



**HAL**  
open science

**Does the EU-ETS affect the firm's capital structure?  
Evidence from French manufacturing firms. LEO  
Working Paper 2024-09**

Aimé Okoko, Pascale Combes Motel, Sonia Schwartz

► **To cite this version:**

Aimé Okoko, Pascale Combes Motel, Sonia Schwartz. Does the EU-ETS affect the firm's capital structure? Evidence from French manufacturing firms. LEO Working Paper 2024-09. 2024. hal-04637992

**HAL Id: hal-04637992**

**<https://univ-orleans.hal.science/hal-04637992v1>**

Preprint submitted on 8 Jul 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Document de Recherche du Laboratoire d'Économie d'Orléans

*Working Paper Series, Economic Research Department of the University of Orléans, University Of Tours  
and University Clermont-Auvergne, France*

**DR LEO 2024-07**



# Does the EU-ETS affect the firm's capital structure? Evidence from French manufacturing firms

Pascale Combes Motel (LEO-UCA), Aimé Okoko (LEO-UCA), Sonia Schwartz (LEO-UCA)

MISE EN LIGNE / ONLINE | 04/06/2024

Laboratoire d'Économie d'Orléans  
Collegium DEG  
Rue de Blois - BP 26739  
45067 ORLÉANS Cedex 2

TÉL | (33) (0)2 38 41 70 37  
MAIL | [leo@univ-orleans.fr](mailto:leo@univ-orleans.fr)  
[www.leo-univ-orleans.fr](http://www.leo-univ-orleans.fr)

# Does the EU-ETS affect the firm's capital structure? Evidence from French manufacturing firms

Pascale Combes Motel (LEO-UCA)<sup>1</sup>, Aimé Okoko (LEO-UCA), Sonia Schwartz (LEO-UCA)

March 18, 2024

## Abstract

This study investigates the impact of the European Union Emissions Trading System (EU-ETS) on the capital structure, namely the debt ratio, of French manufacturing firms from 2007 to 2018. To do this, we construct an original database linking French firms subject to the ETS to their financial variables. Using a matching method, we show that firms participating in the ETS have a higher debt ratio than non-participating ones. To consider the effect of the initial allocation of allowances, we divide our sample of treated firms according to their initial allocation quartile. We find that firms with the lowest initial allowances have the highest debt ratio. Furthermore, the ETS's effect on firms' capital structure is observed during Phase 2 (2008-2012) as opposed to Phase 3 (2013-2020) and concerns firms operating on domestic markets. The effect also differs according to the sectors selected. Our results suggest that, faced with the ETS, firms anticipated the future tightening of environmental constraints. Firms that received the fewest free-of-charge allowances complied by investing in pollution-reduction technologies relying on debt financing. Environmental policy variables, therefore, have an impact on the financial structure of firms.

---

<sup>1</sup> Université Clermont Auvergne – Université d'Orléans, LEO, 45067, Orléans, France.

## Résumé

Cette étude examine l'impact du système européen d'échange de quotas d'émission (SEQE-UE) sur la structure du capital, mesurée par le ratio d'endettement, des entreprises manufacturières françaises entre 2007 et 2018. Pour ce faire, nous construisons une base de données originale reliant les entreprises françaises soumises au SEQE à leurs variables financières. En utilisant une méthode d'appariement, nous montrons que les entreprises participant au SEQE ont un ratio d'endettement plus élevé que celles qui n'y participent pas. Pour étudier l'effet de l'allocation initiale des quotas, nous divisons notre échantillon d'entreprises traitées en fonction de leur quartile d'allocation initiale. Nous constatons que les entreprises ayant les allocations initiales les plus faibles ont le taux d'endettement le plus élevé. En outre, l'effet du SEQE sur la structure du capital des entreprises est observé au cours de la phase 2 (2008-2012) par opposition à la phase 3 (2013-2020) et concerne les entreprises opérant sur les marchés domestiques. L'effet diffère également selon les secteurs retenus. Nos résultats suggèrent que, face au SEQE, les entreprises ont anticipé le futur renforcement des contraintes environnementales. Les entreprises qui ont reçu le moins de quotas gratuits se sont mises en conformité en investissant dans des technologies de réduction de la pollution, et ce en recourant au financement par l'emprunt. Les variables de la politique environnementale ont donc un impact sur la structure financière des entreprises.

## Keywords

EU-ETS, capital structure, initial allocation, propensity scores, entropy balancing.

## JEL codes

C33, G32, Q58, Q53, D22

# 1 Introduction

Several countries have decided to set up carbon pricing mechanisms to curb greenhouse gas emissions. Carbon pricing devices are 68 worldwide, 34 of which are carbon quota markets (World Bank, 2022). For example, in 2005, the European Union set up a market for carbon dioxide emissions known as the EU Emissions Trading System (EU ETS). This market concerns around 11,500 European industrial installations, which accounted for about two billion tonnes, or 45% of European carbon dioxide emissions, when the system was set up (Ellerman and Buchner, 2007). Initially set up to help the European Union meet its commitment under the Kyoto Protocol (European Commission, 2003), the ETS was made permanent as part of the March 2009 Energy-Climate Package. It also plays a pivotal role in the European Green Deal, which aims to achieve carbon neutrality by 2050.

Most EU countries allocated free-of-charge allowances from 2012 to 2020, representing 82% of the pollution cap. Allowances are transferable, enabling firms to choose between polluting (and therefore holding allowances) or reducing their emissions. Such a trading scheme has a significant advantage over a command and control approach. It distributes emissions across firms in a cost-effective way. Furthermore, the final distribution of allowances is independent of the initial allocation when the latter is exogenous (Montgomery, 1972). These pollution allowance markets thus provide flexibility for the regulator, who can distribute allowances according to his objective without compromising market efficiency.

Faced with environmental constraints, firms must adapt to reduce their polluting emissions. Improving environmental performance can involve investing in cleaner technologies (Henderson and Millimet, 2007). The financial sector is a crucial player capable of providing resources to finance and disseminate environmental innovation (D'Orazio and Valente, 2019). If the environmental constraint triggered the demand for loanable funds, the firm's environmental performance may play a role in access to credit. Poor environmental performance could limit the ability to obtain loans. On the contrary, sound environmental practices could be an asset to lenders, incentivising them to provide the financial resources to foster environmental performance. Environmental constraints, therefore, have a potential impact on capital structure.

The market value of a firm is independent of its capital structure, according to the well-known irrelevance theorem of Modigliani and Miller (1958). However, considering corporate taxation (Modigliani and Miller, 1963), the possibility of bankruptcy (Baxter, 1967) or agency costs (Jensen and Meckling, 1976) has highlighted the influence of financial factors such as the debt-equity ratio on investment decisions. Moreover, asymmetric information can exist between the firm's decision-makers and external fund providers. Hence, the choice of the firm's capital structure becomes crucial. Firstly, it highlights how firms finance their activities. Secondly, it enables optimising the returns depending on how investments are funded. This choice eventually impacts its ability to face up to its competitive environment.

Nowadays, environmental regulations increasingly shape firms' competitive environment. To the best of our knowledge, the literature has overlooked the impact of environmental regulations on firms' capital structure. Stated differently, this paper analyses whether environmental constraints set up by the regulator are neutral to firms' capital structure. It, therefore, extends the literature stemming from Montgomery's contribution (Montgomery, 1972) to the corporate finance literature. Interestingly, greenhouse gas emission allowances have become financial instruments (European Commission, 2014), which establishes a link between environmental policy and finance from a regulatory point of view. More specifically, we examine the impact of the EU-ETS on the capital structure of French firms over the period 2007-2018. The expected results have potential policy implications. When the regulator designs an environmental policy, it usually has to consider various parameters such as the type of pollutant, the type of emitter, the nature of the information concerning the abatement costs, and the presence of any market power. Our results could support the regulator paying attention to the banking and financial system situation to design the environmental policy better.

To conduct this study, we are building an original dataset. It merges information on firms' initial allowance allocations obtained from the European Union Transaction Log (EUTL) with firms' financial characteristics provided by the DIANE database. We then carry out an impact analysis to assess whether the ETS has a bearing on the financial structure of firms as measured by their debt ratio. We construct a control group using propensity score matching and weighting methods. Our results show that the EU-ETS affects corporate finance regardless of the method used. According to the Entropy Balancing method, firms belonging to the ETS

have a 14.8 percentage points higher debt ratio than non-participating firms. The results also show that the firms at the bottom of the initial distribution of quotas are the ones that take on the most debt. Furthermore, the ETS's impact on firms' capital structure is observed during phase 2, as opposed to phase 3, and concerns firms operating on domestic markets. The impact also differs according to the sector. Our results suggest that, faced with the ETS, firms anticipated the future tightening of environmental constraints. Those that received the fewest free-of-charge allowances complied by investing in pollution-reduction technologies financed by debt.

## 2 Background and related literature

After presenting the ETS (section 2.1), we look at the consequences of the ETS for corporate performance indicators (section 2.2). We then review the literature on the determinants of the financial structure of firms (section 2.3).

### 2.1 The European Union Emissions Trading System

Crocker (1966) and Dales (1968) introduced the idea of markets for pollution rights to internalise a negative externality. The exchange of quotas makes it possible to obtain a distribution of polluting emissions that minimises the total abatement cost. Another important theoretical result is that the final distribution of quotas does not depend on the initial allocation (Montgomery, 1972). Quota markets are, therefore, particularly attractive to the regulator since they enable flexibility, which the Pigouvian tax does not allow. The regulator can distribute quotas according to its objective (auction or free of charge) or to its equity concerns without undermining cost efficiency. The Acid Rain Program was the first large-scale implementation of this type of market to regulate sulphur dioxide emissions in the United States.

Following the Kyoto Protocol in 1997, the European Union undertook to reduce its carbon dioxide emissions by 8% below 1990 levels over the period 2008 to 2012. To meet this target, it adopted Directive 2003/87/EC, known as the ETS Directive (European Commission, 2003), which defines the legal framework for the European carbon market. It covers around 11,500 installations, corresponding to approximately two billion tonnes of carbon dioxide when the EU-ETS was implemented (Ellerman and Buchner, 2007). The market covers carbon dioxide

emissions from electricity and heat production, energy-intensive industrial sectors (notably oil refineries, steelworks and the production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals), and commercial aviation within the European Economic Area. It also includes nitrous oxide (N<sub>2</sub>O) from the production of nitric acid, adipic acid, glyoxal and glyoxylic acid, and perfluorocarbons (PFCs) from the production of aluminium. These different greenhouse gases are converted into tonnes of carbon dioxide equivalent.

When the EU ETS was introduced in 2005, 27 European Union countries were involved, joined by Norway, Iceland and Liechtenstein in 2008 and Croatia in 2013 (European Commission, 2017). For Phase 1 (2005-2007) and Phase 2 (2008-2012), each European country had to set up its National Allocation Plan (NAP), subject to approval by the European Commission. This process involved determining the allowances allocated to each installation to achieve the national reduction target. Therefore, European Union Quotas (EUAs) constitute the pollution cap. For Phase 3 (2013-2020) and Phase 4 (2021-2030), the European Commission has downsized quotas distributed each year by 1.74% to tighten the environmental constraint. It amounts to a 20% reduction in 2020 compared to 2005, with the pollution cap set to be reduced by 2.2% per year (European Commission, 2009).

Member States are responsible for setting up national registers to record the initial allocation, transfer and sale of EUAs. The European Commission has overseen the national emissions registers by keeping the European Union Transaction Log (EUTL) up to date. Emissions from regulated firms are monitored, reported annually by the firm and verified by independent auditors.

Allowances are mainly allocated free of charge in Phases 1 and 2. Countries could auction up to 5% of their NAP in Phase 1 and 10% in Phase 2. However, this option was little used, and only 0.13% of total allowances were sold during Phase 1, with a slight increase during Phase 2 (Ellerman and Buchner, 2007; Ellerman et al., 2014). The transition from free-of-charge to auctioned allowances is gradual. Since Phase 3, since electricity producers are not subject to international competition, they must buy all their allowances, except for a temporary exemption for eight Central and Eastern European countries. The manufacturing industry continues to receive a share of free-of-charge allowances, down from 80% in 2013 to 30% in



2020. Several sectors “exposed” to carbon leakage (the relocation of production due to climate constraints) benefited from an exemption, with 100% free-of-charge allowances until 2020. Since 2013, the proportion of auctioned allowances to other sectors has risen to 57%. This rate has been kept for the fourth phase, which began in 2021 (European Commission, 2018). The free-of-charge allowances are based on carbon intensity benchmarks established by product since 2013.

According to Montgomery (1972), the final allocation of quotas after trading is independent of their initial allocation. This finding is particularly called into question in the presence of market power (Hahn, 1984) or transaction costs (Stavins, 1995). Concerning the ETS, Zaklan (2023) corroborates Montgomery's (1972) result for firms in the energy sector between 2009 and 2017. While the consequence of the initial allocation of quotas on the final choice of emissions is well documented in the literature, potential implications on corporate financial indicators are overlooked. It is precisely the aim of this study to bridge a gap between environmental policy and corporate finance.

## 2.2 Effects of the ETS on corporate performance

Environmental policies inducing additional compliance costs may negatively affect corporate performance and competitiveness. However, according to Porter's hypothesis, environmental regulations can positively impact firm productivity (Porter and van der Linde, 1995). Strict but flexible, they would encourage firms to question their entire production process, thereby abating pollution and fostering productivity gains. In the following, we first look at the literature addressing environmental efficiency, namely whether the EU-ETS allowed reducing carbon emissions. We then turn to how the EU-ETS affect other dimensions such as investment, productivity and corporate profitability.

Existing studies implement a vast array of methodologies to assess the effect of the EU-ETS. They find that the EU-ETS decreases carbon emissions. Impact analysis methods at the installation level covering four countries (France, Netherlands, Norway and the United Kingdom) provide causal evidence of a 10% decrease in carbon emission reduction up to the end of Phase 1 (Dechezleprêtre et al., 2018). Another study uses the synthetic control method to find that the EU-ETS saved more than 1 billion tons of carbon dioxide despite low carbon prices between 2008 and 2016 (Bayer and Aklin, 2020). A survey of the econometric literature

covering Phases 1 and 2 finds that the overallocation (Phase 1) and the 2008-2009 recession (Phase 2) mitigated the effect of the EU ETS on carbon emissions (Laing et al., 2014). A recent study covering the power generation sector comforts this claim, emphasising that the economic crisis became the leading cause of emission reductions (Chèze et al., 2020).

Regarding investment, productivity and corporate profitability, the literature reaches diverse conclusions. A first strand of the literature focuses on the effect of environmental regulation on investment, which is a crucial step towards committing to less carbon-intensive technologies and fostering innovation. At first glance, European manufacturing industries reacted positively to stricter environmental regulations (Leiter et al., 2011). Other studies specifically focusing on the effects of the EU-ETS on investment decisions found mixed or non-existent impacts. Several authors pointed out that the EU-ETS mainly drove small-scale investments (Hoffmann, 2007; Marcantonini et al., 2017),<sup>2</sup> while others found no effect on investment in carbon-mitigating technologies (Löfgren et al., 2014). Existing studies still cover Phase 1 and Phase 2, which call for further research on the dynamic efficiency of the EU-ETS. The survey conducted by Brohé and Burniaux (2015) on Belgian firms pointed out that expected carbon prices were still too low to attract additional financing to invest in these technologies. In the same vein, there are pieces of evidence that free-of-charge allowances adversely affected low-carbon investments (Teixidó et al., 2019).

Another strand of the literature scrutinises how the EU-ETS can foster corporate productivity or efficiency. Existing studies rely on different datasets and measures and cover various sectors. A study on a large panel of EU firms during Phases 1 and 2 suggests a negligible influence of the EU-ETS on Total Factor Productivity (Marin et al., 2018). This result aligns with D'Arcangelo et al. (2022) findings on Italian manufacturing firms' Total Factor Productivity. Regarding the EU power generation sector, the EU ETS does not significantly affect productivity measured by Data Envelopment Analysis during Phase 1 (Jaraitė and Di Maria, 2012). When it comes to labour productivity, the picture is somewhat different. For instance, studying Norwegian manufacturing firms, Klemetsen et al. (2020) found positive effects on

---

<sup>2</sup> (Jaraitė-Kažukauske and Di Maria, 2016) also found a weak effect of the EU-ETS on the Lithuanian firms' investment from 2010. This effect was supposedly driven by law passed in 2009 by the Lithuanian parliament that limited the possibility to recycle revenues from the sale of EUAs.

labour productivity during Phase 2. This result aligns with the study of EU manufacturing firms by Marin et al. (2018).

Veith et al. (2009) corroborate the positive link between profitability and the ETS for the European power generation sector. Returns in this sector positively correlate with rising quota prices. These results suggest that the ETS increases corporate profits as firms pass on environmental costs in customer prices. Therefore, the ETS's impact on competitiveness should be greater in sectors most exposed to international trade.

While all of the above studies show a positive impact of the ETS on one indicator of firm performance, other studies find no significant impact. For example, Abrell et al. (2011) assessed the effect of the ETS on firms' competitiveness based on data from 2,000 European firms from 2005 to 2008. They conclude that the ETS has a non-significant effect on firms' value-added, marginal profit or employment rate. Anger and Oberndorfer (2008) examine the impact of the ETS on firms' revenue and employment levels, using a sample of German firms from 2005 to 2006. According to their results, the ETS does not impact these variables, which suggests that the effect of carbon regulation on firm competitiveness should, therefore, be limited. Note, however, that these studies cover a short period.

Other studies establish an adverse effect of the ETS on firm indicators. Marin et al. (2018) analyse the impact of phases 1 and 2 of the ETS on a broad set of economic performance indicators such as value-added, turnover, employment, investment, productivity and total factor productivity. Based on a large panel of European firms, they show that the ETS has a negative but small impact on these indicators, particularly in phase 2. Regarding employment, Wagner and Petrick (2014) highlight a negative effect of the ETS during the second phase for French firms.

While many studies evaluate the impact of the ETS on firm performance indicators, it is difficult to see a consensus emerging. We open a new perspective that assesses the link between the ETS and firms' capital structure.

### 2.3 The financial structure of firms

The seminal contribution of Modigliani and Miller established the neutrality of the firm's financial structure to its value (Modigliani and Miller, 1958). The theoretical result holds under

the assumptions of perfect competition, no transaction or agency costs, and no asymmetric information, thus making the different financing methods of the firm perfectly substitutable. Departing from the neutrality of the financial structure has given rise to two main streams of the corporate finance literature, namely the trade-off (TOT) and the pecking order theories (POT). All theories revolve around the benefits and costs of debt financing. However, they differ according to which market imperfection seems most relevant.<sup>3</sup>

The TOT departs from the framework posited by Modigliani and Miller while relaxing several assumptions. First, Modigliani and Miller amended their initial neutrality claim while considering the deductibility of interest payments from corporate-tax liabilities. Hence, debt financing incurs a tax advantage (Modigliani and Miller, 1963). However, indebtedness increases the debt service and, therefore, the firm's default risk: excessive leverage increases the cost of capital (Baxter, 1967). Issuing debt generates agency costs (Jensen and Meckling, 1976) that are borne either by the principal (the owner or shareholders) or the agent (the managers). Minimising the agency costs allows for determining an optimal debt ratio. Bradley et al. (1984) propose a theoretical model synthesising these different developments about the optimal capital structure.

The POT builds on the premise that managers have information that investors do not have (Myers, 1984; Myers and Majluf, 1984). This asymmetric information between the firm and shareholders leads managers to adopt an investment strategy to reduce adverse selection costs. The firm has a preference ranking over financing sources. For instance, it makes sequential choices over funding sources, preferring internal to external financing. This is especially true for small and medium-sized firms, whose owners are usually the managers. Borrowing is not the preferred financing, as it requires rigorous management and implies a dependence on financial institutions compared with internal financing. Capital increases are relegated to the back burner, meaning a loss of power towards new investors.<sup>4</sup> Financial distress can also impact a firm's financial structure (Gordon, 1971). Under the risk of financial

---

<sup>3</sup> (Baker and Wurgler, 2002) argued that firms can also adjust their financing choices on financial market conditions. For instance, they try to raise funds when market conditions are favourable, namely when interest rates are low or stock markets are performing well. The intention is to exploit temporary fluctuations in the cost of equity relative to the cost of other forms of capital. Hence, the "equity market timing" that reflects the intention to benefit from temporary fluctuations in the cost of equity relative to other capital financing costs.

<sup>4</sup> A review of the empirical research on the capital structure is provided by Graham and Leary (2011).

distress, the firm's asset type could affect its financing choice. Thus, holding tangible assets may indicate that the firm is in better financial health and can increase its indebtedness. However, according to the POT, a firm holding many tangible assets prefers to raise less debt.

We study in this paper whether traditional determinants of corporate leverage should be augmented to consider environmental policies. To our knowledge, this channel is overlooked in the literature. Ginglinger and Moreau's (2023) article attempts to assess the effect of climate change risk on the capital structure. Still, it does not directly address the effect of environmental policies on the capital structure. Adeneye et al. (2023) highlight a positive relationship between a voluntary approach, namely sustainable practices such as the ESG's score (Environmental, Social and Governance) and the capital structure. Implementing an environmental policy such as a mandatory climate policy generates additional costs for firms to achieve compliance, which could affect the capital structure. In the following, we econometrically investigate whether the EU-ETS impact the capital structure of French firms.

### 3 Data and descriptive statistics

We describe how we built our database and then present descriptive statistics.

#### 3.1 Database construction and variable selection

We compile an original dataset merging the EUTL (EU Transaction Log) and DIANE databases that provide financial information on French firms. The EUTL database entails information on firms involved in the EU-ETS. It covers all the firms participating in the EU ETS, specifying their country, their verified emissions for each compliance year and their initial allowance allocations. We use the *Initial allocation* variable, our variable of interest. It is expressed in tonnes of carbon dioxide equivalent. We consider its logarithmic value to lessen the influence of extreme values.

The data available are those for plants that are the smallest production units relevant for the decision on inclusion in the ETS. The ETS covers several plants that are managed by accounts. Each plant is linked to a single account, but each account can be linked to several plants. These accounts may belong to firms with Operator Holding Accounts or to individuals with Personal Holding Accounts. To ease the exploitation of the EUTL data, we follow Jaraité et al. (2013). We match the information of the ETS installations to their respective managing

firms and supplement them with the information of the owners of these managers up to the last level. For example, if firm X owns a facility and is itself 50.01% owned by firm Y and Y is also 50.01% owned by firm Z, the latter is the Global Ultimate Owner (GUO) of the facility.

The resulting dataset contains the plants, the firms managing the accounts (firm X in our case) and the GUOs for each firm. A total of 13,512 operator accounts were obtained, of which 1,136 were for France. We retrieve the identifiers of French firms, which are the SIREN (Système d'Identification du Répertoire des ENTreprises - Firm Directory Identification System) numbers. It is a unique INSEE (Institut National de la Statistique et des Études Économiques – National Institute of Statistics and Economic Studies) code used to identify a firm, organisation or association with activities in France. The SIREN number enables us to identify the selected firms.

Since the objective of this study is to analyse the impact of the ETS on corporate capital structure, we need variables that reflect the financial structure, as well as determinants of the capital structure of firms. Using firm identifiers, we obtain these data from the DIANE database. It contains firms' financial data, financial strength indicators, share data for publicly traded firms, scores and valuations, original filings/images, detailed capital structures, market research, economic and firm news, mergers and acquisitions transactions and rumours, maps and map analysis.

We use *Debts* and *Net total assets* to construct the capital structure variable (*Debt ratio*). We follow Ziane (2004) and Daskalakis and Psillaki (2008), according to which the capital structure is defined by the ratio of the firm's debts to its net total assets. Debts represent the borrowings made by firms from financial institutions or their suppliers. Total net assets represent the value of the firm's assets, i.e. what it owns net of loans.

Next, we consider financial variables to control for drivers of the financial structure of firms reported in the corporate finance literature reviewed in Section 2.3. Using fixed assets, we compute the *Asset structure* variable, which represents the proportion of total assets made up of fixed assets. When a firm has tangible assets such as equipment or land, it can reduce costs in the event of financial distress. We also include the *Self-financing ratio* to measure the firm's profitability. Represented by the surplus remaining at the end of the financial year, this ratio indicates the firm's ability to bear costs, repay its loans, distribute incomes or save

without external financing. According to the POT, the most profitable firms prefer to self-finance with internal funds rather than debt. Data on profits are used to calculate the firm's *Profitability*, measured by the ratio between profits and net assets. This ratio allows us to take into account the firm's financing margin. A firm may decide to reduce the payments to investors if it has a high financing requirement. Profitable firms may need less debt to self-finance.

We also consider the level of employment used in the firm, which we measure by the *Number of employees*. A firm with a large workforce has higher costs and could take on debt. We also use *Sales*, the value of total sales, to proxy the size of the business; it is expressed in thousands of euros. A "big" firm is supposed to be more able to generate cash that could, in turn, finance additional investment. We eventually extract the date the business was set up to obtain its *Age*. The age of the firm can have different effects on the use of credit. Within the POT, Berger and Udell (1998) noted that small and medium enterprises make less use of debt as the age of the firm increases, suggesting that firms have a financial life cycle. The intuition is that mature firms have better control over their costs and can access lower interest rates. Long-established firms also have a reputation and accounting history that eases access to credit.

### 3.2 Descriptive statistics

Our database contains a total of 10,627 French firms, of which 392 ETS participants and 10,235 non-participants between 2007 and 2013. Table 1 reports the variables' statistics for different trading phases: 2007 (phase 1), 2008 (phase 2) and 2018 (phase 3). The *Age* variable is the number of years the firm has been in business from its creation until 2018. Firms are, on average, 41 years old and have an average workforce of 874 employees (in 2008). Regarding capital structure, we note that debt represents 58% (in 2008) of the firm's total assets. Allowances distributed over the period averaged 11,8766 tonnes of carbon equivalent per firm in 2008, with a notable strengthening of the policy in phase 3.

The *Debt ratio* increased more rapidly between 2007 and 2013 for firms subject to the EU ETS than for firms not subject to the system. It rose from 0.55 in 2007 to 0.62 in 2013 for treated firms and from 0.64 in 2007 to 0.66 in 2013 for untreated firms. However, this observation alone is insufficient to draw conclusions about the evolution of the difference in

capital structure between the two groups. Firms subject to the EU ETS also have higher average values for the variables selected than firms not subject to the system. For example, they are older and have higher self-financing or sales. These data could suggest that these firms may have easier access to credit. These differences do not allow us to infer the effect of ETS, which necessitates an econometric setting to conduct impact analysis.

The firms in our sample belong to 19 different sectors, listed in Table 2.<sup>5</sup> We have chosen to retain only the six sectors with the most firms for the remainder of our analysis: manufacture of food products (NAF 10), manufacture of paper products (NAF 17), manufacture of chemicals and chemical products (NAF 20), manufacture of other non-metallic mineral products (NAF 23), manufacture of basic metals (NAF 24), and manufacture of motor vehicles, trailers and semi-trailers (NAF 29). These sectors include prominent firms, such as Danone (NAF 10). The chemical products sector is represented by firms such as Lubrizol and Air Liquide (NAF 20), while the minerals sector harbours Rockwool (NAF 23). In the automotive sector (NAF 29), Peugeot is a major player, while in the basic metals sector (NAF 24), our sample includes ArcelorMittal, one of the world's largest steel producers. The free-of-charge allowances allocated to these sectors are shown in Figure A- 1 in Appendix.

---

<sup>5</sup> Table A- 1 gives the full names of the sectors according to the French classification of activities and the shorter names we use in the study.



Table 1. Treated and non-treated firms' characteristics

Variable	Year	Treated			Non-treated		
		Average	Std Deviation	N	Average	Std Deviation	N
Initial allocation (tons CO2eq)	2007	122,990.79	648,450.07	392	-	-	-
Debt ratio (%)		0.55	0.29	392	0.64	0.79	10,235
Debts (thousands of euros)		225,703.95	650,589.67	392	18,482.50	277,324.99	10,235
Asset structure (%)		0.45	0.22	392	0.29	0.21	10,235
Self-financing ratio (%)		5.38	10.38	392	4.61	8.81	10,235
Profitability (%)		0.07	0.68	392	0.04	0.16	10,235
Number of employees		1,439.24	6,697.61	392	140.78	698.58	10,235
Sales (thousands of euros)		446,610.11	842,231.87	392	39,907.20	475,076.75	10,235
Age		42.54	18.40	392	35.14	17.08	10,235
Initial allocation (tons CO2eq)	2008	118,766.84	544,072.19	392	-	-	-
Debt ratio (%)		0.58	0.40	392	0.65	0.99	10,235
Debts (thousands of euros)		199,186.10	518,808.69	392	19,225.66	322,687.36	10,235
Asset structure (%)		0.47	0.21	392	0.30	0.21	10,235
Self-financing ratio (%)		5.79	9.28	392	3.93	10.03	10,235
Profitability (%)		0.01	0.28	392	0.02	0.18	10,235
Age		41.33	18.38	392	35.14	17.08	10,235
Number of employees		874.65	2,066.66	392	135.90	685.45	10,235
Sales (thousands of euros)		427,562.26	809,218.97	392	41,114.78	474,862.30	10,235
Initial allocation (tons CO2eq)	2013	95,232.23	428,369.85	392	-	-	-
Debt ratio (%)		0.62	0.41	392	0.67	26.34	10,235
Debts (thousands of euros)		296,004.12	1,086,656.63	392	17,873.53	162,255.99	10,235
Asset structure (%)		0.45	0.23	392	0.31	0.21	10,235
Self-financing ratio (%)		4.44	7.97	392	3.39	10.26	10,235
Profitability (%)		-0.01	0.33	392	-0.01	2.15	10,235
Age		38.94	18.58	392	35.14	17.08	10,235
Number of employees		1,293.51	4,756.19	392	136.70	636.69	10,235
Sales (thousands of euros)		552,500.89	1,980,141.41	392	42,827.18	463,312.25	10,235
Domestic Market				121			7,050
International Market				171			3,185
With subsidiaries				129			2,221
Without subsidiaries				163			8,014

Source: Authors' calculation from the EUTL and DIANE databases

Table 2. Number of firms by sector and treatment

		2007		2008		2013	
NAF	Manufacturing sectors	Control	Treated	Control	Treated	Control	Treated
<b>10</b>	<b>Food</b>	<b>2945</b>	<b>81</b>	<b>2945</b>	<b>81</b>	<b>2945</b>	<b>81</b>
11	Beverages	264	6	264	6	264	6
12	Tobacco products	2	2	2	2	2	2
13	Textiles	466	4	466	4	466	4
16	Wood and cork products	563	10	563	10	563	10
<b>17</b>	<b>Paper</b>	<b>521</b>	<b>71</b>	<b>521</b>	<b>71</b>	<b>521</b>	<b>71</b>
19	Coking and refining	21	6	21	6	21	6
<b>20</b>	<b>Chemicals</b>	<b>763</b>	<b>65</b>	<b>763</b>	<b>65</b>	<b>763</b>	<b>65</b>
21	Pharmaceutical industry	218	5	218	5	218	5
22	Rubber and plastic	1348	9	1348	9	1348	9
<b>23</b>	<b>Minerals</b>	<b>628</b>	<b>73</b>	<b>628</b>	<b>73</b>	<b>628</b>	<b>73</b>
<b>24</b>	<b>Basic metals</b>	<b>285</b>	<b>26</b>	<b>285</b>	<b>26</b>	<b>285</b>	<b>26</b>
25	Fabricated metal products	15	0	15	0	15	0
26	Computer electronic optical	285	3	285	3	285	3
27	Electrical equipment	88	2	88	2	88	2
28	Machinery	693	3	693	3	693	3
<b>29</b>	<b>Automotive</b>	<b>421</b>	<b>18</b>	<b>421</b>	<b>18</b>	<b>421</b>	<b>18</b>
30	Other transport equipment	207	6	207	6	207	6
31	Furniture	502	2	502	2	502	2

Source: Authors' calculation from the EUTL and DIANE databases. The full name of manufacturing sectors according to the French classification of activities is available in Table A- 1.

## 4 Econometric setup

We present our econometric approach to highlighting the effect of introducing the ETS on the firms' capital structure. To do this, we carry out an impact analysis. It compares firms to the ETS (treated firms) with those not subject to the ETS (untreated firms). The data used comes from DIANE and EUTL for the period 2007-2018. We estimate the Average Treatment Effect to assess and quantify the effect of the EU ETS on the firms' financial structure. The Average Treatment effect on the Treated writes as follows:

$$ATT = E(Debt\_Ratio_{it}^1 | D = 1) - (Debt\_Ratio_{it}^0 | D = 1)$$

$i$  is the index of French firms, and  $t$  is the index for years with  $t = 2007, \dots, 2018$ .  $D$  represents the treatment status.  $(Debt\_Ratio_{it}^1 | D = 1)$  is the Debt Ratio if firms had received the treatment and  $(Debt\_Ratio_{it}^0 | D = 1)$  is the Debt ratio that would have been observed in treated firms had they not been subject to the ETS. As this value is unobserved, it must be estimated. Direct comparison with the control group would only be possible if the

participation decision were random. Where this is not the case, there may be a selection bias conducing to a bias in the treatment effect. As the decision to join the ETS is not random, this problem may arise in our study. To address this issue, that is important for the internal validity of our study, we can rely on matching methods: we compare firms subject to the ETS with a sample of firms that do not participate but share the same characteristics. Matching has been widely used for assessing the efficiency or the competitiveness of the EU (e.g. Verde, 2020 for a review) and to study the drivers of the capital structure (Faccio and Xu, 2015).<sup>6</sup>

We define pre-treatment variables to elaborate the control sample of firms. We discard financial variables because they theoretically do not influence the probability of a firm being treated. Therefore, we consider the following non-financial variables: *Age*, the number of subsidiaries, the domestic or international nature of the firm market and the sector of activity. We add control variables to evaluate the average treatment effect (Rubin and Thomas, 2000). These control variables are deemed to influence the debt ratio of firms, namely financial and non-financial variables, such as *Self-financing ratio*, *Sales*, *Profitability*, *Asset structure*, and *Number of employees*. The addition of year-fixed effects captures temporal variations that are common to all firms, such as macroeconomic factors. Firm fixed effects account for unobserved firm characteristics that do not vary over time.

When we use the Nearest Neighbour Matching method (section 4.1), the control group is made up solely of the selected neighbours, regardless of their distance from the nearest individual. We also use weighting methods that allow us to keep the total sample by weighting individuals by their probability of belonging to the treatment group (section 4.2).

#### 4.1 Matching

Matching methods in impact evaluation involve selecting a sample from the control group in such a way as to cancel out the differences between this sample and the treated group, conditional on several covariates. The aim is to compare similar individuals so that the effect of the difference between the treated and untreated groups can be attributed to the ETS. We, therefore, need to find individuals who are similar to the treated individuals conditionally on

---

<sup>6</sup> Several existing studies on the environmental efficiency of the EU-ETS rely on Difference-in-Differences method (e.g. Dechezleprêtre, Nachtigall and Venmans, 2018). Since our financial data are not available prior to 2007, we are not able to implement Difference-in-Differences.

variables that are not influenced by participation in the ETS. Finding similar individuals conditional on a large number of characteristics can prove problematic. Relying on propensity score matching can circumvent the problem (Rosenbaum and Rubin, 1983; Rosenbaum, 2002; Abadie and Imbens, 2011). The propensity score is the probability that a firm receives the treatment, namely the ETS, based on the observed values of its characteristics.

We first consider the most common method that is  $k = 1$  nearest neighbour matching (1-NN). It matches each treated firm with the control individual with the smallest distance from the treated, namely, the closest propensity score. However, this method of measuring distance may not be accurate if the nearest neighbour has a propensity score value that is quite distant. It is suggested to use more than one nearest neighbour. Then, instead of using a defined number of neighbours, the nearest neighbour matching method can also consist of defining a radius that is a distance threshold within which all individuals will be considered as counterfactuals. When we use the nearest neighbour matching method, the control group is made up solely of the selected neighbours, regardless of their distance from the nearest individual. We, therefore, use weighting methods that allow us to keep the total sample by weighting individuals by their probability of belonging to the treatment group.

## 4.2 Weighting

Weighting methods allow keeping the majority of firms in the control group and giving them weights to reduce the differences in the weighted average between the treatment group and the control group.

Inverse Probability Weighting (IPW) makes it possible to reduce differences between the covariates of two groups (Robins et al., 2000). Instead of keeping the nearest neighbours, the propensity scores are used to weight the control sample. Firms most likely to participate in the treatment are given a higher weight. This method provides more flexibility to eliminate differences in means between the two groups. However, the propensity score is a parametric method which involves estimating the propensity scores and then checking whether the scores satisfy the condition of comparability of the two groups.

The Entropy Balancing is a data pre-processing method used to achieve a balance of covariates between treatment and control groups in observational studies (Hainmueller,

2012). It adjusts the weights of observations so that the distribution of covariates is similar between the treated and the control groups. This method improves on the comparability of treated and control groups, it helps to reduce selection bias and allows for a more accurate estimation of causal effects. Entropy Balancing is deemed an appealing alternative to weighting methods (Zhao and Percival, 2017) since it allows to perfectly balance the characteristics of the treated to the control group.

To be valid, weighting methods and entropy balancing are built on several assumptions. The use of entropy balancing assumes that once the covariates between the groups have been adjusted, no other unobserved factors influence the likelihood of receiving the treatment and the outcome of interest (unconfoundedness hypothesis). The success of entropy balancing also depends on the appropriate selection of covariates to balance. If important confounding variables are omitted, the adjustment will not be sufficient to eliminate selection bias. We address these challenges while balancing on a set of non-financial variables that are the number of years the firm has been in existence (*Age*), the number of subsidiaries (*Subsidiaries*), the domestic or international nature of the firm market (*Market*) and the sector of activity as listed in Table A- 1. Note also that a review of empirical research on capital structure concluded that firm fixed effects likely capture a large part of the unexplained capital structure (Graham and Leary, 2011).

## 5 Results and discussion

We first present the main results, namely the effect of the EU ETS on the capital structure as measured by the debt ratio, and then proceed with a heterogeneity analysis.

### 5.1 Main results

We estimate the effect of the ETS on the debt ratio using different matching and weighting methods (section 5.1.1). We then assess the intensity of the treatment while considering quartiles of initial allowances (section 5.1.2).

#### 5.1.1 EU ETS and capital structure

According to the results of the computation of the propensity scores (Table A- 2 in Appendix), we can construct the control group. The explanatory power of the model is acceptable with a pseudo-R2 equal to 0.36. Figure A- 2 on the left presents the distribution of

scores before and after adjustment using the 1-Nearest Neighbour. Many firms in the treated group have a low probability of being treated, a trend that reverses as the propensity score moves away from zero. Figure A- 2 on the right displays the same distribution after adjustment and shows that the two distributions overlap, suggesting significant similarity between the two groups. Therefore, each individual in the treated group appears to be matched to a similar firm in the untreated group.

Overall, the mean differences between the groups of treated and untreated firms are reduced after applying all the adjustment methods. For nearest neighbour matching methods, we consider one nearest neighbour and a radius of 0.05.<sup>7</sup> For the weighting methods, Inverse Probability Weighting does not reduce the differences in means adequately,<sup>8</sup> unlike Entropy Balancing. Table 3 presents the means of the covariates and shows that they are statistically different between the treated and the control group. Table 4 shows that the means of the covariates after adjustment are not statistically different between the treated and the control group using the Entropy Balancing.

We report treatment effects in Table 5. We estimate all treatments effects with year and firm fixed effects as well as with a set of variables that are the *Self-financing ratio*, *Sales*, *Number of employees*, *Profitability* and *Asset structure* of which descriptive statistics are in Table 1. We display results based on Nearest Neighbour Matching in the first two columns and those based on Inverse Probability Weighting and Entropy Balancing in the last two columns. All four matching methods provide strong evidence that the ETS positively affects the capital structure. Firms participating in the ETS have a higher debt ratio than firms not subject to this environmental regulation. We can observe that the weighting methods allow us to keep a larger number of firms. Given the poor performance of Inverse Probability Weighting for the adjustment of averages, we can consider that the result obtained by this sampling method is underestimated. Thus, we believe that the Entropy Balancing method delivers the most reliable estimates.

---

<sup>7</sup> We also tried other parameters such as 2 or 3 neighbours or using a radius of 0.1 or 0.5, which did not improve the matching.

<sup>8</sup> Means after adjustment using the 1 NN, NN with a radius of 0.05 and IPW are respectively reported in Table A- 3, Table A- 4, and Table A- 5 in Appendix.

According to Entropy results, the debt ratio is 0.148 percentage points higher for firms participating in the EU ETS than for non-participating firms, representing an increase of about half the standard deviation of treated firms in 2007. The magnitudes of the effects with the 1 Nearest Neighbour or the 0.05 Nearest neighbour are pretty similar.

According to the theoretical literature on pollution quota markets, firms trade off between reducing their emissions and buying quotas in the short run, which is known as static arbitrage (Tietenberg, 1985). They can also take a longer-term view and make a dynamic trade-off. In this case, firms balance the cost of buying quotas over several periods against investment in new, less polluting technologies. Our results show an increase in the debt ratio of treated firms, which seems to indicate that firms are making a dynamic trade-off when facing environmental regulation. They choose to invest in new technologies financed by debt. In brief, according to our results environmental policy is a determinant of the capital structure of firms.

Table 3. Means of the covariates before adjustment

NAF	Sectors and Variables	Non-ETS	ETS	T-test p-value
	Age	35.17	37.71	0.00
	Subsidiaries	0.22	0.46	0.00
	Domestic	0.69	0.44	0.00
<b>10</b>	<b>Food</b>	<b>0.29</b>	<b>0.21</b>	<b>0.00</b>
11	Beverages	0.03	0.02	0.00
12	Tobacco products	0.00	0.01	0.00
13	Textiles	0.05	0.01	0.00
16	Wood and cork products	0.05	0.03	0.00
<b>17</b>	<b>Paper</b>	<b>0.05</b>	<b>0.18</b>	<b>0.00</b>
19	Coking and refining	0.00	0.02	0.00
<b>20</b>	<b>Chemicals</b>	<b>0.07</b>	<b>0.17</b>	<b>0.00</b>
21	Pharmaceutical industry	0.02	0.01	0.00
22	Rubber and plastic	0.13	0.02	0.00
<b>23</b>	<b>Minerals</b>	<b>0.06</b>	<b>0.19</b>	<b>0.00</b>
<b>24</b>	<b>Basic metal</b>	<b>0.03</b>	<b>0.07</b>	<b>0.00</b>
25	Fabricated metal products	0.00	0.00	0.00
26	Information technology	0.01	0.01	0.00
27	Electrical equipment	0.03	0.01	0.00
28	Machinery	0.07	0.01	0.00
<b>29</b>	<b>Automotive</b>	<b>0.04</b>	<b>0.05</b>	<b>0.10</b>
30	Other transport equipment	0.02	0.02	0.00
31	Furniture	0.05	0.01	0.00

*Age* is the age of the firm, namely, the number of years the firm has been in business from its creation until 2018. *Subsidiaries* is a dummy variable equal to 1 if the firm has subsidiaries. *Market* is

a dummy variable equal to 1 if the firm operates in the domestic market. The full names of sectors are available in Table A- 1.

Table 4. Means after adjustment – Entropy balancing

NAF	Sectors and Variables	Non-ETS	ETS	T-test p-value
	Age	37.71	37.71	1.00
	Subsidiaries	0.46	0.46	0.98
	Market	0.44	0.44	0.96
10	Food	0.21	0.21	0.97
11	Beverages	0.02	0.02	1.00
12	Tobacco products	0.01	0.01	0.98
13	Textiles	0.01	0.01	0.96
16	Wood and cork products	0.03	0.03	0.96
17	Paper	0.18	0.18	1.00
19	Coking and refining	0.02	0.02	0.99
20	Chemicals	0.17	0.17	0.99
21	Pharmaceutical industry	0.01	0.01	0.99
22	Rubber and plastic	0.02	0.02	0.98
23	Minerals	0.19	0.19	0.99
24	Basic metal	0.07	0.07	0.98
25	Fabricated metal products	0.00	0.00	0.00
26	Information technology	0.01	0.01	0.99
27	Electrical equipment	0.01	0.01	1.00
28	Machinery	0.01	0.01	1.00
29	Automotive	0.05	0.05	0.99
30	Other transport equipment	0.02	0.02	1.00
31	Furniture	0.01	0.01	0.89

Table 5. Impact of the EU ETS on the capital structure  
Dependent variable: debt ratio

	1 - NN	NN .05 distance	IPW	Entropy balancing
ATT	0.124** (0.058)	0.131** (0.059)	0.048*** (0.013)	0.148*** (0.044)
Robust standard errors	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Observations	4,256	4,137	46,615	46,615

p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. Control variables are *Self-financing ratio*, *Sales*, *Number of employees*, *Profitability* and *Asset structure*.

### 5.1.2 Capital structure and free-of-charge initial allowances

The above results consider the impact of being subject to the ETS on the capital structure of French firms. Montgomery (1972) established that the final distribution of quotas, i.e. after



trading on the secondary market, is independent of the initial allocation. This result is corroborated by Zaklan (2023) for the energy sector firms covered by the ETS between 2009 and 2017. If, under specific hypotheses, the initial allocation of quotas does not affect the environmental decisions of firms, it could impact their financial structure. To investigate this point, we divide our sample of treated firms into four according to their allocation quartile. The firms receive different allocations of allowances from one another. We then compare them with the untreated firms that are most similar to them, conditional on our control variables that affect the capital structure: *Self-financing ratio, Sales, Number of employees, Profitability and Asset structure*.

Table 6 reports the effect of the ETS according to the quartile of initial allowances, with the last column showing the estimated effect on the full sample as reported in Table 5. The results, obtained using the Entropy Balancing sampling method, first confirm the positive effect of the ETS on firms' debt ratios. The effect is significant for firms in the first three quartiles. We note that it decreases in absolute value. Firms in the fourth quartile do not differ significantly from the control sample.<sup>9</sup>

According to our results, firms subject to the EU ETS take on more debt than others, and this effect depends on the initial allowances. More specifically, the debt ratio of firms in the first quartile is 0.215 percentage points higher than that of firms not subject to the quota market. The magnitude of the effect is about the same as the 2007 standard deviation of the debt ratio of the treated firms reported in Table 1. However, the magnitude of the effect diminishes for the higher quartile firms. In the Q4 quartile, firms receive the highest quantities of quotas. Their behaviour is similar to that of firms not participating in the ETS. Reflecting to the seminal theoretical result established by Montgomery (1972), the initial allocation of quotas has no impact on a firm's pollution level. This econometric study shows that the initial allocation of quotas influences firms' financial structure.

---

<sup>9</sup> These results are robust when we use the Nearest Neighbour Matching method (Table A- 6 in Appendix).

Table 6. Impact of the EU ETS on the capital structure  
 Dependent variable: debt ratio

	Q1	Q2	Q3	Q4	Total
ATT	0.215***	0.207***	0.177***	0.079	0.148***
	(0.062)	(0.073)	(0.061)	(0.073)	(0.044)
Robust standard errors	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	45,134	45,109	45,115	45,177	46,615

p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. We use Entropy Balancing to build the control group. We keep the same control variables as the results reported in Table 5.

## 5.2 Heterogeneity analysis

We have shown that the ETS increases the share of corporate debt in total net assets. This overall effect could differ depending on the phase of the ETS, the type of market (domestic or international), the economic sector in which the firm operates and profitability.

The effect of the ETS for phases 2 and 3 appears in Table 7. We did not carry out the analysis of phase 1 because the number of observations was too small. We note that the ETS increased the debt ratio during phase 2 (2008-2012). However, this effect is not observed in phase 3 (2013-2018). This result suggests that, in phase 2, firms anticipated a future tightening of environmental constraints. Indeed, the pollution cap was lowered between phases 2 and 3. Firms anticipated the lowering of the pollution cap by choosing to invest in less pollution-intensive technologies. These investments contributed to an increase in the amount of debt on firms' balance sheets. This result corroborates the dynamic arbitrage by firms subject to the ETS.

The effect of the ETS on the financial structure could also depend on whether the firms operate in a domestic or international market. According to our results in Table 8, firms that operate mainly on a domestic market take on the most debt. The treatment effect is statistically zero for firms mainly operating on international markets. As free allocations are primarily granted to sectors exposed to foreign competition, this result confirms the impact of the initial allocation of quotas on the firm's financial structure.

The ETS implies substantial heterogeneity in initial allocations between sectors (Figure A- 1 in the Appendix). We might, therefore, expect our results to differ according to the sector of activity. We report in Table 9 the estimated effects of the ETS according to the sector. Our main result is corroborated for the food, minerals and basic metals sectors. Firms in these sectors take on more debt than those not participating in the ETS. The chemicals and paper sector show a non-significant effect. However, we obtained a different result for the automotive sector, namely a negative effect of the ETS on capital structure. However, this effect could be biased since only 18 firms are included in this sector.

Lastly, we also check whether “profitable” firms react differently to the treatment. We define “Profitable” (“Less profitable”) firms as those whose profitability at the beginning of the study period (2007) is above (below) the median value. The ATT is negative for “Profitable” firms and positive for “Less profitable” firms. Table 10 provided econometric evidence that the EU ETS drove less profitable firms to take on more debt and more profitable firms to take on less debt. Firms could finance the abatement investments through equity or self-financing. Profitable companies could better afford these non-debt-creating investments.

Table 7. Impact of the EU ETS according to the trading phase  
 Dependent variable: debt ratio

	Phase 2	Phase 3
ATT	0.170***	0.054
	(0.057)	(0.054)
Robust standard errors	YES	YES
Year fixed effects	YES	YES
Individual fixed effects	YES	YES
Controls	YES	YES
Observations	19,717	21,824

p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. We use Entropy Balancing to build the control group.

Table 8. Impact of the EU ETS according to the market  
Dependent variable: debt ratio

	Domestic	International
ATT	0.396***	0.015
	(0.134)	(0.026)
Robust standard errors	YES	YES
Year fixed effects	YES	YES
Individual fixed effects	YES	YES
Controls	YES	YES
Observations	27,570	17,422

p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. We use Entropy Balancing to build the control group.

Table 9. Impact of EU ETS according to the sector  
Dependent variable: debt ratio

	Paper	Food	Minerals	Chemicals	Basic metals	Automotive
ATT	0.159	0.045*	0.080***	-0.014	0.077***	-0.130**
	(0.120)	(0.023)	(0.018)	(0.016)	(0.021)	(0.059)
Robust standard errors	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
Observations	2,594	12,030	12,178	12,233	12,244	2,917

p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. We use Entropy Balancing to build the control group.

Table 10. Impact of EU ETS according to the profitability  
Dependent variable: debt ratio

	"Profitable"	"Less profitable"
ATT	-0.076*	0.154**
	(0.040)	(0.064)
Robust standard errors	YES	YES
Year fixed effects	YES	YES
Individual fixed effects	YES	YES
Controls	YES	YES
Observations	21,192	25,423

\*p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. We use Entropy Balancing to build the control group. "Profitable" firms are those of which the 2007 profitability ratio is above the median value.

## 6 Concluding remarks

Our study addresses the effect of the EU ETS on corporate finance. Departing from the Modigliani and Miller irrelevance proposition, we assess the impact of the EU ETS on the capital structure of French firms from 2007 to 2018. We built an original database compiling data from the EU Transaction Log and DIANE databases on initial allowances and firms' financial information to do this.

Our main results are the following. First, we provide robust evidence that emission quotas have a positive and significant effect on firms' capital structure over the period studied: firms subject to the EU ETS have a 0.148 percentage point higher debt ratio than non-participating firms. Second, we sought to determine whether this effect was linked to the initial allowances allocation. To do this, we divided our sample into quartiles of initial allowances. We found that firms with the lowest initial allowances have the highest debt ratio. Moreover, this result holds in phase 2 but not in phase 3, which we explain by firms making a dynamic environmental trade-off: anticipating a tightening of environmental constraints in phase 2, firms have leveraged debt to finance investment in less carbon-intensive technologies. Our main result also holds for firms that operate at a domestic level. One plausible explanation is that since these firms are less exposed to international competition, they have received the fewest quotas. Our results vary across sectors. While the EU ETS has no effect in the paper and chemicals sectors, the food, minerals and basic metals sectors show similar results to the whole sample. Lastly, we provided econometric evidence that the EU ETS drove less profitable firms to take on more debt and more profitable firms to take on less debt.

Our study also contributed to the literature stemming from Montgomery (1972). It focuses on the possible effects of the initial allowances not on the environmental performance but on the corporate finance. Insofar as the effect of free-of-charge allowances vanishes for the highest quartiles of quotas, our results suggest that the initial allocation of quotas impacts firms' financing choices. By setting up a quota market and allocating free-of-charge allowances according to the ETS rule, the regulator leads firms to take on more debt. Therefore, our result means that implementing a quota market must anticipate this effect on corporate finance, which requires the regulator to monitor financial markets. Financial institutions must support

firms subject to environmental constraints to enable them to make the necessary investments by granting them credit facilities.

This study could be improved in several ways. We could consider the variables determining the probability of participation in the market as the thermal capacity, which is the main criterion used to designate the firms submitted to the EU-ETS. Future studies could also analyse sectors individually. In particular, our results for the automotive sector deserve further investigation.

## 7 References

- Abadie, A. and Imbens, G.W. (2011) 'Bias-Corrected Matching Estimators for Average Treatment Effects', *Journal of Business & Economic Statistics*, 29(1), pp. 1–11. Available at: <https://doi.org/10.1198/jbes.2009.07333>.
- Abrell, J., Ndoye, F.A. and Zachmann, G. (2011) *Assessing the impact of the EU ETS using firm level data*. Working Paper 2011/08. Bruegel Working Paper. Available at: <https://www.econstor.eu/handle/10419/77988>.
- Adeneye, Y.B., Kammoun, I. and Ab Wahab, S.N.A. (2023) 'Capital structure and speed of adjustment: the impact of environmental, social and governance (ESG) performance', *Sustainability Accounting, Management and Policy Journal*, 14(5), pp. 945–977.
- Anger, N. and Oberndorfer, U. (2008) 'Firm performance and employment in the EU emissions trading scheme: An empirical assessment for Germany', *Energy Policy*, 36(1), pp. 12–22. Available at: <https://doi.org/10.1016/j.enpol.2007.09.007>.
- Baker, M. and Wurgler, J. (2002) 'Market Timing and Capital Structure', *The Journal of Finance*, 57(1), pp. 1–32. Available at: <https://doi.org/10.1111/1540-6261.00414>.
- Baxter, N.D. (1967) 'Leverage, Risk of Ruin and the Cost of Capital', *The Journal of Finance*, 22(3), pp. 395–403. Available at: <https://doi.org/10.2307/2978892>.
- Bayer, P. and Aklin, M. (2020) 'The European Union Emissions Trading System reduced CO2 emissions despite low prices', *Proceedings of the National Academy of Sciences*, 117(16), pp. 8804–8812. Available at: <https://doi.org/10.1073/pnas.1918128117>.
- Berger, A.N. and Udell, G.F. (1998) 'The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle', *Journal of Banking & Finance*, 22(6), pp. 613–673. Available at: [https://doi.org/10.1016/S0378-4266\(98\)00038-7](https://doi.org/10.1016/S0378-4266(98)00038-7).
- Bradley, M., Jarrell, G.A. and Kim, E.H. (1984) 'On the Existence of an Optimal Capital Structure: Theory and Evidence', *The Journal of Finance*, 39(3), pp. 857–878. Available at: <https://doi.org/10.1111/j.1540-6261.1984.tb03680.x>.
- Brohé, A. and Burniaux, S. (2015) 'The impact of the EU ETS on firms' investment decisions: evidence from a survey', *Carbon Management*, 6(5–6), pp. 221–231. Available at: <https://doi.org/10.1080/17583004.2015.1131384>.
- Chèze, B. et al. (2020) 'On the CO2 Emissions Determinants During the EU ETS Phases I and II: A Plant-level Analysis Merging the EUTL and Platts Power Data', *The Energy Journal*, 41(4). Available at: <https://doi.org/10.5547/01956574.41.4.bche>.
- Crocker, T.D. (1966) 'The structuring of atmospheric pollution control systems', in H. Wolozin (ed.) *The economics of air pollution*. New York: W. W. Norton, pp. 61–86.
- Dales, J.H. (1968) *Pollution, Property & Prices: An Essay in Policy-making and Economics*. Toronto: University of Toronto Press.
- D'Arcangelo, F.M., Pavan, G. and Calligaris, S. (2022) *The Impact of the European Carbon Market on Firm Productivity: Evidence from Italian Manufacturing Firms*. FFEM Working Paper 024.2022. Available at: <https://papers.ssrn.com/abstract=4216588>.
- Daskalakis, N. and Psillaki, M. (2008) 'Do country or firm factors explain capital structure? Evidence from SMEs in France and Greece', *Applied Financial Economics*, 18(2), pp. 87–97. Available at: <https://doi.org/10.1080/09603100601018864>.

- Dechezleprêtre, A., Nachtigall, D. and Venmans, F. (2018) *The joint impact of the European Union emissions trading system on carbon emissions and economic performance*. Paris: OCDE. Available at: <https://doi.org/10.1787/4819b016-en>.
- D’Orazio, P. and Valente, M. (2019) ‘The role of finance in environmental innovation diffusion: An evolutionary modeling approach’, *Journal of Economic Behavior & Organization*, 162, pp. 417–439. Available at: <https://doi.org/10.1016/j.jebo.2018.12.015>.
- Ellerman, A.D. and Buchner, B.K. (2007) ‘The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results’, *Review of Environmental Economics and Policy*, 1(1), pp. 66–87. Available at: <https://doi.org/10.1093/reep/rem003>.
- Ellerman, A.D., Marcantonini, C. and Zaklan, A. (2014) *The EU ETS : eight years and counting*. Working Paper. European University Institute. Available at: <https://cadmus.eui.eu/handle/1814/29517>.
- European Commission (2003) *Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (Text with EEA relevance)*, OJ L. Available at: <http://data.europa.eu/eli/dir/2003/87/oj/eng>.
- European Commission (2009) *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance)*, OJ L. Available at: <http://data.europa.eu/eli/dir/2009/28/oj/eng>.
- European Commission (2014) *Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU (recast) Text with EEA relevance*, OJ L. Available at: <http://data.europa.eu/eli/dir/2014/65/oj/eng>.
- European Commission (2017) *EU ETS Handbook*. Available at: [https://climate.ec.europa.eu/system/files/2017-03/ets\\_handbook\\_en.pdf](https://climate.ec.europa.eu/system/files/2017-03/ets_handbook_en.pdf).
- European Commission (2018) *Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 (Text with EEA relevance)*, OJ L. Available at: <http://data.europa.eu/eli/dir/2018/410/oj/eng>.
- Faccio, M. and Xu, J. (2015) ‘Taxes and Capital Structure’, *Journal of Financial and Quantitative Analysis*, 50(3), pp. 277–300. Available at: <https://doi.org/10.1017/S0022109015000174>.
- Ginglinger, E. and Moreau, Q. (2023) *Climate risk and capital structure*. 737/2021. European corporate governance institute. Available at: [https://www.ecgi.global/sites/default/files/working\\_papers/documents/climateriskandcapitalstructure.pdf](https://www.ecgi.global/sites/default/files/working_papers/documents/climateriskandcapitalstructure.pdf).
- Gordon, M.J. (1971) ‘Towards a Theory of Financial Distress’, *The Journal of Finance*, 26(2), pp. 347–356. Available at: <https://doi.org/10.2307/2326050>.
- Graham, J.R. and Leary, M.T. (2011) ‘A Review of Empirical Capital Structure Research and Directions for the Future’, *Annual Review of Financial Economics*, 3(1), pp. 309–345. Available at: <https://doi.org/10.1146/annurev-financial-102710-144821>.
- Hahn, R.W. (1984) ‘Market Power and Transferable Property Rights\*’, *The Quarterly Journal of Economics*, 99(4), pp. 753–765. Available at: <https://doi.org/10.2307/1883124>.
- Hainmueller, J. (2012) ‘Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies’, *Political Analysis*, 20(1), pp. 25–46. Available at: <https://doi.org/10.1093/pan/mpr025>.

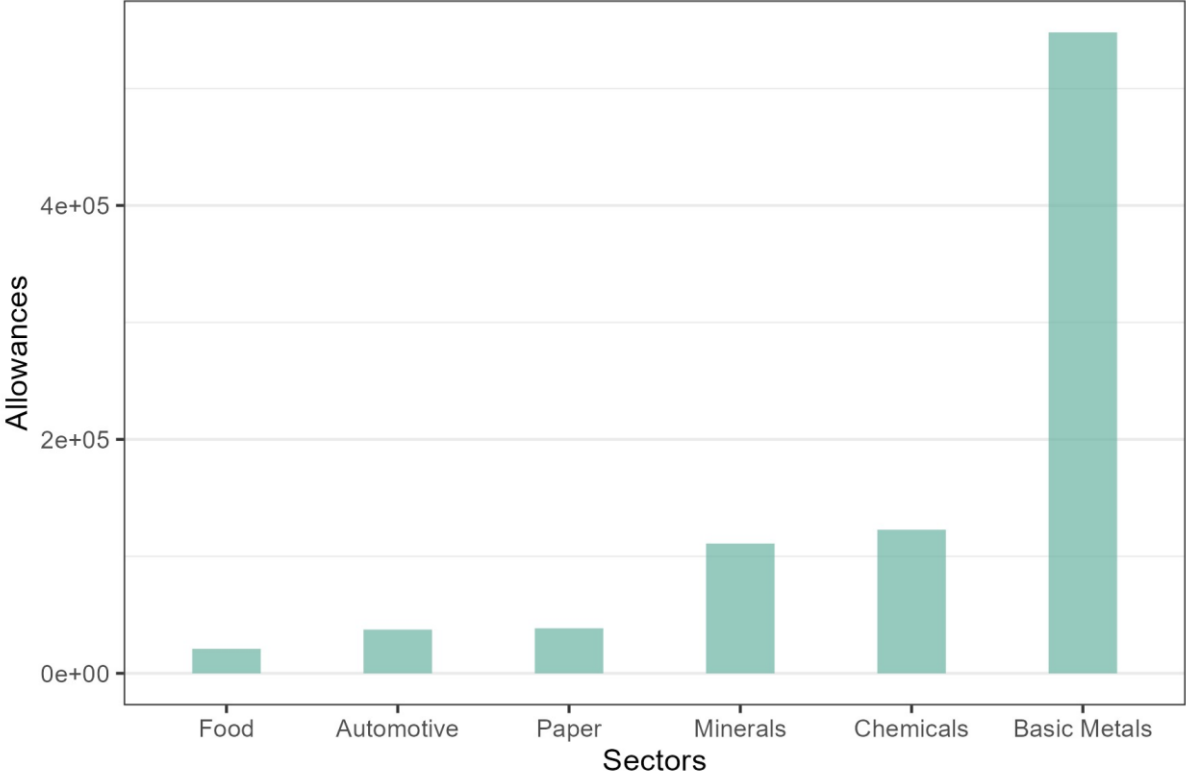


- Henderson, D.J. and Millimet, D.L. (2007) 'Pollution Abatement Costs and Foreign Direct Investment Inflows to U.S. States: A Nonparametric Reassessment', *The Review of Economics and Statistics*, 89(1), pp. 178–183. Available at: <https://doi.org/10.1162/rest.89.1.178>.
- Hoffmann, V.H. (2007) 'EU ETS and Investment Decisions: The Case of the German Electricity Industry', *European Management Journal*, 25(6), pp. 464–474. Available at: <https://doi.org/10.1016/j.emj.2007.07.008>.
- Jaraitė, J. et al. (2013) *Matching EU ETS Accounts to Historical Parent Companies: A Technical Note*. Florence: European University Institute (EUI). Available at: [https://cadmus.eui.eu/bitstream/handle/1814/64596/EU\\_ETS\\_Account\\_to\\_Firm\\_Matching\\_Technical\\_Note.pdf?sequence=1](https://cadmus.eui.eu/bitstream/handle/1814/64596/EU_ETS_Account_to_Firm_Matching_Technical_Note.pdf?sequence=1).
- Jaraitė, J. and Di Maria, C. (2012) 'Efficiency, productivity and environmental policy: A case study of power generation in the EU', *Energy Economics*, 34(5), pp. 1557–1568. Available at: <https://doi.org/10.1016/j.eneco.2011.11.017>.
- Jaraite-Kažukauske, J. and Di Maria, C. (2016) 'Did the EU ETS Make a Difference? An Empirical Assessment Using Lithuanian Firm-Level Data', *The Energy Journal*, 37(1). Available at: <https://doi.org/10.5547/01956574.37.2.jjar>.
- Jensen, M.C. and Meckling, W.H. (1976) 'Theory of the firm: Managerial behavior, agency costs and ownership structure', *Journal of Financial Economics*, 3(4), pp. 305–360. Available at: [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X).
- Klemetsen, M., Rosendahl, K.E. and Jakobsen, A.L. (2020) 'The impacts of the EU ETS on Norwegian plants' environmental and economic performance', *Climate Change Economics*, 11(01), p. 2050006. Available at: <https://doi.org/10.1142/S2010007820500062>.
- Laing, T. et al. (2014) 'The effects and side-effects of the EU emissions trading scheme', *WIREs Climate Change*, 5(4), pp. 509–519. Available at: <https://doi.org/10.1002/wcc.283>.
- Leiter, A.M., Parolini, A. and Winner, H. (2011) 'Environmental regulation and investment: Evidence from European industry data', *Ecological Economics*, 70(4), pp. 759–770. Available at: <https://doi.org/10.1016/j.ecolecon.2010.11.013>.
- Löfgren, Å. et al. (2014) 'Why the EU ETS needs reforming: an empirical analysis of the impact on company investments', *Climate Policy*, 14(5), pp. 537–558. Available at: <https://doi.org/10.1080/14693062.2014.864800>.
- Marcantonini, C. et al. (2017) *Low-carbon innovation and investment in the EU ETS*. Policy Briefs 22. European University Institute. Available at: <https://doi.org/10.2870/402517>.
- Marin, G., Marino, M. and Pellegrin, C. (2018) 'The Impact of the European Emission Trading Scheme on Multiple Measures of Economic Performance', *Environmental and Resource Economics*, 71(2), pp. 551–582. Available at: <https://doi.org/10.1007/s10640-017-0173-0>.
- Modigliani, F. and Miller, M.H. (1958) 'The Cost of Capital, Corporation Finance and the Theory of Investment', *The American Economic Review*, 48(3), pp. 261–297.
- Modigliani, F. and Miller, M.H. (1963) 'Corporate Income Taxes and the Cost of Capital: A Correction', *The American Economic Review*, 53(3), pp. 433–443.
- Montgomery, W.D. (1972) 'Markets in licenses and efficient pollution control programs', *Journal of Economic Theory*, 5(3), pp. 395–418. Available at: [https://doi.org/10.1016/0022-0531\(72\)90049-X](https://doi.org/10.1016/0022-0531(72)90049-X).
- Myers, S.C. (1984) 'Capital Structure Puzzle'. National Bureau of Economic Research (Working Paper Series). Available at: <https://doi.org/10.3386/w1393>.

- Myers, S.C. and Majluf, N.S. (1984) 'Corporate financing and investment decisions when firms have information that investors do not have', *Journal of Financial Economics*, 13(2), pp. 187–221. Available at: [https://doi.org/10.1016/0304-405X\(84\)90023-0](https://doi.org/10.1016/0304-405X(84)90023-0).
- Porter, M.E. and van der Linde, C. (1995) 'Toward a New Conception of the Environment-Competitiveness Relationship', *The Journal of Economic Perspectives*, 9(4), pp. 97–118.
- Robins, J.M., Hernán, M.Á. and Brumback, B. (2000) 'Marginal Structural Models and Causal Inference in Epidemiology', *Epidemiology*, 11(5), pp. 550–560.
- Rosenbaum, P.R. (2002) 'Observational Studies', in P.R. Rosenbaum (ed.) *Observational Studies*. New York, NY: Springer New York, pp. 1–17. Available at: [https://doi.org/10.1007/978-1-4757-3692-2\\_1](https://doi.org/10.1007/978-1-4757-3692-2_1).
- Rosenbaum, P.R. and Rubin, D.B. (1983) 'The central role of the propensity score in observational studies for causal effects', *Biometrika*, 70(1), pp. 41–55. Available at: <https://doi.org/10.1093/biomet/70.1.41>.
- Rubin, D.B. and Thomas, N. (2000) 'Combining Propensity Score Matching with Additional Adjustments for Prognostic Covariates', *Journal of the American Statistical Association*, 95(450), pp. 573–585. Available at: <https://doi.org/10.1080/01621459.2000.10474233>.
- Stavins, R.N. (1995) 'Transaction Costs and Tradeable Permits', *Journal of Environmental Economics and Management*, 29(2), pp. 133–148. Available at: <https://doi.org/10.1006/jeem.1995.1036>.
- Teixidó, J., Verde, S.F. and Nicolli, F. (2019) 'The impact of the EU Emissions Trading System on low-carbon technological change: The empirical evidence', *Ecological Economics*, 164, p. 106347. Available at: <https://doi.org/10.1016/j.ecolecon.2019.06.002>.
- Tietenberg, T.H. (1985) *Emissions trading. An exercise in reforming pollution policy*. Washington, D.C.: Resources for the Future.
- Veith, S., Werner, J.R. and Zimmermann, J. (2009) 'Capital market response to emission rights returns: Evidence from the European power sector', *Energy Economics*, 31(4), pp. 605–613. Available at: <https://doi.org/10.1016/j.eneco.2009.01.004>.
- Verde, S.F. (2020) 'The Impact of the Eu Emissions Trading System on Competitiveness and Carbon Leakage: The Econometric Evidence', *Journal of Economic Surveys*, 34(2), pp. 320–343. Available at: <https://doi.org/10.1111/joes.12356>.
- Wagner, U.J. and Petrick, S. (2014) 'The Impact of Carbon Trading on Industry: Evidence from German Manufacturing Firms', in. *Beiträge zur Jahrestagung des Vereins für Socialpolitik 2014: Evidenzbasierte Wirtschaftspolitik*, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg. Available at: <http://hdl.handle.net/10419/100472>.
- World Bank (2022) *State and Trends of Carbon Pricing 2022*. Washington, DC: World Bank. Available at: <https://doi.org/10.1596/978-1-4648-1895-0>.
- Zaklan, A. (2023) 'Coase and Cap-and-Trade: Evidence on the Independence Property from the European Carbon Market', *American Economic Journal: Economic Policy*, 15(2), pp. 526–558. Available at: <https://doi.org/10.1257/pol.20210028>.
- Zhao, Q. and Percival, D. (2017) 'Entropy balancing is doubly robust', *Journal of Causal Inference*, 5(1), p. 20160010. Available at: <https://doi.org/10.1515/jci-2016-0010>.
- Ziane, Y. (2004) 'La structure d'endettement des PME françaises: une étude sur données de panel', *Revue internationale P.M.E. Économie et gestion de la petite et moyenne entreprise*, 17(1), pp. 123–138. Available at: <https://doi.org/10.7202/1008454ar>.

# 8 Appendix

Figure A- 1. Mean free-of-charge allowances by sector, all phases (tons eq CO2)



Source: EU-ETL and authors' calculations

Table A- 1. NAF (French classification of activities) and variables' names

NAF	Official names	Variable names
10	Manufacture of food products	Food
11	Manufacture of beverages	Beverages
12	Manufacture of tobacco products	Tobacco products
13	Manufacture of textiles	Textiles
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Wood and cork products
17	Manufacture of paper and paper products	Paper
19	Manufacture of coke and refined petroleum products	Coking and refining
20	Manufacture of chemicals and chemical products	Chemicals
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Pharmaceutical industry
22	Manufacture of rubber and plastic products	Rubber and plastic
23	Manufacture of other non-metallic mineral products	Minerals
24	Manufacture of basic metals	Basic metals
25	Manufacture of fabricated metal products, except machinery and equipment	Fabricated metal products
26	Manufacture of computer, electronic and optical products	Computer electronic optical
27	Manufacture of electrical equipment	Electrical equipment
28	Manufacture of machinery and equipment n.e.c.	Machinery
29	Manufacture of motor vehicles, trailers and semi-trailers	Automotive
30	Manufacture of other transport equipment	Other transport equipment
31	Manufacture of furniture	Furniture

n.e.c: not elsewhere classified

Table A- 2. Probit estimates of the propensity score of being treated

NAF		Marginal effects	Standard errors
	Age	0.0001**	(0.00003)
	Subsidiaries	0.002***	(0.0001)
	Domestic	0.045***	(0.001)
<b>10</b>	<b>Food</b>	<b>0.176***</b>	<b>(0.010)</b>
11	Beverages	0.201***	(0.010)
12	Tobacco products	0.200***	(0.025)
13	Textiles	0.204***	(0.010)
16	Wood and cork products	0.185***	(0.010)
<b>17</b>	<b>Paper</b>	<b>0.088***</b>	<b>(0.010)</b>
<b>20</b>	<b>Chemicals</b>	<b>0.142***</b>	<b>(0.010)</b>
21	Pharmaceutical industry	0.202***	(0.010)
22	Rubber and plastic	0.205***	(0.010)
<b>23</b>	<b>Minerals</b>	<b>0.101***</b>	<b>(0.010)</b>
<b>24</b>	<b>Basic metals</b>	<b>0.137***</b>	<b>(0.010)</b>
25	Fabricated metal products	0.230***	(0.016)
26	Computer, electronic and optical	0.204***	(0.011)
27	Electrical equipment	0.202***	(0.010)
28	Machinery	0.217***	(0.010)
<b>29</b>	<b>Automotive</b>	<b>0.178***</b>	<b>(0.010)</b>
30	Other transport equipment	0.189***	(0.010)
31	Furniture	0.198***	(0.010)
	Constant	0.236***	(0.010)
	Observations	138,736	
	Pseudo R2	0.357	

\*p<0.1 ; \*\*p<0.05 ; \*\*\*p<0.01. The reference categories are the Coking and refining sector and firms operating on international markets.

Figure A- 2. Distributional balance of propensity score (1 Nearest Neighbour)

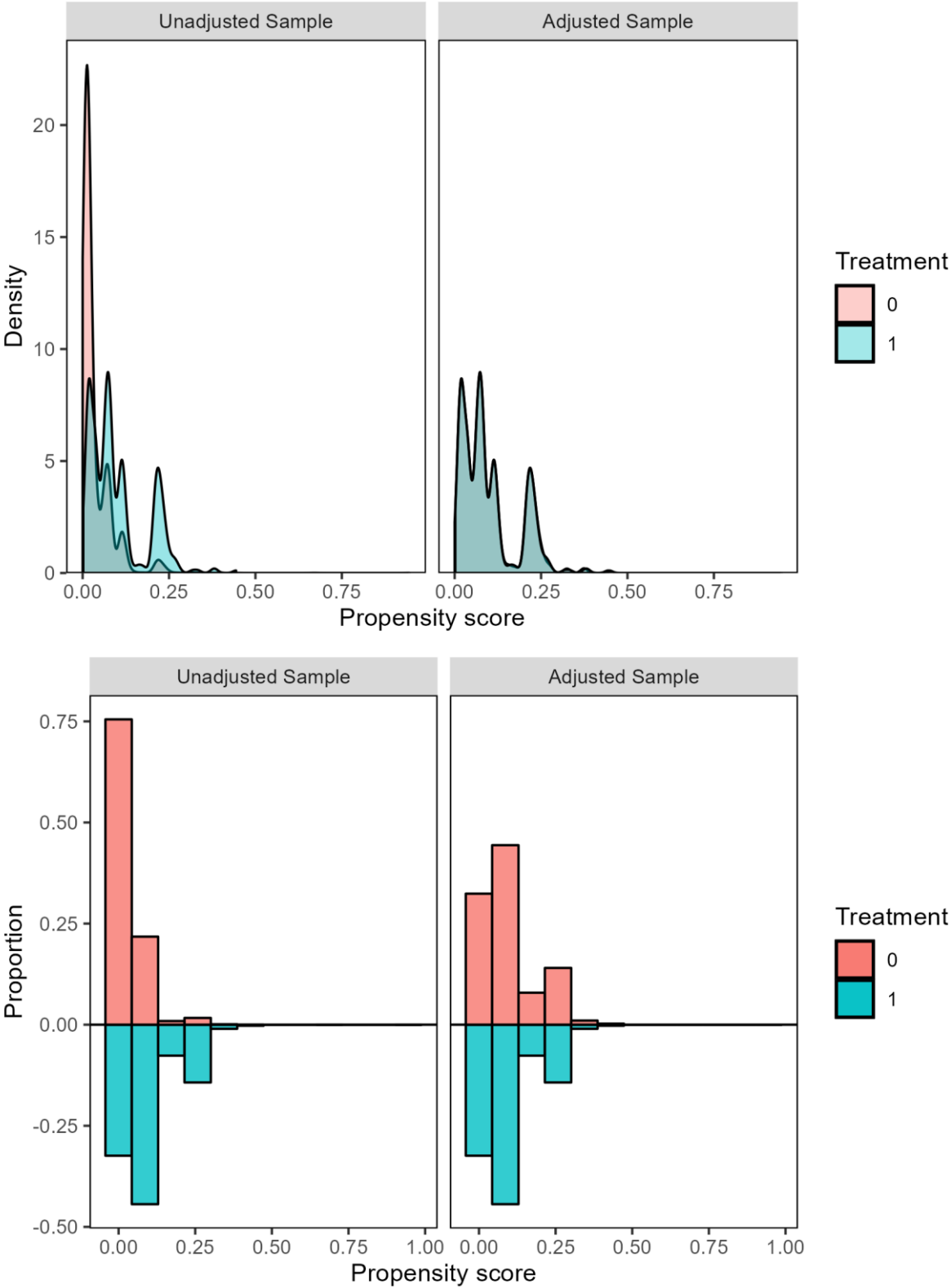


Table A- 3. Means after adjustment – 1 NN

NAF	Variables	Non-ETS	ETS	T-test p-value
	Age	38.62	37.71	0.02
	Subsidiaries	0.34	0.46	0.00
	Domestic	0.46	0.44	0.01
<b>10</b>	<b>Food</b>	<b>0.19</b>	<b>0.21</b>	<b>0.01</b>
11	Beverages	0.02	0.02	1.00
12	Tobacco products	0.00	0.01	0.04
13	Textiles	0.01	0.01	0.23
16	Wood and cork products	0.03	0.03	1.00
<b>17</b>	<b>Paper</b>	<b>0.19</b>	<b>0.18</b>	<b>0.32</b>
19	Coking and refining	0.02	0.02	0.31
<b>20</b>	<b>Chemicals</b>	<b>0.17</b>	<b>0.17</b>	<b>0.73</b>
21	Pharmaceutical industry	0.02	0.01	0.04
22	Rubber and plastic	0.01	0.02	0.00
<b>23</b>	<b>Minerals</b>	<b>0.20</b>	<b>0.19</b>	<b>0.10</b>
<b>24</b>	<b>Basic metal</b>	<b>0.08</b>	<b>0.07</b>	<b>0.05</b>
25	Fabricated metal products			
26	Computer electronic optical	0.00	0.01	0.04
27	Electrical equipment	0.01	0.01	0.17
28	Machinery	0.01	0.01	1.00
<b>29</b>	<b>Automotive</b>	<b>0.04</b>	<b>0.05</b>	<b>0.05</b>
30	Other transport equipment	0.01	0.02	0.27
31	Furniture	0.01	0.01	1.00

Table A- 4. Means after adjustment – calliper 0.05

NAF	Variables	Non-ETS	ETS	T-test p-value
	Age	37.97	37.63	0.37
	Subsidiaries	0.33	0.45	0.00
	Domestic	0.47	0.44	0.00
<b>10</b>	<b>Food</b>	<b>0.19</b>	<b>0.21</b>	<b>0.02</b>
11	Beverages	0.02	0.02	1.00
12	Tobacco products	0.00	0.00	0.00
13	Textiles	0.01	0.01	0.23
16	Wood and cork products	0.03	0.03	1.00
<b>17</b>	<b>Paper</b>	<b>0.19</b>	<b>0.18</b>	<b>0.50</b>
19	Coking and refining	0.01	0.01	0.17
<b>20</b>	<b>Chemicals</b>	<b>0.17</b>	<b>0.17</b>	<b>1.00</b>
21	Pharmaceutical industry	0.02	0.01	0.04
22	Rubber and plastic	0.01	0.02	0.00
<b>23</b>	<b>Minerals</b>	<b>0.20</b>	<b>0.18</b>	<b>0.05</b>
<b>24</b>	<b>Basic metals</b>	<b>0.08</b>	<b>0.07</b>	<b>0.05</b>
25	Fabricated metal products			
26	Computer electronic optical	0.00	0.01	0.04
27	Electrical equipment	0.01	0.01	0.17
28	Machinery	0.01	0.01	1.00
<b>29</b>	<b>Automotive</b>	<b>0.04</b>	<b>0.05</b>	<b>0.05</b>
30	Other transport equipment	0.01	0.02	0.27
31	Furniture	0.01	0.01	1.00



Table A- 5. Means after adjustment – IPW

	Variables	Non-ETS	ETS	T-test p-value
	Age	37.96	37.71	0.37
	Subsidiaries	0.46	0.46	0.92
	Domestic	0.44	0.44	0.97
<b>10</b>	<b>Food</b>	<b>0.20</b>	<b>0.21</b>	<b>0.72</b>
11	Beverages	0.02	0.02	0.91
12	Tobacco products	0.00	0.01	0.36
13	Textiles	0.01	0.01	1.00
16	Wood and cork products	0.03	0.03	0.97
<b>17</b>	<b>Paper</b>	<b>0.18</b>	<b>0.18</b>	<b>0.56</b>
19	Coking and refining products	0.02	0.02	0.35
<b>20</b>	<b>Chemicals</b>	<b>0.17</b>	<b>0.17</b>	<b>0.51</b>
21	Pharmaceutical industry	0.01	0.01	0.95
22	Rubber and plastic	0.02	0.02	0.94
<b>23</b>	<b>Minerals</b>	<b>0.19</b>	<b>0.19</b>	<b>0.89</b>
<b>24</b>	<b>Basic metals</b>	<b>0.07</b>	<b>0.07</b>	<b>0.87</b>
25	Fabricated metal products	0.00	0.00	0.96
26	Computer electronic optical	0.01	0.01	0.99
27	Electrical equipment	0.01	0.01	0.99
28	Machinery	0.01	0.01	0.99
<b>29</b>	<b>Automotive</b>	<b>0.05</b>	<b>0.05</b>	<b>0.60</b>
30	Other transport equipment	0.02	0.02	0.91
31	Furniture	0.01	0.01	0.98

Table A- 6. Impact of the EU ETS by emission quota quartile (1 Nearest Neighbour)

Dependent variable: debt ratio

	Q1	Q2	Q3	Q4	Total
ATT	0.234*** (0.915)	0.275*** (0.113)	0.174*** (0.083)	0.106* (0.073)	0.124** (0.058)
Robust standard errors	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	1,899	1,891	1,867	1998	4,256

\*p&lt;0.1 ; \*\*p&lt;0.05 ; \*\*\*p&lt;0.01