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Abstract

This paper investigates the effects of the introduction of Article 173 of the 2015 Energy Transition for Green Growth (LTECV) Act on French firm-level manufacturing outcomes, with a specific focus on international trade dynamics. The carbon disclosure regulation requires institutional investors and asset managers to publicly disclose the carbon footprint of their portfolios, as well as their exposure to climate risks and their mitigation strategies. Employing a difference-in-differences approach and merging French corporate tax returns and customs data with OECD data on the carbon content of trade (TeCO2), findings show that a 10 percentage point increase in exposure to the regulation is associated with a statistically significant 5.84% drop in firm-level imported carbon emissions. Nevertheless, exposure is also associated with decreases in firm size and in trade activity. Effects are also largely driven by the more financially constrained firms. Findings highlight that increasing investor scrutiny may constrain the continued access to external financing for firms within their portfolios and impact the conduct of daily business activities of these exposed firms. Overall, the paper underscores the real effects of policies that aim to increase climate transparency to help steer investor capital towards less financially risky and more sustainable assets and projects.

Keywords: Carbon Embodied in Imports, Global Value Chains, Environmental Policy, Corporate Finance.

JEL Codes: F18, Q56, Q58, G23, G30

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1 Introduction

Climate change is a source of structural change affecting the financial system and its funding (NGFS, 2019, Löyttyniemi, 2021), posing adverse consequences for the real and monetary economy. The multifaceted nature of climate-related risks are drivers of existing risk to financial stability (ECB, 2020b). In 2019, extreme events generated economic losses totaling 1% of GDP in the European area (ECB, 2021). Climatic hazards can escalate into disasters, causing loss of life, damage to capital stock, and disruptions to economic activity (IMF, 2020). Moreover, the increasing use of fiscal and public policy tools to support national environmental and low-carbon energy transition objectives, coupled with a growing market demand for sustainable products and services, could lead to a devaluation of fossil fuel assets, leaving them obsolete and stranded. More broadly, climate-related physical and transition risks can impact not only the productive capital of highly polluting firms, but also their order books, access to financing, and overall competitiveness (Banque de France, 2023b). Such risks could also ultimately impact the valuation of portfolios invested in these firms, potentially resulting in losses for investors. Climate risks can therefore jeopardize the role of financial institutions as financial intermediaries between lenders and borrowers.

Accordingly, France aims to reach carbon neutrality by 2050 to avert the worst impacts of climate change. To help attain their objective of net zero emissions, the 2015 Energy Transition for Green Growth (LTECV) Act provides a policy-making road-map in terms of climate change mitigation, consistent with its commitments under the Paris Agreement and to the European Union (French Ministry of the Environment, 2020). In addition to temperature goals, the 2015 Paris Agreement agreed on the objective to align finance flows with a pathway towards low GHG emissions and climate-resilient development (UNFCCC, 2016), underlining how sustainable finance is key to the low-carbon transition given the financial system's central role in the economy (ECB, 2020a)[0]. To help reorient investment flows towards activities and projects that can help achieve the objectives of the Paris Agreement and ensure the low-carbon transition, the French government notably introduced non-financial reporting requirements on investors as part of Article 173 of the LTCEV.

Article 173 of the LTCEV (henceforth Art. 173) requires institutional investors and asset managers, but not banks, to disclose in their annual reports information on the carbon footprint of their portfolios, and on how they integrate environmental, social and governance (ESG) considerations, or non-financial factors, in their investment decisions. Larger investors are also required to publish information on their exposure to - and management of - climate change related risks, as well as on how their investment decisions align with national strategies for the energy transition (French Ministry of the Environment, 2019a). The objectives of French legislators in crafting the regulation were twofold (I4CE, 2018). First, to raise awareness among investors of the emissions and associated financial risks stemming from their carbon-intensive investments. Second, to provide public authorities, NGOs, and citizens with transparent corporate non-financial information to empower them to exert pressure on investors to align their investments with the transition towards a low-carbon economy. The disclosure of exposure to climate-related risks would result in better risk management strategies and in a

[0]The financial system in France, totaling approximately €12 trillion of assets, or roughly six times its annual GDP, is large, sophisticated, and integrated both vertically and internationally (UNEP and I4CE, 2015). Moreover while climate investments in France exceeded €100 billion in 2022, an additional €58 billion in investments per year is necessary to reach climate and energy national objectives (I4CE, 2023).

reallocation of funds towards low-carbon assets (2DII, 2015), reflecting the old adage of "what gets measured gets managed" (Carney, 2015). Accordingly, the aim of the Art. 173 is to reduce information asymmetries between lenders and borrowers on the one hand, and between the public and lenders on the other, so as to ultimately improve environmental outcomes. Art. 173 was novel policy-making at the time: France was the first country to mandate such granular information from investors (French Ministry of the Environment, 2019b).

In light of the above, this paper empirically investigates the effects of the introduction of Art. 173 on the trade dynamics and the economic and financial performance of French manufacturing firms most exposed to the regulation as borrowers on the financial market. The analysis is based on corporate tax returns and customs data. Exploiting a Differences-in-Differences (DiD) specification, a 10 percentage point (pp) increase in exposure to Art. 173 is associated with a 5.84% cut in firm-level imported carbon emissions on average following the introduction of the carbon disclosure requirements on investors. However, the drop in imported carbon is accompanied by a decrease in importing activity, primarily along the extensive margin, and in firm size more generally. Findings also do not uncover evidence of a reduction in the carbon intensity of imports, nor in changes in carbon emissions directly emitted in domestic production. Dynamic event study results lend credibility to the identifying assumption of common trends in a DiD setting. At the sector level, the most exposed firms in the manufacturing of fabricated metals and motor vehicles experience the most significant drops in imported carbon relative to other sectors, highlighting the importance of accounting for industry-specific heterogeneity when examining the impact of policy.

Exposure to the policy is measured as the intensity of bond debt relative to total corporate liabilities. Intuitively, firms that are relatively more reliant on issuing bond debt are more likely beholden to the investors that invest in their bonds. In other words, the heavier the burden of bond debt a firm carries, the closer its relationship with, and reliance on, bondholders, or investors that must adhere to the non-financial disclosure requirements outlined in Art. 173 from 2016 onward. Conclusions are robust to an alternative measurement of exposure that takes into account the importance of bond financing in the context of long-term debt financing strategies (bond and bank debt), as opposed to capital structures (total debt). They are also robust to an alternate sample of firms that minimizes heterogeneity that may arise from corporate restructuring or changes in ownership.

As investors face and reckon with information on the polluting behavior of firms in their portfolios, they may seek to protect themselves and their investments from exposure to climate risks. Among other strategies, investors may demand compensation for the additional climate risk they incur for the continued holding of their more carbon-intensive financial assets (carbon premium). Investors could also more directly divest from carbon-intensive activities, i.e., sell securities associated with riskier firms so as to reallocate funds in firms less exposed to climate risks in line with de-carbonization strategies. Finally, investors can also engage with their portfolio firms, i.e., press them for emission reductions and to implement climate mitigation strategies. Among investors, engagement is generally viewed as an important tool to influence corporate behavior (NGFS (2022); Krueger, Sautner and Starks, 2020).

Accordingly, exposure to the carbon disclosure regulation should notably have a constraining effect on firm behavior, as borrowers dependent on the continued funding of their operations and growth are compelled to prioritize environmental sustainability

in order to maintain investor confidence and secure ongoing financial support, aligning their business strategies with evolving environmental standards and investor preferences. Alternatively, as investors re-optimize their portfolios in light of the reduced information asymmetries with their customers, bond-reliant firms may become broadly constrained as a key source of their external financing is in jeopardy. Additional analyses suggest that the main results are driven by the more financially constrained firms exposed to the carbon disclosure requirements, highlighting how increasing investor scrutiny on firms within their portfolios may constrain their continued access to external financing and the conduct of their daily business activities. On the other hand, exposure is not associated with significant effects on the activities of the relatively less financial constrained firms, highlighting a challenge for policymakers relying on disclosure requirements as a tool to ultimately improve environmental outcomes.

The analysis notably focuses on trade dynamics among importing manufacturing firms for several reasons. First, the introduction of a EU-wide Carbon Border Adjustment Mechanism (CBAM) as a tool to price the embedded carbon emissions of imported goods (European Commission, 2024) warrants additional insights on the linkages between importing activities and public policies that aim to constrain polluting activities. As a result, the paper specifically examines the effect of the carbon disclosure requirement (Art. 173) on imported carbon emissions, i.e., the total amount of carbon emissions embodied in imports emitted along global production chains. The focus on imported carbon is also relevant in light of the fact that industry accounts for 20% of GHG emissions in France (Direction Générale du Trésor, 2021) and emissions associated with imports represent half of its carbon footprint[1] (Ministry of Energy Transition, 2022). Moreover, the margins of trade are sensitive to financial or credit constraints (e.g., Manova, 2013, Muûls, 2015, Aristei and Franco, 2014), suggesting that firms would adapt their importing activities and embodied carbon one way or the other as lenders intensify their scrutiny of carbon-intensive activities that expose them to risk. An increasingly intense investor focus on carbon emissions so as to lower their exposure to climate risks can motivate firms to re-calibrate their supply chains so as to reduce their carbon footprint to maintain investor confidence and secure funding. More broadly, understanding how importer firms respond to carbon disclosure requirements sheds light on their readiness to adapt to evolving regulatory landscapes for the energy transition.

These findings provide insights into the effectiveness of climate-related financial disclosure requirements that aim to capture the full extent of corporate carbon footprints, as well as their implications for both environmental and economic performance. The results underscore important policy considerations, highlighting that while such transparency regulations have the potential to drive reductions in carbon emissions, they must be carefully designed to balance environmental objectives with the financial realities faced by firms. As other countries and regions consider implementing similar disclosure requirements, the lessons learned from France's experience with Art. 173 can guide the development of more effective and equitable policies for promoting sustainable finance.

The rest of the paper is as follows. Section 1.1 provides a brief review of the

[1] A country's carbon footprint represents the estimated total GHG emissions resulting from domestic final demand, encompassing household emissions, domestic production emissions (excluding exports), and emissions from foreign economic activities producing goods for imports into the country (Ministry of Energy Transition, 2022)

related empirical literature. Section 2 describes the institutional context. Section 3 presents the data and the methodology behind the construction of key variables. Section 4 details the empirical strategy. Section 5 presents results and interpretations. Section 6 concludes.

1.1 Related empirical literature

Firstly, this paper contributes to the empirical literature that examines the role of lenders in promoting change in borrowing firms through financial pressures, particularly with regards to ESG (environmental, social and governance) performance. In a survey, Brown et al. (2019) find that 82% of institutional investors believe they influence corporate capital structure decisions, and especially among smaller, younger, and more financially constrained firms. The ex-post policy evaluation literature largely focuses on the role of banks as lenders. Exploiting M&A events as quasi-exogenous sources of variation, Houston and Shan (2022) show that banks discipline borrowers when concerned with liability risks and negative media coverage associated with poor environmental performance. They also observe that fear of subsequent exit is most pronounced among borrowers with relatively poor ex-ante ESG ratings and that are bank-dependent. Moreover and following the passage of the California cap-and-trade bill, Ivanov, Kruttli and Watugala (2023) find that banks adjust their exposure to borrower firms through loan re-negotiations should they face difficulties under the regulation. Similarly, Hasan et al. (2024) uncover evidence that banks affiliated with the Task Force on Climate-Related Financial Disclosures (TCFD) influence borrowers through credit rationing and a tightening of financial constraints on non-TFCD-aligning firm borrowers. Wang (2023) also find that banks impose more environmental action covenants in loan contracts and are more likely to terminate borrowers with bad environmental and social performance following the adoption of ESG regulations.

In parallel it also more generally contributes to insights as to the extent to which investors care about climate data and financial risks associated with climate change. Krueger, Sautner and Starks (2020) conclude that institutional investors consider climate risks as important investment risks that have financial implications on their portfolio firms, and that those related to regulation (transition risks) have already started to materialize. More generally, investors not only value sustainability (Hartzmark and Sussman, 2019), they also value and demand climate risk disclosures, and engage their portfolio firms for improvements (Ilhan et al., 2023). As investor awareness of climate change risk has grown, Bolton and Kacperczyk (2023) find evidence of widespread and rising carbon premium (higher stock returns) on a global scale related to both direct firm emissions from production (scope 1) and indirect emissions through the supply chain (scope 2 and 3), reflecting the economic importance investors attach to their exposure to climate risks.

Thirdly, this paper also relates to the literature that investigates the linkages between financial constraints and international trade. Note that this paper argues that the investor carbon disclosure requirements as detailed in Art. 173 takes the form of a financial constraint from the perspective of importer portfolio firms. Bellone et al. (2010) conclude that constraints on external financing negatively impact export participation and the export intensity of French firms. Similarly, Minetti and S. Zhu (2011) observe that credit rationing in Italy is associated with a significant reduction in both a firm's propensity to export and in the intensive margin of exports with a much larger impact than on domestic sales. Results are more pronounced for younger firms, in in-

dustries characterized by greater external finance dependence and in high-tech sectors. Financial constraints can also directly affect environmental outcomes and undermine national low-carbon energy transition objectives. Rehman et al. (2023) provide evidence of a positive relationship between financial constraints and carbon emissions among US firms, with more pronounced results among firms that do not report on environment-related expenditure investment. Following the implementation of California's cap-and-trade program, Bartram, Hou and Kim (2022) find that financially constrained firms relocated their emissions and production outside of California if they possessed underutilized plants out-of-state so to avoid the increase in costs of emitting greenhouse gases in the state, whereas unconstrained firms did not reduce total emissions. Moreover, Zhang et al. (2019) show that financially constrained Chinese firms struggle to invest in the reduction of waste gas emissions.

More generally, this paper contributes to the literature that investigates the real and financial effects of carbon and other non-financial disclosure requirement policies. In a review of the literature, Christensen, Hail and Leuz (2021) contend that reporting mandates often motivate firms to adjust their investment behavior and real activities because they expect investors or other stakeholders to respond to the disclosed information. They highlight the role of investors and industry peers in shaping corporate operational decisions. However they also note that improvements in Corporate Social Responsibility (CSR) often come at a cost, such as in the form of lower productivity, financial profitability or market share.
Both Fiechter, Hitz and Lehmann (2022) and Allman and Won (2022) evaluate the effects of Directive 2014/95, a European Union (EU) mandate on corporate social responsibility (CSR) reporting that came into effect in 2018. The former find a positive relationship between the mandate and CSR transparency and social-related activities. Allman and Won (2022) conclude that ESG disclosure is associated with reductions in under-investments. Moreover, Bolton and Kacperczyk (2021), Jouvenot and Krueger (2021) and Downar et al. (2021) examine the introduction of mandatory firm carbon disclosure requirement in the UK. The former conclude that it resulted in lower stock returns among the most polluting disclosing firms, along with increased divestment by institutional investors. Similarly Jouvenot and Krueger (2021) argue that it increased future costs associated with GHG emissions, as evidenced by capital reallocation towards less polluting firms and negative market reactions to high emission disclosures. On the other hand, Downar et al. (2021) find that exposed EU-ETS firms reduced their emissions carbon intensity without a deterioration of their financial operating performance. They argue that the disclosure mandate increased transparency, thereby pillorying the carbon footprint of firms and creating pressure on management to improve it. Chen, Hung and Y. Wang (2019) also estimate that mandatory CSR reporting led to a cut in profitability among Chinese state-owned enterprises (SOEs), concluding that CSR spending is primarily driven by political and social considerations and that stakeholder pressures can encourage firms to change behavior.

Finally, this paper more specifically examines the impacts of carbon disclosure requirements in France. Mésonnier and Nguyen (2022) investigate the effects of the same policy as in this paper: the transparency requirements defined in Art. 173 of the Energy Transition For Green Growth Act (LTECV). Focusing on the energy sector and leveraging securities data from the Securities Holdings Statistics (SHS), in a DiD setup they find evidence of a sharp decrease (32%) in holdings of bonds and stocks in the portfolios of French-based institutional investors (insurance companies, pension funds, mutual and investment funds and securities dealers) after 2016, and relative to French

banks and non-French institutional investors. They conclude that institutional investors tend to decrease the carbon footprint of their portfolios when forced to disclose detailed climate-related information about their investment. Furthermore, they find that treated investors adjust their holdings of securities mostly along the extensive margin with evidence of a home-bias in portfolio management decisions. The latter result echoes Boermans and Galema (2023) who also observed that the introduction of Art. 173 led to significantly lower French institutional ownership of carbon-intensive foreign stock, but higher ownership of its French counterpart. They conclude that french firms with ex ante high French institutional ownership reduced their carbon emissions faster than other firms abroad following Art. 173, highlighting the success of domestic active engagement. In additional analysis, Mésonnier and Nguyen (2022) also uncover evidence that fossil firms are more likely to commit to emission reduction targets when treated investors hold higher shares of their equity, underlining the rising pressure from their shareholders to increase their ESG engagement with portfolio firms. Ilhan et al. (2023) more generally also conclude that treated French investors engage firms to improve their carbon reporting after 2016.

With respect to Mésonnier and Nguyen (2022) and other relevant literature, the contributions of this paper are fourfold. The focus of this paper is on the real effects of Art. 173 on manufacturing firms, as opposed to the effects on security holdings of investors in specifically the energy sector. Its focus on firm trade and economic outcomes is likely of higher importance to policy-makers concerned about the effectiveness and distributional effects of national policy. The focus on the manufacturing sector more broadly is relevant to the extent that industry accounts for 20% of GHG emissions in France (Direction Générale du Trésor, 2021), around 10% of its GDP and 11% of its workforce, thereby providing a more holistic view of the policy impact. Secondly, corporate bonds may be particularly sensitive to climate regulatory risks as drivers of downside risks (risks associated with losses) (Seltzer, Starks and Q. Zhu, 2024). Such risks may increase the probability of default, affecting bond prices negatively, while having a less predictable effect on equity prices (Campbell and Taksler, 2003). As a result, bondholders may be more directly impacted by carbon-disclosure regulations due to their focus on financial stability and the risk of default (Seltzer, Starks and Q. Zhu, 2024). Furthermore, the bond market, rather than the equity market, is increasingly seen as a marginal source of finance for many firms (Gourio, 2013). The main measure of exposure used in this paper (see below), the ratio of bond debt to total debt, may thus notably capture a firm's sensitivity to investor scrutiny driven by climate-related financial risks. Thirdly, this paper also provides additional insights into the role of financial constraints in shaping firm behavior, showing that firms with limited financial flexibility may face greater difficulties in adjusting to carbon transparency requirements, while the relatively financially constrained may be less inclined to respond to such policies. Such results presents challenges to policymakers either way. Finally, the specific focus on trade dynamics in this paper is relevant since emissions associated with imports represent half of the carbon footprint of France. The national transition towards net zero emissions requires a decrease in imported carbon emissions, and Art. 173 is meant to capture the entire footprint of portfolio firms. Moreover, an analysis of the response of imports to such policy can assist policymakers in better understanding the potential effects of the expanding CBAM.

2 Art. 173 of the Energy Transition for Green Growth Act

A couple months prior to the COP21 conference in 2015 culminating with the signing of the Paris Agreement, the French government passed the Energy Transition for Green Growth Act (*loi relative à la transition énergétique pour la croissance verte* - LTECV) to prepare the country for the "post-oil era" and establish a road-map for climate change mitigation and to diversify its energy mix (French Ministry of the Environment, 2017). Art. 173 of the LTCEV (henceforth Art. 173) requires institutional investors and asset managers, but not banks, to disclose in their annual reports information on how non-financial factors (ESG), and notably climate-related criteria, are considered in their investment decisions. The regulation applies to French-domiciled investors, along with the French-domiciled subsidiaries of foreign investors, amounting to around 840 financial institutions (Novethic, 2016). The regulation applies to all asset classes.

France has an extensive history of extra-financial reporting regulation (UNEPFI, 2016). Its policy track record is set against a backdrop of increasing global recognition of the role financial flows can play in "breaking the Tragedy of the Horizon" (Carney, 2015). At the national level, in 2001 French listed firms were mandated to publish information on Corporate Social Responsibility (CSR) issues as part of the New Economic Regulation (NRE) law. In 2010, the Grenelle II law expanded reporting requirements to include corporate GHG emissions, mandated that ESG data be certified by independent third parties, and extended the reporting requirement scope to large firms and asset managers (mutual and investment funds, securities dealers).

With Art. 173, the French government pioneered the world's first mandatory requirement for large investors[2] to publish information regarding their exposure to - and management of - climate change related risks, as well as on how their investment decisions align with national strategies for the energy transition (French Ministry of the Environment, 2019a). It widened the scope of financial actors subject to the regulation to institutional investors (insurance companies and pension funds). Listed firms are also required to further disclose on their exposure to financial risks related to climate change and on taken mitigation measures. The regulation notably distinguishes asset managers and institutional investors from banks and credit providers, where the latter are mandated to disclose data on their risk of excessive leverage and of any risks exposed by regular stress tests, without a specific focus on carbon and climate considerations (UNEPFI, 2016).

The objective of French legislators in crafting the regulation was twofold (I4CE, 2018). First, to raise awareness among investors of the emissions and associated financial risks stemming from their investments. The underlying assumption is that investors do not adequately price climate change related risks in their risk assessment frameworks. Hence the disclosure of exposure to these risks would result in better risk management strategies and in a reallocation of funds towards low-carbon assets (2DII, 2015). Overall between 2013 and 2016 in France, climate investments totaled up to €32 billion annually, representing over 1% of GDP and more than 6% of investment expenditures (I4CE, 2022). Second, to provide public authorities, NGOs, and citi-

[2] Smaller investors, i.e, investors with a total balance sheet below €500 million or belonging to a corporate group with a total balance sheet below €500 million face less stringent non-financial reporting requirements.

zens with transparent corporate non-financial information and thereby empower them to exert pressure on investors to align their investments with the transition towards a low-carbon economy. The underlying assumption is that investors care about their reputation, about attracting environmentally-conscious customers, and to potentially gain from tax incentives and breaks (as opposed to increasing carbon pricing stringency) thanks to their greener investment strategies (2DII, 2015). Publications of disclosure requirements start in 2017 for the year 2016.

Art. 173 takes a "comply or explain" approach, and without imposing any specific reporting method. Accordingly, the approach grants investors leeway in selecting the best analysis tools, strategies, and reporting methods that align with their objectives and are tailored to their portfolio (UNEP and I4CE, 2015). By not mandating a specific method, Art. 173 recognizes the diversity of investor situations and enables adaptation to individual investment and marketing strategies (FIR, 2016). Investors are required to provide an explanation or justification for any failure to comply with regulatory requirements.

In a government-led assessment of the application of the policy, French Ministry of the Environment (2019a) observes that half of the 48 largest investors (representing 80% of assets managed by asset managers and 75% of assets managed by the insurance industry) publish all required information and 44% do so incompletely. To the extent that the regulation was meant to result in a reference framework to identify best reporting practices, the report also observes heterogeneity in terms of quality, quantity, relevance, and comparability across disclosure information. Moreover, Novethic (2018), in a report covering 100 of the largest investors subject to the regulation, conclude that the most engaged investors also have the most assets under management, with 73% of investors fully complying with Art. 173. Bonds represent the majority of asset holdings in the panel, with corporate bonds representing a third. Moreover, they also find only a small number of players actually deploy low-carbon allocation strategies, while exclusion procedures are relatively widespread across large volumes of assets.

Since the introduction of Article 173 in France, interest has grown in implementing similar policies requiring transparency on non-financial matters. In 2024 the US Securities and Exchange Commission (SEC) has notably adopted rules to require public firms to disclose climate change-related information in their SEC filings. Furthermore, at the European Union (EU) level the Non-financial Reporting Directive requires large firms to disclose non-financial (CSR) information pertaining to ESG issues since 2018. Additionally since 2021 the financial services industry in the EU also have transparency obligations on ESG issues as part of the Sustainable Finance Disclosure Regulation (SFDR). Finally, note that Article 29 of the Energy and Climate Law (*loi énergie-climat*) repealed Article 173 of the LTCEV in 2019 and became enforceable in 2021. It revises, clarifies and strengthens sustainability-related financial disclosures for market players in concordance with European legislation (Direction Générale du Trésor, 2021). It also notably extends the requirements to investment and financing activities of banks and credit institutions.

3 Data and construction of main variables of interest

3.1 Data sources

The balanced panel is composed of manufacturing firms located in metropolitan France and spans the years 2012 through 2019. It merges different databases by year and firm ID (Siren, the 9-digit French firm identifier).

The BIC-RN databases provide administrative data from French corporate tax returns, such as balance sheets and income statements. The analysis also relies on the FARE datasets that provide financial and economic business statistics that also largely come from tax returns. Nevertheless, FARE does not detail certain firm debt composition variables at a granular level, hence the exposure variable used to identify the effect of the policy (see section 3.3) is based on the administrative data, whereas all financial and economic indicators rely on the business statistics.

The LIFI database stems from administrative data to identify the different corporate groups operating in France. A corporate group is its own economic entity: a group of firms composed of a controlling firm (head of group or holding) and all its subsidiary firms. A head of group can notably appoint the majority of executives (INSEE, 2019). Hence the LIFI database helps identify the different heads of groups and their subsidiaries by their firm identifiers. The database is therefore also crucial in the construction of the exposure variable (described below) as it is determined at the group level.

Trade data collected by the French customs administration (Direction Générale Des Douanes Et Droits Indirects, 2022) gives a comprehensive overview of the yearly values, quantities, and weights of exports and imports carried out by French enterprises. The data details each firm's trade activity at the eight-digit product category within the combined nomenclature (CN8) per destination or origin country. CPA2015 industry codes are also given for each good which, at the two-digit level, correspond directly to ISIC revision 4 codes.

Emission intensity data is from the 2021 edition of the OECD's Trade in Embodied CO2 Database (TECO2). The data combines the OECD Inter-Country Input-Output (ICIO) Database and the International Energy Agency (IEA) statistics on CO2 emissions from fuel combustion to derive estimates of CO2 intensity for each bilateral trade relationship across 36 OECD countries, 30 non-OECD countries, as well as a rest of the world aggregate. For each bilateral pair, estimates of CO2 intensity are disaggregated to as many as 36 sectoral codes that correspond to 2-digit ISIC revision 4 codes. The methodology is detailed in an OECD working paper by N. and Guilhoto (2020).

The Eacei (*Enquête sur les consommations d'énergie dans l'industrie*) database provides survey data on energy consumption and expenditure by energy fuel and electricity and in aggregate. It surveys all production plants with over 250 employees, as well as a stratified random sample of plants with at least 20 employees. Stratification is based on activity classification and employment level. Each year, surveyed plants provide information on purchased quantities of energy inputs in metric base units, as well as their cost value in euros (excluding any deductible value-added tax), for the prior calendar year. The monetary value of total energy costs is also provided in the Eacei database. The response rate to the survey is relatively high, at 85% in 2011 and 90% in 2014. Domestic emissions from energy consumption are estimated based on emission

factors (Ademe, 2021) applied to each fuel according to their metric unit across all years. The application of an emission factor to each fuel yields the amount of tons of carbon emissions (tCO_2) a firm emits.

3.2 Construction of main outcome of interest: imported carbon emissions

Evidence suggests that financial institutions regulated under Article 173 began to report the carbon footprint of their investment portfolios (I4CE, 2018), including those emissions not produced by the company itself but by its suppliers. This reporting is part of a broader requirement for institutional investors and asset managers to disclose the carbon footprint of their investments, encompassing emissions throughout the entire supply chain of the firms they invest in.

The impact of french environmental-oriented policies and regulations may be often confined within national borders. Hence the introduction of Article 173 represents a new approach aimed at addressing emissions tied to imports. Furthermore, due to the potential effects of Article 173 on corporate finance as financial institutions adjust their portfolios, imports and their associated carbon emissions are likely to fluctuate since the margins of trade are sensitive to financial constraints (e.g., Manova, 2013; Muûls, 2015).

The calculation of imported carbon emissions for each firm i in year t follows Dussaux, Vona and Dechezlepretre (2023):

$$ImpE_{it} = \sum_{g} \sum_{j} M_{ijt,g\in k} EI_{jt,g\in k} \tag{1}$$

where $EI_{jt}, g \in k$ is the total emissions intensity of product g of sector k in sourcing country j and $M_{ijt,g\in k}$ is the deflated value of imports of firm i of products g in sector k from sourcing country j.[3]
Simply put, Equation (1) calculates the total carbon emissions that firms import from other countries. It multiplies the emissions intensity of products from different sourcing countries by the value of imports for each product and then sums up these products across all sourcing countries and products. Data for $EI_{jt}, g \in k$ comes from the OECD's Carbon Dioxide Emissions Embodied in International Trade (2021 ed.) dataset, using the same emission intensity for all products g in sector k. See Section C for further information on the applied methodology used to construct imported carbon emissions.

3.3 Construction of main exposure variable: the bond intensity of total debt

When firms seek to finance their activities through debt, they typically rely on two main financing options. They can either borrow funds from financial intermediaries such as banks and credit institutions or opt to issue debt securities (bonds) directly in financial markets. Among French non-financial firms, over half of external financing consists of bank credit, although the share of bond financing has risen significantly since the 2008 global financial crisis due to expansionary monetary policies (Dees et al., 2022) and stricter banking regulations (Carré et al., 2022).

[3]Note that commas are omitted between subscripts in this subsection for clarity.

Bondholders can include a diverse array of financial and economic agents, including non-monetary financial institutions, monetary institutions (i.e. central banks) and deposit-taking corporations, government, firms, and households. Investors targeted by Art. 173 are non-monetary financial investors (e.g. insurance firms, pension funds, and asset managers). These investors represented close to three-fifths (57%) of all European holders of bonds issued by European firms (Carré et al., 2022). They must disclose on their integration of climate-related criteria in their investment decisions, their exposure to financial risks due to climate change, and on how their investment decisions align with French environmental and energy objectives. Banks and credit providers, on the other hand, face requirements without a specific focus on carbon and climate considerations.

Note that French corporate tax returns distinguish debt associated with the issuance of corporate bonds from debt associated specifically with banks (i.e. loans)[4]. Total corporate debt additionally includes all other types of financial and operating debt (e.g. inter-company loans, accounts payable to suppliers, social security, and tax-related liabilities).

The main measure of exposure to the carbon disclosure mandate employed in this paper is the bond intensity of total debt as a pre-policy average percentage share, determined at the corporate group level of firm i. Equation (2) indicates the extent of reliance on bond financing relative to overall debt obligations. It is a continuous measure of exposure to the carbon disclosure requirements introduced in 2016 in France, allowing for the investigation of the average marginal effect of an increase in exposure on outcome, holding all else constant.

$$\text{Bond to total debt } (\%)_{i,pre} \equiv \frac{1}{4} \sum_{t=2012}^{2015} \left[\% \frac{\text{group bond debt}}{\text{group total debt}} \right]_{i,t} \tag{2}$$

The use of a percentage accommodates for significant differences in total debt levels. The measure is fixed at the pre-policy level because bond debt intensity could change after 2016 due to the policy. Its pre-reform average (t: 2012-2015) value helps isolate the effect of the policy from other potential confounding factors that might have influenced outcomes after the policy took effect.

Intuitively, firms that carry relatively large amounts of bond debt relative to all other types of corporate debt are more likely beholden to the investors that buy their bonds, such as those targeted in Art. 173. Simply put, heavier relative levels of bond debt suggest closer ties to bondholders, many of which must adhere to the non-financial disclosure requirements outlined in Art. 173 from 2016 onward. Accordingly, firm bond issuers may prioritize strategies and decisions that maintain investor confidence and secure ongoing financial support. As lenders, investors would more closely monitor firms' long-term financial health and risk, and ensure payment of debt, all within the context of their carbon disclosure requirements. They may be more inclined to monitor and act on the climate-related practices of the firms they invest in and encourage the transition to more sustainable supply chains.

Group-level

[4]In French balance sheet liabilities, bond debt includes convertible bonds (*Emprunts obligataires convertibles* - DS) and all other bond debt (*Autres emprunts obligataires* - DT). Bank debt encompasses all loans from banks and credit institutions (*Emprunts et dettes auprès des établissements de crédit* - DU).

The ratios are consolidated at the group level for several reasons[5]. Historically, bond issuers are large firms, as they generally represent lower-risk investment opportunities to investors compared to smaller firms with less proven track records of financial stability and profitability. Firms that are part of corporate groups have easier access to bond financing: 98% of all French bond debt was issued by corporate groups in 2000, the majority of which by the controlling firm (Kremp and Sevestre, 2000). Corporate groups may include firms of different sectors, or the head of a group may belong to a different sector than its subsidiaries. Hence a manufacturing subsidiary might not hold bond debt directly but still rely on such funding through its corporate group. To the extent that the analysis in this paper focuses on manufacturing firms, aggregating bond debt at the corporate group level is crucial to avoid bias, as failing to do so would overlook significant sources of funding that subsidiaries rely on through their corporate groups. This approach not only preserves critical information, particularly for manufacturing subsidiaries that do not hold bond debt directly, but it also ensures the accuracy and reliability of the results by properly accounting for the true financial structure of these firms.

Importantly, evaluating exposure at the group level also helps account for group dynamics among firms within the same group, i.e., they may share resources, strategies, and risks that could affect their outcomes collectively. Unconsolidated debt levels may notably include inter-company loans contracted between firms within the same group, reflecting group organizational choices instead of firm debt obligations and financial stability. Consolidated debt at the group level also provides a clearer picture of corporate indebtedness by mitigating the double-counting problem inherent in unconsolidated debt reporting (Haut Conseil de Stabilité Financière, 2017). This approach also helps address endogeneity concerns by controlling for common unobserved factors that may affect all firms within the same group.

Comparison with other research
Note that Equations (2) echoes the treatment variable used in Bertrand, Schoar and Thesmar (2007), whereby firm exposure to French banking deregulation policies is based on the degree to which they relied on bank financing. It also echoes the treatment variables used in Mésonnier and Nguyen (2022) who evaluate the effects of the same French disclosure requirement on the funding of the energy sector. They notably investigate if firms are more likely to pledge to reduce GHG emissions when institutional investors hold a significant portion of their equity (equity held by institutional investors over total equity), as an additional exposure variable. In this paper, the main exposure variable is the proportion of a firm's total corporate debt held by bondholders that include investors targeted by the carbon disclosure regulation.

3.4 Construction of the panel data and descriptive statistics

Construction of the panel data
The panel consists of importer firms in the manufacturing sector with non-null amounts of consolidated non-bank financial debt[6] relative to total debt. To further improve comparability across firms, the paper minimizes the presence of outlier firms that could bias final results: it omits the top 1% of firms based on the absolute value of the pre-reform (2012-2015) change in the log of total net assets, the ratio of total debt over equity,

[5]Note that exposure is mechanically at the firm-level for independent firms.

[6]Non-bank financial debt includes both bond debt and all other financial debt not associated with credit institutions as detailed in French corporate balance sheets.

the ratio of gross operating surplus over value-added, the log of employment, the log of revenues, and the log of imported carbon emissions (the main outcome variable of interest), as well as the bottom and top 1% of firms based on the pre-reform average of the same firm variables.

The panel of bond and non-bond issuers includes 5 682 firms per year over eight years. For the main analysis, the sample is restricted to only include bond issuers (i.e. firms that carry a non-null amount of consolidated bond debt for every year), or 418 firms per year in a balanced panel. Note that firms are identified as bond issuers when they either directly hold bond debt themselves, or indirectly carry bond debt through their corporate group. The main analysis focuses on the smaller sample of bond issuing firms because they are most directly exposed to the regulation, as detailed in Equation (2), whereas expanding the analysis to the larger sample that includes non-bond issuing firms requires alternative exposure measures. Feasible alternatives and additional robustness checks based on the larger sample that includes non-bond issuers are also presented below.

Summary statistics

Table (A1) provides summary statistics comparing the economic and financial characteristics of the relatively most exposed and least exposed firms to the disclosure regulation. The sample consists of only bond issuers. Since Equation (2) describes a continuous variable, for ease of comparing the relatively more exposed firms with the relatively less exposed firms in this section exposure is based on the median percentage share of the pre-reform average consolidated bond debt over total debt, as detailed below. This dummy version of Equation (2) is also used in robustness checks in the results section.

$$\text{Bond to total debt (dummy)}_i = \begin{cases} 1 \equiv \text{Relatively high, if Exposure}_{i,pre} > \text{p50} \\ 0 \equiv \text{Relatively low, otherwise} \end{cases} \tag{3}$$

Bond issuing firms are similar in terms of trade characteristics. The vast majority of carbon emissions are imported from Western European countries, underlining the strong trade relationships France has with other members of the European Union. Debt variables differ widely across the unconsolidated (firm) level and the consolidated (group) levels. At the unconsolidated level, the percentage share of bond debt is near zero on average across all firms. However, it accounts for an average of 26% of total debt among the relatively more exposed firms when consolidated. The relatively more exposed firm belongs to a corporate group that has more total debt, despite similar average total debt among all firms. Moreover, they also tend to be relatively larger with regards to certain firm characteristics (net assets, net operating income, or value-added), albeit incur lower operating costs and revenues from sales.

Industry composition across both groups of firms is also rather homogeneous, although the food sector represents over a third of the least exposed firms. Overall, food, fabricated metals, chemicals, and rubber and plastics represent close to three-fifths and two-fifths of firms among the least exposed and the most exposed, respectively. More generally, industry composition highlights the fact that bond issuers encompass the traditionally emission-intensive manufacturing sectors.

Figure (A1) further shows the evolution of the bond intensity of total debt - or Equation (2) - at its contemporaneous yearly levels across all years of the panel. The

percentage increases by around 3 percentage points (pp) between 2012 and 2015, dips by 1 pp in 2016, increases then dips again by roughly 1 pp until 2019, the last year of the panel. On average the bond intensity represents 16.4% and 16.8% in the pre-reform and post-reform period, respectively.

French corporate debt dynamics and bond financing
French corporate debt has risen significantly since the 2008 global financial crisis, reflecting mainly an increase in inter-company loans and bonds (Antoun de Almeida et al., 2018) thanks to expansionary monetary policies and stricter banking regulations (Carré et al., 2022) and underlining the increasing importance of corporate groups in France (Antoun de Almeida et al., 2018). Between 1991 and 2018, bond issuances exceeded €500 billion and inter-company loans reached about €680 billion, while domestic bank credit was around €600 billion (IMF, 2019). In 2018, corporate debt in terms of bank credit and bond debt stood at €1.6 trillion (Haut Conseil de Stabilité Financière, 2018). Nevertheless, bank lending still depicts the largest share of external financing to small and medium-sized enterprises (SMEs) in the European area (EA), financing two-thirds of French corporate debt (UNEP and I4CE, 2015). While larger firms have been increasingly reliant on bond issuances to finance their activities, the bulk of bank credit goes to SMEs and mid-tier firms (IMF, 2019).

Overall, French firms are not only responsible for half of the corporate bonds outstanding in the EA, they also tend to have easier access to bond financing as around 8% of large firms have issued a bond since 2010 compared to 4% of large firms in other EA countries (Antoun de Almeida et al., 2018). French firms have the highest share of bond financing in the EA: while the share of bond debt in total firm debt rose from 9% to 16.6% in the latter, it grew from 19% to 30% between 2007 and 2021 in France (Alder, Coimbra and Szczerbowicz, 2023). Moreover, since 2009, bond borrowing drove 14.5 of the 16 percentage points increase in the French firm debt-to-GDP ratio, suggesting the increase was mainly led by larger firms (Khder and Rousset, 2017) driven to substitute bank credit with bond financing (IMF, 2019). Since 2012, bond debt represented over a third of French corporate debt (Haut Conseil de Stabilité Financière, 2018).

In the EA, European financial sector investors represent the majority of corporate bondholders, with 29% from insurance companies and pension funds, 25% from investment funds, and 19% from monetary financial institutions (i.e. central banks and deposit-taking institutions) (Carré et al., 2022). Foreign investors, primarily from European countries, hold approximately half of the debt securities issued by French firms, totaling €600 billion in aggregate and reflecting the international integration of French capital markets (IMF, 2019; Carré et al., 2022). Among French investors, asset managers hold a quarter of all French corporate bonds (AFG, 2012). In 2014, they held €1.4 trillion in corporate stocks and bonds, with 40% of the bonds sourced from French firms (AFG, 2015). Moreover, almost two-thirds of bondholders of corporate commercial papers (short-term debt securities) are French money market funds (Banque de France, 2023a). The French insurance industry represents about €2.3 trillion in net assets and largely invests in debt securities, including corporate bonds, to fulfill liquidity needs (UNEP and I4CE, 2015). Corporate bonds make up 39% of the portfolios in the French insurance industry (Haut Conseil de Stabilité Financière, 2018).

4 Empirical strategy

The empirical strategy employs a differences-in-differences (DiD) approach to investigate the effects of the introduction of investor carbon disclosure requirements on firm-level outcomes, focusing on outstanding corporate bonds that may be held by investors targeted by Art. 173. The construction of the baseline exposure measure, Equation (2), is detailed in section (3.3). For convenience, let Bond to total debt $(\%)_{i,pre} \equiv$ Exposure$_{i,pre}$ in the regression equations below.

Equation (4) is the event study dynamic DiD specification. $y_{i,t}$ represents the outcome variable for firm i at time t, where t denotes years in the panel t = {2012,...,2019}. The equation includes a set of 8 year indicators $\mathbb{1}_{s=t}$ equalling one when the year observed, t, equals the specific indexed year s, and zero otherwise. The main coefficient of interest, β_s, evaluates the evolution of the average effect of exposure to the policy over the years. The reference year (indicator) is set to 2015 for β_s.

$$\begin{aligned} y_{i,t} = \alpha_i + \sum_{\substack{s=2012 \\ s\neq 2015}}^{2019} \beta_s(\text{Exposure}_{i,pre} \times \mathbb{1}_{s=t}) + \sum_k \sum_s \delta_{k,s}(industry_k \times \mathbb{1}_{s=t}) \\ + \sum_s \gamma_s(group_c \times \mathbb{1}_{s=t}) + \sum_s \theta_s(domestic_d \times \mathbb{1}_{s=t}) + \sum_s \eta_s(\mathbf{X}_i^{2012} \times \mathbb{1}_{s=t}) + \varepsilon_{i,t} \end{aligned} \tag{4}$$

Equation (5) is the pooled DiD specification. Its main coefficient of interest, β, estimates the average effect of exposure to the policy in the post-reform period relative to the pre-reform period. The dummy $Post_t$ equals one for the post-reform period ($t = \{2016, ..., 2019\}$) and zero for pre-reform ($t = \{2012, ..., 2015\}$). Both equations are constructed the same except for the terms on β_s and β.

$$\begin{aligned} y_{i,t} = \alpha_i + \beta(\text{Exposure}_{i,pre} \times Post_t) + \sum_k \sum_s \delta_{k,s}(industry_k \times \mathbb{1}_{s=t}) \\ + \sum_s \gamma_s(group_c \times \mathbb{1}_{s=t}) + \sum_s \theta_s(domestic_d \times \mathbb{1}_{s=t}) + \sum_s \eta_s(\mathbf{X}_i^{2012} \times \mathbb{1}_{s=t}) + \varepsilon_{i,t} \end{aligned} \tag{5}$$

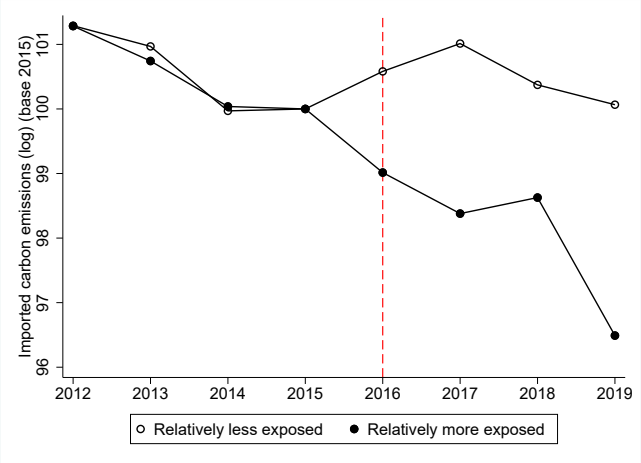
The main outcome of interest is the amount of imported carbon emissions to evaluate whether exposure to the disclosure regulation led to a decrease in pollution through this channel of international trade. Other trade, carbon, and firm competitiveness indicators are also tested as outcome variables to construct a comprehensive picture of how the mandate impacted firms, with a particular focus on assessing whether firms sought to reduce their carbon intensity or were only reacting to the increased financial constraints more generally.

To help account for omitted variable bias, firm dummies (α_i) control for time-invariant firm-specific characteristics. $\delta_{k,s}$ captures industry-by-year shocks and trends at the NACE Rev.2 2-digit industry code level, thereby also controlling for broad macroeconomic trends affecting all firms in a given year. $group_c$ is a dummy variable equalling one if a firm is part of a corporate group in a given year. Hence γ_s captures year-by-year differences between firms that are part of corporate groups and independent firms. $domestic_d$ is also a dummy variable if the head of corporate group is located in France. θ_s captures year-by-year differences between firms whose head of corporate group are located in France and those that are not. η_s capture size-by-year

shocks and trends[7]. $\mathbf{X}_i^{2012}$ is a vector of firm-level size characteristics, notably the log of total net assets, the log of gross operating income, the ratio of total debt over equity and the ratio of gross operating surplus over value-added set at their 2012 levels to minimize correlation with the policy in the post-reform years. Coefficient $\varepsilon_{i,t}$ is the error term.

4.1 Identification

Figure 1: Parallel trends - imported carbon emissions



Note: Figure (1) illustrates the evolution of imported carbon among relatively high exposed and low exposed firms, as identified in Equation (3). Exposure is estimated in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt) across all years. Average trends are indexed to year 2015.

The principal identification assumption in a DiD setting is the parallel trends assumption. It assumes that for given average outcomes, the trajectory of the relatively more exposed firms would have continued to follow the trajectory of the relatively less exposed firms in the absence of the carbon disclosure regulation. This assumption requires that both groups of firms experience similar changes in outcomes pre-policy. Figure (1) plots the evolution of the main outcome of interest - imported carbon emissions - between the relatively most and least exposed firms based on Equations (2) and (3). The construction of imported carbon emissions is detailed in section (3.2).

Before the introduction of the disclosure regulation in 2016, bond-issuing firms experienced nearly identical trajectories in carbon imports, lending credibility to this key identifying assumption. From 2016 onward, Figure (1) illustrates a distinct divergence in trajectories: the relatively more exposed firms experience a large drop in carbon imports, whereas carbon imports among the least exposed are relatively more constant on average across the post-reform years. Note that Figure (2) further separates bond issuers into four quartiles according to Equation (2). The figure again suggests

[7]Note that controlling for time-varying trends by interacting variables with separate year dummies for each year is more robust than controlling for a specific linear trend that would not allow for year specific shocks.

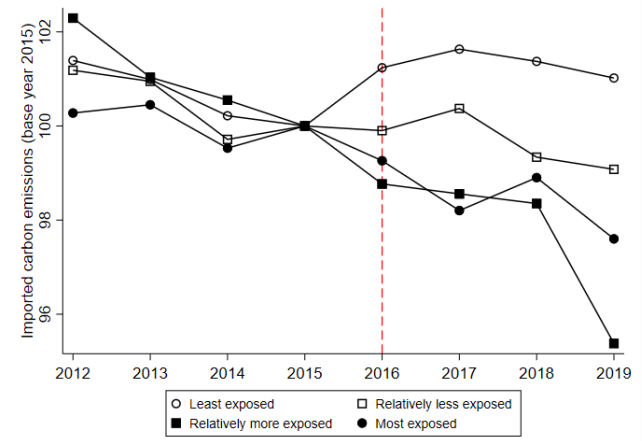
that the relatively less exposed firms do not experience the sharp decline in imported carbon that the relatively more exposed firms experience.

Figure (A2) similarly illustrates the evolution of various other trade and economic performance indicators between the relatively less and more exposed firms. It overall tends to suggest that the most exposed firms also experienced decreases in economic activity following the introduction of the carbon disclosure regulation.

Threats to identification

Potential threats to identification is that results capture overlapping policies or other shocks and trends that are correlated with the effects of the bond intensity of total debt, the main exposure variable used in this paper to estimate the effects of the carbon disclosure requirements introduced in 2016 in France (Art. 173). Note that Art. 173 was introduced as part of the 2015 Energy Transition for Green Growth Act (LTCEV), a policy-making road-map in terms of climate change mitigation, consistent with French commitments under the Paris Agreement, signed a couple months later, and to the European Union. Hence this paper cannot exclude the possibility that the LTCEV, and the Paris Agreement more generally, and abstracting from Art. 173, have not reshaped beliefs among investors and other stakeholders with regards to the urgency to take action against climate change and the possibility of increasing carbon policy stringency to tackle the problem. Bolton and Kacperczyk (2023) notably estimate that the Paris Agreement caused investors to update their beliefs about long-term regulatory risks, albeit also noting that investors particularly payed attention to climate risks only when international commitments were followed up by domestic policy. It is noteworthy that Art. 173 was novel policy-making at the time: France was the first country to mandate such granular non-financial information from investors (French Ministry of the Environment, 2019b).

Figure 2: Parallel trends - imported carbon emissions (by quartiles)



Note: Figure (2) illustrates the evolution of imported carbon (log) among relatively high exposed and low exposed firms. It separates bond issuers into four quartiles according to Equation (2). Average trends are indexed to year 2015.

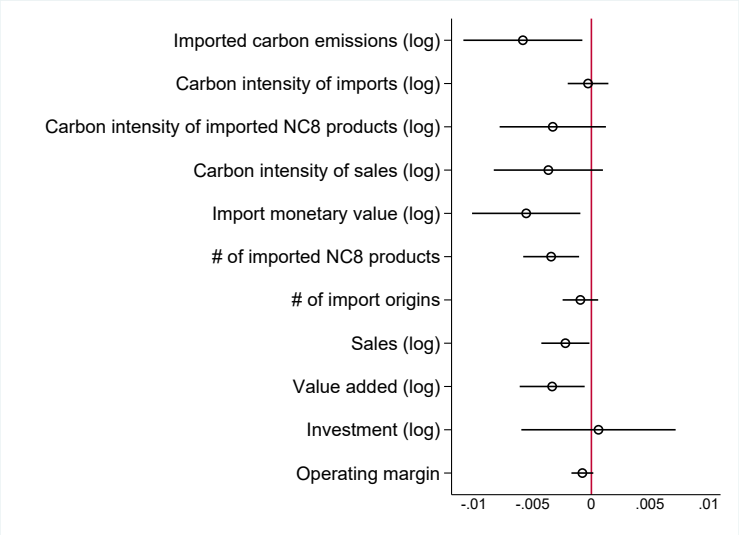
5 Results

Table (1) presents the average DiD effects of exposure to the investor carbon disclosure requirements as detailed Art. 173. Column (1) of the table shows the baseline results based on Equation (2)[8]. Figure (3) illustrates these same average regression results below.

Overall, Figure (3) and Table (1) indicate that exposure to the carbon disclosure requirements are associated with cuts in imported carbon emissions. A 10 percentage points (pp) increase in exposure is associated with a 5.84% drop in the carbon emissions embedded in firm-level imports following the introduction of Art. 173. The result is significant at the 5% level. Nevertheless, exposure is not statistically associated with changes in carbon intensities on average, whether it be the carbon intensity of imports, of imported products or of sales. It is also not associated with shifts in carbon imports away from the most polluting country sources. Instead, results suggests the drop in imported carbon emissions is more likely driven by cuts in trade and economic activities. Exposure is notably associated with lower numbers of imports (NC8 products), revenues and value-added. A 10 pp increase in exposure results in a statistically significant 2.22% reduction in sales in the post-reform period, suggesting that firms are not just cutting back on the number of products imported but are also experiencing a general decline in their operations. The significant drop in import value could reflect broader cost-cutting and downscaling strategies. Overall the drop in carbon imports appears to be driven by changes in importing activities at the extensive margin as opposed to changes at the intensive margin.

[8]Note that all regression results in columns (1), (3)-(5) in Table (1) are multiplied by 1 000 for readability.

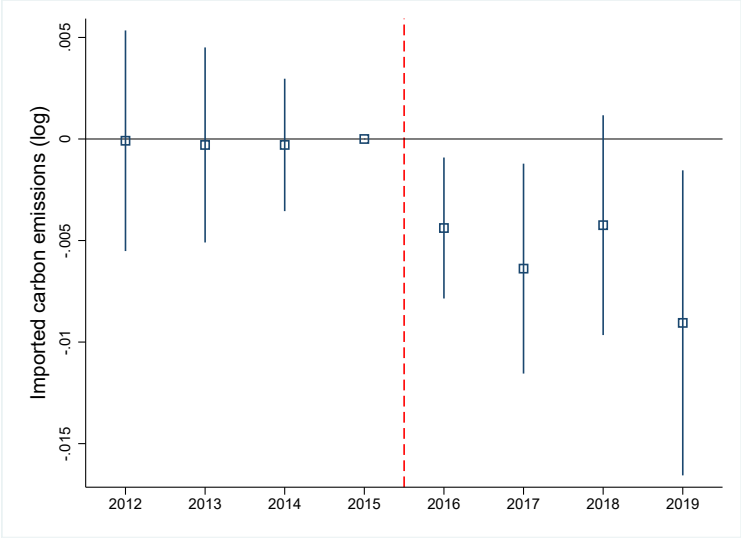
Figure 3: Average DiD effects of exposure to investor carbon disclosure requirements (Art. 173)



Note: Figure (3) presents average effects based on Equation (5). Results are also detailed in Table (1). For readability, the figure omits outcomes not expressed in log. Exposure is defined in Equation (2). The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The sample includes 418 firms that issue bonds (at the corporate level) every year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure (4) illustrates the dynamic year-by-year DiD event study results based on Equation (4). Exposure is not associated with significant effect on imported carbon emissions in the pre-policy period. The absence of noticeable pre-trends helps the identifying assumption of common trends in a DiD setting. However, once the disclosure regulation was introduced in 2016, exposure to the policy is associated with statistically significant decreases in imported carbon, despite a brief rise observed in 2018.

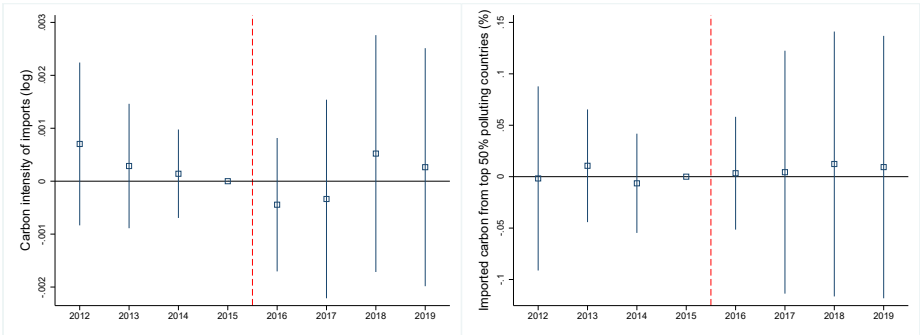
Figure 4: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on firm-level imported carbon emissions



Note: Figure (4) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

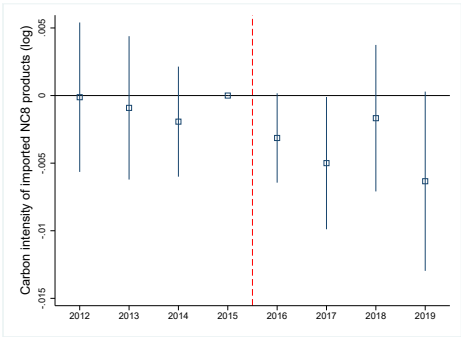
Figure (5) illustrates the same dynamic DiD results for additional firm-level trade and economic performance indicators. The dynamic results tend to corroborate the average DiD results. Notwithstanding slight pre-trends, the carbon disclosure regulation is associated with drops in firm size and activity.

Figure 5: Event study DiD effects of investor carbon disclosure requirements on additional firm-level trade and economic performance indicators

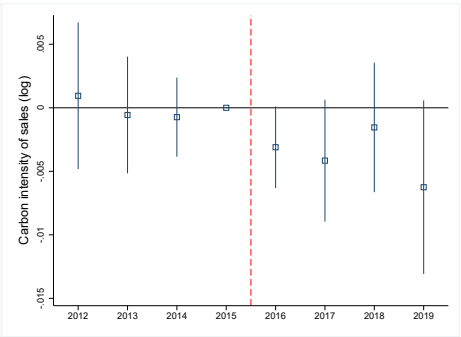


(a) Carbon intensity of imports (log)

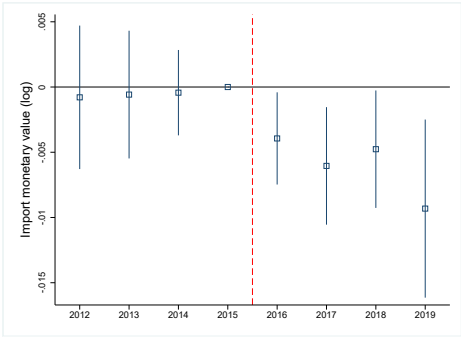
(b) Imported carbon from top 50% (%)



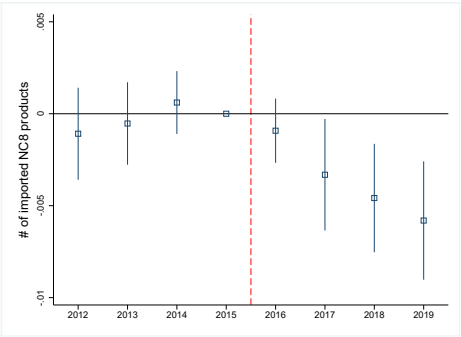
(c) Carbon intensity of NC8 products (log)



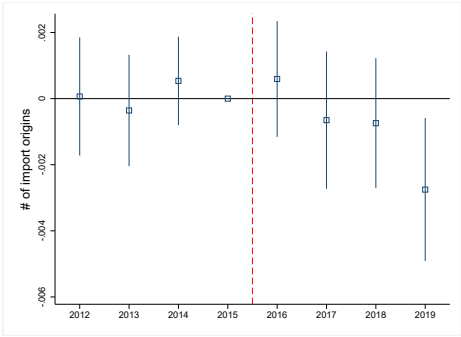
(d) Carbon intensity of sales (log)



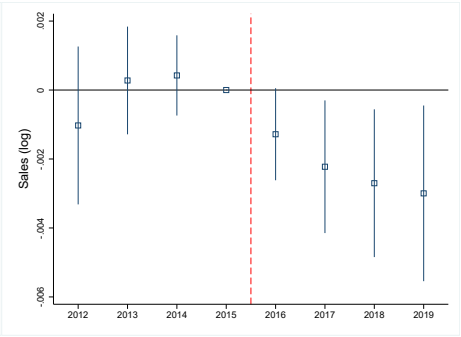
(e) Import value (log)



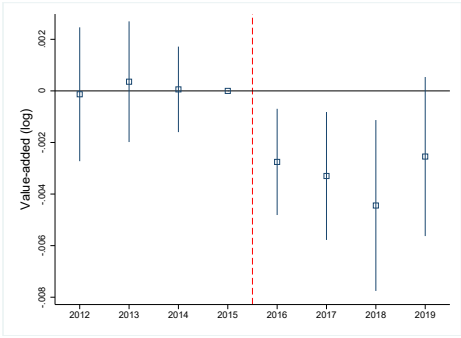
(f) # imported NC8 products



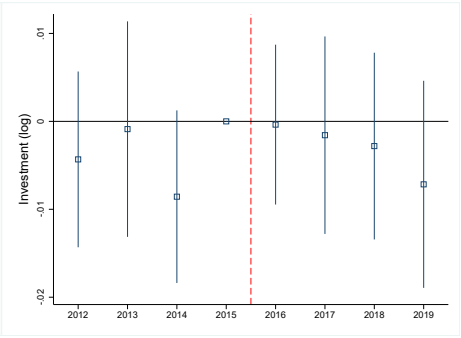
(g) # import origins



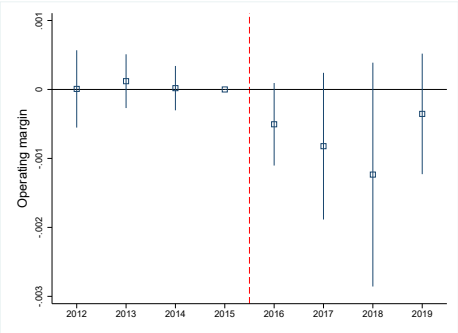
(h) Sales (log)



(i) Value-added (log)



(j) Investment (log)



(k) Operating margin

Note: Figure (5) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

5.1 Additional results

Sector-level heterogeneity
Figure (B1) suggests that fabricated metals and the motors industry experience the most significant declines in imported carbon emissions compared to all other manufacturing sectors, although coefficients are mostly negative throughout.

Domestic emissions
To further investigate the statistically significant drop in imported carbon emissions following the implementation of Art. 173, the panel is merged with the Eacei dataset (see section 3) to estimate firm-level carbon emissions emitted domestically for manufacturing purposes. Figure (B2) indicates that exposure is associated with significant drops in the sum of direct and imported carbon emissions, albeit seemingly entirely driven by cuts in the latter as opposed to the former. While negative, all other coefficients on energy use choices are not statistically significant on average. Results suggests that the decrease of the carbon footprint of exposed firms is likely entirely driven by the decrease in carbon imports and not in changes in adjustments in their domestic production processes.

Export activity
Among exporting bond-issuing firms, exposure to Art. 173 also resulted in a contraction in exporting activities at the extensive margin, reflecting again a general decline in operations. Exposure is statistically associated with drops in the number of NC8 products. To investigate whether exposure is also associated with the probability to export among bond issuers more generally, the pooled and dynamic DiD specification (Equations 5, 4) are converted into a logistical regression with a dummy outcome variable equalling one if a firm exported a non-null amount each year. The coefficients on both β and β_s are not statistically significantly different from zero. In other words, while

exposure is associated with lower numbers of exported products, it is not associated with an exit from export markets altogether.

Source country heterogeneous effects
Further analysis indicates that the negative relationship between exposure to carbon disclosure requirements and both imported carbon emissions and import value is not attributable to any single country of origin. Moreover, although a significant portion of French imports originate from Western Europe, findings do not appear to be driven by country-specific shocks in this region. See Section (D) for further elaboration and additional summary statistics.

5.2 Robustness checks

Alternative exposure: dummy
The main exposure variable, Equation (2), assumes that firms with higher exposure to the investor carbon disclosure requirements react differently from those with lower exposure. Equation (3) dichotomizes Equation (2) firms based on whether they are relatively less and relatively more exposed to the investor carbon disclosure requirements. Average DiD results based on this dummy exposure variable are listed in column (2) in Table (1). On average, the relatively more exposed firms experience a relative 20% decrease in imported carbon emissions post-reform. Overall, results are akin to findings from column (1), notwithstanding an additional significant negative effect on the carbon intensity of sales. Figure (B4) illustrates the same dynamic DiD results for additional firm-level trade and economic performance indicators. The dynamic results tend to corroborate the average DiD results. Notwithstanding slight pre-trends, the carbon disclosure regulation is associated with drops in firm size and activity.

Alternative exposure: bond to bank debt intensity
This paper introduces an alternative measure of exposure to the carbon disclosure requirements as detailed in Equation (6) below: bond debt over the sum of bond debt and bank debt, again as a pre-policy average percentage share, and determined at the corporate group level of firm *i*. While Equation (2) provides a comprehensive overview of the importance of bond financing in external financing, Equation (6) focuses on the importance of bond financing in a more narrowly defined context that is specific to long-term debt financing strategies.

$$\text{Bond to bank debt } (\%)_{i,pre} \equiv \frac{1}{4}\sum_{t=2012}^{2015}\left[\%\frac{\text{group bond debt}}{\text{group bond debt + group bank debt}}\right]_{i,t} \tag{6}$$

The focus on the composition of long-term financing is relevant in the context of carbon disclosure requirements, as ESG and low-carbon investments are usually large and long-term investments in infrastructure and technology (Monasterolo et al., 2022), including offshoring activities and sourcing from more sustainable suppliers with lower carbon footprints in the case of importing carbon. Bond issuances and bank loans are traditionally associated with long-term sources of financing to help finance capital expenditures and expansion and growth projects. Shorter-term financing (e.g. trade credit) mainly serves to finance day-to-day business operations. More generally, sustainable finance is about mitigating the longer-term effects of financial risks related to climate change and climate mitigation policies to ensure long-term and resilient value creation. Intuitively, firms that issue larger amounts of bonds as part of their

long-term debt strategies compared to bank credit are more likely exposed to the carbon disclosure requirement because they are relatively reliant on investors targeted by the policy, compounded by the long-term nature of ESG and sustainable investing.

Table 1: Average DiD effects of investor carbon disclosure requirements (Art. 173) on imported carbon emissions and various trade and economic performance indicators

Sample Bond issuing firms (n) 2012-2019	n = 418 per year			n = 238 per year no corporate restructuring	
	(1)	(2)	(3)	(4)	(5)
Measure of exposure:	Bond to total debt (%)	Bond to total debt (dummy)	Bond to bank debt (%)	Bond to total debt (%)	Bond to bank debt (%)
Trade and carbon outcomes					
Imported carbon emissions (log)	-5.84**	-0.200***	-2.91**	-9.53***	-4.34**
	(.00258)	*(.0747)*	*(.00140)*	*(.00336)*	*(.00175)*
Carbon intensity of imports (log)	-0.284	-0.0178	-0.297	-1.03	-0.647
	(.000882)	*(.0234)*	*(.000415)*	*(.000938)*	*(.000427)*
Imported carbon from top polluting countries 50% (%)	6.73	-0.463	-19.0	-77.0*	-45.2**
	(.0491)	*(1.314)*	*(.0237)*	*(.0450)*	*(.0182)*
Carbon intensity of NC8 imported products (log)	-3.29	-0.113*	-1.36	-6.60**	-2.14
	(.00230)	*(.0680)*	*(.00122)*	*(.00311)*	*(.00159)*
Carbon intensity of sales (log)	-3.67	-0.134**	-1.43	-5.95**	-2.49*
	(.00237)	*(.0663)*	*(.00122)*	*(.00274)*	*(.00144)*
Import monetary value (log)	-5.55**	-0.182***	-2.61**	-8.50***	-3.70**
	(.00235)	*(.0694)*	*(.00131)*	*(.00319)*	*(.00170)*
NC8 imported products (#)	-3.43***	-0.0949***	-1.59***	-3.66***	-1.94***
	(.00121)	*(.0337)*	*(.000564)*	*(.00139)*	*(.000731)*
Import origin countries (#)	-0.937	-0.0459**	-0.961**	-1.94**	-0.851*
	(.000773)	*(.0233)*	*(.000396)*	*(.000961)*	*(.000472)*
Other competitiveness outcomes					
Sales (log)	-2.22**	-0.0671**	-1.48***	-3.76**	-1.89**
	(.00104)	*(.0306)*	*(.000556)*	*(.00157)*	*(.000767)*
Value-added (log)	-3.34**	-.0862**	-1.49**	-5.00**	-2.10**
	(.00141)	*(.0400)*	*(.000711)*	*(.00213)*	*(.000965)*
Total net investment (log)	0.606	-0.0890	-2.52	-3.53	-5.30**
	(.00334)	*(.103)*	*(.00195)*	*(.00541)*	*(.00256)*
Operating margin	-0.767	-.0153*	-0.258	-1.42	-0.419*
	(.000474)	*(.00832)*	*(.000169)*	*(.000964)*	*(.000245)*

Note: Regression results based on continuous exposure (columns 1, 3, 4 and 5) are multiplied by 1 000 for readability.
Table (1) presents average DiD effects of exposure to Art. 173 on various trading activity and economic performance indicators, based on Equation (5). In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. In column (1), Bond to total debt (%) refers to the main exposure variable in this paper, detailed in Equation (2). In column (2), Bond to total debt (dummy) is detailed in Equation (3). In column (3), Bond to bank debt (%) is detailed in Equation (6). Results in columns (1)-(3) are based on a sample that includes firm bond issuers (carry a non-null amount of bond debt every year of the panel). Results in columns (4)-(5) are based on a sample that includes firm bond issuers and do not undergo corporate restructuring throughout the panel.
The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales.
Standard errors are clustered at the firm level and in parentheses. Statistical significance is marked with * for p-value < 0.10, ** for p-value < 0.05, and *** for p-value < 0.01.

Average DiD results are found in column (3) of Table (1). A 10 pp increase in exposure is associated with a 2.91% drop in imported carbon on average, a smaller magnitude compared to column (1). Overall, findings do not considerably differ from measures of exposure used in columns (1) and (2). Figure (B5) illustrates the dynamic DiD effects.

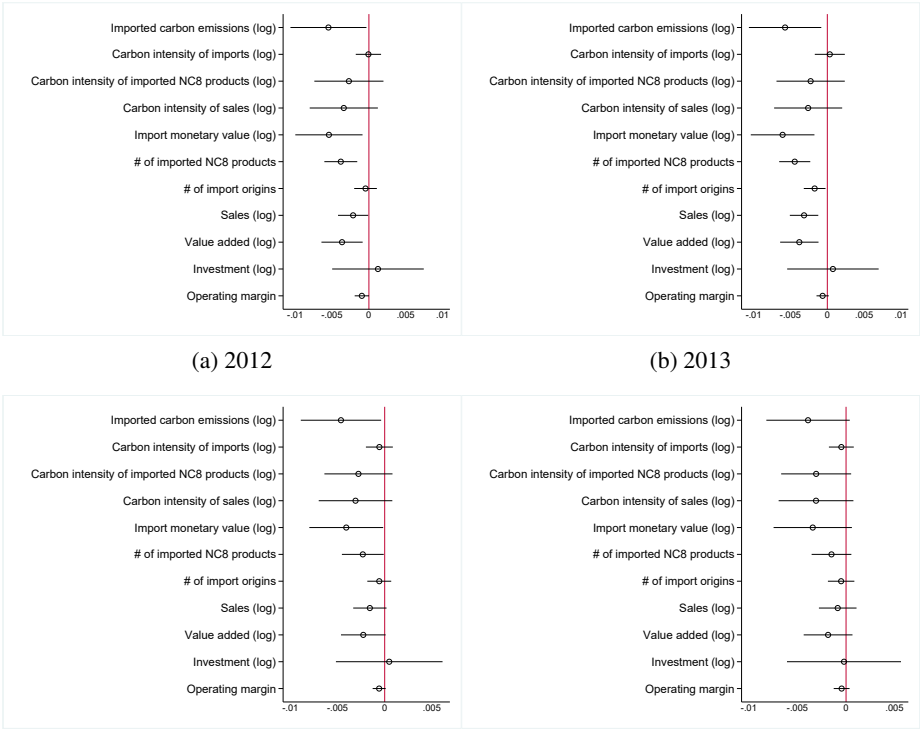
Alternate sample: no change in group ownership

The analysis re-estimates DiD effects on a sample of bond-issuing firms that do not undergo corporate restructuring or changes in corporate ownership throughout the panel. The focus on such firms helps establish a clearer evaluation of the disclosure regulation on firm outcomes by minimizing firm heterogeneity that may arise from corporate restructuring or changes in ownership. Average DiD results are found in columns (4) and (5) for Equation (2) and (6), respectively. Under both measures of exposure, the magnitude of the effects tend to be larger than those found in columns (1) and (3). A 10 pp increase in exposure is associated with a decline in imported carbon ranging between 4.34% and 9.53%, representing stronger decreases than those found for the number of

imported products or sales, reflecting the significant cut in their carbon intensities. The most notable changes are the drops in imported carbon from the top polluting countries, which includes China. A 10 pp increase in exposure is associated with shifts in carbon imports away from relatively carbon-intensive origin countries ranging between 0.77 pp at the 10% level of significance to 0.452 pp at the 5% level of significance. Figures (B6) and (B7) plot the dynamic DiD effects.

Alternative exposure: pre-reform year by year
The main exposure variable detailed in Equation (2) is a pre-reform average across all pre-policy years (2012-2015), potentially masking important year-by-year variations in debt dynamics. To mitigate this concern, Figure (6) presents average DiD results, where exposure is set for each pre-reform year. Moreover, Figure (7) illustrates event study DiD regressions on imported carbon emissions as the main outcome variable based on these same measures of exposure to the carbon disclosure regulation.

Figure 6: Average DiD effects of investor carbon disclosure requirements (Art. 173) (year-specific exposure)



(a) 2012 (b) 2013

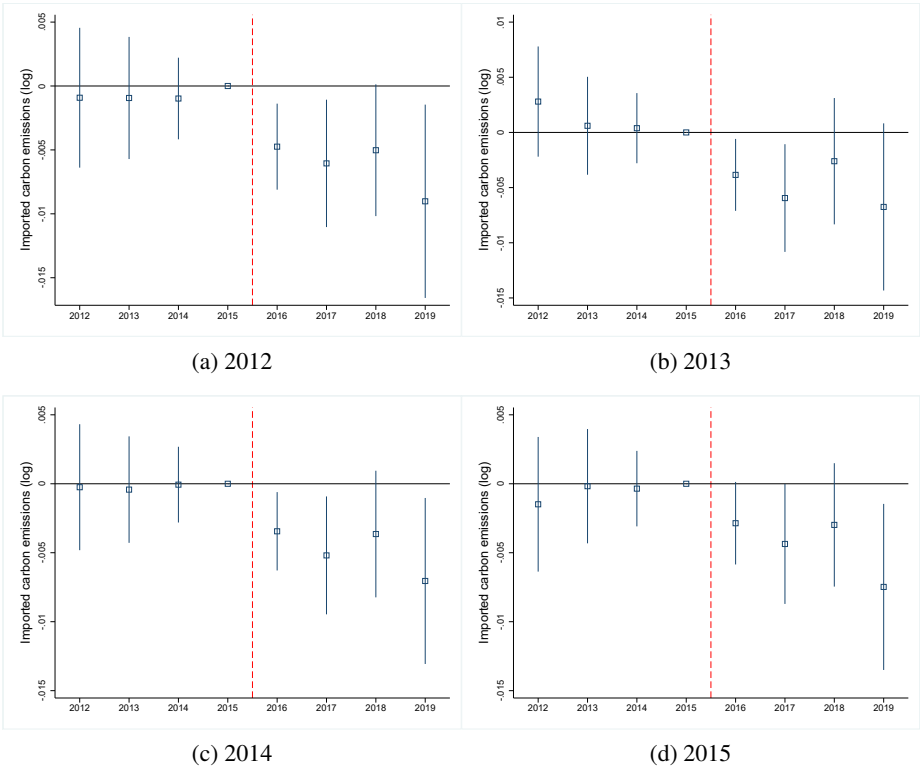
(c) 2014 (d) 2015

Note: Figure (6) presents the average DiD results based on Equation (5). Exposure is set for each pre-reform year, as opposed to a pre-reform average as in Equation (2. The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Overall, results are akin to results found in Figures (3 and (4). While the average effect of exposure set a year prior to the policy implementation on imported carbon

is negative but not statistically significant from zero at the 5% level, its event study results, detailed in Figure (7d), are akin to the Figure (4).

Figure 7: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on firm-level imported carbon emissions (year-specific exposure)



(a) 2012 (b) 2013

(c) 2014 (d) 2015

Note: Figure (7) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is set for each pre-reform year, as opposed to a pre-reform average as in Equation (2. The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Alternate exposure and sample: bond and non-bond issuing firms

DiD results are also re-estimated based on a larger sample of firms that includes both bond issuing and non-bond issuing firms (5 682 firms per year). The sample expansion allows for analyzing all firms potentially subject to increased scrutiny from non-bank financial debt providers following the introduction of the disclosure regulation. It introduces a new measure of exposure: the non-bank financial debt intensity over total debt, again as a pre-policy average percentage share, and determined at the corporate group level of firm i.

$$\text{Non-bank to total debt } (\%)_{i,pre} \equiv \frac{1}{4} \sum_{t=2012}^{2015} \left[\% \frac{\text{group non-bank financial debt}}{\text{group total debt}} \right]_{i,t} \tag{7}$$

Where non-bank financial debt includes all financial debt - including bond debt

and all other miscellaneous financial debt (including inter-company loans) - except for debt associated with banks and credit institutions[9]. The introduction of this second alternative exposure measurement specifically for the larger sample is because most firms do not issue bonds, although they do largely hold miscellaneous financial debt. The underlying assumption is that non-bank investors subject to the carbon disclosure requirements may also provide financing in ways beyond bond financing. Average DiD effects are illustrated in Figure (B8), based on the exposure measured discussed above (Equation 7) and regression Equation (5). Figure (B9) illustrates the dynamic DiD effects with imported emissions as the outcome. Results are akin to Figure (3 and (4) based on only bond issuing firms.

Alternate exposure: bond debt to total assets
The main exposure variable detailed in Equation (2) focuses on the bond intensity of total corporate debt. Intuitively, firms that carry relatively large amounts of bond debt relative to all other types of corporate debt are more likely beholden to the investors that buy their bonds, such as those targeted in Art. 173. Figure (B10) presents average DiD results when exposure is instead measured as the pre-reform average of the ratio of bond debt over total assets, again at the group level. It measures a broader measure of how dependent the firm is on bond financing relative to its asset base (e.g., property, inventory, equipment, cash, etc.). Overall, findings are akin to Figure (3), albeit exposure is also associated with lower levels of investment.

5.3 Financial constraints

The previous section suggests that higher dependence on the financial institutions targeted by Art. 173 is associated with drops in imported carbon emissions and lower competitiveness indicators. Importing firms rely on uninterrupted external funding to conduct their operations and investments: they not only face both fixed and variable expenses but also can face cash flow challenges if relying on imported intermediate inputs that are often paid for in advance of delivery (Wagner, 2015). If the disclosure regulation increased investor scrutiny on firms within their portfolios, then those firms may also face greater financial constraints. As a result, the regulation should impact exposed firms differently based on how financially constrained they were pre-reform. Financial constraints refer to an inelastic supply of external finance, whereby difficulties in accessing external finance can constrain the conduct of daily business activities (Cherchye et al., 2020). Accordingly, exposed firms with limited access to external financing, or those that become more dependent on it, are likely to respond more strongly than firms that are less financially constrained.

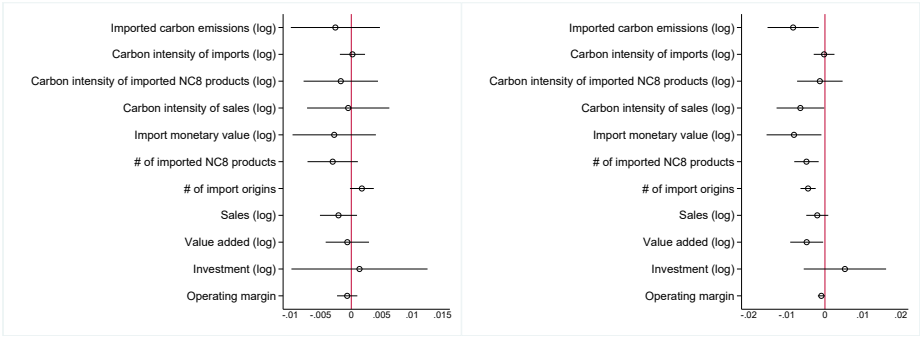
Figures (8)- (11) illustrate average DiD results for split panels based on whether a firm lies above or below the median pre-reform value of various financial constraint measures. These include cash flow, age, sales growth, and growth in the debt ratio. From the sample of 418 bond-issuing firms, Equation (5) is estimated for the different sub-samples of 209 firms that fall on either side of the median for each financial constraint measure.

Cash flow, defined as operating income before depreciation over total assets, is an indicator of how efficiently a firm generates cash from its assets, reflecting its operational efficiency and capacity to generate internal funds (Fazzari, Hubbard and Pe-

[9]Hence the difference between Equation (7) and Equation (2) is the inclusion of miscellaneous financial debt in the former, whereas the latter only includes bond debt in the numerator.

tersen, 1987). Firms are regarded as more financially constrained when this measure falls below the median cash flow to assets ratio. Cash flow here is measured at the group level as cash can be easily moved around to fund the various operations of a corporate group.

Figure 8: Average DiD effects of investor carbon disclosure requirements (Art. 173): by cash flow constraint

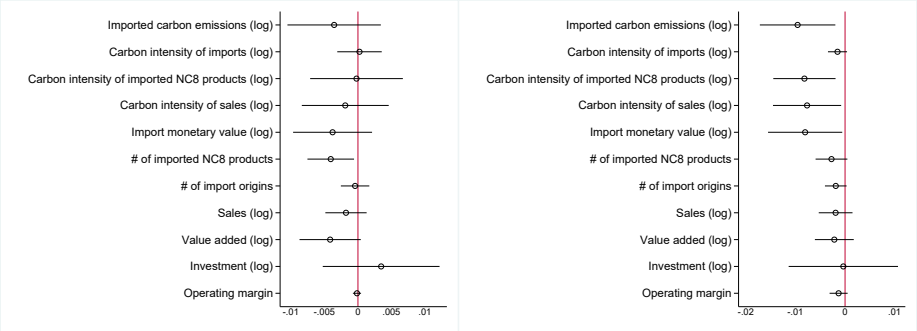


(a) Less financially constrained (b) More financially constrained

Note: Figure (8) presents the average DiD results based on Equation (5) and the exposure measure detailed in Equation (2). Cash flow is defined as operating income before depreciation over total assets. Firms are identified as financially constrained when their cash flow measure falls below the median pre-reform value of the sample. The sample includes 418 bond-issuing firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Firm age is a proxy for a firm's established reputation, reliability, and credit relationships, aspects typically associated with a longer operational history. Compared to younger firms, older firms are generally better resourced in terms of collateral and assets (Coad et al., 2018). As age may also represent a firm's priority in resource allocation within a corporate group, this measure is left at the firm level.

Figure 9: Average DiD effects of investor carbon disclosure requirements (Art. 173): by firm age constraint

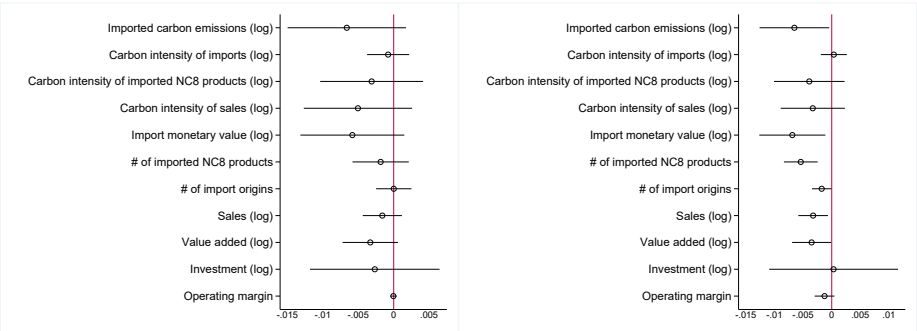


(a) Less financially constrained (b) More financially constrained

Note: Figure (8) presents the average DiD results based on Equation (5) and the exposure measure detailed in Equation (2). Firms are identified as financially constrained when their year of creation falls above the median pre-reform value of the sample (younger firms). The sample includes 418 bond-issuing firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Similarly, firm-specific sales growth, measured as the pre-reform percentage change in sales from 2012 to 2015, is a dynamic indicator of a firm's prospects. This measure is at the firm level as firms with poor or negative sales growth will have difficulty generating internal funds and likely a lower prioritization of resource allocation from any corporate group it may belong to.

Figure 10: Average DiD effects of investor carbon disclosure requirements (Art. 173): by sales growth constraint

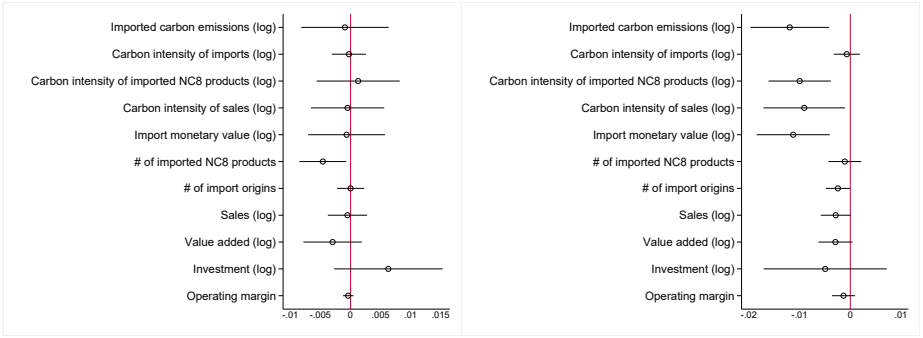


(a) Less financially constrained (b) More financially constrained

Note: Figure (10) presents the average DiD results based on Equation (5) and exposure measure detailed in Equation (2). Firms are identified as financially constrained when their growth in sales falls below the median pre-reform value of the sample. The sample includes 418 bond-issuing firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Finally, the debt ratio, defined as total debt over total assets, is used to gauge a firm's financial leverage, offering insights into its capital structure and reliance on debt financing (Hovakimian, Opler and Titman, 2001). While a higher debt ratio may owe to an optimal alignment within a firm without necessarily indicating that it is over-leveraged, securing additional debt to fund firm operations would become more difficult if a major alternative to equity financing is threatened, especially if there had been recent growth in the debt ratio that constrains future growth. Thus, we interpret corporate groups whose pre-reform growth rate in their debt ratio is above the median growth rate, those that are most increasingly leveraged, as more financially constrained at the onset of Art. 173.

Figure 11: Average DiD effects of investor carbon disclosure requirements: by debt ratio constraint



(a) Less financially constrained (b) More financially constrained

Note: Figure (11) presents the average DiD results based on Equation (5) and exposure measure detailed in Equation (2). Firms are identified as financially constrained when their pre-reform growth rate in their debt ratio is above the median pre-reform value of the sample. The sample includes 418 bond-issuing firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Overall, results from Table (1) appear to be largely driven by the more financially constrained bond issuers. For all measures of financial constraint, exposure to the carbon disclosure requirements is associated with statistically significant reductions in both imported carbon emissions and import values among the most financially constrained firms. Findings suggest that firms whose capital structure was more reliant on bond debt in the pre-reform period were left most vulnerable to induced constraint on this key source of their external financing post-reform. Conversely, the relatively less financially constrained firms show less response to the regulation. These findings echo Bartram, Hou and Kim, 2022, who found that unconstrained firms did not respond to California's cap-and-trade program. In particular, less constrained firms, as defined by cash flow and sales growth, exhibit no statistically significant associations (at the 5% level) between exposure to the regulation and any of the outcome variables. This presents a significant challenge for regulators aiming to push for reductions in the carbon footprint of firms that are not financially constrained.

6 Discussion and concluding remarks

This paper empirically investigates the effects of the introduction of Article 173 of the 2015 Energy Transition for Green Growth (LTECV) Act on French firm-level manufacturing outcomes, with a particular focus on carbon trade dynamics. The carbon disclosure regulation notably requires institutional investors (i.e. the insurance industry and pension funds) and asset managers to publicly disclose the carbon footprint of their portfolios, as well as their exposure to climate risks and on their mitigation strategies. Exposure to the policy is measured as the intensity of bond debt relative to total corporate liabilities, based on the assumption that firms with relatively higher levels of bond debt are more accountable to investors, subject to Art. 173, that buy their bonds. Moreover, exposure to the carbon disclosure regulation should have a constraining effect on firm behavior, as borrowers dependent on the continued funding of their operations and growth are compelled to prioritize environmental sustainability in order to maintain investor confidence and secure ongoing financial support, aligning their business strategies with evolving environmental standards and investor preferences. As a result, firms subject to the financial constraints imposed by the regulation are compelled to adjust their importing activities and associated carbon footprint, as lenders increase their scrutiny of carbon-intensive activities that pose a risk to their portfolios and investments.

Exploiting both a pooled and an event study differences-in-differences approach, results uncover evidence that exposure to the regulation is associated with a cut in imported carbon. A 10 percentage point increase in exposure is associated with a statistically significant 5.84% drop in firm-level imported carbon emissions following the introduction of the investor carbon disclosure requirements. The focus on imported carbon emissions and international trade dynamics is warranted in this paper since emissions associated with imports represent half of the French national carbon footprint. Hence reaching national environmental objectives requires reducing carbon imports in France.

Nevertheless, exposure to the regulation is also associated with decreases in firm size and in trade activity, without a significant change in the carbon intensity of imports. As most French imports already originate from relatively clean Western European sources, manufacturing importers may struggle to find less carbon-intensive origins for imported goods. Such efforts may have a chance of success with complementary public policies that encourage the re-shoring of imported intermediates, thereby eliminating transport-related emissions and benefiting from a relatively low-carbon energy sector in France. Moreover, findings do not uncover evidence of a drop in carbon emissions directly emitted for production purposes, suggesting that the lower carbon footprint is entirely driven by the change in imported emissions. At the sector level, the most exposed firms in the manufacturing of fabricated metals and motor vehicles experience the most significant relative drops in imported carbon. Note that the EU CBAM mandates EU importers, notably in the metals industry, to pay a price on the carbon embedded in imported products. The sector-specific results shows that the drop in carbon emissions across value chains are particularly driven by two manufacturing sectors either directly (fabricated metals) and indirectly (automobiles, due to the inclusion of raw materials), targeted by the EU CBAM. Such results shed some light on the linkages between importing activities and public policies that aim to constrain polluting activities.

Reductions in the carbon embodied in imports come at the expense of economic performance and competitiveness among exposed firms. Findings indicate that these effects are largely driven by the more financially constrained firms exposed to the carbon disclosure requirement. Increasing investor scrutiny on firms within their portfolios may constrain their continued access to external financing and the conduct of their daily business activities. Findings more generally highlight the role of lenders in promoting change in borrowing firms through financial pressures, particularly with regards to ESG performance. Financial constraints can also directly affect environmental outcomes and undermine national low-carbon energy transition objectives with unintended consequences. The lack of response from the relatively less financially constrained firms, combined with the competitiveness costs borne by constrained firms, presents a key challenge for regulators moving forward.

Sustainable finance generates long-term and resilient value creation, requiring policies that address long-term financial risks associated with climate change and increasingly stringent carbon regulations. Article 173 was novel policy-making at the time: France was the first country to mandate such granular information from investors (French Ministry of the Environment, 2019b). This paper uncovers evidence of shifts in behavior among the most exposed French manufacturers, highlighting how environmental policy that leverages corporate finance to correct for information asymmetries can influence lenders in pressuring borrowers, particularly the most financially constrained, within their portfolios to align with national mitigation objectives. Notwithstanding the above, this paper sheds light on the costs borne by the most financially constrained firms exposed to the policy. The results underscore important policy considerations, highlighting that while such transparency regulations have the potential to drive reductions in carbon emissions, they must be carefully designed to balance environmental objectives with the financial realities faced by firms. More comprehensive strategies and support are required to foster significant improvements in the carbon footprint of supply chains without inadvertently hindering the competitiveness of domestic manufacturers in a global marketplace.

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A Descriptive statistics

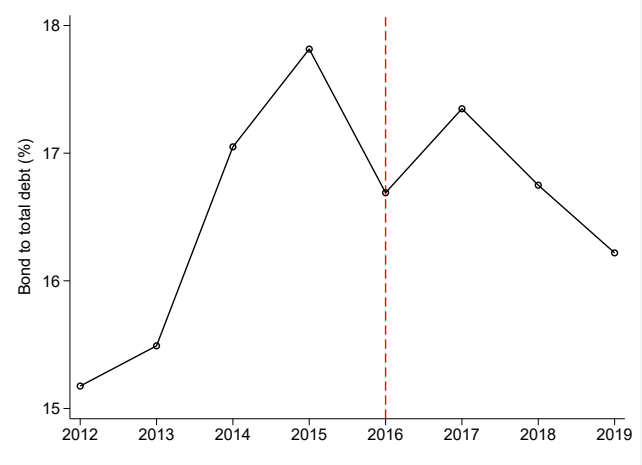
Table A1: Summary statistics by exposure to carbon mandate

	Relatively low exposure		Relatively high exposure	
	Mean	Std. Dev.	Mean	Std. Dev.
Carbon imports (‘1 000, tCO2)	4	7	5	11
Import value (’1 000 000, €)	9	16	10	20
Import weight (’1 000 000, kilograms)	6	15	6	23
Total trade value (’1 000 000, €)	23	41	25	49
Carbon imports from Western Europe over total carbon imports (%)	84	25	82	25
Carbon imports from top 25% polluting countries over total carbon imports (%)	4	15	2	9
Total debt (’1 000 000, €)	27	34	36	68
Bank debt over total debt (%)	13	17	9	15
Non-bank financial debt over total debt (%)	14	18	13	21
Bond debt over total debt (%)	1	2	0	3
Total debt (corporate group-level, ’100 000 000, €)	288	2 064	286	1 019
Bank debt over total debt (corporate group-level, %)	23	14	19	15
Non-bank financial debt over total debt (corporate group-level, %)	28	16	49	18
Bond debt over total debt (corporate group-level, %)	4	4	26	15
Total debt over equity	2	8	3	10
Net assets (’1 000 000, €)	47	62	67	122
Net operating income (’1 000 000, €)	3	8	6	19
Operating costs (’1 000 000, €)	86	132	79	120
Sales (’1 000 000, €)	87	133	81	125
Value-added (’1 000 000, €)	19	26	24	40
Employment (#)	235	315	240	323
Gross operating surplus over value-added	.2	.4	.3	.3
French head of corporate group (%)	91	-	91	-
Never change corporate groups (%)	63	-	53	-

Industry sector composition (Freq., %)			
Relatively low exposure		Relatively high exposure	
Food	35	Food	11
Fabricated metals	9	Fabricated metals	11
Chemicals	8	Rubber and plastics	10
Rubber and plastics	6	Chemicals	10
Motors	6	Electrical equipment	8
Computer, electronic and optical	5	Machinery and equipment n.e.c.	7
Electrical equipment	5	Other non-metallic minerals	7
Basic metals	5	Other manufacturing	5
Machinery and equipment n.e.c.	5	Computer, electronic and optical	5
All other manufacturing sectors	17	All other manufacturing sectors	26

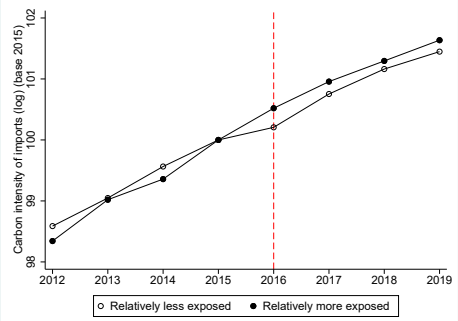
Note: Values are rounded to the nearest integer, with the exception of gross operating surplus over value-added. Values are for year 2012, the first year of the panel. Exposure status is based on Equation (3). The sample includes bond issuers (firms that hold a non-null amount of bond debt) across all years): 418 firms per year. Imported carbon emissions are expressed in tons of carbon emissions. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. Net operating income refers to gross operating revenues minus operating costs. Net assets refer to the difference between total assets and total liabilities. Employment is measured in full-time equivalents. Gross operating surplus (or *Excédent Brut d'Exploitation*, EBE) refers to value-added including operating grants and minus labor costs. Corporate group levels of debt refers to the aggregate debt of an entire corporate group, i.e. a headquarter firm and its subsidiaries.

Figure A1: Evolution of the bond intensity of total debt

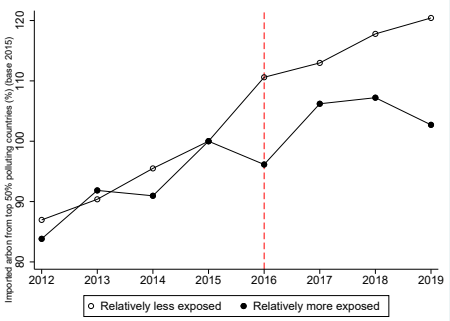


Note: Figure (A1)illustrates the evolution of the contemporaneous values of Equation (2), i.e., the bond intensity of total debt (%) for each year of the panel. The sample includes bond issuers (firms that hold a non-null amount of bond debt) across all years.

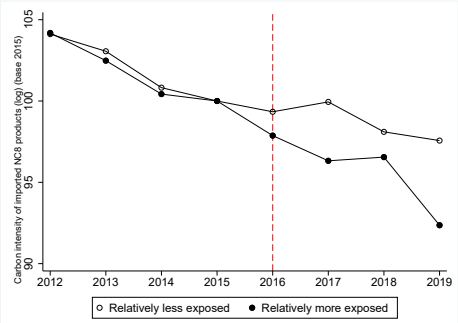
Figure A2: Parallel trends - additional trade and economic performance indicators



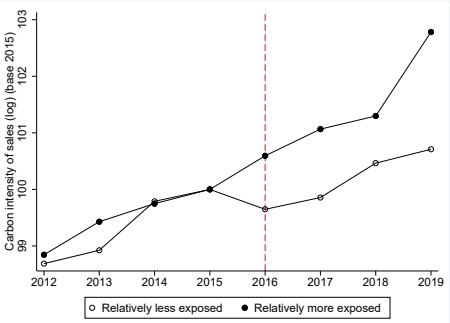
(a) Carbon intensity of imports



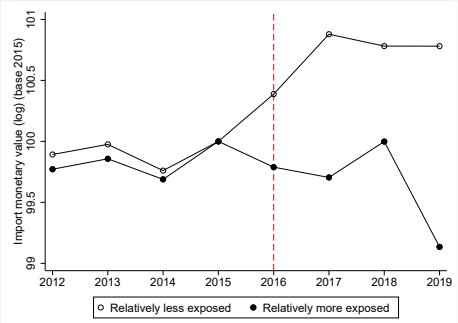
(b) Imported carbon from top 50%



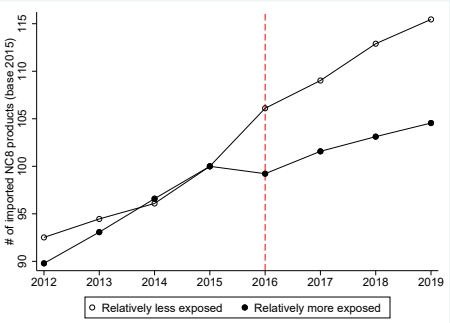
(c) Carbon intensity of NC8 products



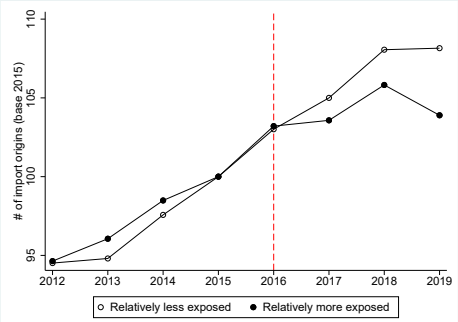
(d) Carbon intensity of sales



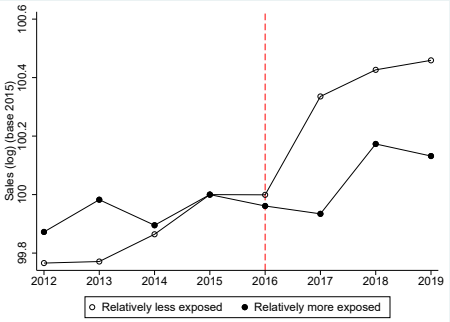
(e) Import value



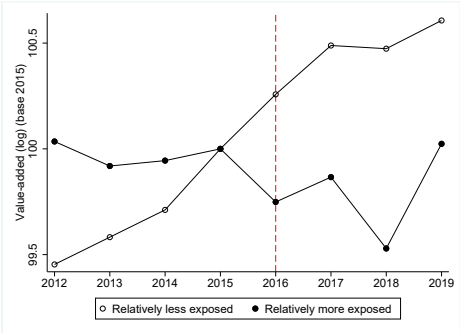
(f) # imported NC8 products



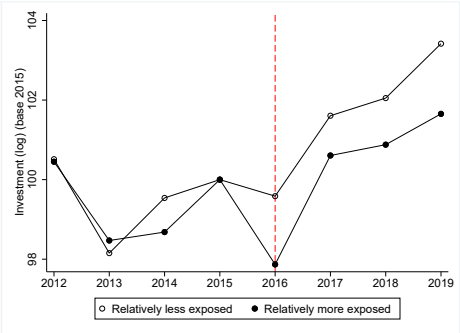
(g) # import origins



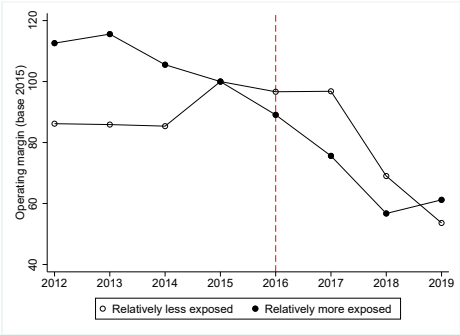
(h) Sales



(i) Value-added



(j) Investment

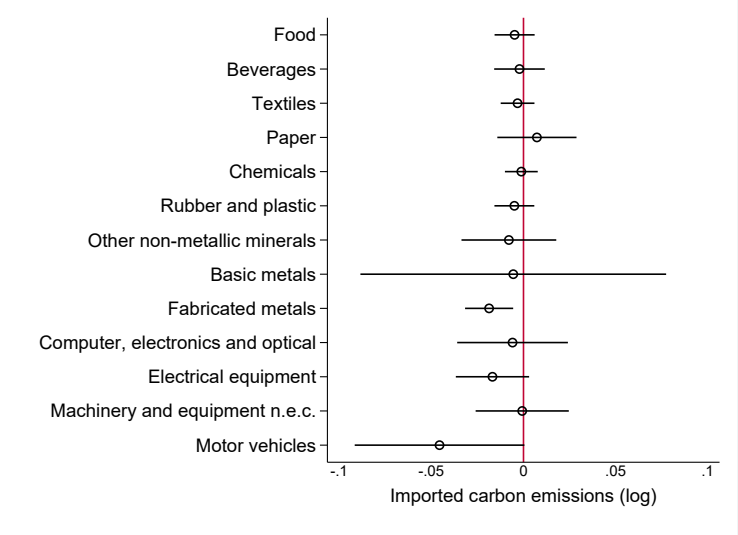


(k) Operating margin

Note: Figure (A2) illustrates the evolution of various trade and economic performance indicators among relatively high exposed and low exposed firms, as identified in Equation (3). Exposure is estimated in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt) across all years. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Average trends are indexed to year 2015.

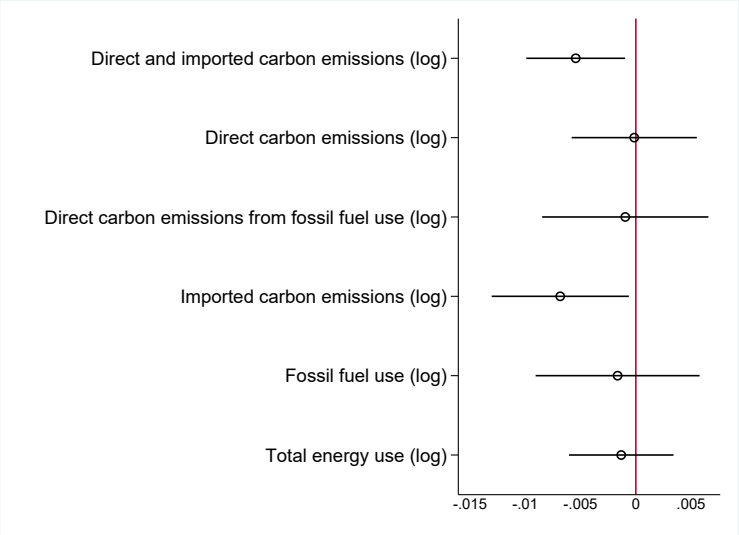
B Results

Figure B1: Average DiD effects of investor carbon disclosure requirement (Art. 173) on firm-level imported carbon emissions across sectors



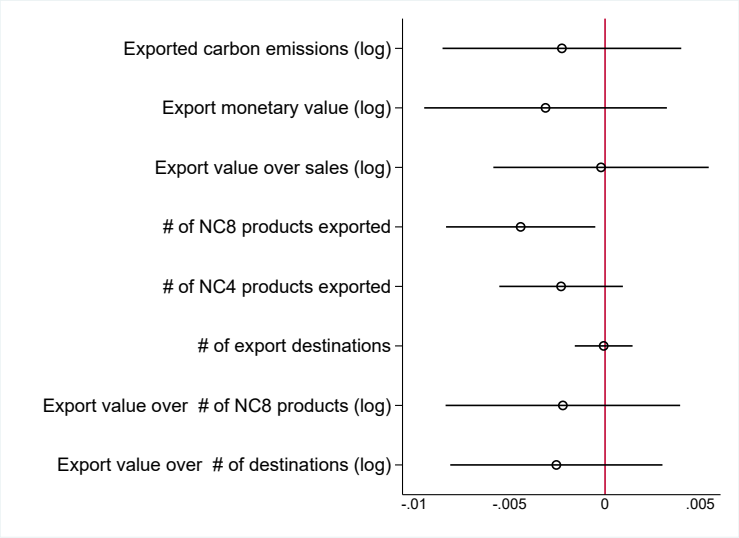
Note: Figure (B1) presents average DiD results based on a modified version of Equation (5), where β is additionally interacted with a dummy variable equalling one for each manufacturing in the sample, null otherwise. Exposure is defined in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). Standard errors are clustered at the firm level. Confidence intervals are set at the 5% level.

Figure B2: Average DiD effects of investor carbon disclosure requirements (Art. 173) on firm-level domestic energy use indicators



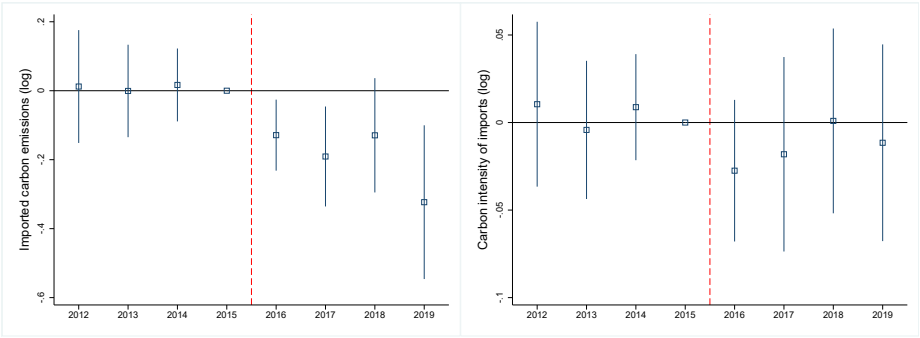
Note: Figure (B2) presents the average DiD results based on Equation (5) on various energy use indicators. Exposure is detailed in Equation (2).
Firm-level direct and imported carbon emissions is the sum of imported carbon emissions (Equation 1), and total direct emissions. To calculate tons of direct emissions, emissions factors from Ademe (2021) are applied to the fossil fuels (natural gas, other gases, coal, lignite, coal coke, petroleum coke, butane propane, heavy fuel, and domestic fuel) and electricity consumed at the firm level, according to their respective CO2 equivalents per unit.
The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). The balanced panel of only bond issuers drops from 418 to 150 firms per year after merging with the Eacei dataset (see section 3). Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B3: Average DiD effects of investor carbon disclosure requirement (Art. 173) on export activities



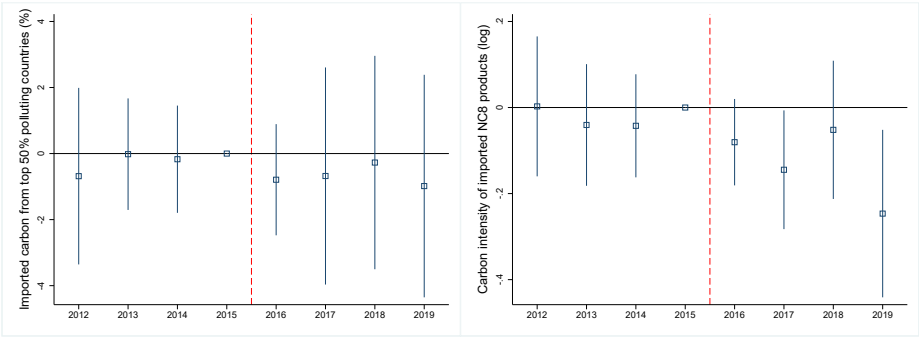
Note: Figure (B3) presents average DiD results based on Equation (5) on various exporting activity indicators. Exposure is detailed in Equation (2). In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years) that also export a non-null amount each year. The final balanced panel includes 283 bond issuing exporter firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B4: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on imported carbon and other firm-level trade and economic performance indicators (bond to total debt dummy)



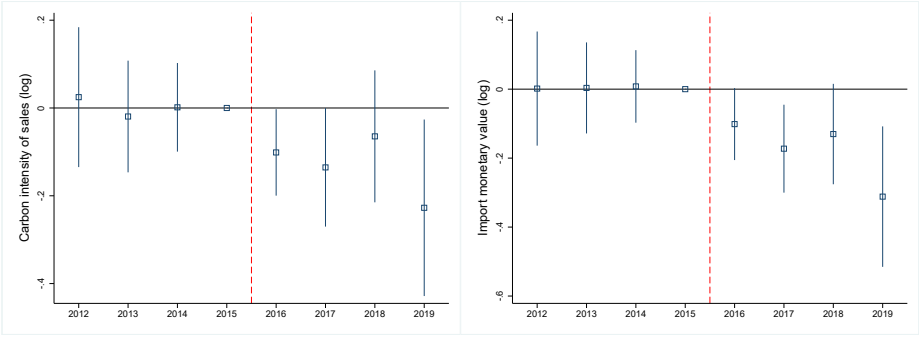
(a) Imported carbon emissions (log)

(b) Carbon intensity of imports (log)



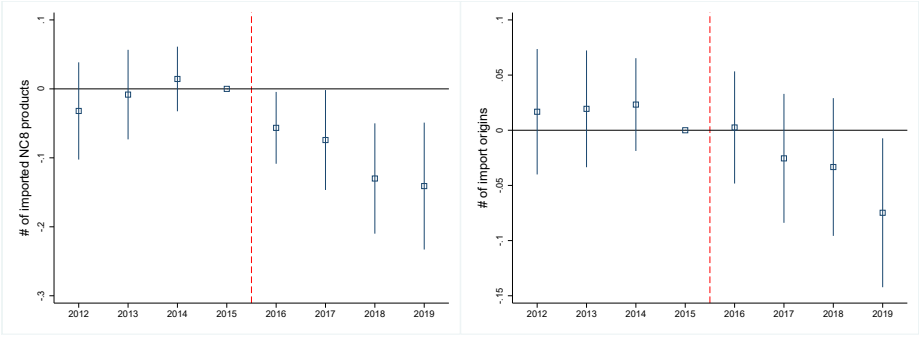
(c) Imported carbon from top 50% (%)

(d) Carbon intensity of NC8 products (log)



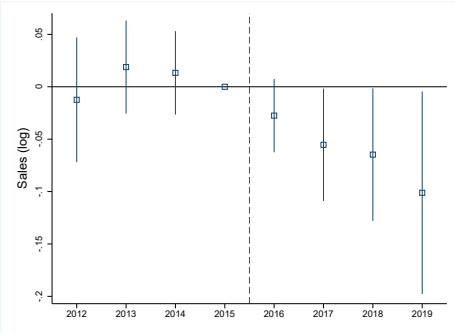
(e) Carbon intensity of sales (log)

(f) Import value (log)

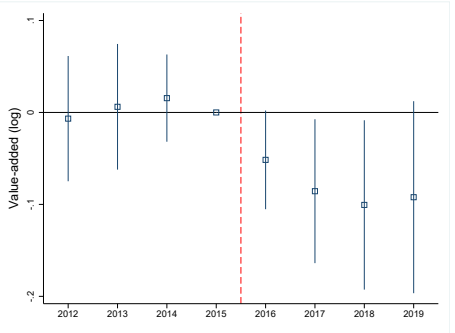


(g) # imported NC8 products

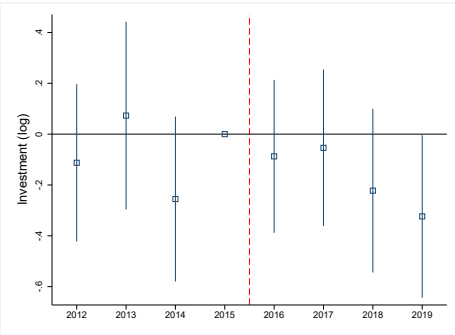
(h) # import origins



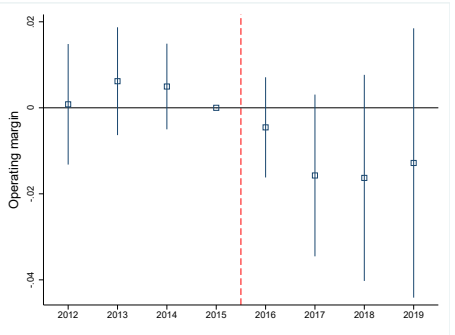
(i) Sales (log)



(j) Value-added (log)



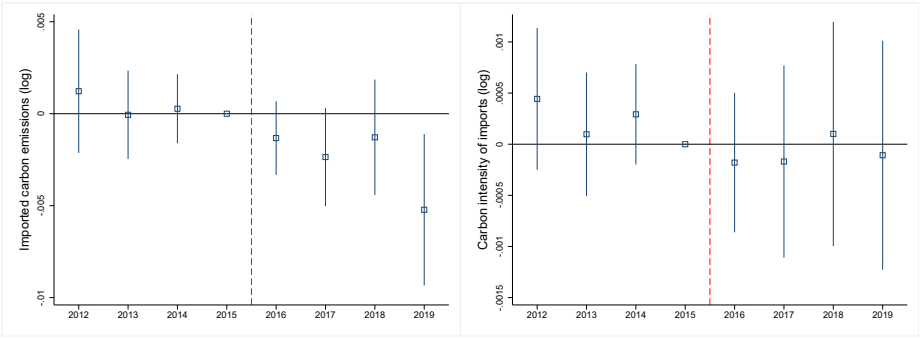
(k) Investment (log)



(l) Operating margin

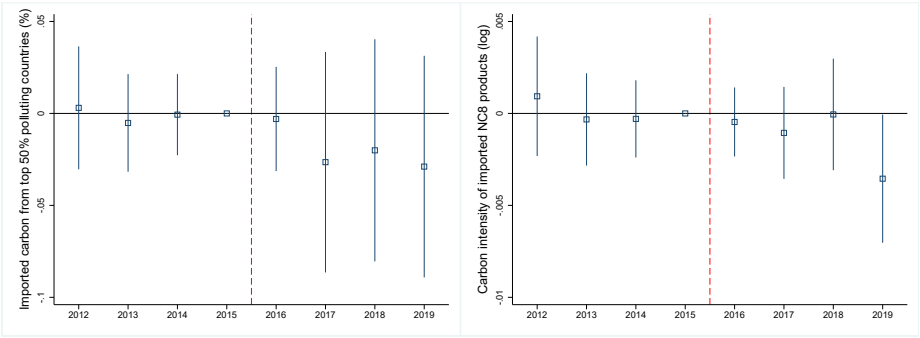
Note: Figure (B4) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (3). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B5: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on imported carbon and other firm-level trade and economic performance indicators (bond to bank debt %)



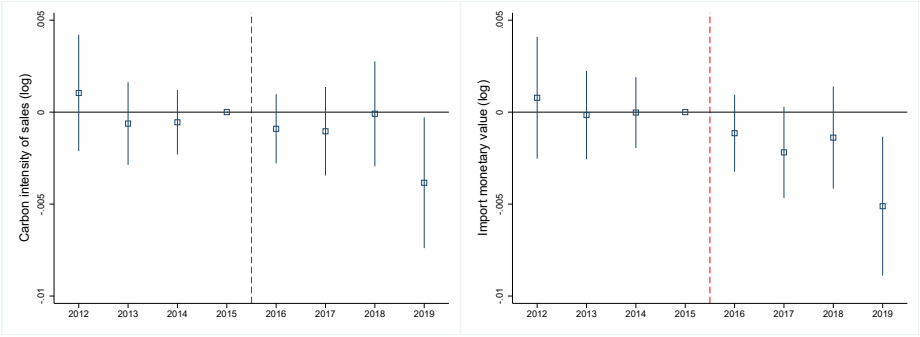
(a) Imported carbon emissions (log)

(b) Carbon intensity of imports (log)



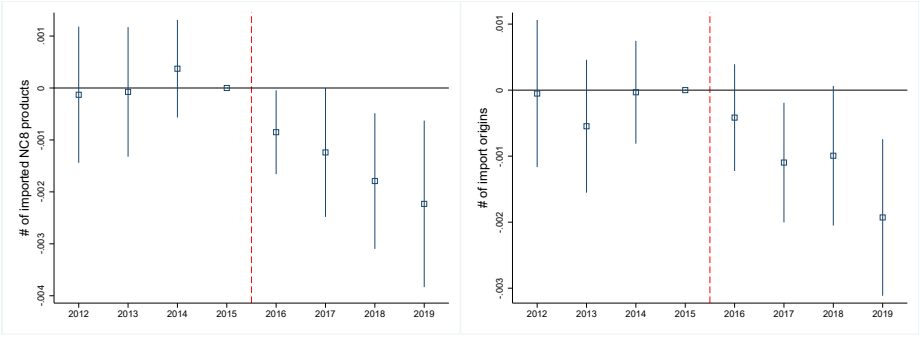
(c) Imported carbon from top 50% (%)

(d) Carbon intensity of NC8 products (log)



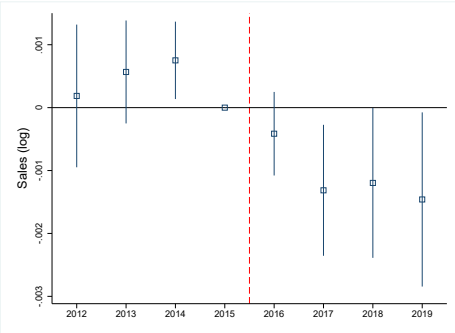
(e) Carbon intensity of sales (log)

(f) Import value (log)

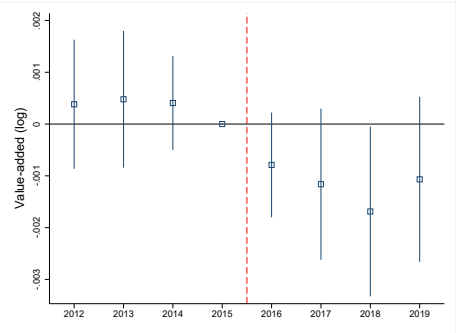


(g) # imported NC8 products

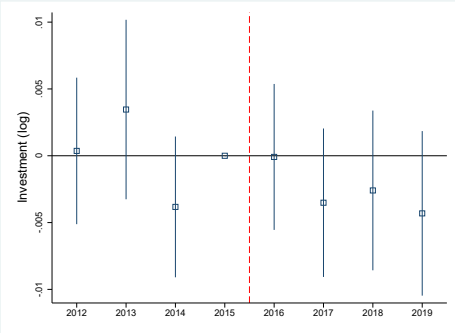
(h) # import origins



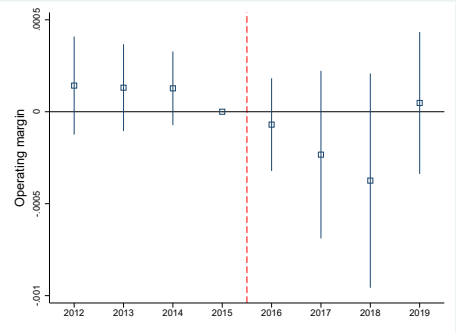
(i) Sales (log)



(j) Value-added (log)



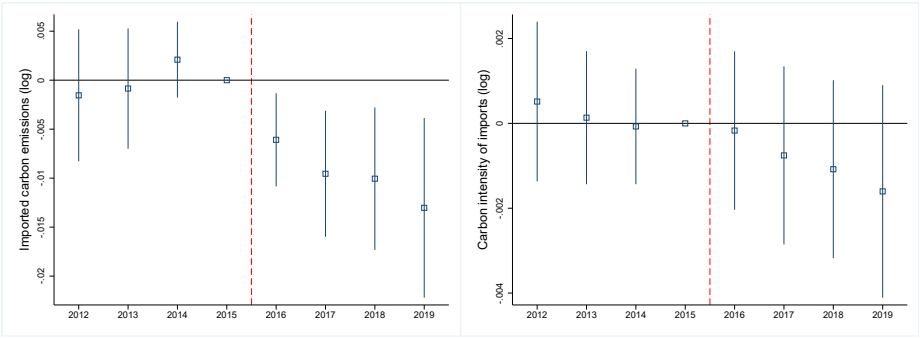
(k) Investment (log)



(l) Operating margin

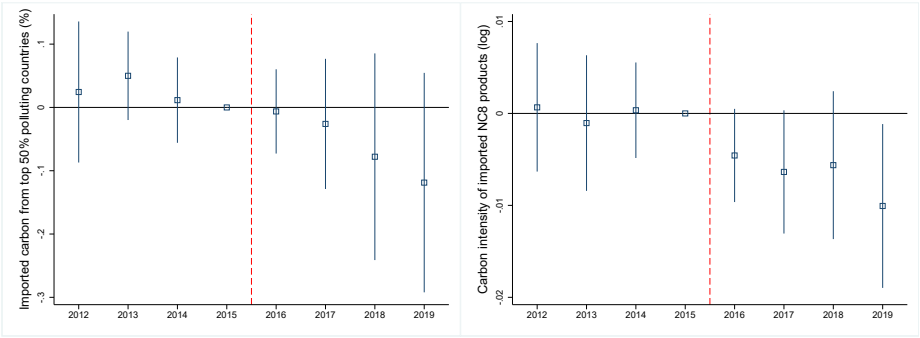
Note: Figure (B5) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (6). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years). In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B6: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on imported carbon and other firm-level trade and economic performance indicators (no corporate restructuring)



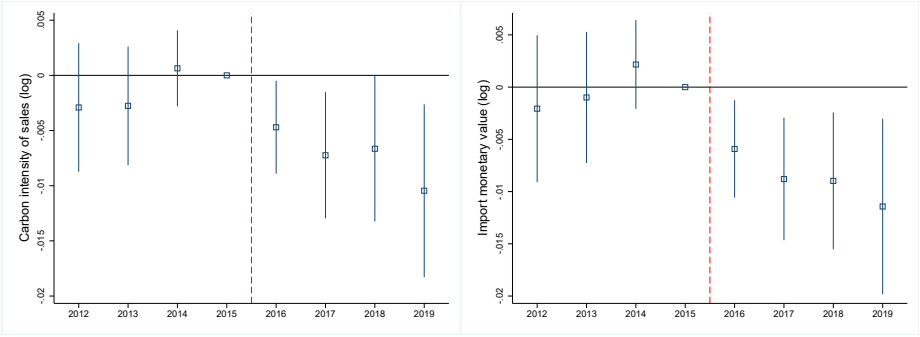
(a) Imported carbon emissions (log)

(b) Carbon intensity of imports (log)



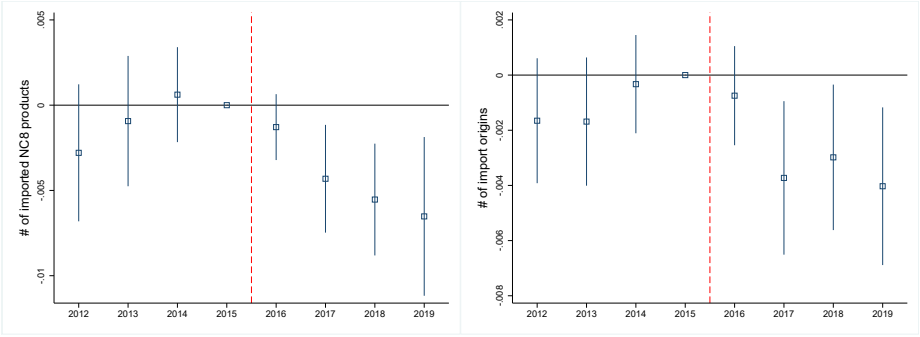
(c) Imported carbon from top 50% (%)

(d) Carbon intensity of NC8 products (log)



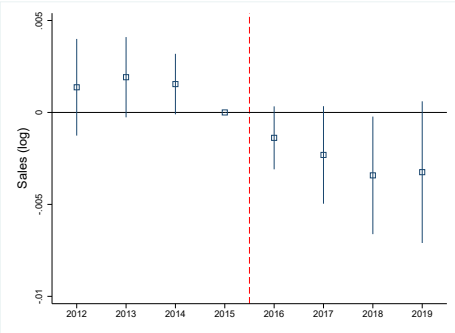
(e) Carbon intensity of sales (log)

(f) Import value (log)

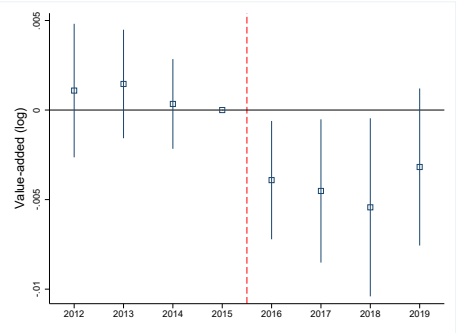


(g) # imported NC8 products

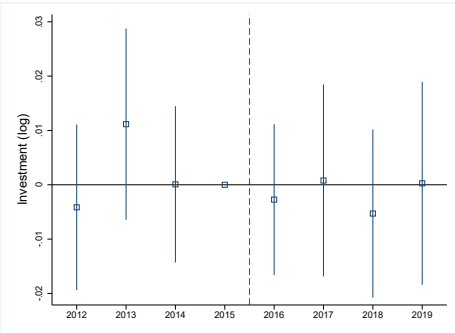
(h) # import origins



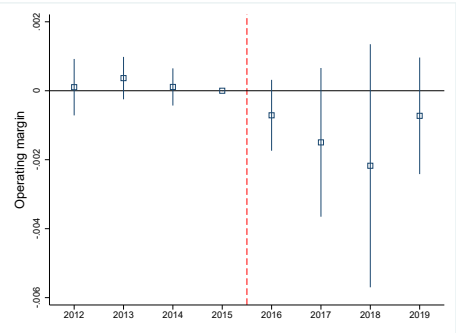
(i) Sales (log)



(j) Value-added (log)



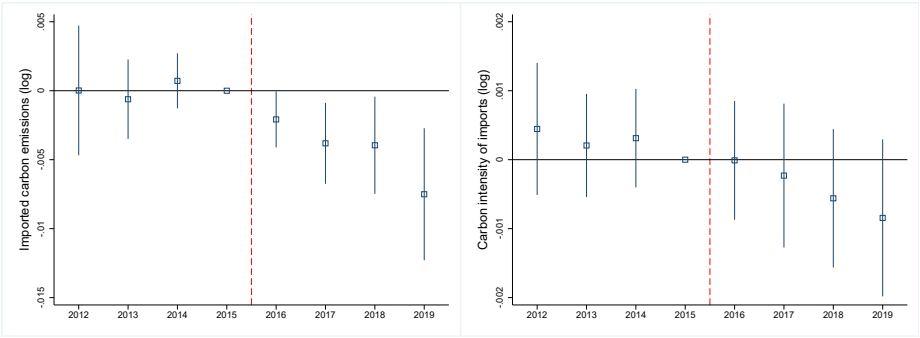
(k) Investment (log)



(l) Operating margin

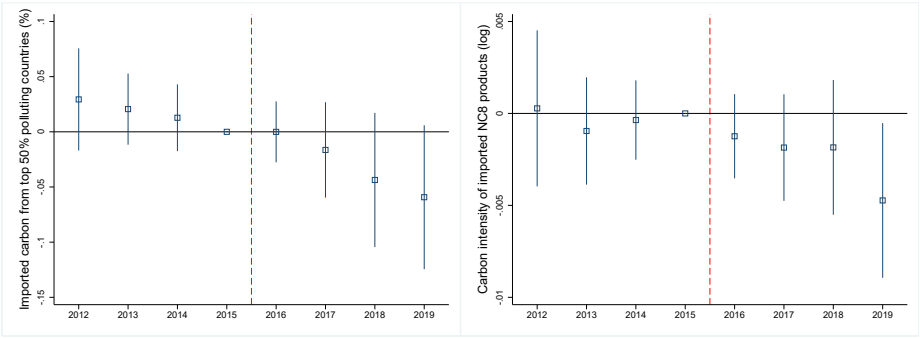
Note: Figure (B6) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (2). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years) that never undergo corporate restructuring or changes in ownership throughout the panel. In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B7: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on imported carbon and other firm-level trade and economic performance indicators (no corporate restructuring, bond to bank debt %)



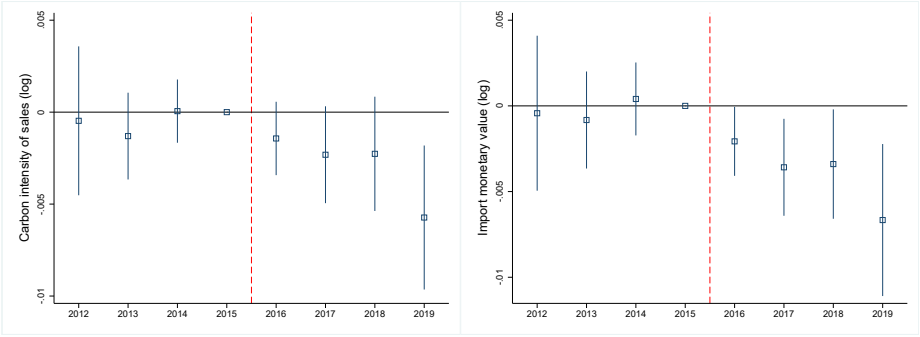
(a) Imported carbon emissions (log)

(b) Carbon intensity of imports (log)



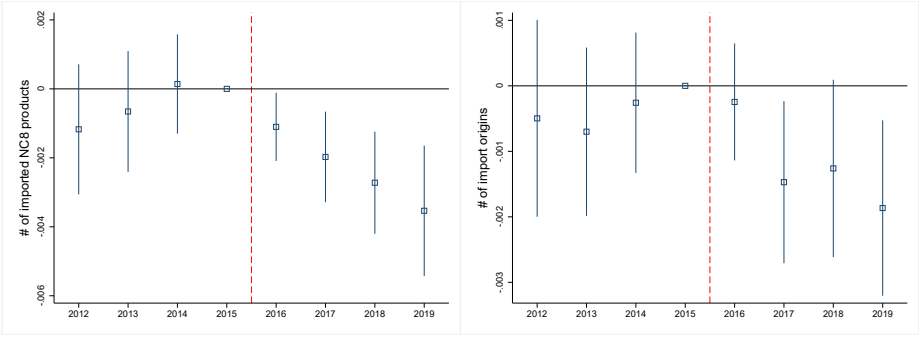
(c) Imported carbon from top 50% (%)

(d) Carbon intensity of NC8 products (log)



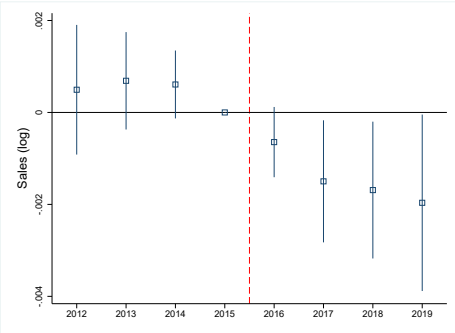
(e) Carbon intensity of sales (log)

(f) Import value (log)

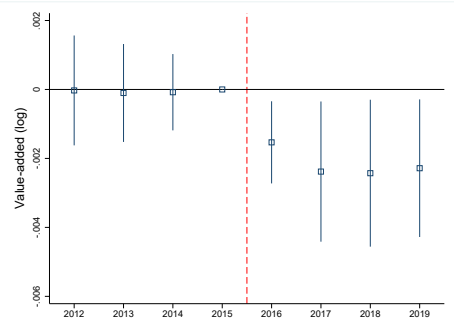


(g) # imported NC8 products

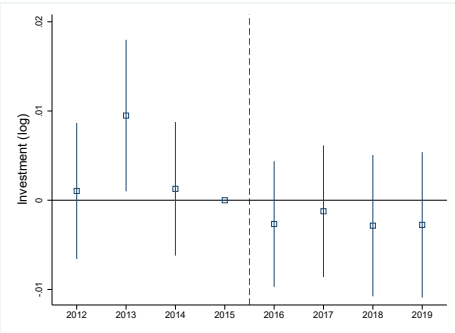
(h) # import origins



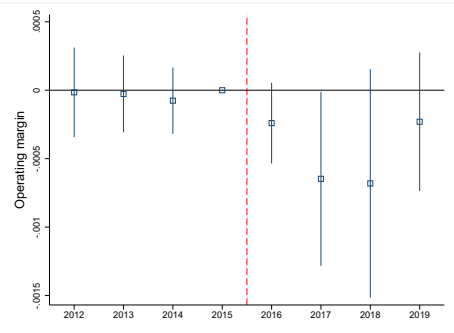
(i) Sales (log)



(j) Value-added (log)



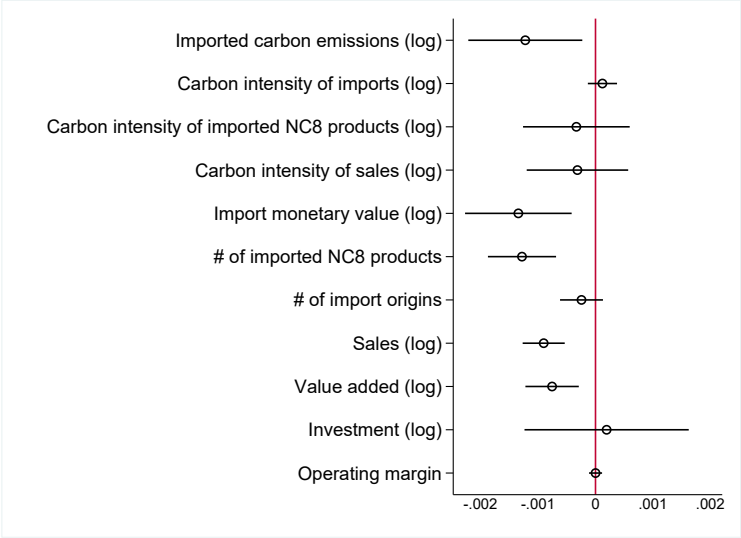
(k) Investment (log)



(l) Operating margin

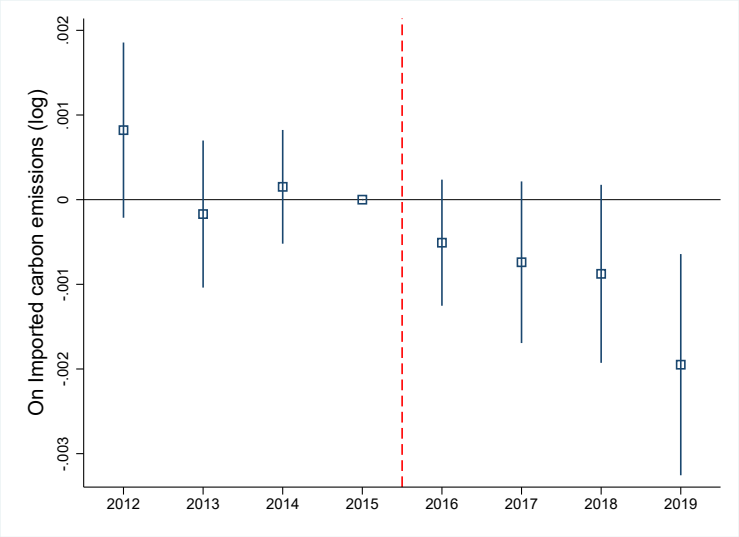
Note: Figure (B7) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (6). The sample includes bond issuers (firms that hold a non-null amount of bond debt across all years) that never undergo corporate restructuring or changes in ownership throughout the panel. In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The carbon intensity of imports refer to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refer to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refer to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B8: Average DiD effects of investor carbon disclosure requirements (Art. 173) (bond and non-bond issuers, non-bank to total debt exposure)



Note: Figure (B8) presents average DiD results based on Equation (5). The exposure measure is detailed in Equation (7). The sample of firms includes both bond issuers and non-bond issuers, amounting to 5 682 firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

Figure B9: Event study DiD effects of investor carbon disclosure requirements (Art. 173) on firm-level imported carbon emissions (bond and non-bond issuers, non-bank to total debt exposure)



Note: Figure (B9) presents the event study dynamic year-by-year DiD results based on Equation (4). Exposure is defined in Equation (7). The sample of firms includes both bond issuers and non-bond issuers, amounting to 5 682 firms per year. Standard errors are clustered at the firm-level. Confidence intervals are set at the 5% level.

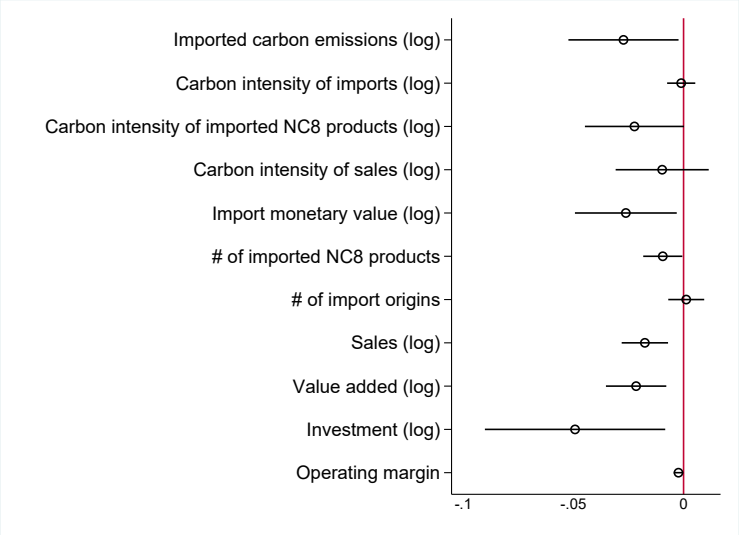


Figure B10: Average DiD effects of exposure to investor carbon disclosure requirements (Art. 173) [exposure: bond debt over total assets]

Note: Figure (B10) presents average effects based on Equation (5). Exposure is defined as below:

$$\text{Bond debt to total assets (log)}_{i,\text{ pre}} \equiv \frac{1}{4}\sum_{t=2012}^{2015}\left[\log\frac{\text{group bond debt}}{\text{group total assets}}\right]_{i,t}$$

The carbon intensity of imports refers to the ratio of imported carbon emissions over import value. Polluting country rankings are determined by the ratio of total carbon imports over total import value across all firms for each country. The carbon intensity of NC8 imported products refers to the ratio of imported carbon emissions over the number of NC8 products. The carbon intensity of sales refers to the ratio of imported carbon emissions over sales. Investment refers to tangible and intangible investments, including revaluation and contributions and net of disposals. Operating margin refers to the ratio of net operating income over sales. In lieu of the linear regression, a Poisson regression applies when the outcome is a count (#) variable. The sample includes 418 firms that issue bonds (at the corporate level) every year. Standard errors are clustered at the firm level. Confidence intervals are set at the 5% level.

C Methodology in construction of main outcome of interest

The calculation of imported carbon emissions for each firm i in year t follows Dussaux, Vona and Dechezlepretre (2023):

$$ImpE_{it} = \sum_{g} \sum_{j} M_{ijt,g\in k} EI_{jt,g\in k} \tag{8}$$

where $EI_{jt}, g \in k$ is the total emissions intensity of product g of sector k in sourcing country j and $M_{ijt,g\in k}$ is the deflated value of imports of firm i of products g in sector k from sourcing country j.[10] Simply put, the equation calculates the total carbon emissions that firms import from other countries. It multiplies the emissions intensity of products from different sourcing countries by the value of imports for each product and then sums up these products across all sourcing countries and products. Data for $EI_{jt}, g \in k$ comes from the OECD's Carbon Dioxide Emissions Embodied in International Trade (2021 ed.) dataset, using the same emission intensity for all products g in sector k. See Section C for further information on the applied methodology used to construct imported carbon emissions.

Neglecting to deflate import values would imply a strong assumption regarding the substitutability of products within a country-sector, as CO2 intensities are only available at the country-sector level. Consequently, all products in the chemical sector imported to France from, for instance, China would be presumed to be substitutable and possess identical CO2 intensity per their value. To circumvent this assumption, import values are deflated at the product level.

Following Dussaux, Vona and Dechezlepretre (2023), who themselves employ the methodology found in Gaulier et al. (2008), the paper constructs a Tornqvist price index. This index serves as an exact price index for a general trans-log production function. The Tornqvist price index is defined as $T_{kt} = \sqrt{L_{kt} P_{kt}}$, where $L_{kt} = \prod_{g\in k}(p_{gt}/p_{g0})^{w_{gk0}}$ is the geometric Lasperyres price index and $P_{kt} = \prod_{g\in k}(p_{gt}/p_{g0})^{w_{gst}}$ is the Paasche price index. p_{gt} is the price of imported product g in year t and w_{gkt} is the share of imports of product g in total imports of sector k.

Import prices are computed as $p_{gt} = \sum_{ij} M_{ijgt} / \sum_{ij} Q_{ijgt}$, where M_{ijgt} is the import value and Q_{ijgt} is the net weight in kilograms. Net weight in kilograms is used as quantity for consistency. Following Gaulier et al. (2008), unrealistic data points where the year-on-year variation in the unit value $p_{ijgt} = M_{ijgt}/Q_{ijgt}$ exceeds 5 times the median variation for product g in time t are initially filtered out. This approach is taken to address outliers that can be common when working with unit values by net weight while retaining a maximal number of observations.

Imported carbon emissions for each firm are calculated using the French customs data spanning from 2012 to 2019, excluding imports from French territories. The analysis centers on manufacturing firms, distinguished by their NAF revision 2 2-digit codes falling within the range of 10 to 33 in the matched administrative data[11]. While some of the largest firms are dropped in the data cleaning process, the aggregate trends

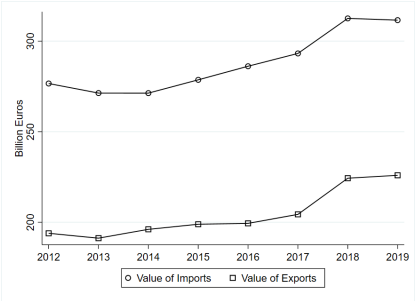
[10] Note that commas are omitted between subscripts in this subsection for clarity.

[11] The total number of these importers dropped slightly from 12,463 in 2012 to 12,359 in 2019. These matched firms represent the bulk of manufacturing shown in the administrative data, with combined total sales rising from 687 billion euros in 2012 to 832 billion euros in 2019. Their imports rose from 112 billion euros in 2012 to 124 billion in 2019 while the CO2 embodied in these imports declined from 59 to 49

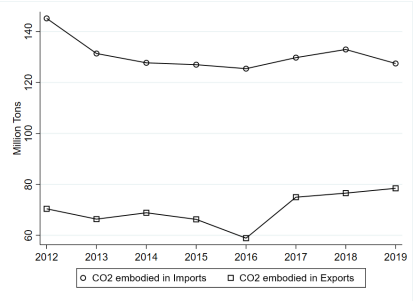
for imports and carbon embodied in imports of the final sample are similar to those of all manufacturing firms in France, as shown in figure (C1). In all years, France was a net importer of CO2 embodied in trade, whether across all firms, all manufacturing firms, or all firms in the balanced sample in focus for this paper.

million tons. The balanced panel of 5 682 firms had a combined total sales of 239 billion euros in 2012 and 270 billion euros in 2019, with imports increasing from 37 billion euros to 42 billion and embodied CO2 decreasing from approximately 19 to 18 million tons.

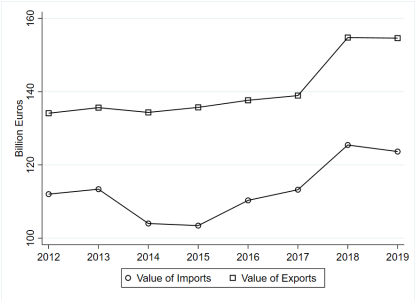
Figure C1: Imports and their Carbon Content



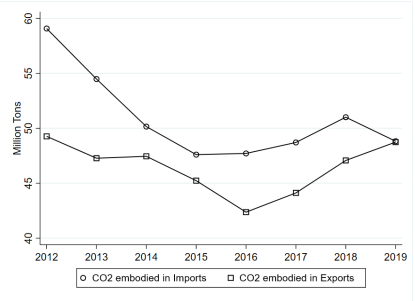
(a) Value of imports, all France



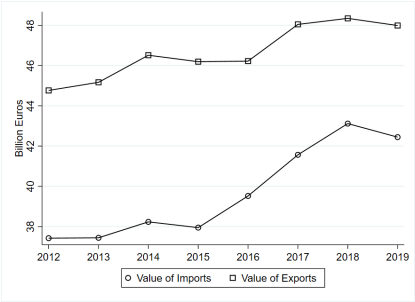
(b) Carbon content, all France



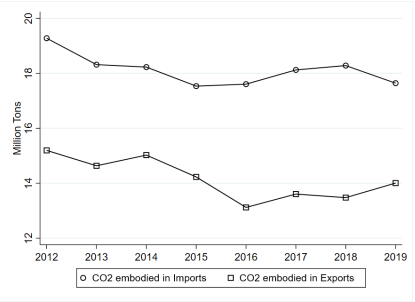
(c) Value of imports, all manufacturers



(d) Carbon content, all manufacturers



(e) Value of imports, sample only



(f) Carbon content, sample only

Note: This figure presents data for imports and the carbon content of imports across three different samples: the total economy, all manufacturing firms, and the balanced panel of 5,682 firms used in this paper.

D Source country heterogeneous effects

Table D1 presents summary statistics for France's top 8 trading partners for the total of all manufacturing firms in 2012, and the aggregate groups of Western Europe and outside of Western Europe. While just 21.5% of manufacturing imports were sourced from outside Western Europe, these imports are twice as carbon-intensive as those from Western Europe, at a carbon intensity of 812 tons of CO2 per million euros worth of imports compared to Western Europe's 440 tons per million euros.

Among France's trade partners in 2012, the largest amount of CO2 embodied in imports came from Germany, at around 38 million tons and an intensity of about 428 tons per million euros worth of imports. The second largest source of CO2 embodied in imports, but coming in only as the 7th largest origin country of French imports, was China at 22 million tons and an intensity of 1 367 tons per euro, about three times the intensity of imports from Germany. Meanwhile, the carbon intensities of other Western European countries are relatively homogeneous, ranging from the low of 428 in Germany to 493 in the Netherlands, and similar homogeneity within industries.

Table D1: Top import partners and CO2, all manufacturing firms

Origin	Imports ('1 000 000 €)	Embodied CO2 ('1 000 tons)	Tons CO2 per 1 000 000 €
Total	345 600	179 700	520
Western Europe	271 400	119 500	440
Not Western Europe	74 180	60 255	812
Germany	89 420	38 239	428
Belgium	39 080	18 132	464
Italy	36 480	15 783	433
Spain	30 880	14 764	478
Netherlands	22 700	11 180	493
Great Britain	22 610	10 988	486
China	16 230	22 134	1 364
Poland	7 930	5 643	793
French Exports	255 100	91 114	357

Note: 2012 values. Western Europe includes two-digit country codes AT, BE, DK, FL, DE, IE, IT, LU, NL, NO, PT, ES, SE, CH, GB.

This dichotomy between Western Europe and the rest of the world warrants investigating whether there may be a shift towards closer-to-home and relatively less carbon-intensive origins in response to. Table D2 shows regression results for explaining imported carbon emissions and import value when isolating import origins at the firm level and largely suggests that dynamics in Western Europe are responsible for the statistical significance found in Table (1. A 10 pp increase in exposure in columns (1) is associated with a statistically significant 6.26% decrease in imported carbon emissions from Western Europe. Note that this result is rather close in magnitude to the result found in column (1) of Table (1): a 10 pp increase in exposure is associated with a 5.84% decrease in total imported carbon. Nevertheless, while columns (1) and (3) show that the continuous exposure variable is not associated with imports or imported carbon from outside of Western Europe, columns (2) and (4) show that there is, and of a relatively high negative magnitude, when utilizing the binary version of exposure.

Table D2: Country Drivers of Impact of Investor Carbon Disclosure Requirement on Manufacturing Firms

Sample:	418 bond issuing firms per year			
Dependent Variable (DV):	Imported carbon (log)		Value of imports (log)	
	(1)	(2)	(3)	(4)
Measure of exposure:	Bond to total debt (%)	Bond to total debt (dummy)	Bond to total debt (%)	Bond to total debt (dummy)
DV isolated for:				
Western Europe	-6.26***	-0.199***	-6.63***	-0.243***
	(0.00230)	*(0.0691)*	*(0.00251)*	*(0.0844)*
Excluding Western Europe	-7.14	-0.458**	-1.82	-1.038***
	(0.00726)	*(0.193)*	*(0.00153)*	*(0.395)*
Germany	-3.52	-0.140	-3.84	-0.201
	(0.00429)	*(0.126)*	*(0.00808)*	*(0.240)*
Excluding Germany	-5.60**	-0.202**	-5.96**	-0.189**
	(0.00277)	*(0.0854)*	*(0.00261)*	*(0.0822)*
Belgium	-4.96	-0.0315	-5.06	0.0584
	(0.00475)	*(0.151)*	*(0.00102)*	*(0.340)*
Excluding Belgium	-5.51**	-0.238***	-6.49**	-0.261***
	(0.00263)	*(0.0787)*	*(0.00318)*	*(0.0890)*
Italy	-7.57*	-0.251*	-20.8**	-0.825***
	(0.00424)	*(0.138)*	*(0.00846)*	*(0.296)*
Excluding Italy	-4.91*	-0.182**	-4.43*	-0.163**
	(0.00255)	*(0.0761)*	*(0.00254)*	*(0.0730)*
Spain	-7.87*	-0.305**	-12.9	-0.472
	(0.00422)	*(0.145)*	*(0.00971)*	*(0.340)*
Excluding Spain	-6.53**	-0.203**	-6.05**	-0.179**
	(0.00275)	*(0.0791)*	*(0.00261)*	*(0.0750)*
Netherlands	-0.046	-0.112	-10.5	-0.312
	(0.00524)	*(0.139)*	*(0.0127)*	*(0.313)*
Excluding Netherlands	-5.38**	-0.167*	-5.15**	-0.150*
	(0.00257)	*(0.0862)*	*(0.00240)*	*(0.0836)*
Great Britain	3.39	-0.0112	-5.75	-0.103
	(0.00432)	*(0.133)*	*(0.00981)*	*(0.306)*
Excluding Great Britain	-5.87**	-0.189**	-5.73**	-0.182**
	(0.00266)	*(0.0783)*	*(0.00244)*	*(0.0723)*
China	-2.04	-0.148	-12.6	0.130
	(0.00442)	*(0.129)*	*(0.0108)*	*(0.299)*
Excluding China	-5.96***	-0.189***	-5.62**	-0.179***
	(0.00228)	*(0.0689)*	*(0.00231)*	*(0.0688)*

Note: All regression results in columns (1) and (3) are multiplied by 1 000 for readability. Table (D2) presents average results from Equation (5). The main outcome variable is the carbon emissions embedded in imports in columns (1) and (2), and the monetary value of imports in columns (3) and (4). Exposure is measured as detailed in Equation (2 for columns (1) and (3) and as detailed in Equation (3) in columns (2) and (4).
Each row isolates the outcome variable for the imported carbon and the value of imports from the specified country or group of countries. For instance, a 10 pp increase in exposure is associated with a 6.26% decrease in imported carbon from exclusively Western Europe, as shown in column (1). Western Europe is defined geographically as those countries from Italy up through Austria, Germany, and Finland and then west to the Atlantic. Standard errors are clustered at the firm level and in parentheses. Statistical significance is marked with * for p-value < 0.10, ** for p-value < 0.05, and *** for p-value < 0.01.

Across all specifications looking at individual import origins, exposure is associated with statistically significant decreases in the metrics for imports from Italy and Spain, but also when excluding these same origins. Other countries that are large French trading partners such as Germany, Belgium, the Netherlands, Great Britain, and China mostly describe a negative but insignificant coefficient when separated, and excluding these countries one by one also does not affect the main results. These findings suggest that no single origin is responsible for the negative association between exposure to the carbon disclosure requirements and imported carbon emissions or im-

port value. Additionally, while the majority of French imports come from Western Europe, this does not necessarily imply that the results are driven by shocks specific to these countries. As noted by Mésonnier and Nguyen, 2022, there had not been any similar legislation to Art. 173 in any other euro area country by the end of 2019.