0.003	−0.003	0.001
	(0.005)	(0.005)		(0.005)	(0.005)	(0.001)
Age$_{f09}$	−0.011	−0.010		−0.012*	−0.012	−0.002
	(0.007)	(0.007)		(0.007)	(0.007)	(0.001)
Group$_{f08}$	−0.005	−0.005		−0.005	−0.005	−0.002
	(0.010)	(0.010)		(0.010)	(0.010)	(0.002)
$\Delta\overline{Sales}_{f09}$		0.006			0.015	0.033***
		(0.027)			(0.030)	(0.010)
Leverage$_{f08}$		0.005			0.020	0.055***
		(0.076)			(0.077)	(0.015)
Δ*Tax debts*$_{f09}$		0.896***			0.905***	−0.001
		(0.262)			(0.262)	(0.037)
Excess $\overline{NPD}_{f07}$ (×100)						−0.094***
						(0.008)
Observations	64986	64986	64986	64986	64986	64986
Firms	10160	10160	10160	10160	10160	10160
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.047	0.047	-	-	-	0.184
Weak identification (KP stat)	-	-	115.8	112.2	131.0	-

All standard errors are clustered at the firm level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. The Kleibergen-Paap statistic (KP stat) tests for the presence of a weak instrument in presence of heteroscedasticity (high values suggest to reject the null hypothesis of weak identification).

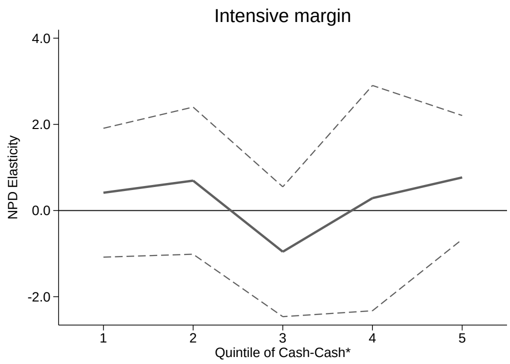
Figure 3: Heterogeneity of the effects of payment delays with the level of cash holdings



(a) Exit



(b) Entry



(c) Variation in exports

Source: BRN-RSI tax returns, customs data, EAE survey. *Field:* manufacturing and wholesale firms.
Lecture: Cash capacity C_f^* is obtained by fitting the outcome of a quantile regression of cash holdings on various firm-level variables (see section 5). All the variables are taken at their 2008 values. Firms are then sorted into five quintiles of $C_f - C_f^*$; the graph displays the coefficient $\Delta\overline{NPD}_{f09}$ of the IV 2SLS (3) regression of the exit/entry probabilities and of the variation of the volume of exports for the different corresponding quintiles. The 95% confidence interval is given by the range between the dotted lines.

Table 6: Alternative specifications.

	(1) Baseline	(2) Derogations	(3) Anticipation	(4) Market	(5) Sector
Panel A: Exit					
$\Delta\overline{NPD}_f(\times 100)$	0.713***	0.705***	0.126***	0.710***	0.893***
	(0.170)	(0.188)	(0.029)	(0.177)	(0.190)
Observations	108479	108479	108474	122479	109507
KP statistic	179.8	133.5	719.9	199.7	489.9
Panel B: Entry					
$\Delta\overline{NPD}_f(\times 100)$	-0.039***	-0.035**	-0.007***	-0.041***	-0.028*
	(0.015)	(0.016)	(0.003)	(0.012)	(0.016)
Observations	557500	557500	557475	751300	560325
KP statistic	208.3	160.2	810.8	234.4	471.7
Panel C: Intensive margin					
$\Delta\overline{NPD}_f(\times 100)$	-0.134	-0.188	-0.022	-0.256	-0.228
	(0.376)	(0.413)	(0.064)	(0.389)	(0.416)
Observations	64986	64986	64982	72080	65663
KP statistic	131.0	94.0	560.6	145.7	395.5

All standard errors are clustered at the firm level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. The Kleibergen-Paap statistic (KP stat) tests for the presence of a weak instrument in presence of heteroscedasticity (high values suggest to reject the null hypothesis of weak identification). All estimations are made according to the IV 2SLS (3) model (see tables 4 and 5). *Baseline* denotes the estimations with the standard specification of $\Delta\overline{NPD}_{f09}$; *Derogations* includes the role of derogations in the computation of the instrument ; *Anticipation* replaces $\Delta\overline{NPD}_{f,08,09}$ by $\Delta\overline{NPD}_{f,07,09}$; in the *Market* column, a market is defined as the product of a country and of a product defined at a 3-digits level (instead of 2 digits) ; in the *Sector* column, payment delays are averaged at a less detailed level of the French classification of activity (3 digits instead of 5).

Table 7: Unobserved firm heterogeneity.

	(1) Baseline	(2) Manufacturing	(3) Wholesale	(4) Dependent	(5) Independent	(6) Large firms	(7) Insulated
				Panel A: Exit			
$\Delta\overline{NPD}_{f09}$ ($\times 100$)	0.713***	0.329*	0.399	0.862***	0.634**	0.239	0.201
	(0.170)	(0.194)	(0.657)	(0.211)	(0.291)	(0.201)	(0.426)
Observations	108479	83841	23936	53784	53966	131891	4221
KP statistic	179.8	101.0	97.2	92.7	116.5	70.1	7.9
				Panel B: Entry			
$\Delta\overline{NPD}_{f09}$ ($\times 100$)	-0.039***	-0.039**	0.078	-0.039**	-0.017	-0.029*	-0.022
	(0.015)	(0.019)	(0.056)	(0.018)	(0.026)	(0.015)	(0.050)
Observations	557500	408875	148575	288300	269175	542475	19500
KP statistic	208.3	100.0	72.1	140.4	68.2	165.5	9.1
				Panel C: Intensive margin			
$\Delta\overline{NPD}_{f09}$ ($\times 100$)	-0.134	-0.772	0.119	0.025	-0.294	-1.134**	0.511
	(0.376)	(0.487)	(1.337)	(0.433)	(0.744)	(0.511)	(1.236)
Observations	64986	51674	12703	32236	32177	85264	2780
KP statistic	131.0	75.8	73.8	76.0	87.0	48.8	6.6

All standard errors are clustered at the firm level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. The Kleibergen-Paap statistic (KP stat) tests for the presence of a weak instrument in presence of heteroscedasticity (high values suggest to reject the null hypothesis of weak identification). All estimations are made according to the IV 2SLS (5) model (see tables 4 and 5). *Baseline* denotes the estimations with the standard specification of $\Delta\overline{NPD}_{f09}$; *Manufacturing* and *Wholesale* columns display the results of the estimation restricted to the corresponding sectors; *Financially independent* (resp. *Financially dependent*) denotes the set of firm whose average external financial dependence $\overline{ExtFin}_{f,07}$ is inferior (resp. superior) to the median; the *Large firms* column shows the result of the estimations performed on the set of firms that belong to a group that is not classified as a SME by the French nomenclature (see section 2.2); in the *Insulated* regression, only the firm whose exports represent more than 50% of total sales and who import more than 50% of their total purchases are retained.

Table 8: Unobserved export market heterogeneity.

	(1) Baseline	(2) EU	(3) Excl. EU	(4) Europe	(5) Asia	(6) Africa	(7) America
Panel A: Exit							
$\Delta\overline{NPD}_{f09}$ ($\times$100)	0.713***	0.888***	0.514**	0.582*	0.151	0.887*	1.018**
	(0.170)	(0.213)	(0.218)	(0.351)	(0.337)	(0.463)	(0.404)
Observations	108479	54508	53971	10076	15068	8512	16815
KP statistic	179.8	171.4	133.5	164.6	132.0	78.8	66.1
Panel B: Entry							
$\Delta\overline{NPD}_{f09}$ ($\times$100)	-0.039***	-0.012	-0.073***	-0.015	0.042	-0.140***	-0.115***
	(0.015)	(0.019)	(0.022)	(0.046)	(0.052)	(0.047)	(0.028)
Observations	557500	312200	245300	44600	44600	44600	111500
KP statistic	209.4	209.4	209.4	209.4	209.4	209.4	209.4
Panel C: Intensive margin							
$\Delta\overline{NPD}_{f09}$ ($\times$100)	-0.072	-0.132	0.011	1.298	1.189	-1.610	-1.660
	(0.376)	(0.448)	(0.603)	(1.068)	(0.973)	(1.423)	(1.247)
Observations	64986	37156	27830	5602	7195	4528	8706
KP statistic	131.5	120.5	91.5	107.3	108.7	53.0	39.5

All standard errors are clustered at the firm level. *, **, and *** denote statistical significance at 10, 5 and 1%. Standard errors are given in parentheses. The Kleibergen-Paap statistic (KP stat) tests for the presence of a weak instrument in presence of heteroscedasticity (high values suggest to reject the null hypothesis of weak identification). All estimations are made according to the IV 2SLS (5) model (see tables 4 and 5). *Baseline* denotes the estimations with the standard specification.

Appendix B Proofs

The first lemma shows that the principal value functions b_E and b_I are concave.

Lemma B.1. *Take R, R^* such that $R^* > R > 0$ and h a solution of the following differential equation*

$$rh(W) = \Pi + (rW - \Pi)h'(W) + \lambda(h(W+X) - h(W_t))$$

with border conditions $b'(W_t) = -1$ for $W_t \geq R^*$ and $\overline{R} = \inf\{W_t \geq R|, |h'(W_t) = -1\}$. Then h is strictly concave on $[R, \overline{R}[$.

Proof: Suppose that $h'(W_2) \geq h'(W_1)$ with $W_2 > W_1 \in [R, \overline{R}[$. Take $W_a = \arg\max_{[W_1,W_2]} h'(W)$. If $W_a > W_1$, then using (B.1)

$$(r+\lambda)\frac{(h(W_a) - h(W_1))}{W_a - W_1} \leq rh'(W_a) + \lambda\frac{(h(W_a+X) - h(W_1+X))}{W_a - W_1}$$

Taking the limit with $W_1 \to W_a$, I get that $h'(W_a) \leq h'(W_a + X)$. If $W_a = W_1$, I know that h' is constant over $[W_1, W_2]$ which implies by a similar reasoning that $h'(W_a) = h'(W_a + X)$. If $W_a + X \geq \overline{R}$, then $h'(W_a) = -1$, contradiction. If $W_a + X < \overline{R}$, it is necessary by construction that h' is nondecreasing on an interval of the form $[W_a, W_a + X]$. Using the same reasoning recursively, we get that there exists $W_h < \overline{R}$ such that $h'(W_h) = -1$, contradiction. ■

Lemma B.2. *If $\tau_E > 0$ (that is if it is not optimal to immediately export), $b'^I(W_E) = b'^E(W_E) \leq 0$.*

Proof (Philippon and Sannikov (2007)): The first equality follows directly from the border conditions given in 1. Suppose then that $b'^I(W_E) = b'^E(W_E) > 0$. By concavity of b_I, $b'_I > 0$ and thus $b_I(W) \leq b_I(W_E) = b_E(W_E) - K$ for all $W \in [R, W_E]$. Taking W_E^* that maximizes b_E, I see that $b_I(W) \leq b_E(W_E^*) - K$. It would be optimal for the firm and the agent to directly choose $W_0^* = W_E^* > W_0$ and to immediately start to export, which is in contradiction with $\tau_E > 0$. ■

Proof of proposition 3: The exporting threshold W_E is then defined by $b_I(W_E) = b_E(W_E) - K$. Calling $V_I = \{\lambda_I, \Pi_I\}$ and $x_E = \{\lambda_E, \Pi_E\}$ I have for $r \in \{I, E\}$ and for $x_r \in V_r$

$$\frac{\partial b_I(W_E)}{\partial x_r} + \frac{\partial b_I(W_E)}{\partial W_E}\frac{\partial W_E}{\partial x_r} + b'_I(W_E)\frac{\partial W_E}{\partial x_r} = \frac{\partial b_E(W_E)}{\partial x_r} + b'_E(W_E)\frac{\partial W_E}{\partial x_r}$$

since W_E is a parameter for b_I. Noticing that

$$\frac{\partial b_s(W_E)}{\partial x_r} = 0 \text{ if } s \neq r,\ b'_I(W_E) = b'_E(W_E) \text{ and } \frac{\partial b_I(W_E)}{\partial W_E} = b'_I(W_E)$$

I get

$$\frac{\partial b_I(W_E)}{\partial x_r} + b'_I(W_E)\frac{\partial W_E}{\partial x_r} = \frac{\partial b_E(W_E)}{\partial x_r}$$

which gives proposition 3 for V_I and V_E. Eventually, $\partial W_E / \partial K = -(b'_I(W_E))^{-1} \geq 0$. ■

Lemma B.3. *For all $\epsilon > 0$, the function $P : W \to E\left[1_{\tau_E < \tau_L} | W_t = W\right]$ is strictly concave (resp. strictly convex) on $[R, W_E - \epsilon]$ if $\lambda_I > r$ (resp $\lambda_I < r$).*

Proof: Noticing first that P is a martingale, writing

$$dP(W_t) = ((rW_t - \Pi_I)P'(W_t) + \lambda_I(P(W_t + X_I) - P(W_t)))dt + (P(W + X_I) - P(W))(dN_t - \lambda_I dt) \quad (17)$$

yields the differential equation verified by P :

$$(\Pi_I - rW_t)P'(W_t) = \lambda_I(P(W_t + X_I) - P(W_t)) \quad (18)$$

On $[W_E - X_I, W_E]$, $P(W + X_I) = 1$ and the differential equation becomes

$$(\Pi_I - rW_t)P'(W_t) = \lambda_I(1 - P(W_t)) \quad (19)$$

On a an interval of the form $[W_E - X_I, W_E - \epsilon]$ with $\epsilon > 0$, this equation can be solved as

$$P(W_t) = 1 - C_\epsilon \left(\frac{\Pi_I - rW_t}{\Pi_I - r(W_E - X_I)}\right)^{\frac{\lambda_I}{r}} \text{ for } W_t \in [W_E - X_I, W_E] \quad (20)$$

with $C_\epsilon > 0$ a constant that depends on ϵ. This function is strictly concave if (resp. strictly convex) if $\lambda_I > r$ (resp $\lambda_I < r$). The following part of the lemma shows that the concavity (convexity) of P "travels" to the rest of the interval through the differential equation (18). Suppose that $\lambda_I > r$ (the other case can be treated by reversing the inequalities in the following) and take $W_\epsilon = \inf\{W_t \in [R, W_E - \epsilon] \,|\, P \text{ is concave}\}$. Let's make the assumption that $W_\epsilon > R$. On $[R, W_E]$, $P'(W_t) = \lambda_I(P(W_t + X_I) - P(W_t))/(\Pi_I - rW_t)$ and thus P'' exists and is given by

$$P''(W_t) = \lambda_I \frac{\left(P'(W_t + X_I) - P'(W_t)(\Pi_I - rW_t) + r(P(W_t + X_I) - P(W_t))\right)}{(\Pi_I - rW_t)^2} \quad (21)$$

By continuity $P''(W_\epsilon) = 0$ and thus

$$(P'(W_\epsilon + X_I) - P'(W_\epsilon))(\Pi_I - rW_\epsilon) + r(P(W_\epsilon + X_I) - P(W_\epsilon)) = 0 \quad (22)$$

Using (18) it can be rewritten

$$P'(W_\epsilon + X_I)(\Pi_I - rW_\epsilon) = (\lambda_I - r)(P(W_\epsilon + X_I) - P(W_\epsilon)) \quad (23)$$

Once again, replacing $(P(W_\epsilon + X_I) - P(W_\epsilon))/(\Pi_I - rW_\epsilon)$ with (18) I eventually get

$$P'(W_\epsilon + X_I) = \left(1 - \frac{r}{\lambda_I}\right)P'(W_\epsilon) \quad (24)$$

The equation (20) shows that $W_\epsilon < W_E - X_I$. On $]W_\epsilon, W_E - \epsilon]$, P is strictly concave. Writing (18) at $W_t = W_\epsilon$ and using the strict concavity of P

$$\begin{aligned}(\Pi_I - rW_\epsilon)P'(W_\epsilon) &= \lambda_I(P(W_\epsilon + X_I) - P(W_\epsilon)) \\ &> \lambda_I \frac{\Pi_I}{\lambda_I} P'(W_\epsilon) \\ &> \Pi_I P'(W_\epsilon + X_I)\end{aligned}$$

where the first inequality comes from $f(y)-f(x) > f'(x)(y-x)$ (which is valid for f strictly concave) and the second inequality from the fact that P' is non increasing on $]W_\epsilon, W_E-\epsilon]$. But then

$$P'(W_\epsilon + X_I) < \left(1 - \frac{rW_\epsilon}{\Pi_I}\right) P'(W_\epsilon)$$

and using (24) I get

$$1 - \frac{r}{\lambda_I} < 1 - \frac{rW_\epsilon}{\Pi_I} \Leftrightarrow W_\epsilon < \frac{\Pi_I}{\lambda_I} < R$$

by assumption (8), contradiction. ■

Proof of proposition 4: The total differential of P with respect to λ_I is given by

$$\frac{dP(W_t)}{d\lambda_I} = \frac{\partial P(W_t)}{\partial \lambda_I} + \frac{\partial P(W_t)}{\partial W_E}\frac{\partial W_E}{\partial \lambda_I}$$

Increasing W_E to $W_E + dW_E$ boils down changing the boundary condition $P(W_E) = 1$ to $P(W_E) = 1 - P'(W_E)dW_E$. We therefore have

$$\frac{\partial P(W_t)}{\partial W_E} = -P'(W_E)P(W_t)$$

But as equation 18 shows, P' is equal to zero at $W_t = W_E$ since $P(W_E + X_I) = P(W_E) = 1$. Using the comparative statics lemma proved in the separate technical appendix, one can then show that

$$\frac{\partial P(W_t)}{\partial \lambda_I} = E\left[\int_0^{\tau_L \wedge \tau_E} e^{-rs}\left(P_I(W_s + X_I) - P_I(W_s) - X_I P'(W_s + X_I)\right) ds \,|\, W_0 = W_t\right]$$

Noting $\Omega_E = \{t \,|\, W_t < W_E - X_E\}$, we get

$$\frac{\partial P(W_t)}{\partial \lambda_I} = E\left[\int_{\Omega_E} e^{-rs}\left(P_I(W_s + X_I) - P_I(W_s) - X_I P'(W_s + X_I)\right) ds + \int_{\overline{\Omega}_E} e^{-rs}(1 - P_I(W_s))\, ds \,|\, W_0 = W_t\right]$$

The first integrand is positive by concavity of P, the second because P is a probability. The treatment of the case where the firm is in state E is similar. ■

Proof of proposition 5: The boundary condition at W_E stated in 2 gives that $b_E(W_E) = b_I(W_E) + K$. Using the comparative statics lemma on b_I, it appears that $\partial b_I(W_E)/\partial K = -1$ which entails $\partial b_E(W_E)/\partial K = 0$. We have then using the same lemma

$$\frac{\partial b_I(W_0)}{\partial K} = -P(W_0) + (1 - P(W_0))\frac{\partial b_I(W_0)}{\partial K}$$

Since $1 - P(W_0) < 1$, $\partial b_I(W_0)/\partial K$ is of the same sign than $-P(W_0)$. As K increases, $e^{-r\Delta} b_E(W_E)$ stays therefore unchanged and $b_I(W_0)$ decreases, which proves the proposition. ■

Appendix C Derogations

This appendix gives the maximum contractual payment delays after the date of the invoice authorized by the LME reform. When the limit varies in 2009 (*e.g.* 120 days between January 01 and May 31 2009 and 80 days between June 01 and December 31 2009), I report the average number of days (100 days).

- *Purchases of living cattle:* 20 days
- *Purchases of perishable products, purchases of alcoholic beverages:* 30 days
- *Manufacture and sale of metal food packaging; record industry; recreational fishing; manual, creative and recreational activities:* 75 days
- *Construction industry; bathroom and heating equipment; sailing stores; industrial tooling; industrial hardware; steel products for the construction industry; automotive tools wholesaling:* 85 days
- *DIY stores; stationery and office supplies; tire industry; drugs with optional medical prescriptions; pet trade; garden stores; coatings, paints, glues, adhesives and inks; sports stores ; leather industry; clothing sector:* 90 days
- *Jewellery, gold- and silversmiths' trade; round wooden elements; food supplements; optical-eyewear industry; cooperage :* 105 days
- *Firearms and ammunition for hunting:* 115 days
- *Quads, two- or three-wheeled vehicles, recreational vehicles::* 125 days
- *Agricultural supplies:* 150 days
- *Toy stores:* 170 days
- *Book edition, agricultural machines:* 195 days