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Redha Fares

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Présentée et soutenue publiquement par

Redha FARES

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**BANKRUPTCY, PERFORMANCE AND MARKET SELECTION:  
EVIDENCE FROM FIRMS IN FRANCE**

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# Abstract

The objective of this Ph.D. dissertation is to have a better comprehension of the bankruptcy event for firms that are operating in France. We focus mainly on firms considered to be among the best-performing ones, i.e., exporting firms and innovating firms, that have a higher proportion of default than the general proportion. In the first chapter, we focus on the exporting firms' sunk costs linked to the foreign markets to evaluate if it acts as an exit barrier or raises their likelihood of going bankrupt. In the second chapter, we estimate the impact of business expenditures on R&D on firms' survival likelihood to assess how the risk firms take to innovate affects the likelihood of cessation of payment. Finally, in the last chapter, we evaluate how the exit of defaulting firms contributes to the French productivity growth compared to other firm exits. To do so, we use multiple databases to obtain all the information needed across the dissertation (BODACC for information on bankrupt firms, FICUS-FARE for accountancy variables, DADS for labor variables, among others), and other databases that are more specific for the first and second chapters: the custom data on import and exports and the innovation survey. To tackle several methodology issues, such as unobserved variables, truncation bias, and unobserved individual heterogeneity, various methods are used, particularly panel data methodologies applied to non-linear models. We find that sunk costs are not a barrier to exit since it limits the liquid assets available in case of financial difficulties. We also find that R&D activities require a minimum amount of investment to raise the survival likelihood. Finally, we find that the exit of defaulting firms contributes positively and significantly to productivity growth.

**Mots-clés:** Bankruptcy, Performance, Firms, Exports, France, Innovation, Productivity, Sunk costs, Matching, Decompositions, Panel data, Duration analysis

# Resumé

L'objectif de cette thèse de doctorat est de mieux comprendre l'événement de la faillite pour les entreprises qui opèrent en France. Nous nous concentrons principalement sur les entreprises considérées comme étant parmi les plus performantes, c'est-à-dire les entreprises exportatrices et les entreprises innovantes, qui ont une proportion de défaillance plus élevée que la proportion générale. Dans le premier chapitre, nous nous concentrons sur les coûts irrécupérables des entreprises exportatrices liés aux marchés étrangers afin d'évaluer s'ils agissent comme une barrière à la sortie ou augmentent leur probabilité de faire faillite. Dans le deuxième chapitre, nous estimons l'impact des dépenses des entreprises en R&D sur la probabilité de survie des entreprises afin d'évaluer comment le risque pris par les entreprises pour innover affecte la probabilité de cessation de paiement. Enfin, dans le dernier chapitre, nous évaluons comment la sortie des entreprises défaillantes contribue à la croissance de la productivité française par rapport aux autres sorties d'entreprises. Pour ce faire, nous utilisons plusieurs bases de données afin d'obtenir toutes les informations nécessaires à l'ensemble de la thèse (BODACC pour les informations sur les entreprises en faillite, FICUS-FARE pour les variables comptables, DADS pour les variables de travail, entre autres), ainsi que d'autres bases de données plus spécifiques aux premier et deuxième chapitres : les données personnalisées sur les importations et les exportations et l'enquête sur l'innovation. Pour résoudre plusieurs problèmes méthodologiques, tels que les variables non observées, le biais de troncature et l'hétérogénéité individuelle non observée, diverses méthodes sont utilisées, en particulier des méthodologies de données de panel appliquées à des modèles non linéaires. Nous trouvons que les coûts irrécupérables ne sont pas une barrière à la sortie puisqu'ils limitent les actifs liquides disponibles en cas de difficultés financières. Nous constatons également que les activités de R&D nécessitent un montant

minimum d'investissement pour augmenter la probabilité de survie. Enfin, nous trouvons que la sortie des entreprises défailtantes contribue positivement et significativement à la croissance de la productivité.

**Mots-clés :** Faillite, Performance, Entreprises, Exportations, France, Innovation, Productivité, Coûts irrécouvrables, Matching, Décompositions, Données de panel, Modèles de durée

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À ma mère.  
À mon père.

*“Well, I don’t know what will happen now. We’ve got some difficult days ahead. But it really doesn’t matter with me now, because I’ve been to the mountaintop.”*

Dr. Martin Luther King Jr.

# **General Introduction**

An essential part of both industry and economic dynamics is firms' exits. Bartelsman et al. (2009) show that French firms exits account for around 8% of all firms, which is also the OECD country average. The French firms' exit rate is lower than the one of the USA and Denmark but higher than the one of West Germany, Finland, and the Netherlands. Exit is part of the economic growth through market selection. In a perfect economic environment, firms enter when they predict that they are efficient enough to face the competition of the sector. These firms produce and learn about their actual efficiency, thus about their survival probability. If they are efficient enough, they become a part of the incumbent firms, also known as survivors. At the other end of the spectrum, when firms (incumbents or entrants) are not efficient enough, or if their efficiency lowers over time (at least relative to their competitors), they should exit the market and stop misusing the resources (inputs) they employ to produce. However, due to the existence of different types of exit and the use of exit routes as a whole, measurement issues arise in the literature.

The first type is the *exit from the top*, i.e. firms that are considered to be efficient enough to be bought by another firm or group through a merger and acquisition. Jovanovic and Rousseau (2008) show that mergers can help incumbents to have access more easily to new technology introduced by the entrants in the industry they operate. Filson and Songsamphant (2005) also demonstrate that, under certain conditions, large firms in declining industries might want to merge with smaller ones, to what may represent the most cumulated profitable solution. The second exit type is the *exit from the bottom*, namely the "real exit" from the market since the firms stop entirely operating due to their poor performances.<sup>1</sup> For these firms, two possibilities might arise: i) the head of the firm decides to exit voluntarily; ii) the firm goes bankrupt and is involved in a bankruptcy proceeding.

Regarding the two possible type of *exit from the bottom*. The first one can encompass various situations and are unobservable for the econometrician. These

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<sup>1</sup>Many different causes may impact the performances of firms, such as radical innovations, rendering firms obsolete. However, it can also be caused by an increased competition, or the insufficient firms' inner efficiency.

situations range from the retirement of the firm's head to a decision based on the poor economic performances of the firm. The second type, firms' bankruptcy, is more straightforward. Bankruptcy occurs when the firm is no longer able to repay its debts. By definition, insolvent firms, or equivalently bankrupt firms, are in acute financial distress, meaning they cannot face their creditors' claims with their assets. Note that these assets might have enough value, but they might not be accessible to reimburse the debt incurred at the due date. Following the definition used by the French national institute of statistics and economic studies (Institut national de la statistique et des études économiques, or INSEE thereafter), a firm is considered bankrupt when it ceases payment for at least 45 days. At this date, the creditors ask for the triggering of a procedure by the Court.

Bankruptcies might arise when firms have too many illiquid assets. These assets are not easily mobilizable, like sunk costs, and cause the firm to have too few assets to convert both easily and rapidly into cash to reimburse its debts, thus causing its insolvency. On the opposite, firms also might not have enough assets, liquid or not, to face the creditors' claims and go bankrupt too. In any case, when bad performances are at the origin, such exits have little in common with mergers and acquisitions.

If the French exit rate accounts for around 8% of all firms in the economy, firms involved in a bankruptcy procedure account for 1.1% to 1.3% each year (Coface, 2018). Figure 1, shows the number of firms involved in such procedures from 2000 to 2019. This number increased steadily before the 2008's financial crisis, then, the number has reached its peak just after in 2009, at 63,412 defaults, stabilized over 60,000 until 2015, and sharply decreased after 2016. Therefore, although only a small fraction of exiting firms go bankrupt, the results are heterogeneous depending on firms' activities.

In a real economic environment, market's imperfections interfere with the market selection. For instance, among the numerous imperfections, asymmetry of information lowers the confidence between creditors and debtors as the latter have

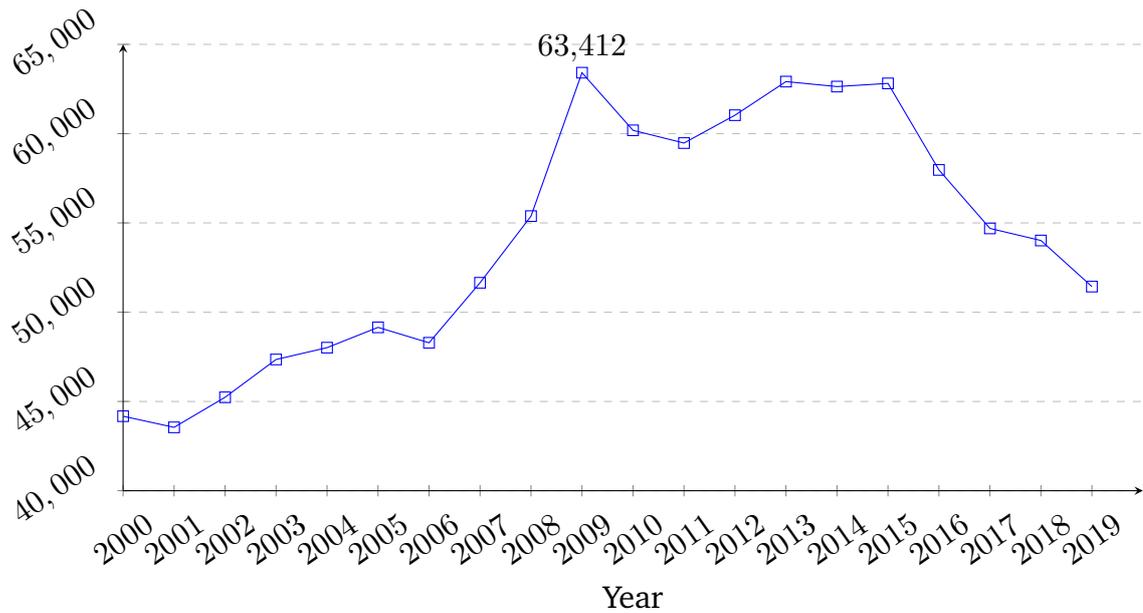


Figure 1: Number of Defaulting firms – source: INSEE

no incentive to reveal high risks to the former. Thus, bankruptcy laws are needed to provide a framework that aims to mitigate these flaws.

It should be noted that bankruptcy procedures are not immediate; they take time to be resolved. During the proceeding, numerous events might take place and will affect a firm’s likelihood to continue business. Moreover, the objectives of the framework also change the way the Court handles insolvency. If the laws are debtor-friendly, the Court will seek to save the firm if possible to preserve employment. Nevertheless, if it is creditor-friendly, the framework will aim at reimbursing them at the fullest if possible, by focusing on liquidating the assets as rapidly as possible. In the remaining of this introduction, we first present implication of the differences in bankruptcy regimes. Then, we present the contribution of this thesis, that aims at empirically analyzing the French bankruptcy procedure.

## Bankruptcy regimes: benefits and implications

In this section we provide some historical background on bankruptcy regimes, then highlight their main differences and consequences, especially in the French

context.

## **Some historical features on bankruptcy regimes**

Bankruptcy laws are an essential part of the market selection process. Due to market imperfections, creditors might want to take as little risk as possible with respect to their investments or, at least, want the debtors to support the risk collectively via higher interest rates. By doing so, they cover their loss and diminish the possibilities for firms to access the funding that their investments require to develop their activities and grow. This phenomenon of credit rationing, in turn, reduces the potential growth of the economy. To counteract this vicious circle, legislators have introduced rules in order to restore confidence towards firms.

Bankruptcy frameworks trace their roots to northern Italian cities that were highly involved in trading around the 13<sup>th</sup> and 14<sup>th</sup> centuries. The purpose of these regulations was twofold for the debtors: i) to reduce debtors' incentives to flee; ii) to avoid adopting the “gambling for resurrection” strategy in game theory.<sup>2</sup> Besides, creditors could not further prosecute the debtor, which reduces the incentive to use the failing debtor's assets. Subsequently the framework thus developed reached other trading cities in Europe and was finally incorporated in the legal framework of France and England in the 17<sup>th</sup> century. However, France and England did not follow the same path.

On the one hand, France followed the Italian path with two distinct procedures: reorganizing the firm and liquidating it. On the other hand, England chose to propose liquidation only as a bankruptcy procedure, while the firm's continuation could only happen through a private accord reached between creditors and debtors.<sup>3</sup> Even if the English framework did not encourage the protection of the

---

<sup>2</sup>This strategy arises when a weakened head of a firm is willing to continue fighting against the market exit. If a good outcome arises, the firm might be able to continue operating (see Downs and Roche, 1994).

<sup>3</sup>For a more comprehensive view of the history both systems and their differences see Sgard (2010).

debtors, the French system was not debtors-friendly at the time. Failing debtors had the social stigma of not being able to meet their debts successfully. Nonetheless, the English creditors-friendly framework and the French debtors-friendly were the two main historical visions of the way to handle firms with financial difficulties.<sup>4</sup> Consequently, literature discusses both of their advantages and limitations.

## **The differences between the two regimes**

Prior to entering into details of the regimes and their differences, it is crucial to define the *ex-ante* and *ex-post* effectiveness. On the one hand, *ex-ante* effective frameworks seek to avoid firms that are efficient enough to enter into a bankruptcy procedure. Then, the framework should provide incentives to the firm's head to make decisions that prevent the firm from going bankrupt. On the other hand, *ex-post* effective regimes want to minimize the loss of values of bankrupt firms, either by saving them or by reimbursing at maximum the creditors.

Even if historically we could split systems between the two visions of bankruptcy regimes, all systems recognize the importance of mixing both in order to achieve an optimal outcome. For this reason, we do not have the two extreme cases but many shades in between them. Having a perfect mix of the two regimes will enable legislators to reduce the market's selection errors.

### **Creditors-friendly frameworks**

To protect creditors' interests, creditors-friendly bankruptcy frameworks do not overrule the debtors' assets' priorities and let creditors obtain securities over debtors' assets, preventing the latter from selling them without the former's consent. As

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<sup>4</sup>There also exist different shades in-between. Thereby, even the United Kingdom (UK thereafter), one of the historically most creditor-friendly frameworks, introduced debtor-friendly elements in its framework in 2004. In order to encourage revisions by the European Union (EU thereafter) countries of their respective frameworks, the European Commission, in February 2015, started to work on the standardization of the bankruptcy framework across the EU and pushing for an in-between approach.

Aghion et al. (1992) state, these frameworks provide an ex-ante effectiveness. They create an incentive of good governance for managers, thanks to a credible threat. This threat can either be liquidating the firm's assets or replacing the manager with an administrator representing creditors' interests. However, as Frouté (2007) points out, it has a different impact on firms depending on whether they are in financial distress or not. When they are not, the incentive of this system is to have good governance and to seek to have long-run profits instead of short-run profits with a long-run deficit.

Nevertheless, when the firm is in distress, these creditors-friendly bankruptcy laws pressure the manager to invest in riskier investments to raise profits in the short run. This incentive drawback is to reduce the investments with long-run profitability, raising the exit probability in the long term. For this reason, managers jeopardize the chances of remaining in the market in the future to save their position.

The goal of these legislations is to fully reimburse the creditors, or at least as much as possible. For this purpose, the framework encourages the Courts to liquidate firms. It allows reducing the occurrences of firms staying in the market while they should exit, although it raises the occurrences of firms but should stay in the market that are forced to exit. Undue exits of the market occur more frequently in such frameworks because, when a firm is in a financially difficult situation, the value of its assets depreciates: its assets should not have enough value to reimburse its claims. As a consequence, if the remaining assets lose even more value due to the bankruptcy proceeding, the bankruptcy laws should facilitate the rapid reimbursement to the creditors, if the legislation's goal is to protect creditors' interest. This is the reason why creditors-friendly bankruptcy laws seek to facilitate rapid liquidations.

## **Debtors-friendly frameworks**

In debtor-friendly bankruptcy legislation, the main focus is on the renegotiation of the debtor liabilities and the reorganization of its assets. By doing so, they aim at minimizing social consequences, in order to: i) reduce undue liquidations; ii) provide an optimal incentive for assets acquisitions by the manager. Because managers do not fear losing their position due to the decisions made prior to the bankruptcy, the consequences of these frameworks are opposed to the previous ones. Contrarily, firms with financial difficulties focus on long-run profitable investment plans. First, it reduces the under-investments issues (insufficient profit expectations with a positive net actualized value of the investments, or NAVI). Second, since the responsibility of the manager is not involved at first, the over-investment problem increases before the failure.<sup>5</sup> However, when the bankruptcy procedure starts, the firm manager's responsibility is engaged. Therefore, both issues decrease after the failure since the firm hopes to continue operating and the manager to stay in position. A drawback of these procedures comes from the possible reckless decisions taken by managers who know they will not be held responsible for the actions undertaken before the bankruptcy procedure starts. Indeed, since the responsibility is not engaged before the beginning of the procedure, it does not encourage the manager to make prudent decisions regarding the firm's investments.

## **The French bankruptcy system**

The French system, at least since 1985, is recognized for being protective towards the debtors. The legislator aims to preserve employment, acknowledged by the French Senate (2005) since it stated that “[The existing framework has a] primary objective of preserving the activity of companies and thus employment

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<sup>5</sup>Over-investment occurs when the NAVI is negative, but the short-run profit is positive.

[...].”<sup>6</sup> Considering particular contemporaneous French framework, it revolves around three procedures: i) the safeguard procedure; ii) the reorganization procedure; iii) the liquidation procedure.

The safeguard procedure starts when the firm faces some financial difficulties without cessation of payment issues. It is a way to prevent bankruptcy of firms that are likely to go bankrupt, thanks to a reorganization of their assets and liabilities. If the procedure is not successful, the firm ends up being in a cessation of payment for at least 45 days, then the procedure is converted either to a reorganization procedure or a judicial liquidation, depending on the likelihood of success to save the firm.<sup>7</sup> During the proceeding, the Court appoints a trustee to prepare a plan to make the company viable in the long term.

The reorganization and liquidation procedures are triggered when the firm is in a cessation of payment for 45 days, or potentially more if it follows the end of the safeguard procedure. They can be triggered by the debtor, at least one creditor, or the Court itself. The decision of the procedure is based on the likelihood of survival of the firm. If it is unlikely, then the judicial liquidation starts; if the reorganization of both the assets and the liabilities is possible, a reorganization procedure starts. In case of a reorganization, as in the safeguard procedure, the Court appoints a trustee to prepare a continuation plan. The plan is conceived while the trustee tries to understand the company’s strengths and weaknesses during an observation period. However, contrary to a safeguard procedure, if the trustee thinks that the firm’s continuation is finally not feasible at the end of the observation period of reorganization, the procedure is converted into a liquidation one. Moreover, if the continuation plan fails and the firm is still unable to reimburse its creditors, the Court converts the procedure to a judicial liquidation.

When the Court pronounces firm’s liquidation, a trustee is appointed to liqui-

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<sup>6</sup>The citation, in French in the text, is as follow “[L]’objectif premier [des dispositifs législatifs existant est] de préserver l’activité des entreprises, et par là même l’emploi [...]”

<sup>7</sup>The likelihood is assessed by the Court based on the evidence brought by either the trustee or the firms’ head.

date all of the firm's assets to reimburse the creditors at the maximum possible amount. However, it is rarely the case because the priority rule is frequently overruled by super-priority creditors (for instance new loans granted when either a reorganization or safeguard procedure started, the social debts such as wages or social security and government taxes). For this reason, the liquidation stops when the assets are extinguished or when the creditors are fully reimbursed, whichever happens first, knowing that the bankruptcy starts when the company assets cannot cover its claims.

While the duration of the safeguard and reorganization procedures can reach a maximum of 10 years, including the observation period of 6 months renewable twice for a total period of maximum 18 months, the liquidation procedure might not last more than two years without an observation period.<sup>8</sup>

We can also add mutual agreement procedures, which entangles both the conciliation procedure and ad-hoc mandates, which are different in multiple ways from the other three. Firstly, these procedures are private to raise the probability of an accord between the debtor and its creditors. Secondly, although the Court can be involved in the proceeding, the third-party mandated has to help both parties to find an agreement and allow the firm to continue its activities. However, it does not decide the dispute as a judge would do otherwise. This way, bankruptcy can be avoided for firms likely to have experienced a slight bump in the road but are not unfitted to operate in the market. Nevertheless, the procedure has to begin before the cessation of payments occurs.

The safeguard procedure was introduced in 2005 after the French Senate observed that firms in mutual agreement procedures have a higher survival rate than the other firms involved in the other bankruptcy procedures. With a framework close to the reorganization proceeding compare to the mutual agreement ones, the

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<sup>8</sup>An exception is made for the farmers as a natural person who rely on cyclical seasons. Thus, both safeguard and reorganization procedures can last a maximum of 15 years, and the observation period depends on the profession's specificities. The liquidation process has the same maximum duration rule as the other firms. However, we do not include them in the scope of our analysis since their activity is too specific.

safeguard procedure was created to help firms before the bankruptcy occurs.<sup>9</sup>

As pointed out in the report of the Haut Comité Juridique de la Place Financière de Paris – Groupe de Travail “Défaillances d’Entreprises” (2016), out of 63,000 procedures opened in 2015, almost 69% are judicial liquidations, 29% reorganization procedures, and only 2% are safeguard proceedings. In 2018, according to Zapha and Fouet (2021), mutual agreement procedures account for 5% of all the procedures, but were mainly used by large firms, i.e. the one that are less subject to insolvencies.

Given that firms do not fall into the definition of bankrupt firms used by INSEE, and because of the mutual agreement procedures’ secrecy that makes it unobservable, we do not place both safeguard and mutual agreement procedures in our scope of study.

## **The market selection biases**

We previously discussed the way frameworks are conceived to minimize errors of two kinds (undue liquidations and inefficient firms staying in the market), but not their economic implications. If the market selection is not biased, it should distinguish firms according to their survival capabilities. Thus, survivors should stay in the market because they are productive enough to operate, and exiting firms should leave it because they cannot operate efficiently. However, distinguishing them perfectly is impossible, and two types of errors arise. Let type I errors refer to the fact that poor-performing firms stay in the market, and type II errors the fact that firms that should stay in the market are forced to exit. Both types of errors are displayed synthetically in Figure 2. Since the Court wants to reimburse creditors’ claims as fast as possible, the creditors-friendly framework might be biased toward the type II errors. Type I errors should be more frequent in debtors-friendly frameworks since the primary objective is to save the firms.

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<sup>9</sup>See Leclerc and Hug De Larauze (2011) for a complete review of the French bankruptcy regime and the comparison with other regimes.

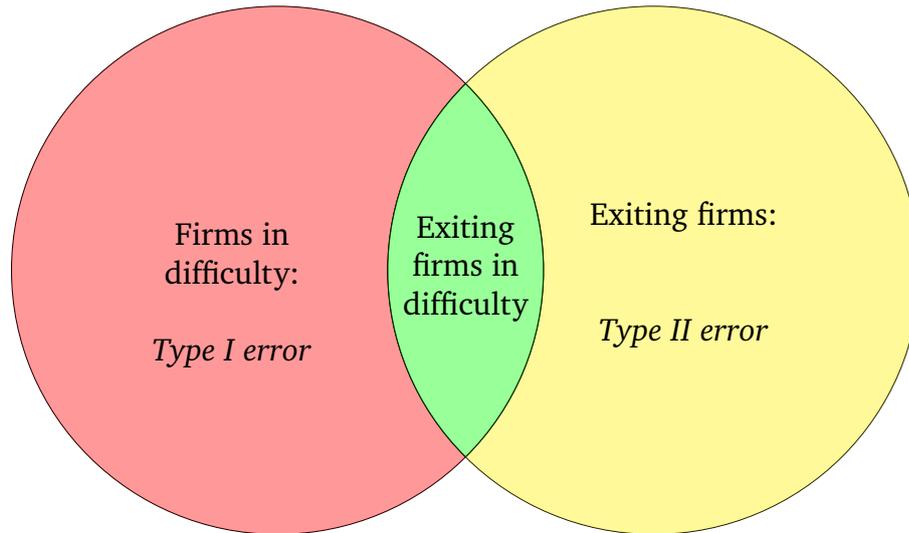


Figure 2: The two types of errors

There are two ways of measuring the efficiency of bankruptcy frameworks. It can be by using economic indicators or financial ones. We present both approach in the following sections.

### **Economic-based efficiency measurement of bankruptcy frameworks**

Considering type I errors, they can occur because of barriers to exit, which are the obstacles firms face that make market's exit costly for them such as sunk costs. However, unlike firms' voluntary exit, firms do not initiate bankruptcies, but the Court imposes it to them due to the creditors' request. Thus, if type I errors happen, it should be related to the creditors. Indeed, since they are the main plaintiffs, if they decide not to ask the Court to trigger a proceeding, the procedure might not start. Zombie firms are a good example of the type I errors. Zombie firms are defined in the literature as mature firms that are not able to cover their interest rates with their operational profits for more than three years. According to Ben Hassine et al. (2019), zombie firms are not a minor phenomenon. They show, out of a panel of firms that are defaulting, zombie or both defaulting and zombie, that zombies firms that are not defaulting, namely type I errors, account for 43% of them. In the whole French economy, Coface (2018) evaluates their occurrences

between 4% and 5%. This is more than in Germany but less than in Italy and Spain. Thus, even if it is not the best performing framework, the French framework seems to discriminate firms that should enter into the bankruptcy procedure better than others.

On the contrary, type II errors could ensue from the preferences of the legislators. Indeed, we can distinguish two types of performances. One relies on economic indicators such as the apparent productivity of labor, or the total factor productivity (the part of the production not explained by labor and capital), and the other relies on financial indexes, like the financial performances. Since the bankruptcy is triggered based on financial indexes, it is possible that relatively economically efficient firms face financial difficulties due to a shock (a crisis) or due to delay of payment from some important clients. In such cases, firms might not face their creditors' claims while being well suited for operating in the market. If the framework is too biased towards the creditors' reimbursement, the Court would likely decide to liquidate firms that are economically efficient enough.

To sum up, when type I errors arise, firms that should exit the market remain active. If the bankruptcy system does not evacuate these firms, they use inputs less efficiently than the other firms, reducing the economy's growth potential, the loans available for more performing firms, and the labor force available. On the contrary, when the type II errors occur, efficient firms have to leave the market where they operate. This error implies that potential growth is lost because the Court was too prompt to liquidate the firms. Therefore, both of these errors are sub-optimal situations.

In order to start assessing the French framework, we might first approach type II errors. While in a debtors-friendly framework one should avoid type II errors, France's proportion of direct liquidations is important, as it is next to 70% out of the procedures.<sup>10</sup> Moreover, half of the firms involved in a safeguard or a reorganiza-

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<sup>10</sup>See Haut Comité Juridique de la Place Financière de Paris – Groupe de Travail “Défaillances d’Entreprises” (2016).

tion procedure are liquidated after three years and two-third after eight years. This high proportion of liquidation might be due to the high effectiveness of the mutual agreement procedures. This procedure allows firms with a high likelihood of surviving to avoid the other bankruptcy proceedings or to prepare a plan with higher chances of success. Hence, even firms involved in procedures created to help them reorganize themselves and survive are likely to exit the market definitively: they cannot be saved before the cessations of payments occur, so they exit the market all together, explaining the high liquidation rate in a debtor-friendly framework.

On the one hand, it appears that the French framework performs well to avoid type I errors. Indeed, as Adalet McGowan et al. (2018) show, firms considered as zombies account for around 2% of the firms in 2012. This number is one of the lowest one among the countries they considered. This low proportion of zombie firms in the whole economy is also confirmed by Ben Hassine et al. (2019), even if the share is at around 5% and higher than that in Coface (2018). On the other hand, the screening of firms in difficulty and the mutual agreement proceedings before bankruptcy are the reasons to explain the low type II errors, as stated by the French Senate (2005). As a consequence, this framework seems to generate minor economic growth losses due to type II errors.

### **Financial-based efficiency measurement of bankruptcy frameworks**

More financial-based studies show that the French framework does not perform as well as the above findings may suggest. As an example, the 2020 Doing Business survey of the World Bank shows that France has the lowest recovery and resolving rates among similar economies. This is as shown in Table 1 that present descriptive values and the associated country ranks among the 190 countries covered in the analysis.

From Table 1, we see that France performs significantly worse than the UK to recover the creditors' investments from the insolvency procedures (more than 10

Location	Resolving Insolvency score		Recovery rate (cents on the dollar)		Time (years)		Cost (% of estate)	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Japan	90.2	3	92.1	1	0.6	2	4.2	15
Norway	85.4	5	91.9	2	0.9	7	1.0	1
Belgium	84.1	9	89.4	5	0.9	7	3.5	2
Denmark	85.1	6	88.5	7	1.0	10	4.0	9
Finland	92.7	1	88.0	8	0.9	7	3.5	2
Ireland	79.2	19	86.1	11	0.4	1	9.0	33
United Kingdom	80.3	14	85.4	13	1.0	10	6.0	19
Australia	78.9	20	82.7	15	1.0	10	8.0	27
United States	90.5	2	81.0	17	1.0	10	10.0	49
Austria	77.4	22	79.9	19	1.1	18	10.0	49
Germany	89.8	4	79.8	20	1.2	22	8.0	27
Spain	79.2	18	77.5	23	1.5	27	11.0	64
France	74.6	26	74.8	24	1.9	55	9.0	33
Italy	77.5	21	65.6	35	1.8	49	22.0	131
Portugal	80.2	15	64.8	37	3.0	109	9.0	33

Table 1: Ranking of countries' bankruptcy frameworks (source: Doing Business 2020 - World Bank)

percentage points). In addition, the procedure's cost in France is 50% higher than the UK framework. However, UK does not have the best performing framework considering these criteria. Moreover, we can see that fast procedures do not necessarily mean low costs. Ireland has the fastest framework, but the proceedings cost 9% of the firms' estate, which rank it 33<sup>rd</sup>, which is the same level as Portugal, the 109<sup>th</sup> ranked for the proceeding duration. Indeed, the heterogeneity among frameworks is relatively high. If Denmark, the UK, Australia, and the United States have the same proceeding duration, the costs and recovery rates are heterogeneous. Besides, these factors should not be the only ones to be considered when observing the efficiency of regimes.

The literature that first focused on bankruptcy mainly uses financial measures to see whether or not the frameworks considered operate well. To do so, it tests either the ex-ante or the ex-post efficiencies of bankruptcy laws. In this literature, ex-ante efficiency focuses on the incentive given to the manager to avoid bankruptcy thanks to a "*pater familias* behavior". At the other end of the spectrum, ex-post efficiency refers to the screening of firms to distinguish well firms in distress and other firms,

and how well the procedures end, by assessing, for example, the value lost during the proceeding or the cost of the procedure. Camacho-Miñano et al. (2013) for instance, assesses if the criterion used in Spain to declare a firm bankrupt is the best one or if other indicators outperform it. By doing so, this article seeks to obtain a better indicator, allowing debtors monitoring to be done more efficiently by their creditors.

The loss from outcomes of bankruptcy proceedings is a vastly used measure to test the ex-post efficiency, as in the World Bank's annual Doing Business surveys. It can come from maximizing the creditors' profits through a reorganization of the debtor, or the proportion of the debtor's claims recovered by the creditors. Even though, this analysis is highly relevant to distinguish the efficiency from a financial basis, we do not tackle this point of view.

We prefer focusing on more economical ways of assessing the ex-ante and ex-post efficiency. Considering the ex-ante efficiency, we need to ensure that the framework discriminates firms with a temporary cash-flow issue, especially during an economic crisis, such as in 2008-2010, from firms with structural issues. That way, we can ensure that the screening is done properly and that firms involved in such procedures are the ones that are not productive enough to stay in the market.

To tackle the ex-post efficiency, we can rely on the reallocation of resources process, instead of proceedings' costs or job preservation. If the impact of firms' exit of the market due to their financial distress on the reallocation of resources is positive, it means that the firms exiting the market due to the procedures are inefficient and they have misused the resources to produce. This point cannot be taken into account via purely financial indexes, but incorporating economic variables might help to shed a different light on this topic. Furthermore, we focus on the French case for one reason: we want to know why the benchmarks, such as Doing Business's World Bank, do not conclude that the French system is good while other studies, such as Adalet McGowan et al. (2018), seem to conclude otherwise. In addition to this, bankruptcy data has been available since 2008, which helps us tackle this

question using panel data analysis.

Finally, this thesis focuses on economic performance measures since they are less likely to be subject to activity contingencies, as compared to profitability measures.

## **Using bankruptcies: advantages and limitations**

Using bankruptcies as a definition of firms' exits has some advantages and drawbacks. As previously stated, real exits from the market are difficult to observe. Nevertheless, bankrupt firms are in acute financial distress. If they exit the market in such a debtor-friendly framework, it should be due to their inability to face the competition in their market. If the framework is well-designed, exiting the market after being involved in a collective procedure can be considered as a real exit from the market.<sup>11</sup> Moreover, in the literature, bankruptcy is frequently used. For instance, the French central bank and INSEE use defaulting firms' indicators in their publications and reports, and so do other researchers as well (see among others Blazy et al., 2011, Fougère et al., 2013, Epaulard and Zapha, 2021).

However, some drawbacks arise when using this definition of actual exit. First, since we do not consider the voluntary exit, the picture is incomplete as we do not account for many exits. Furthermore, since we focus on the economic performances, we do not consider the other aspect of firms' performances, as the financial one. We do not cover the entire spectrum of the exit nor the bankruptcy laws in this thesis, as it only focuses on economic performances of the French bankruptcy system.

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<sup>11</sup>The term collective procedure is used interchangeably with bankruptcy procedure.

## The dissertation's contribution

The purpose of this thesis is to analyze bankruptcy empirically as a mechanism of market selection, linked to economic performances and exit barriers. We focus more specifically our attention on exporting firms and innovative companies. Both of them are subject to more hazardous outcomes due to the uncertain nature of their activities. In addition, these firms should be among the best-performing ones (Crépon et al., 1998, Bernard and Jensen, 1999, for both type of firms' activities, see among others), thus being less involved in such procedures. It turns out they have a higher defaulting rate than the one observed in the general population of firms. From our data, presented thereafter, we find that 9% of exporters and 6% of innovative firms are involved in a bankruptcy proceeding, while the share in the economy is 1.3%.

Another focus is made on the reallocation process induced by bankrupt firms to see if the framework helps to reallocate resources towards the best-performing firms. Since the economy is the way to use scarce resources the most efficiently possible, the good reallocation of resources is also a critical component of a good bankruptcy framework when considering economic performance indicators.

Let us first present our data in the next section, before linking this thesis to the literature.

## The data

All empirical work has to use databases that contain the most reliable source of information to tackle the subject. Since this thesis revolves around the characteristics of French firms that go bankrupt, we use five core databases for all chapters. The first and the most important one is the *Bulletin officiel des annonces civiles et commerciales* (BODACC thereafter), which records all the information about the bankruptcy procedures, from the beginning of the procedure to its end,

starting 2008. This database allows us to distinguish between firms involved in a bankruptcy proceeding and those that are not.

Four databases are used to obtain information about the firms we use to create firm-level database with a panel dimension. First of all, *Fichier complet unifié de Suse* and *Fichier approché des résultats d'Ésane* (respectively FICUS and FARE thereafter) contain accountancy information at the firm-level every year such as the value-added, the liabilities, intermediate inputs, which are used to characterize firms in the models we estimate. The first one, FICUS, ends in 2007, while the second starts in 2008 and has roughly the same information available. Then, the *Déclaration annuelle des données sociales* (DADS thereafter) is the database that contain the most accurate vision of the firms' labor force; thus, we mainly use this database to obtain information about the labor variables. However, we know that firms might not operate alone and can be part of a group. To control for the group membership and if the firms are part of an international group, the *Liaisons financières* (LiFi thereafter) database is used.

However, apart from the third chapter, which relies on firms' productivity, the first and second chapters require more information on specific matters. The first chapter, focusing on exporting firms, needs to control trade exposure, so we utilize the French customs databases to observe imports and exports between 1993 and 2015. The information available monthly is at the product-firm-date level and was aggregated at the firm-product-year level to have comparable datasets. However, not all transactions are reported by exporters and, depending on the destination and the year, thresholds differ significantly. If the threshold is at €1,000 for non-EU destinations, the threshold can be as high as €400,000 for EU destination countries.

In the second chapter, focusing on R&D investments, we use R&D survey of the *Ministère de l'Enseignement Supérieur et de la Recherche* (Ministry for Higher education and Research). The information about the R&D investments is available at the firm-level every year. While it does not contain as much information about the firms' innovation activities as the *Community innovation survey*, it allows the econo-

metrician to follow firms in the time, thus allowing us to use the panel dimension to control unobserved heterogeneity. However, due to public budget constraints, only innovative firms investing €400,000 are exhaustively surveyed. The others are surveyed for, at most, two consecutive years.

## **Thesis plan and related literature**

Although traditional mechanisms of an economic-based decision of exiting the market are well documented in the literature, it does not depict the whole story. Firms that believe they can stay in the market but cannot face their creditors' claims are not considered. Indeed, bankruptcy procedures openings are based on accountancy indexes, and this dimension is not tackled thoroughly in the literature. What happens when a firm accumulates too much sunk costs due to its activity? How does a fierce innovation competition impact the survival of the firm? What are the implications of the bankruptcy framework on market selection?

These questions are addressed in the chapters of the thesis. The following subsections present the related literature in these chapters one after another.

### **Foreign market exposure and bankruptcies**

In the first chapter, we turn our attention on in the intriguing the fact that the exporters have a bankruptcy rate higher than the overall population of firms in the French economy. If the economic literature about firms' exit does not tackle the type of exit, the literature makes it clear: i) when firms exit the market they show lower performances compared to the survivors (see among others Bellone et al., 2006, Blanchard et al., 2012, Brandt et al., 2012); ii) exiting firms have a trend of performances' degradation prior the exit (see among others Griliches and Regev, 1995, Kiyota and Takizawa, 2007, Blanchard et al., 2014). Both effects are robust to country and period changes. Consequently, the exit is not a sudden event; it follows a downward trend of performances.

This inertia of the firms' past trends can be seen in multiple aspects of the decisions made by the firm. For instance, we see that a non-negligible part of the exporting firms is bankrupt. According to the model developed by Melitz (2003) and its derivations, exporting firms are supposed to withstand the additional costs of this activity. Nevertheless, this contradicts the 9% of exporting firms that are in such acute financial distress that they are involved in a collective procedure. While many studies acknowledge the relation between exporting activities and performances (see among other Bernard and Jensen, 1999, Hiller et al., 2017), it does not imply that all the exporters are the best-performing ones. For instance, Girma et al. (2003) show that firms entering the export market learn their chances of surviving in it by operating in foreign destinations. However, when the firms are leaving the export market, they experience a loss of output since the domestic market is not sufficient to maintain their past level of production when they were exporting their products. It can be seen as a shrinking market share from the firm's perspective.

In this chapter, we assess the impact of the sunk cost linked to the export activity on the firm survival. To do so, we estimate the part of the sunk cost that are linked to the domestic market to infer the residual sunk costs, which is linked to the export market. Then, we use a probit model to estimate its impact on the bankruptcy probability. We also try to assess the possible presence of sunk costs fallacy from the "inaction zone" derived from real options model (O'Brien and Folta, 2009). The first one is the irrational behavior of the firm's manager to invest on sunk costs due to the fear of losing the previous investments, while the second one is the rational decision made of not losing a market that is costly to regain without investing more.

We find that the defaulting firms have significantly larger amount of sunk costs, especially linked to the export market, than comparable non-defaulting firms. Moreover, we find that, at first, defaulting firms seem to have an irrational behavior, with significantly larger export's sunk costs, but at the date of the default they are not significantly different from their competitors. This result points toward a mix of

the two theory, with an over-investment in these sunk costs few years before the default, and gradually switching to a more rational behavior, thus entering into the inaction zone.

### **Innovation activities and financial distress**

If the first chapter focuses on the productivity as a whole, in the second chapter we focus on a component that generate firms' productivity but is also risky: innovation activities.

In the related literature, even if poor performances of companies can have multiple causes, we will focus on two specific ones. The first one is the firm's inability to compete against its competitors due to its lack of inner performance, as developed by Jovanovic (1982) in the passive learning model. The second one is related to firms struggling to fight with their competitors, in the active learning model of Ericson and Pakes (1995). In a dynamic situation where the productivity level matters less than its dynamic, firms have to invest in order to raise their performances and to keep up with the competitors. However, the investments are subject to uncertainty since the outcome is not sure. Consequently, if the outcome is lower than expected or if the other firms' efficiency grows more rapidly, the firm goes down to the back of the pack and becomes one of the least performing firms. Thus, the firm has to exit the market if it is too far behind the other firms.

While the passive learning model might well describe firms operating in industries that do not rely on innovations, the active learning model fits to firms in sectors that innovate a lot and at a rapid pace. As an example, in the mobile phone industry, before the smartphone outbreak, Nokia and Motorola had formed a strong oligopoly. However, their leading position did not last long after the innovation introduced by Apple, which was a game-changer for the industry. Today, to maintain their leading positions, firms such as Samsung and Apple have to invest considerable amounts in Research and Development because Chinese firms gain lots of

market share.

However, as pointed out by active learning model, firms are willing to act on their performances, but uncertainty may lead to the default of payment. These bets can be seen as investments in innovation activities. They contain a risk of failure or of a “lower-than-expected” outcome, leading the firm to exit the market. Thus, these activities can put the firm at risk. Nevertheless, if the return is sufficient to stay competitive, the firm can stay. Otherwise, the firms that have lower than expected outcomes repeatedly might come to a situation where they are in a cessation of payment because of the illiquid assets they have accumulated and the low revenue of the investments they have consented to invest.

In this chapter we seek to assess the impact of R&D expenditures on the firm survival, while taking into account for the non-random selection of firms that are surveyed for their R&D activities. To do so, we introduce the panel dimension in a duration analysis.

We find that the effect of R&D is U-shaped and the threshold where the impact of these investments become positive differ greatly depending on the sectoral technology intensity.

### **Market selection and bankruptcy framework's performances**

In the third chapter, we consider a complementary approach of the bankruptcy framework's efficiency measurements. To do so, we analyzes the impact of the exit of bankrupt firms in the reallocation of resources.

At a more aggregate economic level, firms in acute financial distress exiting the market should have their resources reallocated better. This is addressed following productivity growth's decompositions first proposed by Baily et al. (1992) and Olley and Pakes (1996) and then refined with new terms allowing to analyze more precisely the origins of productivity growth. By leaving the market, exiting firms free productions factors and inputs that others, better-performing, can use.

The process of reallocation of resources has been well documented in Foster et al. (2001), Melitz and Polanec (2015) and Ben Hassine (2019). They find that the net entry of firms contribution (entering firms contribution minus the one from exiting firms) of these decompositions allows to assess the impact of firms' renewal.

Nonetheless, if there is no doubt about the definition of entering firms (first appearance in the database), the exit term definition is not as straightforward, because it hides a variety of situations described above. Since they do not discriminate exit forms, mergers and acquisitions are treated the same way as bankruptcies and exit from the manager's decision due to lack of performance.

However, it is crucial to know how these exits act on the productivity growth since, as stated by Foster et al. (2006), entering firms take the place of less performing firms exiting the market. If firms exit the market through a bankruptcy proceeding and the bankruptcy framework works well, the impact should be positive. Otherwise, firms' exit caused by bankruptcy procedures would negatively impact the growth of productivity in the economy. Moreover, the significance of the effects is also important. Since standard decompositions do not have standard errors, it is impossible to assess if all the terms significantly impact the resources reallocations.

In this last chapter, we tackle these two limitations. First, we use the BODACC database to assess if the exit is due to bankruptcy. Second, we propose a bootstrap strategy to assess the significance of all the terms of the decompositions we use.

We find that the impact of the exit of bankrupt firms is both positive and highly significant. However, the impact is even larger after the 2008 financial crisis, pointing toward a cleansing occurring mainly due to the defaulting firms leaving the market. The bankrupt firms exiting the market seem to be significantly less efficient than the other firms. Moreover, their exit impact even more positively the reallocation than the other types of exits, even if there are some heterogeneity across sectors.

# Chapter 1

**Why would exporters in difficulty  
not exit?**

## 1.1 Introduction

To survive in domestic markets, firms need to be productive; however to export they need to be even more productive because export is a risky and costly activity for all firms. Therefore the most productive firms are facing better than others the challenging international environment. This result has been widely established in the literature. In its seminal paper Melitz (2003) demonstrates a positive correlation between export decision and performances. Only the top-performing firms can support additional sunk costs related to this export activity. Among others, Roberts and Tybout (1997) and Bernard and Jensen (2007) confirm empirically that sunk costs of export can be substantial. Consequently, a firm in difficulty should surrender its export business in order to minimize the losses and the potential risks incurred abroad.

Financial difficulties arise when a firm cannot reimburse its creditors, e.g., banks or suppliers.<sup>1</sup> When this situation occurs for 45 consecutive days, an insolvency procedure is triggered. This procedure is classified as a reorganization procedure if the court believes that the firm only needs better management of its assets to face its liabilities; otherwise, when financial difficulties are deeper, the firm enters in a liquidation process (see Section 1.3.1 and Appendix A.1 for details). Contrary to a more classic economic based exit decision, bankruptcy procedures start without the consent of the manager. Because the Court imposes the timing of the firm's bankruptcy the exit is not in the hands of the firm's owner. From a sample of 35,276 French exporting firms followed over the 2008-2016 period, we observe that more than 9% of them have dealt with an insolvency procedure or equivalently are in bankruptcy due to financial difficulties. Note that in the whole French firms' population the number of defaulting firms is much lower, that is 1.5%.

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<sup>1</sup>From an accounting perspective, a firm is deemed to be in insolvency if its current assets are no longer sufficient to pay its current liabilities. Current assets is a group of assets the firm can easily and rapidly transform into cash, such as receivables from customers or discountable bills. Current liabilities are liabilities requiring immediate payment, such as wages, charges or overdue bills.

In this paper, we attempt to explain why firms that encounter financial difficulties do not exit from export markets.

Our analysis is mainly based on two strands of the literature. The first one relies on the relationship between exports and firm dynamics. There is a debate since results are mixed. On the one hand, Vicard (2014) provides evidence that export activity increases the probability of default when we compare new exporters with incumbent exporters. On the other hand, Wagner (2013) highlights how two-way traders (i.e. simultaneously importers of intermediate goods and exporter of final products) are less exposed to the risk of default. Moreover as Martins and Yang (2009) demonstrate, it is well established in the learning-by-exporting literature that a correlation exist between productivity and export activity, especially in developed economies. The second one is related to firm dynamics and the role played by sunk costs within this framework. The sunk cost fallacy and the real options model offer two frameworks to better analyze the impact of sunk costs on firm exit. The real options model emphasizes the rationality behind the consideration to sunk costs in case of exit. Under uncertainty, a significant improvement of the situation is feasible making the exit less relevant. Since the re-entry gives rise once again to the payment, either fully or in part, of sunk costs, a firm may prefer to incur some current losses with the purpose of preserving the option of future profitable decisions in the event of a substantial improvement in the overall situation (Dixit, 1992). O'Brien and Folta (2009) find that the option value of keeping an operation alive dissuades firm exits when entry/exit sunk costs are sizable. Two ways to assess presence of real option model can be used. The first is that sunk costs do not have a significant impact on the probability of default (firms that are in an inaction zone do not stop exporting but do not invest more in sunk costs). The second is to seek for changes in the export market to which firms export (firms withdraw from a difficult market to refocus themselves on an easier one).

On the other hand, the sunk cost fallacy refers to the decisions made on an irrational basis since the firm does not consider future outcomes to make its decision but

consider the amount already invested. There is a decision-making bias because a sunk cost is by definition non-recoverable and cannot influence the payoffs of future decisions. According to this theory, a firm in distress that continues to invest is perceived as having an irrational decision. Applying this theory to the export decision, the sunk costs fallacy would refer to the payment of current sunk costs ensure the export continuity, because of the fear of losing previous investment. In this case, because of over-accumulation or over-investment, the sunk costs should raise the firm's probability of bankruptcy.

The contribution of our paper is two-fold. First, we examine how these sunk costs interact with the default probability in order to better understand the dynamics of the exporting firms in distress by considering the firms performances and the role played by the sunk costs. Second, contrary to the existing literature which only test for their presence (see among other Roberts and Tybout, 1997, Bernard and Sjöholm, 2003, Esteve-Perez et al., 2013) but without observing them, we propose an original methodology, based on Kessides (1990), to estimate separately the firm specific sunk costs due to domestic activity from the ones due to exporting activity.<sup>2</sup> To do so, we use a propensity score matching (PSM therefor) to estimate both types of sunk costs.

To provide a better understanding of the characteristics of exporters that go through bankruptcy, we estimate a probit model to evaluate the likelihood of default in the following three years while controlling for a set of firm-level and industry-level characteristics. We test whether or not the weight of the sunk costs becomes stronger as the firms approach its exit. We use a unique dataset, based on three different French sources, that combines rich information about the legal procedures, matched with firm-level data on international transactions as well as accounting variables. In the empirical analysis, we restrict the sample to exporting firms involved in a legal procedure at least once during the period 2008 and 2016.

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<sup>2</sup>Following Kessides (1990), we construct global sunk costs as a deflated sum of tangible and intangible liabilities, without amortization. Since the liabilities can still be used to operate after the end of the amortization, we do not amortize the liabilities.

Our findings suggest that the sunk costs linked to export activity represent a key determinant of firm exit since those costs lower the probability of survival, in addition to firm performances. The sunk cost burden influences the decision of the firm exit and its timing or, in our case, even force them. From our results, we have evidence that sunk costs have a negative impact on firms' survival. This finding is in line with the over-accumulation of sunk costs that might be explained by the limited rationality of the manager in the case of the sunk costs fallacy framework. Due to too much illiquid assets, they cannot meet the limit day of payment, which causes the Court's decision of triggering the bankruptcy process. However, our results are also in line with the predictions of the real options theory because we find evidence that the firm in distress makes changes in the exports strategy prior to the procedure (contradicting the sunk costs fallacy). Defaulting exporters are in an inaction zone in the years prior to the triggering of legal procedures. It may be rational that the firms that encounter difficulties continue to serve export markets waiting for an improvement of its financial situation. For these reasons, we cannot rule out one explanation over another. We also show that after controlling for the size, age, and factor intensities, plants are more likely to exit if they are part of a large firm, part of a multi-plant firm or part of a multinational firm.

We organize the paper as follows: we present the model in Section 1.2, and then we describe our empirical strategy and the data in Section 1.3. Section 1.5.1 presents some stylized facts, and in Section 1.5.2, we give our results and some robustness checks. We finally conclude in Section 1.6.

## **1.2 Literature review**

It is well documented in the theoretical literature that firms' performance impacts their ability to stay in the market, both domestic and foreign. As exporters are the best performing firms, default should not be possible for them. This is not consistent with the empirical fact that 9% of French exporters are in default over

the period 2008-2016. However even if a firm is not performing enough it does not systematically exit since there are barriers to exit as sunk costs that are supported not only on domestic markets but also on export markets. To provide some insights on this puzzle, we propose to consider three strands of the literature: exporters performances, defaulting firms and defaulting exporters.

### **1.2.1 Exporters' performance**

Melitz (2003) points out that firm productivity is an important matter in regard to production destination strategies. The more efficient a firm is, the more it can handle additional sunk costs, and it can sell its product in more distant locations. Otherwise, it sells only on the domestic market. If selling on the domestic market is still too difficult, then the firm leaves the market. This sunk cost encompasses a range of costs, such as the costs of searching for commercial opportunities abroad, complying with customs procedures, or finding local retailers. The model of Schröder and Sørensen (2012), a dynamic version of the one developed by Melitz (2003), adds exogenous technological progress and endogenous exit decision in this model. The firm decides to exit when it knows that it is not productive enough to stay in the market (either the export market or the domestic one). Apart from this refinement, the conclusions are identical. Only the most productive firms can enter the exporting market, due to additional sunk costs. Hiller et al. (2017) make and test some predictions derived from this model. Among them, they find evidence that survival firms are more productive than the one exiting the export market and the domestic market.

With his model of international trade, Chaney (2016) highlights a relationship between liquidity constraints and the difficulty of exporting. The presence of liquidity constraints creates difficulties in financing the sunk costs of exporting. Thus, less productive firms may exit the market when they face those constraints.

Empirically, Bernard and Jensen (1999) assess how export status and produc-

tivity growth interact. They show that high-performing firms become exporters and exporters grow more quickly than non-exporters. They also demonstrate that the productivity growth of incumbent exporters is slower than that of new exporting firms. They explain this deceleration of productivity growth by two potential factors: a temporary excessive acceleration from the new exporters; the productivity of firms exiting the export market that can lower the overall productivity of exporters.

Bernard et al. (2011) show that the number of products a firm exports matters. The more liberalized a market is, the more firms will specialize in the production of products they sell in this market. Besides, as a firm exports to more destination markets, the more it exports products.

### **1.2.2 Defaulting firms**

The decision to export can be made rationally by a top-performing firm. However, according to the literature, a firm learns if it is performing well enough to continue its activity or not. Jovanovic (1982) and Hopenhayn (1992) construct models of passive learning because the firm has a defined but unknown and unalterable productivity parameter. It has to produce in order to know whether it is efficient enough to produce or if it has to exit. Following Ericson and Pakes (1995), we can consider that firms are engaged in a process of active learning to improve their productive performances, although uncertainty exists on the outcome of investment. If a firm faces an unsatisfactory outcome in response to the innovation made and if it occurs multiple times, then it will become, relative to other firms, a less-performing firm. Since a whole tranche of literature focuses on those situations where all firms, exporting or not, can face a loss of performance, this dynamic approach seems more appropriate for our analysis. The literature on firm failure has highlighted the existence of a “shadow of death”, which refers to a lower productivity per exiting firm relative to incumbents even several years before

the exit. Griliches and Regev (1995) were the first to highlight this phenomenon, where firms that will exit face a loss of productivity multiple years earlier.

Both Kiyota and Takizawa (2007), using Japanese firm-level data, and Blanchard et al. (2014), with French firm-level data, find the same fact. They both conclude that the shadow of death exists, but they also find that sunk costs prevent exit and that unobserved heterogeneity must be taken into account to avoid underestimating the impact of performance indexes. Consequently, market exit does not represent a sudden event; however, a much longer and downward trend of efficiency seems robust.

A key factor of exit is firm-level productive efficiency at the moment of failure, not just past trends. Empirically, a robust negative relationship exists between productivity and failure. Bellone et al. (2006), for example, use a duration model methodology and draw conclusions about both the dynamics and the level of productivity of French firms. First, incumbent firms that are exiting face a lower efficiency level, measured by TFP, profitability, and size. Second, years before exit, firms face a negative trend for all efficiency indicators, concluding those regarding the existence of the shadow of death.

Blanchard et al. (2012) compute TFP and sunk costs at the firm level and Herfindahl's concentration index at the industry level. They then run a pooled and random effect panel probit. They find a positive and significant correlation between the probability of survival and productivity, age, and sunk costs. Therefore, the more efficient a firm is, the lower its probability of leaving the market. Brandt et al. (2012) also find a negative and robust correlation between exiting firms and productivity.

Another stand of literature tackle the decision of the owner to decide to stay in the market, even when it appear to be clear from the outside perspective that the situation is evolving to a critical situation with amounts invested in sunk costs that are out of control. The first branch is the sunk costs fallacy. It is generally assumed

that the more a firm invests, the more it tries to be profitable. Nevertheless, if it does not succeed as expected, the firm will invest more in those sunk costs, because the head of the firm does not want to “lose” the amount already invested. This phenomenon is quite simple but is not based on rational behavior. If the investment is not profitable, the firm should stop spending to avoid losing more money, to avoid losing even more assets. Otherwise, they would end-up with more sunk costs than they should. As O’Brien and Folta (2009) note, the sunk cost fallacy is based on the assumption that people are not able to make decisions in their own best interest. In an incomplete information economic environment, where we only know the potential outcomes and not the real outcomes, agents have to decide based on bounded rationality.

However, when it appears that the choice of staying in the market is rational, the limited rationality of the firm’s owner might be difficult to sustain. The real option model theory tackle these cases. As O’Brien and Folta (2009) notes, when facing great uncertainty and a high amount of sunk costs, poorly performing firms will not exit the market. Exiting the market means losing the stock of the wide variety of sunk costs, such as “strategic asset stocks”, defined by Dierickx and Cool (1989), and knowledge, i.e., the innovation savoir-faire, steadily accumulated through the company’s exporting history. Thus, exiting and re-entering the market when the economic environment is more favorable also means losing competitiveness compared to the pre-exit situation, even if the firm does not perform well (Dierickx and Cool, 1989, O’Brien and Folta, 2009). For this reason, firms will stay in an inaction zone, hoping for better times, but without investing more than already invested. Moreover, the incompleteness of information, and thus the range of possible outcomes, might favor the decision for those firms to stay in a supposedly more difficult and risky business. The way to differentiate them will be by assessing the impact of over-accumulated sunk costs in the probability of entering in a bankruptcy procedure, or even a change in the risk taken by the firm.

### 1.2.3 Defaulting exporters

Even though broad strands of literature focus on exporting and defaulting firms, the existent research has paid little attention to the relationship between exporting and firm closure. Among the exceptions, Bernard and Jensen (1999) find that firms that exported in the previous year have a lower probability of market exit than non-exporters. However, they take into account the possible endogeneity of the export choice by taking the lag of the exporting status. We can argue that it does not perfectly take into consideration the export decision, which is not only driven by the past exporter status, thus can lead to a selection bias of the prior exporting status. This bias can then lead to a possible bias in the estimation of the impact on the survival of export activities.

Other related studies focus on the entry and exit of export markets and their impact on firm survival. Girma et al. (2003) examine the consequences of export market exit on firm performance. Based on the PSM methodology, to estimate the probability of exiting export markets, they match firms on the predicted probability, and then conducted a difference-in-differences estimation to assess the effect of leaving the export market on three outcomes: productivity, employment, and output. They find that while exiting export markets negatively impacts all firm outcomes in the short-term, productivity is the only one that does not suffer in the long run. The authors explain that firms gain experience from previous exports through a “learning by doing” effect. Firms compete against better-performing firms and therefore learn about those firms’ best practices. Nevertheless, due to the lack of domestic opportunities, output faces the largest, most significant, and most durable fall. In addition, the negative effect is also persistent for employment.

The study by Wagner (2013) highlights a stronger relationship for German firms between imports and firm survival. He shows that when he disentangles exporters only from firms which also import (two-way trade), being an exporter does not protect significantly against market exit. In other words, there are trader survival

premia: the risk of exit is lower for importers and for firms that both import and export than for exporters. He explains these results with the choice of diversification for exporting firms only. These companies do not want to suffer the economic cycle of the domestic market if it is not favorable. Therefore, they expand to counteract this risk. However, that does not mean they are more efficient than other firms. In contrast, importers, especially two-way traders, are more integrated into the international market than exporters, which is a sign of efficiency.

In the case of Vicard (2014), the paper focuses on the relationship between export decisions and the probability of firm survival. In this paper, firms can fall into three categories: a firm can be only domestic, a new exporter, or an incumbent exporter. He finds that incumbent exporters have a lower probability of default in comparison with new exporters. In addition, after exiting export markets, exporters have a higher probability of default than similar domestic firms. This finding highlights that exporting contains risk. In other words, exporting does not prevent firms from defaulting, but it increases the probability of going into bankruptcy for former exporters compared to similar domestic-only firms that did not choose this path. These firms return to their level of productivity and factors of production from before they began to export, but they still have a higher level of debt as a result of the export activities they stopped. Therefore, they cannot sustain this level of indebtedness and also exit the domestic market.

The question remains of why a significant share of exporters are involved in a default. The existence of sunk exit costs can explain the persistence of exporters' status. Consequently, firms may remain active in export markets as long as the value of continuing to export exceeds the exit costs. Bernard and Jensen (1999) highlight that in switching to domestic activity only, exporters exhibit bad performances afterwards. In leaving export markets, firms face difficulties. A level of sunk costs that is too high can cause these difficulties, which are illiquid assets that are no longer available for use. From data on Chilean plants, Das et al. (2007) estimate a substantial amount of sunk costs exporter that enter in the foreign markets

(around 400,000 U.S. dollars). However, staying inside the market will not increase them by a considerable amount. Thus, since it can be more costly to exit and re-enter foreign markets, sunk costs can create a barrier to exit, which can increase their financial difficulties. Indeed, the assets invested in sunk costs will not be available if the firm faces difficulties reimbursing its creditors. The firm's situation may worsen, and it might end with an insolvency. When firms are insolvent, the Court triggers the bankruptcy procedure. Indeed, the decision to start bankruptcy procedures are out of the manager's hand, and is only based on accountancy and not on economic, as considered in the literature.

## **1.3 The probit model**

### **1.3.1 Data**

To implement our analysis, we use two main databases. The first one we use is the official bulletin of civil and commercial announcements database (BODACC thereafter), which gives us information about the firms that were in default between 2008 and 2016. In France, the BODACC provides information on legal procedures. There are three different procedures for companies in distress (from the least intrusive to the most intrusive): the safeguard procedure, the reorganization procedure, and the liquidation procedure. The safeguard procedure, introduced in 2005, is relatively new. This procedure aims to allow firms that face a critical situation but are not declared insolvent to maintain their business activity and level of employment while also regulating liabilities. At the end of the safeguard plan, the procedure can be converted to a reorganization or liquidation procedure depending on the situation of the debtor. The judicial administrator can have an active or a passive role: the decision power of the debtor will be reduced at the expense of the administrator in case of an active mission. This procedure can last ten years at

most for all companies except for farming companies (fifteen years).<sup>3</sup>

The liquidation procedure, similarly to the reorganization procedure, can be triggered only if the firm is in a state of insolvency. It can be opened either after the reorganization procedure if it fails or after a safeguard procedure if the company became unable to reimburse its creditors or directly opened after the insolvency if the firm is considered impossible to save. It lasts for two years maximum and is completed only if liabilities are completely reimbursed or if assets are extinguished. Safeguard procedures can be started without insolvency, so the court has to state if the company needs its help. This rule is not as clear as the insolvency rule. For this reason, we will focus on the liquidation and reorganization procedures.

The second database includes annual French customs data over the period 1993-2015, which provides us with firm-level data on trade.<sup>4</sup> French customs uses the European Combined 8-digit Nomenclature (CN8).<sup>5,6</sup> We classify markets according to their ease of access. We consider a market easy to access when it is part of the European Union and difficult otherwise. We distinguish markets this way because there is not enough heterogeneity to differentiate firms otherwise. In our database, almost all firms export to an easy market, defined by Chaney (2014) as a foreign market (or its neighbor) in which some French firms already operate (because of trade networks).

In addition, for firm-level information, we use the Unified Corporate Statistics System, the File approaching the results of the Elaboration of Annual Statis-

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<sup>3</sup>A simplified safeguard procedure exists for large firms. To be eligible, the firm has to have at least 20 employees, a turnover greater than €3,000,000 before taxes, or a balance sheet greater than €1,500,000. The plan must be voted by creditors who detained at least two-thirds of the total debt. Note that a regular simplified procedure is different from a financial simplified safeguard procedure (which concerns firms deeply indebted to banks, with the majority of their financial creditors' supports).

<sup>4</sup>Exports at the product level are available for more than 230 trading partners.

<sup>5</sup>Some flows are exempt from declarations.

<sup>6</sup>Within the European Union, French exporters declare their shipment if their cumulated export value for a given year exceeds €460,000. This threshold has changed over the period: the limit was F250,000 from 1993 to 2001, F650,000 from 2001 to 2006 (€100,000), €150,000 from 2006 to 2011, and €460,000 since 2011. This threshold can be an important limitation when the number of firms is the main concern. Concerning exports to non-European countries, the threshold is lower (€1,000).

tics of Companies, the Annual Declaration of Social Data and the Financial Links between Enterprises Survey (FICUS, FARE, DADS, and LiFi, respectively). First, we use FICUS and FARE to obtain information about the accountability of French firms. Those databases contain comprehensive information about, for example, assets, materials, revenue, and value-added. The data began in 2000 and ended in 2014. Then, we use the DADS database, which groups all the information about firms' human capital. FICUS and FARE contain this information as well, but DADS is more reliable since the data are more accurately gathered. We use the labor variable from this database to estimate the production function. Since the literature pointed out the impact of being part of a group, we use LiFi, which illustrates the financial links between firms, to evaluate firms' group membership. In our sample, 11,902 firms out of 31,975, which means approximately 37% of our sample, are part of a group. We restrict our sample to firms that have more than five employees and €5,000 of tangible assets so that we do not have to deal with the measurement problem due to small firms.

### **1.3.2 The model**

We aim to explain why a substantial share of export firms are insolvent. First of all, we have to identify defaulting firms. The French National Institute of Statistics (INSEE) considers the default as the entry into a legal procedure (either liquidation or reorganization). Nonetheless, we cannot strictly apply this definition at year  $t$ . Although firms have to give information about their accounting, most of them do not provide this information several years before they default (most of them two to three years). For this reason, missing values arise in our samples before the date of entrance in the BODACC. In order to not exclude those firms, we define the default as entering a legal procedure in the following three years (see Figure 1.1). Using this definition instead of the year of the default, the number of failing firms we

observe goes from 4,404 to 10,134.<sup>7</sup> We use this definition in consideration of the

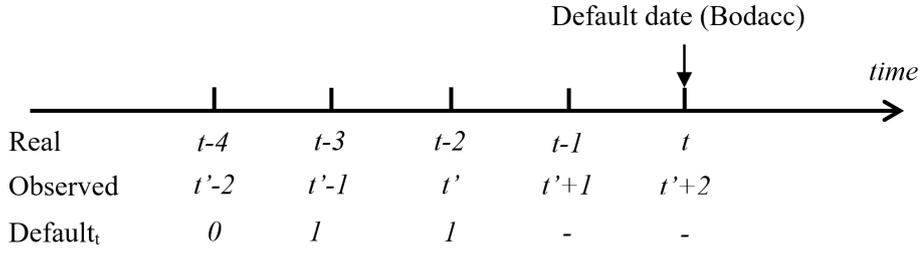


Figure 1.1: Example of the computation of the default variable

number of firms disappearing from the database in the years before the default. Thanks to this definition, we can consider a larger number of defaults in our analysis. In Figure 1.1, we take the example of a firm that appears as defaulting in the BODACC database two years after we last see it in other databases. To estimate the impact of sunk costs linked to export activities on the probability of default, we use the following probit regression model:

$$\mathbb{P}(Default_{it} = 1 | X_{it}) = \Phi(\beta_0 + \beta_1 tfp_{it} + sunk\_costs'_{it}\theta + Z'_{it}\gamma + \alpha_i + \varepsilon_{it}) \quad (1.1)$$

where  $tfp_{it}$  is the performance index we will use for firm  $i$  at year  $t$  which is estimated according to the methodology proposed Levinsohn and Petrin (2003) (more details in Appendix A.2),  $sunk\_costs'_{it}$  is the vector containing the amount of sunk costs related to the export activity and the one related to the domestic activity of firm  $i$  at year  $t$  (see Section 1.4).  $Z_{it}$  is the vector of control variables:  $Group_{it}$  is a dummy equal to 1 if the firm is part of a group, either as the group's head or as the subsidiary, and 0 otherwise.  $Conc_{it}$  is the Herfindahl concentration index, and  $\log(mes_j t)$  is the minimum efficient scale of the industry  $j$  at the year  $t$ .

More precisely, the Herfindahl's concentration index is computed at the two-

<sup>7</sup>When we take  $t+1$  and  $t+2$ , the number of firms we observe as defaulting are respectively 8,289 and 9,840.

digit NACE level as follows:

$$\sum_{i=1}^{N_t^j} \left( \frac{Y_{it}}{\sum_{i=1}^{N_t^j} Y_{it}} \right)^2 \times 1000 \quad (1.2)$$

where  $Y_{it}$  is the output of firm  $i$  at time  $t$ . It ranges between 0 and 1000, the latter being the less competitive sector possible and 0 being the value for the market with the most competition. The minimum efficient scale is defined by Comanor and Wilson (1967) for each sector as:

$$\frac{\frac{1}{N_\Omega} \sum_{i \in \Omega} Y_{it}}{\sum_i Y_{it}} \quad (1.3)$$

where  $\Omega$  is the subsample of the largest firms accounting for 50% of the output in each sector. Finally,  $T$  is the vector of the time dummies. For the concentration index and the MES, we utilize the deflated value-added as a measurement of the output from FICUS and FARE.

Considering firms' performances, we use the estimation of total factor productivity (TFP thereafter) method developed by Levinsohn and Petrin (2003). It allows use to estimate the inner firm performances every year. For more details, see Appendix A.2.

We also try to consider the risk of operating in the export market. First, we include a dummy variable and its lags in order to take into account the impact of export status dynamics on the firm default. Second, we use the number of destination and the share of destination, distinguishing OECD and EU countries with the rest of the world.<sup>8</sup> The idea behind this approach is quite straightforward, since the more a firm exports to different countries, the more this export activity will generate sunk costs to sustain this activity. In addition, differentiate destinations as part of OECD or not can proxy the difficulty of serving the markets.

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<sup>8</sup>Due to data limitation in the time dimension of our panel, we were not able to follow Ghosal (2010), with the estimate of the root mean square error of a model that explains export turnover by its lags.

The last variable which is our main focus is the firms' sunk costs linked to the domestic and export activities separately. We explain in details how we estimate them in the following section (Section 1.4).

In order to assess the shadow of death effect, we will use up to three lags of all our firm-specific variables. This will allow us to test if the effect is reinforced over time (confirming the shadow of death hypothesis) , or diluted (invalidating this hypothesis).

Since we cannot use within transformation due to the incidental parameters problem, Mundlak (1978) allows us to control for possible correlation between our observable explanatory variables and the unobserved heterogeneity.<sup>9</sup> Consequently, we will estimate this model with this methodology, with the addition of bootstrap to estimate robust standard errors.

## **1.4 Export sunk costs: an identification using propensity score matching**

Theoretically, we can make a clear distinction between the sunk costs supported by firms to access the domestic market and those supported to access the export market (Melitz, 2003, Yi and Wang, 2012). By contrast, in the data, we can control only for the presence of overall sunk costs, without the distinction between the sunk costs related to the domestic activity and export one.

We propose to measure the sunk costs with a new methodology. The sunk costs directed to the export activity can be viewed as the difference between the global sunk costs of the exporting firm and the sunk costs linked to the domestic market. This difference can be estimated due to the matching methodology, which allows comparison between treated firms and their constructed counterfactuals. In addition, knowing that the decision to export is not a random process, matching

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<sup>9</sup>For more information, see Wooldridge (2010) Part IV, Chapter 15 Section 8.2, or Greene (2004).

the firms will allow us to randomize the treatment allocation. Using this property, we can extract the sunk costs of non-exporters, which are statistically identical to exporters. We will consider this difference to be the sunk costs directly linked to export activity.

This methodology will allow us to compute the two types of sunk costs for each exporting firm each year. Thus, because we will calculate it by firm and by year, Mundlak's methodology (Mundlak, 1978) allows us to control the individual unobserved heterogeneity in our primary model. The critical steps are the matching methodology used and the variable choice. We will perform PSM, and the model retained will be discussed later.

The literature frequently uses the method of PSM proposed by Rosenbaum and Rubin (1983). This is a convenient methodology because it allows us to obtain a single index built from the observed characteristics of firms to match treated firms with non-treated firms. Its central component is the choice of independent variables, so we have complete independence between the unobserved characteristics and the outcome, the sunk costs related to firms' export activity. Consequently, we must use all the explanatory variables of the decision to export in the model to discriminate properly the sunk costs related to exports. Hence, we can see this approach as a way to explain the difference in export status between two firms that are statistically identical, where the decision to export is a random process. This probability is estimated with a probit using the data available between 2006 and 2014.

$$P(\text{Export}_{it} = 1 \mid X_{it}) = \Phi(\beta_0 + X'_{it}\beta + \bar{X}'_i\gamma + S'_{it}\delta + \varepsilon_{it}) \quad (1.4)$$

Since the choice of the covariates is crucial to obtaining a good quality of matching, we follow Roberts and Tybout (1997) and Vicard (2014) to predict the export choice. We use a set of industry dummies at the two-digit NACE level ( $S_{it}$ ), a dummy of foreign ownership, and a dummy of importer status. We also use the logarithm of continuous variables, such as the lag of the productivity index of the firm, age,

Variables	(1) All manufacturing industries	(2) Food products, beverages, and tobacco	(3) Other industrial products, coking and refining	(4) Electrics, electronics, and informatics products	(5) Transporting materials	(6) Clothing industries	(7) Wood and paper industries
Foreign group <sub>it</sub>	0.078 (0.064)	0.186 (0.182)	0.097 (0.083)	0.075 (0.174)	0.174 (0.382)	-0.279 (0.315)	0.056 (0.180)
Importer <sub>it</sub>	0.649*** (0.032)	0.470*** (0.108)	0.740*** (0.042)	0.628*** (0.093)	0.534*** (0.167)	0.942*** (0.141)	0.324*** (0.078)
Log TFP <sub>i,t-1</sub>	0.015 (0.013)	-0.037 (0.042)	0.029 (0.018)	-0.010 (0.037)	-0.066 (0.068)	-0.039 (0.065)	0.028 (0.033)
Log number of employees <sub>i,t-1</sub>	0.481*** (0.051)	0.774*** (0.153)	0.390*** (0.069)	0.574*** (0.174)	0.530** (0.221)	0.840*** (0.218)	0.478*** (0.128)
Log liabilities <sub>i,t-1</sub>	0.083*** (0.023)	0.063 (0.071)	0.083*** (0.031)	0.057 (0.073)	0.199 (0.127)	0.141 (0.103)	0.083 (0.057)
Log age <sub>i,t-1</sub>	-0.123** (0.060)	-0.734*** (0.200)	-0.152* (0.080)	-0.066 (0.188)	0.623** (0.311)	-0.104 (0.288)	0.002 (0.160)
ΔLog TFP <sub>i,t-1</sub>	-0.015* (0.009)	0.032 (0.026)	-0.022* (0.012)	-0.016 (0.023)	-0.029 (0.036)	0.045 (0.044)	-0.030 (0.024)
ΔLog number of employees <sub>i,t-1</sub>	-0.217*** (0.043)	-0.431*** (0.114)	-0.209*** (0.059)	-0.139 (0.149)	-0.491** (0.212)	-0.196 (0.189)	-0.065 (0.106)
ΔLog liabilities <sub>i,t-1</sub>	-0.029 (0.022)	0.040 (0.065)	-0.051* (0.030)	-0.039 (0.076)	0.034 (0.120)	-0.058 (0.102)	-0.008 (0.054)
ΔForeign group <sub>it</sub>	-0.016 (0.049)	-0.115 (0.131)	-0.007 (0.067)	-0.024 (0.153)	-0.459* (0.257)	0.139 (0.225)	0.025 (0.129)
ΔImporter <sub>it</sub>	-0.158*** (0.021)	-0.132* (0.072)	-0.181*** (0.028)	-0.152** (0.067)	-0.182 (0.114)	-0.289*** (0.089)	-0.049 (0.053)
Intra-individual average							
- Foreign group <sub>it</sub>	0.566*** (0.091)	1.218*** (0.284)	0.512*** (0.119)	0.505* (0.266)	0.736 (0.483)	0.388 (0.419)	0.144 (0.244)
- Importer <sub>it</sub>	3.470*** (0.066)	3.766*** (0.234)	3.483*** (0.089)	3.887*** (0.190)	2.753*** (0.304)	4.706*** (0.286)	1.825*** (0.138)
- Log TFP <sub>i,t-1</sub>	0.385*** (0.038)	0.757*** (0.153)	0.167*** (0.051)	0.543*** (0.118)	0.343* (0.193)	0.505*** (0.160)	0.416*** (0.104)
- Log number of employees <sub>i,t-1</sub>	-0.053 (0.058)	-0.533*** (0.175)	0.191** (0.079)	-0.085 (0.202)	-0.009 (0.269)	-0.901*** (0.239)	-0.019 (0.149)
- Log liabilities <sub>i,t-1</sub>	0.162*** (0.030)	0.498*** (0.096)	-0.033 (0.041)	0.316*** (0.101)	0.020 (0.166)	0.212* (0.128)	0.291*** (0.075)
- Log age <sub>i,t-1</sub>	0.598*** (0.062)	1.506*** (0.212)	0.567*** (0.082)	0.589*** (0.193)	-0.396 (0.314)	0.366 (0.287)	0.308* (0.162)
- ΔLog TFP <sub>i,t-1</sub>	0.031 (0.141)	-0.787 (0.666)	0.291 (0.205)	0.166 (0.328)	1.041 (0.785)	-1.719*** (0.576)	0.106 (0.315)
- ΔLog number of employees <sub>i,t-1</sub>	-0.829*** (0.279)	2.761*** (0.991)	-1.953*** (0.390)	-1.445 (0.943)	0.274 (1.409)	-1.238 (0.931)	0.701 (0.664)
- ΔLog liabilities <sub>i,t-1</sub>	-0.139 (0.145)	1.621*** (0.486)	-0.397* (0.204)	-0.421 (0.485)	-0.423 (0.722)	-1.044* (0.559)	-0.585* (0.349)
- ΔForeign group <sub>it</sub>	0.137 (0.239)	-0.388 (0.908)	0.479 (0.320)	-0.029 (0.736)	0.875 (1.270)	-0.864 (0.921)	0.053 (0.563)
- ΔImporter <sub>it</sub>	0.410 (0.289)	-3.626*** (1.221)	1.842*** (0.385)	-0.650 (0.871)	-1.176 (1.419)	0.303 (1.076)	-0.495 (0.643)
Constant	-9.324*** (0.179)	-13.332*** (0.624)	-7.432*** (0.541)	-8.437*** (0.512)	-6.419*** (0.824)	-6.447*** (0.587)	-7.888*** (0.431)
# of obs	228,939	48,296	111,700	25,311	6,575	11,714	25,343
# of firms	36,371	7,847	17,793	4,067	1,081	1,940	4,117
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AUC	0.899	0.906	0.879	0.895	0.906	0.896	0.819
Log-likelihood	-59,364	-7,753	-31,963	-5,514	-1,805	-2,832	-9,033

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.1: Probit models for propensity score matching

tangible assets, and the number of employees. Except for the age variable, we also use each variable's first difference to control the dynamic of the firm. Growing and more efficient firms should have an increased probability of being exporters. Then, we match the firms by year, using the five nearest neighbors, with a caliper of 0.01.

We run 6 various models, (with and without Mundlak methodology and first differences variables). Our preferred model is the most complete model, since the signs are consistent with the literature and it has both the highest log-likelihood

and area under the curve. Moreover, the essential hypothesis behind the PSM is the non-omitted variable hypothesis. Since we use panel data with a correction of endogeneity caused by individual fixed effect, we can be confident that this hypothesis is respected. In order to account for sectoral heterogeneity, we estimate

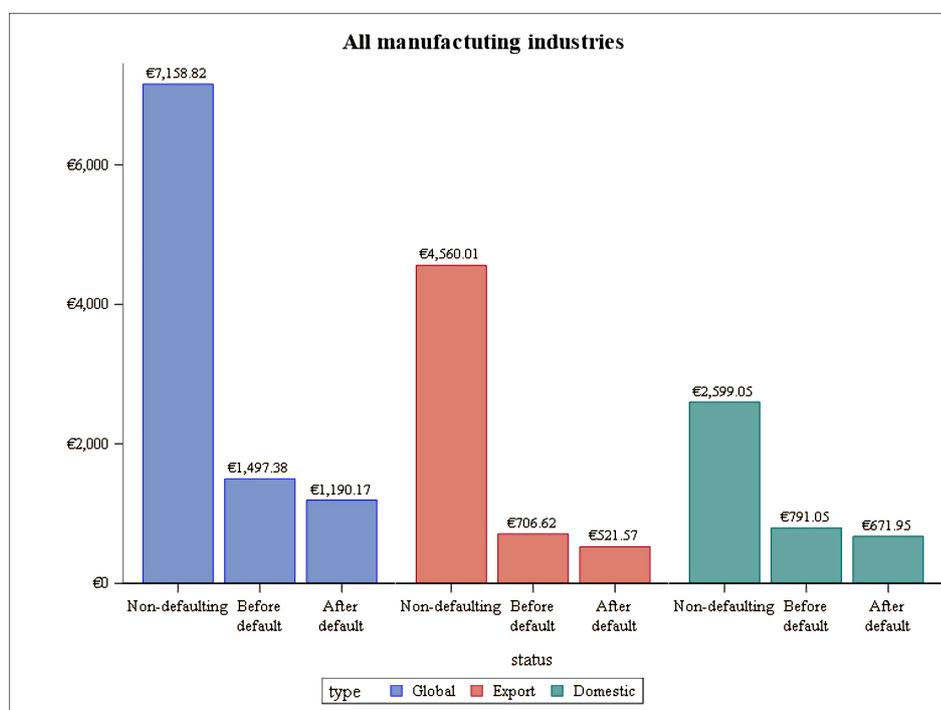


Figure 1.2: Average amount of sunk costs – All manufacturing industries

our model at the industry-level, following the same classification we used in our TFP estimations. The results are shown in Table 1.1.

Considering the estimations, we can distinguish two parts. First the intra-individual average of our covariate, which indicate us about the effect between firms. We can see that our results are consistent with the predictions of the trade models. most productive firms are more likely to export. Moreover, firms that are being part of a group also have a higher predicted probability of exporting, which does reflect the ease of firms in groups to export their products to other firms of their group. The age of the firm also have a consistent positive impact on the firms probability of exporting, except in the sectors of clothing and transport materials, which have non-significant impact. Moreover, the difference of size between firms does not seem to have an impact overall, but when it does, it can be positive (Other

industrial products, coking and refining) or negative (Food products, beverages, and tobacco and Clothing industries).

Second, the covariates, which reveal the impact of a change inside the firm. We find that companies that start importing are more likely to export, while having a change of their productivity or their foreign group membership does not have a significant impact. Those two latter effects can be explained by the inertia of those variables. They do not change rapidly over time. It also explains why their first differences are insignificant. The size of the company however has an impact. About the number of employees, it has a positive impact on the probability of exporting.

Even if we do not have the same prediction rate for every sector, the AUC never drops below 80%, which is a good prediction rate. Moreover, as shown in Table A.6.2, the number of firms matched is also critical. The number of observations is lower since we use some lagged variables' first difference in our model and, for non-continuous exporters that do not export continuously, all the observations cannot be matched.<sup>10</sup> When the domestic sunk costs are assessed, we subtract these computed sunk costs from those already observed.<sup>11</sup> The sunk costs linked to export and the domestic market differ between firms in distress and continuing firms and between firms in distress before and after triggering the procedure, as shown in Figure 1.2 and Table A.5.1. Therefore, the firms in distress, while they have less sunk costs than overall incumbents, seem to have an excess of costs before triggering the procedure, and they try to eliminate it, either to reimburse their creditors with them in the case of a liquidation procedure or to lower their liabilities. Since the gap between incumbents and defaulting firms is quite large, it seems to point to a negative relationship between sunk costs and default. Nonetheless, we do not take into account other variables influencing the default. The following control variables will be considered.

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<sup>10</sup>For those observations, we infer a value for the domestic sunk cost that is equal to the minimum of the domestic sunk costs average and the sunk costs observed.

<sup>11</sup>We use the maximum of 0 and the difference between the two sunk costs.

## 1.5 Results

### 1.5.1 Statistics

Since we are interested in the probability of default, we distinguish firms according to their defaulting status: a firm can be defaulting or not, and whether defaulting firms are observed before or after the procedure has been triggered.<sup>12</sup> Considering the different firm-level export status, we compare the productivity of the different categories of firms to identify to what extent the distributions differ. We call *incumbent exporter* a firm which exports during the entire period (from 2006 to 2014) and *non-incumbent exporter* a firm that does not export continuously during the same period. Another difference relies on the firm export behaviour i.e. the destination of the products shipped. We also created five quintiles of productivity by sector to see the distribution of the firms. As the figures in Appendix A.3 show, non-defaulting firms that do not export and the ones that stopped exporting either a long time ago (i.e., between 10 and 15 years) or a short time ago (i.e., 5 years) have similar distributions of productivity, which is skewed towards the less efficient firms in the first two quintiles. Current exporters also have similar distributions. They are skewed towards the most productive firms in the last two quintiles. We also find that short-term export status history has a larger impact on productivity than long-term export status history. For example, in Figure A.3.2, firms that continuously exported for two years have a higher productivity than firms that exported two years ago, stopped exporting the year after and exported again in year  $t$ . Moreover, when we consider the last year of exporting, whether firms are continuous exporters or not, the distribution of productivity is more skewed towards the 5<sup>th</sup> quintile when they export in  $t$  instead of when they export for the last time in  $t-1$  or before. Therefore, there seems to exist not an exporter productivity premium but a continuous exporter productivity premium, and current export status is more

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<sup>12</sup>Only 4,404 defaulting firms allow us to distinguish before and after the triggering, over the 10,134 defaulting firms considered.

relevant than previous export status.

Now, non-exporting firms and those that exported at least once since the beginning of the period have a very different distribution of productivity than firms that have more regular export activity. Non-exporters have a relatively even distribution between the 1<sup>st</sup> and the 4<sup>th</sup> quintiles, but a bit less for the 5<sup>th</sup>, while exporters have a distribution skewed toward the 4<sup>th</sup> and 5<sup>th</sup> quintiles. This finding confirms the higher productivity of exporters compared to purely domestic firms, as exposed first empirically by Bernard and Jensen (1999) and then theoretically by Melitz (2003). Nevertheless, considering the default in the three next years (see Section 1.3.2), the distributions of productivity between non-exporters and exporters are similar. In this case, more than 60% of firms are in the first two quintiles. Nevertheless, more than 20% of exporters – considered the most efficient firms – are involved in a collective procedure or become involved in one in the following three years. Does export status protect from difficulties? Alternatively, does the way they export matter the most?

It appears counterintuitive that one-fifth of exporters are among the less-performing firms. A possible explanation could be that the too high level of sunk costs prevents exporters from leaving this market. The sunk costs acting as a barrier of exit hypothesis is plausible since we see that being subject to an insolvency procedure creates a significant difference in the average number of products exported. Indeed, when the decision is not the hand of the manager, the more rational decision of exiting riskier market is taken. The same phenomenon also occurs for the number of destination countries. Notably, we observe, on average, significant decreases of 1.31 (resp. 0.75) products exported (resp. destination countries) per firm after the collective procedure is triggered. Therefore, for the firms in distress, the destination of export seems crucial, as pointed out by Bernard et al. (2011) and Fontagné et al. (2018). However, it should be noted that when a firm is involved in an insolvency procedure, an administrator named by the court is in charge. Therefore, the decision to decrease the number of destinations and products exported

can be made by the administrator. The administrator can also decide to focus on some core products in those difficult times. Thus, we see a gap between defaulting and non-defaulting firms. This gap also exists for the export sunk costs, as shown in Figure 1.2 and table A.5.1. Therefore, are the levels of sunk costs too high for firms to sustain their activity, particularly export activity? Does the gap between non-defaulting and defaulting firms in terms of sunk costs prevent exit? This will be discussed in the next section.

In Table A.4.1, we see that exporting firms that are not in default export more products than defaulting firms before the default arises. The same conclusions arise concerning the number of destination countries. It appears that exporters involved in a collective procedure do not perform as well as the other firms in the export market. Firms that become less efficient compared to domestic and other exporting firms have no choice but to exit the market. If we go further into detail, we can see that the destination can be another factor. Now, we will compare the average number of products exported before and after the procedure is triggered, and depending on the export destination, we can see different things. First, if the firms are exporting to neighboring countries, the number of products shipped does not decrease significantly. This phenomenon is even truer if the destination countries are EU bordering countries. Similarly, if the destination is a non-bordering EU country, the decrease is not significant, either. Therefore, if the destination countries are within the EU, regardless of whether they are bordering or not, the reduction in the number of products exported is not significant. In contrast, if the destinations are non-bordering countries outside the EU, then the decline is both important and significant. A plausible explanation is the sunk costs. We can see that the costs to export to the nearest neighbor are low enough and thus are not significantly different from the domestic market. Hence, these firms do not have any incentive to leave. Conversely, it may seem too costly to continue serving markets that are outside the EU and far from France. Therefore, these findings suggest that firms refocus their activities towards less costly ones. However, this step seems to happen

only after insolvency, while in this paper, we are focusing on the determinants of insolvency.

To summarize, exports to the "easy" market are still sustainable for firms in distress, but they reduce their exports to more difficult destinations. This can be a sign of less competitiveness towards other French exporters, but also indigenous firms in the foreign market. Moreover, the firms in distress that are trying to disengage themselves progressively from those difficult destinations, as shown in Table A.4.1, gradually reduce their amount of sunk costs linked to the export market, but only after the triggering of the procedure. Thus, the sunk costs will act as exit barriers. If this assumption is verified, then we will have a good explanation of why exporters are still exporting while being in a collective procedure, and the theoretical background will remain valid. Otherwise, it will mean that other variables are at stake and are not controlled for with those statistical analyses. To confirm this hypothesis, we must find a way to infer the part of the sunk costs linked to the export market and then evaluate the dynamic of the sunk costs years before the entry into a collective procedure. Doing so will help exporting firms reduce sunk cost pressure, but it is not enough to stop their export activities.

## **1.5.2 Probit estimations**

### **1.5.2.1 Firms' performances and default**

The estimates of the impact of sunk costs linked to export activities are reported in Table 1.2. Columns (1) to (6) report results for all exporting firms (incumbent or not). We dissociates incumbents exporters from non-incumbents in columns (7)–(9). From our results, we find that productivity decreases the probability of being in default. Additionally, because the coefficients of productivity are negative and more and more significant, the closer time of default is, more significant is its effect. This result confirms both our statistics (see Appendix A.3) and the previous findings of the existing literature: the decline in productivity is a robust finding in

Variables <sup>(a)</sup>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All			Incumbent exporters					
$tfP_{it}$	-0.177*** (0.025)	-0.174*** (0.024)	-0.112*** (0.037)	-0.182*** (0.030)	-0.202*** (0.029)	-0.139*** (0.033)	-0.183*** (0.028)	-0.183*** (0.033)	-0.143*** (0.036)
$tfP_{it-1}$	-0.064*** (0.025)	-0.059*** (0.022)	-0.070** (0.034)	-0.065*** (0.025)	-0.067** (0.027)	-0.083*** (0.030)	-0.071** (0.030)	-0.076*** (0.029)	-0.104*** (0.036)
$tfP_{it-2}$		0.013 (0.028)	0.038 (0.031)		0.015 (0.026)	0.040 (0.028)		0.010 (0.026)	0.026 (0.033)
$tfP_{it-3}$			0.058* (0.032)			0.060** (0.030)			0.044 (0.036)
Sunk costs:									
$Export_{it}$	0.064*** (0.022)	0.062*** (0.022)	0.051** (0.025)	0.048** (0.023)	0.055** (0.024)	0.043 (0.027)	0.120*** (0.026)	0.117*** (0.034)	0.123*** (0.038)
$Export_{it-1}$	0.035*** (0.013)	0.024** (0.010)	0.045** (0.019)	0.035*** (0.011)	0.026** (0.010)	0.045*** (0.012)	0.037** (0.017)	0.021 (0.014)	0.096*** (0.033)
$Export_{it-2}$		0.030*** (0.011)	0.019* (0.011)		0.026*** (0.009)	0.018* (0.011)		0.029** (0.014)	0.031** (0.014)
$Export_{it-3}$			0.022** (0.011)			0.016 (0.013)			-0.003 (0.013)
$Domestic_{it}$	0.137*** (0.036)	0.133*** (0.035)	0.112** (0.044)	0.141*** (0.037)	0.153*** (0.033)	0.134*** (0.041)	0.148*** (0.036)	0.142*** (0.047)	0.127*** (0.038)
$Domestic_{it-1}$	0.030 (0.032)	0.025 (0.028)	0.093** (0.042)	0.028 (0.031)	0.024 (0.033)	0.098** (0.039)	0.024 (0.036)	0.028 (0.030)	0.095** (0.039)
$Domestic_{it-2}$		-0.017 (0.025)	-0.023 (0.027)		-0.019 (0.023)	-0.025 (0.030)		-0.044 (0.029)	-0.057 (0.039)
$Domestic_{it-3}$			0.006 (0.035)			0.001 (0.033)			-0.015 (0.032)
$Exporter_{it-1}$	-0.111 (0.093)	-0.075 (0.077)	-0.129 (0.125)						
$Exporter_{it-2}$		-0.091 (0.081)	-0.092 (0.096)						
$Exporter_{it-3}$			-0.038 (0.088)						
Group:									
$Foreign_{it}$	-0.305*** (0.102)	-0.309*** (0.112)	-0.349** (0.161)	-0.335** (0.137)	-0.296** (0.126)	-0.332** (0.143)	-0.333** (0.135)	-0.336*** (0.110)	-0.307* (0.165)
$Foreign_{it-1}$	-0.549*** (0.086)	-0.513*** (0.104)	-0.520*** (0.123)	-0.572*** (0.094)	-0.531*** (0.104)	-0.542*** (0.133)	-0.523*** (0.107)	-0.493*** (0.097)	-0.564*** (0.141)
$Foreign_{it-2}$		-0.100 (0.087)	-0.369*** (0.121)		-0.087 (0.070)	-0.382*** (0.133)		-0.090 (0.079)	-0.347** (0.147)
$Foreign_{it-3}$			-0.120 (0.087)			-0.098 (0.079)			-0.095 (0.113)
$All_{it}$	0.160** (0.076)	0.183** (0.079)	0.179** (0.089)	0.154** (0.071)	0.203*** (0.077)	0.201** (0.090)	0.217** (0.104)	0.235*** (0.085)	0.291** (0.120)
$All_{it-1}$	0.328*** (0.084)	0.199*** (0.071)	0.157* (0.087)	0.349*** (0.073)	0.186** (0.073)	0.147* (0.087)	0.309*** (0.103)	0.192*** (0.074)	0.118 (0.108)
$All_{it-2}$		0.413*** (0.077)	0.314*** (0.079)		0.414*** (0.067)	0.309*** (0.091)		0.384*** (0.090)	0.328*** (0.110)
$All_{it-3}$			0.361*** (0.098)			0.375*** (0.090)			0.450*** (0.119)
$Conc_{it}$	0.001 (0.004)	0.001 (0.005)	0.002 (0.006)	0.001 (0.004)	0.000 (0.005)	0.002 (0.005)	0.003 (0.006)	0.003 (0.006)	0.007 (0.006)
$\log(mes_{it})$	0.684 (0.732)	0.750 (0.754)	1.442 (0.883)	0.732 (0.671)	0.726 (0.722)	1.428* (0.830)	0.378 (0.812)	0.427 (1.109)	1.269 (1.072)
Constant	6.024 (7.384)	6.508 (7.336)	10.700 (9.188)	7.647 (7.003)	9.982 (7.266)	12.610 (8.326)	15.220* (8.281)	15.520 (10.980)	22.180** (10.310)
# of obs	103,898	103,898	87,554	103,898	103,898	87,554	75,509	75,509	63,741
# of firms	20,679	20,679	19,835	20,679	20,679	19,835	11,771	11,771	11,558
Sector & Year	Yes								
Bootstrap	100	100	100	100	100	100	100	100	100

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

(a) We introduce intra-individual means of variables as regressors to control for a possible correlation between co-variables and unobserved individual heterogeneity, following the methodology proposed by Mundlak (1978).

Table 1.2: Probability of being involved in a legal procedure in the next 3 years

the shadow of death literature (Griliches and Regev, 1995, Kiyota and Takizawa, 2007, Blanchard et al., 2014). Indeed, when a firm is become less and less efficient compared to its competitors, it will lose market shares and will be unable to stay profitable. This situation generally ends-up with an exit of firms. Moreover, it verify our first impression from our descriptive statistics that exiters are less efficient than incumbents.

#### **1.5.2.2 Firms' sunk costs and default**

According to our results, we find that the two types of sunk costs, export ones and domestic ones, are positively correlated with default event. According to the theoretical literature, sunk costs prevent exit because they cannot be refunded if the firm leaves the market. However, here, sunk costs do not seem to act as a barrier to exit. One explanation is that the inertia of export activity can be defined as an opportunity cost of leaving a market. Since firms invest in these foreign markets, they do not want to lose potential opportunities to sell their products. Doing so will shrink firms' potential market size. This phenomenon should be heightened when exports are the firms' main source of revenue. The proportion of illiquid assets will be too high for firms in distress. Just before they become involved in a collective procedure, their assets cannot be converted into liquid assets, causing a default of payment. However, by doing so, they ignore the signal that their situation is precarious, and they should stop invest more and more in those illiquid assets. This is an irrational behavior from the manager, hence pointing towards the sunk costs fallacy explanation.

The important portion of assets invested in sunk costs leads to another issue: the illiquidity of assets invested. When a firm is not in good shape, it wants to convert its assets in cash to meet the due dates of receivables. However, if the amount of sunk costs is too high, the firm may be trapped in an illiquidity situation, where it cannot reimburse its creditors within 45 days. After this due date, the legal pro-

cedure is triggered, either by a creditor, a prosecutor, or the court itself. It is not the decision of the firm's leadership. This explanation seems robust since the sunk costs related to the domestic market have the same effect on the default probability: the estimated coefficients are either positive and significant or non-significant. Therefore, sunk costs do not act as a barrier to exit but raise the difficulty of the firm's survival. This result can also be viewed as confirmation of the sunk cost fallacy hypothesis.<sup>13</sup>

A last plausible explanation is the real option model. It is generally assumed that the more a firm invests, the more it tries to be profitable, but if it does not succeed as expected, the firm will invest more in those sunk costs. However, if the head of the firm bases its decisions on rational behavior, it should stop spending to avoid losing more money. Moreover, as O'Brien and Folta (2009) note, the sunk cost fallacy is based on the assumption that people are not able to make decisions in their own best interest. In an incomplete information economic environment, where we only know the potential outcomes and not the real outcomes, agents have to decide based on bounded rationality. Hence, we can accept this assumption, but we need to test it to make sure it is not a rational decision. About the past exporter status, we do not find evidence of a significant impact of past exporter status on the probability of being involved in a collective procedure. Weak exporter heterogeneity may explain this finding: more than half of firms are continuous exporters. A way to address this limitation is to focus only on continuous exporting firms. In columns (7) to (9) of Table 1.2, we find the same effects for all the variables; we can then accept the robustness of this result: past export status does not have any significant effect on default.

Regarding the standard control variables, we find that the group affiliation has a significant impact on firms' default. When firms are affiliated with a group, it raises the likelihood of default. However, being part of an international group lowers the

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<sup>13</sup>However, because we focus only on the variables that cause entry into in a collective procedure and not what happens afterwards, we cannot draw conclusions regarding the cause of this reduction of export sunk costs.

Variables	European Union countries			OECD countries								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Number of destinations			Share of destinations			Number of destinations			Share of destinations		
$tf_{it}$	-0.183*** (0.032)	-0.186*** (0.030)	-0.139*** (0.040)	-0.184*** (0.032)	-0.182*** (0.031)	-0.142*** (0.042)	-0.184*** (0.033)	-0.187*** (0.038)	-0.141*** (0.043)	-0.179*** (0.028)	-0.180*** (0.029)	-0.142*** (0.045)
$tf_{it-1}$	-0.073** (0.028)	-0.079*** (0.028)	-0.101** (0.040)	-0.072** (0.033)	-0.076*** (0.025)	-0.103*** (0.038)	-0.074*** (0.025)	-0.081*** (0.029)	-0.105** (0.043)	-0.070** (0.031)	-0.075*** (0.029)	-0.103*** (0.038)
$tf_{it-2}$		0.009 (0.029)	0.025 (0.035)		0.011 (0.030)			0.008 (0.033)	0.023 (0.036)		0.011 (0.028)	0.026 (0.038)
$tf_{it-3}$			0.044 (0.042)			0.044 (0.039)			0.043 (0.033)		0.044 (0.028)	0.044 (0.051)
Sunk costs:												
$Export_{it}$	0.116*** (0.032)	0.114*** (0.031)	0.121*** (0.034)	0.118*** (0.028)	0.113*** (0.027)	0.120*** (0.037)	0.117*** (0.034)	0.115*** (0.026)	0.121*** (0.030)	0.118*** (0.030)	0.115*** (0.028)	0.121*** (0.034)
$Export_{it-1}$	0.035** (0.015)	0.020 (0.015)	0.096*** (0.036)	0.036*** (0.018)	0.021 (0.014)	0.093** (0.040)	0.036*** (0.014)	0.020 (0.020)	0.094** (0.039)	0.036** (0.017)	0.021* (0.012)	0.093*** (0.032)
$Export_{it-2}$		0.028* (0.016)	0.032* (0.018)		0.029** (0.013)	0.031** (0.016)		0.029* (0.016)	0.032* (0.019)		0.029* (0.018)	0.031* (0.017)
$Export_{it-3}$			-0.001 (0.014)			-0.003 (0.019)			-0.002 (0.016)			-0.003 (0.015)
$Domestic_{it}$	0.143*** (0.042)	0.137*** (0.046)	0.119*** (0.046)	0.149*** (0.035)	0.141*** (0.043)	0.126** (0.056)	0.142*** (0.041)	0.137*** (0.037)	0.119** (0.047)	0.145*** (0.039)	0.138*** (0.039)	0.125*** (0.043)
$Domestic_{it-1}$	0.019 (0.032)	0.025 (0.036)	0.088** (0.040)	0.023 (0.039)	0.029 (0.032)	0.093** (0.046)	0.019 (0.037)	0.024 (0.026)	0.088* (0.050)	0.022 (0.039)	0.027 (0.043)	0.092* (0.047)
$Domestic_{it-2}$		-0.051* (0.026)	-0.060* (0.032)		-0.045 (0.031)	-0.057* (0.030)		-0.053 (0.033)	-0.062** (0.029)		-0.046 (0.031)	-0.058 (0.036)
$Domestic_{it-3}$			-0.019 (0.037)			-0.015 (0.033)			-0.022 (0.037)			-0.015 (0.035)
Destination countries:												
$Inside EU/OECD_{it}$	0.020* (0.012)	0.021* (0.011)	0.012 (0.012)	0.124 (0.134)	0.119 (0.118)	0.038 (0.156)	0.083** (0.037)	0.086** (0.039)	0.084 (0.054)	0.413 (0.280)	0.420 (0.259)	0.196 (0.336)
$Inside EU/OECD_{it-1}$	0.012 (0.010)	0.009 (0.008)	0.010 (0.012)	-0.146 (0.136)	-0.114 (0.100)	-0.013 (0.119)	0.024 (0.034)	0.019 (0.039)	0.032 (0.035)	0.051 (0.283)	0.057 (0.258)	0.057 (0.293)
$Inside EU/OECD_{it-2}$		0.009 (0.009)	0.007 (0.010)		-0.040 (0.098)	0.003 (0.104)		0.012 (0.038)	-0.012 (0.043)		0.113 (0.246)	0.045 (0.216)
$Inside EU/OECD_{it-3}$			0.010 (0.010)			-0.224* (0.118)			0.004 (0.044)			-0.215 (0.290)
$Outside EU/OECD_{it}$	0.015 (0.010)	0.015 (0.013)	0.015 (0.012)	0.015 (0.012)	0.015 (0.007)	0.015 (0.009)	0.009 (0.008)	0.009 (0.007)	0.006 (0.009)	0.006 (0.009)	0.006 (0.009)	0.006 (0.009)
$Outside EU/OECD_{it-1}$	0.006 (0.005)	0.002 (0.004)	-0.002 (0.005)	-0.002 (0.005)	0.015* (0.008)	0.015* (0.008)	0.015* (0.008)	0.009 (0.007)	0.007 (0.008)	0.007 (0.008)	0.009 (0.008)	0.007 (0.008)
$Outside EU/OECD_{it-2}$		0.005 (0.003)	-0.003 (0.004)		0.013* (0.008)	0.013* (0.008)		0.013* (0.008)	0.008 (0.008)		0.013* (0.008)	0.008 (0.008)
$Outside EU/OECD_{it-3}$			0.014*** (0.004)			0.018** (0.009)			0.018** (0.009)			0.018** (0.009)
# of obs	75,509	75,509	63,741	75,509	75,509	63,741	75,509	75,509	63,741	75,509	75,509	63,741
# of firms	11,771	11,771	11,558	11,771	11,771	11,558	11,771	11,771	11,558	11,771	11,771	11,558
Sector & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bootstrap	100	100	100	100	100	100	100	100	100	100	100	100

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.3: Probability of being involved in a legal procedure in the next 3 years – Effect of easy destinations – Continuous exporters only

probability of being in default, and it is highly significant. This finding is counter-intuitive when we consider the "footloose" literature (see, among others, Mata and Portugal, 2002, Bernard and Sjöholm, 2003, Görg and Strobl, 2003, Alvarez and Görg, 2009). Multinational firms should have a higher probability of exiting than domestic firms. However, because we are considering a rather particular subsample, exporters, it is only logical to not have the same conclusions as studies that consider all firms. Globally, because the Herfindahl's concentration index ( $Conc_{it}$ ) and the log ( $mes_{it}$ ) are insignificant, sectoral determinants seems to be not crucial.

Turning to the export variables, we test whether or not the export history over the past three years plays a role. To do so, we introduce a binary variable *Exporter* which is equal to one if the given firm export in the previous year considered, and zero otherwise. It allows us to seek for a shadow of death in the export activity, which corresponds to a progressive withdrawal as the default is imminent. However, we do not find any significant impact on the default probability, meaning that there is not major change in the export activity that can be related to the probability of defaulting. This can be explained by the existence of sunk costs linked to the export activity.

### 1.5.2.3 Sunk costs fallacy or real options model

In Table 1.3 we estimate models with the number of destination and the share of destinations according to the difficulty of the market, which help us to illustrate how firms deal with risk, as in real options models. In the column (1) to (6), the destination considered is the European Union, since it is easier to access the market of countries inside the Single Market. In the column (7) to (12), we took the OECD membership as an easy market, because countries part of OECD are more similar in term of economic development than the other countries and can be seen as a robustness check. Overall, we do not find a decrease in exports to

“more difficult markets”.<sup>14</sup>. Nevertheless, the heterogeneity of economic activities and opportunities within EU countries can be too large to consider all of them as easy markets. When considering the OECD destination, i.e. columns (7) to (12), only the number of destinations at the time of default has a positive impact on the default probability, thus we can consider our findings robust.

Considering that only the number of destination estimations in  $t$  is significant, our findings seem to be in line with the predictions of real options model theory. As O’Brien and Folta (2009) notes, the inertia we find here can be logically explained, especially when sunk costs are high. When facing great uncertainty and a high amount of sunk costs, poorly performing firms will not exit the market. Since exiting the market means losing the stock of the wide variety of sunk costs, such as “strategic asset stocks”, and knowledge, steadily accumulated through the company’s exporting history. Thus, exiting and re-entering the market when the economic environment is more favorable also means losing competitiveness compared to the pre-exit situation, even if the firm does not perform well (Dierickx and Cool, 1989, O’Brien and Folta, 2009). For this reason, firms will stay in an inaction zone, hoping for better times. It can be mistaken with the sunk costs fallacy, but with our results and the difference in exports towards difficult destinations before and after the procedure is triggered (Table A.4.1), it seems that the incompleteness of information, and thus the range of possible outcomes, is important enough for those firms to stay in a supposedly more difficult and risky business. However, we the significant impact of the number of destination in  $t$  point towards an exit from the inaction zone to refocus the efforts on easier markets. This description seems to be in line with the first explanation of the positive relation between the default and export sunk costs: the inertia of export activity. However, when the firm is in default, the manager does not make decisions anymore. An administrator nominated by the court now owns the decision power to save the company. The administrator needs to improve the firm’s situation as quickly as possible. For these reasons, it

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<sup>14</sup>Control variables are not displayed here but are similar to those in the primary model shown in Table 1.2

is logical to reduce the number of markets to which the firm exports in order to focus on the company's historical export market, as shown in Appendix A.4. We observe a similar phenomenon for the amount of sunk costs after the triggering of the procedure (Figure 1.2 and Table A.5.1).

In Table 1.3, the signs and significance of our productivity index and the sunk costs linked to the export market and domestic market coefficients do not change compared to Table 1.2. We still find a positive correlation between firms' default probability and their level of sunk costs and a negative correlation with their productivity. Therefore, the slight decrease in destinations when a firm is, or will be, in default, as seen in Section 1.5.1, does not seem to hold when we take into account multiple factors, such as productivity or sunk costs.<sup>15</sup>

However, only modeling the probability of default in the next 3 years do not allow us to really detect the existence of the inaction zone. To be sure that it is either the sunk cost fallacy, the real options model or a mix of them, we have to rely on the the probability of entering into a collective proceeding. The results displayed in Table 1.4 show that the results are mixed. At first, there is a significant and positive impact on the probability of defaulting the years before the entry into a procedure of the sunk costs linked to the export activity. In the year of the default, this effect is globally insignificant. These results point toward a sequential effect: i) at first firms invest more than their non-defaulting counterparts and are in trapped a sunk costs fallacy; ii) then the firm knowing it will become defaulting are cutting the losses, entering in an inaction zone. This result might reflect the will of the firm to not lose the investment made to establish themselves into the foreign market. But, by doing so, they keep having a consistently higher level of sunk costs linked to the export activity than the others, which rises the amount of illiquid assets they have. This, in turn, increases the likelihood that these companies will exit the market.

These results are also confirmed in the regressions with the destination coun-

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<sup>15</sup>We also try to assess the dynamics of products exported, but the models estimated do not seem conclusive.

Variables <sup>(a)</sup>	(1)	(2)	(3)	All	(4)	(5)	(6)	(7)	(8)	(9)
									Incumbent exporters	
$tfp_{it}$	0.011 (0.019)	0.010 (0.020)	0.038* (0.021)	0.004 (0.020)	0.004 (0.022)	0.030 (0.020)	0.013 (0.026)	0.013 (0.025)	0.050* (0.026)	
$tfp_{it-1}$	-0.121*** (0.018)	-0.113*** (0.024)	-0.108*** (0.020)	-0.119*** (0.019)	-0.113*** (0.022)	-0.110*** (0.020)	-0.134*** (0.026)	-0.126*** (0.027)	-0.135*** (0.030)	
$tfp_{it-2}$		-0.011 (0.018)	0.008 (0.022)		-0.004 (0.020)	0.012 (0.020)		-0.002 (0.027)	0.026 (0.024)	
$tfp_{it-3}$			0.055*** (0.020)			0.061*** (0.023)			0.042* (0.023)	
Sunk costs:										
$Export_{it}$	0.002 (0.018)	0.008 (0.017)	-0.004 (0.019)	-0.021 (0.016)	-0.017 (0.014)	-0.026* (0.015)	0.028 (0.021)	0.037* (0.022)	-0.013 (0.023)	
$Export_{it-1}$	0.064*** (0.011)	0.048*** (0.010)	0.078*** (0.015)	0.046*** (0.007)	0.034*** (0.008)	0.045*** (0.010)	0.079*** (0.011)	0.053*** (0.016)	0.153*** (0.030)	
$Export_{it-2}$		0.041*** (0.008)	0.020** (0.009)		0.034*** (0.008)	0.018** (0.009)		0.051*** (0.013)	0.023* (0.013)	
$Export_{it-3}$			0.042*** (0.008)			0.028*** (0.007)			0.047*** (0.012)	
$Domestic_{it}$	-0.040 (0.025)	-0.041 (0.026)	-0.065*** (0.025)	-0.030 (0.027)	-0.032 (0.028)	-0.054** (0.025)	-0.039 (0.032)	-0.039 (0.031)	-0.084** (0.034)	
$Domestic_{it-1}$	0.143*** (0.029)	0.129*** (0.040)	0.147*** (0.032)	0.142*** (0.030)	0.131*** (0.035)	0.151*** (0.031)	0.163*** (0.039)	0.150*** (0.043)	0.187*** (0.042)	
$Domestic_{it-2}$		0.009 (0.026)	0.002 (0.026)		-0.002 (0.026)	-0.005 (0.025)		0.006 (0.035)	-0.014 (0.030)	
$Domestic_{it-3}$			-0.032 (0.021)			-0.039 (0.026)			-0.034 (0.024)	
$Exporter_{it-1}$	-0.400*** (0.079)	-0.347*** (0.075)	-0.484*** (0.100)							
$Exporter_{it-2}$		-0.169*** (0.060)	-0.130* (0.068)							
$Exporter_{it-3}$			-0.274*** (0.070)							
Group:										
$Foreign_{it}$	-0.253** (0.114)	-0.243** (0.117)	-0.272** (0.113)	-0.284** (0.110)	-0.276** (0.115)	-0.301** (0.128)	-0.276** (0.131)	-0.265** (0.125)	-0.294** (0.149)	
$Foreign_{it-1}$	-0.722*** (0.117)	-0.639*** (0.121)	-0.626*** (0.129)	-0.749*** (0.095)	-0.665*** (0.113)	-0.646*** (0.123)	-0.680*** (0.095)	-0.577*** (0.114)	-0.589*** (0.165)	
$Foreign_{it-2}$		-0.129* (0.071)	-0.207* (0.107)		-0.134* (0.069)	-0.221** (0.111)		-0.184** (0.077)	-0.211 (0.129)	
$Foreign_{it-3}$			-0.155** (0.066)			-0.164*** (0.062)			-0.142* (0.073)	
$All_{it}$	-0.297*** (0.074)	-0.241*** (0.079)	-0.183** (0.084)	-0.326*** (0.081)	-0.269*** (0.071)	-0.212*** (0.080)	-0.301*** (0.095)	-0.234*** (0.080)	-0.180* (0.105)	
$All_{it-1}$	0.550*** (0.091)	0.328*** (0.106)	0.348*** (0.105)	0.592*** (0.100)	0.361*** (0.099)	0.383*** (0.121)	0.489*** (0.077)	0.239** (0.109)	0.258** (0.107)	
$All_{it-2}$		0.526*** (0.077)	0.418*** (0.098)		0.558*** (0.091)	0.442*** (0.094)		0.600*** (0.086)	0.499*** (0.095)	
$All_{it-3}$			0.256*** (0.065)			0.286*** (0.082)			0.252** (0.098)	
$Conc_{it}$	-0.001 (0.004)	-0.001 (0.004)	0.001 (0.004)	-0.001 (0.004)	-0.001 (0.003)	0.001 (0.004)	0.002 (0.003)	0.002 (0.004)	0.005 (0.004)	
$\log(mes_{it})$	-0.209 (0.476)	-0.103 (0.427)	0.376 (0.540)	-0.228 (0.425)	-0.157 (0.378)	0.301 (0.476)	-0.425 (0.509)	-0.275 (0.499)	0.404 (0.514)	
Constant	-4.527 (4.290)	-3.687 (3.888)	-0.281 (4.918)	-4.421 (3.873)	-3.840 (3.593)	-0.582 (4.290)	-4.828 (4.781)	-3.754 (4.330)	1.118 (4.858)	
# of obs	103,872	103,872	87,554	103,872	103,872	87,554	75,509	75,509	63,741	
# of firms	20,673	20,673	19,835	20,673	20,673	19,835	11,771	11,771	11,558	
Sector & Year	Yes									
Bootstrap	100	100	100	100	100	100	100	100	100	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.4: Probability of being involved in a legal procedure

(a) We introduce intra-individual means of variables as regressors to control for a possible correlation between co-variables and unobserved individual heterogeneity, following the methodology proposed by Mundlak (1978).

tries as shown in Table 1.5. However, concerning the impact of the destination, we see some changes. First, the impact of the number of product shipped on the default is positive or non-significant for the previous years, while at the time  $t$ , there is a negative impact on the bankruptcy likelihood. Moreover, when taking into consideration the share of inside EU destination countries, the negative effect

Variables	European Union countries											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Number of destinations						Share of destinations					
tf <sub>it</sub>	0.013 (0.027)	0.012 (0.026)	0.050* (0.028)	0.011 (0.024)	0.011 (0.024)	0.048* (0.026)	0.012 (0.026)	0.010 (0.024)	0.047* (0.025)	0.013 (0.025)	0.014 (0.023)	0.051* (0.028)
tfP <sub>it-1</sub>	-0.136*** (0.029)	-0.127*** (0.032)	-0.136*** (0.024)	-0.135*** (0.029)	-0.127*** (0.025)	-0.135*** (0.025)	-0.136*** (0.022)	-0.126*** (0.029)	-0.135*** (0.024)	-0.136*** (0.027)	-0.129*** (0.028)	-0.137*** (0.026)
tfP <sub>it-2</sub>		-0.003 (0.024)	0.025 (0.023)		-0.003 (0.022)	0.025 (0.023)		-0.003 (0.028)	0.024 (0.022)	0.027 (0.027)	-0.002 (0.027)	0.027 (0.023)
tfP <sub>it-3</sub>			0.043* (0.023)			0.041* (0.023)			0.042* (0.025)		0.042* (0.025)	0.042* (0.025)
Sunk costs:												
Export <sub>it</sub>	0.027 (0.019)	0.037* (0.022)	-0.011 (0.025)	0.025 (0.019)	0.034* (0.021)	-0.014 (0.027)	0.028 (0.019)	0.038* (0.022)	-0.010 (0.026)	0.025 (0.022)	0.034 (0.023)	-0.016 (0.022)
Export <sub>it-1</sub>	0.079*** (0.014)	0.054*** (0.014)	0.151*** (0.029)	0.077*** (0.017)	0.052*** (0.011)	0.147*** (0.033)	0.078*** (0.013)	0.053*** (0.014)	0.151*** (0.029)	0.078*** (0.012)	0.053*** (0.014)	0.152*** (0.027)
Export <sub>it-2</sub>		0.050*** (0.010)	0.022** (0.011)		0.050*** (0.009)	0.023** (0.012)		0.049*** (0.009)	0.022 (0.014)	0.022 (0.013)	0.051*** (0.011)	0.022* (0.013)
Export <sub>it-3</sub>			0.046*** (0.014)			0.045*** (0.010)			0.045*** (0.012)		0.045*** (0.012)	0.047*** (0.012)
Domestic <sub>it</sub>	-0.038 (0.037)	-0.039 (0.039)	-0.082*** (0.030)	-0.038 (0.035)	-0.039 (0.032)	-0.081** (0.033)	-0.038 (0.034)	-0.038 (0.034)	-0.080** (0.033)	-0.039 (0.033)	-0.040 (0.031)	-0.083** (0.035)
Domestic <sub>it-1</sub>	0.162*** (0.044)	0.152*** (0.048)	0.190*** (0.034)	0.164*** (0.042)	0.150*** (0.038)	0.185*** (0.041)	0.162*** (0.035)	0.148*** (0.044)	0.185*** (0.038)	0.166*** (0.042)	0.154*** (0.041)	0.189*** (0.038)
Domestic <sub>it-2</sub>		0.007 (0.037)	-0.011 (0.030)		0.008 (0.031)	-0.011 (0.031)		0.004 (0.042)	-0.013 (0.031)	0.006 (0.035)	0.006 (0.035)	-0.014 (0.027)
Domestic <sub>it-3</sub>			-0.035 (0.023)			-0.033 (0.022)			-0.036* (0.020)			-0.034 (0.026)
Destination countries:												
Inside EU/OECD <sub>it</sub>	-0.042*** (0.011)	-0.036*** (0.009)	-0.043*** (0.009)	-0.335*** (0.109)	-0.310*** (0.099)	-0.437*** (0.109)	-0.035 (0.032)	-0.027 (0.033)	-0.040 (0.034)	-0.164 (0.258)	-0.133 (0.234)	-0.335 (0.287)
Inside EU/OECD <sub>it-1</sub>	0.039*** (0.007)	0.023** (0.011)	0.021** (0.011)	-0.132 (0.090)	-0.129 (0.120)	0.088** (0.105)	0.079** (0.038)	0.063** (0.026)	0.079** (0.040)	0.158 (0.227)	0.107 (0.232)	0.043 (0.259)
Inside EU/OECD <sub>it-2</sub>		0.026*** (0.009)	0.023** (0.011)		0.024 (0.082)	0.073 (0.102)		0.059* (0.032)	0.055 (0.041)	0.254 (0.189)	0.239 (0.189)	0.225 (0.225)
Inside EU/OECD <sub>it-3</sub>			-0.001 (0.009)			-0.145 (0.111)		0.020 (0.036)	0.020 (0.036)			-0.232 (0.229)
Outside EU/OECD <sub>it</sub>	-0.010 (0.009)	-0.011 (0.009)	-0.020** (0.009)				-0.029*** (0.007)	-0.026*** (0.007)	-0.029*** (0.008)			
Outside EU/OECD <sub>it-1</sub>		0.003*** (0.001)	-0.003 (0.004)				0.029*** (0.005)	0.012** (0.006)	0.007 (0.009)			
Outside EU/OECD <sub>it-2</sub>		0.005 (0.004)	0.007* (0.005)					0.023*** (0.005)	0.016** (0.007)			
Outside EU/OECD <sub>it-3</sub>			0.001 (0.005)					0.007 (0.005)	0.007 (0.005)			
# of obs	75,509	75,509	63,741	75,509	75,509	63,741	75,509	75,509	63,741	75,447	75,424	63,659
# of firms	11,771	11,771	11,558	11,771	11,771	11,558	11,771	11,771	11,558	11,769	11,766	11,548
Sector & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bootstrap	100	100	100	100	100	100	100	100	100	100	100	100

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.5: Probability of being involved in a legal procedure – Effect of easy destination countries – Continuous exporters only

is also significant in  $t$ , but not in the previous years. Considering OECD destination countries, there is no significant impact of the share of OECD destination countries on the probability of going bankrupt compare to the share of non-OECD countries. While the result is identical for the number of products shipped to OECD countries, shipping product to non-OECD destination countries rise significantly bankruptcy event likelihood in the previous years, but significantly lower it in the year of default. It can result from the fact that firms that can sustain higher number of product in the date of potential bankruptcy event, have the ability to sustain such high sunk costs. Nonetheless, it does not seem to reflect a difference in the share of the destinations between bankrupt firms and non-bankrupt ones.

## 1.6 Conclusion

In this paper, we have identified that a representative portion of French exporters are in insolvency proceedings. This is a paradox, as it is well documented in the literature that only high-performing firms export. Higher economic performance allows firms to sustain additional costs, including sunk costs linked to export activity. As export sunk costs are at the core of this analysis, we propose an original approach based on a matching method to identify these sunk costs. Firm performance is measured through firms' total factor productivity, which is obtained from the estimate of production function by industry.

Furthermore, control for selection bias due to the lack of control for firm heterogeneity in gravity equations, as Helpman et al. (2008) do, is not enough. From the model developed by Melitz (2003) there is a cut-off point from which the firms are efficient enough to export. It exists a cut-off point, where the firms are efficient enough to export (extensive margin). Moreover, due to higher transport costs, the farthest the destination is, the higher the cut-off point is and more efficient the firms need to be (intensive margin). However, our results suggest that the mechanisms at work are more complex.

From our findings, we can conclude that if the economic performance of the firm is essential for its survival, the larger the sunk costs are, *ceteris paribus*, the higher the probability of default is. When we take into account the performance and the control variables, sunk costs do not prevent exit; instead, they tend to accelerate it. In addition, when firms are at the precipice of becoming involved in an insolvency procedure, they do not tend to reduce the number of export destinations until it is already too late to do so. Therefore, due to the high uncertainty of export activity, they are in an inaction zone, as the real options model predicts. Our contribution is the addition of the accountancy-based decision to enter into an insolvency procedure. Because the firm's economic decisions are no longer made by the firm but by the court and its advisors, they are no longer relevant.

Export decisions contain many risks, and firms may be interested in insuring their exports. This insurance prevents them from suffering from unexpected exogenous events that jeopardize their survival. However, insuring low-performing firms will raise the overall risk and thus the amount all firms will have to pay to be covered. This higher amount will raise the cost of exporting and weaken firms that would have been well managed enough to continue their activity. In addition, since the investment in sunk costs is too illiquid, it can induce a misallocation issue. As Foster et al. (2001) note, exit has a significant role in reallocation. Since exporters have higher sunk costs than domestic firms, they can hinder the market's selection process, even if some exporters are involved in a collective procedure.

However, our paper has limitations. For example, we discriminate the sunk costs considering only two markets: domestic and export markets. We do not discriminate among export markets. Moreover, we do not distinguish the products that firms export. Some products may face fiercer competition than others. Moreover, an analysis of the interaction between the product and the destination country can improve our understanding of firms' behaviors within the international competition context. However, since we focus our study on firm-level data, this approach was outside the scope of this study; however, it could be developed in future work.

## **Chapter 2**

# **R&D expenditures and firm survival**

## 2.1 Introduction

Innovation drives firm survival as long as innovation output is positively correlated with firm performances. However, R&D investments are costly, highly illiquid and high-risk activities since the outcome is uncertain, particularly when the firm operates in a competitive environment. Two cases are possible: i) the outcome path is successful and the investment was worth it because it allows the firm to maintain its competitiveness on the market; ii) the outcome path is unsuccessful giving rise to financial difficulties (particularly when it is repeated) and to the weakening of its position on the market. The example of the Covid-19 vaccine race demonstrates both the crucial step for firms which compete in this sector and the risk of innovative activities. In France, 6.5% of firms surveyed for their R&D activities are involved in a collective procedure, while in the population of French firms, only 1.5% of firms are involved in such procedures.

Different measures of innovation are proposed in the literature as patents or shares of innovative sales (Crépon et al., 1998, Alam et al., 2022), which represent the outputs of innovation or R&D investments which are the inputs of innovation. Indicators based on patents are constrained by the winner bias, the patent filing and its maintenance. Some firms may stop protecting its patents because of a negative costs-benefits balance. Note that it may be a part of the strategy of the firm not to deposit a patent to avoid drawing the attention of its competitor, and to choose to keep it as an industrial secret. Based on Chinese data, Chen et al. (2022) bring to light that the number of patents is directly related to R&D expenditure disclosures but the latter may be under-estimated in case of insufficient institutional protection and high market competition. To avoid this measurement issue, we predict the R&D expenditures to measure innovation at the firm-level. This indicator has the advantage to be available for larger samples, with a panel dimension.

To understand why firms in distress may take the decision to do (or to continue)

innovation investment, we have to refer to the well-known strand of the literature on firm dynamics that is the passive and active learning models. While in the passive learning model developed by Jovanovic (1982), firms base their decision on their inner efficiency, in the active learning model developed by Ericson and Pakes (1995), they base it on the dynamic of their efficiency. This dynamic of efficiency is fueled by innovation, through R&D expenditures. The empirical literature has highlighted the importance of innovations in the performance of firms. Some of the studies highlight the productivity-innovation relationship using productivity level (Crépon et al., 1998, Janz et al., 2003, Mairesse and Jaumandreu, 2005), while other studies focus on productivity growth (Geroski, 1989, Huergo and Jaumandreu, 2004, Duguet, 2006). All these papers conclude that there is a positive relationship between productivity and innovation, which is robust to the period and the country considered. These findings are consistent with the prediction of Ericson and Pakes (1995). The more successful innovations firms make, the more they improve their productivity levels, allowing them to continue to be competitive and to stay on the market.

However, results are mixed in the literature about the relationship between innovation and survival of firms (see in particular Fernandes and Paunov, 2015, Ugur et al., 2016). As a result of the uncertainty this activity yields, the R&D investment can lead to a less efficient outcome than the competitors' ones. Moreover, since innovation is a risky investment, in case of consecutive unsuccessful outcomes, firms may lose competitiveness and become unable to continue their activities to some extent. Nonetheless, because innovations can also improve firms' productivity, R&D may prevent exit by allowing firms to stay competitive. In this case, it can be seen as a way for firms to diversify the products they sell, thus decreasing the risk.

The aim of this paper is to investigate the relationship between firms' R&D investments, performances, and their survival. Our goal is to determine whether the firms' R&D intensity protect the firms from defaulting, or if it leads to accelerate its downfall. We contribute to the literature on firm survival and R&D investment

since no consensus emerges from prior studies. From a methodological aspect, we propose an empirical strategy that allows us to tackle multiple issues. First, we do not consider all types of exits (mergers and acquisitions and voluntary exits are excluded), meaning that we only consider firms in accurate financial distress. Second, we use selection models to predict the investment in R&D. Since all firms do not declare their innovation expenditures and the process is not a random one, we take this selection bias into account, following the works which examine the impacts of indirect R&D such as “*Crédit d’Impôt Recherche*” (see among others Ben Has-sine et al., 2020). Being well-known that innovation and firms’ inner efficiency are tightly entangled, we assess innovation’s net firms’ performance. Lastly, we use a survival analysis with the panel dimension of the data and introduce a term to tackle unobserved heterogeneity. This more comprehensive approach enables to grasp the real firm-level effect of both innovative activities and inner efficiency.

Our results suggest that R&D intensity has a U-shaped relationship with survival, indicating that the firm survival increases from a certain level of R&D investments. According to our estimates this threshold is large and reachable only by few firms that massively invest in these risky activities. We also find a strong and positive effect of firms efficiency net of innovation activities on their survival. However, contrary to our expectations, we find a negative correlation between firms’ efficiency, which is net of R&D expenditures, and innovation investment, pointing towards the need for efficient firms to invest more than their lesser efficient counterpart. Finally, we find that the impact of both innovation investments and inner efficiency net of innovation activities on firms’ survival differs greatly depending on the technological level of the industry they belong to.

This paper is organized as follows. First, we review the literature on the relationship between R&D investment and firm survival in Section 2.2. We describe the databases we use and our empirical strategy in Section 2.3. Then, in Section 2.4 we present some descriptive statistics and our results. Section 2.5 concludes.

## **2.2 Relationship between R&D expenditure and survival**

Our paper relies on three nexus which link R&D investment (and more widely innovation), firm performances and firm survival. We will review each of them.

### **2.2.1 Innovation and firms' performances**

The empirical literature about innovative firms is rich, and the main consistent empirical evidence may be summarized in the paper of Klette and Kortum (2004). To sum up their stylized facts, R&D expenditures input of innovation intensity (defined as the ratio of R&D expenditures over sales) is independent of firm size, highly skewed and their differences are persistent. The R&D expenditures follow a geometric random walk, meaning that, there is little change over short-time period in firms R&D investments.

One main contribution of innovative activities' studies is the CDM method (Crépon et al., 1998), which tackles both selection bias and simultaneity issues of innovative investments and their outputs, like patents for example. As documented by Broström and Karlsson (2017), many studies use their methodology to treat the selection bias. Those papers focus on the intensive margins, meaning that they primarily focus on the impact of innovations' outputs on productivity rather than on the investments required to innovate. However, as a counterexample, Arqué-Castells and Mohnen (2015) use the CDM framework on Spain data to assess how public subsidies, as a mean to smooth the sunk costs due to entering and continuing innovative activities, act on the incentive firms have to invest on R&D afterwards. They find that the firms are willing to invest when the subsidies are large enough to start these activities and then pursue them. However, these papers only analyze what happens for incumbents firms (intensive margin) without considering the possibility of bankruptcy (market exit) by R&D firms.

Another strand of the literature focus on the determinants of firms performances. Among them, there are the expenditures in R&D. The total productivity of factors (TFP) which measures firm efficiency is based on quality of inputs, experience, managerial abilities, the environment in which the firm operates (*external factors* and the buyer-supplier relationships as in Bernard et al., 2019), information technology uses in addition to R&D investments.<sup>1</sup> With regard to our question of interest, in Doraszelski and Jaumandreu (2013) the path of firm productivity results from R&D expenditures even if the outcomes are uncertain. Another channel is through product innovation: R&D investments can lead to higher product quality improving firm performances (see among others Bartel et al., 2007).

In the same line, Aw et al. (2008) show that exporters are more likely to do R&D since the potential gains of productivity can be spread across more markets. Based on Taiwanese firm-level data, their results indicate that R&D heightens firm productivity and thus increases the profits of exporting which finally increases also the return to R&D expenditures. In addition, export and R&D activities are complement according to Aw et al. (2005). The combination of both decisions enhances firm productivity because of technology transfers from foreign customers. Note that Liu and Qiu (2016) show that the innovation decision of a firm negatively depends on importing intermediate inputs (due to an access to better technologies at a cheaper price thanks to imports). Using Chinese firms-level data from 1998 to 2007, they find that a reduction of tariff encourages imports of high-quality intermediate and reduce innovative activities. Importing the innovation can prevent firms with low innovation skills and/or high risk aversion from having negative outcomes of R&D.

We will test the following assumption:

**H1)** Firm's efficiency and innovation investments are positively correlated.

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<sup>1</sup>See Syverson (2011) for a complete review of literature on all determinants.

## 2.2.2 Performances and exit

In the literature, firms' performances and survival are tightly entangled, with two theoretical models to explain the decision of exiting a market. The first one, the passive learning model explained in the paper of Jovanovic (1982), states that firms' inner performances are key to survive. However, since this efficiency is idiosyncratic, it is both unobservable *ex-ante* and imperfectly observable *ex-post*. Thus, after producing for a period of time, firms learn their inner productivity, and if it turns out that they are not sufficiently competitive in the market, they exit. In these models, firms do not have the opportunity to change their efficiency. The second one is the active learning model of firms performances of Ericson and Pakes (1995). In this paper, they formalized the fact that firms can act on their own performances. The model being dynamic, the initial level of efficiency is less important than its dynamic. If the firm cannot improve its performance at the same pace than its competitor, then this firm becomes one of the least performing firms and becomes unable to maintain its position in the market. R&D investments are the perfect example of firms' actions seeking to increase their efficiency and/or their product range in order to improve the firm performances and to stay in the game. We will mainly focus on the active learning approach.

In the empirical literature, firms performances are a well-known factor of survival. In the seminal paper of Griliches and Regev (1995), with the shadow of death model, they found a negative impact of productivity on the exit of Israeli firms. This finding is consistent over time and across countries. Bellone et al. (2006) also find a robust relation between efficiency and failure, both static and dynamic. The dynamic and the level at the time of default are both important. On the other hand, Kiyota and Takizawa (2007) while finding evidence of the relation between firms' productivity dynamics and survival, also conclude that there is no proof of sudden death of firms.

We will test the following hypothesis:

H2) Higher firm efficiency raises the survival probability.

### 2.2.3 Innovation and exit

Since the papers using the CDM framework mainly use CIS database (the European surveys on firms' innovation activities), which contains only incumbents and cannot be used as a panel database, they cannot take into account the inherent risk of this activity, as presented by Ericson and Pakes (1995). In the case of the winner-takes-all competition (see for instance Loury, 1979, Lee and Wilde, 1980), the first to achieve the innovation will take, if not all, the largest market share, thus the sales due to this (or these) innovation(s). The rest of firms will only pick-up the crumb, no matter how much they invested in the project. Even if the reality can be less extreme, the first mover have a higher return on its innovation. In addition, focusing only on outputs result in only focusing on successful outcomes of the innovation, because other outcomes are not observable, there is a possibility of survivorship bias. The reason being that, if the loss of the firms are too big, or too frequent, they might be at the end of the pack and be forced to exit.

In the literature about outcome of innovation and survival, the results are mixed. Fernandes and Paunov (2015) examine the relationship between innovation and plant survival. Innovation exposes to higher risk and thus to a higher probability of exit. In their analysis, the risk is measured as the diversification of sources of revenue; the technical risk due to the production of new products; the market uncertainty. Based on discrete-time hazard models, their results suggest that product innovation and the introduction of several products limits the probability of plant death. Innovation is even more valuable when the new product is exported and for firms making investment or importing input (higher productive efficiency). In addition, the first (lack of diversification) and the third one (market risk) are significant while the second one (the proximity of new production to past production) is not. Thus innovative single-plant firms are more likely to die compare to other

firms (non-innovative firms and multi-products ones).

In their paper Eisdorfer and Hsu (2011) test and validate three hypothesis from firm-level patent data. First the level of a firm's technology competitiveness predicts its likelihood to fail. They state that financial ratios are not sufficient to capture the situation of a firm and its technology competitiveness is then a better measure. Second, the relation between bankruptcy and macroeconomic conditions is weaker for high technology sectors. Last, bankruptcy of firms in high technology sectors are more costly, which is due to the higher depreciation of the goods produced the inventories and the intermediate inputs used for the producing process.

Considering the sectoral heterogeneity, Sueyoshi and Goto (2009), using data on machinery and electric equipment industries find mixed results of R&D expenditures on financial performances. While the effect is positive for machinery industry, for electric equipment industry the effect is negative. They explain their results by the different products life cycles and the product development paces. The changes in the electric equipment industry is faster than the other one. Because it is a lesser mature industry, the electric equipment sector is associated with high risk but potentially high return innovative investment, while the machinery sector is a more mature industry, so the investments contain less risks but also lower returns.

Ugur et al. (2016) estimate an unshared frailty duration model with and without left truncation, which provides evidence of an inverted-U pattern between innovative activities (i.e. R&D and new products) and survival rates. The market concentration leads innovative firms to survive even longer. Moreover, the authors find evidence that the creative destruction (measured by R&D intensity of the industry) process is negatively correlated with survival time. Finally, the characteristics of the firm are essential since small and young firms, which are the most exposed to the risk of failure, seem to benefit even more from outcomes of R&D investments to survive (Cefis and Marsili, 2006). This result is even stronger on the long run.

We need also to mention the export decision in this nexus. R&D expenditures

through innovations at the product and process level impact positively the probability of export as long as the benefits outweigh the costs of innovation.<sup>2</sup> The R&D expenditures-firms' export survival nexus is directly related to the firms' survival question. A substitution relationship does exist between external cooperation and internal innovation particularly when innovative activities rely on the foreign external knowledge stock (see Luh et al., 2016). However, Zhang et al. (2018) demonstrate that knowledge spillovers increase firm survival. Indeed, import and export-related spillovers affect positively firm productivity due to the dissemination of information and foreign knowledge. The combination of innovation efficiency (measured by patents) and the internationalization of the firm reduces the firm exit.

We will test the following hypotheses:

**H3-a)** High level of investments in innovative activities lower the bankruptcy event probability, thus increases the firms' survival probability.

**H3-b)** The intensity of this effect should be positively correlated with the technology intensity of the sector.

## 2.3 Empirical strategy

### 2.3.1 Data

We will estimate the impact of business expenditures on research and development (BERD, therefore) on survival at the firm-level. To do so, we combine French datasets and estimated covariates.

Our paper revolves around two main databases. First, the R&D survey over the period 2006-2014, which provides firm-level data on R&D expenditures. We can use these information to know which firm innovates, the amount and, using

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<sup>2</sup>Among others see Dai et al. (2020); Van Beveren and Vandenbussche (2010); Damijan and Kostevc (2015); Altomonte et al. (2013).

the panel dimension, the frequency. As Bellégo and Dortet-Bernadet (2014) point out, this survey does not regroup all the firms' R&D activities. A sample of firms is selected each year, depending on their activity. Three possibilities arise. First, companies doing BERD for more than €750,000 are extensively surveyed. Second, companies that do less than €750,000 of BERD are interrogated for a maximum of two consecutive years. Third, firms suspected of investing in BERD, thanks to cross-referencing of firm-level information, are all surveyed. While the first two categories regroup existing firms that had at least once declared doing R&D activities in the past year, the third category is a set of companies that were never surveyed, but are likely to invest in innovative activities. However, and as Bellégo and Dortet-Bernadet (2014) show, firms that are less than two-year-old and the smallest firms have very few chances of being surveyed two consecutive years. One of the reasons is that smaller firms are less likely to have enough assets to meet the threshold of €750,000, and thus to be surveyed continuously. Moreover, even if this truncation did not exist, some firms would invest in such activities because of their unobserved characteristics. For these reasons, we can see that the selection process is not random. We then use a strategy that takes this into account to infer the amount of BERD invested by the firm is.

The second dataset is the official bulletin of civil and commercial announcements database (BODACC thereafter), which gives us information about firms' default between 2008 and 2016. In France, BODACC provides information only on legal procedure a firm is involved into. After reaching 45 consecutive days of insolvency, the French bankruptcy regime requires the triggering of a collective procedure — knowing that the decision on the procedure is left up to the Court.<sup>3</sup> There are three different procedures for companies in distress, ranked from the less to the most intrusive: the safeguard procedure, the reorganization procedure and the liquidation procedure. While the last two procedures are quite common, the safeguard one is both new and unusual.<sup>4</sup> It allows firms that are facing a critical

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<sup>3</sup>See Appendix A.1.

<sup>4</sup>Safeguard procedure was introduced in 2005.

situation, but not in a cessation of payment, to ask for the Court help, in order to maintain both activity and employment, while regulating liabilities. At the end of the safeguard plan, if it was not successful enough, the procedure can be converted to a reorganization or liquidation procedure depending on the situation of the debtor. In the reorganization procedure case, the judicial administrator can have an active or a passive role: the decision power will be reduced at the expense of the administrator in case of an active mission. The procedure can last at ten years at most for all companies, with the exception of farming companies (fifteen years).<sup>5</sup>

The liquidation procedure, similarly to the reorganization procedure, can be triggered only if the firm is in a state of insolvency. It can be opened either after the failure of the reorganization plan, or directly after the safeguard procedure if the company became unable to reimburse its creditors or directly opened after the insolvency if the firm is considered impossible to save. It lasts for two years maximum and is completed only if liabilities are fully reimbursed or if the assets are extinguished. Since safeguard procedure can be started without insolvency, the Court has to state whether or not the company needs its help. This rule is not as clear as the insolvency rule. For this reason, we will focus on the liquidation and reorganization procedures. The default date is defined as the date when procedure is triggered. This is an accountancy-based exit decision, and the decision does not even lie in the manager's hand. It is completely external to the firm, and, contrary to the economic-based decision, the literature does not consider this particular approach.

In addition, for firm-level variables such as assets, materials, revenue, the number of employee and value-added, we use the Unified Corporate Statistics System,

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<sup>5</sup>A simplified safeguard procedure exists for large firms. To be eligible, the firm has to have at least 20 employees, a turnover greater than €3,000,000 before taxes, or a balance sheet greater than €1,500,000. The plan must be voted by creditors who detained at least two-thirds of the total debt. Note that a regular simplified procedure is different from a financial simplified safeguard procedure (which concerns firms deeply indebted to banks, with the majority of their financial creditors' supports).

the File approaching the results of the Elaboration of Annual Statistics of Companies, the Annual Declaration of Social Data and the Financial Links between Enterprises Survey (FICUS, FARE, DADS, and LiFi, respectively). Those databases are used to either compute or estimate our control variables. We restrict our sample to firms that have more than five employees and €5,000 of tangible assets so that we do not have to deal with the measurement problem due to small firms.

### 2.3.2 Selection equation

Since a limited number of firms are engaging R&D expenditures, a selection bias may exist. More precisely, our sample contains firms evenly and unevenly surveyed, i.e. large firms and smaller ones. In order to control the selection bias, we partially follow the CDM framework (Crépon et al., 1998). The equation model from the Tobit II (Amemiya, 1984) will allow us to assess all firms' R&D expenditures by controlling for the selection bias. The first step of the two-equation model is the selection equation which estimates the probability of engaging R&D activity for a given firm. The variable  $E\_RD_{it}$ , our latent variable, is a binary variable capturing whether or not the firm  $i$  does R&D in year  $t$ . The equation is written as follows:

$$E\_RD_{it} = \begin{cases} 1 & \text{if } E\_RD_{it}^* = \beta'_1 z_{1it} + \alpha_{1i} + \epsilon_{1it} > 0 \\ 0 & \text{otherwise.} \end{cases} \quad (2.1)$$

where  $E\_RD_{it}^*$  is the latent variable and  $z_{1it}$  is the vector of independent variables predicting the R&D activity. We disaggregate the error term with  $\alpha_{1i}$  the unobserved individual heterogeneity term, and  $\epsilon_{1it}$  the idiosyncratic term. The second step is the interest equation which estimates the amount devoted in innovative activities by the firm. The  $BERD$  is positive if we observe it and zero otherwise. We estimate the following equation with the  $BERD$  in logarithm:

$$\log(BERD_{it}) = \begin{cases} \log(BERD_{it}^*) = \beta'_2 z_{2it} + \alpha_{2i} + \epsilon_{2it} & \text{if } E\_R\&D_{it}^* = 1 \\ -\infty & \text{otherwise} \end{cases} \quad (2.2)$$

where  $\log(BERD_{it}^*)$  is the latent variable for R&D expenditures and  $z_{2it}$  the vector of independent variables that predict the amount the firm  $i$  will invest in R&D activities. Again, in this equation, we split the error term in two, with  $\alpha_{2i}$  the unobserved individual heterogeneity term and  $\epsilon_{2it}$  the error term. Although we can estimate the two equations separately, they are not independent. We assume that error terms follow a bivariate distribution, conditional on the respective independent variables.<sup>6</sup> This distribution has a zero-mean, variances  $\sigma_1^2$ , which is set at 1 for identification purpose, and  $\sigma_2^2$  and a covariance of  $\sigma_{12} = \rho_{\epsilon_{1it}, \epsilon_{2it}} \sigma_2$ , with  $\rho_{\epsilon_{1it}, \epsilon_{2it}}$  being the correlation between error terms.

We then predict the amount of BERD each firm would have done, based on the TOBIT II model, and then use this generated regressor in our main model.

The specification of both equations (2.1) and (2.2) are very important because we need to predict accurately the amount of R&D expenditures for each firm. In order to be able to predict as accurately as possible, the choice of vectors of variables  $z_{1it}$  and  $z_{2it}$  is critical. Firstly, the vector  $z_{1it}$  contains the Herfindahl index, as a measure of local competition. As Aghion et al. (2005) and Gilbert (2006) pointed out, the effect of competition on innovation expenditures can be non-linear, with an inverted U-shape relationship. When the competition is low, the incentive to innovate is low too, but when a firm is too dominant or is part of a cartel, the incentive can also be low. It is computed at the two-digit NACE level as follows:

$$\text{Herfindahl}_{jt} = \sum_{i=1}^{N_t^j} \left( \frac{Y_{it}}{\sum_{i=1}^{N_t^j} Y_{it}} \right)^2 \times 1000 \quad (2.3)$$

where  $Y_{it}$  is the output of firm  $i$  at time  $t$  in the sector  $j$ . It ranges between 0 and 1,000, the latter being the less competitive sector possible and 0 being the market's value with the highest competition. We use the deflated value-added as the output.

We also introduce the technology intensity level of the sector the firm belongs to, using the classification of Eurostat. At the end, we have 5 categories: high-

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<sup>6</sup>It is important to highlight that the normality of the distribution is not crucial (Olsen, 1980).

technology manufacturing sectors, med-high-technology manufacturing sectors, med-low and low-technology manufacturing sectors, high-knowledge services sectors, low-knowledge services sectors.<sup>7</sup>

Secondly, as Klette and Kortum (2004) point out in its stylized facts, firm size is an important factor in the R&D activity decision. To take this effect into account, we introduce the number of employees in log by firm and year. Lastly, following Blanchard et al. (2005), Aw et al. (2007) and Vancauteran et al. (2015), we include dummies controlling for the group characteristics (being a part of a group and foreign control) and three trade status dummies (exporter, importer two-way trade). The foreign market exposition can have mixed effects on R&D investments. Imports for instance, can either reduce firms' R&D over sales ratio or imports of better quality inputs can maximize their chance of having a positive outcome for their innovative activities, (see Liu and Qiu, 2016). We also include both year and industry dummies to control for business cycle and industry characteristics. We also include a financial variable, the interest expenses over debt ratio.

In equation (2.2), the vector  $z_{2it}$  includes almost firm-specific and sector-specific controls as  $z_{1it}$  does. Some differences between  $z_{1it}$  and  $z_{2it}$  are required to be able to identify equation (2.2). For this reason, we use the turnover export's share instead of the trade status dummies, the foreign group membership and we have a financial variable, the debt over sales ratio, which is defined as the debts of the firm divided by the sales turnover. As proposed by Zabel (1992), we introduce the Mundlak correction (Mundlak, 1978), which allows for the correlation between regressors and unobserved heterogeneity in both equations.

### 2.3.3 Survival analysis

We implement a survival analysis to assess the impact of R&D expenditures on firms' survival. We use the model to predict the failure (default). Survival analysis

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<sup>7</sup>For more detailed information, see [https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec\\_esms\\_an3.pdf](https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf).

revolves around four concepts: the density function, the cumulative distribution, the survival function, and the hazard rate. While the two latter are specific in the survival analysis literature, all of them are closely related. Let be  $T$  the duration,  $T > 0$ . The cumulative distribution is the probability that  $T$  is lower than a particular value  $x$ , i.e.:

$$F_T(x) = Pr[T < x], x \in \mathbb{R}_+^* \quad (2.4)$$

This is the fraction of firms that had been defaulting in  $x$ . Considering the density function of the duration, this is only is the derivative of the cumulative, given by:

$$f_T(x) = \frac{\partial F_T(x)}{\partial x} \quad (2.5)$$

If those two concepts are widely known, the duration data analysis's particularities are the survival function and the hazard rate. The survival function directly refers to the opposite of the cumulative distribution. While the cumulative distribution grows with the firms' "death", the survival function declines with them. This function is defined by the fraction of firms that did not exit at the time  $x$ , i.e.:

$$S_T(x) = Pr[T > x] = 1 - F_T(x) \quad (2.6)$$

Finally, the hazard rate is the conditional probability of defaulting in  $x$ , knowing that the firm was not defaulting before this date, i.e.:

$$\lambda_T(x) = \lim_{\Delta x \rightarrow 0} \frac{1}{\Delta x} Pr[x < T \leq x + \Delta x | T > x] = \frac{f_T(x)}{S_T(x)} \geq 0 \quad (2.7)$$

However, the survival analysis relies not only on descriptive statistics but also on more advanced models to explain the duration. The most commonly used models are the proportional hazard models (PH, therefor), such as Cox-PH model (Cox, 1972), or accelerated duration models. Those models can use parametric or semi-parametric specifications, according to the need for flexibility, to assess covariates' impact on duration. Even if basic models cannot consider a change in the covariate

over time, more sophisticated models using spell and frailty specifications can take into account unobserved heterogeneity in addition to changes over time.

Because in our model we will use time-variant variables, with possible unobserved heterogeneity, we consider the use of shared frailty duration models. As Hougaard (1995) shows, this model is similar to Cox-PH model, with the addition of an unobserved heterogeneity term, that we note  $\alpha_i$ . For the  $t^{\text{th}}$  year of observation of the  $i^{\text{th}}$  individual, we note  $T_{it}$  the survival time and  $C_{it}$  its censorship. We observe  $Y_{it} = \min(T_{it}, C_{it})$  and the event indicator is  $\delta_{it} = I_{\{T_{it} \leq C_{it}\}}$ . Shared frailty model specifies the frailty variable's conditional risk function as follow:

$$\lambda_{it}(x | \alpha_i) = \alpha_i \lambda_0(x) \exp(\beta' Z_{it}) \quad (2.8)$$

where  $\lambda_0(x)$  is the based-hazard function;  $Z_{it} = (Z_{1it}, \dots, Z_{pit})'$  the vector of explicative variables with a year (denoted  $t$ ) and a firm dimension (denoted  $i$ ),  $\beta$  the vector of corresponding parameters, and  $\alpha_i$  are the unobserved random variables (the frailty variables), shared by the same firm  $i$ . We consider that  $\alpha_i$  terms follow a gamma distribution, thus are independent and identically distributed random variables with an unit-mean and an unknown  $\theta$  variance, as discussed by Hougaard (1995).<sup>8</sup>

The vector  $Z_{it}$  contains, among other control variables, the R&D expenditures or total factor productivity (TFP thereafter). Since we cannot observe TFP, we have to compute it with the method developed by Levinsohn and Petrin (2003). The results are reported in Table B.1.1 highlighting an heterogeneity between manufacturing sectors on how production factors impact the value added. The electricity, electronics and informatics products sector is the most capital-intensive industry, while the clothing industry is the most labor-intensive sector and the second most capital intensive. On the other hand, the food products, beverages and tobacco industry is less capital and labor intensive. Moreover, all these industries comprise

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<sup>8</sup>Other distributions are possible, such as log-normal and positive stable distributions, but rapidly converge to a gamma distribution.

roughly two-thirds of labor and one-third of capital, which is consistent with the literature.

However, TFP contains multiple factors that affect the firms value-added in addition to labor and capital. As Crépon et al. (1998) show, among other factors, firms' productivity and innovation activities are tightly entangled. This is the reason why it is impossible to use the TFP estimated in the main model. We use the log of BERD and its square, to estimate a fixed-effect model to extract the impact of innovation from the productivity index. We then compute the difference between the TFP the predicted value by the fixed-effect model (results are displayed in Table B.2.1), by subtract its linear prediction to the actual value estimated. By doing so, we obtain  $\log(\widehat{\text{tfp}}_{it})$ , i.e. the TFP (in logarithm) net of BERD.

Multiple other factors can impact the default, that is why we use additional control variables. First, we use the firm-specific variables: the group membership (as the head or only a subsidiary), and the foreign group membership. Second, we also introduce the industry-related variable Herfindalh's concentration index (as explained in Section 2.3.2).

Because we are using accelerated duration models, we will not expose our results in term of impact of covariates on the probability of failing, but rather on the firms' survival, which is more in line with both the literature and the accelerated time failure model.

## 2.4 Results

### 2.4.1 Statistics

Since the results are mixed in the literature, we cannot have a preconceived idea about BERD's impact on firms' survival. However, some statistics displayed in Figure B.3.1 and Tables 2.1 and B.3.1 give us some insight into the behavior of

firms in terms of BERD. First, the more the sector has a high technology–knowledge competition, the more firms invest. Thus large firms in high-technology manufacturing sectors and knowledge-intensive sectors have more BERD investments than their respective counterpart (see Table B.3.1). However, for firms in service industries, large firms operating in knowledge-intensive sectors invest three times more than the ones in less knowledge-intensive sectors. Even if large companies’ gap is thin for the manufacturing firms, the one between intermediate-size companies denotes an important difference between them.

Second, despite those differences, we can see as an important gap between size class of firms in all those sectors. The vast majority of amount invested in innovative activities is the result of large companies’ investment. More interestingly, the lower the technology/knowledge is required in the sector, the higher the gap is. The more the sector is technology- or knowledge-intensive, the smaller firms should invest to remain competitive and to maintain their market position. We should keep in mind that only the bigger firms are surveyed consistently over time, which could lead to an observation bias for the micro-companies and small and medium firms. Nonetheless, the difference is significant between intermediate-sized and large firms.

	All			Never defaulting			Defaulting		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Foreign group membership <sub>t-1</sub>	1,425,257	0.13	0.34	1,372,794	0.13	0.34	52,463	0.10	0.30
Share of export <sub>t-1</sub>	1,425,257	0.05	0.15	1,372,794	0.05	0.16	52,463	0.05	0.14
Debt over sales ratio <sub>t-1</sub>	1,425,257	0.40	0.94	1,372,794	0.40	0.96	52,463	0.48	0.37
Number of employees <sub>t-1</sub>	1,425,257	2.92	0.99	1,372,794	2.92	1.00	52,463	2.93	0.86
Herfindahl index <sub>t-1</sub>	1,425,257	13.82	38.18	1,372,794	13.75	38.10	52,463	15.78	40.18
Exporter only <sub>t-1</sub>	1,425,257	0.05	0.22	1,372,794	0.05	0.22	52,463	0.06	0.24
Importer only <sub>t-1</sub>	1,425,257	0.08	0.27	1,372,794	0.08	0.27	52,463	0.07	0.26
Both exporter and importer <sub>t-1</sub>	1,425,257	0.15	0.36	1,372,794	0.15	0.36	52,463	0.14	0.35
Group membership <sub>t-1</sub>	1,425,257	0.38	0.48	1,372,794	0.38	0.48	52,463	0.30	0.46
Number of employees <sub>t-1</sub>	1,425,257	2.92	0.99	1,372,794	2.92	1.00	52,463	2.93	0.86
R&D activity (all sample)	1,425,257	0.03	0.16	1,372,794	0.03	0.16	52,463	0.02	0.14
Export activity	1,425,257	0.21	0.40	1,372,794	0.21	0.40	52,463	0.19	0.40
Number of employees	1,425,257	2.92	1.00	1,372,794	2.92	1.00	52,463	2.89	0.86
Foreign group membership	1,425,257	0.11	0.31	1,372,794	0.11	0.31	52,463	0.07	0.25
Herfindahl index	1,425,257	14.07	38.13	1,372,794	14.00	38.07	52,463	15.88	39.56

Table 2.1: Descriptive statistics of defaulting vs non defaulting firms: All sectors

Table 2.1 displays descriptive statistics on the variables we use in our models,

the Tobit and the survival, for all sectors, while in Table B.5.1 some statistics are displayed by tech-level sectors. We see that firms in knowledge-intensive or high-technology sectors have a higher probability of investing in innovative activities, have a higher amount invested in BERD, both predicted by the Tobit, and observed. We also see that those firms are more often part of a multinational group or local group than other firms. Moreover, the firms are slightly bigger in terms of employment or liabilities, even if the employment gap is not important between High and Medium-High Technology sectors. Note that the average productivity index for non-defaulting firms, does not differ across manufacturing sectors. While the defaulting firms have a lower average-productivity index than their non-defaulting counterparts in the same sector, the difference between manufacturing sectors for failing companies is more revealing. The more the sector is technology-intensive, the lesser firms' productivity at the time of default is. This can be caused by the greater impact of innovation on the probability of exiting in the higher innovative sectors compared to the others. Another valid explanation would be the impact of innovations' investment with negative outcomes on these firms' efficiency. Unsuccessful outcome may result in a loss of competitiveness, and it may be worsen in cutting edge sector, where innovation is crucial (Sueyoshi and Goto, 2009). This would be in line with the predictions of the active learning model developed by Ericson and Pakes (1995).

## 2.4.2 Selection equation

In Table 2.2 we display the estimation of equation (2.1) in column (1) and equation (2.2) in columns (2) and (3). Note that the column (3) takes into account the selection bias. . Therefore, this specification is more relevant. Moreover, we note a large and significant correlation between the idiosyncratic terms a.k.a “Heckman's  $\rho$ ” (i.e.  $\rho_{\epsilon_{1it}, \epsilon_{2it}}$  in Table 2.2), comforting us in our choice of correcting sample selection bias.

	(1) Equation of decision w/ selection effect	(2) Equation of interest w/out selection effect	(3) Equation of interest w/ selection effect
Herfindahl <sub>t-1</sub>	-0.000*** (-2.801)		
Trade status:			
– Exporter <sub>t-1</sub>	0.006*** (19.830)		
– Importer <sub>t-1</sub>	0.001** (1.993)		
– Both <sub>t-1</sub>	0.001** (2.360)		
Group membership:			
– All <sub>t-1</sub>	0.000* (1.908)		
– Foreign <sub>t-1</sub>		-0.035** (-2.532)	-0.000** (-2.438)
Share export <sub>t-1</sub>		0.074** (2.117)	0.001** (2.079)
Debt over sales ratio <sub>t-1</sub>		-0.017 (0.894)	-0.000 (-0.893)
Log number of Employees <sub>t-1</sub>	0.005*** (10.601)	0.356*** (9.746)	0.035*** (11.547)
Sector (ref: Medium-Low and Low Tech Manufacturing)			
– High Technology Manufacturing	0.022*** (5.412)	0.642*** (11.865)	0.150*** (5.703)
– Medium-High Technology Manufacturing	0.012*** (8.038)	0.269*** (6.428)	0.076*** (8.466)
– Knowledge-Intensive Services	0.015*** (10.587)	0.952*** (23.246)	0.110*** (11.866)
– Less Knowledge-Intensive Services	-0.005*** (-8.571)	0.314*** (6.092)	-0.033*** (-9.093)
# obs	1,425,257	36,210	1,425,257
# firms	173,672	9,139	173,672
Individual fixed effects correlation ( $\rho_{\alpha_{1it}, \alpha_{2it}}$ )	0.117* (1.959)	0.117* (1.959)	0.117* (1.959)
Idiosyncratic terms correlation ( $\rho_{\epsilon_{1it}, \epsilon_{2it}}$ )	-0.699*** (-6.050)	-0.699*** (-6.050)	-0.699*** (-6.050)

Student-t computed with standard errors clustered at firm-level-statistics in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2.2: Tobit estimation – The determinants of R&D’s activity

The decision of doing R&D activities depends positively on the size of the firm the categories (being part of a group) and the participation in international trade (being exporter and/or importer variables have a positive coefficient). Considering the technology intensity of the firm’s sector, the results differ across industry. Compare to the medium-low and low-tech manufacturing sector, all the coefficients are positive, except for the less knowledge-intensive services, indicating that the firms operating in this technology or knowledge intensive sectors, are more likely to engage innovative activities to better compete. This result is reaffirmed by the coefficient associated with the Herfindahl index. The more competition there is, the more firms are likely to do R&D investment.

In column (2) and (3), the dependent variable is BERD, which is continuous. The set of regressors slightly differs from the column (1), because of identification purpose.<sup>9</sup> As for the decision of R&D, we have some firm-specific and sector-specific determinants, which play a role in the amount invested. Regarding the exposure to the foreign markets, when a firm increases the share of exports in the overall turnover of one percentage point, it increases the assets invested in R&D by 0.1 percentage point, *ceteris paribus*. Exporting firms face a fierce competition, which force them to innovate (product and/or quality) more than others. This result must be related to findings on trade status in column (1). Turning to the size of the firm, an increase of the number of employees by one percent is associated with an increase of the R&D investment by 3.8 percentage points. Once we have controlled for the other covariates, the financial health of the firm, through the debt over sales ratio, impacts to a lesser extent the amount invested compared to the other determinants. Besides, firms that belong to an international group, invest less in R&D than the others, because R&D activities are generally concentrated in the headquarter or in specific affiliates (vertical specialization). R&D investments are higher in high technology or knowledge intensive sectors. This is in line with our previous findings. Firms in high technology or knowledge intensive sectors invest in R&D more often and more substantially.

### **2.4.3 Survival analysis**

The results of the survival model are displayed in Table 2.3. Columns (1) to (4) allows us to confront models, i.e., with and without the control variables and with and without the quadratic terms, to choose the most fitted specification. First, we see that the introduction of the control variables changes the sign of the coefficient linked to the BERD elasticity, regardless of the presence of the quadratic terms. So, it is essential to introduce the control variables; otherwise, the estimation will not

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<sup>9</sup>Wherever possible, dummy variables have been replaced by continuous ones, which refers to common characteristics.

reflect its actual impact on firms' survival. Second, the introduction of quadratic terms allows us to understand better the impact of firms' productivity and BERD on survival. For these reasons, we will use the model estimated with the specification on column (4), the complete one.

Overall, concerning the control variables, we see that, contrary to what we expected, being an exporter does not prevent from exiting the market. However, being a large firm or belonging to a foreign group prevents entry into a bankruptcy procedure. Firms that operate in sectors with higher concentrations exhibit a lower probability of surviving. Although Herfindahl's index seems to have a U-shape relationship, the quadratic term coefficient is very small, which leads us to believe that the positive effect is negligible compared to the negative effect. Interestingly, we find that productivity and survival have a positive relationship and have an exponential relationship. This finding means that the more a firm is efficient, the more likely it will survive a longer period. More than that, since the quadratic term is both positive and significant, the effect will be greater for the highest-performing firms. On the other hand, we find that the BERD investment has a U-shaped relationship with the survival probability. At first, the more a firm invests in BERD, the less likely it will survive. Then, after reaching a certain level of investment, BERD increases the probability of staying in the market, which is coherent with the risk inherent in such investments. This effect is not a surprise since low investments in such risky activities are a financial burden with a low probability of high enough returns. This financial constraint can add to others, put the firm in a more difficult situation, and precipitate the firm's default. On the other hand, high enough investment in innovative activities should result in more frequent positive outcomes, thus increasing the firm's survival. Seeing this threshold varies according to the sectoral technology intensity the firms belong to is not a surprise either. In line with the prediction of the active learning model developed by Ericson and Pakes (1995), the fiercer the competition is, the higher the investments firms consent in such activities are.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Technology level		Manufacturing		Services <sup>(a)</sup>
					High	Low	High-&Med-Tech	Low-Tech	High-Know
$\log(\widehat{tfp}_{it})$	2.645*** (0.053)	2.293*** (0.054)	4.051*** (0.050)	3.869*** (0.050)	2.596*** (0.112)	4.178*** (0.057)	4.708*** (0.281)	3.988*** (0.109)	2.149*** (0.125)
$\log(\widehat{tfp}_{it})^2$			0.392*** (0.010)	0.372*** (0.009)	0.228*** (0.016)	0.417*** (0.013)	0.435*** (0.049)	0.366*** (0.018)	0.195*** (0.020)
$\log(\widehat{BERD}_{it})$	0.518*** (0.088)	-0.607*** (0.083)	0.649*** (0.181)	-1.522*** (0.221)	-0.777*** (0.305)	-4.164*** (0.536)	-2.523*** (0.465)	-3.936*** (0.622)	-1.100* (0.583)
$\log(\widehat{BERD}_{it})^2$			-0.060 (0.038)	0.229*** (0.052)	0.116** (0.058)	0.948*** (0.221)	0.262*** (0.078)	0.971*** (0.247)	0.216* (0.128)
Exporter <sub>it</sub>		-0.119** (0.059)		-0.105* (0.062)	-0.441*** (0.167)	-0.095 (0.068)	-0.428 (0.269)	0.488*** (0.109)	-0.723*** (0.260)
$\log(\text{size}_{it})$		0.805*** (0.030)		0.614*** (0.031)	0.659*** (0.087)	0.639*** (0.034)	1.528*** (0.216)	0.422*** (0.071)	0.537*** (0.095)
Foreign group <sub>it</sub>		2.502*** (0.087)		2.537*** (0.098)	2.333*** (0.225)	2.613*** (0.110)	3.029*** (0.384)	2.668*** (0.198)	2.033*** (0.274)
Conc <sub>it</sub>		-0.007*** (0.001)		-0.012*** (0.001)	-0.034*** (0.003)	-0.009*** (0.001)	-0.001 (0.023)	0.012*** (0.004)	-0.034*** (0.004)
Conc <sub>it</sub> <sup>2</sup>				0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	-0.000 (0.000)	-0.000* (0.000)	0.000*** (0.000)
Constant	19.390*** (0.101)	16.480*** (0.130)	21.960*** (0.127)	19.480*** (0.160)	21.340*** (0.467)	19.020*** (0.171)	18.700*** (0.934)	20.610*** (0.339)	21.670*** (0.569)
# obs	1,417,815	1,417,815	1,417,815	1,417,815	233,799	1,184,016	53,392	256,452	180,407
# of firms	173,672	173,672	173,672	173,672	31,968	144,171	7,093	32,954	24,953
Log-likelihood	-102,672	-101,599	-99,927	-99,158	-13,661	-85,278	-3,439	-21,044	-10,137
Likelihood-ratio test	564.000	721.000	98.820	259.200	11.200	302.600	2.477	2.470	11.920
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.058	0.058	0.000
$\sigma^{(b)}$	5.179	4.950	6.040	5.736	6.403	5.568	5.992	6.054	6.419
$\theta^{(c)}$	8.026	9.004	1.538	2.788	2.149	3.113	0.943	0.419	3.276

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2.3: Probability of not being involved in a legal procedure - Full survival model

<sup>(a)</sup> Because of a convergence issue, the results for Low-Knowledge Services sectors are not displayed.

<sup>(b)</sup> Ancillary parameters of the log-normal distribution.

<sup>(c)</sup> Variance of  $\alpha_i$ .

Considering columns (5) to (9), we can see the heterogeneity of these effects across different sectors, which differs in the technological intensity required to keep up with their competitors. If the effects of TFP and BERD on survival follow the same pattern across different technology intensity sectors, for others, signs and significance can differ greatly between them. However, as predicted with the hypothesis H3-b), for manufacturing sectors, the magnitude of the TFP is greater in high-tech sectors than in low-tech intensive ones. In the high-technology level sectors (column (5)), which encompass high- and med-high-technology intensive manufacturing sectors and high-knowledge intensive services sectors, the variables' impact does not differ from the estimations with all firms. The main difference comes from the magnitudes of the effects, which are lower in the TFP and BERD estimation, for instance, while being an exporter is accelerating the time of failure. Nevertheless, in the Low technology level sectors column (6), we see that the effect of being an exporter is no longer significant, while the magnitudes of the effects of both TFP and BERD are larger than in the high-technology level sectors. The impacts of size and foreign group membership are similar for both sectoral classifications.

In columns (7) to (9), we dig further into the details of the impacts of the covariates for each sectoral technology intensity. About the control variables, we see that, for manufacturing firms, the effect of being an exporter is either insignificant or positive on survival, while it is significantly negative for high-knowledge intensive services. Considering the firm's size, the magnitude of the effect is greater in high-technology intensive manufacturing sectors than in the other two. In addition, being part of a foreign group have a more significant impact on high-technology intensive manufacturing sectors than the others. Finally, even if the Herfindahl concentration index on survival is insignificant only for high-technology intensive manufacturing sectors, the effect is different for low-technology intensive manufacturing sectors (inverted U-shape relationship) and high knowledge-intensive services sectors (U-shaped relationship).

Concerning the interest variables, in column (7), the firms in the high- and med-high-technology intensive manufacturing sectors display a more important role of TFP in survival than in the high-knowledge intensive services sectors, displayed in column (9). However, the magnitude is similar in the low-technology-intensive manufacturing sector. That seems to point to an "efficiency premia" in the manufacturing sector, at least compared to high-knowledge intensive service sectors. Considering the BERD's effect on survival, the magnitudes are different across sectors. However, only the turning points will discriminate where BERD's marginal effect will be positive. Indeed, since the effects have opposite signs, the marginal effect of R&D investments on survival is, at first, negative and then positive; thus, we have to identify the turning point. This well-known turning point is such as the marginal effect is equal to zero. After this point, in the case of a negative effect of the covariate and a positive effect of the square of the covariate, each additional unit of the covariate will increase the firm survival probability. Considering the amount invested in BERD, the turning point is the point from where each euro invested will have a positive impact on the survival probability.<sup>10</sup> We computed the thresholds for the different sectors, and results are displayed in Table 2.4 and shown graphically in Figure 2.1. We first see that the turning points depend dramatically on sectors. The more a sector required innovating to stay competitive, the larger is the threshold. For manufacturing firms, Low-technology intensive sectors have the lowest amount required (€7,589.580), while the high- and med-high-technology intensive sectors have the highest one (€123,332.690). However, the level of investment firms also depends on the sector. In the higher the threshold is, the more firms reach the required threshold. In the manufacturing high-technology sectors and low-technology sectors, the average amounts invested for firms over the threshold are respectively €566,497.690 and €26,542.100.

Even if these non-linear effects of R&D expenditures have the same shape across

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<sup>10</sup>To compute the Turning Point, we differentiate the function by  $\log(\text{BERD}_{it})$ , i.e.:

$$\frac{\partial \beta_1 \times \log(\text{BERD}_{it}) + \beta_2 \times \log(\text{BERD}_{it})^2}{\partial \log(\text{BERD}_{it})} = 0 \Leftrightarrow \text{BERD}_{it} = \exp\left(-\frac{\beta_1}{2 \times \beta_2}\right).$$

different sectors, as Figure 2.1 shows, the thresholds differ greatly between them. The more a sector requires large investments in order to compete, the larger the amount invested has to be. However, when we compare those thresholds with the amount invested that our Tobit-model predicts, only few firms are able to reach those amounts of BERD. This finding may confirm that investing in R&D, even if it, with successful outcomes, can improve their competitiveness, it is a risky and costly activity for firms. In Figure 2.1c, i.e. for high-tech intensity sectors (both manufacturing and services), we can see that, after the turning point, the impact of amount invested in R&D on survival slows down. So, for bigger investments, the average effect of the amount invested does not have an important impact on the firm's survival. Moreover, for those firms, this negative impact on their survival is balanced by the other factors, such as productivity and the size.

		Threshold (in euros)		Number of firms	Share	Average
All		27,747.450	Below	1,419,046	99.56%	1,032.78
			Above	6,211	0.44%	175,750.08
Tech-level	High-tech	28,478.170	Below	229,358	97.67%	1,144.86
			Above	5,472	2.33%	192,734.58
	Low-tech	8,990.810	Below	1,188,923	99.87%	1,010.77
			Above	1,504	0.13%	34,245.80
Manufacturing	High-manuf	123,332.690	Below	51,843	96.43%	1,761.79
			Above	1,920	3.57%	566,497.69
	Low-manuf	7,589.580	Below	257,047	99.39%	1,043.68
			Above	1,584	0.61%	26,542.10
Services	High-serv	12,759.760	Below	178,695	98.69%	1,040.89
			Above	2,372	1.31%	108,894.77

Table 2.4: Number of firms above or below the thresholds of BERD's marginal effects

However, we can expect heterogeneity between firms, according to their efficiency. It is only natural to expect a productive firm to need a higher level of investment in R&D than a less productive one. That is why we needed to consider this interaction between TFP and BERD. The results are shown in Table 2.5 and graphically displayed in Figure B.4.1.

Before commenting on the results, it is essential to understand what is inside

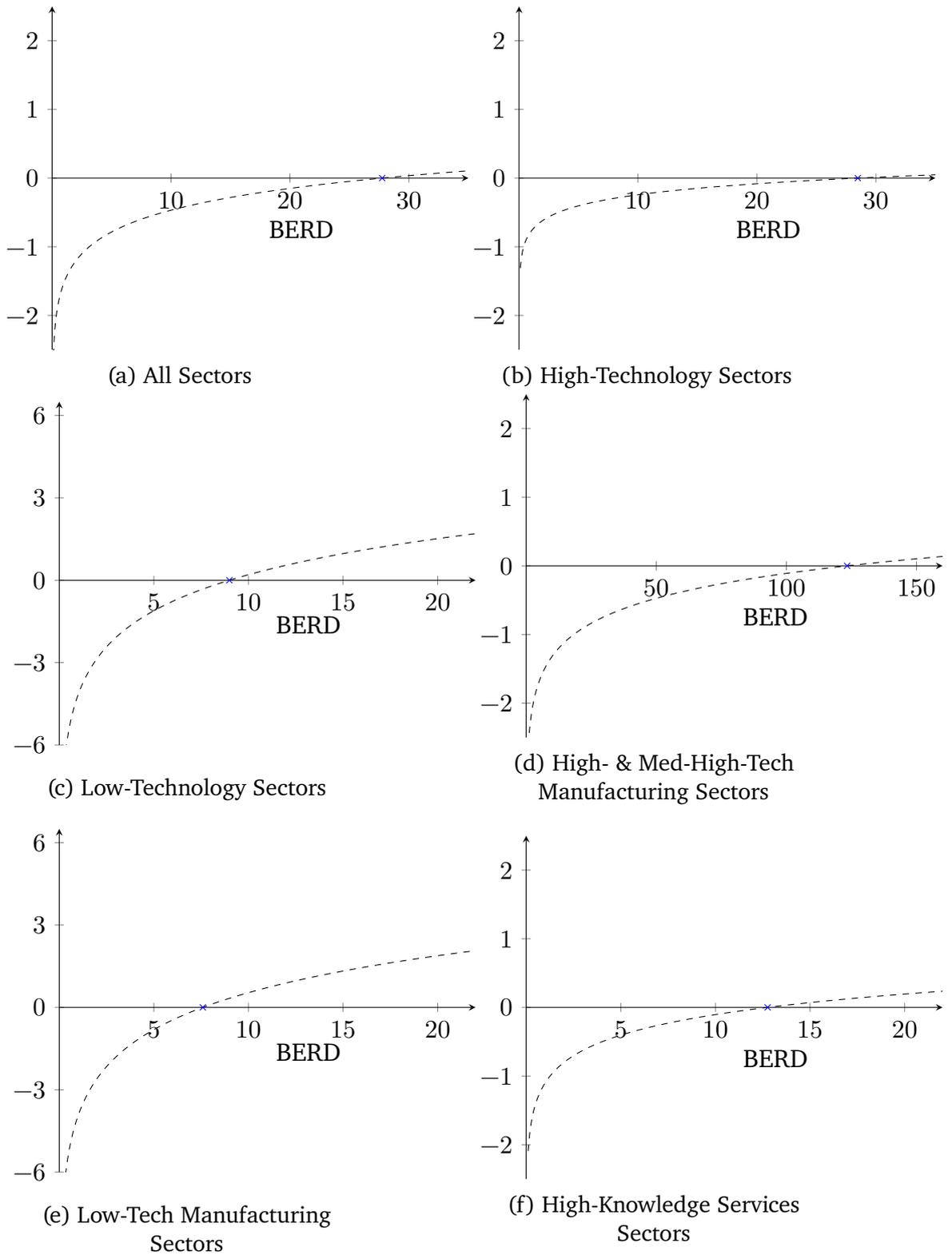


Figure 2.1: BERD's turning points (in thousand euros)

TFP. It is the value-added part that is not explained by using the classical inputs: capital and labor. It can contain various factors, such as R&D expenditures or

	(1)	(2)	(3)	(4)	(5)	(6)
	All	Technology level High	Low	Manufacturing High-&Med-Tech	Low-Tech	Services High-Know <sup>(a)</sup>
$\log(\widehat{tfp}_{it})$	3.924*** (0.051)	2.611*** (0.116)	4.251*** (0.058)	5.207*** (0.324)	4.203*** (0.114)	2.158*** (0.127)
$\log(\widehat{tfp}_{it})^2$	0.378*** (0.009)	0.230*** (0.016)	0.429*** (0.014)	0.490*** (0.061)	0.392*** (0.020)	0.195*** (0.020)
$\log(\widehat{BERD}_{it})$	-1.691*** (0.215)	-0.784*** (0.304)	-5.633*** (0.565)	-2.713*** (0.461)	-5.591*** (0.673)	-1.040* (0.591)
$\log(\widehat{BERD}_{it})^2$	0.339*** (0.055)	0.122** (0.059)	2.528*** (0.348)	0.319*** (0.080)	2.409*** (0.376)	0.220* (0.126)
$\log(\widehat{tfp}_{it}) \times \log(\widehat{BERD}_{it})$	-0.931*** (0.116)	-0.074 (0.136)	-3.044*** (0.309)	-0.688*** (0.195)	-2.776*** (0.327)	-0.112 (0.248)
Exporter <sub>it</sub>	-0.110* (0.062)	-0.441*** (0.167)	-0.090 (0.068)	-0.430 (0.269)	0.521*** (0.110)	-0.729*** (0.260)
$\log(\text{size}_{it})$	0.610*** (0.031)	0.657*** (0.087)	0.636*** (0.034)	1.447*** (0.213)	0.416*** (0.071)	0.536*** (0.095)
Foreign group membership <sub>it</sub>	2.512*** (0.098)	2.328*** (0.225)	2.585*** (0.109)	2.947*** (0.379)	2.624*** (0.196)	2.032*** (0.274)
Conc <sub>it</sub>	-0.012*** (0.001)	-0.034*** (0.003)	-0.010*** (0.001)	-0.004 (0.023)	0.012*** (0.004)	-0.034*** (0.004)
Conc <sub>it</sub> <sup>2</sup>	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	-0.000 (0.000)	-0.000* (0.000)	0.000*** (0.000)
Constant	19.470*** (0.159)	21.330*** (0.467)	19.010*** (0.170)	19.110*** (0.917)	20.620*** (0.334)	21.670*** (0.570)
# obs	1,417,815	233,799	1,184,016	53,392	256,452	180,407
# of firms	173,672	31,968	144,171	7,093	32,954	24,953
Log-likelihood	-99,128	-13,661	-85,229	-3,432	-21,009	-10,137
Likelihood-ratio test	270.700	11.340	314.600	3.109	3.929	11.830
p-value	0.000	0.000	0.000	0.039	0.024	0.000
$\sigma^{(b)}$	5.726	6.401	5.556	5.968	6.020	6.421
$\theta^{(c)}$	2.831	2.162	3.154	0.977	0.508	3.261

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2.5: Probability of not being involved in a legal procedure - Full survival model with cross term

(a) Due to convergence issue, the results for Low-Knowledge Services sectors are not displayed.

(b) Ancillary parameters of the log-normal distribution.

(c) Variance of  $\alpha_i$ .

management skills. However, since we extracted the part from BERD, we have a productivity net of R&D investments. Thus, we can use a cross term to assess the impact of both R&D investments and firms' performances.

Concerning the control variables, we have the same level of magnitude and signs that we have in the models without the cross-term. About the cross-term, depending on the sectors' intensity, the coefficients are either negative or insignificant. Moreover, regardless of the technology intensity, the impact is significant at the one-percent level in the manufacturing sectors. This negative relationship can confirm that the more a firm is productive, the more it must invest in innovative activities to help it survive. This result contradicts the hypothesis H1) Thus, we can see this variable as a re-scale of the turning point, which considers the net firms' efficiency level.

Nonetheless, coefficients linked to the impact of TFP and BERD did not change by much, except for some sectors. In the low-technology level sectors (column (6) of Table 2.3 and column (3) of Table 2.5) and low technology-intensive manufacturing sectors (column (8) of Table 2.3 and column (5) of Table 2.5), the magnitude of both quadratic and level coefficients linked to the impact of BERD on survival are larger when the cross-term is introduced. Moreover, the increase seen in the low-technology level sectors might be driven by the low technology-intensive manufacturing sectors. Consequently, only significant investments in R&D protect firms, and the more a firm is already efficient, the more it must invest to have a positive effect on its survival. However, the more a firm is efficient, the more likely it will survive. So, not only do those results confirm hypotheses H2) and H3-a), but they also add a complement. With a low level of investment, the BERD represents a burden for the firm survival (due to the low probability of successful outcome), while the effect of BERD on survival turns to be positive as the firm consents to invest more extensively. This

Considering the turning points of BERD with the addition of the crossed impact of firms' productivity and R&D expenditures, displayed in Figure B.4.1, we see the heterogeneity across sectors. For high technology-intensity sectors, the importance of high investments for high productive firms is even more accentuate. For the high-technology level and high-knowledge intensive services sectors, respectively columns (2) and (6) of Table 2.5, and Figure B.4.1b and Figure B.4.1f, the cross term effect on firm's survival is insignificant.<sup>11</sup> Nonetheless, this does not necessarily point toward an absence of effect, but might instead signify that an even higher level of investment should be required for even highly efficient firms. Moreover the low magnitude of those terms leads to higher level of investment needed, especially for highly productive firms.

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<sup>11</sup>When computing the Turning Points, the differentiation leads to this new expression:  $BERD_{it} = \exp\left(-\frac{\beta_1 + \beta_3 \times \log(\text{tfp}_{it})}{2 \times \beta_2}\right)$ , which includes the productivity inside.

## 2.5 Conclusion

The R&D is a risky investment and might put the firm in a difficult financial situation, and even lead to bankruptcy in the worse case. The literature has highlighted both the importance and the risk of innovation activities for firms dynamics. As the active learning framework points-out, firms have the incentive to invest in innovative activities to try to improve their performances. When the investment is not successful enough, compared to the other firms, it becomes a burden for this firm which might even accelerate its failure.

In this paper, we contribute to the existing literature. Firstly, we use BODACC database to discriminate “true” exit from the market. Secondly, we concentrate our study on the extensive margin of R&D, while most studies use the intensive margin. Thirdly, we use a methodology allowing us to tackle both the issue of right-censoring and unobserved heterogeneity with the shared-frailty duration analysis. Lastly, we use a selection equation to treat the auto-selection issue of R&D investment.

Based on large panel databases on French firms, we find that firm’s investment in R&D has an U-shaped relationship with firm-survival. For small amount of BERD, the survival probability decreases while it turns positive for larger amounts. This suggest that firms should invest substantial amounts in R&D in order to mitigate the burden of this highly illiquid investments. According to our estimates, this result is even stronger for high-tech industries compare to lower-tech ones indicating that the level of technology required to perform in the sector matters.

We also see the importance of helping firms to invest in innovative activities. Our paper brings public policy recommendation that are twofold. First, encouraging firms to invest larger amount in such activities should help them to overcome the negative effect because there is a positive relationship between the level of R&D investment and the firm survival probability. Second, there is a high disparity of

the effect of BERD across sectors and firms level of productivity. The lower their efficiency is, the higher the return of helping them to innovate could be. In all sectors, the positive effect of R&D investment happens at lower amount for lower level of efficiency, and could raise their survival. For this reason, it might be more cost-effective to help those firms, rather than highly efficient firms that require higher investments and already have higher survival probability thanks to their productivity.

## **Chapter 3**

**Productivity growth and resource  
(mis)allocation in France: New  
insights from bankruptcy and  
inference**

### 3.1 Introduction

Understanding the way production factors are reallocating in an economy or an industry allows a better comprehension of the potential misallocation of resources and where they occur the most. As the Council (2019) show, after a deceleration of the productivity growth in the 1990's, the French productivity dropped in the period following the 2008's crisis. According to OECD, French productivity growth between 2007 and 2012 average at -0.4%. Moreover, according to them, in France *“The decline in productivity has been accompanied by a greater dispersion of performance between companies. This could be a sign of misallocation of resources between companies”*. The intuition is that distortions (financial frictions, public subsidies to maintain employment, etc.) contribute to keeping non-performing firms in the market and may induce in a larger productivity gap between the most productive and the least productive firms. The slowdown in productivity growth and the role played by resource misallocation has been addressed by several studies (see among others, Cette et al., 2017, Berthou, 2016, Midrigan and Xu, 2014, Restuccia and Rogerson, 2013, Hsieh and Klenow, 2009, Restuccia and Rogerson, 2008).

Periods of recessions are economically difficult, but they allow least productive firms to exit the market, which, in turn, help the market selection. Moreover, by freeing resources from the least productive firms, the best performing ones can have better use of available resources than the least performing ones. An improvement in resource reallocation can therefore result in aggregate productivity growth. In the opposite case, when the least performing firms trap important productive resources, aggregate productivity growth would be lower, all other things being equal. This paper is part of this new literature where aggregate productivity growth depends not only on the way each firm combines its own resources (learning effect) but also on the way these productive resources are (re)allocated across firms (resource reallocation).

Different decompositions in the literature allow to have an insight into how these two components drive the aggregate productivity growth, which is in turn affected by different category of firms: incumbent, entering, and exiting firms. Production factors are reallocating between incumbents, optimally from less performing ones toward most performing ones and between entering and exiting firms. In this last case, the Schumpeterian allocative efficiency suggests that entry of new innovative firms into a (competitive) market results in the disappearance of old firms and ensures the permanent renewal of production structures.

The renewal of production structures through entry and exit of firms is often measured with error in the literature and without statistical inference. The generally accepted definition for exiting firms is very rough; these are firms that disappear from the database. However, exiting can occur due to multiple causes: from a merger and acquisition, from a voluntary exit of a manager, or even from a bankruptcy.<sup>1</sup> In the first case, the contribution to the aggregate productivity growth might be ambiguous since it is not an actual exit from the market but rather a kind of reallocation with mixed effects on productivity (for a literature review, see Schiffbauer et al., 2017), while the two latter cases are real exits and should be treated as they are. Furthermore, with regard to statistical inference, the different decompositions proposed in the literature give insight into the magnitude of each contribution but do not settle the significance of the different terms. Moreover, the destruction part of the creative-destruction process that caused by an acute financial distress leading to the opening of a bankruptcy procedure can also help us to tackle the efficiency of the framework. Indeed, the literature tackle efficiency of the frameworks by assessing the efficiency of the indicators used to decide if a firm is bankrupt or not (Camacho-Miñano et al., 2013), or if the procedure allow for the maximum monetary outcome for creditors, either a reimbursement of the debtor liabilities in case of liquidation, or mitigate their loss during the reorganization

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<sup>1</sup>Exits occurring in the middle of the period studied and due to factors other than those mentioned here (change of scope or of the INSEE information system) are a priori taken into account by means of a linear interpolation, provided that the exit does not exceed three consecutive years.

of the debtor's debt (see among other Hart, 2000, Blazy et al., 2013). However, we can also assess the efficiency of a framework with the way the resources are reallocated. On the one hand, when firms are exiting while being involved in a bankruptcy procedure, they should be among the wasteful firms. Therefore, their exit should have a positive impact on the aggregate productivity growth. On the other hand, when firms that are efficient enough to stay in the market do exit of the market through a bankruptcy procedure, an error occurs and is a sign of an ill-functioning bankruptcy framework.

The objective of this paper is twofold: i) to have a more precise measure of firms' exit in order to take into account the market's selection process contribution on resource reallocation; ii) measure the significance of each contributions terms (internal firm-specific productivity and resources reallocation) to the productivity growth. To our knowledge, previous studies have not addressed these issues.

To achieve the first objective, we will introduce a new term in the decompositions to seek the possible misinterpretation of misallocation due to the exit. This will be possible thanks to the official bulletin of civil and commercial announcements database (BODACC henceforth), which allows us to identify firms that really exit the market. Considering the second one, we propose a new methodology using bootstrap to infer standard errors and assess the significance of the different decomposition terms. We will use two decompositions of productivity growth, one proposed by Foster et al. (2001) and the other one proposed by Melitz and Polanec (2015) (respectively FHK and MP henceforth), which are the latest methods developed to decomposed productivity growth that were derived, respectively, from Baily et al. (1992) Olley and Pakes (1996) (BHC and OP respectively henceforth). The results obtained show that the contribution of defaulting firms are both positive and, overall, highly significant. These results are robust across both sector and time, and also between the decomposition methods we use. These results are robust across both sector and time, and also between the decomposition methods we use. Considering the other terms, the results are more mixed. For non-defaulting

exiting firms, entering firms and for incumbents terms are not consistently significant, especially during the 2009-2013 period. For incumbents, depending of the sector and term considered, both learning and reallocation contributions can be non-significant.

The reminder of the paper is organized as follows. Section 3.2 reviews the relevant literature. Section 3.3 presents the data, the different decomposition methods and the bootstrap methodology. Section 3.4 presents the descriptive statistics and discusses the results. Finally, Section 3.5 concludes.

## **3.2 Literature review**

The recent strand of literature focusing on misallocation of resources has gained significant importance since the seminal works of Restuccia and Rogerson (2008) and Hsieh and Klenow (2009). According to the theoretical model of the latter, in the absence of distortions, marginal productivity should be equal across firms. In accordance with this (neoclassical) conjecture, they estimate that China's and India's productivities would increase by 30-50% and 40-60% respectively, if both countries had the allocative efficiency of the US. Following a similar approach Petrin and Sivadasan (2013) measure the extent of the misallocation by the gap between marginal product of an input and its marginal cost at the plant level. The authors show that the value of this plant-input gap corresponds to the change in the aggregate output when the plant change the corresponding input by one unit. A sizable allocative inefficiency for blue- and white-collar labor is found in the Chilean case before and after an increase in firing costs.

A second approach by Bartelsman et al. (2013) suggests that resources are better reallocated when firm-specific productivity and firm size are positively correlated. Indeed, evidence presented suggests that the distribution of productivity and firm size are positively correlated. This relationship is stronger in the more

advanced economies compared to transition economies. This result is consistent with the OP's findings that following the deregulation of the US telecommunications equipment industry, the size/productivity covariance increased substantially which would indicate a better inputs and outputs reallocation.

In the continuity of OP, recent literature has mainly focused on two aspects of the resource reallocation. First, it seeks the presence of resource misallocation between incumbent firms: to what extent resources are reallocated from the less performing incumbent firms to the most performing ones? Second, it tries to assess the role played by the Schumpeterian creative-destruction process: to what extent resources released by exiting firms are reallocated towards entering firms?

BHC, for instance, use a fairly simple decomposition, with two main terms, a term for incumbent firms and a term for net entry. Nevertheless, the net entry term has a sensitivity to the frequency of entry and exit, which is too high due to not having any reference point, which means that the entry term is always positive and exit entry is always negative. Griliches and Regev (1995) (GR thereafter) and OP develop decompositions with a highlight on the incumbents. The decomposition proposed by GR has two terms, namely within and between terms, which are the contribution of the learning by the firm and the reallocation of resources between firms, respectively, and is well fitted for incumbents but not for the entering and exiting firms during the period considered. They treat them simply as the same firms to seek changes in the industry productivity.

On the other hand, OP do not consider those firms and focus on the potential misallocations among incumbent firms. Their decomposition has two terms. One is the average productivity in the economy considered, while the second is a covariance term allowing to measure allocation performances in the sector considered. Even if it is not sensitive to same bias as the decompositions derived from BHC, this one does not allow the use of entry and exit in the analysis, which can significantly contribute to reallocation (see Foster et al., 2006). In order to have a better understanding of the reallocation patterns for incumbents, entering and exiting firms,

FHK and MP proposed decompositions that include them all. The FHK decomposition is a refinement of the one developed by BHC, while MP add the entry and exit of firms in the decomposition of OP, seeking to reduce a potential bias in the entering firms' contribution of productivity growth, but does not compare entering and exiting firms to the overall set of firms in the first period, including exiting firms. The comparison set of firms is only the continuing firms of the year we see the firms, i.e.  $t$  for entering and  $t-k$  for exiting firms. Therefore, it then reduces the sample bias, due to the exclusion of the supposedly least performing firms from the reference productivity of entering and exiting terms. However, as Ben Hassine (2019) points out, this bias does not seem to always reflect in the data, so it will be interesting to see if we see any difference between the two decompositions.

Two main findings can be drawn from this literature. First, the contribution of the learning effect and reallocation of resources on productivity growth is unsettled and depends in particular of the period studied. In case of crisis, for instance, the decrease of demand induced firms to lower their production, leading to a lower firm production performance. Second, the cleansing played a role in the productivity changes thanks to the exit of less productive and already on the edge of withdrawal firms.<sup>2</sup> Exiters can affect the market in two ways: i) they help in reducing entry barriers in the market considered; ii) they allow incumbents to restructure themselves to catch up with the growth experienced before the crisis struck. Foster et al. (2006) test this effect and find that, in the US retail sector, firms' renewal during the 1990's help reallocation resources, while Lentz and Mortensen (2008) test the creative-destruction theoretical model they have developed on Danish firms' data between 1992 and 1997. To estimate this impact, the latter use both FHK and BHC decomposition and use the Denmark data to estimate the parameters of the theoretical model. From the theoretical model, they derive a decomposition of productivity with three main terms: i) a net entry term which capture the creative-destruction process,; ii) a residual term which account for the impact of heterogeneous growth

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<sup>2</sup>We define exiters as firms exiting operating in the market in  $t-k$  but not in  $t$  anymore.

rate after entry, and; iii) a selection term that account for the share of continuing firms' growth. From the last term, they find that 53% of Denmark's aggregate productivity growth came from labor reallocation.

Considering the French case, Cette et al. (2017) find that, since the beginning of the 2000s, the dispersion of productivity has increased, while they do not find any evidence of decrease in innovations. Their results point towards a less efficient reallocation of resources than in the 2000s. Moreover, Fontagné and Santoni (2015) confirm this finding and show that most misallocations, measured as the gap of the wages from the product's marginal value, occur for smaller and older firms. Finally, the comparison between reallocation and firms' turnover (i.e., the exit and entry of firms in a market) of Osotimehin (2019) shows that in France from 1989-2007, reallocation contributed more to the sectoral productivity than the process of creative destruction described by Schumpeter (1942), and can be understood as a "cleansing effect" of the market. Indeed, the entry of new firms in a market might lead to the exit of old firms since the former bring innovations that discard the latter.<sup>3</sup>

### **3.3 Empirical strategy**

In this section, we will first present the databases we use and then we will present the methodology we adopt to, both, decompose the productivity growth and infer the significance of each term.

#### **3.3.1 Data**

We use multiple databases to obtain all the information we need. First, the official bulletin of civil and commercial announcements database (BODACC henceforth) gives us information about firms in such acute financial distress that they

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<sup>3</sup>For a more comprehensive theoretical framework of the creative-destruction process, see Aghion and Howitt (1992).

are involved in a bankruptcy procedure between 2008 and 2016. According to the INSEE definition, a firm is considered defaulting when it cannot reimburse its creditors for 45 consecutive days. When this situation occurs, two different legal procedures can be triggered: a reorganization or liquidation. The Court makes the decision, which rules if the firm's assets can be reorganized to face the liabilities or not. If the Court decides it is feasible, a reorganization procedure is triggered; otherwise, a liquidation procedure starts.<sup>4</sup> However, in both cases, the firm is considered a defaulting one.

Because decompositions use a firm-level productivity index, we use the total factor of productivity (TFP hereafter). However, since it is unobservable, we need to estimate it. To do so, we estimate a Cobb-Douglas production function using the control variable methodology of Levinsohn and Petrin (2003), which corrects the estimation for both simultaneity and selection biases. We can write the production function in a way to show the TFP:

$$y_{it} = \log(tfp_{it}) + \beta_l l_{it} + \beta_k k_{it} + \varepsilon_{it} \quad (3.1)$$

where  $y_{it}$  is the value-added (i.e., the output) of the firm  $i$  at the time  $t$  in logarithm,  $l_{it}$  and  $k_{it}$  are, respectively, the labor and capital inputs used to produce, also in logarithm,  $\beta_l$  and  $\beta_k$  are their elasticities,  $\varepsilon_{it}$  is the idiosyncratic shocks, and  $\log(tfp_{it})$  is the productivity index. The input and output parameters come from two databases. First, Uni-fied Corporate Statistics System, the File approaching the results of the Elaboration of Annual Statistics of Companies (FICUS and FARE respectively) are then used to obtain the valued-added and the capital of the firms. FICUS is the database used until 2007 included, and FARE replaced it starting from 2008. From this database, we also use an auxiliary variable necessary to identify the elasticities, the intermediate input in the case of Levinsohn and Petrin (2003) methodology. Second, since it is the most trustworthy base for social data, we use

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<sup>4</sup>A third procedure exists, the safeguard procedure. Nevertheless, since the procedure must start before the firm enter in a cessation of payment, we do not consider these firms as defaulting.

the annual declarations of social data (DADS) to obtain information on the labor input. The results of the production function estimation are reported in Table C.1.1.

### 3.3.2 Decompositions and Standard Errors

#### 3.3.2.1 Decompositions

Decompositions of productivity can be classified according to two basic specifications with refinements. The first branch is the OP decomposition, with the average productivity and a co-variance term of productivity and market share. MP use this static decomposition and convert it into a dynamic one, which allows assessing the contribution of entry and exit of firms. The other branch takes roots in the BHC decomposition, which proposed a decomposition of the productivity growth into four components: two for the incumbents (a within-effect term, a reallocation-effect term), and two others for the net entry (an entry term and an exit term). The decomposition of GR and FHK are refinements of the BHC one. While the first uses the average aggregate productivity between the two periods considered between the two periods, the seconds use the average aggregate productivity at the beginning of the period considered. Moreover, the FHK decomposition introduces a covariance term. We present this decomposition below:

$$\begin{aligned}
 \Delta P_t = & \underbrace{\sum_{i \in C} \theta_{it} \Delta p_{it}}_{\text{Within effect}} + \underbrace{\sum_{i \in C} \Delta \theta_{it} (p_{it} - P_{t-k})}_{\text{Between effect}} + \underbrace{\sum_{i \in C} \Delta \theta_{it} \Delta p_{it}}_{\text{Covariance}} \\
 & + \underbrace{\sum_{i \in N} \theta_{it} (p_{it} - P_{t-k})}_{\text{Entry effect}} - \underbrace{\sum_{i \in X} \theta_{i,t-k} (p_{i,t-k} - P_{t-k})}_{\text{Exit effect}} \\
 & \underbrace{\hspace{10em}}_{\text{Net entry effect}}
 \end{aligned} \tag{3.2}$$

Where  $P_t$  is the average productivity in year  $t$ ,  $p_{it}$  is the productivity of the firm  $i$  in year  $t$  and  $\theta_{it}$  is the weight of the firm  $i$  in the market at the year  $t$ . As a productivity measure, we use the total factor productivity in logarithm.  $C$  subset encompasses the continuing firms of the sample, i.e., firms that stay in the market from  $t-k$  to

$t$ ,  $X$  the exiting firms, i.e., the firms in the market in  $t-k$  but not in  $t$ , and  $N$  the subsample of firms entering the market, and still performing on the market in  $t$ . The "within" term represents the share of productivity resulting from the evolution of the continuing firms while performing in the market, namely the learning effect. The second term (between) modifies the aggregate productivity growth following a change in the market composition, while the third one (covariance) is an interaction term between productivity changes and size changes between the two periods. This term can be interpreted as a misallocation since it shows if the market and the productivity grow in the same direction. For example, a firm with an important dynamic of productivity enhancement should also be the one with a market share growing rapidly. However, if this term can be understood as part of the reallocation effect, it does not mean the most productive firms will have the biggest growth. Finally, the last terms encompass the contribution of both the entry and the exit. The entry part is positive when entering firms are more productive than the average aggregate productivity in  $t-k$ . Therefore, they should be more productive than the overall firms previously producing, including the exiting firms. The exiters' contribution is the difference between their productivity in  $t-k$ , i.e., the last time we observe them, and the overall productivity at the same period. If the exiters have lower productivity than the average of the firms, then it contributes positively on the productivity growth. These last two terms are the Schumpeterian "cleansing effect" contribution to the evolution of aggregate productivity.

However, we can see the first limitation here. Among the exiters, there is significant heterogeneity of cases. Since the exiting firms are defined as exiting firms from our databases, we have three central cases that fall into two categories: i) the firm exiting is a well-performing one, is recognized as a valuable acquisition by a bigger firm, and is bought in merger-acquisition, thus leaves the database, but not the market; ii) the firm is not performing well enough, and the manager does not see a good reason to stay in the market since the firm cannot compete against its competitors but do not have debts, so it leaves the market and our database; iii) the

firm is not performing well enough and has accumulated too much liabilities and cannot reimburse its creditors, falling into a bankruptcy procedure and disappear from our database. In the first case, the exit is positive, with a good outcome because of good performances. In the other two cases, the exit falls into the category of a good exit because of the poor performances displayed by the firms. To take this into account, and thanks to the BODACC database allowing us to distinguish defaulting firms from the others, we propose the following alternative to this decomposition:

$$\begin{aligned}
\Delta P_t = & \underbrace{\sum_{i \in C} \theta_{it} \Delta p_{it}}_{\text{Within effect}} + \underbrace{\sum_{i \in C} \Delta \theta_{it} (p_{it} - P_{t-k})}_{\text{Between effect}} + \underbrace{\sum_{i \in C} \Delta \theta_{it} \Delta p_{it}}_{\text{Covariance}} + \underbrace{\sum_{i \in N} \theta_{it} (p_{it} - P_{t-k})}_{\text{Entry effect}} \\
& - \left( \underbrace{\sum_{i \in X_d} \theta_{i,t-k} (p_{i,t-k} - P_{t-k})}_{\text{Exit of defaulting firms effect}} + \underbrace{\sum_{i \in X_{nd}} \theta_{i,t-k} (p_{i,t-k} - P_{t-k})}_{\text{Exit of non-defaulting firms effect}} \right)
\end{aligned} \tag{3.3}$$

where  $X_{nd}$  and  $X_d$  are respectively non-defaulting and defaulting firms that exit the market between  $t-k$  and  $t$ . Since MP describe a potential bias in the entering and exiting terms of the FHK decomposition, we will also use their decomposition. This bias comes from the productivity used as a reference to compare the productivity of exiting and entering firms. The decomposition they propose as an alternative is a dynamic version of the one introduced by OP. The static one decompose the productivity between two terms: a baseline productivity in  $t$  and a covariance term that measure the individual deviation from the baseline productivity:

$$\begin{aligned}
P_t &= \sum_i \theta_{it} p_{it} = \bar{p}_t + \sum_i (\theta_{it} - \bar{\theta}_t) (p_{it} - \bar{p}_t) \\
&= \bar{p}_t + \text{cov}(\theta_{it}, p_{it})
\end{aligned} \tag{3.4}$$

The dynamic version of this decomposition allow us to introduce the contribution

of firms' turnover in the productivity growth, with a decomposition as follow:

$$\begin{aligned}
\Delta P_t = & \underbrace{\Delta \bar{p}_t}_{\text{Within effect}} + \underbrace{\Delta \text{cov}(\theta_{it}, p_{it})}_{\text{Reallocation}} + \underbrace{\sum_{i \in N} \theta_{it} \left[ \sum_{i \in N} \frac{\theta_{it}}{\sum_{i \in N} \theta_{it}} p_{it} - \sum_{i \in C} \frac{\theta_{it}}{\sum_{i \in C} \theta_{it}} p_{it} \right]}_{\text{Entry effect}} \\
& - \underbrace{\sum_{i \in X} \theta_{i,t-k} \left[ \sum_{i \in X} \frac{\theta_{i,t-k}}{\sum_{i \in X} \theta_{i,t-k}} p_{i,t-k} - \sum_{i \in C} \frac{\theta_{i,t-k}}{\sum_{i \in C} \theta_{i,t-k}} p_{i,t-k} \right]}_{\text{Exit effect}}
\end{aligned} \tag{3.5}$$

where  $\Delta \bar{p}_t = \frac{1}{n_t} \sum_{i \in C} p_{it} - \frac{1}{n_{t-k}} \sum_{i \in C} p_{i,t-k}$ . The within-effect in this decomposition, contrary to the one from FHK decomposition, is an unweighted average productivity of continuing firms while the covariance effect is a change in the covariance term of OP decomposition. Therefore, we cannot directly compare the two decompositions we use. Concerning the last term, it can be split in two distinct part to distinguish the contribution of defaulting firms and non-defaulting ones the same way as in Equation (3.3), which is as follow:

$$\begin{aligned}
\Delta P_t = & \Delta \bar{p}_t + \Delta \text{Cov}(\theta_{it}, p_{it}) + \sum_{i \in N} \theta_{it} \left[ \sum_{i \in N} \frac{\theta_{it}}{\sum_{i \in N} \theta_{it}} p_{it} - \sum_{i \in C} \frac{\theta_{it}}{\sum_{i \in C} \theta_{it}} p_{it} \right] \\
& - \underbrace{\sum_{i \in X_d} \theta_{i,t-k} \left[ \sum_{i \in X_d} \frac{\theta_{i,t-k}}{\sum_{i \in X_d} \theta_{i,t-k}} p_{i,t-k} - \sum_{i \in C} \frac{\theta_{i,t-k}}{\sum_{i \in C} \theta_{i,t-k}} p_{i,t-k} \right]}_{\text{Exit of defaulting firms effect}} \\
& - \underbrace{\sum_{i \in X_{nd}} \theta_{i,t-k} \left[ \sum_{i \in X_{nd}} \frac{\theta_{i,t-k}}{\sum_{i \in X_{nd}} \theta_{i,t-k}} p_{i,t-k} - \sum_{i \in C} \frac{\theta_{i,t-k}}{\sum_{i \in C} \theta_{i,t-k}} p_{i,t-k} \right]}_{\text{Exit of non-defaulting firms effect}}
\end{aligned} \tag{3.6}$$

### 3.3.2.2 Standard Errors

To provide a better understanding of resource misallocation, we propose to implement statistical inference on the decompositions through bootstrapping. A limit of the decompositions proposed until now is the lack of insight into the significance

of each term. The literature suggests ways to find magnitudes, but magnitudes are not enough if they are not paired with their significance. To overcome this issue, we propose a method to estimate standard error using the bootstrap methodology. To do so, we set up our bootstrap methodology by using all the firms in our sample. If a firm is selected in an iteration, all its apparitions in the databases are selected. We use the unrestricted random sampling method to have both an equal probability of selecting firms and the possibility of replacement. However, we need to generate enough replications; therefore, we perform 100 iterations to raise the likelihood of converging to each term's real value. We also decided to set each sub-sample before any calculations, and force them to be representative of the overall population, by stratifying each of them at the sector and type (incumbent, entering, exiting) level.

## **3.4 Results**

### **3.4.1 Statistics**

We see, from Table 3.1, that the overall average productivity is close to that of the incumbents. Indeed, the number of firms staying in the market is higher than the two other categories of firms. Nonetheless, these firms do not necessarily have the highest productivity average. In the first two years of the first period, exiting firms that are not involved in a bankruptcy procedure have a higher productivity, on average, than the continuing firms: 64.511 in 2006 and 63.605 in 2007 for the non-defaulting exiting firms versus 61.179 and 62.339 respectively for incumbents. However, the last year we observe them, i.e. in 2008, their productivity has dropped below that of the incumbents. Contrarily, the other firms exiting the economy, the defaulting ones, are consistently under-performing. However, during this first period the same pattern arise: when the 2008's crisis happens, all types of firms experience a downfall in their productivity.

In the second period, all types of firms display an increase in their productivity

Period	Year	All firms	Incumbents	Entering	Exiting		
					All	Defaulting	Others exit
Period 1	2006	61.229	61.179		62.377	41.490	64.511
	2007	61.975	62.339	55.789	61.414	39.972	63.605
	2008	58.265	59.111	51.820	55.126	34.807	57.202
	2009	56.768	56.982	54.913			
	Average	59.512	59.903	53.888	59.639	38.756	61.773
Period 2	2010	58.558	59.496		51.377	37.718	59.900
	2011	60.152	60.953	58.572	52.685	38.087	62.252
	2012	59.042	59.750	55.715	52.247	37.025	62.256
	2013	58.540	59.205	54.078			
	Average	59.074	59.851	55.393	51.958	37.728	61.068

Table 3.1: Average TFP

over time, even if they do not return to their pre-crisis levels. Nevertheless, incumbent firms, on average, perform less than the non-defaulting exiters. As shown in Table 3.2, this category of exiting firms are less dominant in the subsample of exiting firms; the proportion of defaulting firms have risen from 9.3% to 38.4%. One explanation could come from the BODACC database. If the data on bankrupt firms starts in 2008, we can only see firms that exit the market before that date and appear in the BODACC starting 2008. Thanks to the existence of a lag between the year of disappearance of the firms in the FICUS-FARE database and the appearance of the firms in the BODACC database, we can see some of the exiting firms that appear to be bankrupt years after their exit from the other databases. Still, the overall exiting firms' productivity is substantially lower than the incumbents.

Considering the entering firms, they do not have the same performances that the incumbents' have. Moreover, it seems that they do not have the dynamic to improve their performances to match that of their competitors.

From Table 3.2, we see that the differences in productivity that we observe between incumbents and non-defaulting exiters might come from the higher heterogeneity of incumbents. While incumbents account for 86.3% and 78.1% of firms in the first and second period respectively, while the non-defaulting exiting firms account for 3.4% and 6.3% of all firms, in the first and second period respectively.

It will be interesting to see if the large gap between defaulting and non-defaulting exiting firms is reflected in the different decompositions. Moreover, the differences of contribution from the two kinds of exits on the resource reallocation should also be interesting.

Type of firms	2006-2009	2010-2013	2006-2013
Incumbents	166,414	171,876	141,986
Entering	19,220	25,588	55,478
All	7,258	22,468	31,686
Exiting			
Defaulting	673	8,638	9,760
Other	6,585	13,830	21,926

Table 3.2: Number of firms according to their type

### 3.4.2 Decompositions

The results of the proposed decompositions are displayed in the next sections. We show the differences between decompositions and the difference of terms inside them.

#### 3.4.2.1 Exit term: usual definition vs. decomposition

Period	Incumbents		Entry	Net entry			$\Delta P$ (%)
	Within	Reallocation to continuing firms		All exit	Exit due to default	Other exits	
FHK							
2006-2013	-4.891	2.243	-3.573	1.024	1.320	-0.297	-5.197
2006-2009	-23.766	28.556	-0.248	-0.273	0.124	-0.397	4.269
2010-2013	-3.249	1.590	-1.537	1.879	1.564	0.315	-1.317
MP							
2006-2013	-4.890	1.438	-2.988	1.243	1.387	-0.144	-5.197
2006-2009	-24.259	29.548	-0.735	-0.285	0.123	-0.407	4.269
2010-2013	-0.123	-1.735	-1.567	2.108	1.649	0.459	-1.317

Table 3.3: FHK and MP Decompositions - All sectors

In the results displayed in Table 3.3, we see that, there are a lot of heterogeneity across periods and terms. By focusing first on the full 2006-2013 period for the whole French economy, we see that, for the incumbent firms the reallocation inside

firms and the reallocation between firms bear opposite signs. The first one reflects the ability of firms to learn and progress over time, while the reallocation to continuing firms encompass both between-effect and covariance terms. The learning term is negative, and the second one is positive, but is insufficient to compensate the poor performance of the learning effect.

Considering the net entry on the whole period, i.e. the addition of entry and exit, the contribution is negative, at -2.549 percentage points (pp thereafter) for the FHK decomposition and -1.745pp for the MP one. In both cases, this is mainly due to the effect of entering firms that do not perform as well as either the average firms or the average incumbent in the market. But the exiting firms, if they contribute positively on the productivity growth, they do not have the same contribution according to the way they exit.

Defaulting firms contribute positively the reallocation of resources (1.320pp for FHK and 1.387pp for MP), while non-defaulting firms have a negative contribution on productivity growth (-0.297pp and -0.144pp for FHK and MP respectively). Therefore, it seems that defaulting firms are, on average, firms that had to exit the market. By doing so, they help firms that are more efficient to access the production factors they should have (mis)used if they stayed in the market. In contrast, the fact that the other exiting firms seem to contribute negatively, on average, the productivity growth points toward the exit of firms that should not have left the market, but did anyway. This might be due to other form of exits, such as merger-and-acquisitions, that make well-performing firms disappear from the database. However, both signs and magnitude of the different effects differ across industries.

As shown in Table C.2.1, when we analyze the incumbents' contributions in each sector, we see that the terms have globally opposite contribution on the reallocation of resources. On the one hand, for the learning effect, we see that, if the majority of sectors have negative values for this term, in food products, beverages and tobacco industries, information and communication industries, financial activities and insurance industries and especially in the wood and paper industries, the

learning effect on productivity growth is positive. In the wood and paper industries it is even the effect that drives the productivity growth in this sector. On the other hand, the reallocation between incumbents contributes almost always positively towards productivity growth. Only financial activities and insurance industries have a negative contribution of reallocation between incumbent firms. Nonetheless, the magnitude of this term is mainly low, thus it does not drive the reallocation in the different sectors, with the notable exception of electric, electronics, and informatics products industries.

After taking into account the role of incumbent, we can see the contribution of the creative-destruction process through the effect of both entering and exiting firms from the market. Considering the first category, we see that, overall, the firms that are entering into the market seem to be less efficient than the average firms in the market at the end of the period. The fact that only two sectors have positive contribution of their entering firms over the period (namely wood and paper industries and real estate activities) points toward a deficit of performances for entering companies in almost all sectors in the economy. The other side of the creative-destruction process, the exits of firms, have an inverse conclusion. Apart from the legal, accounting, management architectural, engineering, control and technical analysis activities, the exit of the firms allows the industries to reallocate their resources towards better-suited firms. When entering into further details of the exit, we see that defaulting firms' contribution on productivity growth is always positive, even if the magnitudes are not especially large.

The results are more mixed concerning the other exiting firms' contributions. It can either be positive or negative. In some cases it can even drives the exit terms value. The only sector contributing negatively to the overall exit term also has the highest value, in absolute terms, and is negative. Therefore, it outweighs the positive contribution of the defaulting firms' exits. Then, we clearly see a distinction between the contributions of the two types of exits. In one case we have evidence that, on average, the defaulting firms exiting the market are less performing than

the average firms in their market. In the other case, the results are more heterogeneous. If the contribution of exiting firms on resource reallocations can be both large and positive, it can also be negative. In this latter case, firms that do not suffer from a lesser competitiveness exit the market.

If the decomposition of productivity growth at the sectoral level is informative, the period might be too important and encompass different realities. Indeed, prior to 2008's economic crisis, both economy and productivity growth were hindered. For these reasons, we divide the time span in two periods: a first one from 2006 to 2009, and a second one between 2010 and 2013. The first time period encompasses the transition between the periods prior to the economic crisis to the beginning of it, while the second one covers the period post crisis. The results are displayed in Table 3.3 for all sectors and Tables C.2.2 and C.2.3 for a sectoral-level decomposition.

The main difference between the two periods is the magnitude of the incumbents' terms, both learning and reallocation ones. In the 2006-2009 period, the overall average effect of the productivity growth's learning component is at -23.766pp and the reallocation is at 28.566pp for FHK and -24.259pp and 29.548pp, respectively, for MP. From 2010 to 2013, the learning term is still negative and the reallocation one is still positive but the magnitudes of both terms for each decomposition dropped drastically.

Another interesting fact is the difference of the net entry across periods. In the first period, for the whole economy, exit and entry terms on both decompositions are negative, while in the second period the contribution of exits is positive and outweighs the negative entry terms. So the destruction component seems to drive the Schumpeterian process of creative-destruction. Moreover, during the period 2010-2013, in the exit term, the subsample of defaulting firms are the biggest contributors of the exit component: 1.564pp out of 1.879 for FHK decomposition and 1.649pp out of 2.108pp for MP one. For the 2006-2009 period, the exit of defaulting firms contributes positively to the overall growth, but their contribution

are outweighed by the negative contribution of the other exits term, leading to an overall negative exit contribution according to both decomposition method.

In the same way we observe heterogeneous results across sectors when analyzing the results of the decomposition between 2006 and 2013, the differences are also reflected after splitting the period in two. Indeed, the 2008's crisis struck the entire economy, but it contributes to each sector differently. For the incumbent firms, we see a clear difference between the two period considered. Compared to 2006-2009 period, the magnitude of the reallocation and learning terms both dropped in the second one. Even if they still mainly drive the reallocation process, the gap between incumbents and net entry is shrinking.

We also observe a clear difference in the entry and exit terms. The entrants in the 2006-2009 period have contributed negatively to the overall economic growth and in most of the sectors ones, but the magnitudes were not important. In the second period considered, the firms entering in the market can have a bigger contribution on productivity growth, especially in some sectors such as food products, beverages and tobacco sector or financial activities and insurance industries, which are the main contributor to their decompositions. The same conclusion arise for the exit terms. While the magnitude of the different exit terms are low in the first period considered, in the 2010-2013 period, there magnitudes are all higher. Moreover, the overall contribution of exits is always positive across sectors. These overall exit terms are driven by the defaulting firms' component, except for the food products, beverages and tobacco sectors, the financial activities and insurance industries and the real estate activities sector. In these cases, the other exits terms were larger than the defaulting firms' term. In all sectors except for the information and communication industries, the exits also contribute positively to productivity growth.

These results are interesting, because they help us obtain an insight in the way the French bankruptcy framework discriminate firms in financial distress. Since firms in such an acute financial distress that they are involved in a bankruptcy procedure and exit the market contribute positively, we can say that the French

bankruptcy framework helps the reallocation process. It is especially true since its role appear to be even more important during the years following the 2008 crisis, notably after 2010, where the economic crisis started to be noticeable in France. The other exits do not have a contribution as clear as the defaulting firms. If in the 2010-2013 period they contribute positively to the productivity growth, in the 2006-2009 time span, they do not. If in some sectors they can act positively on the productivity growth, in other it is the opposite. Thus, the fact that the part that depends on the defaulting firms' exit is always positive means that the firms that are involved in a bankruptcy procedure and exit the market would have, indeed, misused the productions factors needed to produce, which would have, in turn, hindered global the productivity growth.

The difference of firms' turnovers at a sectoral level are also different. Compared to the 2006-2009 period, the entry and exit of firms have a more important contribution on the sector-level productivity growth. Entries are mainly negative across sectors between the two periods, but the magnitude increased after the crisis. The entering firms are less productive than the incumbents and seemingly even more after the crisis. Contrarily to entries, the differences between the pre- and post-crisis periods has a more significant contribution on exits. Prior to the crisis, the exits had mixed contribution on the productivity depending on the sector considered, while after the crisis, the components are always positive. If in both case the defaulting firms' part of the exit term are positive for all sectors, the magnitudes increase by a significant amount. The other types of exits are the share of exits that can cause the overall exit term to be negative in the first period. In the second one, these firms' exits have a positive contribution on the productivity growth. The only exception is the information and communication industries sector, but the overall exit term is still positive.

To sum up, when comparing the results of the two decompositions, we see that the results of each period are quite similar. In both cases we see the importance of incumbent firms. Between 2006 and 2009, the learning component show that

firms did not see their productivity grow. Even worse, they seemingly lost performances during the period. On the contrary, the reallocation between incumbent firms seems to have positive contribution on the productivity growth, and the magnitude of the effect is large enough to outweigh the learning effect. This points toward a good reallocation of resources from the least performing incumbent firms to the better performing one during this period. From 2010 to 2013, the incumbents' contribution become negative and drive the negative productivity growth. If the FHK decompositions point toward the learning effect that outweigh the reallocation one, the MP decompositions results show that the reallocation is the main contributor to the downfall of the productivity during this period. In both case, the reallocation of resources towards the best firms does not seem to work as efficiently as it was during the previous period.

Considering the net entry, we clearly see the negative contribution of the entering firms, which seem to be unable to be at either the average productivity of the firms in  $t$ , or at the average productivity of incumbent firms in  $t$ . The exit terms contribution varies more according to the sector and the type of exit considered. Since we want to seek the potential errors produced by the bankruptcy framework, we take an interest on the contribution of defaulting firms. The fact that the terms are always positive show that the defaulting firms that exit the market would have hindered the productivity growth. This results is robust to the method used and the time period. The contribution is higher in the period of economic difficulty that make the firms survival more difficult, but even in calmer periods, the influence is positive. Therefore, we can conclude that the French framework seem to work well to distinguish firms that are in unable to continue from the ones that are able to continue.

Period	Incumbents			Net entry			$\Delta P$
	Within	Reallocation to continuing firms		Entry	Exit		
		Between	Cov		Defaults	Other exits	
2006-2013	-4.896*** (0.069)	-0.787*** (0.039)	3.033*** (0.076)	-3.575*** (0.068)	1.318*** (0.021)	-0.289*** (0.037)	-5.196*** (0.105)
2006-2009	-23.776*** (0.259)	-0.387*** (0.047)	28.961*** (0.432)	-0.249*** (0.062)	0.123*** (0.006)	-0.394*** (0.018)	4.278*** (0.212)
2010-2013	-3.233*** (0.092)	-3.128*** (0.132)	4.708*** (0.143)	-1.533*** (0.048)	1.562*** (0.021)	0.320*** (0.030)	-1.304*** (0.104)

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### (a) FHK decompositions

Period	Incumbents			Net entry			$\Delta P$
	Within	Reallocation to continuing firms		Entry	Exit		
		Between	Cov		Defaults	Other exits	
2006-2013	-4.891*** (0.089)	1.438*** (0.076)	29.568*** (0.477)	-2.992*** (0.069)	1.385*** (0.023)	-0.136*** (0.042)	-5.196*** (0.105)
2006-2009	-24.271*** (0.277)	29.568*** (0.477)	29.568*** (0.477)	-0.737*** (0.065)	0.122*** (0.006)	-0.405*** (0.018)	4.278*** (0.212)
2010-2013	-0.114 (0.113)	-1.737*** (0.164)	-1.737*** (0.164)	-1.565*** (0.048)	1.647*** (0.022)	0.464*** (0.032)	-1.304*** (0.104)

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### (b) MP decompositions

Table 3.4: FHK and MP decompositions with bootstrap and default - All sectors

### 3.4.2.2 When adding bootstrap

Estimating the bootstrap is an important step to have a better understanding of the important source of resources' reallocation in the economy. At the first glimpse, we can see two things from the results displayed in Tables 3.4 to 3.6 and Tables C.3.1 to C.3.4: i) bootstrap estimations of each term for both decompositions are close to the ones obtain without it; ii) all terms do not differ significantly from zero.

Since the results are similar between the two methods, we can be confident about the robustness of our bootstrap methodology. The bootstrap seems to be a good methodology in order to obtain convergent estimations of the different terms of the decompositions. Thus, we do not have major differences for the magnitudes of the decompositions terms contributions to the productivity growth.

Considering the FHK decompositions reallocation among incumbents' terms, we do not present them as we previously done, we present each term separately, since

they were estimated separately. From the results of both decompositions for the whole economy's productivity growth during the entire 2006-2013 period, we see that each terms are highly significant. However, if we see that for the 2006-2009 period, all terms are significant for both decomposition method, the conclusions from 2010-2013 period differ slightly. If we cannot compare directly the learning terms from each decompositions directly, we see that the FHK one is significant at the 1% level, while in the MP decomposition it is insignificant.

If the results are similar at the economic-level, when we apply our methodology at the industry-level, we see that they also are similar to the initial decompositions. Therefore, we have the expected result of the high heterogeneity across sectors. First, during the 2006-2013 period we see that the Food products, beverages and tobacco industries are not significantly different from zero, thus, they do not contribute significantly the productivity growth. Considering contribution of exiting firms, we see the distinction between defaulting firms and the other exits. The former category contributes both positively and significantly the reallocation process, while the results are more mixed across sectors for the latter one. With both MP and FHK, the Transporting materials and the Other scientific and technical activities sectors do not contribute significantly the reallocation process according to the FHK decomposition. On the other hand, with the MP decomposition, other exit from the Other industrial products, coking and refining industries are highly significant, while with FHK they are not contributing significantly the reallocation process. Nevertheless, the defaulting firms exiting the market are the one that have a consistent positive contribution on resources reallocations, pointing toward an overall well-functioning French bankruptcy framework.

After assessing the significance of the contribution of the decompositions terms during the whole 2006-2013 period, we can analyze the two sub-periods to seek a change in the significance of each term depending on the economic cycle. Apart from the magnitudes of the terms, which are still roughly the same depending if we use the bootstrap or not, from the Tables 13 and 14, we see that in both period

Sectors	Number of firms	Incumbents			Net entry			ΔP
		Within	Reallocation to continuing firms		Entry	Exit		
			Between	Covariance		Defaults	Other	
Food products, beverages and tobacco industries	11,917	-0.172 (0.325)	-1.164*** (0.067)	2.053*** (0.291)	-12.652*** (0.308)	0.991*** (0.070)	2.504*** (0.156)	-8.440*** (0.453)
Other industrial products, coking and refining industries	20,986	-2.417*** (0.261)	-0.882*** (0.148)	2.938*** (0.244)	-1.184*** (0.097)	1.362*** (0.054)	0.115 (0.069)	-0.068 (0.279)
Electrics, electronics, informatics products industries	4,580	-1.227* (0.658)	-0.931*** (0.091)	3.581*** (0.569)	-0.833*** (0.199)	1.541*** (0.126)	0.355*** (0.133)	2.485*** (0.637)
Transporting materials	1,170	-10.573*** (1.194)	-0.788*** (0.159)	2.814*** (0.230)	-1.549* (0.790)	1.987*** (0.247)	-0.440 (0.381)	-8.550*** (1.380)
Clothing industries	2,260	-1.799** (0.812)	-0.201* (0.105)	2.168*** (0.188)	-1.073*** (0.342)	2.287*** (0.227)	0.567** (0.239)	1.950** (0.879)
Wood and paper industries	4,801	13.867*** (0.417)	-0.497*** (0.052)	2.845*** (0.338)	2.113*** (0.231)	1.421*** (0.142)	0.322** (0.137)	20.072*** (0.514)
Construction industries	39,010	-20.415*** (0.185)	-0.680*** (0.107)	3.842*** (0.186)	-6.871*** (0.087)	1.146*** (0.041)	0.231*** (0.039)	-22.747*** (0.152)
Wholesale and retail trade, transport, accommodation and catering industries	99,206	-2.057*** (0.115)	-0.944*** (0.061)	2.578*** (0.101)	-6.279*** (0.093)	0.874*** (0.025)	0.874*** (0.048)	-4.955*** (0.132)
Information and communication industries	6,621	1.228** (0.578)	-1.542*** (0.102)	3.274*** (0.338)	-2.406*** (0.365)	1.588*** (0.137)	-0.944*** (0.265)	1.198 (0.738)
Financial activities and insurance industries	2,184	5.131*** (1.333)	-1.959*** (0.358)	0.571 (1.128)	-9.973*** (1.403)	0.659*** (0.133)	2.564*** (0.814)	-3.007* (1.727)
Real estate activities	3,614	-6.180*** (0.720)	-0.947*** (0.136)	4.765*** (0.766)	1.884*** (0.615)	0.904*** (0.104)	1.932*** (0.275)	2.357** (0.932)
Legal, accounting, management architectural, engineering, control and technical analysis activities	18,710	-3.363*** (0.271)	-1.184*** (0.150)	2.542*** (0.358)	-2.099*** (0.221)	0.546*** (0.043)	-4.170*** (0.129)	-7.727*** (0.398)
Other scientific and technical activities	14,091	-1.908*** (0.317)	-0.962*** (0.069)	2.495*** (0.208)	-7.704*** (0.403)	1.517*** (0.119)	-0.306 (0.189)	-6.870*** (0.516)

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3.5: FHK decomposition with bootstrap and default – By sector (2006-2013)

using the FHK decomposition, the learning components are significant, with the notable exception of the Other industrial products, coking and refining industry for the 2010-2013 period. Regarding the reallocation, to continuing firms, we see that the inter-firm terms contributions of the reallocation, are either significant and negative, or insignificant in the case of the Transporting materials and the Clothing industries sectors. The covariance terms, which capture the fact that incumbent firms' productivity's trends should be the same than their market share evolution between the starting and ending year of each period considered (either both are raising or both are lowering). We see that in both the 2006-2009 and 2010-2013 periods, this is the factor that drive the positive reallocation we see in the decomposition without bootstrap. This is even more blatant in the first period, with the really high magnitude of these terms.

Considering firms' entries, the number of sectors where their contribution is

Sectors	Number of firms	Incumbents		Net entry			ΔP
		Learning	Reallocation to continuing firms	Entry	Exit		
					Defaults	Other	
Food products, beverages and tobacco industries	11,917	0.500 (0.400)	1.663*** (0.417)	-14.884*** (0.318)	1.144*** (0.074)	3.137*** (0.183)	-8.440*** (0.453)
Other industrial products, coking and refining industries	20,986	-1.554*** (0.341)	1.137*** (0.311)	-1.374*** (0.103)	1.483*** (0.059)	0.241*** (0.075)	-0.068 (0.279)
Electrics, electronics, informatics products industries	4,580	-0.097 (0.747)	1.683*** (0.638)	-1.267*** (0.208)	1.667*** (0.135)	0.499*** (0.142)	2.485*** (0.637)
Transporting materials	1,170	-10.796*** (1.345)	0.681* (0.395)	-0.225 (0.831)	2.116*** (0.266)	-0.325 (0.402)	-8.550*** (1.380)
Clothing industries	2,260	-1.754* (0.998)	1.699*** (0.306)	-1.532*** (0.348)	2.674*** (0.265)	0.863*** (0.263)	1.950** (0.879)
Wood and paper industries	4,801	17.740*** (0.526)	1.168*** (0.436)	-0.964*** (0.214)	1.634*** (0.155)	0.494*** (0.146)	20.072*** (0.514)
Construction industries	39,010	-23.261*** (0.202)	0.896*** (0.183)	-2.016*** (0.091)	1.290*** (0.045)	0.344*** (0.042)	-22.747*** (0.152)
Wholesale and retail trade, transport, accommodation and catering industries	99,206	-1.376*** (0.143)	1.146*** (0.121)	-6.795*** (0.099)	0.952*** (0.027)	1.118*** (0.054)	-4.955*** (0.132)
Information and communication industries	6,621	3.670*** (0.689)	0.496 (0.437)	-3.757*** (0.382)	1.629*** (0.144)	-0.841*** (0.304)	1.198 (0.738)
Financial activities and insurance industries	2,184	7.948*** (1.672)	2.048 (1.765)	-16.921*** (1.469)	0.690*** (0.139)	3.228*** (0.979)	-3.007* (1.727)
Real estate activities	3,614	-6.949*** (0.842)	4.295*** (1.043)	1.703*** (0.631)	0.987*** (0.110)	2.321*** (0.314)	2.357** (0.932)
Legal, accounting, management architectural, engineering, control and technical analysis activities	18,710	-3.923*** (0.408)	1.544*** (0.470)	0.295 (0.232)	0.419*** (0.044)	-6.062*** (0.198)	-7.727*** (0.398)
Other scientific and technical activities	14,091	-1.392*** (0.408)	1.263*** (0.294)	-8.252*** (0.433)	1.621*** (0.130)	-0.110 (0.220)	-6.870*** (0.516)

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3.6: MP decomposition with bootstrap and default – By sector (2006-2013)

non-significant is roughly the same between the two periods. However, all significant contributions to the productivity growth are negative, except for the Real estate activities sector in the 2006-2009 period. So, either entering firms are unable to meet their competitors' productivity or they are not statistically different from them.

Apart from the Legal, accounting, management architectural, engineering, control and technical analysis activities sector for the 2006-2009, the exits of defaulting firms contribute both positively and –highly– significantly for all sectors and period considered. The higher contribution of defaulting firms of the reallocation process, in the 2010-2013 period compared to the previous one, we identify with the decomposition without bootstrap are also confirmed.

It is interesting to note that the non-significant terms are not always in sectors with the least firms. Legal, accounting, management architectural, engineer-

ing, control and technical analysis activities, in the MP decomposition has a non-significant term of entering firms, while it is the fourth sector in firms' number. Moreover, non-significant contributions mainly arise when the contribution is close to zero.

Sectors	FHK			MP		
	2006-2013	2006-2009	2010-2013	2006-2013	2006-2009	2010-2013
All	[1.276; 1.360]	[0.111; 0.135]	[1.521; 1.603]	[1.340; 1.430]	[0.110; 0.134]	[1.604; 1.690]
Food products, beverages and tobacco industries	[0.851; 1.131]	[0.087; 0.203]	[0.948; 1.204]	[0.996; 1.291]	[0.090; 0.206]	[1.039; 1.306]
Other industrial products, coking and refining industries	[1.255; 1.468]	[0.118; 0.186]	[1.547; 1.875]	[1.367; 1.600]	[0.119; 0.188]	[1.633; 1.978]
Electrics, electronics, informatics products industries	[1.290; 1.791]	[0.122; 0.313]	[1.017; 1.637]	[1.400; 1.934]	[0.123; 0.316]	[1.069; 1.719]
Transporting materials	[1.497; 2.477]	[0.181; 0.437]	[1.719; 2.917]	[1.589; 2.643]	[0.184; 0.443]	[1.775; 3.045]
Clothing industries	[1.837; 2.738]	[0.155; 0.432]	[1.471; 2.490]	[2.149; 3.199]	[0.159; 0.439]	[1.635; 2.725]
Wood and paper industries	[1.140; 1.702]	[0.145; 0.282]	[1.508; 2.103]	[1.326; 1.941]	[0.148; 0.286]	[1.672; 2.319]
Construction industries	[1.064; 1.227]	[0.073; 0.108]	[1.656; 1.847]	[1.201; 1.379]	[0.074; 0.109]	[1.815; 2.024]
Wholesale and retail trade, transport, accommodation and catering industries	[0.824; 0.924]	[0.080; 0.109]	[1.146; 1.260]	[0.899; 1.005]	[0.080; 0.110]	[1.216; 1.334]
Information and communication industries	[1.317; 1.859]	[0.084; 0.217]	[1.132; 1.593]	[1.344; 1.915]	[0.083; 0.217]	[1.152; 1.631]
Financial activities and insurance industries	[0.395; 0.923]	[0.110; 0.121]	[0.239; 0.790]	[0.415; 0.965]	[0.110; 0.121]	[0.262; 0.825]
Real estate activities	[0.697; 1.110]	[0.068; 0.184]	[0.752; 1.142]	[0.769; 1.205]	[0.069; 0.185]	[0.800; 1.204]
Legal, accounting, management architectural, engineering, control and technical analysis activities	[0.460; 0.632]	[-0.005; 0.048]	[0.529; 0.810]	[0.333; 0.506]	[-0.021; 0.033]	[0.549; 0.838]
Other scientific and technical activities	[1.281; 1.752]	[0.024; 0.145]	[1.504; 1.899]	[1.363; 1.879]	[0.024; 0.145]	[1.589; 2.007]

Table 3.7: MP and FHK exit of defaulting firms confidence intervals (at the 5% level)

### 3.5 Conclusion

In this paper we interest ourselves about the way the reallocation process took place during a difficult period: the 2008's crisis. There is a slowdown in productivity in this period, but we wanted to understand how the types of firms, i.e. incumbents, entering or exiting, acted on the process. Moreover, we know that the firms that are exiting the market leave due to various reasons and not necessarily their low performances. Therefore, we decided to decompose the exiting firms' subsample into two distinct parts: i) firms that are involved in a bankruptcy procedure, the defaulting firms; ii) firms exiting the market for other, unspecified, reasons. The

interest of this distinction is twofold.

First, it helps us to have a better understanding about exiting firms' dynamics by distinguishing the contribution of firms in acute financial distress and other exits on productivity growth. Second, we can see if the French bankruptcy framework helps the market selection to discriminate firms that are not suited for their activities, to firms that are productive enough.

In addition to this contribution, we also propose a method using bootstrap that aims to assess the significance of the decompositions' terms. This method is easy to implement and provide results that are less subject to potential sectoral changes of firms compare to the method proposed to this day.

Our first main finding is that the contribution of the defaulting firms on productivity growth is always positive, even if the effects are not large in some sectors in the first period considered, while the contribution of other exits can be negative . Therefore, the contribution of exits on productivity growth is positive overall. Moreover, the years following the 2008's crisis, firms' exits contributed more substantially to the reallocation process than in the first period considered. If some heterogeneity exist, these results are robust across sectors. This result is consistent with the comparison made of insolvency frameworks, which rank the French one among the well-designed one (Adalet McGowan et al., 2018).

Our second main finding, is that the contribution of defaulting firms on the productivity growth is robust and is highly significant, both across sectors and periods. Only one sector do not have a significant contribution of these firms on the productivity's growth, but only on the first period considered. The non-significance of these contributions seems to be less related to the number of firms in the sample than the low magnitude of the terms.

So, we see that the French framework, not only seems to discriminate firms quite well, in period of crisis it helps the market considerably, and significantly, by liquidating firms that are not suited for the competition. This result seems to be in

line with the conclusions presented by McGowan and Andrews (2018). They state that the French framework have numerous measures to help firms that are viable to avoid bankruptcy, thanks to prevention and streamlining of firms.

However, our time span did not consider what happen after 2013, and the economic crisis did affect firms for few more years. That is why further research should be done to assess the contribution of defaulting firms on the reallocation process. Moreover, if defaulting firms that are efficient enough to continue their activities are one type of error possible, another encompasses the firms that should leave the market but are allowed to stay and keep producing, (mis)using the resources. These incumbent firms are considered zombie and should hindered the productivity growth. This question should also be tackled in future researches.

# **General Conclusion**

## Main results

The primary objective of this dissertation is to understand the mechanism behind the bankruptcy event in relation with the market selection process. On the one hand, in the first two chapters, we focus our attention on firms that are considered as being among the best performing firms (i.e. exporting and innovating firms), while being, at the same time, more likely to go bankrupt compared to the overall firm population. On the other hand, in the third chapter, we look at the way in which the exit of bankrupt firms contributes to productivity growth. Moreover, we focus on the period just before and after the 2008 crisis, i.e. the period where exits are at their peak, due to the destruction stage of the destructive-creation process.

From the first two chapters, we find that the least performing firms, among both the exporting and innovative firm populations, have an increased probability of exiting the market. This result is consistent with the existing literature. However, when controlling for the firms' performances, some subtleties arise. Firstly, when we consider the exporting firms, we see that the firms that invest too much in illiquid assets have a higher risk of bankruptcy. Additionally, we observe that the behaviors of defaulting exporters seem, primarily, irrational until it is too late, which points towards the presence of sunk costs fallacy. Secondly, for the innovative firms, we find a U-shaped relationship between firms' investments in R&D and their survival. This result highlights that a minimum level of asset investment is required in order to outweigh the risk associated with this high-risk activity. On the contrary, if the firms do not reach a certain amount of investment, this activity is detrimental to their survival.

The third chapter focuses on how productivity growth was impacted after the 2008 financial crisis, specifically in regard to the contribution that results from the exit of defaulting firms. As already seen in the literature, we find a decreasing trend in the years following the crisis, when the French economy was finally im-

pacted. During this period, we observe the positive and significant contribution of the bankrupt firms' exits to productivity growth. This is new evidence that the French bankruptcy framework is, overall, well-suited to distinguish firms that are not efficient enough to continue producing from those that are performing well and that should stay in the market. The impact was significant during this critical time during the economic crisis.

All these chapters use empiric strategies to tackle these problematics. To do so, we use administrative databases for firms' characteristics (capital, labor force, export/import status and intensity, innovation investments, etc.) that we have merged with Commercial Court rulings on insolvencies. As a result, we obtain an original and rich panel database that contains yearly information at the firm-level. It allows us to use empirical methods that take into account the bias from omitted variables that do not vary over time.

In this dissertation, we have four main contributions. Firstly, we decompose the sunk costs of exporting firms into two components, with one related to the domestic activities and the other to the exporting activities. This, to our knowledge is a first in the literature. Secondly, we have been able to implement a survival analysis in panel with a "frailty" that is shared by the firms over-time and that is not commonly used in the literature. Thirdly, we decompose the exit term of the productivity growth decompositions between the exits of defaulting firms and other exits. Lastly, to have a good grasp on the significance of the contribution of each term in these decompositions, we propose a bootstrap methodology to compute the average contribution of each term and their standard errors. This dissertation, therefore, also provides some methodological contributions. In addition, some policy implications can be drawn from our work. The following section\* will present and discuss them.

## Policy implications

From the first chapter, we see the importance of screening by the creditors of exporting firms. Indeed, when the illiquid assets of the firms resulting from the exporting activities become too important, the risk of failure increases for the firm. Therefore, the export insurance costs take this risk into account, which makes it even more expensive to export, reducing, mechanically, the profitability of such an activity. This jeopardizes the survival of other firms that could have sustained the sunk costs of exporting without this “additional premium”.

The second chapter focuses on the extensive margin of R&D, i.e. firms' expenditures in innovative activities. We observe that, since they will not have a return on investment high enough, on average, to stay competitive, firms that do not invest sufficiently will negatively affect their likelihood of survival. Moreover, if the threshold varies depending on the technology intensity required in the industry, firms that are not among the most efficient ones might benefit largely from investing more. In order to limit the risk taken, it may be interesting to concentrate the subsidies on these firms to help them grow without forcing them to invest their capital stocks. A large variety of public financing mechanisms exists, both direct and indirect, in order to incite firms to innovate or to help them sustain this highly capital-intensive activity. In France, the mechanisms are provided by the region, the country or at the EU-level and account for a €1.5 billion, according to Ben Hassine et al. (2020). Helping firms that invest more modestly might raise their survival probability. By doing so, the amount of investment necessary to raise firms' survival would come from the public financing mechanism and not from firms' illiquid assets. This could be even more effective in high-technology intensive sectors, where the investment in innovative activities required is the largest among the other sectors.

In the third chapter, we take an interest in productivity growth during a crisis

period. An important finding is that the framework seems to be well-suited to distinguish inefficient firms since the contribution of exiting firms facing bankruptcy is both positive and significant. Therefore, the French framework seems to be particularly well adapted to face periods of economic turbulence. Since the EU started a reflection about the harmonization of bankruptcy systems among its countries, we can confirm that, as stated by Adalet McGowan et al. (2018), the French framework is performing well in terms of avoiding undue liquidations and should be considered as an example in that regard. If this dissertation's chapters contribute to the economic literature on trade, bankruptcy, innovation and firms' performances, there are both some limitations and research perspectives that derive from them.

## **Limitations and research perspectives**

In this dissertation, we use administrative databases. If they contain the most objective and complete view of the firm population, they also have some drawbacks. First, the information available is sometimes incomplete, especially in the first two chapters. In the first chapter, we do not distinguish sunk costs according to the destination market nor do we consider the products' impact on survival. In the second chapter, we do not have as much information about the outcomes of the R&D as in the CIS survey. If the CIS survey does not allow the use of the panel dimension, due to a large attrition of firms across survey waves, it contains a lot of information about the outcomes of firms' innovation activities, contrary to the R&D survey. Therefore, we do not tackle the impact of the intensive margin aspect of R&D activities on firms' survival, but it could be interesting to see how R&D outcomes act on firms' survival.

The third chapter focuses on splitting the exit terms of the productivity growth decompositions into two subsamples to assess the performances of the bankruptcy framework: defaulting firms and other exits. However, as stated before, the framework should help the selection market process by helping inefficient firms to exit.

We can measure this in two ways: i) are bankrupt exiting firms the inefficient ones; ii) are the firms staying in the market the efficient ones. In this chapter, and in this dissertation, we focus on the first measurement method. If data limitation is not an issue here, the fact that we only account for the defaulting firms versus the other exits is a limitation in our analysis. Moreover, since we do not account for the inefficient firms that stay in the market, we do not conclude about their contribution to the productivity growth in this crucial post-financial crisis period. Nonetheless, since Adalet McGowan et al. (2018) show that the number of zombie firms is low in the French economy, it should not affect our results for continuing firms too much. Furthermore, since we wanted to assess how the different contributors of productivity growth are affected by the 2008 crisis period, we do not tackle the period following the immediate economic crisis recovery, i.e., from 2014 onwards.

This dissertation allows us to have a better understanding of the determinants that cause firms to go bankrupt. However, a lot of work has to be done to fully understand the mechanism behind bankruptcy, which can be derived from our work. To pursue the first chapter's research, we must tackle the relation between product and destination markets with bankruptcy. Moreover, in the theoretical models, the rule of exiting the market should also take into account the cessation of payments, since exporters' productivity is heterogeneous, and they are not always among the most productive firms. In order to better understand how R&D investments affect firms' survival, it could be interesting to further explore all the investments firms can mobilize to innovate: public subsidies, direct or indirect, should also be taken into account. By doing so, we could better understand the real impact of such measures on firms' survival. For the third chapter, a logical continuation would be to decompose the terms between "healthy" incumbent firms and "zombie" ones, i.e. those that cannot operate efficiently enough to stay in the market but continue to produce (Adalet McGowan et al. (2018)). This new decomposition would help us to comprehend how those firms hindered the productivity growth instead of exiting

the market.

Another further development of the last chapter would be to pursue the analysis until recent years to assess the productivity growth contributions of each type of firm, at least until the COVID-19 pandemic outburst. With the shutdown of businesses and Courts, and the help from the government, this pandemic is the last major shock, and to determine how the economy will manage to recover from it, we must understand the previous dynamics first. Moreover, the different shutdowns of the economy have shed light on the subsidies provided to help firms. In 2020, the French government spent €206 billion to help firms survive the losses caused by the stoppage of activity, but before that, other financial aids were already available. In 2021, 2069 public financial mechanisms are available for French firms for various needs (creation, exports, innovation, among others).<sup>5</sup> The way these public fundings act on firms' survival is another important topic to tackle, to have a better grasp on the way to improve the efficiency of public spending.

However, this dissertation focuses on the firms' side of the story before the default, but not during or after. Therefore, we do not consider the outcome of bankruptcy procedures. For instance, what happens to defaulting firms' workers or their creditors after the liquidation? Before the end of the bankruptcy process, is the process efficient, or could it be optimized? Thanks to the World Bank's Doing Business survey, we know that the French framework costs 9% of the firms' assets, and is ranked 33<sup>rd</sup> (see Table 1), but the recovery rate is at 74.8% for the creditors. Concerning the workers, to our knowledge, no work has been done to analyze the way in which being unemployed following the bankruptcy of a firm acts on the probability of finding a new job rapidly. These would be interesting subjects to tackle, in order to have a better understanding of these topics.

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<sup>5</sup>This number is available at <https://www.aides-entreprises.fr/>, which make an inventory of the public financial aids.

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# Appendices

# **Appendix A**

## **Appendix for Chapter 1**

# A.1 Legal procedures

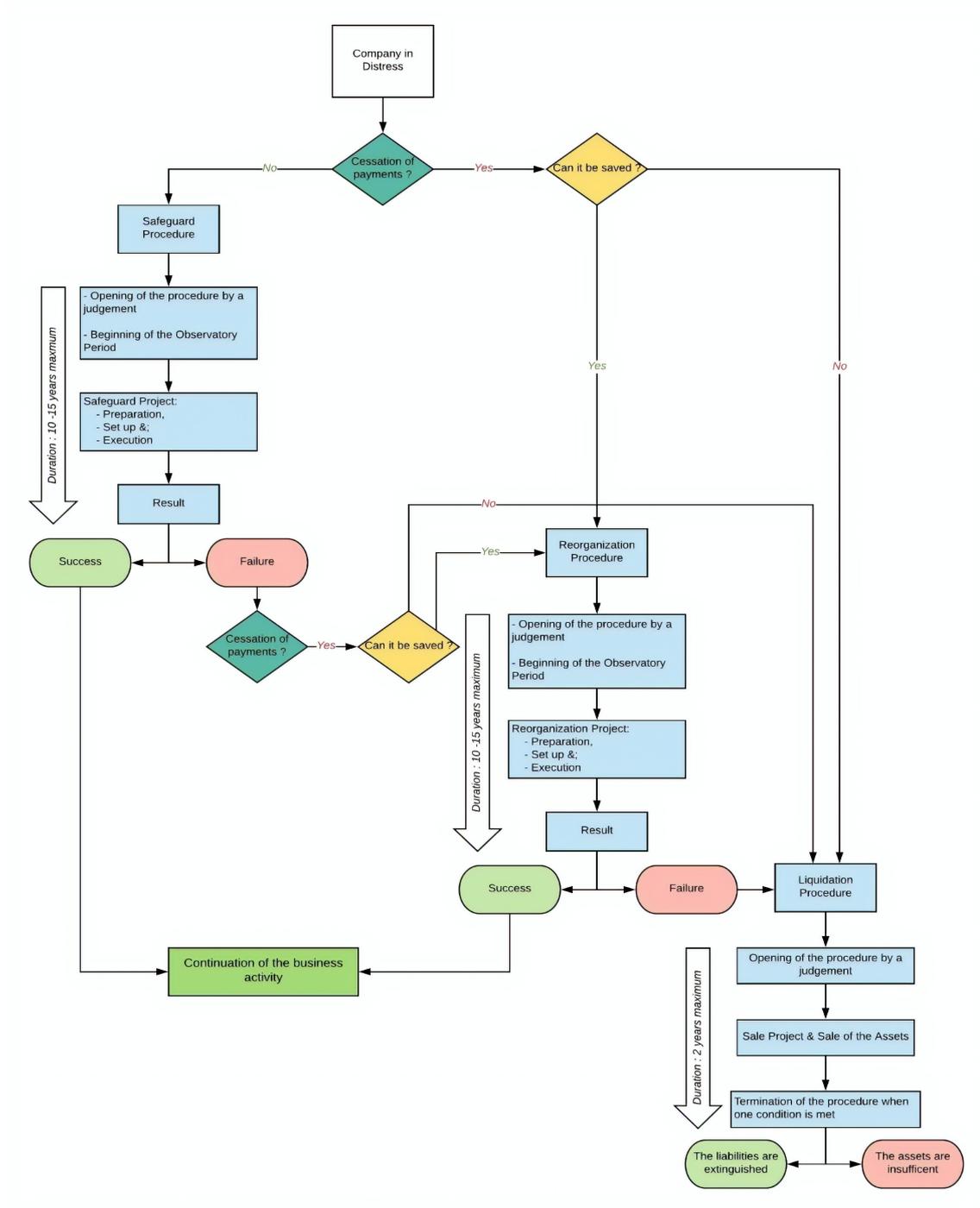


Figure A.1.1: French system of legal procedures

## A.2 Total factor productivity

To assess firms' performance, the total factor productivity (TFP thereafter) is a well-admitted measure. In brief, the firm productivity corresponds to what we cannot explain by the observable inputs, that is the contribution to the output of other inputs not used in the production function and to technological efficiency. We use a standard methodology which is based on a log-linearized Cobb-Douglas production function to measure the TFP with our sample of French firms.

$$Y = A_{it} K_{it}^{\alpha_K} L_{it}^{\alpha_L} \quad (\text{A.2.1})$$

where  $L$  and  $K$  are production factors (labor and capital, respectively), and  $A$  is the TFP. Since we can log-linearize this function, we can use linear estimators. However, the estimation of the production function raises some econometric issues. The first is the simultaneity problem. If the firm knows its unobserved productivity, then the amount of input used and productivity must be correlated. Hence, the OLS estimator of input elasticities will be biased. Another problem is that the exit of firms will be endogenous. We can link firm productivity to how well the company performs in the market. We can also link this performance to the firm's exit from the market. Therefore, the firm cannot randomly decide to exit; it should be a consequence of its productivity. In this case, the exit is not exogenous, which is the other reason why OLS will be biased. To control for these biases, Levinsohn and Petrin (2003) propose a solution using a control function. They do not instrument endogenous regressors but add a proxy variable to control for bias.

Contrary to Olley and Pakes (1996), they propose using materials instead of investment as a proxy. The number of firms using materials is much greater than the number of investing firms. Except for this difference in the proxy used, the two papers use the same methodology: a two-step, semi-parametrical estimator. The

log-linearized production function takes the following form:

$$y_{it} = \alpha_0 + \alpha_L l_{it} + \alpha_K k_{it} + \alpha_m m_{it} + \omega_{it} + \varepsilon_{it} \quad (\text{A.2.2})$$

where  $y_{it}$ ,  $l_{it}$ ,  $k_{it}$ , and  $m_{it}$  are, respectively, the output, labor, physical capital and intermediate inputs of firm  $i$  in year  $t$ , which operate in industry  $j$  (omitted for readability), while  $\alpha_0 + \omega_{it}$  is the TFP. Here, we allow the variation of technology across industries. The demand for  $m_{it}$  depends on the firm's capital and productivity:

$$m_{it} = m_{it}(k_{it}, \omega_{it}) \quad (\text{A.2.3})$$

Levinsohn and Petrin also show that we can invert the intermediate demand function, so  $\omega_{it}$  depends on  $k_{it}$  and  $m_{it}$ :

$$\omega_{it} = \omega_{it}(k_{it}, m_{it}) \quad (\text{A.2.4})$$

In the first step, they estimate labor elasticity, solving

$$y_{it} = \alpha_L l_{it} + \phi_{it}(k_{it}, m_{it}) + \varepsilon_{it} \quad (\text{A.2.5})$$

where

$$\phi_{it}(k_{it}, m_{it}) = \alpha_0 + \alpha_K k_{it} + \omega_{it}(k_{it}, m_{it}) \quad (\text{A.2.6})$$

They use a third-order polynomial approximation in  $k_{it}$  and  $m_{it}$  in place of  $\phi_{it}(k_{it}, m_{it})$ .

At this step, the labor elasticity is estimated. The second stage identifies the capital elasticity. We assume that TFP follows a first-order Markov process,

$$\omega_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it} \quad (\text{A.2.7})$$

where  $\xi_{it}$  is a productivity shock.

Finally,  $\hat{\alpha}_k$ , the estimation of  $\alpha_k$  is the solution to the minimization of the

squared sum of the sample residuals of the production function, given as

$$\min_{\alpha_k^*} \sum_{it} (\widehat{\varepsilon_{it} + \xi_{it}})^2 = \min_{\alpha_k^*} \sum_{it} (\hat{\alpha}_l l_{it} - \alpha_k^* k_{it} - E[\omega_{it} | \omega_{it-1}])^2 \quad (\text{A.2.8})$$

Levinsohn and Petrin (2003) use a control function methodology to control for both the simultaneity and the selection bias in the OLS estimator of the production function. To do so, they propose a two-step estimator, with a proxy that allows for identifying the labor and the capital intensity, the intermediates inputs. In the first step, they use a semi-parametrical function, with the non-parametric part estimated by a third-order polynomial function of intermediates and capital. This step estimates the labor elasticity, and then, the results are injected in the second step, which estimates the capital elasticity. Then, the estimation of the production function can be computed for each firm to find the value of  $\log(A_{it})$ , which is the variable  $tfp_{it}$ .

The results are displayed in the Table A.2.1 and are consistent with the literature.

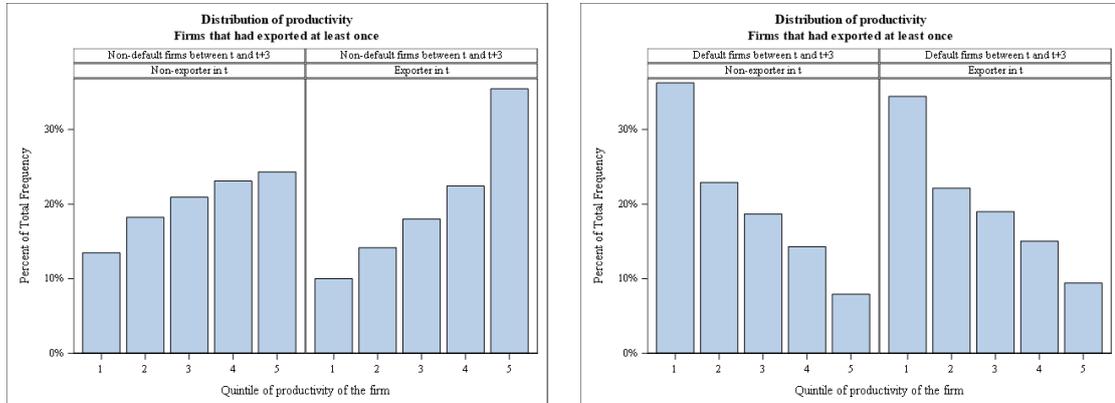
	(1) Food products, beverages, and tobacco	(2) Other industrial products, coking and refining	(3) Electrics, electronics, and informatics products	(4) Transporting materials	(5) Clothing industries	(6) Wood and paper industries
$l$	0.537*** (0.012)	0.613*** (0.007)	0.554*** (0.015)	0.637*** (0.031)	0.652*** (0.014)	0.617*** (0.015)
$k_{-1}$	0.185*** (0.013)	0.300*** (0.011)	0.357*** (0.025)	0.246*** (0.050)	0.341*** (0.035)	0.229*** (0.024)
# of obs	65,419	153,000	34,424	8,797	16,286	34,537

Standard errors in parentheses

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table A.2.1: Estimation of total factor productivity, 2006 – 2014

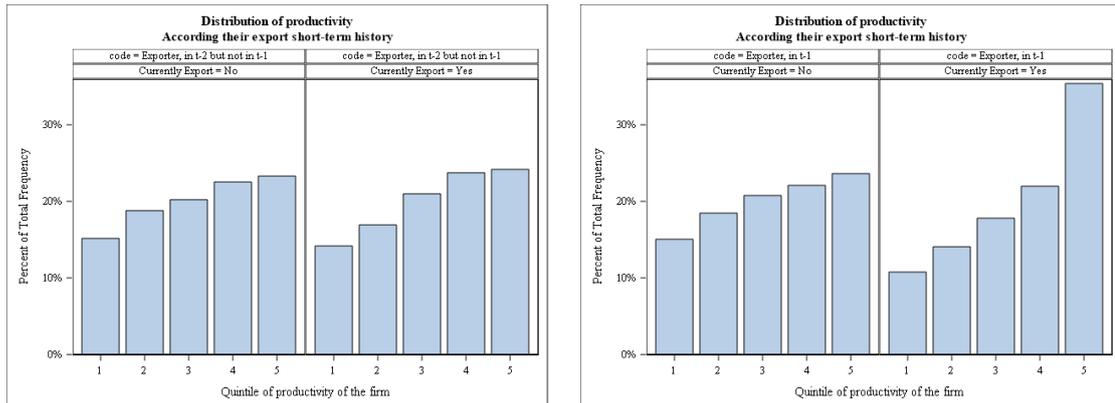
## A.3 Distribution of firms according to productivity



(a) Non-default firms

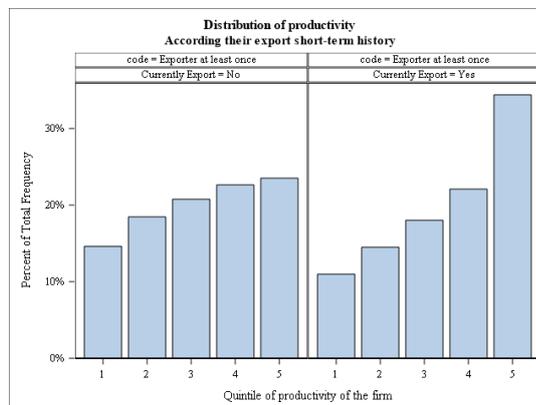
(b) Default firms

Figure A.3.1: Distribution of productivity for exporting firms, whether they export or not



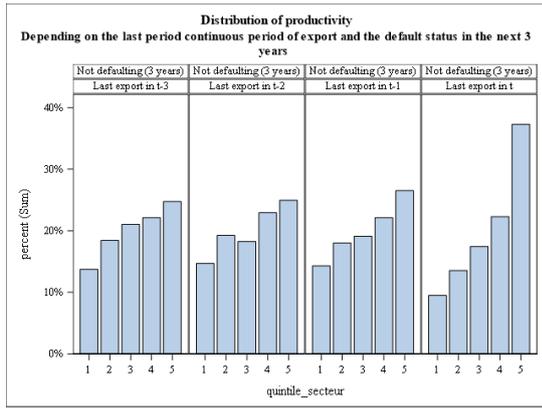
(a) Firms that exported two years ago

(b) Firms that exported one year ago

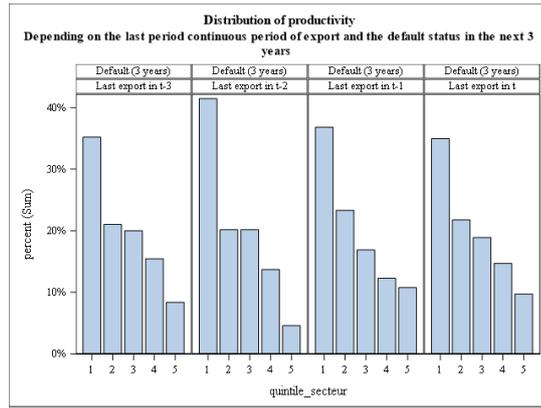


(c) Firms that had exported

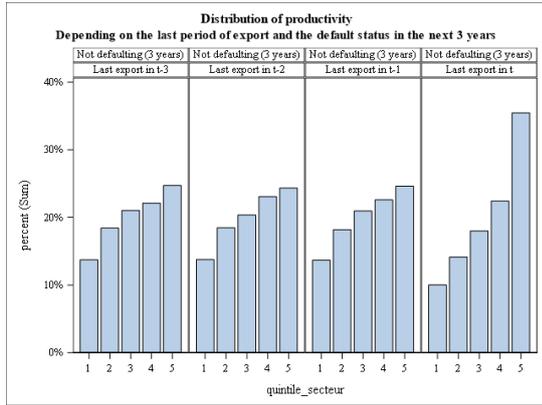
Figure A.3.2: Distribution of productivity depending on the short-term history of whether they export or not



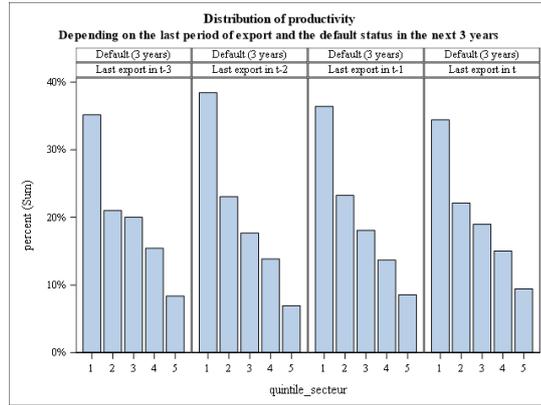
(a) Non-defaulting exporters (continuous)



(b) Defaulting exporters (continuous)

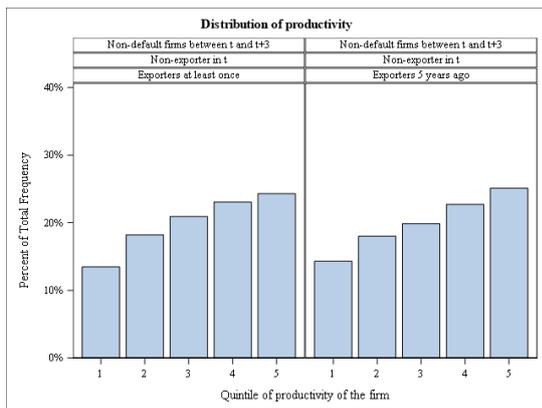


(c) Non-defaulting exporters

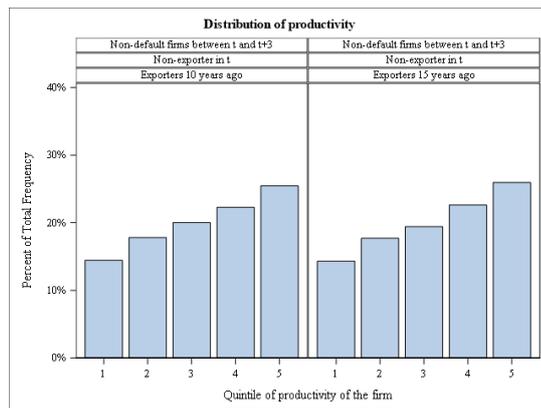


(d) Defaulting exporters

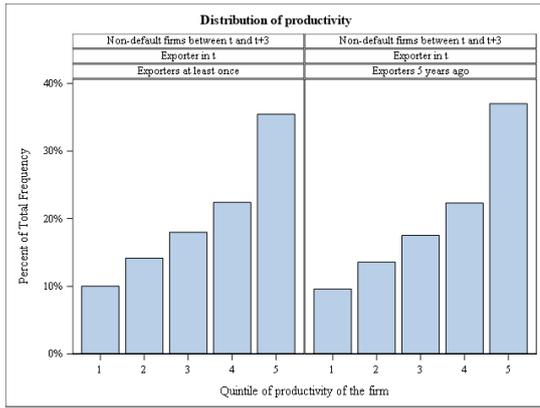
Figure A.3.3: Distribution of productivity depending on last exporting year, continuous or not



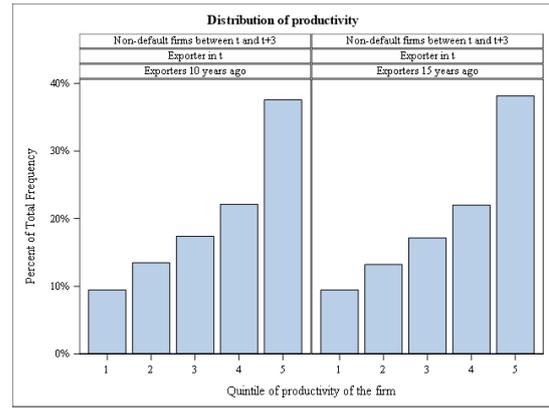
(a) Do not in  $t$  – at least once and 5 years ago



(b) Do not in  $t$  – 10 and 15 years ago

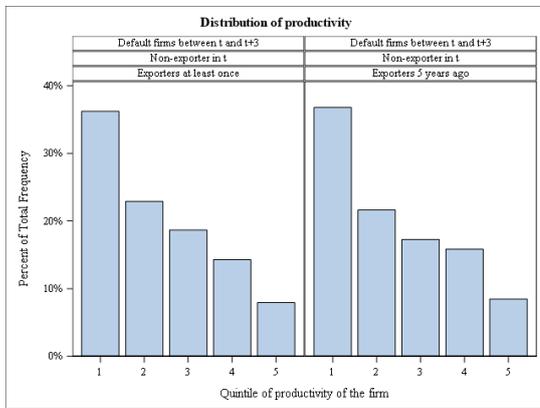


(c) Do in  $t$  – at least once and 5 years ago

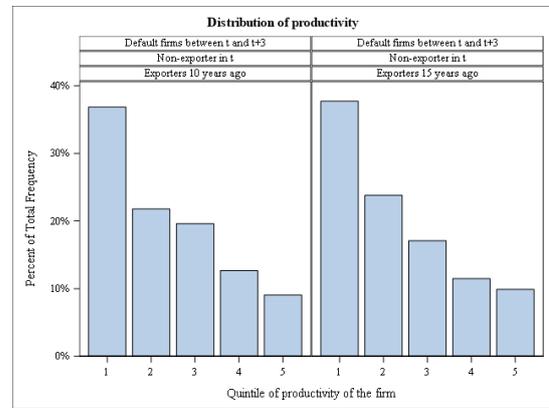


(d) Do in  $t$  – 10 and 15 years ago

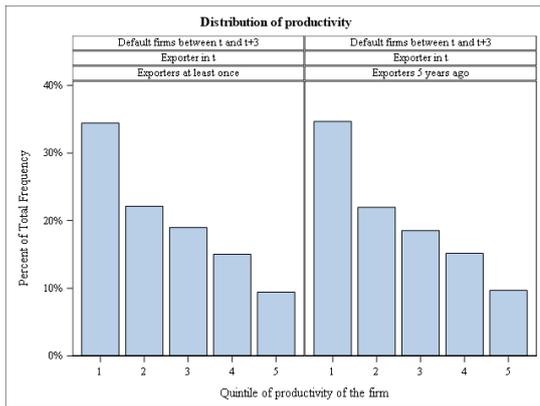
Figure A.3.4: Distribution of productivity for non-default exporting firms, whether they export or not in  $t$



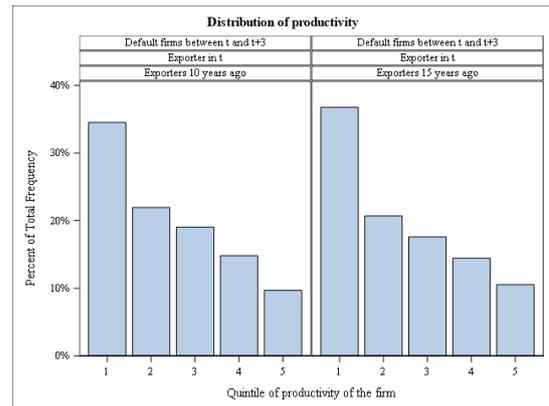
(a) Do not in  $t$  – at least once and 5 years ago



(b) Do not in  $t$  – 10 and 15 years ago



(c) Do in  $t$  – at least once and 5 years ago



(d) Do in  $t$  – 10 and 15 years ago

Figure A.3.5: Distribution of productivity for default exporting firms, whether they export or not in  $t$

## A.4 Export behavior according to the firm's default status

			Never	Defaulting			
			Defaulting	All	Before	After	
All	Variety	Average	47.34	28.61	30.34	24.03	
		Minimum	1	1	1	1	
		Maximum	10,805	1,883	1,684	1,883	
	Products	Average	15.00	10.15	10.68	8.76	
		Minimum	1	1	1	1	
		Maximum	1,739	382	339	382	
	Countries	Average	9.79	7.68	7.84	7.26	
		Minimum	1	1	0	0	
		Maximum	171	99	92	92	
	OECD	Variety	Average	4.85	2.82	3.00	2.32
			Minimum	0	0	0	0
			Maximum	1,388	235	235	200
Products		Average	3.66	2.30	2.48	1.83	
		Minimum	0	0	0	0	
		Maximum	946	235	235	200	
Countries		Average	0.78	0.66	0.66	0.64	
		Minimum	0	0	0	0	
		Maximum	6	6	6	6	
Non-OECD		Variety	Average	42.64	25.83	27.36	21.74
			Minimum	0	0	0	0
			Maximum	9,768	1,805	1,678	1,805
	Products	Average	14.16	9.67	10.15	8.41	
		Minimum	0	0	0	0	
		Maximum	1,721	380	336	380	
	Countries	Average	9.02	7.03	7.19	6.62	
		Minimum	0	0	0	0	
		Maximum	166	94	94	74	
	# obs			281,099	10,114	7,352	2,762

Table A.4.1: Number of varieties, products and destinations according to default status

Rank	Non-defaulting firms	Firms Before Default	Firms After Default
1	Belgium	Belgium	Belgium
2	Germany	Greece	Greece
3	Spain	Spain	Spain
4	Italy	Italy	Italy
5	Luxemburg	Germany	Bulgaria
6	United-Kingdom	Bulgaria	Germany
7	Portugal	Belarus	Netherlands
8	Greece	Portugal	Portugal
9	Netherlands	United-Kingdom	Lithuania
10	Austria	Ireland	United-Kingdom
11	Slovenia	Netherlands	Malta
12	Sweden	Luxemburg	Estonia
13	Cyprus	Estonia	Belarus
14	Angola	Papua New Guinea	Luxemburg
15	Ireland	Austria	Ireland

Table A.4.2: Most frequent destination depending on the firms defaulting status

## A.5 Sunk costs per category and industry

		All manufacturing industries			Food products, beverages, and tobacco			Other industrial products, coking and refining		
		Incumbent	Defaulting		Incumbent	Defaulting		Incumbent	Defaulting	
			Before	After		Before	After		Before	After
Sunk costs:										
<i>Export</i>	Mean	4,560.01	706.62	521.57	7,045.10	831.53	538.67	4,299.99	541.23	347.46
	SD	44,546.87	5,217.44	3,713.90	38,236.91	2,378.78	1,426.76	56,000.22	5,444.32	3,695.04
<i>Domestic</i>	Mean	2,599.05	791.05	671.95	3,590.24	2,167.03	1,904.76	3,856.96	936.41	796.20
	SD	11,508.35	5,053.29	3,802.46	5,942.35	3,326.68	2,719.91	16,025.79	6,961.63	5,250.97
<i>Global</i>	Mean	7,158.82	1,497.38	1,190.17	10,635.07	2,998.50	2,443.35	8,156.58	1,477.22	1,143.58
	SD	50,387.93	9,515.39	6,872.56	40,844.31	4,733.09	3,818.45	64,834.80	12,288.67	8,781.93
# of obs.		96,211	5,987	1,815	11,954	273	58	46,701	304	910
		Electrics, electronics, and informatics products			Transporting materials			Clothing industries		
		Incumbent	Defaulting		Incumbent	Defaulting		Incumbent	Defaulting	
			Before	After		Before	After		Before	After
Sunk costs:										
<i>Export</i>	Mean	3,800.90	1,402.71	882.53	14,793.06	615.68	784.75	1,396.74	431.03	387.31
	SD	17,337.53	7,839.72	5,341.02	71,957.64	2,280.67	3,179.62	8,027.89	2,367.78	1,015.77
<i>Domestic</i>	Mean	455.98	330.36	344.67	1,671.27	885.39	824.32	269.36	215.66	245.23
	SD	381.13	330.96	357.52	4,020.10	961.66	950.54	431.32	212.66	232.71
<i>Global</i>	Mean	4,256.83	1,732.80	1,227.14	16,464.28	1,501.02	1,609.01	1,693.01	646.62	632.48
	SD	17,427.49	7,931.26	5,431.02	72,529.43	2,746.85	3,618.52	8,086.41	2,436.48	1,155.99
# of obs.		17,482	1,022	322	3,707	194	66	709	644	252
		96,211	5,987	1,815	11,954	273	58	46,701	304	910
		Wood and paper industries								
		Incumbent	Defaulting							
			Before	After						
Sunk costs:										
<i>Export</i>	Mean	2,425.78	648.13	800.25						
	SD	12,732.35	2,025.50	3,360.13						
<i>Domestic</i>	Mean	1,158.53	797.80	760.27						
	SD	1,991.59	1,230.54	1,467.83						
<i>Global</i>	Mean	3,534.23	1,445.87	1,531.68						
	SD	13,803.45	2,790.47	4,340.78						
# of obs.		9,277	814	207						

Table A.5.1: Statistics on sunk costs, in thousand euros, depending on the default status

## A.6 Propensity score matching

### A.6.1 PSM models

	(1)	(2)	(3) Excl. 1-year exporters	(4)	(5)	(6) Excl. 1-year exporters
Foreign group <sub>t</sub>	0.376*** (0.036)	0.475*** (0.046)	0.498*** (0.052)	0.050 (0.047)	0.078 (0.064)	0.083 (0.071)
Importer <sub>t</sub>	1.100*** (0.021)	1.571*** (0.030)	1.686*** (0.036)	0.535*** (0.021)	0.649*** (0.032)	0.694*** (0.035)
Log TFP <sub>t-1</sub>	0.039*** (0.009)	0.080*** (0.014)	0.083*** (0.015)	0.005 (0.009)	0.015 (0.013)	0.015 (0.015)
Log labor <sub>t-1</sub>	0.901*** (0.022)	0.841*** (0.024)	0.947*** (0.028)	0.434*** (0.038)	0.481*** (0.051)	0.533*** (0.057)
Log liabilities <sub>t-1</sub>	0.291*** (0.013)	0.292*** (0.015)	0.321*** (0.017)	0.082*** (0.018)	0.083*** (0.023)	0.086*** (0.026)
Log age <sub>t-1</sub>	0.388*** (0.021)	0.443*** (0.023)	0.464*** (0.025)	-0.102** (0.047)	-0.123** (0.060)	-0.251*** (0.069)
Δ Log TFP <sub>t-1</sub>		-0.045*** (0.009)	-0.235*** (0.047)		-0.015* (0.009)	-0.032 (0.055)
Δ Log labor <sub>t-1</sub>		-0.410*** (0.037)	-0.691*** (0.023)		-0.217*** (0.043)	-0.179*** (0.023)
Δ Log liabilities <sub>t-1</sub>		-0.144*** (0.020)	-0.044*** (0.010)		-0.029 (0.022)	-0.014 (0.010)
Δ Foreign group <sub>t</sub>		-0.210*** (0.043)	-0.469*** (0.039)		-0.016 (0.021)	-0.251*** (0.046)
Δ Importer <sub>t</sub>		-0.634*** (0.021)	-0.167*** (0.022)		-0.158*** (0.022)	-0.036 (0.024)
Constant	-8.258*** (0.098)	-8.566*** (0.114)	-9.278*** (0.130)	-9.092*** (0.164)	-9.324*** (0.179)	-10.172 (0.207)
# Observations	265,310	228,939	213,187	265,310	228,939	213,187
# Firms	36,371	36,371	33,874	36,371	36,371	33,874
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Mundlak	No	No	No	Yes	Yes	Yes
AUC	0.881	0.889	0.887	0.899	0.899	0.899
Log-likelihood	-71,423.444	-62,046.032	-53,895.571	-67,771.646	-59,364.018	-51,040.456

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table A.6.1: Probit models for propensity score matching - all firms

## A.6.2 Post-matching tests

			Off support	On support	Total
Food products, beverages and tobacco	Continuous	Untreated		31,929	31,929
		Treated		9,005	9,005
	Non-continuous	Untreated		36,017	36,017
		Treated		3,274	3,274
Other industrial products, coking and refining	Continuous	Untreated		40,574	40,574
		Treated		35,333	35,333
	Non-continuous	Untreated		61,026	61,026
		Treated		15,341	15,341
Electrics, electronics, and informatics products	Continuous	Untreated		3,482	3,482
		Treated		15,791	15,791
	Non-continuous	Untreated		6,454	6,454
		Treated		3,066	3,066
Transporting materials	Continuous	Untreated	0	1,381	1,381
		Treated	10	3,096	3,106
	Non-continuous	Untreated		2,577	2,577
		Treated		892	892
Clothing industries	Continuous	Untreated	0	2,072	2,072
		Treated	4	6,477	6,481
	Non-continuous	Untreated		3,704	3,704
		Treated		1,529	1,529
Wood and paper industries	Continuous	Untreated		8,862	8,862
		Treated		6,045	6,045
	Non-continuous	Untreated		15,042	15,042
		Treated		4,256	4,256

Table A.6.2: Common support

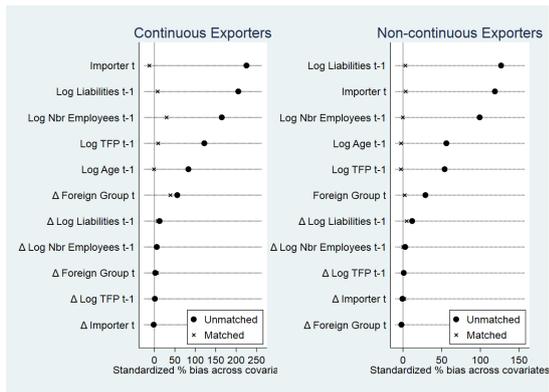
			Treated	Controls	Difference	S.E.	T-stat
All manufacturing industries	Continuous	Unmatched	8,743.40	354.28	8,389.12	189.80	44.20
		Matched	8,743.40	5,314.74	3,428.66	220.00	15.58
	Non-continuous	Unmatched	1,251.44	483.88	767.12	31.37	24.47
		Matched	1,251.44	1,130.59	120.84	56.67	2.13
Food products, beverages and tobacco	Continuous	Unmatched	12,958.28	443.95	12,514.32	259.58	48.21
		Matched	12,958.28	6,801.39	6,156.89	515.23	11.95
	Non-continuous	Unmatched	3,481.07	675.93	2,805.14	79.73	35.18
		Matched	3,481.07	2,664.36	816.71	208.08	3.93
Other industrial products, coking and refining	Continuous	Unmatched	10,398.52	333.47	10,065.06	367.58	27.38
		Matched	10,398.52	14,425.17	-4,026.65	428.85	-9.39
	Non-continuous	Unmatched	1,095.64	429.15	666.50	49.68	13.42
		Matched	1,095.64	1,035.86	59.79	88.92	0.67
Electrics, electronics, and informatics products	Continuous	Unmatched	4,781.94	152.58	4,629.36	311.57	14.86
		Matched	4,781.94	656.27	4,125.66	161.42	25.56
	Non-continuous	Unmatched	400.27	221.95	178.32	25.59	6.97
		Matched	400.27	471.33	-71.06	35.07	-2.03
Transporting materials	Continuous	Unmatched	19,249.58	211.84	19,037.75	2,113.44	9.01
		Matched	19,308.99	1,955.80	17,353.19	1,418.57	12.23
	Non-continuous	Unmatched	1,862.08	524.85	1,337.23	387.30	3.45
		Matched	1,862.08	2,242.17	-380.09	595.52	-0.64
Clothing industries	Continuous	Unmatched	1,839.21	235.47	1,603.74	186.16	8.61
		Matched	1,840.22	497.79	1,342.43	194.43	6.90
	Non-continuous	Unmatched	473.23	335.54	137.69	36.26	3.80
		Matched	473.23	549.11	-75.88	47.66	-1.59
Wood and paper industries	Continuous	Unmatched	5,142.69	255.65	4,887.03	178.92	27.31
		Matched	5,142.69	2,394.87	2,747.82	225.29	12.20
	Non-continuous	Unmatched	862.60	387.95	474.65	23.66	20.06
		Matched	862.60	815.81	46.79	39.10	1.20

Table A.6.3: Matching correction results

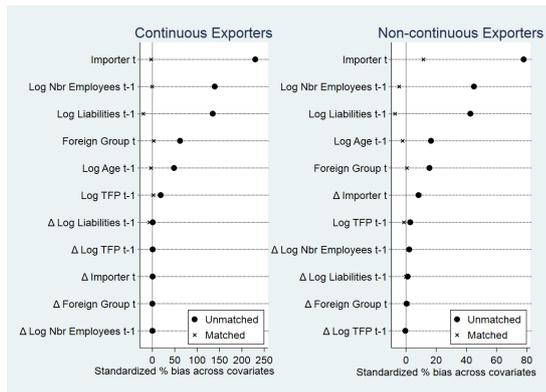
			PsR2		p>Chi2	Mean bias	Med bias	B	R	%Var
All manufacturing industries	Continuous	Unmatched	0.561	127,032.71	0.000	74.3	57.2	249.3*	2.05*	86
		Matched	0.036	7,586.40	0.000	7.8	3.5	45.2*	0.81	86
	Non-continuous	Unmatched	0.126	18,422.32	0.000	27.0	17.1	93.6*	1.50*	100
		Matched	0.002	173.46	0.039	2.9	2.8	11.1*	1.09	71
Food products, beverages and tobacco	Continuous	Unmatched	0.617	26,617.07	0.000	79.9	55.9	267.5*	2.43*	89
		Matched	0.038	949.71	0.000	8.6	5.9	46.7*	1.02	100
	Non-continuous	Unmatched	0.246	5,551.14	0.000	45.6	29.0	153.9*	1.43	89
		Matched	0.002	20.53	0.039	2.7	2.1	11.2	1.25	78
Other industrial products, coking and refining	Continuous	Unmatched	0.554	58,124.52	0.000	57.6	18.5	249.9*	1.88	100
		Matched	0.012	1,139.29	0.000	4.5	4.4	25.5*	0.93	100
	Non-continuous	Unmatched	0.107	8,162.19	0.000	19.3	8.3	84.6*	1.55	78
		Matched	0.002	103.69	0.000	2.8	1.5	11.6	1.04	89
Electrics, electronics, and informatics products	Continuous	Unmatched	0.581	10,578.09	0.000	63.8	27.6	264.4*	1.83	100
		Matched	0.083	3,626.94	0.000	18.2	8.3	69.5*	2.67*	100
	Non-continuous	Unmatched	0.104	1,246.50	0.000	19.7	5.4	81.0*	1.29	67
		Matched	0.002	16.08	0.138	3.0	2.6	10.2	1.09	67
Transporting materials	Continuous	Unmatched	0.675	3,737.00	0.000	76.6	28.7	298.2*	2.46*	100
		Matched	0.335	2,874.78	0.000	33.6	22.2	158.3*	1.66	89
	Non-continuous	Unmatched	0.128	505.95	0.000	23.7	7.7	91.9*	1.31	89
		Matched	0.005	12.97	0.295	5.2	5.4	17.0	0.89	56
Clothing industries	Continuous	Unmatched	0.598	5,662.93	0.000	50.4	8.0	297.3*	0.6	100
		Matched	0.066	1,190.25	0.000	8.7	3.2	58.9*	4.12*	89
	Non-continuous	Unmatched	0.144	911.97	0.000	15.5	4.7	100.1*	1.04	33
		Matched	0.009	37.36	0.000	5.3	4.9	22.1	1.03	78
Wood and paper industries	Continuous	Unmatched	0.481	9,677.76	0.000	57.0	43.1	205.9*	2.43*	89
		Matched	0.047	782.52	0.000	12.4	4.2	51.5*	0.84	89
	Non-continuous	Unmatched	0.094	1,920.87	0.000	21.9	11.3	78.7*	1.29	89
		Matched	0.002	23.20	0.017	2.7	1.9	10.4	1.01	56

\* if B>25%, R outside [0.5; 2]

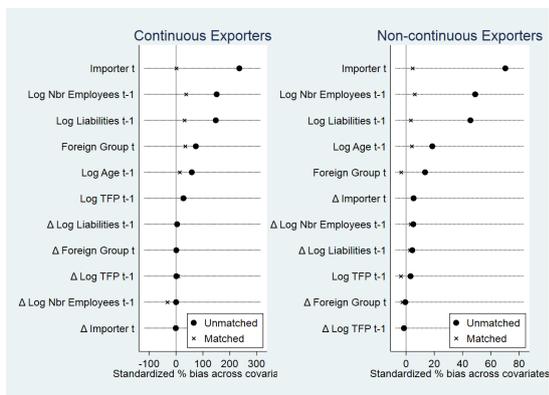
Table A.6.4: Balance check summary



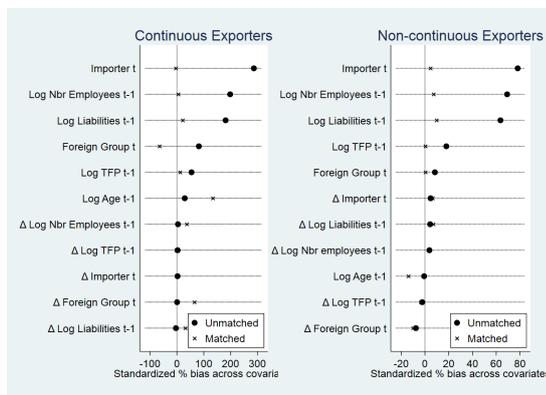
(a) Food products, beverages and tobacco



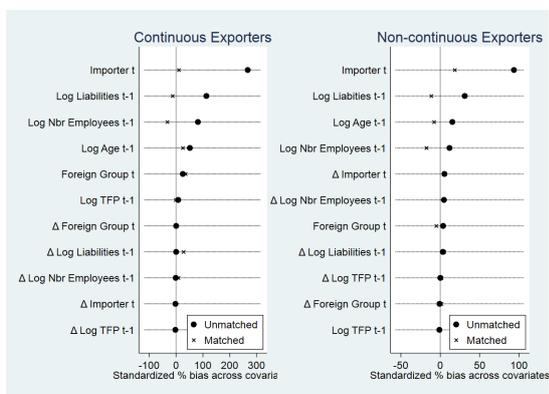
(b) Other industrial products, coking and refining



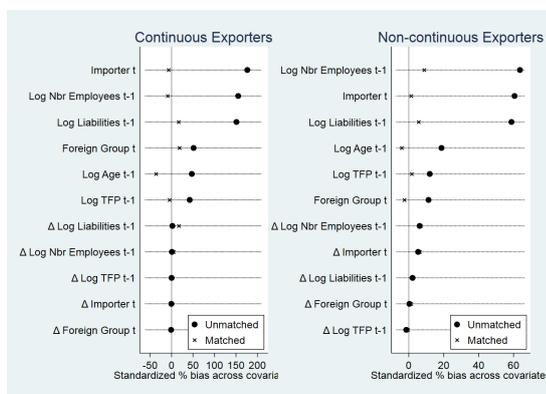
(c) Electrics, electronics, and informatics products



(d) Transporting materials



(e) Clothing industries



(f) Wood and paper industries

Figure A.6.1: Matching standardized bias correction

Variables <sup>(a)</sup>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All				Incumbent exporters				
$tfP_{it}$	0.011 (0.019)	0.010 (0.020)	0.038* (0.021)	0.004 (0.020)	0.004 (0.022)	0.030 (0.020)	0.013 (0.026)	0.013 (0.025)	0.050* (0.026)
$tfP_{it-1}$	-0.121*** (0.018)	-0.113*** (0.024)	-0.108*** (0.020)	-0.119*** (0.019)	-0.113*** (0.022)	-0.110*** (0.020)	-0.134*** (0.026)	-0.126*** (0.027)	-0.135*** (0.030)
$tfP_{it-2}$		-0.011 (0.018)	0.008 (0.022)		-0.004 (0.020)	0.012 (0.020)		-0.002 (0.027)	0.026 (0.024)
$tfP_{it-3}$			0.055*** (0.020)			0.061*** (0.023)			0.042* (0.023)
Sunk costs:									
$Export_{it}$	0.002 (0.018)	0.008 (0.017)	-0.004 (0.019)	-0.021 (0.016)	-0.017 (0.014)	-0.026* (0.015)	0.028 (0.021)	0.037* (0.022)	-0.013 (0.023)
$Export_{it-1}$	0.064*** (0.011)	0.048*** (0.010)	0.078*** (0.015)	0.046*** (0.007)	0.034*** (0.008)	0.045*** (0.010)	0.079*** (0.011)	0.053*** (0.016)	0.153*** (0.030)
$Export_{it-2}$		0.041*** (0.008)	0.020** (0.009)		0.034*** (0.008)	0.018** (0.009)		0.051*** (0.013)	0.023* (0.013)
$Export_{it-3}$			0.042*** (0.008)			0.028*** (0.007)			0.047*** (0.012)
$Domestic_{it}$	-0.040 (0.025)	-0.041 (0.026)	-0.065*** (0.025)	-0.030 (0.027)	-0.032 (0.028)	-0.054** (0.025)	-0.039 (0.032)	-0.039 (0.031)	-0.084** (0.034)
$Domestic_{it-1}$	0.143*** (0.029)	0.129*** (0.040)	0.147*** (0.032)	0.142*** (0.030)	0.131*** (0.035)	0.151*** (0.031)	0.163*** (0.039)	0.150*** (0.043)	0.187*** (0.042)
$Domestic_{it-2}$		0.009 (0.026)	0.002 (0.026)		-0.002 (0.026)	-0.005 (0.025)		0.006 (0.035)	-0.014 (0.030)
$Domestic_{it-3}$			-0.032 (0.021)			-0.039 (0.026)			-0.034 (0.024)
$Exporter_{it-1}$	-0.400*** (0.079)	-0.347*** (0.075)	-0.484*** (0.100)						
$Exporter_{it-2}$		-0.169*** (0.060)	-0.130* (0.068)						
$Exporter_{it-3}$			-0.274*** (0.070)						
Group:									
$Foreign_{it}$	-0.253** (0.114)	-0.243** (0.117)	-0.272** (0.113)	-0.284** (0.110)	-0.276** (0.115)	-0.301** (0.128)	-0.276** (0.131)	-0.265** (0.125)	-0.294** (0.149)
$Foreign_{it-1}$	-0.722*** (0.117)	-0.639*** (0.121)	-0.626*** (0.129)	-0.749*** (0.095)	-0.665*** (0.113)	-0.646*** (0.123)	-0.680*** (0.095)	-0.577*** (0.114)	-0.589*** (0.165)
$Foreign_{it-2}$		-0.129* (0.071)	-0.207* (0.107)		-0.134* (0.069)	-0.221** (0.111)		-0.184** (0.077)	-0.211 (0.129)
$Foreign_{it-3}$			-0.155** (0.066)			-0.164*** (0.062)			-0.142* (0.073)
$All_{it}$	-0.297*** (0.074)	-0.241*** (0.079)	-0.183** (0.084)	-0.326*** (0.081)	-0.269*** (0.071)	-0.212*** (0.080)	-0.301*** (0.095)	-0.234*** (0.080)	-0.180* (0.105)
$All_{it-1}$	0.550*** (0.091)	0.328*** (0.106)	0.348*** (0.105)	0.592*** (0.100)	0.361*** (0.099)	0.383*** (0.121)	0.489*** (0.077)	0.239** (0.109)	0.258** (0.107)
$All_{it-2}$		0.526*** (0.077)	0.418*** (0.098)		0.558*** (0.091)	0.442*** (0.094)		0.600*** (0.086)	0.499*** (0.095)
$All_{it-3}$			0.256*** (0.065)			0.286*** (0.082)			0.252** (0.098)
$Conc_{it}$	-0.001 (0.004)	-0.001 (0.004)	0.001 (0.004)	-0.001 (0.004)	-0.001 (0.003)	0.001 (0.004)	0.002 (0.003)	0.002 (0.004)	0.005 (0.004)
$\log(mes_{it})$	-0.209 (0.476)	-0.103 (0.427)	0.376 (0.540)	-0.228 (0.425)	-0.157 (0.378)	0.301 (0.476)	-0.425 (0.509)	-0.275 (0.499)	0.404 (0.514)
Constant	-4.527 (4.290)	-3.687 (3.888)	-0.281 (4.918)	-4.421 (3.873)	-3.840 (3.593)	-0.582 (4.290)	-4.828 (4.781)	-3.754 (4.330)	1.118 (4.858)
# of obs	103,872	103,872	87,554	103,872	103,872	87,554	75,509	75,509	63,741
# of firms	20,673	20,673	19,835	20,673	20,673	19,835	11,771	11,771	11,558
Sector & Year	Yes								
Bootstrap	100	100	100	100	100	100	100	100	100

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table A.6.5: Probability of being involved in a legal procedure – Model 1

<sup>(a)</sup> We introduce intra-individual means of variables as regressors to control for a possible correlation between co-variables and unobserved individual heterogeneity, following the methodology proposed by Mundlak (1978).

# **Appendix B**

## **Appendix for Chapter 2**

## B.1 Total factor productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Food products, beverages and tobacco	Other industrial products, coking and refining	Electrics, electronics, informatics products	Transporting materials	Clothing industries	Wood and paper industries	Construction industries
$l_t$	0.537*** (0.012)	0.613*** (0.007)	0.554*** (0.015)	0.637*** (0.031)	0.652*** (0.014)	0.617*** (0.015)	0.616*** (0.006)
$k_{t-1}$	0.185*** (0.013)	0.300*** (0.011)	0.357*** (0.025)	0.246*** (0.050)	0.341*** (0.035)	0.229*** (0.024)	0.258*** (0.009)
Observations	65,419	153,000	34,424	8,797	16,286	34,737	254,964

	(8)	(9)	(10)	(11)	(12)	(13)
Variables	Wholesale and retail trade, transport, accommodation and catering	Information and communication industries	Financial activities and insurance industries	Real estate activities	Legal, accounting, management, architectural, engineering, control and technical analysis activities	Other scientific and technical activities
$l_t$	0.599*** (0.004)	0.717*** (0.015)	0.507*** (0.040)	0.602*** (0.022)	0.608*** (0.009)	0.603*** (0.006)
$k_{t-1}$	0.222*** (0.005)	0.181*** (0.017)	0.150*** (0.037)	0.290*** (0.059)	0.330*** (0.017)	0.236*** (0.014)
Observations	608,474	40,692	9,632	23,193	102,628	72,712

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table B.1.1: Estimation of total factor productivity, 2006 – 2014

## B.2 Panel Fixed-effect estimation of TFP

	(1)	(2)
$\log(\widehat{\text{BERD}}_{it})$	-0.047*** (0.008)	-0.077*** (0.016)
$\log(\widehat{\text{BERD}}_{it})^2$		0.006** (0.003)
Constant	3.693*** (0.000)	3.694*** (0.001)
# of obs	1,425,257	1,425,257
R-squared	0.000	0.000
# of firms	173,672	173,672
Industry FE	No	No

Standard errors clustered at firm-level in parenthesis  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table B.2.1: Fixed-effect estimation of TFP

### B.3 Average amount invested in BERD

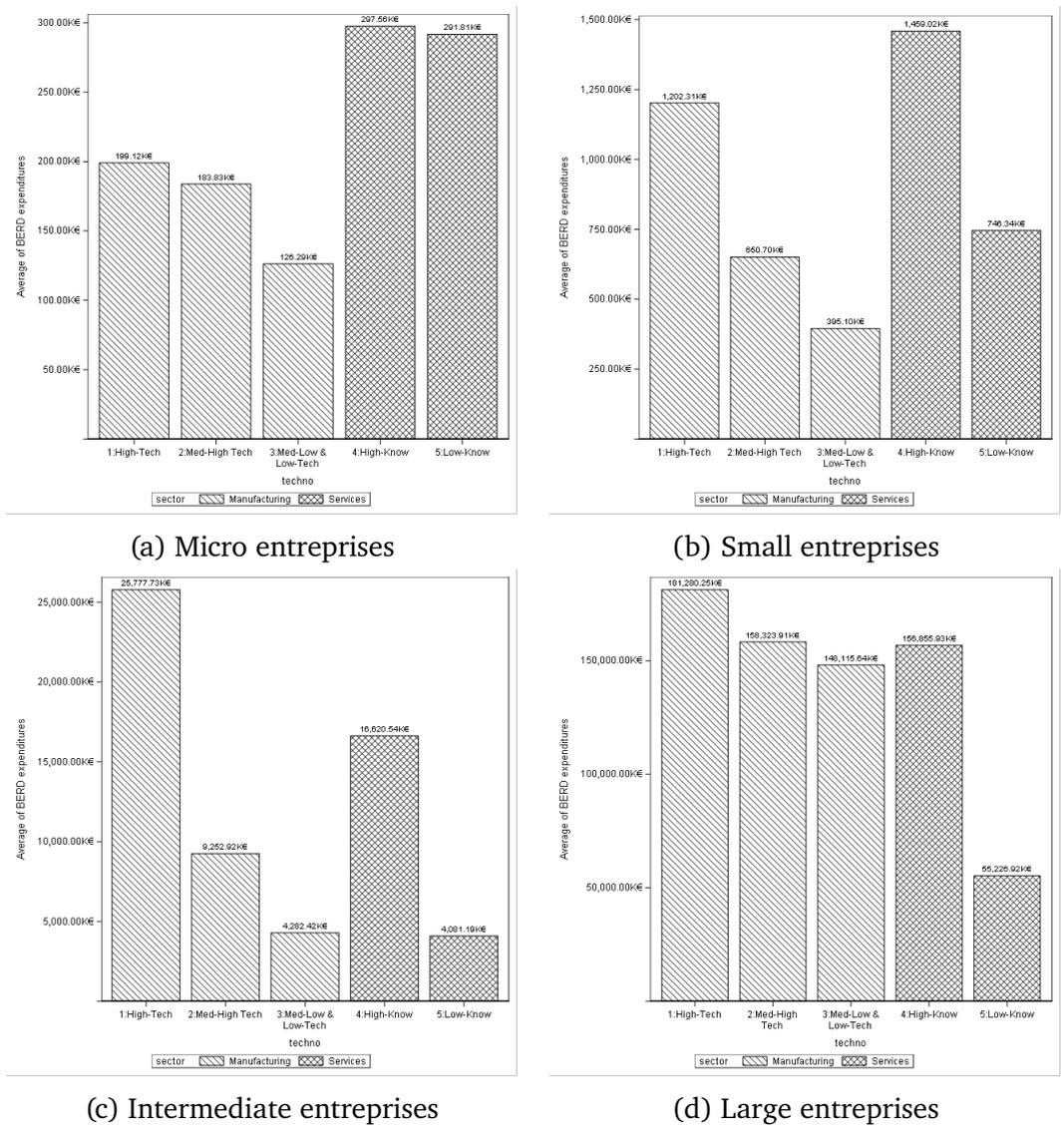


Figure B.3.1: Average amount invested in BERD according size across Eurostat technological sector classification–Services firms

Sector	Technology	Size	Average BERD amount (in K€)	Overall share	In-tech-level share	In-firm size share
Manuf	High Tech	Micro	199.12	0.03%	0.10%	18.12%
		Small	1202.31	0.16%	0.58%	27.00%
		Intermediate	25777.73	3.37%	12.37%	42.95%
		Large	181280.25	23.69%	86.96%	25.90%
	Med-High Tech	Micro	183.83	0.02%	0.11%	16.73%
		Small	650.70	0.09%	0.39%	14.61%
		Intermediate	9252.92	1.21%	5.49%	15.42%
		Large	158323.91	20.69%	94.01%	22.62%
	Low Tech	Micro	126.29	0.02%	0.08%	11.50%
		Small	395.10	0.05%	0.26%	8.87%
		Intermediate	4282.42	0.56%	2.80%	7.14%
		Large	148115.64	19.35%	96.86%	21.17%
Services	High Knowledge	Micro	297.56	0.04%	0.17%	27.09%
		Small	1459.02	0.19%	0.83%	32.76%
		Intermediate	16620.54	2.17%	9.48%	27.69%
	Low Knowledge	Large	156855.93	20.49%	89.51%	22.41%
		Micro	291.81	0.04%	0.48%	26.56%
		Small	746.34	0.10%	1.24%	16.76%
		Intermediate	4081.19	0.53%	6.76%	6.80%
		Large	55226.92	7.22%	91.52%	7.89%

Table B.3.1: BERD statistics

## B.4 Turning points with TFP cross-term

## B.5 Statistics by sectors

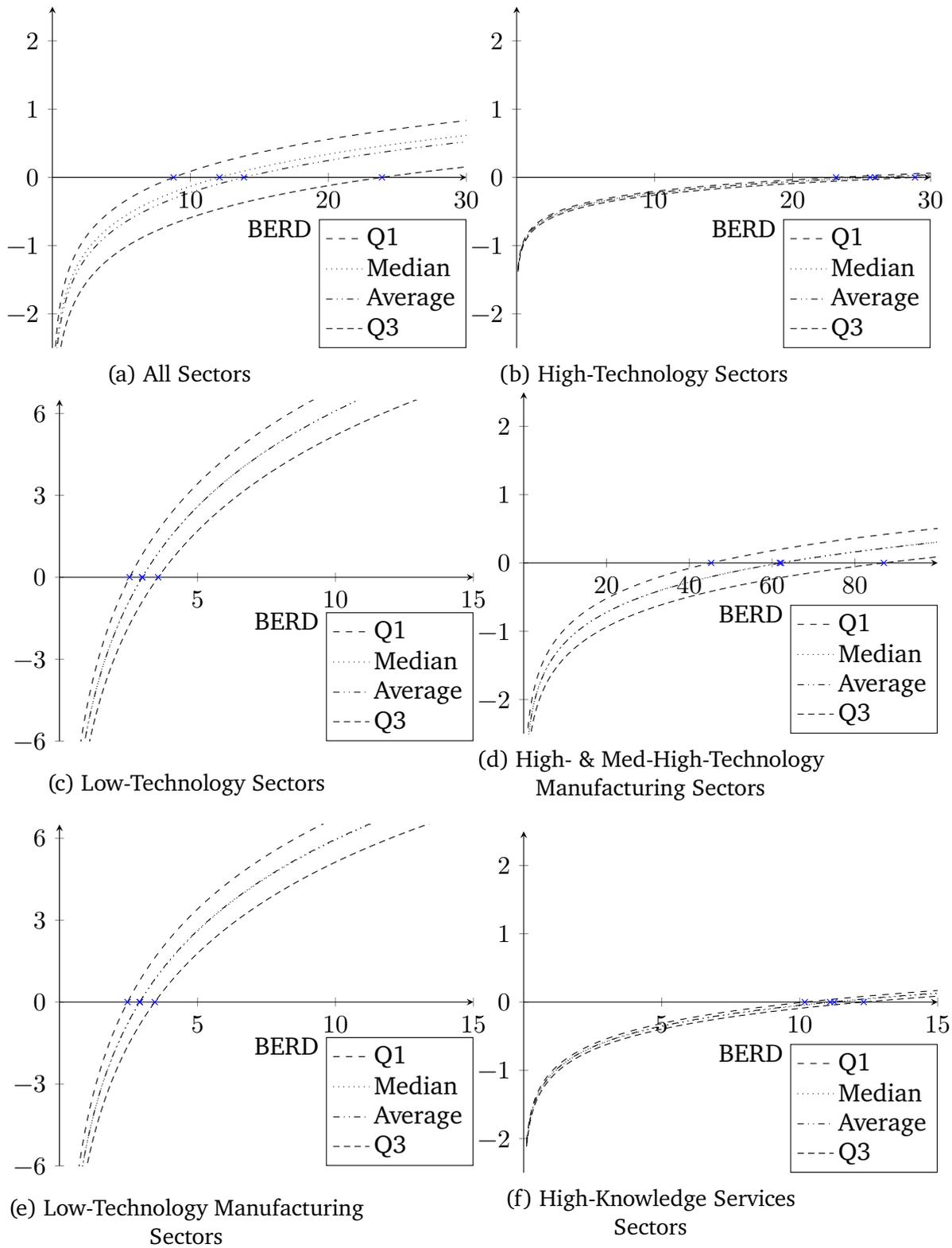


Figure B.4.1: BERD's turning points (in thousand euros)

				Never defaulting			Defaulting		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
1: High-Technology Manufacturing									
R&D activity (all sample)	10,089	0.34	0.47	9,745	0.34	0.47	344	0.23	0.42
BERD in log	3,338	7.11	1.88	3,263	7.12	1.88	75	6.41	1.54
Tfp in log	10,089	3.52	0.71	9,745	3.54	0.71	344	3.05	0.75
Export activity	10,089	0.79	0.40	9,745	0.79	0.41	344	0.82	0.38
Liabilities in log	10,089	6.33	2.06	9,745	6.34	2.07	344	5.89	1.57
Foreign group membership	10,089	0.68	0.47	9,745	0.68	0.47	344	0.69	0.46
Herfindahl index	10,089	23.66	10.76	9,745	23.77	10.83	344	20.52	7.69
2: Medium-High Technology Manufacturing									
R&D activity (all sample)	43,674	0.21	0.40	41,776	0.21	0.41	1,898	0.12	0.32
BERD in log	8,566	6.51	1.81	8,359	6.53	1.82	207	5.78	1.13
Tfp in log	43,674	3.53	0.70	41,776	3.55	0.70	1,898	3.21	0.72
Export activity	43,674	0.73	0.45	41,776	0.73	0.44	1,898	0.67	0.47
Liabilities in log	43,674	6.31	1.85	41,776	6.34	1.86	1,898	5.60	1.43
Foreign group membership	43,674	0.63	0.48	41,776	0.64	0.48	1,898	0.57	0.50
Herfindahl index	43,674	13.70	14.49	41,776	13.69	14.51	1,898	13.81	13.86
3: Medium-Low and Low Technology Manufacturing									
R&D activity (all sample)	258,631	0.05	0.21	244,215	0.05	0.21	14,416	0.03	0.16
BERD in log	10,915	5.74	1.58	10,584	5.76	1.58	331	5.27	1.22
Tfp in log	258,631	3.53	0.75	244,215	3.55	0.75	14,416	3.22	0.78
Export activity	258,631	0.39	0.49	244,215	0.40	0.49	14,416	0.36	0.48
Liabilities in log	258,631	5.65	1.58	244,215	5.67	1.59	14,416	5.32	1.35
Foreign group membership	258,631	0.44	0.50	244,215	0.44	0.50	14,416	0.38	0.49
Herfindahl index	258,631	8.95	24.18	244,215	8.98	24.38	14,416	8.49	20.57
4: Knowledge-Intensive Services									
R&D activity (all sample)	181,067	0.06	0.24	176,632	0.06	0.24	4,435	0.06	0.23
BERD in log	10,350	6.54	1.67	10,116	6.55	1.68	234	5.77	1.22
Tfp in log	181,067	3.91	0.89	176,632	3.92	0.89	4,435	3.65	0.81
Export activity	181,067	0.11	0.31	176,632	0.11	0.31	4,435	0.12	0.32
Liabilities in log	181,067	5.22	1.46	176,632	5.23	1.47	4,435	4.76	1.30
Foreign group membership	181,067	0.45	0.50	176,632	0.45	0.50	4,435	0.34	0.47
Herfindahl index	181,067	16.28	47.10	176,632	16.19	47.23	4,435	19.96	41.80
5: Less Knowledge-Intensive Services									
R&D activity (all sample)	931,796	0.00	0.06	900,426	0.00	0.06	31,370	0.00	0.05
BERD in log	3,041	6.02	1.73	2,984	6.04	1.73	57	5.15	1.26
Tfp in log	931,796	3.70	0.70	900,426	3.71	0.70	31,370	3.46	0.65
Export activity	931,796	0.14	0.35	900,426	0.14	0.35	31,370	0.09	0.29
Liabilities in log	931,796	5.37	1.44	900,426	5.38	1.44	31,370	4.97	1.21
Group membership	931,796	0.36	0.48	900,426	0.36	0.48	31,370	0.25	0.43
Herfindahl index	931,796	14.97	40.12	900,426	14.84	39.88	31,370	18.77	46.13

Table B.5.1: Descriptive statistics of defaulting vs non defaulting firms: by sector

# **Appendix C**

## **Appendix for Chapter 3**

## C.1 Production function

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Food products, beverages and tobacco	Other industrial products, coking and refining	Electrics, electronics, informatics products	Transporting materials	Clothing industries	Wood and paper industries	Construction industries
$l_{it}$	0.545*** (0.009)	0.621*** (0.006)	0.556*** (0.014)	0.623*** (0.029)	0.653*** (0.012)	0.633*** (0.012)	0.623*** (0.005)
$k_{i,t-1}$	0.152*** (0.010)	0.275*** (0.012)	0.340*** (0.026)	0.164** (0.065)	0.311*** (0.034)	0.210*** (0.021)	0.226*** (0.006)
# obs	84,744	167,879	37,194	9,697	17,722	37,850	299,998
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1							
	(8)	(9)	(10)	(11)	(12)	(13)	
	Wholesale and retail trade, transport, accommodation and catering	Information and communication industries	Financial activities and insurance industries	Real estate activities	Legal, accounting, management, architectural, engineering, control and technical analysis activities	Other scientific and technical activities	
$l_{it}$	0.605*** (0.004)	0.713*** (0.012)	0.517*** (0.029)	0.566*** (0.018)	0.613*** (0.007)	0.603*** (0.005)	
$k_{i,t-1}$	0.187*** (0.004)	0.165*** (0.016)	0.097*** (0.023)	0.180*** (0.046)	0.280*** (0.015)	0.201*** (0.010)	
# obs	739,103	49,042	13,801	28,394	124,277	98,506	
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1							

Table C.1.1: Estimation of total factor productivity, 2006 – 2014

## C.2 Sectoral decomposition

Sector	FHK					MP					ΔP (%)		
	Incumbents		Net entry			Incumbents		Net entry					
	Within	Reallocation	Entry	Exit		Within	Reallocation	Entry	Exit				
				All	Other				All	Other			
Food products, beverages and tobacco	-0.228	0.908	-12.654	3.494	0.993	2.501	0.443	1.663	-14.865	4.279	1.145	3.134	-8.481
Other industrial products, coking and refining	-2.458	2.083	-1.188	1.479	1.361	0.118	-1.590	1.155	-1.375	1.727	1.483	0.244	-0.084
Electrics, electronics, informatics products	-1.224	2.703	-0.824	1.891	1.530	0.362	-0.097	1.746	-1.262	2.160	1.655	0.505	2.546
Transporting materials	-10.634	2.025	-1.577	1.519	1.987	-0.468	-10.889	0.702	-0.238	1.758	2.111	-0.353	-8.667
Clothing industries	-1.840	1.949	-1.112	2.871	2.290	0.581	-1.801	1.680	-1.566	3.555	2.678	0.877	1.868
Wood and paper industries	13.792	2.326	2.131	1.753	1.433	0.320	17.630	1.171	-0.939	2.140	1.648	0.492	20.002
Construction industries	-20.427	3.177	-6.877	1.382	1.147	0.235	-23.269	0.905	-2.021	1.640	1.292	0.348	-22.746
Wholesale and retail trade, transport, accommodation and catering	-2.041	1.626	-6.274	1.755	0.878	0.877	-1.366	1.150	-6.796	2.078	0.956	1.122	-4.934
Information and communication industries	1.229	1.705	-2.468	0.654	1.598	-0.943	3.680	0.451	-3.812	0.801	1.639	-0.838	1.120
Financial activities and insurance industries	5.075	-1.311	-9.903	3.073	0.638	2.435	7.924	2.001	-16.727	3.737	0.667	3.070	-3.065
Real estate activities	-6.088	3.650	1.789	2.877	0.911	1.966	-6.830	4.082	1.621	3.355	0.996	2.359	2.227
Legal, accounting, management architectural, engineering, control and technical analysis activities	-3.371	1.367	-2.058	-3.621	0.543	-4.163	-3.924	1.550	0.331	-5.640	0.416	-6.056	-7.683
Other scientific and technical activities	-1.894	1.512	-7.768	1.227	1.536	-0.309	-1.379	1.247	-8.323	1.531	1.641	-0.110	-6.924

Table C.2.1: FHK and MP decompositions by sector (2006-2013)

Sector	2006-2009						2010-2013									
	Incumbents			Net entry			Incumbents			Net entry						
	Within	Reallocation	Entry	All	Exit	Defaults	Other	AP (%)	Within	Reallocation	Entry	All	Exit	Defaults	Other	AP (%)
Food products, beverages and tobacco	-13.945	21.672	-2.332	0.728	0.141	0.587	6.123	-7.881	1.713	-8.070	3.031	1.072	1.959	-11.208		
Other industrial products, coking and refining	-27.227	31.264	-0.306	0.229	0.151	0.078	3.959	-0.191	1.842	-0.358	1.998	1.713	0.285	3.292		
Electrics, electronics, informatics products	-32.474	29.932	0.087	0.512	0.221	0.291	-1.942	2.872	2.299	0.044	1.759	1.341	0.418	6.973		
Transporting materials	-26.185	24.145	-1.480	0.449	0.298	0.151	-3.071	-5.753	1.077	-0.080	2.384	2.287	0.097	-2.373		
Clothing industries	-34.525	33.361	-0.638	0.550	0.276	0.274	-1.252	2.306	1.740	-0.662	2.737	1.953	0.784	6.121		
Wood and paper industries	-9.062	24.465	0.367	0.404	0.212	0.192	16.174	1.573	1.748	0.062	2.397	1.823	0.574	5.779		
Construction industries	-32.115	33.231	-0.621	0.190	0.089	0.101	0.685	-9.186	1.190	-1.571	2.000	1.750	0.251	-7.567		
Wholesale and retail trade, transport, accommodation and catering	-22.041	26.897	-1.375	0.315	0.093	0.223	3.797	-1.950	1.371	-3.438	2.193	1.200	0.993	-1.824		
Information and communication industries	-13.325	18.001	-0.641	-0.025	0.146	-0.172	4.010	-2.286	2.305	-2.599	0.728	1.348	-0.620	-1.852		
Financial activities and insurance industries	16.138	-2.352	-1.168	0.079	0.073	0.006	12.697	3.323	1.255	-9.691	3.268	0.503	2.765	-1.845		
Real estate activities	-20.231	19.259	3.202	0.432	0.116	0.316	2.662	-6.254	2.682	-2.930	3.311	0.926	2.385	-3.191		
Legal, accounting, management architectural, engineering, control and technical analysis activities	-26.277	36.141	0.439	-4.551	0.022	-4.572	5.752	-3.030	2.020	0.071	1.024	0.658	0.366	0.084		
Other scientific and technical activities	-18.952	24.542	-0.722	0.075	0.085	-0.010	4.943	-2.391	1.203	-1.420	1.671	1.801	0.107	-0.937		

Table C.2.2: FHK decomposition by sector and subperiod

Sector	2006-2009						2010-2013						
	Incumbents		Net entry		ΔP (%)		Incumbents		Net entry		ΔP (%)		
	Within	Reallocation	Entry	All			Exit	Other	Within	Reallocation			Entry
Food products, beverages and tobacco	-14.390	23.198	-3.435	0.750	0.143	6.123	-3.770	-3.427	-7.458	3.447	1.168	2.280	-11.200
Other industrial products, coking and refining	-27.341	31.622	-0.555	0.232	0.152	3.959	2.918	-1.223	-0.594	2.191	1.808	0.383	3.292
Electrics, electronics, informatics products	-33.596	30.946	0.187	0.520	0.224	-1.942	6.409	-1.044	-0.299	1.907	1.409	0.498	6.973
Transporting materials	-27.197	25.038	-1.368	0.456	0.302	-3.071	-3.786	-1.256	0.071	2.598	2.377	0.222	-2.373
Clothing industries	-34.997	33.786	-0.605	0.564	0.281	-1.252	5.348	-1.240	-1.078	3.090	2.149	0.941	6.121
Wood and paper industries	-8.935	25.237	-0.538	0.411	0.215	16.174	4.681	-1.319	-0.314	2.732	2.014	0.718	5.779
Construction industries	-32.085	33.337	-0.760	0.193	0.090	0.685	-6.602	-2.330	-0.906	2.271	1.917	0.353	-7.567
Wholesale and retail trade, transport, accommodation and catering	-21.945	27.359	-1.939	0.322	0.094	3.797	1.155	-1.753	-3.681	2.454	1.273	1.182	-1.824
Information and communication industries	-11.513	16.713	-1.164	-0.026	0.146	4.010	1.032	-1.006	-2.706	0.829	1.376	-0.547	-1.852
Financial activities and insurance industries	17.543	-0.879	-4.046	0.079	0.073	12.697	8.847	-0.148	-14.443	3.899	0.531	3.368	-1.845
Real estate activities	-20.916	19.826	3.314	0.438	0.117	2.662	-5.072	1.095	-2.907	3.693	0.979	2.714	-3.191
Legal, accounting, management architectural , engineering, control and technical analysis activities	-34.841	47.132	-0.354	-6.185	0.006	5.752	1.255	-2.378	0.069	1.138	0.682	0.455	0.084
Other scientific and technical activities	-19.553	26.016	-1.598	0.078	0.085	4.943	1.158	-2.492	-1.511	1.909	1.801	0.107	-0.937

Table C.2.3: MP decomposition by sector and subperiod

## C.3 Sectoral decompositions with bootstrap

### C.3.1 FHK's decompositions

Sectors	Number of firms	Incumbents			Net entry			ΔP
		Within	Reallocation		Entry	Exit		
			Between	Covariance		Defaulting	Other	
Food products, beverages and tobacco industries	9,147	-14.100*** (1.037)	-0.182** (0.074)	22.074*** (1.587)	-2.434*** (0.283)	0.145*** (0.029)	0.590*** (0.061)	6.094*** (0.751)
Other industrial products, coking and refining industries	19,273	-27.109*** (0.888)	-0.434*** (0.121)	31.523*** (1.411)	-0.307** (0.152)	0.152*** (0.017)	0.079*** (0.030)	3.905*** (0.653)
Electrics, electronics, informatics products industries	4,306	-32.398*** (1.640)	-0.286** (0.133)	30.168*** (2.759)	0.050 (0.425)	0.217*** (0.048)	0.279*** (0.073)	-1.971 (1.424)
Transporting materials	1,079	-26.330*** (2.854)	0.030 (0.284)	24.416*** (4.125)	-1.554** (0.770)	0.309*** (0.065)	0.164*** (0.061)	-2.964 (2.211)
Clothing industries	2,117	-34.828*** (2.369)	-0.228 (0.180)	34.062*** (3.845)	-0.647 (0.487)	0.294*** (0.070)	0.261*** (0.069)	-1.086 (1.856)
Wood and paper industries	4,438	-8.776*** (1.522)	-0.347*** (0.122)	24.318*** (2.507)	0.412 (0.272)	0.214*** (0.035)	0.192*** (0.039)	16.014*** (1.174)
Construction industries	34,050	-32.039*** (0.611)	-0.506*** (0.097)	33.575*** (1.036)	-0.601*** (0.155)	0.090*** (0.009)	0.100*** (0.015)	0.619 (0.481)
Wholesale and retail trade, transport, accommodation and catering industries	81,659	-22.078*** (0.347)	-0.670*** (0.070)	27.628*** (0.563)	-1.391*** (0.102)	0.094*** (0.007)	0.224*** (0.021)	3.808*** (0.284)
Information and communication industries	5,561	-13.254*** (1.302)	-1.782*** (0.387)	19.748*** (1.975)	-0.638** (0.310)	0.150*** (0.034)	-0.184* (0.098)	4.040*** (0.978)
Financial activities and insurance industries	1,415	16.211*** (1.039)	-0.822*** (0.109)	-1.533*** (0.187)	-1.204 (0.889)	0.115*** (0.003)	0.018 (0.149)	12.785*** (1.494)
Real estate activities	3,246	-20.470*** (1.603)	-0.460*** (0.167)	19.917*** (2.459)	3.237*** (0.505)	0.126*** (0.029)	0.322*** (0.073)	2.673** (1.223)
Legal, accounting, management architectural, engineering, control and technical analysis activities	16,242	-26.277*** (1.175)	-1.494*** (0.195)	37.611*** (2.150)	0.462 (0.283)	0.022 (0.013)	-4.569*** (0.145)	5.754*** (1.145)
Other scientific and technical activities	10,359	-18.954*** (1.141)	-0.360*** (0.091)	24.787*** (1.767)	-0.705** (0.309)	0.085*** (0.030)	-0.008 (0.063)	4.844*** (0.806)

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table C.3.1: FHK decompositions with bootstrap and default - By sector (2006-2009)

Sectors	Number of firms	Incumbents			Net entry			ΔP
		Within	Reallocation		Entry	Exit		
			Between	Covariance		Defaulting	Other	
Food products, beverages and tobacco industries	11,614	-7.884*** (0.375)	-4.542*** (0.697)	6.281*** (0.742)	-8.055*** (0.168)	1.076*** (0.064)	1.970*** (0.142)	-11.153*** (0.400)
Other industrial products, coking and refining industries	20,071	-0.216 (0.254)	-2.878*** (0.391)	4.754*** (0.448)	-0.360*** (0.073)	1.711*** (0.083)	0.287*** (0.079)	3.298*** (0.267)
Electrics, electronics, informatics products industries	4,399	2.848*** (0.674)	-3.038*** (0.816)	5.386*** (0.961)	0.035 (0.186)	1.327*** (0.156)	0.400*** (0.134)	6.958*** (0.677)
Transporting materials	1,124	-5.757*** (0.937)	-2.040* (1.118)	3.105*** (1.090)	-0.021 (0.560)	2.318*** (0.302)	0.088 (0.380)	-2.307** (1.126)
Clothing industries	2,109	2.322*** (0.771)	-2.549** (1.146)	4.292*** (1.140)	-0.652** (0.254)	1.981*** (0.257)	0.800*** (0.274)	6.194*** (0.954)
Wood and paper industries	4,580	1.516*** (0.523)	-2.503*** (0.844)	4.295*** (0.909)	0.070 (0.156)	1.806*** (0.150)	0.576*** (0.127)	5.760*** (0.491)
Construction industries	38,395	-9.206*** (0.203)	-3.356*** (0.333)	4.535*** (0.359)	-1.562*** (0.067)	1.751*** (0.048)	0.256*** (0.034)	-7.582*** (0.214)
Wholesale and retail trade, transport, accommodation and catering industries	96,992	-1.945*** (0.112)	-2.911*** (0.176)	4.281*** (0.196)	-3.433*** (0.054)	1.203*** (0.029)	0.994*** (0.046)	-1.811*** (0.131)
Information and communication industries	6,401	-2.353*** (0.640)	-3.352*** (0.679)	5.671*** (0.912)	-2.629*** (0.270)	1.362*** (0.116)	-0.588** (0.228)	-1.888*** (0.628)
Financial activities and insurance industries	2,212	3.685** (1.626)	-3.597*** (1.225)	4.541** (2.276)	-9.436*** (0.960)	0.514*** (0.139)	2.763*** (0.644)	-1.530 (1.340)
Real estate activities	3,571	-6.292*** (0.724)	-1.907*** (0.633)	4.625*** (1.015)	-2.906*** (0.244)	0.947*** (0.098)	2.397*** (0.256)	-3.137*** (0.683)
Legal, accounting, management architectural, engineering, control and technical analysis activities	14,709	-3.044*** (0.357)	-4.024*** (0.534)	6.043*** (0.617)	0.062 (0.141)	0.669*** (0.071)	0.335*** (0.113)	0.041 (0.389)
Other scientific and technical activities	13,755	-2.385*** (0.335)	-3.460*** (0.528)	4.657*** (0.547)	-1.401*** (0.245)	1.702*** (0.100)	-0.039 (0.165)	-0.927** (0.465)

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table C.3.2: FHK decompositions with bootstrap and default - By sector (2010-2013)

### C.3.2 MP's decompositions

Sectors	Number of firms	Incumbents		Net entry			ΔP
		Learning	Reallocation	Entry	Exit		
					Defaulting	Other	
Food products, beverages and tobacco industries	9,147	-14.547*** (1.091)	23.430*** (1.762)	-3.547*** (0.300)	0.148*** (0.029)	0.610*** (0.063)	6.094*** (0.751)
Other industrial products, coking and refining industries	19,273	-27.232*** (0.948)	31.453*** (1.543)	-0.552*** (0.157)	0.153*** (0.017)	0.082*** (0.030)	3.905*** (0.653)
Electrics, electronics, informatics products industries	4,306	-33.526*** (1.805)	30.901*** (3.047)	0.149 (0.421)	0.220*** (0.049)	0.284*** (0.074)	-1.971 (1.424)
Transporting materials	1,079	-27.400*** (3.174)	25.410*** (4.713)	-1.456* (0.780)	0.313*** (0.065)	0.168*** (0.062)	-2.964 (2.211)
Clothing industries	2,117	-35.330*** (2.467)	34.299*** (4.033)	-0.623 (0.503)	0.299*** (0.070)	0.270*** (0.070)	-1.086 (1.856)
Wood and paper industries	4,438	-8.670*** (1.544)	24.760*** (2.606)	-0.489* (0.281)	0.217*** (0.035)	0.196*** (0.040)	16.014*** (1.174)
Construction industries	34,050	-31.997*** (0.628)	33.154*** (1.100)	-0.731*** (0.161)	0.091*** (0.009)	0.102*** (0.015)	0.619 (0.481)
Wholesale and retail trade, transport, accommodation and catering industries	81,659	-21.980*** (0.357)	27.423*** (0.594)	-1.959*** (0.103)	0.095*** (0.007)	0.229*** (0.021)	3.808*** (0.284)
Information and communication industries	5,561	-11.437*** (1.377)	16.679*** (2.151)	-1.167*** (0.320)	0.150*** (0.034)	-0.185* (0.100)	4.040*** (0.978)
Financial activities and insurance industries	1,415	17.609*** (0.974)	-0.844*** (0.266)	-4.114*** (0.837)	0.115*** (0.003)	0.018 (0.150)	12.785*** (1.494)
Real estate activities	3,246	-21.142*** (1.728)	20.006*** (2.820)	3.355*** (0.544)	0.127*** (0.029)	0.327*** (0.074)	2.673** (1.223)
Legal, accounting, management architectural, engineering, control and technical analysis activities	16,242	-34.851*** (1.648)	47.115*** (2.834)	-0.328 (0.317)	0.006 (0.014)	-6.188*** (0.202)	5.754*** (1.145)
Other scientific and technical activities	10,359	-19.571*** (1.225)	25.897*** (2.010)	-1.561*** (0.345)	0.085*** (0.031)	-0.006 (0.066)	4.844*** (0.806)

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table C.3.3: MP decompositions with bootstrap and default - By sector (2006-2009)

Sectors	Number of firms	Incumbents		Net entry			ΔP
		Learning	Reallocation	Entry	Exit		
					Defaulting	Other	
Food products, beverages and tobacco industries	11,614	-3.772*** (0.563)	-3.397*** (0.863)	-7.449*** (0.165)	1.172*** (0.067)	2.292*** (0.158)	-11.153*** (0.400)
Other industrial products, coking and refining industries	20,071	2.897*** (0.328)	-1.193*** (0.441)	-0.597*** (0.070)	1.806*** (0.087)	0.385*** (0.083)	3.298*** (0.267)
Electrics, electronics, informatics products industries	4,399	6.505*** (0.874)	-1.109 (1.117)	-0.310* (0.183)	1.394*** (0.164)	0.478*** (0.140)	6.958*** (0.677)
Transporting materials	1,124	-3.677*** (1.165)	-1.387 (1.391)	0.131 (0.568)	2.410*** (0.320)	0.216 (0.401)	-2.307** (1.126)
Clothing industries	2,109	5.371*** (1.157)	-1.246 (1.219)	-1.072*** (0.251)	2.180*** (0.275)	0.961*** (0.289)	6.194*** (0.954)
Wood and paper industries	4,580	4.608*** (0.684)	-1.258 (0.905)	-0.306* (0.157)	1.996*** (0.163)	0.720*** (0.136)	5.760*** (0.491)
Construction industries	38,395	-6.599*** (0.268)	-2.367*** (0.377)	-0.894*** (0.065)	1.920*** (0.053)	0.359*** (0.035)	-7.582*** (0.214)
Wholesale and retail trade, transport, accommodation and catering industries	96,992	1.159*** (0.149)	-1.751*** (0.216)	-3.677*** (0.054)	1.275*** (0.030)	1.183*** (0.050)	-1.811*** (0.131)
Information and communication industries	6,401	1.098 (0.711)	-1.131 (0.886)	-2.736*** (0.256)	1.392*** (0.121)	-0.511** (0.250)	-1.888*** (0.628)
Financial activities and insurance industries	2,212	8.995*** (2.034)	-0.214 (2.965)	-14.220*** (1.128)	0.543*** (0.142)	3.366*** (0.759)	-1.530 (1.340)
Real estate activities	3,571	-5.127*** (0.891)	1.144 (1.258)	-2.886*** (0.248)	1.002*** (0.102)	2.730*** (0.282)	-3.137*** (0.683)
Legal, accounting, management architectural, engineering, control and technical analysis activities	14,709	1.191** (0.488)	-2.332*** (0.690)	0.065 (0.143)	0.693*** (0.073)	0.423*** (0.123)	0.041 (0.389)
Other scientific and technical activities	13,755	1.153** (0.466)	-2.489*** (0.662)	-1.490*** (0.244)	1.798*** (0.105)	0.102 (0.177)	-0.927** (0.465)

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table C.3.4: MP decompositions with bootstrap and default - By sector (2010-2013)