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# Three Essays on Sustainable Finance and Corporate Finance

Caroline Raskopf

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Finance**

Soutenue par

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# Introduction

Le rôle prépondérant de la finance est d'allouer les ressources financières en dirigeant l'argent des épargnants vers les entreprises demandeuses en capital et disposant d'opportunités d'investissement. Pendant de nombreuses décennies, cette allocation était principalement basée sur la rentabilité et le risque des entreprises. Cependant, la crise environnementale et la prise en compte de nouveaux enjeux sociaux, tels que l'inclusion et la diversité, ont été à l'origine de l'émergence d'une nouvelle finance : la finance durable.

La banque de France définit la finance durable comme « l'ensemble des pratiques financières visant à favoriser l'intérêt de la collectivité sur le long terme ». En d'autres termes, la finance durable permet d'orienter les flux financiers vers les entreprises ayant un impact positif sur la société. La finance durable est composée de 3 piliers. Le premier pilier est la finance solidaire qui permet d'investir dans des projets à forte utilité sociale. Le second pilier est la finance verte qui facilite le financement de projets dans la transition énergétique et dans la lutte contre le réchauffement climatique. Enfin, le troisième pilier est la finance responsable, également appelée investissement socialement responsable (ISR). L'ISR consiste à investir dans des entreprises de manière « socialement responsable », c'est-à-dire en prenant en compte la rentabilité ainsi que certains critères environnementaux, sociaux et de gouvernance (ESG).<sup>1</sup>

Selon un rapport de la Global Sustainable Investment Alliance, en 2020, l'ISR représentait 35 milliards de dollars d'actifs sous gestion (AUM) au niveau mondial soit 35,9% du total des actifs sous gestions, contre 27,9% en 2016. Ces chiffres témoignent de l'importance de l'ISR dans la finance d'aujourd'hui ainsi que de sa forte croissance. L'ampleur de l'ISR est hétérogène suivant les zones géographiques, avec un fort développement en Europe (12 milliards de dollars AUM) et aux États-Unis (17,1 milliards de dollars AUM). L'ISR peut revêtir

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<sup>1</sup>Il est important de noter que cette thèse n'explorera pas la dimension gouvernance de l'ESG.

plusieurs formes : l'exclusion des entreprises ou secteurs les moins responsables, la sélection des entreprises basée sur les critères ESG avec des approches comme l'approche Best-in-Class ou encore l'approche thématique avec des investissements uniquement basés sur la réduction des émissions carbone par exemple. En 2020, les principales stratégies mises en place étaient l'intégration ESG représentant 25,1 milliards USD AUM et l'exclusion représentant 15 milliards USD AUM.

La finance durable est aujourd'hui un pan important de la finance qui ne cesse de grandir. Il est cependant important de prendre en compte les acteurs au cœur de cette transformation de la finance que sont les entreprises. Afin que la finance durable ait un impact significatif sur la société, il est important de comprendre dans quelles mesures les entreprises participent à la détérioration, mais aussi à l'amélioration de notre monde, quels mécanismes peuvent être mis en place afin de les inciter à jouer un rôle positif, et enfin comment communiquer une information juste aux investisseurs. Cette introduction a pour but de brièvement expliciter les réponses apportées par la recherche académique à ces questions dans le but de comprendre comment cette thèse s'insère dans cette littérature et fournit également des réponses partielles.

## **0.1 Les entreprises au cœur des problématiques ESG**

### **0.1.1 Impact des entreprises sur l'environnement et les êtres humains**

Depuis le début des théories économiques, l'entreprise est l'agent au cœur de la croissance et à la jonction de l'investisseur, du consommateur, du fournisseur et des salariés. Elle est définie par l'INSEE<sup>2</sup> comme une « unité économique juridiquement autonome dont la fonction principale est de produire des biens ou des services pour le marché. » Lors de cette production, l'entreprise peut générer des externalités négatives. D'après la théorie économique, une externalité est le fait que la consommation ou la production d'un agent affecte la production (externalité de production) ou la consommation d'un autre agent. Une externalité négative existe lorsque la production d'une entreprise a un impact négatif sur la production (exemple : la baisse du nombre de poissons dans l'océan impactant le secteur de la pêche) ou sur la consommation (exemple : l'utilisation de substances toxiques augmente la demande de médicament) d'autres agents économiques, en-

gendrant un coût social qu'elle ne paye pas. Les externalités négatives sont souvent invoquées à propos du volet environnemental du fait de l'utilisation des ressources naturelles (communs) et des émissions toxiques (Nordhaus, 1977). Cependant, elles s'appliquent aussi au volet social. Lorsqu'une entreprise ne respecte pas les droits de l'homme, cela a une incidence négative sur les populations locales et reporte le passage vers une société plus respectueuse de l'être humain. En finance d'entreprise, schématiquement, le rôle de l'entreprise est de faire appel à l'argent de ses investisseurs puis d'investir cet argent dans des projets rentables, créant ainsi de la valeur et participant à la croissance. L'entreprise va donc évaluer les potentiels projets qu'elle peut entreprendre en fonction des recettes et des coûts qu'ils vont générer. Le problème des externalités négatives est que le coût social imposé à la société par la production de l'entreprise n'est pas pris en compte dans l'évaluation des projets, pénalisant les projets responsables. Cette approche de l'évaluation des investissements sans prise en compte des externalités négatives est profondément ancrée dans la vision de l'entreprise défendue par Milton Friedman (Friedman, 1970). D'après Friedman, l'unique raison d'être de l'entreprise est la maximisation des profits. Aujourd'hui, cette vision est contestée et de nombreux d'acteurs appellent à une internalisation des externalités négatives par les entreprises, que ce soit dans l'intérêt des actionnaires (Hart and Zingales, 2017) ou de toutes les parties prenantes (Liang and Renneboog, 2020). Dès 2019, la France a modifié le Code Civil avec la loi PACTE<sup>3</sup> afin d'inclure les enjeux sociaux et environnementaux dans la définition de l'entreprise.

### **0.1.2 Les politiques environnementales et sociales des entreprises**

Si les entreprises sont à l'origine d'externalités négatives, elles représentent également la clé de voute de la transformation vers un monde plus durable. En effet, les entreprises sont les acteurs qui investissent afin de développer les nouvelles technologies permettant d'internaliser ces externalités négatives qu'elles peuvent générer (ex : système de capture du CO<sub>2</sub>). L'environnemental Kuznets Curve illustre ce propos en démontrant que la relation entre croissance économique et pollution adopte une forme de courbe en cloche, c'est-à-dire que plus la croissance augmente, plus la pollution augmente jusqu'à un certain point où l'innovation inverse la tendance (Gross-

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<sup>2</sup>Il est important de noter que cette thèse n'explorera pas la dimension gouvernance de l'ESG.

<sup>3</sup>Plan d'Action pour la Croissance et la Transformation des Entreprises

man and Krueger, 1995). Au niveau de l'entreprise, cette innovation se traduit par la production de brevets et par des dépenses en recherche et développement (R&D) plus élevées (Cohen et al., 2020; Haščič and Migotto, 2015). Avant même d'innover, le premier pas pour les entreprises souhaitant développer une approche plus durable est d'adopter des pratiques et des technologies déjà existantes qui lui permettraient de moins polluer et d'avoir une conduite plus responsable vis-à-vis de ses parties prenantes (Biais and Landier, 2022; Oehmke and Opp, 2019). Les entreprises peuvent aussi participer au développement durable en communiquant une information sur leurs activités environnementales et sociales aux autres parties prenantes (Matsumura et al., 2014; Stanny and Ely, 2008). Les différentes méthodologies utilisées afin de mesurer ces informations seront développées dans la troisième partie de cette introduction. Enfin, les entreprises peuvent s'engager en participant à des programmes de développement durable comme le UNGC<sup>4</sup> ou à respecter certains objectifs comme la réduction des émissions à effet de serre avec le SBTi<sup>5</sup> (Bolton and Kacperczyk, 2022; Li and Wu, 2020). Cette liste recense les principales mesures que peuvent mettre en place les entreprises, mais n'est pas exhaustive.

Toutes ces mesures requièrent des ressources financières importantes et toutes les entreprises n'ont pas le même accès à celles-ci (Almeida et al., 2004; Hennessy and Whited, 2007). De nombreuses études ont démontré le lien positif entre difficulté financière et pollution (Eccles et al., 2014; Levine et al., 2019; Bartram et al., 2022; Kim and Xu, 2022) ou mise en danger du personnel (Cohn and Wardlaw, 2016). Ce dernier point souligne l'importance pour la finance durable d'orienter les flux financiers de manière optimale afin de financer au mieux la transformation vers un monde plus orienté vers l'ESG.

## **0.2 Les incitations aux politiques environnementales et sociales des entreprises**

Plusieurs facteurs peuvent expliquer pourquoi certaines entreprises développent davantage leurs politiques environnementales et sociales. Bénabou and Tirole (2010) ont été parmi les premiers à les expliciter. Ils en recensent trois principales. La première raison de développer des politiques

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<sup>4</sup>United Nations Global Compact

<sup>5</sup>Sciences-based Target Initiative

environnementale et sociale est l'intérêt long terme de l'entreprise. La deuxième raison est que de telles politiques sont implémentées à la demande des parties prenantes, que ce soit des actionnaires (Hart and Zingales, 2017), des consommateurs (Servaes and Tamayo, 2013; Dai et al., 2021) ou des salariés (Brekke and Nyborg, 2008). Enfin, la dernière est que les dirigeants ont des préférences plus marquées en ce sens. Si les deux premières raisons peuvent s'accorder avec l'idée que le rôle de l'entreprise est de maximiser l'utilité des actionnaires, la dernière raison fait émerger de potentiels coûts d'agence. L'article de Ferrell et al. (2016) démontrant que les entreprises qui développent le plus leur RSE sont celles souffrant le moins de coûts d'agence, la présente introduction ne s'attardera pas sur cette dernière potentielle explication.

### **0.2.1 Impact sur la performance et le risque de l'entreprise**

La première raison pour les entreprises d'investir dans la protection de l'environnement ou le social serait la performance long terme de l'entreprise. Cette opposition entre profit court terme et prise en compte des problématiques sociétales et environnementales est soutenue par de nombreuses recherches montrant l'impact négatif de la myopie des dirigeants ou des investisseurs sur les performances ESG (Akey and Appel, 2021; Kim and Xu, 2022). Cependant, le lien entre investissements ESG et performance est encore en débat dans la littérature empirique. De nombreux articles existent sur le sujet, confrontant différentes approches (voir par exemple Orlitzky et al. (2003) et Margolis et al. (2009)). Il apparaît que les différences de résultat pourraient provenir de la nature hétérogène des investissements durables. Si ceux-ci sont adaptés à l'activité de l'entreprise et lui permettent de concurrencer ses concurrents, ils sont créateurs de valeurs (Albuquerque et al., 2019; Cao et al., 2019). A contrario, s'ils ne sont que le fruit d'un dépassement du rôle du dirigeant, alors l'impact sur la valeur de l'entreprise sera neutre ou négatif.

Cette prise de conscience du nouveau rôle de l'entreprise au sein de la société via son impact social et environnemental fait peser de nouveaux risques que nous avons pu voir se matérialiser avec les scandales Orpea et Volkswagen (Hoepner et al., 2018). De manière intéressante, les politiques RSE diminuent le risque systématique (Albuquerque et al., 2019), alors que l'irresponsabilité sociétale augmente le risque idiosyncratique (Oikonomou et al., 2012). Comme nous l'avons vu précédemment, les parties prenantes ont des préférences qui ont changé



et prennent en compte de manière croissante les critères environnementaux et sociaux. Ce changement n'est pas sans impact sur l'entreprise. La demande va évoluer vers des produits et services plus responsables. Pour certains secteurs comme le secteur pétrolier, la totalité de leurs activités sera remise en cause. Ainsi, certaines entreprises pourraient se retrouver avec à leur bilan des actifs bloqués, ou stranded assets, c'est-à-dire des actifs dont la valeur a été totalement dépréciée et qui ne vaudront plus rien ([Atanasova and Schwartz, 2019](#); [Byrd and Cooperman, 2018](#); [Delis et al., 2019](#)). Pour ce qui est des actionnaires, s'ils choisissent d'investir dans des entreprises responsables, le prix des actions des entreprises les moins responsables vont baisser, augmentant la rentabilité attendue par les actionnaires pour investir. Cela signifie que l'entreprise devra payer aux actionnaires un coût du capital plus élevé pour le risque accru qu'ils prennent ([Bolton and Kacperczyk, 2021](#); [Chava, 2014](#); [El Ghouli et al., 2011](#); [Heinkel et al., 2001](#); [Seltzer et al., 2019](#); [Sharfman and Fernando, 2008](#)). Il est important de souligner toutefois que ce risque peut se changer en opportunités pour certaines entreprises telles que celles travaillant dans la transition écologique.

Du fait de l'urgence climatique et de la demande croissante pour des entreprises plus responsable socialement, les institutions gouvernementales implémentent de plus en plus de lois relatives à l'ESG. Cette pression réglementaire fait peser un risque conséquent sur les entreprises qui peuvent du jour au lendemain se retrouver dans l'obligation de mettre en place des investissements coûteux afin de ne pas risquer des amendes ou des scandales dommageables pour leurs réputations ([Shapiro and Walker, 2018](#)). Ce risque réglementaire est perçu aujourd'hui comme le plus important par les investisseurs. Concernant le volet environnemental, les réglementations peuvent prendre la forme de lois limitant les émissions, de la mise en place d'un marché de quota carbone suivant la logique de théorème de Coase ([Bartram et al., 2022](#); [Coase, 1960](#); [Ivanov et al., 2022](#)), d'une taxe carbone inspirée par la taxe pigouvienne ([Acemoglu et al., 2012](#); [Golosov et al., 2014](#)), ou d'un mix des deux ([Fischer and Newell, 2008](#)).

En plus de ce risque de transition et réglementaire, à l'instar de tous les acteurs, les entreprises sont physiquement exposées aux risques environnementaux. La crise climatique réduit le chiffre d'affaires au global ([Addoum et al., 2020](#); [Custódio et al., 2022](#)) et la production des entreprises, en particulier dans l'industrie et l'agriculture ([Mendeisohn et al., 1994](#); [Deschênes](#)

and Greenstone, 2012; Dell et al., 2012; Zhang et al., 2018). Les actifs immobiliers exposés à la montée du niveau de la mer sont dépréciés (Baldauf et al., 2020; Bakkensen and Barrage, 2017), réduisant l'accès à la dette s'ils sont utilisés comme collatéral. Enfin, la main d'œuvre aussi est impactée avec une baisse de la productivité due à l'augmentation d'occurrence des températures extrêmes (Graff Zivin and Neidell, 2014). Pour contrebalancer ces risques opérationnels additionnels auxquelles elles sont exposées, les entreprises réduisent leurs leviers d'endettement (Chang et al., 2018; Ginglinger and Moreau, 2019).

## 0.2.2 Le rôle des investisseurs

Les actionnaires étant les premiers concernés par les risques ESG, l'actionnariat des entreprises ainsi que sa structure jouent donc un rôle prépondérant sur leurs politiques ESG. Avant de détailler l'impact de l'actionnariat, il est nécessaire de comprendre comment les actionnaires peuvent influencer les politiques environnementales et sociales des entreprises. Premièrement, les actionnaires peuvent « voter avec leurs pieds », c'est-à-dire simplement désinvestir de l'entreprise s'ils considèrent que l'activité de l'entreprise ne remplit pas leurs critères environnementaux et sociaux (Hong and Kacperczyk, 2009). Deuxièmement, ils peuvent directement s'engager auprès de l'entreprise en votant des propositions environnementales et sociales (Dimson et al., 2015; Edmans et al., 2022; He et al., 2019). Enfin, les actionnaires peuvent nommer des administrateurs orientés RSE qui pourront apporter leur expertise au conseil d'administration et aider au développement de politiques environnementales et sociales.

Les entreprises peuvent être soit détenues par des actionnaires privés, on parlera d'entreprise privée ou non cotée, soit par un actionnariat public sur les marchés de capitaux, on parlera d'entreprise publique ou cotée. De manière générale, les actionnaires privés sont souvent plus intéressés par la performance long terme de l'entreprise puisque les titres sont très peu liquides et qu'ils investissent sur le long terme. De plus, leur portefeuille est généralement moins diversifié, ce qui fait qu'ils ont tendance à davantage s'engager auprès de l'entreprise. Les entreprises non cotées sont plus susceptibles d'encourager la mise en place de politique RSE, que ce soit avec la réduction de la pollution (Shive and Forster, 2020) ou la sécurité des employés (Cohn and Wardlaw, 2016). Cependant, le marché du capital investissement est très hétérogène et cer-

taines voix se sont élevées pour alerter sur le fait que certains actifs polluants, particulièrement dans le secteur de l'énergie, sont vendus aux entreprises non cotées par les entreprises cotées.<sup>6</sup> En effet, les entreprises avec un actionnariat public sont soumises à des réglementations environnementales et sociales plus strictes, renforcées parfois par la réglementation des sociétés de gestion d'actif.<sup>7</sup> Les résultats de [Dyck et al. \(2019\)](#) et de [Azar et al. \(2021\)](#) suggèrent que les investisseurs institutionnels favorisent la performance ESG, majoritairement, car ils souhaitent se couvrir contre les risques réglementaires ([De Haas and Popov, 2019](#); [Dyck et al., 2019](#); [Krueger et al., 2020](#)).

Au-delà de l'actionnaire, il semblerait que les créanciers influencent également l'implémentation des politiques RSE. En effet, les taux d'intérêt appliqués aux entreprises les moins responsables sont plus élevés, incitant les entreprises à devenir plus durables pour bénéficier d'un coût de la dette plus faible ([Seltzer et al., 2019](#); [Bellon, 2021](#)). Par ailleurs, le marché a vu deux innovations financières majeures apparaître avec les obligations vertes qui sont des obligations adossées à des projets environnementaux ([Flammer, 2021](#); [Zerbib, 2022](#); [Tang and Zhang, 2020](#)) et les Sustainability-Linked bonds qui sont des obligations dont le taux d'intérêts est indexé sur des critères environnementaux et sociaux ([Berrada et al., 2022](#); [Kölbel and Lambillon, 2022](#)). Ces deux nouveaux produits financiers facilitent le financement de projets durables par de la dette. Cependant, l'influence des investisseurs sur la performance environnementale et sociale de l'entreprise est restreinte par la responsabilité limitée. Moins un investisseur sera tenu responsable pour les actions de l'entreprise, plus celui-ci délaissera la prise en compte des critères environnementaux et sociaux aux profits des bénéficiaires court terme ([Akey and Appel, 2021](#); [Bellon, 2021](#)). En outre, des explications comportementales éclairent également sur la sensibilité des investisseurs aux politiques environnementales et sociales. La culture ou le pays des investisseurs ([Liang and Renneboog, 2017](#)), leurs préférences politiques ([Baldauf et al., 2020](#); [Di Giuli and Kostovetsky, 2014](#)) et leurs expériences ([Choi et al., 2020](#)) peuvent expliquer pourquoi cer-

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<sup>6</sup><https://blogs.law.ox.ac.uk/business-law-blog/blog/2022/06/dark-and-dirty-assets-greening-climate-driven-asset-partitioning>

<sup>7</sup>On pourrait citer en France la loi sur la « déclaration de performance extra-financière » qui impose aux entreprises cotées de plus de 500 salariés avec un total de bilan supérieur à 20 millions d'euros ou un chiffre d'affaires de plus de 40 millions d'euros d'inclure dans leurs rapports annuels les informations relatives aux thèmes sociaux et environnementaux. Les entreprises non cotées de plus de 500 salariés avec un total de bilan ou de chiffre d'affaires dépassant 100 millions d'euros ainsi que certains établissements spécifiques (ex : banque, assurance) sont aussi concernés. (<https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000035401863>)

tains investisseurs sont impliqués dans les politiques RSE des entreprises. Malgré un changement de préférence des investisseurs pour des raisons éthiques ou de perception de risque, la finance durable ne pourra financer correctement la transition vers un mode plus durable que si une information juste leur est transmise.

### 0.3 Mesure de l'impact environnemental et social des entreprises

La finance est une discipline dominée par l'analyse quantitative, ce qui s'avère problématique lorsque l'on parle d'impact environnemental et social. Comment traduire quantitativement des concepts complexes extrêmement hétérogènes en fonction des secteurs et entreprises dans une information simple et synthétique ? Le débat reste ouvert en particulier, car il existe différentes perceptions de ce que devrait être la durabilité. Afin de donner les clés au lecteur, nous listerons ci-dessous les méthodes les plus utilisées. Dans le but de donner un cadre au développement durable, l'ONU a défini 17 objectifs de développement durable.



Source : <https://www.un.org/sustainabledevelopment/fr/2015/09/25/les-etats-membres-de-lonu-adoptent-un-nouveau-programme-de-developpement-audacieux/>

Avec l'aide de ces 17 objectifs de développement durable, des agences de notation extra financières généralistes telles que V.E., RobecoSAM, Sustainalytics, ou Trucost, ont développé

des scores et notes basés sur les trois piliers de l'ESG. Cependant, chaque agence décide de ce qu'elle intègre dans chacun de ces piliers et chacune a sa propre approche de la durabilité et de ce qui devrait être évalué dans ces scores. Certaines agences ont une vision idéologique basée sur des valeurs morales alors que d'autres ont une approche pragmatique basée sur la matérialité du risque ESG et donc sur la valeur de l'entreprise évaluée (Eccles et al., 2014). Ces différences de vision conduisent à une grande hétérogénéité des scores. Bartram et al. (2022) démontre que la corrélation entre eux est très faible à l'inverse des scores de crédit. Cette incertitude est problématique, car elle pourrait conduire à la baisse de la demande pour les actions des entreprises responsables (Avramov et al., 2021) et à une augmentation de la pollution (Brandon et al., 2019). Il est donc urgent de mieux comprendre la construction de ces scores et comment faire en sorte que les investisseurs obtiennent la meilleure information possible.

## **0.4 Présentation des travaux de recherche composant cette thèse**

L'objectif de cette thèse est d'apporter une contribution aux travaux existants en matière de finance durable, tant sur les incitations que sur les barrières aux politiques environnementales et sociales des entreprises.

### **0.4.1 Premier chapitre : Femmes administratrices et performance environnementale et sociale**

Ce premier chapitre coécrit avec Edith Ginglinger met en lumière l'effet positif des femmes administratrices dans les conseils d'administration sur la performance environnementale et sociale (E&S) des entreprises en exploitant l'implémentation de la loi Copé-Zimmerman en 2011. Cette loi impose aux entreprises françaises de plus de 500 salariés ou réalisant un chiffre d'affaires d'au moins 50 millions d'euros des quotas de genre dans les conseils d'administration avec un minimum de 20% d'administrateurs du sexe minoritaire en 2014 et 40% en 2017. L'avantage de la mise en œuvre de cette loi, c'est qu'elle constitue un « quasi-natural experiment » nous perme-

tant d'étudier l'effet des femmes au sein des entreprises sans être corrompu par les problèmes d'endogénéité inhérents à ce sujet. Les résultats montrent que les femmes ont un impact positif sur les performances E&S, suggérant qu'une manière pour l'investisseur d'inciter l'entreprise à développer ses politiques ES est de nommer des administrateurs femmes. Dans un deuxième temps, nous avons étudié par quels biais les femmes influencent la performance E&S. Premièrement, les quotas ont favorisé la formation de comités RSE ainsi que la place des femmes au sein de ceux-ci. Cependant, la création seule de ces comités n'explique pas l'entièreté de nos résultats. Dans un deuxième temps, nous avons donc observé que les femmes ne sont pas seulement plus susceptibles de rejoindre un comité RSE mais aussi les autres comités tels que le comité d'audit ou de nomination. Cette augmentation de leur présence à des postes importants signifie qu'elles ont plus d'autorité dans le conseil d'administration et sont plus à même d'amener leur expertise. Il s'avère que les femmes administratrices avant même la mise en place des quotas ont plus d'expériences professionnelles en lien avec les thématiques environnementales et sociales. L'augmentation de la performance environnementale du fait de l'augmentation du pourcentage de femmes au sein des conseils d'administration peut donc s'expliquer par leurs expertises spécifiques, qu'elles sont plus en mesure d'imposer.

Dans un premier temps, cette étude participe à la littérature sur l'impact des femmes à des postes importants dans les entreprises et plus spécifiquement sur leur effet sur la performance E&S ([Cronqvist and Yu, 2017](#); [Dyck et al., 2023](#); [Francoeur et al., 2019](#)), que ce soit sur le nombre d'infractions environnementales [Liu \(2018\)](#) ou sur la consommation d'énergie renouvelable [Atif et al. \(2021\)](#). Cet article contribue à la littérature sur la manière d'encourager les politiques environnementales et sociales des entreprises ([Di Giuli and Kostovetsky, 2014](#); [Liang and Renneboog, 2017](#)) et plus particulièrement sur la façon dont les actionnaires peuvent inciter les dirigeants à investir dans les thématiques RSE ([Flammer et al., 2019](#); [He et al., 2019](#); [Hoepner et al., 2018](#)). Nous démontrons ici que les actionnaires qui souhaitent inciter les entreprises à investir dans des politiques environnementales et sociales peuvent nommer des femmes administratrices dans les conseils d'administrations, car du fait de leur expertise ES, elles seront plus susceptibles de promouvoir de telles politiques.

## **0.4.2 Deuxième chapitre : Scores environnementaux et effort de réduction de la pollution**

Les scores environnementaux composant le premier pilier des notes ESG sont utilisés de manière croissante du fait de l'essor considérable de la finance durable. Cependant, il n'existe aujourd'hui aucun consensus sur ce que devrait représenter ces scores aussi bien du côté des professionnels de la finance que des chercheurs. On peut distinguer au sein de la littérature académique deux points de vue différents. Premièrement, ces scores peuvent être utilisés afin d'inciter les entreprises polluantes à investir dans des politiques environnementales dans le but de bénéficier d'un coût du capital plus faible. Dans cette optique, les scores représentent le stock de pollution de l'entreprise ou le fait d'être une entreprise polluante. Le second point de vue est que ces scores doivent refléter la performance environnementale de l'entreprise, c'est-à-dire les efforts entrepris pour réduire la pollution, en d'autres termes le flux de pollution. Afin de répondre à cette question, cet article utilise des données sur les investissements de réduction de la pollution entrepris par les entreprises industrielles en France appariées avec la base de données ESG V.E. (Vigeo Eiris). Dans un premier temps, les résultats montrent une corrélation non significative entre les investissements verts et les notes environnementales. Dans un deuxième temps, l'échantillon est divisé entre les entreprises réputées pour être hautement polluantes et les autres. La corrélation devient négative pour les entreprises hautement polluantes. Ces deux résultats combinés suggèrent que les notes environnementales reflètent le stock de pollution des entreprises. Afin d'être sûr que les résultats ne proviennent pas du fait que les entreprises les plus polluantes sont obligées légalement d'investir dans la réduction de la pollution alors que certaines entreprises moins polluantes le font uniquement par éthique. Cet article utilise l'occurrence d'un accident polluant dans une des usines du groupe comme un choc exogène au fait d'être perçu comme polluant. Les résultats sont similaires qu'en utilisant la classification par industrie.

Ce deuxième article s'insère dans la littérature sur les scores ESG ([Berg et al., 2022](#); [Eccles and Strohle, 2018](#); [Avramov et al., 2021](#); [Brandon et al., 2019](#); [Tang et al., 2021](#); [Cohen et al., 2020](#)) ainsi que dans le débat entre activisme et désinvestissement des actionnaires ([Chava, 2014](#); [De Angelis and Tankov, 2020](#); [Heinkel et al., 2001](#); [Pástor et al., 2021](#); [Bolton and Kacperczyk, 2021](#); [Edmans et al., 2022](#); [Hart and Zingales, 2017](#); [Oehmke and Opp, 2019](#)). De plus, ce



chapitre de thèse démontre que si certaines firmes structurellement polluantes sont pénalisées avec un coût du capital plus important, les notes environnementales peuvent être contreproductive puisque ce sont elles qui ont le plus besoin de capital pour leur transition écologique.

### **0.4.3 Troisième chapitre : Contraintes financières et choix d'investissement dans la prévention ou le traitement de la pollution**

Le troisième chapitre de cette thèse analyse le rôle des contraintes financières dans le choix des méthodes de réduction de la pollution chronique<sup>8</sup> par les entreprises industrielles. La base de données ANTIPOL qui recense les investissements entrepris par les établissements industriels en France permet d'étudier la distinction entre les investissements de traitement et de prévention de la pollution. Cet article montre que les contraintes financières réduisent les investissements de prévention et encouragent les investissements de traitement lorsqu'une loi environnementale est mise en place.

Les investissements de prévention et de traitement de la pollution sont impactés différemment par les contraintes financières en raison de leur nature hétérogène. Dans le cas du traitement, la pollution est générée au cours du processus de production, puis l'entreprise détruit cette pollution en la capturant et en la traitant. Quant à la prévention de la pollution, il s'agit d'éviter la création de la pollution. La pollution n'est donc pas générée dans ce dernier cas. En évitant la formation de la pollution et en améliorant l'efficacité des processus de production, les investissements de prévention de la pollution réduisent les coûts sur le long-terme, engendrant des bénéfices. Ils peuvent de ce fait être profitables, avoir une Valeur Actuelle Nette (VAN) positive, et améliorer la performance de l'entreprise (King and Lenox, 2002; Petraru et al., 2010; Porter and Van Der Linde, 1995b; Shen, 1995; Schoenherr, 2012). A contrario, les investissements de traitement de la pollution ne réduisent aucun coût<sup>9</sup> et ne participent pas à la croissance de l'entreprise (Brião and Tavares, 2007). Cependant, les investissements de traitement sont moins coûteux à entreprendre, car ils nécessitent moins d'adaptation des lignes de production et de formation du personnel. Dans un contexte sans loi environnemental, les entreprises financière-

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<sup>8</sup>La pollution chronique est la pollution générée par les activités habituelles des entreprises. À l'opposé se trouve la pollution accidentelle pouvant être créée par une fuite ou une explosion.



ment contraintes ne vont pas investir dans la réduction de la pollution, dans la mesure où les deux types d'investissement sont coûteux. Elles préfèrent garder leurs ressources financières pour des investissements en lien avec leur activité. À l'opposé, les entreprises non financièrement contraintes vont investir dans les investissements de prévention de la pollution si elles perçoivent que leur VAN est positive. C'est pourquoi les premiers résultats montrent que les contraintes financières réduisent les investissements de prévention, mais n'ont pas d'impact sur les investissements de traitement. Les résultats sont d'abord obtenus au moyen d'un modèle OLS simple à effet fixe année et industrie. Dans un deuxième temps, une augmentation d'une taxe locale (la Cotisation Foncière des Entreprises) est utilisée pour établir un lien causal grâce à la méthode de *staggered differences-in-differences*. Lorsque la loi environnementale est mise en place, les entreprises contraintes vont se retrouver dans l'obligation d'investir dans la réduction de la pollution et opteront pour le traitement de la pollution, moins coûteux pour eux à court-terme. La loi environnementale utilisée pour obtenir ces résultats est l'Industrial Emission Directive (IED).

Ce chapitre de thèse contribue principalement à la littérature sur les obstacles aux politiques environnementales des entreprises (Akey and Appel, 2021; Choi et al., 2019; De Haas and Popov, 2019; Dyck et al., 2019), et plus particulièrement sur l'impact négatif des contraintes financières (Bartram et al., 2022; Cohn and Deryugina, 2018; Dang et al., 2020; Goetz, 2018; Kim and Xu, 2022; Levine et al., 2020). Par ailleurs, cette étude participe au débat sur la relation entre la performance de l'entreprise et les politiques environnementales (Konar and Cohen, 2001; Oikonomou et al., 2012; Albuquerque et al., 2020; Hoepner et al., 2018). En effet, il met en lumière l'existence de différents types d'investissements, chacun ayant des effets distincts sur la performance. Cet article a également des implications pour les pouvoirs publics qui souhaitent mettre en place de nouvelles lois environnementales et s'insère donc dans la littérature sur l'évaluation de ces lois (Farzin and Kort, 2000; Shapiro and Walker, 2018; Shapiro and Metclaf, 2021). S'ils souhaitent développer la prévention de la pollution, il est nécessaire de prendre en compte son coût additionnel à court terme. Une potentielle solution serait d'encourager le marché des obligations vertes afin que les entreprises les plus contraintes puissent financer leurs projets de prévention de la pollution.

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<sup>9</sup>Les coûts réputationnels et réglementaires sont considérés comme équivalents pour les deux types d'investissements et donc négligés.

# Chapter 1

## **Women directors and E&S performance: Evidence from board gender quotas**

*Joint work with Edith Ginglinger*

Using the natural experiment created by France's 2011 board gender quota law, we find that the presence of women on boards increases firms' environmental and social (E&S) performance. Since the passage of the law, firms are more likely to create an E&S committee. However, E&S committees are not the only channel through which the inclusion of women on boards drives E&S performance. After the quota law, women are increasingly serving as members and chairs of board committees. We find that, prior to being recruited to boards, women directors have more environmental and social experience than men. Combined with their increased authority after the introduction of quotas, their E&S experience allows them to steer companies toward more E&S oriented policies.

## 1.1 Introduction

Investors are becoming increasingly attentive to environmental and social (E&S) concerns when making investment selections. At the end of 2020, 3,038 investors were signatories of the United Nations' Principles for Responsible Investment (UNPRI) network, representing \$103.4 trillion in assets under management (compared to \$21 trillion in assets under management and 203 signatories in 2010).<sup>1</sup> On the bondholder side, credit rating agencies have recently acquired several extra-financial rating agencies to include E&S risk in their assessment of the credit risk.<sup>2</sup> As E&S criteria become increasingly important for investors, they also become critical to the financing and investment decisions of corporations. Firms' E&S exposure shapes their ability to raise equity, cost of capital, reputational and operational risks, and value.<sup>3</sup> While many investors and CEOs emphasize the importance of E&S issues, the actual implementation of E&S actions varies substantially across firms, raising questions regarding the means for investors to ensure that the companies in their portfolios are acting in accordance with their E&S expectations. Several mechanisms are available for investors to reduce the companies' exposure to E&S risks. Investors can directly engage with the management of the firms in which they invest to encourage them to reduce risks stemming from E&S characteristics (Hoepner et al., 2018). They can propose shareholder resolutions on E&S issues at general meetings (He et al., 2019) or require the integration of E&S criteria into executive compensation (Flammer et al., 2019). Getting the E&S message across through the board of directors, elected by the general meeting of shareholders, is the most immediate and direct way to drive the orientations favored by shareholders. One of the most effective solutions to align boards with investors' E&S priorities is to appoint more E&S oriented directors.

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<sup>1</sup>PRI signatories commit to incorporating ESG issues into investment analysis, decision-making processes, and ownership policies. The signatories "believe that an economically efficient, sustainable global financial system is a necessity for long-term value creation. Such a system will reward long-term, responsible investment and benefit the environment and society as a whole." (<https://www.unpri.org/pri>).

<sup>2</sup>For example, S&P acquired Trucost, a provider of carbon and environmental data and risk analysis (2016), and the ESG ratings arm of RobecoSAM (2019). Moody's acquired Four Twenty Seven, a provider of data related to physical climate risks (2019), and Vigeo-Eiris, a provider of ESG data (2019).

<sup>3</sup>A large literature focused on examining the impact of E&S on the firm performance exists. Most papers—but not all—note that the E&S ratings positively influence the firm value. For a review of these papers, see, for example, Orlitzky et al. (2003), Margolis et al. (2009) and Gillan et al. (2021). E&S policies may affect firm value through reduction in the firm risk (El Ghouli et al., 2011; Oikonomou et al., 2012; Albuquerque et al., 2019), an increase in the number of analysts following the firm (Durand et al., 2019), higher post-acquisition returns (Deng et al., 2013), better access to financing (Cheng et al., 2014), and higher resilience during crisis periods (Lins et al., 2017;

In this paper, we examine how the presence of women on boards impacts the firms' E&S performance, considering the adoption of a board gender quota in France as a natural experiment. Women directors can contribute to the board performance through enhanced monitoring (Adams and Ferreira, 2009; Schwartz-Ziv, 2017), thereby reducing the potential for and amount of agency costs linked to E&S expenses. In addition, women directors can contribute through their advisory role by diversifying the board's values, expertise and skill types. Previous literature suggests a gender gap in the way social and environmental issues are viewed. Women are more personally concerned than men about climate change, and more willing to change their lifestyles to reduce the effects of climate change.<sup>4</sup> In the US, they express greater concern about climate change than do men (McCright, 2010). Women also appear to act more ethically than men (Franke et al., 1997) and to be more transformational leaders, eliciting more trust and confidence from a firm's stakeholders (Eagly et al., 2003). The presence of female directors increases corporate philanthropic contributions, probably because women value more the external stakeholder relationships that such donations allow (Marquis and Lee, 2013). Furthermore, women tend to be less overconfident than men (Huang and Kisgen, 2013), and firms led by overconfident executives tend to engage less in socially responsible activities (Tang et al., 2015), which makes it more likely for gender-diverse boards to achieve a higher E&S performance. Female directors are more likely to possess skills in human resources and sustainability that are often lacking in boards (Kim and Starks, 2016).<sup>5</sup> All of these prior observations of female adopting more favorable behavior towards E&S issues, lead us to test the hypothesis that appointing female directors may help enhance the firms' E&S performance.

To overcome the endogeneity issue that could result from E&S friendly firms electing women directors and women self-selecting into more E&S oriented firms, we rely on the implementation of a board gender quota in France. The law was adopted in January 2011 and required that

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Albuquerque et al., 2020).

<sup>4</sup><https://www.pewresearch.org/fact-tank/2015/12/02/women-more-than-men-say-climate-change-will-harm-them-personally/>

<sup>5</sup>According to the PWC 2020 Annual Corporate Directors Survey, 60% of female directors are likely to see the link between E&S and strategy, versus 46% for male directors. Further, a survey conducted in March 2021 by the "Banque Publique d'investissement" on the values that guide French small and medium-sized business leaders, shows that the majority of women leaders adopt an E&S approach for their company, while men are overrepresented among leaders who describe their E&S approach as underdeveloped. There are several anecdotal evidence of women initiatives in the E&S fields, including a female director who participated in the creation of an E&S committee or, more generally, women business leaders who have made E&S issues a priority in their strategies

20% (40%) of the boards be composed of women by 2014 (2017). We employ a difference-in-differences estimation approach to explore changes in the E&S performance after the quota, relative to firms not affected by the quota law. Firms in other European countries would have been the most intuitive choice as a control group. However, over the considered period, most European countries implemented board gender quotas (for example, 40%, 30%, and 33% in Spain, Netherlands, and Italy, respectively) or adopted soft laws (for example, goals of parity in the UK corporate governance code). Therefore, we consider two control groups that we believe are comparable and unaffected, over the considered period, by the board diversity policies. First, we use a sample of US firms matched by size, industry, and E&S score. Specifically, we match French and US firms before the implementation of the quota law. Over the considered period, the US is the largest developed country without a quota for female directors on boards. Furthermore, the French and US boards have similar characteristics ([Adams and Ferreira, 2009](#)). As the E&S scores of US firms are, on average, lower than those of French firms, matching the sample in terms of the E&S score is critical to our analysis. However, because French regulations related to E&S may specifically affect the E&S performance of firms operating in France, as an alternative control group, we consider firms listed in Paris that are headquartered abroad and not subject to the quota law. As the ESG ratings from different providers disagree substantially ([Berg et al., 2022](#)), we rely on two data providers to evaluate the E&S performance. We use data from Asset 4 (Refinitiv) and that provided by Vigeo-Eiris, a global leader in ESG data, which Moody's acquired in 2019. We clean the social scores for all indicators related to gender diversity. Using two databases enables us to cross-validate our results.

We find that after the introduction of the board gender quota in France, the E&S performance of French firms is significantly enhanced compared to both the US matched sample and the sample of firms listed in Paris that are not subject to the quota law. To control for time-invariant unobserved firm characteristics, we include firm fixed effects in our regressions, thereby ensuring that the omitted factors do not drive the results. We find an increase in the global E&S score and each of its components: environmental scores and social scores. Our results are both statistically and economically significant. We build on the critical mass theory introduced by [Kanter \(1977\)](#) that crossing a certain threshold of diversity in a team will significantly affect its performance.

[Konrad et al. \(2008\)](#) and [Schwartz-Ziv \(2017\)](#) show this threshold is on the order of three women for boards. We argue that the first steps of the law are the ones that allow companies to cross the critical threshold of the number of women on their boards, which will enable them to influence E&S policies. We have conducted several tests that confirm that it is indeed the addition of several women to a board that leads to an increase in E&S performance.

Subsequently, we explore the channels through which women on boards positively influence E&S performance. First, we find that the probability that a firm has an E&S committee increases after the quota law. This law, by prompting firms to add women to boards, renders the establishment of an E&S committee more likely. Furthermore, the probability that women are a part of and chair E&S committees also increases post quota. However, E&S committees are not the only channel through which the inclusion of women influences E&S performance. Even when companies choose not to create such a committee, the E&S performance is enhanced after the introduction of the gender quota on boards. After the implementation of the board quota, the authority of the women on the board increases. Women are more often members of the main committees (audit, compensation, and nomination). These committees play a key role in terms of E&S. In particular, the audit committee monitors the E&S disclosure and control, and the nomination committee oversees the screening in terms of expertise and skills related to E&S. If female directors are more oriented toward E&S policies, their increased power in board committees enables them to promote these policies. Our findings suggest that after the implementation of the board quota law and the increase in the percentage of women on boards, boards are structured to become more E&S oriented, whether the decisions are instructed in an E&S committee or directly discussed at the board level or in the main committees.

Our next question relates to the characteristics that lead women directors to be more E&S friendly. In our main regressions, we control for independence, age, tenure, and network. Female directors more frequently have diverse careers and experiences in organizations that are not solely business oriented ([Hillman et al., 2002](#)). More generally, [Laufer et al. \(2003\)](#) find that jobs related to social and environmental issues remain predominantly female in France. From a consumer perspective, [Brough et al. \(2016\)](#) highlight a green-feminine stereotype, which may cause men to avoid green behaviors that threatens their gender identity and may explain the

overrepresentation of women in environment-related activities. The arrival of several women may create a new balance on the board that enable overcoming possible male reluctance towards E&S policies. Furthermore, the influence of gender in the values of directors may also help explain how the E&S performance changes after the gender law quota. Based on value measures developed by [Schwartz \(1992\)](#), [Adams and Funk \(2012\)](#) note that male directors are more concerned with achievement and power, whereas female directors attribute higher importance to self-transcendence values, such as universalism and benevolence. Based on these previous academic findings, we argue that the values of female directors are closer to E&S considerations, and that women have been exposed to E&S experiences more than men. To proxy for these dimensions we consider the directors' experience in positions related to E&S issues, such as sustainability manager or human resources manager, as well as their prior experience in board E&S committees. We also measure the length of the experience as the number of years during which the director has held positions related to E&S activities. We find that female directors have significantly more E&S experience than male directors, and their experience spans over a longer period of time. Our findings suggest that, once they join the boards, female directors prior experience increases the overall expertise of the boards in E&S issues, and enable them to steer firms toward more E&S oriented policies. Our findings indicate that the E&S performance of boards in which E&S expertise was weak before the quota law have benefited the most from the arrival of female directors. Board gender quotas enable women to act with more authority, allowing them to assert their E&S priorities.

Several tests confirm the robustness of our results and associated conclusions. First, the results likely depend on the quality of the control groups considered in our natural experiment. As an alternative control group, we build a sample of culturally related firms, i.e., foreign firms with either a French CEO or at least 10% of French directors or directors having studied or worked in France for at least three years. Social and environmental concerns are deeply rooted in French culture.<sup>6</sup> When run by French people, foreign companies not subjected to quota laws may be more likely to be aware of E&S issues. Our results remain qualitatively similar and confirm the positive impact of women directors on firms' E&S performance. Second, our results remain unchanged when all US firms are considered as a control group. Third, we also replicate our

tests on a sample of French firms only, and the results are similar. Therefore, we are confident that our results are not merely due to a selection effect of the ESG rating agencies or the choice of a given control group. Fourth, as French companies can choose between a unitary board or a dual board (Belot et al., 2014), and board quotas apply only to supervisory boards and not to management boards, we also ensure that no firm in the considered sample changes the board structure after the implementation of the quota law.

Our paper contributes to several lines of research. First, this research is related to the literature on the drivers of E&S performance. Bénabou and Tirole (2010) discuss three views of E&S. In the first view, E&S is motivated by the willingness of the management or board members to engage in philanthropy even if doing so harms profits. In such cases, E&S expenses represent an agency cost. If Cheng et al. (2019) and Di Giuli and Kostovetsky (2014) confirm the existence of private benefits from E&S expenses, most empirical results fail to find evidence that E&S policies reflect agency problems (Ferrell et al., 2016). According to the second view, several stakeholders want corporations to engage in socially responsible behavior, and a considerable number of firms cater to this demand, which is consistent with profit maximization. In this case, the channels through which E&S affects firm value are related to the awareness of the customers (Luo and Bhattacharya, 2006; Servaes and Tamayo, 2013; Dai et al., 2021), employees (Delmas and Pekovic, 2013; Flammer and Luo, 2017; Levine et al., 2020) and suppliers (Schiller, 2017; Cao et al., 2019). According to the third view (doing well by doing good), socially responsible investors position themselves as long-term investors who monitor the CEOs and correct short-termism, leading firms to adopt better E&S practices and orient themselves toward long-term value maximization. Several papers confirm this view. Dyck et al. (2019) find that greater institutional ownership is associated with higher firm-level E&S scores. European investors and investors that are signatories to the UNPRI have a more substantial impact on the firms' E&S performance (Gibson Brandon et al., 2022). Legal origin also appears to be a key determinant of E&S policies. E&S ratings are higher for firms located in civil law countries than for those in common-law countries (Liang and Renneboog, 2017). Furthermore, it is interesting to note

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<sup>6</sup>Social rights have been recognized in France since the 1946 constitution (Herrera, 2009). Environmental concerns have existed for a long time in France, with developed ecological movements and a Ministry of the Environment as early as 1970. In 2005, the environment charter was included in the constitution.



how investors induce firms to adopt E&S policies. Investors often engage privately and with the objective of reducing downside risks (Lins et al., 2017; Hoepner et al., 2018). In addition, shareholders engage publicly by submitting E&S shareholder proposals at general meetings. He et al. (2019) find that in 2004–2016, more than 20% of all shareholder proposals relate to E&S issues. Even if these proposals rarely receive the 50% support rate required to pass, the average support rate increases from less than 5% in 2004 to 20% in 2016. Flammer et al. (2021) find that environmental shareholder activism increases the voluntary disclosure of climate change risks and is particularly effective if long-term and green institutional shareholders initiate such a requirement. Finally, Cavaco et al. (2020) and Flammer et al. (2019) find that the integration of E&S criteria in executive compensation, a practice that has become more prevalent over time, leads to an increase in the E&S performance. In contrast with direct investor engagements or CEO compensation schemes, our setting enables us to examine the manner in which investors can influence the firms' E&S performance by changing the composition of the board of directors and rendering it more E&S oriented.

Second, our research contributes to the literature focused on examining the relationship between the board gender diversity and E&S performance. Atif et al. (2021) find that renewable energy consumption is positively related to women's presence on the board. Liu (2018) shows that firms with greater board gender diversity are less frequently sued for environmental infringements. Dyck et al. (2023) find that by introducing a female director on the board, the environmental performance increases by 14%. Francoeur et al. (2019) note that the impact of gender-diverse boards on the E&S performance differs across E&S dimensions. The presence of women on boards leads to higher E&S performance in terms of the environment, suppliers, and the community but does not influence the employee and customer dimensions. Cronqvist and Yu (2017) even find that male executives partially internalize their daughters' experiences and values: the presence of a CEO who has a female child increases a firm's E&S rating by approximately 11.9% compared to that of a median firm, the effect being approximately one-third that of an executive being female. However, endogeneity issues affect the robustness of several of these results. Considering the introduction of board quotas in France in 2011 allows us to conduct a natural experiment and assert that the presence of women on boards causally

determines the E&S performance.

Third, our paper extends existing work that explores board committees<sup>7</sup>, especially the presence of an E&S committee<sup>8</sup>, and its impact on the E&S performance. Only a few researchers have focused on E&S committees. [Eccles et al. \(2014\)](#) report that the likelihood of forming a sustainability committee is greater for high-sustainability companies than that for low-sustainability companies. Boards with an environmental committee exhibit increased transparency related to environmental issues ([Peters and Romi, 2014](#)), enhanced environmental performance ([Walls et al., 2012](#)), and reduced industry fines ([Davidson and Worrell, 2001](#)). [Burke \(2019\)](#) find that the presence of a sustainability committee enhances corporate social performance. However, [Berrone and Gomez-Mejia \(2009\)](#) indicate that environmental committees do not influence the link between the CEO pay and environmental performance. Nevertheless, the presence of an E&S committee may only be an outcome of a prior E&S oriented strategy, which could explain the mixed evidence in the literature. We find that the quota law, by prompting firms to add women to the board, also causes firms to create E&S committees without any direct enhancement in the E&S performance.

Finally, our paper is related to a strand of research exploring the consequences of gender quotas in different institutional settings: Norway ([Ahern and Dittmar, 2012](#); [Matsa and Miller, 2013](#); [Bertrand et al., 2019](#); [Eckbo et al., 2022](#)), France ([Ferreira et al., 2018](#); [Rebérioux and Roudaut, 2019](#)), Europe ([Kuzmina and Melentyeva, 2020](#)), and more recently, California ([von Meyerinck et al., 2019](#); [Hwang et al., 2019](#); [Greene et al., 2020](#)). However, none of these papers examines the impact of board gender quotas on E&S performance. The remaining paper is structured as follows. Section 2 describes the institutional context of board quotas. Section 3 presents the considered dataset and variables. Section 4 describes the analysis of the empirical results, and section 5 presents the concluding remarks.

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<sup>7</sup>[Chen and Wu \(2016\)](#) analyze the structure of board committees, and [Adams et al. \(2021\)](#) investigate the effects of committees on direction information, board decision-making and corporate performance. [Kolev et al. \(2019\)](#) review the literature on outcomes associated with board committees.

<sup>8</sup>Each firm has its own name for this committee, for example “safety, health and environmental affairs,” “sustainability” or “ethics, environmental and social”. For simplicity, we refer to such committees as E&S committees. In all these cases, we refer to committees within the boards of directors.

## **1.2 Board gender quotas**

### **1.2.1 Board gender quotas in France**

In France, the Zimmermann–Copé law, adopted on January 27, 2011, requires a minimum of 20% of women on company boards from January 2014, with the proportion increased to 40% on January 1, 2017. The quota applies to all board members, insiders, and outsiders, except directors representing employees. The quota applies to all listed and nonlisted companies employing at least 500 employees or with revenues of at least EUR 50 million over the three previous years. The three legal forms for listed companies are subject to this law: Sociétés Anonymes (limited liability corporations), Commandites par actions (limited partnerships), and Societas Europaea (the European company statutes). Nonlisted companies can opt for other legal forms that are not subject to quotas. The law was submitted to the French National Assembly on December 3, 2009, and adopted in the first reading on January 20, 2010. The parliamentary debates continued throughout 2010 to January 2011, when the law was formally adopted. As many companies anticipated the adoption of the law in 2010, we exclude this year when comparing the prequota period with the post quota period. The quota law does not apply to companies that are not headquartered in France. Therefore, our first control group includes firms listed in Paris but headquartered out of France, involving French and foreign firms.

### **1.2.2 Board gender quotas in Europe**

The issue of quotas on boards has been subject to extensive debates in Europe for several years. In 2003, Norway became the first country to adopt a law requiring that at least 40% of directors be of each gender, and this law was implemented in 2008. Furthermore, several European countries adopted regulations regarding women on boards (Italy, Spain, Netherlands, Belgium, Austria). Germany, initially reluctant to adopt quotas, finally adopted a law establishing a quota of 30% effective in 2016 (after the end of the considered period) for the 100 largest listed companies. As most German firms have a dual board, quotas apply to supervisory boards. Soft laws are also frequently adopted: corporate governance codes recommend a goal of representation of both genders on boards (Luxembourg, UK, and Sweden). On November 14, 2012, the European

Commission adopted a proposal for a directive setting a minimum objective that listed companies in Europe would have 40% of the underrepresented gender in non-executive board-member positions from 2020. After being blocked in the Council for a decade, the directive has been adopted in November 2022 and will enter into force starting in 2026.

### **1.2.3 Board gender quotas in the US**

No quota for female directors existed in the US during our sample period, which ends in 2016. However, in September 2018, California became the first state in the US to mandate female directors on the boards of listed firms. The law mandates all companies headquartered in the state to have at least one female director by the end of 2019. Moreover, the law requires that by the end of 2021, all firms have at least one female director if the board has four members or fewer and two (three) female directors if the board has five (six or more) members. As US firms are not subject to quotas over our sample period, our second control group is composed of US firms, matched to French firms by size, E&S scores, and industry before the implementation of the quota law. Figure 1 shows the annual average percentage of female directors for French firms, US firms and our control groups composed of matched US firms and firms listed in Paris and headquartered abroad.

## **1.3 Data**

### **1.3.1 E&S data**

To evaluate the E&S performance, we consider two databases: Asset 4 (Refinitiv) and the Vigeo-Eiris (Moody's) database. To examine the impact of the introduction of quotas in France, we need the E&S scores of French companies before 2010. Unfortunately, several ESG data providers offer limited coverage for France before 2012. For example, the coverage of the RobecoSAM databases for companies in our sample does not start until 2010, depriving us of a pre-quota period. The ESG data from MSCI are characterized by major changes between 2011 and 2012 (from KLD to MSCI ESG). Consequently, these two databases are not usable in our study, and we select the Asset 4 and Vigeo-Eiris datasets, which offer a reasonably high coverage for

French firms around the board gender quota law.

#### *Asset 4 database*

In 2020, the Asset 4 database covers 70% of the global market cap, resulting in more than 9,000 companies included in the leading equity-indices such as S&P 500, DJ STOXX, FTSE 250, or CAC 40. Asset 4 ESG scores rely on the screening of each company by more than 150 research analysts across 450 ESG data points, using publicly available and verifiable data such as annual reports, CSR reports, company websites, or NGO websites. Among these 450 metrics, which can be categorical or continuous (e.g., for the workforce category, the metrics can be a dummy for the existence of a training policy or the average training hours), the 186 most relevant and comparable data points are compiled into ten categories. Before the compilation, the value of each ESG data point is converted into a percentile score depending on other companies within the industry. Thus, the most superior and inferior companies have a score of one and zero, respectively. Next, the scores of the ten subthemes are obtained by adding the pertinent percentile scores for the category. This sum is converted into a percentile score by using the same approach as that for the data points. The categories include resource use, emissions, innovation, workforce, human rights, community, product responsibility, management, shareholders, and CSR strategy. Finally, the category scores are organized into three pillars (environment, social, and governance) and aggregated by a weighted average using industry-dependent weights (e.g., if a category is more important for a given industry, it is assigned a higher weight). The final ESG score, ranging from 0 to 100, is the relative average of the category scores. Furthermore, Asset 4 provides ESG ratings based on ESG scores, with each grade being assigned according to a range of scores. In this study, we focus only on continuous scores. To construct our environmental, social, and E&S scores, we follow several steps. First, to avoid any mechanical correlation between the women directors and E&S scores, we generate E&S scores that are free of any gender or female-related measures (e.g., the gender pay gap percentage or number of women employees). Owing to the granularity of the data provided by Asset 4, we can locate all the gender-based measures and generate category scores without any of these measures, thereby obtaining a social and an E&S score unaffected by gender-based items. Second, as there is no

academic reason to retain the weight provided by Asset 4, instead of aggregating the relevant category scores into the social or environmental pillar score by a weighted average, we assign the same weight to each category. Following [Cheng et al. \(2014\)](#), our E&S score is the equally-weighted average of the social and environmental scores.

#### *Vigeo-Eiris database*

Vigeo-Eiris is the leading ESG rating agency in Europe.<sup>9</sup> In 2019, Vigeo-Eiris covered 3853 firms globally (1488 in Europe and 1226 in North America). The Vigeo-Eiris Corporate ESG dataset applies a positive screening approach to rate how a firm complies with the conventions, guidelines, and declarations of international organizations such as the United Nations (UN) and Organization for Economic Cooperation and Development (OECD). The Vigeo-Eiris ratings cover six broad dimensions: human rights, human resources, business behavior toward customers and suppliers, corporate governance, environment, and community involvement. These dimensions are further divided into 38 ESG criteria. For example, the environmental dimension is split into waste management, transportation, water, energy, and environmental strategy. For each criterion, Vigeo-Eiris uses a framework based on three pillars of questioning (leadership, implementation, and results) and nine angles of analysis (visibility, exhaustiveness, ownership, allocated resources, coverage, scope, indicators, stakeholder feedback, controversy management) to form the final score based on a scale of 0 to 100. The 38 ESG scores are used to compute the corresponding ESG scores (environmental, social, and governance) through the mean of a weighted average. The weights correspond to the relevance of the ESG criteria among the sector of the company. Vigeo-Eiris provides continuous scores on a scale from 0 to 100 and a rating, defined as a Z-score, which measures how far the scores deviate from the average in the industry. Firms are rated relative to their industry peers from both domestic and international markets. Thus, the ratings do not depend on the cross-country differences in jurisdiction and regulation. In our paper, we rely on continuous scores.

Finally, as in the case of Asset 4, our question of the impact of female directors on the ESG performance may generate mechanical correlations if the E&S scores consider the criteria related

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<sup>9</sup>The Vigeo-Eiris database has been used by [Ferrell et al. \(2016\)](#) and [Eccles and Strohle \(2018\)](#), among other researchers

to diversity. Vigeo-Eiris granted us access to the detailed proprietary dataset, which enabled us to compute an adjusted score for the social score and E&S score by excluding all items linked to diversity and gender. Furthermore, as implemented in the case of Asset 4 and to make the results more comparable across the two databases, we compute equally weighted social, environmental, and E&S scores.

The two ESG data providers differ in several aspects. Asset 4 was created and designed by a financial data provider: Thomson Reuters. The adopted best-in-class method, which is focused on institutional investors and asset managers, is pragmatic and quantitative. In contrast, Vigeo-Eiris was born from the merger of a foundation created by churches and charities (EIRIS) and the first French socially responsible investing (SRI) rating agency created by the former secretary-general of a French labor union. Vigeo-Eiris is more focused on stakeholders, and its approach is more qualitative. The use of these two databases allows us to test our result on the two main types of ESG data providers: values-based (Vigeo-Eiris) and value-based (Asset 4) [Eccles and Strohle \(2018\)](#).

### **1.3.2 Financial data and matching procedure**

Separate matched samples for the US and headquartered abroad groups are built, depending on the availability of E&S ratings. In each sample, we provide summary statistics for France and the control subgroups. We obtain information regarding the boards and directors (gender, tenure, age, education, role, or employment) from the Management Diagnostic's BoardEx database and financial and accounting data from Compustat. We select non-financial companies (sic code from 6020 to 6799) for US and France, and firms listed in Paris in 2010 or 2011 and headquartered abroad. We obtain a total of 33,990 firm-year observations and 5,364 firms over the period 2007–2016. After the merger with Asset 4 (Vigeo-Eiris) and after removing all observations with missing values, we obtain a total of 8,093 (3,965) firm-year observations and 1,589 firms (700). We match each French firm to a US firm, year by year, in 2007, 2008, and 2009, through a propensity score matching based on three criteria: E&S score, size, and industry. The nearest neighbor method is adopted. For the years after 2009, we retain only the firms matched in 2009. We obtain 659 (687) and 654 (709) firm-years for the US and France, respectively. The French

sample is composed of two parts: a sample matched with the US sample, which represents 654 (709) firm-years and is used as the treatment group with the US matched sample, and a total sample of 718 (828), which is used as the treatment group with the headquarter abroad sample.

### **1.3.3 Descriptive statistics**

Table 1.1 reports the summary statistics regarding firm-year observations for France, the matched US firms and the headquarter abroad sample over the period 2007–2016. Panels A and B report the statistics for the samples covered by Asset 4 and Vigeo-Eiris, respectively. Due to the requirement for coverage by Asset 4 or Vigeo-Eiris, our sample constitutes large companies. The financial characteristics (size, profitability, leverage) of the firms in the treated and control groups are similar, except that the market-to-book ratio is higher for US firms. French boards are, on average, less independent (48%) compared to US boards (81%) and headquarter abroad boards (68%). Over the whole period, the percentage of female directors is 21% in France, compared to 17% in the US and 16% in the headquarter abroad sample. However, the trend differs between France and the control groups, as shown in Figure 1.1. On average, the percentage of female directors in France is 10% and 28% before and after 2010, respectively (Asset 4 sample). Moreover, the director characteristics in the three countries under consideration are similar. Time on the board is longer for US directors, who are also older than French and headquarter abroad directors (63 compared to 59 and 61). Our matching procedure between French and US firms uses E&S scores in addition to the size and industry. The Asset 4 sample corresponds to similar grades for French firms and US firms, whereas the firms listed in Paris and headquartered abroad exhibit higher E&S scores. In contrast, as the average Vigeo E&S scores are significantly lower for US firms compared to French firms, and Vigeo's coverage of US companies prior to 2010 was limited, even after the matching procedure, the E&S scores of US firms remain lower than those of French firms. In contrast, on average, the Vigeo scores are similar for French firms and firms listed in Paris and headquartered abroad. In summary, the matching quality of French/US companies is better for the Asset4 data sample, while foreign-headquartered companies are more comparable to French companies in the Vigeo data sample.



## 1.4 Empirical results

### 1.4.1 Determinants of E&S scores

We first measure the determinants of ESG ratings in a multivariate analysis. Our baseline test examines the relationship between the percentage of female directors on the board and firms' E&S scores, using the specification:

$$E\&Sscore_{i,t+1} = \alpha + \beta X_{i,t} + \gamma Y_{i,t} + \delta + \varepsilon_{1,t} \quad (1)$$

We use, as independent variables, the overall adjusted E&S score, and decomposition of this score in the environmental and social scores (without items linked to diversity, gender, and board of directors). We add a lead by one year on E&S scores, which may seem short to measure the effects of environmental policy changes. Modifying the production processes may take longer than one year. However, some environmental policy choices can have relatively rapid effects, such as waste management, reduced paper and plastic use, energy savings, or switching to a green electricity supplier. Some social decisions can also be implemented in the short term, such as a responsible number of working hours or the introduction of employee participation. Philanthropy may also be quick to implement.  $X_{i,t}$  is the percentage of female directors on the board in year  $t$ ,  $Y_{i,t}$  are a set of firm-level control variables in year  $t$  and  $\delta$  are year and firm fixed effects. For firm-level control variables, we consider the firm size, market to book, leverage, ROA, percentage of independent directors on the board, average time on board of directors, average board network (average number of years on other boards of listed firms in which the directors sit) and average director age. We cluster standard errors at the firm level.

We report the results of these regressions in Table 1.2. In columns 1, 3, and 5, we use Asset4 scores and in columns 2, 4 and 6, we use Vigeo scores. We find a positive impact of the percentage of female directors on the board on the following year E&S performance, measured by the overall score and each of its components.

To analyze in more detail how adding women to the board increases E&S scores, we conduct several additional tests. First, Figure 1.5 shows the dynamic treatment effects before and after the firm crosses a certain threshold of women on its board on the E&S scores. We first examine

the impact on E&S performance of moving from an all-male board to a board with one or more women (threshold of 0), and then the impact of having a critical number of women (Konrad et al., 2008; Schwartz-Ziv, 2017). To approximate this number, we use a threshold of 15% of the board, which represents 2 or 3 women depending on the size of the board. Figure 1.5a shows the estimate once the firm starts recruiting women (threshold of 0% and less than 15% of the board), and Figure 1.5b shows the results for firms crossing the threshold of 15% women on their boards. The results highlight a significant increase in E&S scores after crossing the 15% threshold, but not after the firm starts recruiting women, suggesting that women only have an impact when there are several of them on the board. These findings thus support the notion of a critical mass that allows for an effective impact of women on boards. Given these results, a fortiori, the first threshold of the law, which is 20% of the board, should allow us to observe significant effects on E&S performance. In a second test, we show that the addition of a single woman in a given year does not change the E&S score of the following year, but that the score increases as soon as two women are added (for the Asset4 sample, Table 1.3, column 3) and three women for both Asset4 and Vigeo samples (Table 1.3, column 5 and 6). The introduction of the quota of women on boards in France has led to precisely this type of situation of several women joining a board in the same year.

### **1.4.2 Gender quota effects on the E&S scores**

Examining the relationship between the percentage of women on boards and E&S performance is challenging because of endogenous matching of firms and directors. On the demand side, firms choose directors corresponding to their values and goals; for example, firms with greater concern for E&S issues and larger and more profitable firms are more likely to hire female directors. On the supply side, directors choose companies whose policies fit with their beliefs. If women are more sensitive to E&S issues, they will prefer to sit on boards of firms with a developed E&S culture. In both cases, the correlation between women's representation and the E&S scores of the firm does not result from a real effect of the presence of women but from a match between E&S concerned directors and E&S concerned firms. Even if we include firm fixed effects to control for time-invariant firm characteristics in the previous regressions, we

cannot completely rule out the existence of an endogeneous bias. To address these concerns, we consider the French Copé–Zimmerman law, which introduces a gender quota on French boards, as a natural experiment. As the law applies to all French listed companies, all companies must hire female directors, regardless of their E&S culture, allowing us to measure the real impact of female directors on the E&S scores.

We consider a difference-in-differences methodology and run the following regression:

$$E\&Sscore_{i,t+1} = \alpha + \beta_1 Treated_{i,t} + \beta_2 Treated \times Postquota_{i,t} + \gamma Y_{i,t} + \delta + \epsilon_{1,t} \quad (2)$$

where the dependent variable is one of the E&S scores of firm  $i$  in year  $t + 1$ . To avoid the bias resulting from several companies anticipating the law, we exclude the year 2010. Our posttreatment period variable is a dummy that equals one for all years from 2011 to 2016. The treated dummy equals one for French firms and zero for firms in our control groups. The interaction between the posttreatment dummy and the treated dummy yields the effect of the quotas on the E&S performance. We add year fixed effects and firm fixed effects, and the standard errors are robust and clustered by firm.  $Y_{i,t}$  represents a set of firm-level control variables in year  $t$ , and  $\delta$  denotes the year and firm fixed effects. Firm-level control variables are the same as those in equation (1).  $\beta_2$  is equal to the change in the E&S ratings for French firms relative to firms belonging to the control groups (either US matched firms or firms listed in France but headquartered abroad) following the quota law. The captured effect indicates the impact of being a French firm after the quota law while controlling for the firms' characteristics and year and firm fixed effects.

We graphically examine the E&S ratings for firms in the control groups and treatment group (France) in each test. We run the following regression:

$$E\&Sratings_{i,t} = \alpha + \sum_{t=2007}^{2016} \beta_t \cdot Treated_{i,t} 1[Year = t] + Treated_{i,t} + \delta + e_{i,t} \quad (3)$$

$\delta$  represents the year and firm fixed effects. We obtain a treatment effect in each period in our sample to assess whether the parallel trend assumption is violated. All the treatment effects are

relative to 2007. Figure 1.2a shows the results of this regression examining the impact of being a French firm compared to the US matched firms. The solid line curve indicates the coefficient estimates, and the dotted lines are the bands of a 95% confidence interval around these estimates. The treatment effect is not statistically significantly different from zero in the prequota period and becomes significantly positive after the quota law implementation. Figure 1.2b highlights similar results for the control group of firms listed in Paris and headquartered abroad. These figures provide reasonable evidence that the parallel trend hypothesis is satisfied.

Table 1.4 reports the results of the difference-in-differences regressions for the overall score (columns 1 to 4), environmental score (columns 5 to 8), and social score (columns 9 to 12). We use the Asset 4 and Vigeo scores alternately. The results in columns 1, 3, 5, 7, 9, 11 and columns 2, 4, 6, 8, 10, 12 correspond to the use of US firms and firms headquartered abroad as a control group, respectively. Larger firms exhibit higher E&S performance. After the quota law, the E&S performance of French firms, evaluated using the overall score, significantly increases, regardless of the US or headquartered abroad firms being used as a control group. The results are similar when considering environmental and social scores for both Asset 4 and Vigeo scores.

In Table 1.4, we replicate these tests on the sample of French firms alone. The results are similar to those established on the matched samples, and show that the E&S performance of French firms increases after the introduction of the quota of women on boards.

### **1.4.3 Board quotas and E&S committees**

We explore the channels through which female directors can enhance the E&S performance. The first channel is the probability of having an E&S committee. We use detailed data on committees available in the Boardex database. We classify all committees with denominations related to environmental and social issues, for example, “safety, health and environmental affairs” or “sustainability” or “ethics, environmental and social” as E&S committees. Figure 1.3 shows the average percentage of firms with E&S committees in France, the US total sample, the US matched group and headquartered abroad group over 2008–2016. After the quota law, the percentage of French firms with an E&S committee increased, whereas the control group firms did

not exhibit notable changes in the E&S committees.<sup>10</sup>

To confirm this observation, we perform a regression analysis of the likelihood that each firm has an E&S committee in a given year. The independent variable is a dummy variable that equals one if the firm has an E&S committee. We add year fixed effects and firm fixed effects, and the standard errors are robust and clustered by firm. Alternately, we perform a probit regression. Firm-level control variables are the same as those in equation (1). Table 1.6 reports our results. Large firms are more likely to have an E&S committee. The probability of having an E&S committee significantly increases after the gender quota, for both E&S scores and the two control groups. Therefore, in addition to increasing the percentage of female directors, gender quotas also influence the board structure as they induce firms to create E&S committees. In Table 1.7, we replicate these tests on the sample of French firms alone. The results are similar to those found on the matched samples, and show that the likelihood that French firms create an E&S committee increases after the introduction of the quota of women on boards. To confirm our results from a dynamic perspective, and to ensure that the addition of women, and not other reasons, explain the creation of an E&S committee, Figures 1.5c and 1.5d show the dynamic treatment effects before and after the firm crosses a certain threshold (0% and 15%) of women on its board on the likelihood of having an E&S committee. Figure 1.5d shows that crossing the 15% threshold leads to a significant increase in the likelihood of having an E&S committee, which is not observed when firms move from an all male board to a board with at least one women (Figure 1.5c). In an additional test, we examine the impact of adding one, two or three women to a board on the likelihood of forming an E&S committee. Our findings in Table 1.8 suggest that it is the addition of three women to the board that triggers a significant impact (+13% with Asset 4, +9% with Vigeo) on the probability of forming an E&S committee (Table 1.8, columns 5 and 6). The 2011 gender quota law was precisely an event that led firms to recruit several women to their boards after 2011.

Figure 1.4 shows that the percentage of female directors sitting on E&S committees in France significantly increases after 2010, more than the percentage of female directors sitting on other

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<sup>10</sup>The percentage of firms with E&S committees in the United States is stable over time at around 20%, while it is higher in the sample of matched US firms. The fact that the criterion of E&S scores before quota was used in the matching procedure causes an over-selection of US companies towards companies with pro-E&S policies (compared to average US companies), which more frequently have E&S committees.

committees. Table 1.9 provides descriptive statistics on committee membership at the director-year level for France and compares the proportion of men and women before and after 2010 for both Asset 4 and Vigeo-Eiris samples. The results confirm that women sit more frequently on E&S committees after 2010. The increase in female directors on E&S committees stems from the increase in the number of E&S committees but also from the proportion of female directors in each committee. Before 2010, 5% of male and female directors are E&S committee members. After 2010, 8% of male directors and 14% of female directors are E&S committee members. The proportion of female directors who are members of audit committees increases from 27% to 34% (Asset 4) and from 25% to 33% (Vigeo). Furthermore, after 2010, female directors are more often the chairs of E&S committees than male directors. The regression results reported in Table 1.10 underline that the quota law significantly increases the likelihood that a woman chairs the E&S committee (columns 1 to 8) and the percentage of women on the main committees (columns 9 to 12). These results highlight that women are being assigned significant responsibilities on the boards after the quota law, which has given them more power and has enabled them to assert their priorities.

Our next question seeks to understand whether the effect of women on the E&S performance occurs exclusively through the E&S committee or whether it can also occur in the absence of such a committee. It is challenging to separate the committee effect from the women's effect, as the quota increases the likelihood of setting up an E&S committee. Therefore, we examine the impact of the quota law on firms without any E&S committee during the period 2007–2016. We rerun our regressions corresponding to specification (2) on the subsample of firms without an E&S committee. Table 1.11 reports the obtained results. The E&S performance significantly increases after the quota law, even for firms without an E&S committee. These results suggest that the finding that the E&S performance is enhanced after the gender quota law is driven by the rise in the number of female directors and not only by the increased number of E&S committees after the implementation of the gender quota. If the mission of an E&S committee is to oversee the entire E&S strategy of the company, the other committees also have important roles. The audit committee monitors E&S disclosure and control, the compensation committee oversees the E&S criteria integration into executive compensation plans, and the nomination committee

oversees the screening in terms of expertise and skills related to E&S. The fact that women are on these committees in greater numbers allows them to influence their priorities. If women are more oriented toward E&S policies, the quota law increases their power within the board, enabling them to promote these policies.

#### **1.4.4 Board quotas and director characteristics**

To explain the influence of female directors on the E&S policies, we examine the directors' characteristics, especially those that may be related to E&S. We define two main variables: E&S experience and the length of this experience. We consider the observable characteristics of directors to proxy for E&S experience. We define the variable E&S experience as a dummy equal to one when a director held a position related to environmental and social issues, such as sustainability director or human resources director or a prior position in board E&S committees. The experience acquired by women in their previous positions will benefit the firms where they accept a position as director, thus representing a transfer of E&S expertise between firms. Table 1.12 reports descriptive statistics at the director-year level of French directors before and after 2010 for the Asset4 sample (Panel A) and the Vigeo sample (Panel B). As highlighted at the board level, female directors are more independent, younger, and have a smaller network than male directors. Female directors have significantly more E&S experience than male directors, both before and after the quota law. Furthermore, women E&S experience is also longer than men experience, especially after the implementation of the quota law. We confirm these results using a regression on a sample of director-year observations to show that even when controlling for other directors characteristics, women have more E&S experience (Table 1.13, columns 1 to 4) and their experience spans over a longer period of time (Table 1.13, columns 5 to 8). As a result, the E&S experience of the board as a whole increases after the implementation of the law, due to the addition of women who have more experience in this area, as results reported in Table 1.14 show. We find that, after the quota law implementation, the average percentage of directors with E&S experience increases for the whole board (Table 1.14, columns 1 to 4), and it increases even more for the subsample of the more powerful directors that are members and chairs of committees (Table 1.14, columns 5 to 8). Using director-level tests,

we find that directors with E&S experience increase the likelihood that the firm will establish an E&S committee (Table 1.15, columns 1 and 2), are more likely to be member of the E&S committee (Table 1.15, columns 3 and 4) and to be chair of the E&S committee (Table 1.15, columns 5 and 6).

If their prior E&S experience is the main explanation for the impact of women on the board on E&S performance, then boards that already had this type of expertise before the quota law should be little impacted by the law. We test this prediction by separating our sample into two subsamples based on the E&S expertise of the board before the law. The first sub-sample includes companies with less than 10% of directors with E&S expertise in 2009, and the second includes companies with more than 10% of directors with E&S expertise. We rerun our regressions corresponding to specification (2) on both subsamples of firms. Table 1.16 reports the results. We find that when the company's board has little past E&S experience, the effect of the quota law strongly and significantly increases E&S scores in all data configurations and control samples (Table 1.16, columns 1 to 4). On the other hand, when the board already has E&S experience, the addition of women no longer has a significant effect on E&S scores in most cases (Table 1.16, columns 5 to 8).

Overall, our findings suggest that, prior to joining the board, female directors have more E&S experiences that make them more likely to support E&S policies. The quota law increases the number of female directors on boards and assign them more power, which they can use to pursue their E&S priorities.

#### **1.4.5 Robustness checks**

In our main tests, we use two control groups to conduct our difference-in-differences analysis. As a robustness check, we re-estimate our model specification (2) on the total US firm sample (instead of a matched sample). The coefficient of our postquota treated variable remains significantly positive and similar to the coefficient pertaining to the matched US sample. As an alternative control group, we adopt a culturally related sample composed of foreign firms with at least 10% French directors, or directors having studied in France, or directors that worked for at least 3 years in France. Our findings confirm the positive impact of female directors on



E&S performance. Currently, our sample covers 3 years before the quota law and 6 years after. Unfortunately, E&S and board data do not cover a sufficient number of French companies before 2009, and we cannot extend the pre-quota period. To balance the sample pre and post quota, we rerun our tests on a sample of 3 years before and 3 years after the quota, and our results remain qualitatively similar.

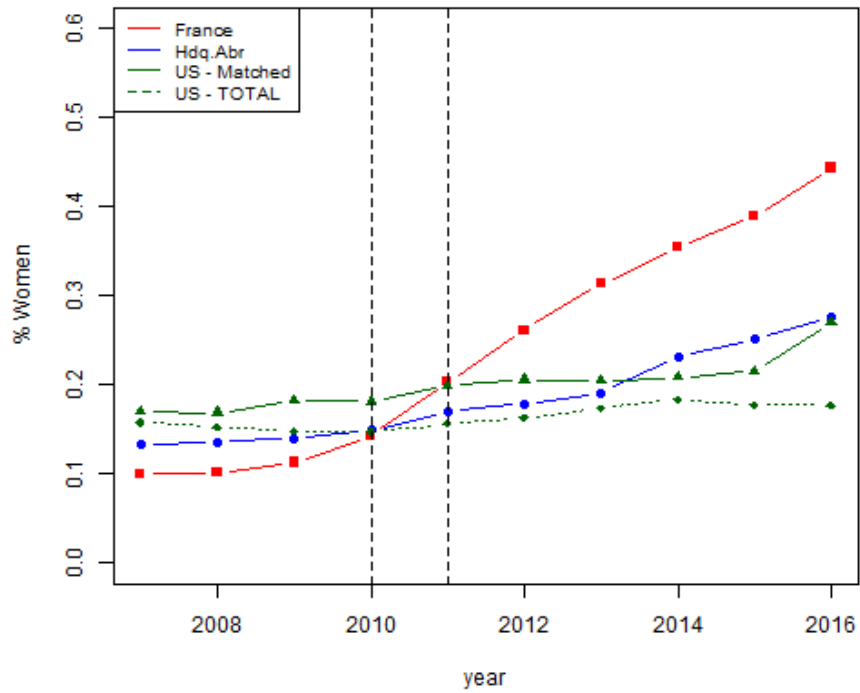
French companies can choose between unitary boards and dual boards. As gender quotas apply to supervisory boards but not to management boards, companies could opt for a supervisory board to maintain an all-male management board. We verify that no firm switched its board structure to a dual board in our sample after implementing the gender quota law. Finally, we conduct a placebo analysis by running the same regressions over the period 2007–2009, assuming that the exogenous change (quota law) occurred in 2008 (pseudo-event year). The coefficient on the variable “postquota\*treated” is never significantly different from zero in this placebo analysis.

## **1.5 Conclusion**

We analyze the impact of female directors on the firms’ E&S performance. As a natural experiment, we use the 2011 French law introducing a mandatory board gender quota for all French firms. We find that after the introduction of the quota, the E&S performance of French firms is enhanced. We investigate several channels to explain our results. After the quota, firms are more likely to have an E&S committee, and female directors are more likely to sit on this committee and chair it. However, the E&S committee is not the only channel to increase E&S, as E&S scores increase after the quota law even for firms without an E&S committee over the whole period. After the quota law, women are increasingly serving as members of major committees. Before joining the board, women are more likely than men to have experience in environmental and social positions. After the implementation of the quota and the arrival of several women on a board, the E&S expertise of the board increases, and the resulting decisions lead to an enhanced E&S performance. The quota law empowers female directors and allows them to promote their priorities, such as E&S policies.

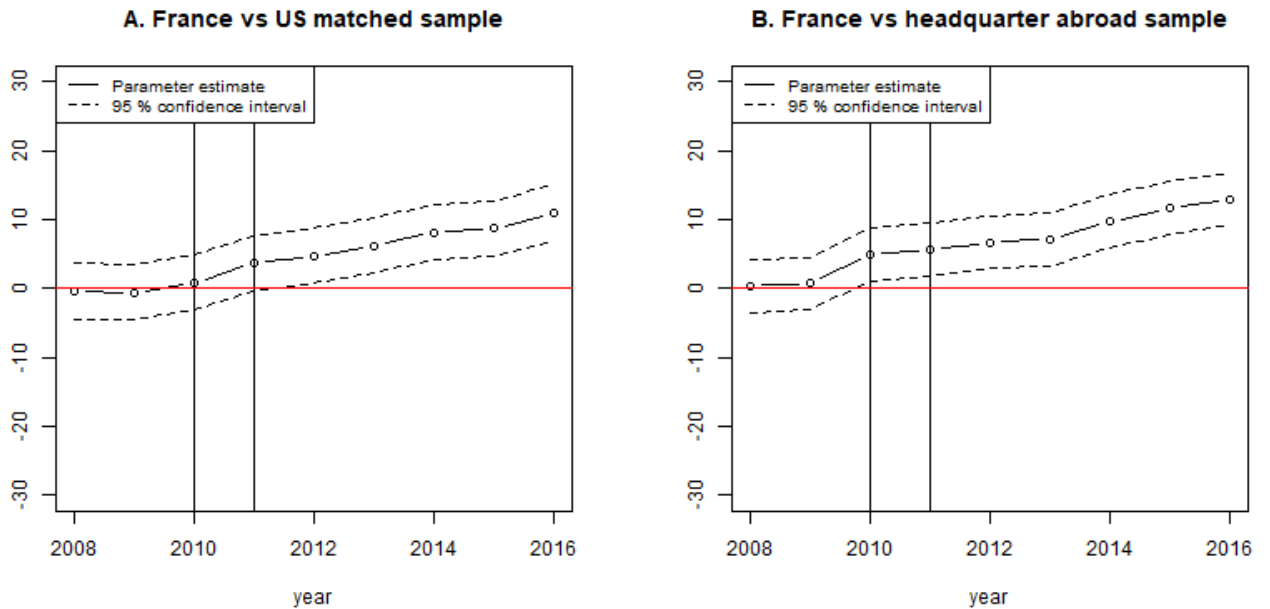
**Figure 1.1: Average percentage of female directors in France.**

This Figure shows the annual average percentage of female directors in French firms and our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. The sample includes all firms covered by BoardEx and Asset4 over the period 2008-2016.



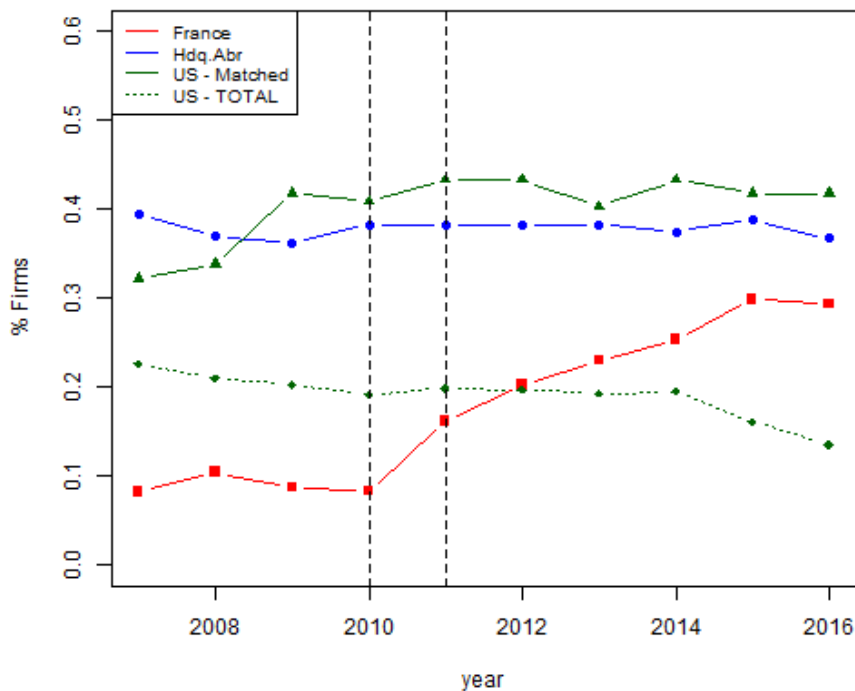
**Figure 1.2: Parallel trends.**

Figure A shows the regression coefficients from  $E\&S ratings_{i,t} = \alpha + \sum_{t=2007}^{2016} \beta_t \cdot Treated_{i,t} 1[Year = t] + Treated_{i,t} + \Delta + e_{i,t}$  with  $\Delta$  year and firm fixed effects. The control group is the matched US sample, and we plot all the interaction terms. Figure B represents coefficients from the same regression; however, the control group is the headquartered abroad sample. The sample includes all firms covered by BoardEx and Asset4.



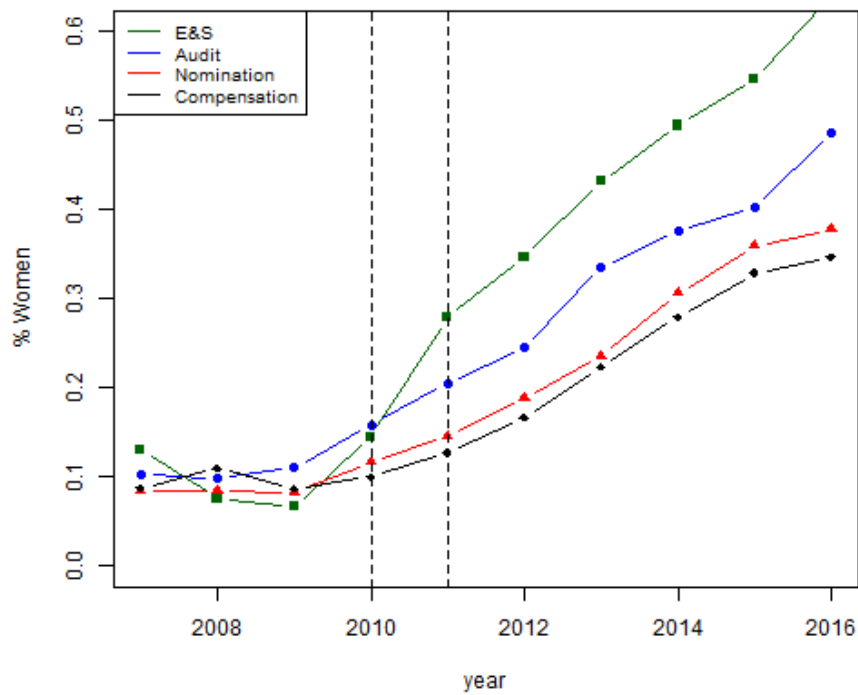
**Figure 1.3: Average percentage of firms with E&S committees.**

This Figure shows the annual average percentage of firms with E&S committees for French firms and our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. The sample includes all firms covered by BoardEx and Asset4 over the period 2008-2016.



**Figure 1.4: Average percentage of female directors sitting on board committees in France.**

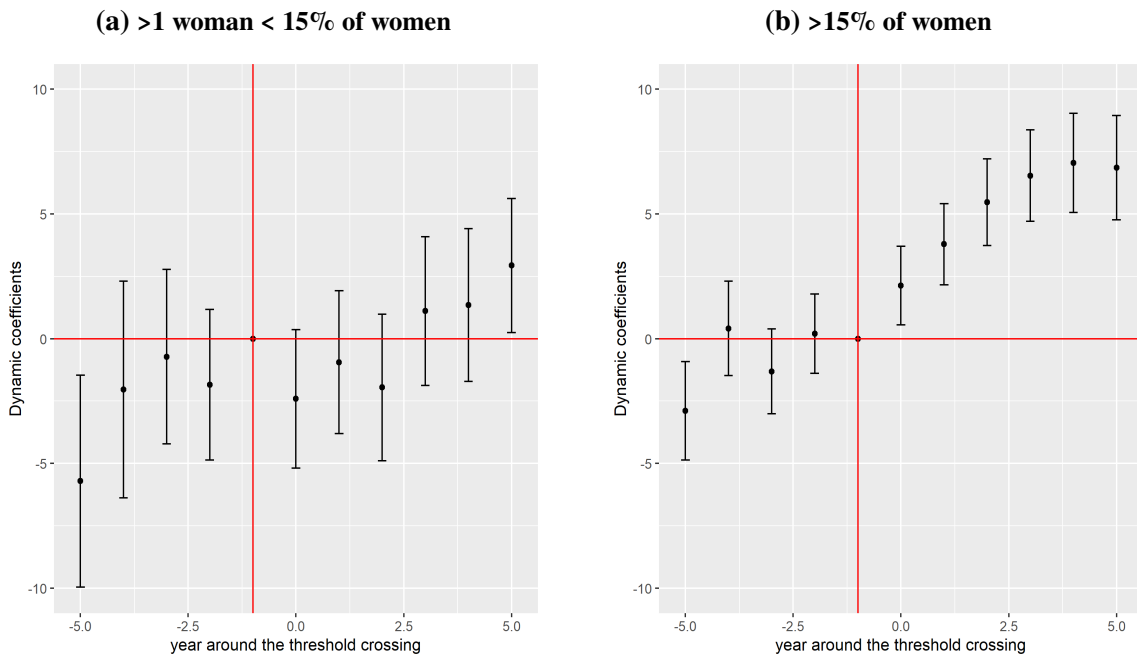
This figure shows the annual average percentage of female directors sitting on a given board committee in France for firms that have such a committee. The sample includes all firms covered by BoardEx and Asset4 over the period 2008-2016.



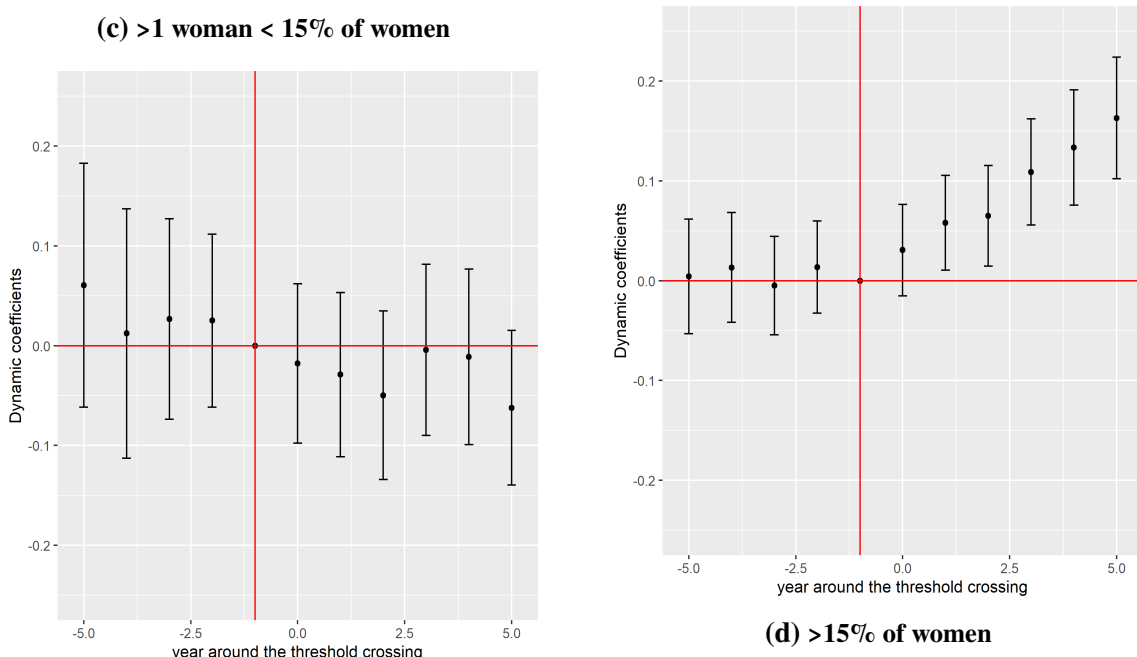
**Figure 1.5: Women on boards, E&S score and E&S.**

This Figure shows the dynamic treatment effects before and after the company reaches a certain threshold of women directors in their boards on the E&S score and E&S committee creation. More specifically, we use the following regression:  $Y_{i,t+1} = \alpha + \sum_{k=-5}^{-2} \beta_k \cdot Treated_{i,k} 1[Time = k] + \sum_{k=0}^5 \beta_k \cdot Treated_{i,k} 1[Time = k] + \beta_1 X_{i,t} + \Delta + e_{i,t}$  with  $\Delta$  year and firm fixed effects and  $X_{i,t}$  a vector of firm-level controls.  $Y_{p,t+1}$  represents the E&S score in Figures (a) and (b) or a dummy equal to one if the firm has an E&S committee in Figures (c) and (d).  $Treated_{i,k}$  is a dummy equal to one if the firm nominates at least one woman and up to 15% of women in Figure (a) and (c) and a dummy of one if the firm nominates more than 15% of women. in Figure (b) and (d). The year of reference is  $t = -1$ , and the confidence intervals for standard errors are computed at the 90% level. The sample includes all firms covered by BoardEx and Asset4 over the period 2007–2016.

*Panel A: E&S score*



*Panel B: E&S committee*



**Table 1.1: Summary statistics.**

This table summarizes firm-year characteristics for France and our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. Panels A and B report the summary statistics for 1,788 and 1,844 firm-year observations over the period 2007–2016, respectively. Observations with missing information are excluded. The appendix provides the definitions of the variables.

<b>Panel A: Asset 4</b>	France			United States - Matched			Headq.abroad		
<i>Firm characteristics</i>	N	Mean	SD	N	Mean	SD	N	Mean	SD
Size	718	23.11	1.30	659	23.13	1.25	470	24.33	1.31
Market.to.Book	718	2.11	1.68	659	4.08	6.37	470	3.20	7.97
Leverage	718	0.20	0.15	659	0.22	0.14	470	0.22	0.14
ROA	718	0.04	0.05	659	0.06	0.08	470	0.06	0.06
<i>Board characteristics</i>									
Women	718	0.25	0.16	659	0.20	0.12	470	0.19	0.11
Boardsize	718	13.39	3.38	659	11.15	2.10	470	13.75	5.38
Independent	718	0.57	0.21	659	0.97	0.07	470	0.77	0.30
Tenure	718	6.58	3.25	659	7.99	2.92	470	6.51	2.47
Network	718	3.90	1.91	659	4.98	1.49	470	4.45	1.78
Age	718	59.03	4.44	659	62.74	3.12	470	60.86	3.56
<i>ES characteristics</i>									
E&S.Score	718	59.83	20.51	659	55.94	21.58	470	69.62	21.25
Social.Score	718	59.76	21.58	659	59.61	20.51	470	73.29	20.36
Env.Score	718	59.91	23.24	659	52.28	25.76	470	65.95	24.45
<b>Panel B: Vigeo</b>	France			United States			Headq.abroad		
<i>Firm characteristics</i>	N	Mean	SD	N	Mean	SD	N	Mean	SD
Size	828	22.86	1.43	678	23.58	1.04	418	24.56	1.02
Market.to.Book	828	2.03	1.69	678	4.81	8.45	418	3.26	8.05
Leverage	828	0.19	0.14	678	0.24	0.14	418	0.22	0.13
ROA	828	0.03	0.06	678	0.07	0.07	418	0.06	0.06
<i>Board characteristics</i>									
Women	828	0.24	0.16	678	0.21	0.10	418	0.19	0.11
Boardsize	828	12.97	3.46	678	11.58	2.10	418	14.26	5.37
Independent	828	0.55	0.21	678	0.97	0.07	418	0.76	0.30
Tenure	828	6.80	3.25	678	8.55	2.67	418	6.55	2.49
Network	828	3.81	2.00	678	5.36	1.70	418	4.45	1.80
Age	828	59.16	4.49	678	63.14	3.00	418	60.65	3.46
<i>ES characteristics</i>									
E&S.Score	828	40.55	12.37	678	29.43	9.58	418	41.82	10.70
Social.Score	828	41.19	13.12	678	27.97	8.85	418	40.90	11.40
Env.Score	828	39.90	12.83	678	30.90	12.10	418	42.75	11.64

**Table 1.2: Women on boards and E&S score.**

This table reports the OLS estimates of the percentage of female directors on the E&S score, environmental score, and social score. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. All models include year and company fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S.Score <sub>t+1</sub>		Env.Score <sub>t+1</sub>		Social.Score <sub>t+1</sub>	
Women	14.74*** (4.22)	6.24*** (2.17)	11.07** (4.62)	4.89* (2.85)	18.40*** (4.91)	7.58*** (2.22)
Size	5.13*** (1.67)	2.82*** (1.03)	5.65*** (1.91)	3.04* (1.55)	4.61** (2.10)	2.59*** (0.92)
Market.to.Book	-0.04 (0.04)	-0.03* (0.02)	-0.11** (0.05)	-0.04 (0.02)	0.02 (0.05)	-0.03 (0.02)
Leverage	-3.92 (5.97)	-3.14 (2.41)	-5.70 (6.56)	-1.68 (2.81)	-2.15 (6.65)	-4.60* (2.61)
ROA	-0.29 (6.92)	-4.03 (3.50)	1.56 (9.07)	-5.91 (4.15)	-2.14 (7.13)	-2.15 (3.51)
Independent	1.78 (3.69)	-0.17 (2.58)	2.44 (3.87)	-0.35 (3.52)	1.12 (4.90)	0.001 (2.24)
Tenure	0.31 (0.30)	0.13 (0.14)	0.34 (0.36)	0.13 (0.17)	0.29 (0.34)	0.13 (0.16)
Network	-0.04 (0.40)	0.28 (0.24)	0.04 (0.48)	0.41 (0.31)	-0.13 (0.45)	0.16 (0.23)
Age	0.07 (0.22)	-0.15 (0.13)	0.08 (0.26)	-0.18 (0.14)	0.07 (0.25)	-0.12 (0.14)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
E&S scores	A4	Vigeo	A4	Vigeo	A4	Vigeo
Observations	1,788	1,844	1,788	1,844	1,788	1,844
Adjusted R <sup>2</sup>	0.89	0.91	0.87	0.85	0.85	0.91

**Table 1.3: New women on boards and E&S score.**

This table reports the OLS estimates of the effect of adding one, two, or three female directors to the board on the E&S score. The sample includes all companies covered by BoardEx and, alternatively, Asset4 and Vigeo over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. Columns (1) and (2) refer to the inclusion of one woman, columns (3) and (4) of two women, and columns (5) and (6) of three women on the board during our periods of interest. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S.Score <sub>t+1</sub>					
OneNewEntry	1.30 (1.00)	0.74 (0.48)				
TwoNewEntry			2.34** (0.93)	0.62 (0.47)		
ThreeNewEntry					3.31*** (1.11)	0.98* (0.55)
Size	5.31*** (1.73)	2.80*** (1.07)	5.12*** (1.70)	2.80*** (1.07)	5.14*** (1.67)	2.74*** (1.06)
Market.to.Book	-0.06 (0.04)	-0.04** (0.02)	-0.05 (0.04)	-0.04** (0.02)	-0.05 (0.05)	-0.04** (0.02)
Leverage	-5.35 (6.17)	-3.83 (2.42)	-5.85 (6.20)	-4.02* (2.43)	-4.63 (6.11)	-3.61 (2.42)
ROA	-1.25 (7.21)	-3.88 (3.46)	-1.12 (7.09)	-4.15 (3.44)	-0.58 (7.07)	-4.35 (3.36)
Independent	3.75 (4.01)	0.42 (2.68)	3.01 (3.98)	0.41 (2.72)	2.68 (3.95)	0.32 (2.71)
Tenure	0.36 (0.30)	0.15 (0.14)	0.40 (0.31)	0.16 (0.14)	0.42 (0.31)	0.16 (0.14)
Network	-0.37 (0.50)	0.16 (0.22)	-0.39 (0.50)	0.13 (0.22)	-0.38 (0.49)	0.13 (0.22)
Age	-0.01 (0.23)	-0.17 (0.12)	0.04 (0.22)	-0.17 (0.12)	0.07 (0.22)	-0.16 (0.12)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
E&S scores	A4	Vigeo	A4	Vigeo	A4	Vigeo
Observations	1,788	1,844	1,788	1,844	1,788	1,844
Adjusted R <sup>2</sup>	0.89	0.91	0.89	0.91	0.89	0.91



**Table 1.4: Effect of the quota law on the E&S scores.**

This table reports the OLS estimates of the treatment effects of the quota (post\_quota\_treated) on the E&S score, environmental score, and social score. The sample includes French firms and, alternately, one of our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. The results are reported for both Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period starts in 2011, and the year 2010 is excluded. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S.Score <sub>t+1</sub>				Env.Score <sub>t+1</sub>				Social.Score <sub>t+1</sub>			
Post_quota_treated	7.75***	8.22***	4.08***	4.05***	4.49*	6.35***	3.28**	4.59***	11.01***	10.08***	4.87***	3.51***
	(2.03)	(1.84)	(0.99)	(1.21)	(2.67)	(2.32)	(1.36)	(1.55)	(2.15)	(2.22)	(0.97)	(1.22)
Size	5.42***	5.99***	3.65***	3.63**	5.29**	6.51***	3.78**	4.15*	5.55**	5.47**	3.53***	3.10**
	(2.06)	(1.92)	(1.06)	(1.49)	(2.56)	(2.11)	(1.72)	(2.24)	(2.47)	(2.53)	(0.90)	(1.25)
Market.to.Book	-0.07	-0.02	-0.02	-0.02	-0.11**	-0.12*	-0.02	-0.04	-0.03	0.07	-0.03	0.01
	(0.07)	(0.06)	(0.01)	(0.03)	(0.05)	(0.07)	(0.02)	(0.04)	(0.11)	(0.05)	(0.02)	(0.02)
Leverage	-2.61	2.17	-1.77	-2.41	-8.01	2.12	0.91	-1.92	2.79	2.22	-4.45	-2.89
	(6.58)	(7.53)	(2.72)	(3.77)	(7.58)	(8.22)	(3.28)	(4.31)	(7.79)	(8.48)	(2.86)	(3.98)
ROA	-1.31	-8.64	-2.75	-6.56	3.69	-11.12	-3.48	-9.29	-6.31	-6.16	-2.01	-3.84
	(9.27)	(9.42)	(3.70)	(4.79)	(12.88)	(13.42)	(4.39)	(6.37)	(8.69)	(10.32)	(3.71)	(4.71)
Independent	5.46	2.08	2.16	-0.07	5.29	4.95	1.83	0.60	5.63	-0.79	2.49	-0.75
	(4.72)	(3.52)	(2.15)	(2.43)	(5.87)	(3.91)	(2.91)	(3.52)	(6.37)	(4.77)	(2.35)	(2.11)
Tenure	0.44	0.33	0.06	0.13	0.48	0.30	-0.004	0.10	0.41	0.37	0.13	0.16
	(0.37)	(0.42)	(0.15)	(0.20)	(0.47)	(0.51)	(0.18)	(0.23)	(0.40)	(0.45)	(0.17)	(0.23)
Network	-0.42	-0.33	0.23	0.40	-0.26	-0.21	0.35	0.56*	-0.59	-0.45	0.11	0.24
	(0.48)	(0.49)	(0.22)	(0.25)	(0.61)	(0.60)	(0.29)	(0.32)	(0.49)	(0.53)	(0.21)	(0.24)
Age	0.07	0.01	-0.18	-0.22	0.02	-0.06	-0.17	-0.31*	0.12	0.08	-0.19	-0.13
	(0.29)	(0.25)	(0.13)	(0.14)	(0.37)	(0.32)	(0.15)	(0.16)	(0.30)	(0.28)	(0.16)	(0.17)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Group	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	1,180	1,069	1,236	1,121	1,180	1,069	1,236	1,121	1,180	1,069	1,236	1,121
Adjusted R <sup>2</sup>	0.88	0.89	0.91	0.89	0.86	0.86	0.85	0.84	0.84	0.85	0.92	0.89

**Table 1.5: Effect of the quota law on the E&S scores: sample with only French firms.**

This table reports the OLS estimates of the treatment effects of the quota (post\_quota) on the E&S score, environmental score, and social score. The sample includes French firms. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period starts in 2011, and the year 2010 is excluded. All models include year and industry or company fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S.Score <sub>t+1</sub>				Env.Score <sub>t+1</sub>				Social.Score <sub>t+1</sub>			
Post_quota	10.46***	9.33***	3.41***	3.25***	9.71***	8.16***	5.16***	4.70***	11.21***	10.50***	1.66**	1.80**
	(1.59)	(1.66)	(0.69)	(0.67)	(1.92)	(2.15)	(0.81)	(0.82)	(1.80)	(1.98)	(0.75)	(0.76)
Size	6.57***	12.36***	4.99***	8.33***	5.84***	11.02***	4.83***	8.87***	7.31***	13.71***	5.15***	7.78***
	(1.05)	(2.54)	(0.54)	(1.32)	(1.25)	(2.87)	(0.65)	(2.19)	(1.32)	(3.40)	(0.59)	(1.30)
Market.to.Book	-0.17	0.43	-0.41	0.19	-0.71	0.13	-0.43	0.10	0.37	0.73	-0.38	0.29
	(0.78)	(0.61)	(0.26)	(0.20)	(0.75)	(0.69)	(0.30)	(0.23)	(0.89)	(0.74)	(0.26)	(0.25)
Leverage	-9.80	-1.00	-6.36	-0.35	-6.85	-4.96	-3.46	1.48	-12.75	2.95	-9.27	-2.17
	(11.12)	(9.88)	(6.31)	(4.92)	(12.43)	(10.43)	(6.67)	(5.40)	(11.49)	(12.72)	(6.47)	(5.45)
ROA	-32.08	-42.00**	10.64	-10.75*	-28.61	-43.16*	7.78	-11.18	-35.55	-40.84***	13.50*	-10.32*
	(25.54)	(17.10)	(7.20)	(5.77)	(21.92)	(24.90)	(7.75)	(7.26)	(34.49)	(14.45)	(7.93)	(5.50)
Independent	4.58	7.93	0.77	2.67	8.88*	11.39**	0.78	3.58	0.28	4.47	0.76	1.76
	(6.08)	(5.17)	(3.50)	(2.51)	(5.28)	(5.50)	(3.69)	(3.13)	(8.16)	(7.15)	(3.78)	(2.85)
Tenure	-0.12	0.43	-0.17	0.04	-0.57	0.59	-0.29	-0.06	0.32	0.27	-0.04	0.14
	(0.55)	(0.58)	(0.25)	(0.22)	(0.54)	(0.69)	(0.29)	(0.23)	(0.66)	(0.66)	(0.27)	(0.27)
Network	0.97	-0.48	0.78	0.70***	1.21	-0.60	0.69	0.80***	0.73	-0.35	0.88*	0.61*
	(0.91)	(0.54)	(0.50)	(0.27)	(0.93)	(0.66)	(0.51)	(0.30)	(1.03)	(0.59)	(0.53)	(0.32)
Age	0.81***	-0.10	-0.09	-0.41***	0.81***	-0.23	-0.06	-0.46***	0.81**	0.02	-0.11	-0.37*
	(0.25)	(0.34)	(0.19)	(0.15)	(0.27)	(0.43)	(0.22)	(0.14)	(0.32)	(0.38)	(0.19)	(0.19)
Industry FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	646	646	747	747	646	646	747	747	646	646	747	747
Adjusted R <sup>2</sup>	0.60	0.84	0.66	0.89	0.62	0.81	0.60	0.85	0.48	0.80	0.66	0.88

**Table 1.6: Effect of the quota law on the E&S committee presence.**

This table reports the OLS estimates of the treatment effects of the quota (*post\_quota\_treated*) on the probability of having an E&S committee. The sample includes French firms and, alternately, one of our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period starts in 2011, and the year 2010 is excluded. All models include year fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S committee <sub>t+1</sub>							
	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>
Post_quota_treated	1.06*** (0.23)	0.25*** (0.05)	0.69** (0.29)	0.19*** (0.07)	1.01*** (0.22)	0.20*** (0.06)	0.59** (0.26)	0.12* (0.06)
Treated	-1.21*** (0.39)		-0.86** (0.39)		-0.57* (0.31)		-0.26 (0.29)	
Size	0.38*** (0.09)	0.04 (0.07)	0.44*** (0.10)	0.07 (0.11)	0.34*** (0.10)	0.02 (0.07)	0.28*** (0.09)	-0.09 (0.12)
Market.to.Book	0.01 (0.01)	-0.004* (0.002)	0.0005 (0.01)	0.003 (0.003)	0.03* (0.02)	0.01* (0.003)	0.03 (0.02)	0.01** (0.003)
Leverage	0.83 (0.68)	-0.09 (0.14)	-0.28 (0.66)	-0.20 (0.19)	0.12 (0.80)	-0.12 (0.14)	0.24 (0.69)	-0.22 (0.21)
ROA	-0.53 (1.05)	-0.25 (0.21)	-1.04 (0.89)	0.02 (0.26)	-0.32 (1.85)	0.01 (0.30)	0.65 (1.55)	0.05 (0.26)
Independent	-0.22 (0.62)	-0.11 (0.23)	-0.004 (0.60)	-0.20 (0.23)	0.87** (0.43)	0.10 (0.18)	0.59 (0.39)	0.03 (0.20)
Tenure	-0.01 (0.03)	0.002 (0.01)	0.01 (0.03)	-0.01 (0.01)	-0.005 (0.03)	-0.003 (0.01)	-0.003 (0.03)	-0.01 (0.01)
Network	0.04 (0.05)	0.001 (0.02)	0.03 (0.05)	-0.003 (0.02)	0.02 (0.05)	-0.01 (0.02)	0.01 (0.05)	-0.01 (0.02)
Age	0.02 (0.03)	0.001 (0.01)	0.01 (0.03)	0.0001 (0.01)	0.002 (0.03)	0.001 (0.01)	-0.0004 (0.03)	0.004 (0.01)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes
Control Group	US	US	US	US	Hq.Abr	Hq.Abr	Hq.Abr	Hq.Abr
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	1,180	1,180	1,236	1,236	1,069	1,069	1,121	1,121
Adjusted R <sup>2</sup>		0.68		0.64		0.66		0.63
Log Likelihood	-590.66		-619.31		-537.28		-564.71	
Akaike Inf. Crit.	1,219.32		1,276.62		1,112.56		1,167.41	

**Table 1.7: Effect of the quota law on the E&S committee presence: sample with only French firms.**

This table reports the OLS estimates of the treatment effects of the quota (post\_quota) on the probability of having an E&S committee. The sample includes French firms. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period starts in 2011, and the year 2010 is excluded. All models include year and industry or company fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%..

	E&S committee <sub>t+1</sub>							
	<i>probit</i>		<i>OLS</i>		<i>probit</i>		<i>OLS</i>	
Post_quota	0.87***	0.18***	0.19***	0.55**	0.14***	0.17***		
	(0.21)	(0.05)	(0.06)	(0.22)	(0.04)	(0.05)		
Size	0.38***	0.09***	0.01	0.29***	0.09***	−0.08		
	(0.12)	(0.03)	(0.10)	(0.10)	(0.02)	(0.14)		
Market.to.Book	0.04	−0.01	0.005	−0.001	−0.01	−0.01		
	(0.05)	(0.02)	(0.02)	(0.05)	(0.01)	(0.01)		
Leverage	−0.67	−0.05	−0.02	−0.37	−0.12	−0.08		
	(1.22)	(0.25)	(0.15)	(0.94)	(0.23)	(0.25)		
ROA	−2.68	−0.28	−0.36	−0.21	−0.09	−0.17		
	(3.02)	(0.58)	(0.41)	(1.55)	(0.29)	(0.30)		
Independent	−0.24	−0.08	−0.10	−0.43	−0.19	−0.13		
	(0.58)	(0.16)	(0.22)	(0.50)	(0.12)	(0.24)		
Tenure	−0.08*	−0.02*	−0.003	−0.06*	−0.02	−0.01		
	(0.04)	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)		
Network	−0.03	−0.01	−0.01	−0.03	−0.01	−0.01		
	(0.06)	(0.02)	(0.02)	(0.05)	(0.01)	(0.02)		
Age	0.03	0.01	0.001	0.02	0.01	0.002		
	(0.04)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)		
Industry FE	Yes	No	No	Yes	No	No		
Firm FE	No	Yes	Yes	No	Yes	Yes		
E&S scores	A4	A4	A4	Vigeo	Vigeo	Vigeo		
Observations	646	646	646	747	747	747		
Adjusted R <sup>2</sup>	0.17	0.59	0.58	0.14	0.55	0.55		

**Table 1.8: New women on boards and E&S committee.**

This table reports the OLS estimates of the effect of adding one, two, or three female directors to the board on the probability of having an E&S committee. The sample includes all companies covered by BoardEx and, alternatively, Asset4 and Vigeo over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. Columns (1) and (2) refer to the inclusion of one woman, columns (3) and (4) of two women, and columns (5) and (6) of three women on the board during our periods of interest. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S committee <sub>t+1</sub>					
OneNewEntry	−0.01 (0.03)	−0.02 (0.03)				
TwoNewEntry			0.01 (0.03)	0.01 (0.03)		
ThreeNewEntry					0.13*** (0.04)	0.09** (0.04)
Size	0.05 (0.06)	0.04 (0.09)	0.05 (0.06)	0.04 (0.09)	0.04 (0.06)	0.03 (0.09)
Market.to.Book	0.001 (0.003)	0.002 (0.002)	0.001 (0.003)	0.002 (0.002)	0.001 (0.003)	0.002 (0.002)
Leverage	−0.23* (0.14)	−0.28* (0.16)	−0.24* (0.14)	−0.28* (0.16)	−0.21 (0.14)	−0.26 (0.16)
ROA	−0.17 (0.19)	0.01 (0.22)	−0.18 (0.19)	0.01 (0.22)	−0.16 (0.18)	−0.02 (0.22)
Independent	0.17 (0.15)	0.07 (0.17)	0.17 (0.15)	0.06 (0.17)	0.13 (0.14)	0.04 (0.17)
Tenure	−0.001 (0.01)	−0.004 (0.01)	−0.001 (0.01)	−0.004 (0.01)	0.003 (0.01)	−0.002 (0.01)
Network	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
Age	−0.001 (0.01)	−0.001 (0.01)	−0.001 (0.01)	−0.0003 (0.01)	0.002 (0.01)	0.002 (0.01)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
E&S scores	A4	Vigeo	A4	Vigeo	A4	Vigeo
Observations	1,788	1,844	1,788	1,844	1,788	1,844
Adjusted R <sup>2</sup>	0.69	0.67	0.69	0.67	0.70	0.67

**Table 1.9: Female directors and board committees.**

This table summarizes director-year characteristics regarding board committees for France over the period 2007–2016. Panel A reports summary statistics for 9,587 director-year observations present in the Asset 4 sample and Panel B reports summary statistics for 10,703 director-year observations present in the Vigeo sample. The appendix provides the definitions of the variables.

<b>Panel A: Asset 4</b>							
<i>Before 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
E&S members	3,573	0.05	0.22	0.05	0.05	-0.003	-0.27
Audit members	3,573	0.26	0.44	0.26	0.27	-0.003	-0.13
Compensation members	3,573	0.24	0.43	0.25	0.23	0.01	0.61
Nomination members	3,573	0.22	0.42	0.23	0.20	0.03	1.14
E&S chairman	3,573	0.01	0.11	0.01	0.003	0.01	2.91
Audit chairman	3,573	0.07	0.25	0.07	0.04	0.03	3.09
Compensation chairman	3,573	0.06	0.25	0.07	0.06	0.01	0.73
Nomination chairman	3,573	0.06	0.23	0.06	0.07	-0.01	-0.92
<i>After 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
E&S members	6,014	0.10	0.30	0.08	0.14	-0.06	-6.29
Audit members	6,014	0.30	0.46	0.28	0.34	-0.06	-4.43
Compensation members	6,014	0.27	0.44	0.27	0.26	0.01	1.05
Nomination members	6,014	0.25	0.43	0.26	0.23	0.03	2.86
E&S chairman	6,014	0.02	0.16	0.02	0.03	-0.01	-2.14
Audit chairman	6,014	0.07	0.26	0.08	0.06	0.02	2.66
Compensation chairman	6,014	0.07	0.25	0.07	0.05	0.02	3.51
Nomination chairman	6,014	0.06	0.24	0.06	0.05	0.01	1.96
<b>Panel B: Vigeo</b>							
<i>Before 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
E&S members	3,858	0.05	0.22	0.05	0.06	-0.01	-0.64
Audit members	3,858	0.28	0.45	0.28	0.25	0.03	1.12
Compensation members	3,858	0.26	0.44	0.26	0.22	0.04	1.65
Nomination members	3,858	0.23	0.42	0.24	0.20	0.03	1.53
E&S chairman	3,858	0.01	0.11	0.01	0.003	0.01	3.30
Audit chairman	3,858	0.07	0.26	0.08	0.03	0.05	4.74
Compensation chairman	3,858	0.07	0.25	0.07	0.05	0.02	1.67
Nomination chairman	3,858	0.06	0.24	0.06	0.06	0.0001	0.004
<i>After 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
E&S members	6,845	0.09	0.29	0.08	0.13	-0.05	-6.20
Audit members	6,845	0.30	0.46	0.29	0.33	-0.04	-3.02
Compensation members	6,845	0.27	0.44	0.27	0.26	0.01	0.70
Nomination members	6,845	0.25	0.43	0.25	0.23	0.03	2.26
E&S chairman	6,845	0.02	0.15	0.02	0.03	-0.01	-2.50
Audit chairman	6,845	0.07	0.26	0.08	0.06	0.03	3.90
Compensation chairman	6,845	0.07	0.25	0.07	0.05	0.02	2.75
Nomination chairman	6,845	0.06	0.24	0.06	0.05	0.01	1.23

**Table 1.10: Effect of the quota law on the presence of women on board committees.**

This table reports the treatment effects estimates of the quota (*post\_quota\_treated*) on the probability of having a woman chair the committee and the percentage of women members in the committee. The dependent variable in columns 1 to 8 is a dummy equal to one if the committee chairperson is a woman. The dependent variable in columns 9 to 12 is the percentage of women on the committee. The sample includes French firms and, alternately, one of our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. The results are reported for the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period begins in 2011, and the year 2010 is excluded. All models include year and firm fixed effects and our usual controls: Size, Market.to.Book, Leverage, ROA, Independent, Tenure, Network, Age. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Committee chairwoman				Percentage of women members							
	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>	<i>probit</i>	<i>OLS</i>	<i>OLS</i>			
<b>Panel A: E&amp;S committee</b>												
Post_quota_treated	6.66***	0.38*	11.28***	0.24	5.46***	0.45*	5.91***	0.37*	0.25***	0.20***	0.30***	0.30***
	(0.76)	(0.23)	(0.91)	(0.21)	(0.61)	(0.24)	(0.70)	(0.20)	(0.07)	(0.05)	(0.07)	(0.07)
Treated	-7.56***	-0.70	-11.70***	-0.49	-4.93***	-0.96	-5.15***	-0.92*	-0.39*	-0.38**	0.03	0.48*
	(1.06)	(0.48)	(1.26)	(0.36)	(0.54)	(0.59)	(0.59)	(0.47)	(0.21)	(0.16)	(0.31)	(0.27)
Observations	357	357	386	386	286	286	278	278	357	386	286	278
Adjusted R <sup>2</sup>		0.68		0.59		0.61		0.62	0.65	0.67	0.69	0.72
Log Likelihood	-190.49		-223.50		-140.27		-124.09					
Akaike Inf. Crit.	418.99		485.01		318.53		286.18					
<b>Panel B: Audit committee</b>												
Post_quota_treated	0.69*	0.08	0.73*	0.08	0.88**	0.10	0.94**	0.12**	0.16***	0.18***	0.15***	0.15***
	(0.38)	(0.07)	(0.39)	(0.05)	(0.42)	(0.06)	(0.43)	(0.06)	(0.04)	(0.03)	(0.05)	(0.05)
Treated	-1.09**	-0.76***	-0.81*	-0.95***	-0.73*	-0.32**	-0.82*	-0.21	-0.32***	0.01	0.19	0.19
	(0.43)	(0.15)	(0.44)	(0.17)	(0.41)	(0.16)	(0.43)	(0.18)	(0.08)	(0.07)	(0.13)	(0.13)
Observations	990	990	1,030	1,030	810	810	838	838	990	1,030	810	838
Adjusted R <sup>2</sup>		0.62		0.62		0.65		0.64	0.63	0.64	0.63	0.64
Log Likelihood	-406.51		-389.99		-343.15		-345.95					
Akaike Inf. Crit.	851.01		817.99		724.30		729.90					
<b>Panel C: Compensation committee</b>												
Post_quota_treated	0.57	0.03	0.53	0.01	0.57	0.02	0.76	0.04	0.08**	0.12***	0.07*	0.09**
	(0.36)	(0.07)	(0.41)	(0.07)	(0.42)	(0.07)	(0.48)	(0.07)	(0.04)	(0.03)	(0.04)	(0.04)
Treated	-0.18	-0.51***	-0.53	-0.21*	-0.15	-0.30	-0.09	-0.11	-0.12	-0.17*	-0.02	0.07
	(0.44)	(0.12)	(0.51)	(0.12)	(0.52)	(0.22)	(0.56)	(0.23)	(0.10)	(0.09)	(0.09)	(0.12)
Observations	974	974	1,010	1,010	766	766	784	784	974	1,010	766	784
Adjusted R <sup>2</sup>		0.57		0.57		0.58		0.61	0.56	0.58	0.56	0.58
Log Likelihood	-389.54		-420.64		-268.29		-271.00					
Akaike Inf. Crit.	817.08		879.27		574.58		580.01					
<b>Panel D: Nomination committee</b>												
Post_quota_treated	0.62**	0.06	0.53	0.01	0.72**	0.09	1.15***	0.14	0.09**	0.08**	0.03	0.06
	(0.30)	(0.08)	(0.36)	(0.08)	(0.33)	(0.08)	(0.41)	(0.09)	(0.04)	(0.04)	(0.05)	(0.05)
Treated	-0.16	0.03	-0.51	-0.25*	-0.23	-0.82***	-0.24	-0.76***	-0.15*	-0.34***	-0.27***	-0.13
	(0.38)	(0.13)	(0.46)	(0.14)	(0.38)	(0.23)	(0.46)	(0.26)	(0.08)	(0.10)	(0.10)	(0.14)
Observations	827	827	845	845	672	672	680	680	827	845	672	680
Adjusted R <sup>2</sup>		0.56		0.56		0.58		0.58	0.56	0.53	0.59	0.58
Log Likelihood	-378.42		-387.45		-293.25		-277.85					
Akaike Inf. Crit.	794.83		812.90		624.51		593.69					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Control Group	US	US	US	US	Hq.Abr	Hq.Abr	Hq.Abr	Hq.Abr	US	US	Hq.Abr	Hq.Abr
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo	A4	Vigeo	A4	Vigeo

**Table 1.11: Effect of the quota law on the E&S scores: sample of firms without E&S committee over 2007–2016.**

This table reports the OLS estimates of the treatment effects of the quota (post\_quota\_treated) on the E&S score, environmental score, and social score. The sample includes French firms and, alternately, one of our control groups composed of matched US firms and firms listed in Paris and headquartered abroad. Only firms with no E&S committee during the entire period of interest are included. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period begins in 2011, and the year 2010 is excluded. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S.Score <sub>t+1</sub>				Env.Score <sub>t+1</sub>				Social.Score <sub>t+1</sub>			
Post_quota_treated	9.42***	4.59***	9.96***	3.59**	7.80**	3.84*	11.05***	4.32**	11.04***	5.34***	8.87***	2.86*
	(2.80)	(1.47)	(2.53)	(1.63)	(3.45)	(1.97)	(3.01)	(2.15)	(3.06)	(1.45)	(3.28)	(1.58)
Size	7.25**	1.71	6.48**	2.23	7.21**	2.16	6.71***	2.18	7.30*	1.26	6.24*	2.29
	(3.09)	(1.15)	(2.63)	(1.91)	(3.20)	(1.54)	(2.56)	(2.43)	(3.96)	(1.28)	(3.79)	(1.94)
Market.to.Book	-0.20**	-0.07*	-0.08	-0.08***	-0.20*	-0.09*	-0.15*	-0.13***	-0.20*	-0.05	-0.004	-0.03
	(0.09)	(0.04)	(0.06)	(0.03)	(0.11)	(0.05)	(0.08)	(0.04)	(0.10)	(0.05)	(0.06)	(0.03)
Leverage	-3.84	-2.32	0.97	-1.85	-6.69	0.28	3.72	-1.47	-0.99	-4.92	-1.78	-2.22
	(7.78)	(3.16)	(8.42)	(4.80)	(8.35)	(3.96)	(9.20)	(5.44)	(9.51)	(3.29)	(9.82)	(5.00)
ROA	-9.76	-4.70	-18.51	-10.42	-1.46	-7.59	-20.88	-12.91	-18.07	-1.82	-16.15	-7.93
	(12.66)	(4.68)	(13.04)	(6.43)	(16.94)	(6.27)	(16.00)	(8.41)	(12.06)	(4.48)	(15.60)	(5.78)
Independent	1.04	3.30	-2.18	3.54	1.22	2.88	2.33	5.93**	0.86	3.72	-6.69	1.16
	(5.74)	(2.36)	(4.86)	(2.25)	(7.28)	(2.81)	(5.37)	(2.74)	(7.82)	(3.09)	(6.69)	(2.82)
Tenure	0.04	0.24	0.21	0.42	-0.15	0.12	0.18	0.45	0.23	0.35	0.24	0.38
	(0.50)	(0.21)	(0.55)	(0.27)	(0.58)	(0.26)	(0.61)	(0.32)	(0.58)	(0.26)	(0.64)	(0.31)
Network	-0.35	0.40	-0.22	0.41	0.19	0.68**	0.25	0.61*	-0.90*	0.13	-0.69	0.22
	(0.54)	(0.25)	(0.54)	(0.28)	(0.65)	(0.32)	(0.65)	(0.35)	(0.54)	(0.26)	(0.57)	(0.26)
Age	0.11	-0.19	0.17	-0.31*	-0.12	-0.23	-0.10	-0.43**	0.34	-0.15	0.45	-0.19
	(0.34)	(0.19)	(0.31)	(0.17)	(0.40)	(0.20)	(0.35)	(0.21)	(0.38)	(0.22)	(0.37)	(0.21)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Group	US	US	Hq.Abr	Hq.Abr	US	US	Hq.Abr	Hq.Abr	US	US	Hq.Abr	Hq.Abr
E&S scores	A4	Vigeo	A4	Vigeo	A4	Vigeo	A4	Vigeo	A4	Vigeo	A4	Vigeo
Observations	678	667	600	655	678	667	600	655	678	667	600	655
Adjusted R <sup>2</sup>	0.89	0.91	0.91	0.90	0.88	0.86	0.89	0.86	0.84	0.91	0.86	0.89



**Table 1.12: Director characteristics.**

This table summarizes director-year characteristics regarding board committees for France over the period 2007–2016. Panel A reports summary statistics for 9,587 director-year observations in the Asset 4 sample and Panel B reports summary statistics for 10,703 director-year observations in the Vigeo sample. The appendix provides the definitions of the variables.

<b>Panel A: Asset 4</b>							
<i>Before 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
Independent	3,573	0.43	0.50	0.42	0.48	-0.06	-2.04
Tenure	3,565	6.54	6.41	6.59	6.12	0.48	1.29
Network	3,495	3.60	4.01	3.82	1.67	2.16	9.68
Age	3,533	58.70	10.17	59.20	54.11	5.09	8.44
Prev.ES.Exp	3,572	0.11	0.32	0.11	0.18	-0.07	-3.31
Nbryear.ES.Exp	3,573	2.23	7.35	2.18	2.78	-0.60	-1.40
E&S.Score	3,573	54.92	21.62	54.79	56.42	-1.63	-1.29
<i>After 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
Independent	6,014	0.50	0.50	0.43	0.67	-0.24	-17.39
Tenure	6,003	7.03	6.74	8.18	4.14	4.04	24.98
Network	5,927	3.92	4.38	4.61	2.22	2.39	22.10
Age	5,965	58.64	10.02	60.21	54.68	5.53	19.94
Prev.ES.Exp	6,014	0.13	0.34	0.10	0.22	-0.12	-10.98
Nbryear.ES.Exp	6,014	2.71	8.22	2.22	3.95	-1.73	-6.75
E&S.Score	6,014	65.48	17.29	64.90	67.02	-2.12	-4.37
<b>Panel B: Vigeo</b>							
<i>Before 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
Independent	3,858	0.43	0.49	0.42	0.46	-0.03	-1.23
Tenure	3,849	6.93	6.79	6.92	7.02	-0.10	-0.25
Network	3,766	3.58	4.01	3.79	1.69	2.10	9.80
Age	3,793	59.04	9.96	59.48	54.93	4.55	7.71
Prev.ES.Exp	3,857	0.11	0.31	0.10	0.18	-0.08	-3.93
Nbryear.ES.Exp	3,858	2.08	7.05	1.98	3.02	-1.04	-2.37
E&S.Score	3,858	40.29	13.01	40.20	41.31	-1.10	-1.69
<i>After 2010</i>	N	Mean	SD	Men	Women	Diff	t.stat
Independent	6,845	0.47	0.50	0.41	0.64	-0.23	-17.15
Tenure	6,830	7.16	7.11	8.29	4.16	4.13	25.54
Network	6,751	3.79	4.39	4.41	2.15	2.26	22.11
Age	6,766	58.59	10.17	60.10	54.59	5.51	20.54
Prev.ES.Exp	6,845	0.13	0.33	0.09	0.21	-0.11	-11.10
Nbryear.ES.Exp	6,845	2.56	8.00	2.10	3.80	-1.70	-7.13
E&S.Score	6,845	42.80	11.77	42.39	43.93	-1.53	-4.90

**Table 1.13: E&S experience of female directors.**

This table reports the OLS estimates of the impact of being a female director on the E&S experience. The results are reported at the director level for French firms over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Prev.ES.Exp				Nbryear.ES.Exp			
Women	0.11*** (0.02)	0.10*** (0.03)	0.10*** (0.02)	0.09*** (0.02)	1.37*** (0.53)	1.40** (0.61)	1.40*** (0.51)	1.42** (0.58)
Independent		0.07*** (0.02)		0.06*** (0.02)		2.04*** (0.51)		1.85*** (0.49)
Tenure		-0.001 (0.002)		-0.001 (0.001)		0.03 (0.05)		0.02 (0.05)
Network		0.001 (0.002)		0.002 (0.002)		0.05 (0.06)		0.07 (0.05)
Age		0.001 (0.001)		0.0002 (0.001)		0.04** (0.02)		0.02 (0.02)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E&S score	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	9,367	9,367	10,413	10,413	9,367	9,367	10,413	10,413
Adjusted R <sup>2</sup>	0.08	0.09	0.08	0.09	0.06	0.08	0.06	0.08

**Table 1.14: Effect of the law on the percentage of directors with E&S experience in France.**

This table reports the OLS estimates of the treatment effects of the quota (post\_quota) on the percentage of directors with E&S experience. The sample includes French firms. The results are reported for both the Asset 4 and Vigeo samples over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period begins in 2011, and the year 2010 is excluded. All models include year and industry or firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Pc.Prev.ES.EXP <sub>t+1</sub>				Pc.Prev.ES.EXP.HJ <sub>t+1</sub>			
Post_quota	0.03*** (0.01)	0.03** (0.01)	0.03*** (0.01)	0.02** (0.01)	0.06*** (0.01)	0.05*** (0.02)	0.05*** (0.01)	0.05*** (0.01)
Size	0.02** (0.01)	0.02 (0.02)	0.02*** (0.01)	0.02 (0.02)	0.02 (0.01)	0.01 (0.03)	0.02*** (0.01)	0.02 (0.03)
Market.to.Book	0.0002 (0.004)	0.01* (0.005)	0.001 (0.003)	0.01** (0.003)	0.002 (0.01)	0.01* (0.005)	0.003 (0.005)	0.01** (0.004)
Leverage	0.10 (0.06)	0.003 (0.05)	0.12* (0.07)	0.02 (0.07)	0.14* (0.08)	0.06 (0.06)	0.16** (0.08)	0.03 (0.10)
ROA	-0.08 (0.17)	0.22* (0.13)	0.09 (0.07)	0.21*** (0.07)	-0.14 (0.20)	0.09 (0.15)	0.11 (0.09)	0.21** (0.08)
Independent	-0.08* (0.04)	-0.03 (0.05)	-0.06* (0.03)	-0.003 (0.04)	-0.12* (0.07)	-0.05 (0.07)	-0.10** (0.05)	0.005 (0.06)
Tenure	-0.005* (0.003)	0.001 (0.003)	-0.01** (0.003)	-0.002 (0.003)	-0.01* (0.004)	-0.0001 (0.005)	-0.01* (0.004)	-0.001 (0.005)
Network	-0.001 (0.004)	-0.003 (0.004)	0.004 (0.004)	0.001 (0.004)	0.005 (0.01)	-0.001 (0.01)	0.01* (0.005)	0.002 (0.005)
Age	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.003)	0.002 (0.004)	0.001 (0.003)	0.002 (0.003)
Industry FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	646	646	747	747	646	646	747	747
Adjusted R <sup>2</sup>	0.32	0.69	0.33	0.70	0.26	0.66	0.27	0.65

**Table 1.15: E&S experience of women directors and E&S committees.**

This table reports the OLS estimates of the impact of being a director with E&S experience on E&S committees. The results are reported at the director level for French firms over the period 2007–2016. We delete observations with missing information, and the financial variables are trimmed at 1%. All models include year and firms fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firm are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	E&S committee member		E&S committee chair		E&S committee	
Prev.ES.Exp	0.05*** (0.02)	0.05*** (0.02)	0.02* (0.01)	0.02* (0.01)	0.02** (0.01)	0.02* (0.01)
Independent	0.01 (0.01)	0.01 (0.01)	0.02** (0.01)	0.02** (0.01)	-0.02** (0.01)	-0.02** (0.01)
Tenure	0.0003 (0.001)	-0.001 (0.001)	-0.0001 (0.0004)	-0.0001 (0.0003)	-0.0005 (0.001)	-0.001 (0.001)
Network	-0.003** (0.001)	-0.002 (0.001)	-0.0002 (0.001)	0.0002 (0.001)	-0.0005 (0.001)	-0.001 (0.001)
Age	0.001 (0.001)	0.001* (0.0005)	0.001** (0.0003)	0.001** (0.0003)	0.001 (0.0005)	0.001 (0.0005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
E&S score	A4	Vigeo	A4	Vigeo	A4	Vigeo
Observations	9,367	10,413	9,367	10,413	9,367	10,413
Adjusted R <sup>2</sup>	0.24	0.24	0.06	0.06	0.62	0.60

**Table 1.16: Quota law and E&S scores: Breakdown between firms with a high and low percentage of directors with E&S experience.**

This table reports the OLS estimates of the treatment effects of the quota (*post\_quota\_treated*) on the E&S score. The sample includes French firms and our control groups composed of matched US firms. The results are reported for both Asset 4 and Vigeo samples over the period 2007–2016. Columns (1) to (4) report the results for firms with less than 10% of directors with E&S experience in 2009, and columns (5) to (8) for the others. We delete observations with missing information, and the financial variables are trimmed at 1%. The post-quota period starts in 2011, and the year 2010 is excluded. All models include year and firm fixed effects. The appendix provides the definitions of the variables. Standard errors clustered by firms are reported in parentheses. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Low.Prev.ES.EXP				High.Prev.ES.EXP			
	E&S.Score <sub>t+1</sub>							
Post_quota_treated	14.06***	11.73***	4.28***	4.05**	1.08	2.01	4.09***	2.65
	(2.93)	(2.72)	(1.60)	(1.70)	(3.35)	(2.95)	(1.29)	(1.83)
Treated	-10.39*	-1.29	14.05***	2.98	3.96	-8.25*	11.37***	1.59
	(5.36)	(5.08)	(3.08)	(2.60)	(5.71)	(4.46)	(2.83)	(3.38)
Size	7.29***	11.78***	5.24***	5.16***	9.98***	9.54***	5.58***	5.42***
	(1.43)	(1.46)	(0.77)	(0.77)	(1.67)	(1.22)	(0.75)	(0.76)
Market.to.Book	0.02	-0.16	0.01	-0.10	0.33	-0.08*	-0.04	-0.07
	(0.10)	(0.21)	(0.06)	(0.10)	(0.24)	(0.05)	(0.05)	(0.05)
Leverage	-26.69**	-22.65*	-7.53	-13.72**	-10.07	3.46	1.74	-6.69
	(12.89)	(13.08)	(4.92)	(6.05)	(9.60)	(9.96)	(5.69)	(7.26)
ROA	-17.73	10.78	10.15	3.11	17.93	-41.27*	3.42	-14.20
	(17.61)	(20.58)	(6.74)	(7.36)	(11.80)	(23.44)	(6.10)	(13.41)
Independent	-7.77	0.55	1.54	-0.64	2.70	8.10	-0.81	-0.05
	(8.69)	(4.76)	(5.16)	(3.07)	(8.48)	(6.93)	(4.80)	(4.67)
Tenure	-0.27	0.25	0.36	0.12	-0.02	0.87**	0.14	0.20
	(0.60)	(0.63)	(0.33)	(0.37)	(0.48)	(0.39)	(0.26)	(0.28)
Network	0.44	1.08	0.29	0.25	0.77	1.07	0.77	1.54**
	(0.80)	(1.03)	(0.47)	(0.51)	(0.94)	(1.17)	(0.50)	(0.61)
Age	0.78**	0.20	-0.23	-0.09	-0.23	-0.32	-0.59**	-0.50*
	(0.32)	(0.42)	(0.20)	(0.20)	(0.41)	(0.38)	(0.30)	(0.29)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Group	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr	US	Hq.Abr
E&S scores	A4	A4	Vigeo	Vigeo	A4	A4	Vigeo	Vigeo
Observations	601	553	632	580	579	516	604	541
Adjusted R <sup>2</sup>	0.54	0.67	0.65	0.58	0.66	0.68	0.80	0.68

## Variables definitions

The table shows the names and definitions of the variables

Variable name	Definition
<i>Firm characteristics</i> <span style="float: right;"><i>Source: Compustat</i></span>	
Size	Logarithm of total asset in millions of Euros
Market.to.Book	Market value of the equity divided by book value of the equity
Leverage	Long-term debt divided by the total asset
ROA	Net income divided by total asset of the previous year
<i>Board characteristics</i> <span style="float: right;"><i>Source: Boardex</i></span>	
Women	Percentage of women on board
Boardsize	Number of directors on board
Independent	Percentage of independent directors on board
Tenure	Average time on board of directors
Network	Average time that directors sit on the board of other listed companies
Age	Average age of directors sitting on the board
E&S committee	Dummy equal to one if the firm has an E&S committee
(X)NewEntry	Dummy equal to one if (X) women join the board
Pc.Prev.ES.EXP	Percentage of directors with E&S experience
<i>Board committees</i> <span style="float: right;"><i>Source: Boardex</i></span>	
Committee chairwoman	Dummy equal to one if the chairperson of the committee is a woman
Percentage of women members	Percentage of women sitting on the committee
Pc.Prev.ES.EXP.HJ	Percentage of directors members or chairs of committees with E&S experience
E&S members	Dummy equal to one if the director is a member of an E&S committee
Audit members	Dummy equal to one if the director is a member of an audit committee
Compensation members	Dummy equal to one if the director is a member of a compensation committee
Nomination members	Dummy equal to one if the director is a member of a nomination committee
E&S chairperson	Dummy equal to one if the director is the chairperson of an E&S committee
Audit chairperson	Dummy equal to one if the director is the chairperson of an audit committee
Compensation chairperson	Dummy equal to one if the director is the chairperson of a compensation committee
Nomination chairperson	Dummy equal to one if the director is the chairperson of a nomination committee
<i>Director characteristics</i> <span style="float: right;"><i>Source: Boardex</i></span>	
Prev.ES.Exp	Dummy equal to one when a director held a position related to environmental and social issues, such as sustainability director or human resources director or a prior position in board E&S committees
Nbyear.ES.Exp	Percentage of directors members or chairs of committees with E&S experience
<i>Board committees</i> <span style="float: right;"><i>Source: Vigeo-Eiris / Asset 4</i></span>	
E&S.Score	Equiweighted average of the environmental and social scores free from any diversity measure
Social.Score	Equiweighted social score free from any diversity measure
Env.Score	Equiweighted environmental score



## **Chapter 2**

# **Environmental Scores: Pollution Stock or Flow?**

This paper investigates the relationship between pollution reduction investments and environmental scores provided by ESG rating agencies. Using a unique French plant level dataset and several group level ESG databases, I first show that environmental scores are negatively correlated with the likelihood of investing in pollution reduction. For intensive margins, the results depend on whether firms are perceived as highly polluting. Environmental scores and amounts invested in pollution reduction are significantly more negatively related to high polluting firms. Overall, my results highlight that environmental scores do not measure the effort of firms to reduce pollution, the flow of pollution, but the level of pollution generated by firms and the stigmatization of polluting firms, the stock of pollution.



## 2.1 Introduction

According to the European Commission, sustainable finance is defined as including environmental, social, and governance (ESG) criteria in investment decisions.<sup>1</sup> It aims to reallocate capital to develop a more sustainable way of producing and consuming. Due to the growing environmental awareness, asset managers have developed funds based on ESG considerations that have grown impressively in recent years. In 2020, in the United States, sustainable investing accounts for \$17.1 trillion in assets under management (AUM), of which \$16.6 trillion is tied to the inclusion of ESG criteria, a number that has increased by 42% from 2018.<sup>2</sup> To include ESG criteria in their investments, assets managers have developed several approaches. The three most used are exclusion and negative screening, engagement, and ESG integration (Amel-Zadeh and Serafeim, 2018; Boffo and Patalano, 2020). Except for engagement, which consists of direct shareholder engagement to influence companies' ESG behavior, the two other approaches can use ESG data, specifically ESG ratings, to identify the most or least sustainable companies. On the other side, academics and practitioners have not agreed on what environmental scores must represent. Should they reflect the pollution generated by the firms or the involvement of firms to protect the environment? These two notions are quite different because some companies are structurally polluting and must invest in pollution reduction, while others are relatively protected. Understanding whether ESG ratings are a reward for a company that invests significantly in the environment or an incentive for a high polluting company is crucial to optimally allocate the capital needed for the ecological transition and respect investors' preferences.

This paper analyzes the relationship between environmental ratings and firms' pollution abatement efforts (pollution abatement investments). First, I show that the likelihood of investing in pollution abatement is negatively related to environmental ratings, while the general results for intensive are more mitigated. However, the results are more striking when distinguishing between high polluting and low polluting groups. High polluting firms making more efforts to tackle pollution have lower environmental scores, while low polluting firms investing more to reduce pollution have higher scores compared to them. These findings highlight that

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<sup>1</sup>[https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance\\_en](https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance_en)

<sup>2</sup>US SIF 2020 (source: <https://www.ussif.org/files/Trends%20Report%202020%20Executive%20Summary.pdf>)

environmental scores measure the pollution emitted by firms, the stock of pollution, and not the pollution abatement efforts, the flow of pollution.

Sustainable finance is a new field with high information asymmetry between managers and shareholders. ESG ratings are supposed to reduce this information asymmetry and increase transparency (Cheng et al., 2014). However, they are increasingly criticized for several reasons. One of the least discussed criticisms in the academic literature is related to environmental ratings. They would be overly oriented towards physical emissions, and associated risk, and not representative of companies' green innovation (Cohen et al., 2020). For example, Bloomberg Businessweek has accused MSCI of measuring not the environmental impact of companies but the impact of the environmental crisis on companies.<sup>1</sup> The fact that ESG ratings measure physical pollution instead of companies' participation in the ecological transition could raise some questions if the marketing of ESG funds is to invest in companies with a positive impact on the environment.<sup>2</sup> If ESG ratings do not convey the right information to investors, this would suggest that investors' preferences are not reflected in their investments, and thus the impact of sustainable finance could be reduced or diluted. However, there is no consensus in the academic literature on whether ESG ratings should assess the company's involvement in the ecological crisis or the pollution generated in the production process. On the one hand, ESG ratings and sustainable funds are often described as an incentive for high polluting companies to reduce pollution via a higher cost of capital (De Angelis and Tankov, 2020; Bolton and Kacperczyk, 2021; Chava, 2014; Choi et al., 2021; Heinkel et al., 2001). Indeed, if the additional cost of capital for high polluting firms, due to a greater demand for highly ESG-rated firms, is higher than the cost of reducing pollution, high polluting firms are incentivized to invest in pollution reduction. In this case, the relationship between pollution abatement effort (investment in pollution abatement) and ESG ratings should be negative or at least insignificant. Companies that invest considerable amounts in pollution reduction could be either highly rated companies that invest for ethical reasons or the biggest polluters. They are the farthest from their optimal pollution generation

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<sup>1</sup><https://www.bloomberg.com/graphics/2021-what-is-esg-investing-msci-ratings-focus-on-corporate-bottom-line>

<sup>2</sup>For instance, the fund iShare MSCI USA ESG Select ETF is sell as « Obtain exposure to a range of large- and mid-cap U.S. stocks with leading environmental, social, and governance practices », while using MSCI for ESG data (<https://www.ishares.com/us/products/239692/ishares-msci-usa-esg-select-etf>).

and must make more significant efforts to no longer be considered high polluting companies. Only when a certain optimal threshold is reached will the company no longer be considered a polluter, have a better ESG rating, and reduce its capital cost. On the other hand, ESG ratings are also widely used to proxy the ESG corporate policies ([Albuquerque et al., 2019](#); [Dai et al., 2021](#); [Ferrell et al., 2016](#); [Servaes and Tamayo, 2013](#)). Since, in these academic papers, ESG scores are supposed to reflect the willingness of the company to invest or not in environmental protection, the relationship between ESG scores and pollution abatement efforts should be positive. Indeed, the companies that are the most environmentally oriented are those that make the most effort to preserve the environment and, therefore, the ones that spend the most money to reduce pollution.

Exploiting a unique French dataset giving me access to the amount of pollution abatement investments spent by 763 plants belonging to 195 industrial groups in France from 2009 to 2018, I study the relationship between pollution reduction efforts and environmental scores. First, I investigate this relationship across the sample using a simple OLS model, including plant, firm, and group level controls, as well as plant-level industry year fixed effects to investigate variation across plants. The inclusion of industry fixed effects is important because ESG ratings are calculated taking into account the industry. Therefore, comparing companies across sectors could reflect the difference in ratings related to sectors and not companies. The results show that factories that invest in pollution reduction belong to groups with lower environmental scores. On the contrary, plants that invest higher amounts in pollution reduction belong to groups with higher environmental scores. The first result is significant and consistent with the fact that, on average, plants that invest in pollution control are also the most polluting and that environmental scores reflect the pollution generated. For intensive margins, the coefficients are insignificant, meaning that the relationship could be more fluctuating depending on the specific characteristics of the groups. As discussed in the development of the hypotheses, the results could suggest that environmental scores represent the stock rather than the flow of pollution to incentivize firms to reduce pollution.

Nevertheless, the relationship could be different if the firm is considered a high polluter, depending on what the environmental scores represent. In their article, [Cohen et al. \(2020\)](#) point

out that green innovation is generally rewarded by higher environmental scores, except for the energy sector, where the correlation becomes negative. The energy sector is considered one of the main polluting sectors and is often excluded from ESG funds. If polluting sectors are not credited for their greater environmental innovations, then groups considered high polluting are unlikely to be credited for their pollution reduction efforts. Coming back to the distinction between pollution stock and flow, if environmental scores represent the flow and pollution abatement efforts, the relation should always be positive regardless of whether the firms are considered high polluting. However, the relation could be more complex if environmental scores reflect the pollution groups generated to act as an incentive to reduce pollution. Environmental scores must not reflect pollution abatement efforts but only the fact that the group is highly polluting. In other words, the relationship between pollution abatement efforts and environmental scores should be negative for high polluting groups and positive for low polluting groups.

To explore how being perceived as a high or low polluting group may affect the relationship between pollution abatement efforts and environmental scores, I use the industries to which the different groups belong and add an interaction term between the dummy variable of one if the firms are in an industry considered highly polluting and the pollution abatement variables.<sup>1</sup> Starting with extensive margins, the results highlight that low polluting groups with plants investing in pollution abatement have lower environmental scores than high polluting groups. An interpretation of the result could be that low polluting groups, those with high environmental scores, owning plants not investing in pollution abatement do not need to reduce pollution. In countries with stringent environmental laws, such as France, we can consider that all high polluting groups must invest in pollution reduction, while some low polluting groups might not invest in pollution reduction. Conversely, the results for the intensive margins show that high polluting groups with plants investing higher amounts in pollution reduction have lower environmental scores, while the reverse is true for low polluting groups. This last result supports the idea that environmental scores do not measure firms' efforts to reduce the pollution generated by their activities but the degree of pollution emitted, meaning that environmental scores are constructed

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<sup>1</sup>The groups perceived as high polluting belong to the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), and coking and refining.

to be an incentive for polluting groups. My results are robust to the inclusion of plant-, firm-, and group level controls and industry-year fixed effects.

My previous results could be biased if, among the high polluting groups, the plants that invest the most are also the largest polluters, while among the low polluting groups, the plants that invest the most are the most willing to invest in environmental protection. In this specific situation, my results would not demonstrate that environmental scores stigmatize high polluting groups but would reflect different reasons for plants to invest in pollution reduction within the two categories of groups. To overcome this bias and study how being perceived as high polluting impacts the relationship between pollution abatement efforts and environmental scores, I employ a difference-in-difference methodology by exploiting the occurrence of polluting incidents in at least one of the groups' plants. Implicitly, I assume that before a polluting incident occurs in one of their plants, groups are considered low polluting and high polluting after. This hypothesis is tested using firm level OLS regression with firm-level and group-level controls as well as year and firm fixed effects. After the polluting incident, the environmental score of the affected groups decreases significantly, meaning that my hypothesis is satisfied. In contrast to firms that do not invest in pollution reduction, those that do have lower environmental scores. For intensive margins, firms that invest in pollution reduction have better environmental scores unless one of their plants has a pollution incident. As soon as the group is considered polluting, the relationship between pollution reduction and environmental scores becomes negative. This is consistent with my previous results highlighting that pollution abatement efforts and environmental scores are correlated differently depending on whether they are considered high polluting. The results are robust to the inclusion of plant-, firm-, and group level controls, as well as industry-year and plant fixed effects. Overall, I interpret my results as ESG scores reflecting both the pollution emitted and the stigma attached to high polluting firms, rather than reflecting firms' pollution reduction efforts.

Finally, ESG ratings could be very different [Berg et al. \(2022\)](#) due to different views on sustainability [Eccles and Strohle \(2018\)](#). Therefore, to test whether different approaches to ESG can explain the previous results, I use MSCI as an alternative ESG data provider. While V.E. is more value-oriented and bases its scores on international principles, MSCI uses a more prag-

matic approach, reflecting ESG risk exposure. I find similar results to those obtained with V.E., which means that the environmental score measuring pollution stock is not determined by the sustainability perspective.

This study contributed to the growing literature studying ESG ratings. [Berg et al. \(2022\)](#) highlight that ESG ratings diverge significantly across ESG providers (MSCI, Sustainalytics, V.E, RobecoSAM, and Asset 4) mainly because of scope and measurement divergence, while [Eccles and Strohle \(2018\)](#) show that the origin of the ESG rating agencies has a substantial impact on ESG measures. This ESG rating uncertainty can be problematic for the impact of sustainable finance on global pollution ([Avramov et al., 2021](#)), as ESG disagreement could lead to lower demand for « green » stocks and higher stock returns ([Brandon et al., 2019](#)). Moreover, [Tang et al. \(2021\)](#) show that ESG ratings can suffer from conflicts of interest as companies with the same institutional investors as the ESG raters receive higher ratings. More closely related to my paper, [Cohen et al. \(2020\)](#) find that the energy sector is one of the leading producers of green patents, while this sector is explicitly excluded from many ESG indices, and thus, ESG ratings do not seem a good proxy for green innovation. I add to this literature by showing that ESG measures do not reflect firms' efforts to reduce pollution (flow) but more the pollution generated by the firms (stock), which is a broader result than [Cohen et al. \(2020\)](#), who focus only on innovation. Furthermore, through the quasi-experiment with polluting incidents, I show that these results come from the perception of groups' pollution and not from different incentives for plants to reduce pollution within the two categories.

This paper also relates to the strand of literature about how sustainable finance impact environmental corporate policies. For instance, [Azar et al. \(2021\)](#) highlight that the « Big three » asset managers reduce carbon emissions, while [Dyck et al. \(2019\)](#) show that firms with institutional ownership have better CSR ratings. More specifically, this article adds to the debate between engagement and divestissement. [Chava \(2014\)](#), [De Angelis and Tankov \(2020\)](#), and [Heinkel et al. \(2001\)](#) argue that thanks to exclusionary and negative screening, the cost of capital will increase, and if this additional cost is lower than the cost to become low polluting, firms will choose to become more environmentally responsible. The cost of capital increase could either come from investors' preferences ([Pástor et al., 2021](#)) or from a higher transition risk ([Bolton and](#)

Kacperczyk, 2021). Edmans et al. (2022) develop a model showing that fully excluding a brown industry does not give any incentive for the manager to reduce pollution externalities, while a « tilting » strategy such as « best-in-class » better incentivizes the manager to take corrective actions. Conversely, Hart and Zingales (2017) argue that companies must follow the preferences of shareholders, who are mainly socially responsible shareholders, by voting to determine corporate policies. Oehmke and Opp (2019) demonstrate that social investors help firms to be greener by improving financing capacity. In this paper, I show that ESG ratings do not measure firms' environmental performance but only the pollution level of the firms and their stigmatization as high polluting firms, even within the same industry. Investing massively in funds excluding or underweighting high polluting firms with low ESG rating could be counterproductive. Indeed, instead of helping high polluting firms in their ecological transition by providing them enough capital to undertake the necessary investments, it could only give low polluting firms cheap financing without changing the production process structure. Overall, my paper suggests that the best way to make companies greener is both to finance high polluting companies and participate in determining company policies, either by providing social proposals at general meetings or by engaging directly with management.

The paper is structured as follows: The second section describes the data. Section three details the methodology. Section 4 provides the results, while section 5 presents some additional tests. Finally, section 6 concludes.

## **2.2 Data**

### **2.2.1 Environmental Data**

Environmental data come from the unique French survey ANTIPOL, conducted by the French official statistical service.<sup>1</sup>In this survey, French industrial plants must report annually on all investments undertaken to reduce pollution, either at their initiative or comply with the legislation. The survey covers the industrial sector with industries such as the production of goods, food products, chemical or metallurgy industry. Industries are defined according to the first two

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<sup>1</sup>INSEE (*Institut National de la Statistique et des Etudes Economique*)

digits of the NAF<sup>2</sup> code, which is similar to the US SIC code. The threshold for inclusion in the survey is 100 employees for ordinary plants and 50 for polluting plants. In order to have a balanced sample, I kept in my sample only the plants for which the survey is mandatory, i.e., plants with more than 250 employees. Pollution abatement investments refer to all investments in equipment, buildings, and land that contribute to reducing pollution. There are two types of pollution reduction investments. The first relates to specific investments, including all the spending on facilities solely dedicated to pollution reduction (e.g., retention tank, filter, pump, and compressor). In contrast, the second type, integrated investment, is the extra cost paid for more environmentally-friendly equipment (e.g., a machine emitting fewer toxic emissions or generating less waste). In the paper, I do not distinguish the two types of investment, and I consider pollution reduction effort as any money spent on investing in pollution abatement.

### **2.2.2 Financial Data**

To access financial data, I use FARE<sup>1</sup>, also provided by the French official statistical service and the French Ministry of Finance. This database compiles all individual company accounting data. This administrative data is obtained from the annual tax return companies must declare to the tax authorities. Therefore, this database contains all the financial statements of French companies, whether they are public or private. The financial information is at the company level, while the information on pollution reduction is at the plant level. It is necessary to have a common identifier for both levels. In France, each company is identified by a unique 9-digit SIREN and each plant by a unique 14-digit SIRET. The first nine digits correspond to the SIREN, and the last five are specific to the establishment. I first found the SIREN number of the different establishments in the ANTIPOL database. Then I directly merged the two databases by year and SIREN.

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<sup>2</sup>*Nomenclature des Activités Françaises*

<sup>1</sup>*Fichier Approché des Résultats d'Esane*



### 2.2.3 V.E (Vigeo Eiris)

V.E, former Vigeo Eiris, is an ESG rating agency acquired by Moody's in 2019. It was born from the 2005 merger of Vigeo, the first SRI rating agency in France, and Ethical Investment Research Services (EIRIS) Ltd., a consulting firm for NGOs and charities. Since then, V.E has become the leading ESG agency in Europe, with one of the best coverage in France. V.E's ESG ratings are derived from 38 criteria: 12 for the environmental dimension, 19 for social, and 9 for governance. For each criterion, there is a set of « Principles of Action » derived from the norms and standards of organizations such as the United Nations (UN), the International Labour Organization (ILO), or the Organization for Economic Co-operation and Development (OECD). Each criterion is scored on a scale of zero to one hundred, and each score is calculated by averaging the three main pillars (leadership, implementation, and results), which are further divided into nine different dimensions (visibility, exhaustiveness, ownership, allocated resources, coverage, scope, indicators, stakeholder feedback, controversy management). Once the 38 criteria have been assessed, each is assigned a weight ranging from zero to three. Each weighting depends on the materiality of the sectoral criterion (companies are classified into 40 different sectors). The weighting is zero if it is not relevant and three if it is highly relevant to the sector. Then, the environmental, social, and governance scores are computed with the weighted average and, finally, the Overall ESG score. In the paper, only the environmental score will be studied. The 12 criteria of the environmental dimension are environmental strategy, accidental pollution, biodiversity, local pollution, green products, water, atmospheric emissions, waste, transportation, environmental standards in the supply chain, use and disposal of products, and finally, energy. However, usually, the head of the group is rated, which could be problematic for multinational groups headquartered outside France. In order to have information on the financial links between companies and to identify the group head, I use the LIFI dataset. This dataset, also produced by the French official statistical service and the French Ministry of Finance, aims to identify groups of companies operating in France and gives the list of companies owned by the group. One of the main advantages of LIFI is that companies are identified with the SIREN while the group heads are identified with their Bureau van Dijk identifier. In order to match the V.E as well as the FARE and Antipol databases, I downloaded from Orbis a table of correspondence between

the ISINs and the Bureau van Dijk identifiers, thanks to which I could match the V.E and LIFI databases. Then with the SIREN, I integrated the ANTIPOL and FARE databases. Figure 2.1 shows a schema of the database structure.

#### **2.2.4 Sample**

After merging all the databases, my sample relies on three levels of data : (1) plant level data for pollution abatement investments, (2) firm level data for financial information (3) group level data for environmental scores. I drop firms with total assets or sales less than zero. In addition, the energy production industry is specific, so I remove all companies operating in this sector. Indeed, the energy sector is both highly strategic and polluting, making it a highly subsidized and environmentally regulated sector. In addition, companies in these specific sectors generally have low ESG ratings, which could make the results regarding the relationship between pollution reduction investments and environmental ratings artificially negative. I choose to winsorize my financial and pollution abatement investments variables at the 5% level because data come from a database with private and public firms and can be less reliable than other databases containing only public firms. I decide to winsorize environmental scores at the 1% level. My sample contains 5,501 plant-year, 3,394 firm-year, and 1,419 group-year observations for 763 plants, 465 firms, and 195 groups from 2009 to 2018. Table 2.1 provides summary statistics for the sample at the firm, plant, and group levels. The descriptive statistics for firms' characteristics are relatively standard. Companies are large, with a significant part of tangible assets, 25% of the total assets. More interestingly, 37% of companies receive investment grants. For group characteristics, the average ESG score is 40.27, and the average environmental score is 38.37. 78% of them are multinational groups, 25% are French, 39% are European, and 25% are non-European. Panel B shows the key variables of pollution reduction investments, 72% of the plants in my sample invest in pollution reduction, and they invest an average of 273,670 euros. These high figures reflect France's strict environmental regulations for industrial companies.

## 2.3 Baseline analysis

I begin my analysis by examining the relationship between pollution abatement efforts and ESG ratings. Since investments to reduce pollution are primarily relevant to environmental scores, I focus only on these. First, I categorize the groups into five quantiles, from those with the highest scores to those with the lowest scores per year. Figure 2.3 plots these quantiles with the average percentage of plants investing in pollution reduction and the associated average amounts. It shows that plants belonging to groups with high environmental scores are not more likely to invest in pollution reduction, but when they do it, they invest higher amounts. However, these results could be biased, as I do not control for omitted variables. To better understand the relationship between pollution reduction investments and environmental scores, I run an ordinary least squares (OLS) model with group environmental score as the dependent variable, using the following regression:

$$\text{Environmentalscore}_{c,t} = \alpha + \beta_1 \text{PollutionAbatEffort}_{p,t} + \beta_2 W_{c,t} + \beta_3 Z_{p,t} + \beta_4 X_{i,t} + \gamma_{j,t} + \epsilon_{p,t} \quad (1)$$

where  $c$  represents groups,  $i$  firms,  $p$  plants,  $j$  plant level industries, and  $t$  years. My main independent variable,  $\text{PollutionAbatEffort}_{p,t}$ , is a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $\mathbb{1}(\text{Inv.Green})$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $\text{Log}(\text{Inv.Green} + 1)$ ). I report the results in Table 2.2, where columns (1) through (4) present the estimates for intensive margins and columns (5) through (8) for extensive margins. I include some controls to control for omitted variables. I add controls at the firm level, which are  $\text{Size}$ ,  $\text{Tang.Asset}$ ,  $\text{Capex.Asset}$ ,  $\text{Cash.Asset}$ , and  $\text{SubInvDum}$ . I also add some controls at the group level. I control for belonging to a multinational group ( $\text{MultinationalGroup}$ ), knowing that some manufacturing groups are international and can delocalize their pollution, and for being owned by a French group ( $\text{FrenchGroup}$ ), as they have a higher part of their activities in France. Lastly, I include the variable  $\text{EuroForeignGroup}$  to consider that Europe is the most environmental-friendly area in the world. Finally, I control for the plants' size by adding the  $\text{Employee.Plant}$  variable, because bigger plants can pollute more and have higher resources to invest in pollution reduction. In

columns (4) and (9), I include year and industry fixed effects to control time and industry heterogeneity, while I add year-industry fixed effects in columns (3) and (7) to take into account that each industry's relationship to environmental issues has changed over the years. The results in Table 2.2 highlight that plants investing higher amounts in pollution reduction are not owned by groups with higher environmental scores, as the coefficients are not significant. Columns (5) through (8) show that the reverse is true for the extensive margin. The coefficients are significant in columns (5), (7), and (8). Plants investing in pollution reduction appear to be owned by groups with lower environmental scores. A potential explanation could be that high polluting groups are more likely to invest in pollution reduction. This section shows that the relationship between pollution abatement efforts and environmental scores is negative for extensive margins but unclear for intensive margins. Concerning the latter, the relation could depend on specific firm characteristics. Therefore, in the next section, I distinguish between high and low polluting groups.

## **2.4 High and low polluting firms**

### **2.4.1 Classification by industry**

High polluting groups are defined at the industry level. The industries considered to be high polluting are food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining. The classification chosen is based on two sources. First, I use the classification from the article by [De Haas and Popov \(2019\)](#), which gives the carbon intensity<sup>1</sup> by sector and allows identifying the most CO<sub>2</sub> emitting sectors in Europe. Second, I use information from the European Environment Agency (EEA), which provides the contributions of the French industrial sector to air and water pollution and waste generation by industry. Figure 2.2 shows the graphs provided by the EEA. In France, the three leading industries responsible for hazardous waste generation are chemicals, food and beverages, and metal production and manufacturing, while for air pollution, chemicals, non-metallic minerals, and ferrous metals appear to be the

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<sup>1</sup>CO<sub>2</sub> emissions per value-added

top three contributors. However, some « sin » industries are often excluded from SRI<sup>2</sup> funds for ethical reasons unrelated to pollution (Hong and Kacperczyk, 2009; Zerbib, 2022). As these specific industries can be stigmatized and for this reason have lower ESG scores, I excluded alcohol production, tobacco, and weapons manufacturing from the sample. Figure 2.4 shows that plants owned by high polluting groups invest more to reduce pollution and invest higher amounts, which is consistent with the idea that high polluting groups must invest higher amounts in order to reduce further the pollution generated. Table 2.3 presents the summary statistics of the high and low polluting groups subsample. Unsurprisingly firms owned by high polluting groups have more tangible assets and receive more investment grants. Regarding the variables of interest, plants belonging to high polluting groups invest higher amounts in reducing pollution than those owned by low polluting groups. Furthermore, high polluting groups have lower environmental scores. They are also less likely to be a multinational group, although more likely to be a European and non-European group than a French one.

Consistent with the paper of Cohen et al. (2020), Table 2.4 reports that the correlation between pollution reduction effort and environmental scores is different for high and low polluting groups. First, for intensive margins, high polluting groups with plants investing large amounts in reducing pollution have lower environmental scores, while the opposite is true for low polluting groups. The difference between high and low polluting groups is economically and statistically significant. Plants owned by low polluting groups and whose  $\text{Log}(\text{Inv.Green} + 1)$  variable is one standard deviation higher than the mean, belong to groups with a higher environmental score of  $1.436(1.73 * 0.83)$ . For high polluting groups, the environmental score is lower of  $-0.8131((-1.30 + 0.83) * 1.73)$ . Interestingly the results are reversed for extensive margins. Coefficients are negative for low polluting groups and positive for high polluting groups, but they are insignificant. To sum up, my results show that environmental scores reflect the pollution generated by the firms and not the pollution abatement effort of groups.

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<sup>2</sup>Socially Responsible Investment

## 2.4.2 Polluting incident

The above results could be biased if plants have different incentives to reduce pollution within the high and low polluting groups. For example, if, for the most polluting groups, the plants that invest the highest amount in pollution reduction are also the ones that most need to do so to meet environmental standards. Whereas for the least polluting groups, the companies that invest the most want to impact the environment positively and signal themselves as green companies. I use a quasi-experiment to overcome this bias where firms exogenously switch from low to high polluting firms. Indeed, I consider that a company that suffers a polluting incident will exogenously switch from low to high polluting, knowing that ESG rating agencies are poor predictors of ESG scandals (Utz, 2019). To access the accident data, I use the Analysis, Research, and Information on Accidents (ARIA) database produced by the Bureau for Analysis of Industrial Risks and Pollution (BARPI).<sup>1</sup>The ARIA database lists all the technological and industrial accidents in France. However, not all accidents are related to pollution, and minor incidents have no impact on firms' ESG ratings. Therefore, I consider as polluting accident an event that results in a release of pollutants and has a score of at least three over six on one of the European accident scales. Unfortunately, ARIA does not provide access to the plant where the incident occurred. I consider the plant to be involved in the incident if the plant is in the same municipality as the incident and the group to which the plant belongs is in the same industry as the incident.<sup>2</sup>Then, I aggregate the dummy at the group level. Groups considered as experiencing a polluting incident (*PollutingIncident*) are groups with at least one accident within their plants. Table 2.5 presents summary statistics for groups with and without pollutant incidents. Unsurprisingly, groups experiencing a polluting incident in one of their plants have lower environmental scores, yet they are less likely to come from Europe and less from French or Non-European groups. Firm and plant characteristics are relatively similar to Table 2.3 except for tangible assets and cash. In order to test if the groups are considered low polluting before the polluting incident and high polluting after, I use a staggered differences-in-differences methodology by running an OLS regression model with the dependent variable, the environmental score, and as an independent variable, my dummy *PollutingIncident*. I run the regression at the firm level to control for firms'

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<sup>1</sup><https://www.aria.developpement-durable.gouv.fr/the-barpi/the-aria-database/?lang=en>

<sup>2</sup>For more accuracy, the industries are defined by the first four digits of the NAF code

financial characteristics because they could impact the probability of both investing to avoid a polluting accident and environmental ratings. I include industry-year fixed effects and group fixed effects to examine intragroup variation. I add firm fixed effects in the last columns to avoid omitted variables bias. The estimates in Table A1 report that the groups' environmental scores are reduced by 2.55 points after the incident, suggesting that the impacted groups are considered high polluting after the incident. This fact is even further verified in Figure 2.5, which presents the coefficient dynamics for environmental scores around the incident by taking the year of the incident as the reference year. The coefficients are insignificant and close to zero before the polluting incident and strongly negative and significant after.

Next, I examine the impact of a pollution accident on the relationship between pollution reduction investments and environmental scores using the following regression :

$$\begin{aligned} EnvironmentalScore_{c,t} = & \alpha + \beta_1 PollutingIncident_{c,t} \times PollutionAbatEffort_{p,t} + \beta_2 W_{c,t} + \beta_3 Z_{p,t} \\ & + \beta_4 X_{i,t} + \gamma_{j,t} + \mu_p + \varepsilon_{p,t} \end{aligned} \quad (2)$$

where  $EnvironmentalScore_{c,t}$  is the environmental score of group  $c$  in year  $t$ .  $PollutionAbatEffort_{p,t}$  represents one of my pollution abatement investment measures for a plant  $p$  in year  $t$ , that is  $\mathbb{1}(Inv.Green)$  for extensive margins, and  $\text{Log}(Inv.Green + 1)$  for intensive margins.  $W_{c,t}$  is a vector of group level controls, including  $NoEuroForeignGroup$ ,  $FrenchGroup$ , and,  $MultinationalGroup$ .  $Z_{p,t}$  represents plant level controls and is only composed of  $Employees.Plant$ .  $X_{i,t}$  is a vector of firm level controls, including  $Size$ ,  $Tang.Asset$ ,  $Cash.Asset$ ,  $Capex.Asset$ , and,  $SubInvDum$ . I add industry-year fixed effects,  $\gamma_{j,t}$ , and plant fixed effects,  $\mu_p$ , as I study the variation within plants. Standard errors are clustered at the plant level. Table 2.6 presents the regression estimates of equation (2). Regarding intensive margins, the coefficients are significant and negative for plants owned by groups experiencing a polluting incident after the incident and positive and significant otherwise. Those results show that, before the groups are considered highly polluting, spending more money to protect the environment is positively related to environmental scores, while once the groups are considered highly polluting, the correlation turns negative. For extensive margins, the estimates are also similar to the previous section. The coefficients are negative and significant for plants in a group with a polluting incident after the incident and

positive but insignificant for other establishments. A potential explanation for this last result could be that plants investing in pollution abatement are those you need the most to do it. To conclude, my findings demonstrate that environmental scores measure more the stigmatization of high polluting firms than firms' efforts to reduce pollution.

## 2.5 Values vs. Value

ESG ratings from different ESG raters can differ significantly. [Berg et al. \(2022\)](#) find an average correlation of 0.54 between the ESG ratings of different ESG agencies. A potential explanation for these discrepancies would be the different approaches to sustainability. Specifically, ([Eccles and Strohle, 2018](#)) proposes a categorization among ESG rating agencies between value-based and value-based. Therefore, I chose to use MSCI as ESG data provider to see whether the sustainability approach can play a role in its measurement. MSCI comes from the financial ratings industry and thus has a more pragmatic view of sustainable finance. MSCI promotes the materiality of ESG risk, and ESG ratings are created using quantitative performance measures within the industry. In contrast, the origin of V.E. is deeply linked to charities and trade unions. Therefore, the ratings are based on a qualitative methodology using norms and standards of international institutions (e.g., the United Nations or the International Labor Organization) with a strong stakeholder focus. In other words, while V.E. has a values-based approach and focuses on the impact of companies on the world, MSCI has a value-based approach and emphasizes exposure to ESG risks.

Table A2 in the Appendix reports summary statistics for the MSCI sample. Although the MSCI sample is smaller, the company's characteristics are similar to those of the VE sample. However, plants invest lower amounts in pollution abatement, which could be explained by the fact that there are more non-European groups. The baseline regression results for MSCI are in the Appendix, in Table A3. The coefficients for intensive margins are insignificant and negative. These different estimates compared to V.E could be explained by the fact that MSCI assesses the environmental risk borne by the groups, while V.E assesses whether the groups follow international standards. The estimates of extensive margins are also the opposite of V.E's. Next, I rerun the regression with the decomposition between high and low polluting firms. I present MSCI's



results in Table 2.8. This time, the results are similar to those of V.E. For intensive margins, the estimates for the high polluting groups are negative and significant, while for the low polluting groups, they are positive. For extensive margins, the results are both positive and insignificant. These results suggest that the fact that environmental scores reflect the stock of pollution rather than the flow of pollution does not stem from a different approach to sustainability.

## 2.6 Conclusion

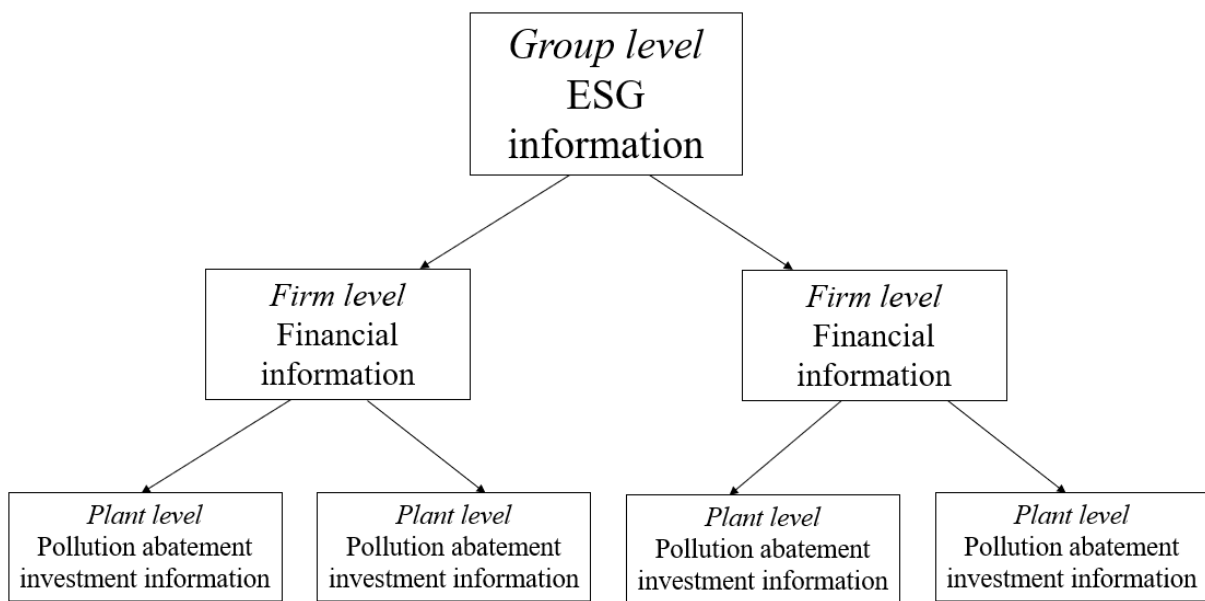
Growing environmental awareness has led asset managers to develop green funds massively. Many of them use ESG ratings and, more specifically, environmental scores to evaluate the environmental quality of companies. However, these ratings are increasingly criticized, mainly because what they are assessing is unclear. Even within the academic literature, it is not clear whether environmental scores should reflect the efforts undertaken by companies to reduce pollution, the flow of pollution, or whether they should measure the pollution generated by companies, the stock of pollution. In this paper, I fill this gap in the literature by analyzing the relationship between environmental scores and firms' pollution reduction efforts. Using a single dataset containing all pollution reduction investments of industrial plants with more than 250 employees, this study finds that environmental scores measure firm-generated pollution and the stigma of high polluting firms.

Indeed, environmental scores are negatively correlated with the probability of investing in pollution reduction, meaning that most firms with high environmental scores are less likely to invest in pollution reduction. These results could be explained by highly polluting firms that must invest in pollution abatement in a highly environmentally regulated country like France. Furthermore, I show that the relationship between the amount invested in pollution abatement and environmental scores depends on whether the firm is in a highly polluting industry. The correlation is significantly more negative if firms are seen as highly polluting by ESG rating agencies, suggesting that ESG rating agencies. The results are robust to the use of quasi-experiment on the fact to be high or low polluting, the occurrence of a polluting incident in the group, implying that environmental scores assess the level of firms' pollution and the stigmatization as high polluting firms. Knowing ESG ratings do not measure companies' involvement in reducing pollution, but

only the level of pollution generated is essential for understanding the impact of sustainable finance on the environment. Indeed, it is a good thing to encourage companies to reduce pollution, but if ESG ratings direct green flows to already low-polluting companies instead of allocating them to those that need to invest massively to become greener, this could be counterproductive and not favour the ecological transition.

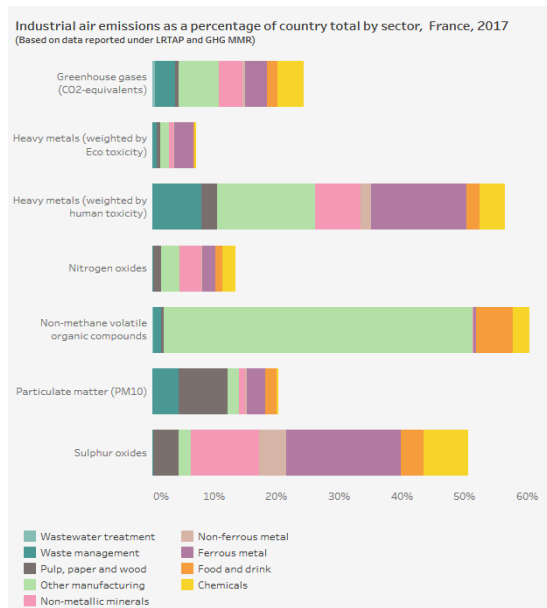
**Figure 2.1: Diagram of the data structure**

This figure depicts the different levels of the database structure

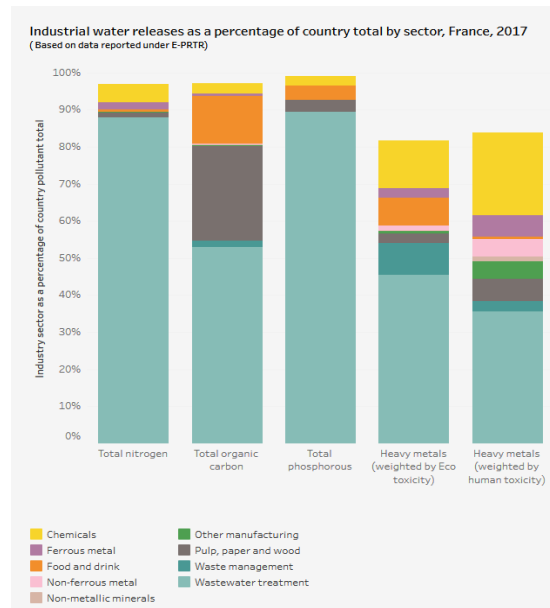


## Figure 2.2: Contribution of the industrial sector to the emission of pollution in France

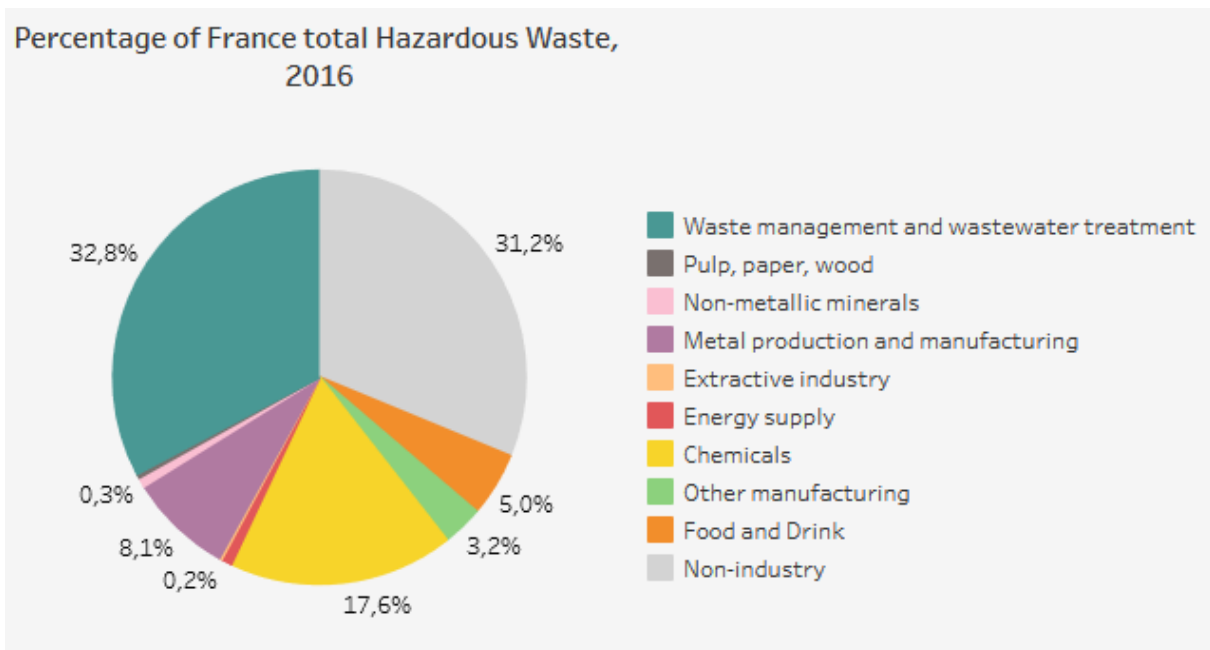
This figure shows the contribution of the French industrial sector to the emission of air and water pollution as well as waste production in France. Figure 2a reports air pollution, Figure 2b water pollution, and Figure 2c waste production.



(a) Air pollution



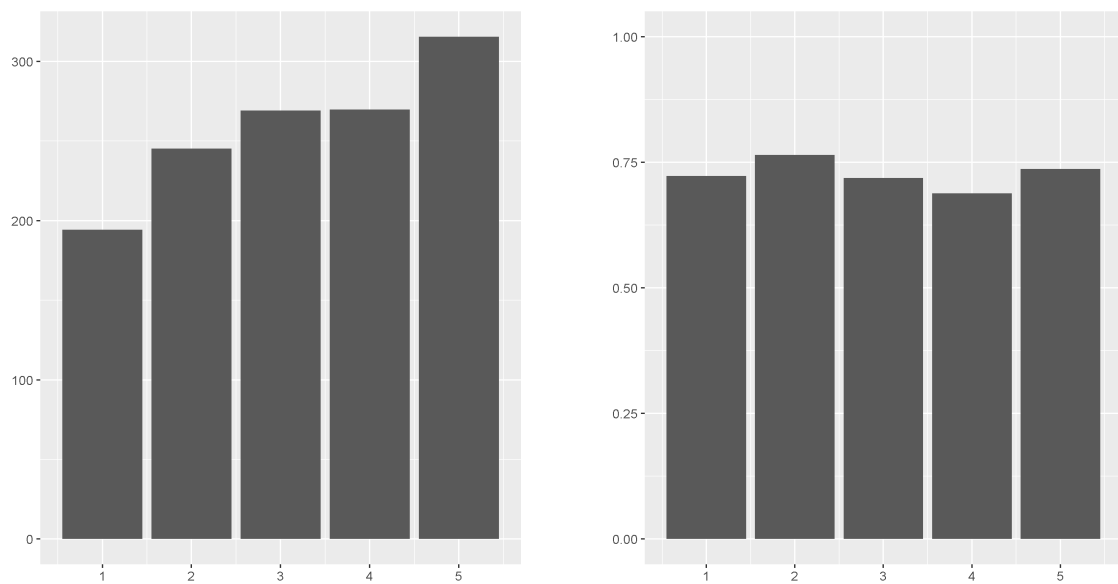
(b) Water pollution



(c) Waste

### Figure 2.3: Pollution abatement efforts by environmental quintiles

This figure shows *pollution abatement efforts* made by firms to reduce pollution depending on environmental quintiles. The quintiles are computed by year at the group level. Figure 3a reports the average annual amounts invested by industrial plants in pollution abatement, and Figure 3b the annual percentage of plants investing. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. The environmental quintiles are computed by year.

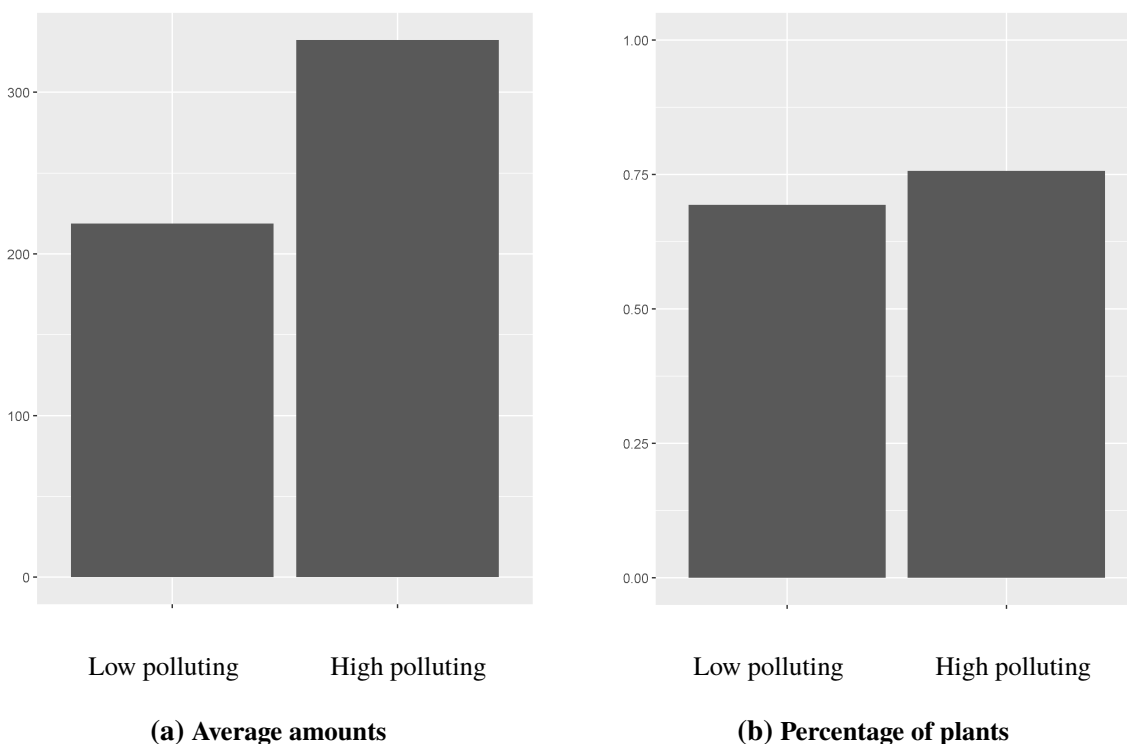


(a) Average amounts

(b) Percentage of plants

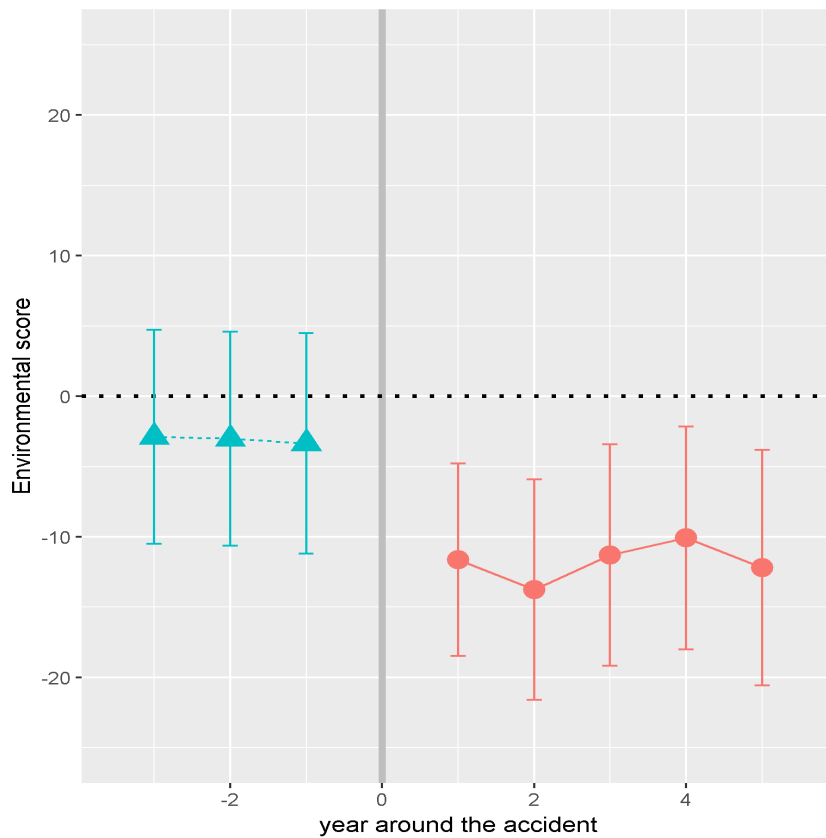
**Figure 2.4: Pollution abatement efforts by high and low polluting groups**

This figure shows *pollution abatement efforts* made by firms to reduce pollution depending on whether they are perceived as high polluting. Figure 4a reports the average annual amounts invested by industrial plants in pollution abatement, and Figure 4b the annual percentage of plants investing. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. High polluting groups are groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining.



**Figure 2.5: Impact of polluting incident on environmental scores**

This figure displays the coefficient dynamics for environmental scores around the polluting incident. More specifically, I use the following regression:  $EnvironmentalScore_{g,t} = \alpha + \sum_{k=-3}^{-1} \beta_k \cdot PollutingIncident_{g,k} 1[Time = k] + \sum_{k=1}^5 \beta_k \cdot PollutingIncident_{g,k} 1[Time = k] + \mu_{j,t} + e_{p,t}$  with  $\mu_{j,t}$ , industry-year fixed effects.  $PollutingIncident_{g,k}$  represents a dummy equal to one if the group owned at least one plant experiencing an polluting incident, and  $1[Time = k]$  a dummy equal to one for each year around the polluting incident. The sample contains all French industrial firms owning plants with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 465 firms and 195 groups from 2009 to 2018. The reference year is the year of the polluting incident. The confidence intervals are reported at the 5% level.



**Table 2.1: Summary statistics**

This table summarizes the characteristics of the firm-year, plant-year, and group-year. Panel A presents summary statistics at the company level, Panel B at the plant level, and Panel C at the group level. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. Variable definitions are in the appendix.

<b>Panel A: Firm characteristics</b>	N	Mean	SD	P25	Median	P75
Size	3,394	11.67	1.22	10.74	11.63	12.82
Cash.Asset	3,394	0.03	0.07	0.0001	0.002	0.02
Capex.Asset	3,394	0.05	0.05	0.02	0.04	0.07
Tang.Asset	3,394	0.25	0.17	0.10	0.21	0.37
SubInvDum	3,394	0.37	0.48	0	0	1
NbrPlants	3,352	4.34	6.55	1	2	4
<b>Panel B: Plant characteristics</b>	N	Mean	SD	P25	Median	P75
1 (Inv.Green)	5,501	0.72	0.45	0	1	1
Inv.Green (keuros)	3,979	273.67	398.17	21.60	90	329.89
Log(Inv.Green +1)	3,979	4.43	1.73	3.12	4.51	5.80
Employees.Plant	5,501	5.93	1.22	5	6	7
<b>Panel C: Group characteristics</b>	N	Mean	SD	P25	Median	P75
ESG score	1,419	40.27	12.18	31	40	50
Environmental score	1,419	38.37	16.15	27	39	51
MultinationalGroup	1,419	0.78	0.41	1	1	1
EuroForeignGroup	1,419	0.39	0.49	0	0	1
NoEuroForeignGroup	1,419	0.35	0.48	0	0	1
FrenchGroup	1,419	0.25	0.43	0	0	1



**Table 2.2: Relationship between pollution abatement effort and environmental scores**

This table reports the OLS regression estimates studying the relationship between *pollution abatement effort* and environmental scores. The dependent variable is the group environmental scores, and *pollution abatement effort* could be a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $\mathbb{1}(Inv.Green)$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $Log(Inv.Green + 1)$ ). The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. Standard errors are clustered at the plant level. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score							
Log(Inv.Green +1)	0.27 (0.21)	0.32 (0.21)	0.15 (0.21)	0.20 (0.22)				
$\mathbb{1}(Inv.Green)$					-1.32** (0.59)	-0.95 (0.59)	-1.20** (0.56)	-1.36** (0.57)
Size	2.34*** (0.45)	2.28*** (0.46)	1.85*** (0.49)	1.91*** (0.49)	2.18*** (0.40)	2.12*** (0.41)	1.54*** (0.42)	1.60*** (0.43)
Tang.Asset	18.80*** (3.00)	18.41*** (3.01)	13.15*** (3.31)	12.59*** (3.45)	18.23*** (2.76)	18.33*** (2.76)	11.75*** (3.15)	11.09*** (3.23)
Capex.Asset	1.76 (7.66)	2.54 (7.60)	8.54 (7.25)	11.76 (8.03)	-2.10 (6.68)	-2.34 (6.60)	4.15 (6.42)	8.66 (6.90)
Cash.Asset	-24.41*** (7.14)	-23.79*** (7.15)	-20.46*** (7.48)	-21.94*** (7.79)	-14.54** (6.43)	-13.98** (6.47)	-14.17** (6.35)	-14.76** (6.61)
SubInvDum	-0.14 (0.91)	-0.11 (0.90)	-0.17 (0.90)	-0.21 (0.92)	0.08 (0.81)	0.16 (0.81)	0.16 (0.82)	0.12 (0.84)
NoEuroForeignGroup	-10.50*** (1.49)	-10.61*** (1.50)	-10.56*** (1.51)	-10.90*** (1.58)	-10.81*** (1.36)	-10.88*** (1.36)	-10.71*** (1.37)	-11.03*** (1.42)
FrenchGroup	8.57*** (1.09)	10.03*** (1.09)	9.36*** (1.12)	9.32*** (1.16)	8.17*** (1.00)	9.52*** (1.00)	8.97*** (1.03)	9.00*** (1.06)
MultinationalGroup	-0.47 (0.74)	-4.39*** (0.89)	-4.20*** (0.87)	-4.83*** (0.97)	0.44 (0.65)	-3.32*** (0.84)	-3.38*** (0.82)	-4.01*** (0.92)
Employees.Plant	-0.05 (0.36)	-0.03 (0.36)	1.03** (0.42)	0.92** (0.43)	-0.22 (0.33)	-0.18 (0.33)	1.11*** (0.38)	1.08*** (0.39)
Year FE	No	Yes	Yes	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No	No	Yes	No
Industry#Year FE	No	No	No	Yes	No	No	No	Yes
Observations	3,979	3,979	3,979	3,979	5,501	5,501	5,501	5,501
Adjusted R <sup>2</sup>	0.33	0.34	0.38	0.38	0.30	0.32	0.37	0.37

**Table 2.3: Summary statistics – High and low polluting groups**

This table summarizes the characteristics of the firm-year, plant-year, and group-year by high and low pollution groups. Panel A presents summary statistics at the company level, Panel B at the plant level, and Panel C at the group level. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. High.Polluting groups are groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining. Variable definitions are in the appendix.

	High.Polluting			Low.Polluting				
<b>Panel A: Firm characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
Size	1,496	11.63	1.19	1,881	11.69	1.24	0.06	1.53
Cash.Asset	1,496	0.02	0.06	1,881	0.03	0.07	0.01	4.38
Capex.Asset	1,496	0.06	0.05	1,881	0.05	0.05	-0.001	-0.78
Tang.Asset	1,496	0.27	0.18	1,881	0.24	0.16	-0.04	-6.05
SubInvDum	1,496	0.41	0.49	1,881	0.33	0.47	-0.08	-4.53
NbrPlants	1,490	4.52	6.83	1,845	4.16	6.30	-0.37	-1.60

	High.Polluting			Low.Polluting				
<b>Panel B: Plant characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
1 (Inv.Green)	2,565	0.76	0.43	2,913	0.69	0.46	-0.06	-5.23
Inv.Green (keuros)	1,940	332.37	438.62	2,020	218.73	346.90	-113.65	-9.02
Log(Inv.Green +1)	1,940	4.68	1.74	2,020	4.20	1.69	-0.48	-8.74
Employees.Plant	2,565	5.70	1.12	2,913	6.15	1.25	0.45	14.10

	High.Polluting			Low.Polluting				
<b>Panel C: Group characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
ESG score	704	39.32	12.23	705	41.08	12.06	1.76	2.71
Environmental score	704	36.38	15.99	705	40.15	16.09	3.77	4.41
MultinationalGroup	704	0.75	0.43	705	0.81	0.39	0.06	2.92
EuroForeignGroup	704	0.44	0.50	705	0.35	0.48	-0.09	-3.47
NoEuroForeignGroup	704	0.40	0.49	705	0.31	0.46	-0.09	-3.37
FrenchGroup	704	0.15	0.36	705	0.34	0.48	0.20	8.81

**Table 2.4: Differences between high and low polluting groups in the relationship between pollution abatement effort and environmental scores**

This table reports the OLS regression estimates studying the relationship between *pollution abatement effort* and environmental scores depending on whether the group is perceived as high polluting. The dependent variable is the group environmental scores, and *pollution abatement effort* could be a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $\mathbb{1}(Inv.Green)$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $Log(Inv.Green + 1)$ ). The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. Standard errors are clustered at the plant level. High.Polluting groups are groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score			
High.Polluting_Log(Inv.Green + 1)	-1.25*** (0.42)	-1.30*** (0.43)		
High.Polluting_1(Inv.Green)			-0.09 (1.16)	0.25 (1.17)
Log(Inv.Green + 1)	0.76*** (0.25)	0.83*** (0.26)		
1(Inv.Green)			-1.15 (0.74)	-1.45* (0.75)
Size	2.02*** (0.49)	2.08*** (0.50)	1.55*** (0.43)	1.60*** (0.43)
Tang.Asset	13.10*** (3.34)	12.52*** (3.48)	11.60*** (3.18)	10.95*** (3.26)
Capex.Asset	9.28 (7.32)	12.83 (8.12)	4.13 (6.44)	8.66 (6.93)
Cash.Asset	-20.64*** (7.45)	-22.17*** (7.74)	-14.33** (6.35)	-14.86** (6.60)
SubInvDum	-0.20 (0.90)	-0.18 (0.92)	0.16 (0.82)	0.16 (0.84)
NoEuroForeignGroup	-10.60*** (1.50)	-11.00*** (1.57)	-10.72*** (1.37)	-11.09*** (1.42)
FrenchGroup	9.27*** (1.16)	9.11*** (1.20)	8.96*** (1.07)	8.90*** (1.11)
MultinationalGroup	-4.20*** (0.88)	-4.80*** (0.97)	-3.30*** (0.82)	-3.93*** (0.93)
Employees.Plant	0.95** (0.41)	0.84** (0.42)	1.08*** (0.38)	1.06*** (0.39)
Year FE	Yes	No	Yes	No
Industry FE	Yes	No	Yes	No
Industry X Year FE	No	Yes	No	Yes
Observations	3,960	3,960	5,478	5,478
Adjusted R <sup>2</sup>	0.38	0.39	0.37	0.37

**Table 2.5: Summary statistics – Polluting incident vs. control groups**

This table summarizes the characteristics of the firm-year, the plant-year, and the group-year. Panel A presents summary statistics at the company level, Panel B at the plant level, and Panel C at the group level. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. Polluting incident groups are groups experiencing at least one polluting incident in one of their plants during the period of interest. Variable definitions are in the appendix.

	Polluting incident			Control				
<b>Panel A: Firm characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
Size	175	12.19	1.20	3,219	11.64	1.21	-0.54	-2.70
Cash.Asset	175	0.04	0.08	3,219	0.03	0.07	-0.01	-2.41
Capex.Asset	175	0.05	0.04	3,219	0.06	0.05	0.01	5.17
Tang.Asset	175	0.18	0.14	3,219	0.25	0.17	0.07	9.31
SubInvDum	175	0.37	0.48	3,219	0.37	0.48	0.002	0.63
NbrPlants	172	4.84	5.37	3,180	4.31	6.60	-0.53	2.67

	Polluting incident			Control				
<b>Panel B: Plant characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
1 (Inv.Green)	325	0.83	0.38	5,176	0.72	0.45	-0.11	-1.58
Inv.Green (keuros)	270	444.03	491.75	3,709	261.27	387.65	-182.76	-2.91
Log(Inv.Green + 1)	270	5.14	1.69	3,709	4.38	1.72	-0.76	-2.89
Employees.Plant	325	6.33	1.36	5,176	5.91	1.20	-0.42	-7.04

	Polluting incident			Control				
<b>Panel C: Group characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
ESG score	40	40.22	14.91	1,379	40.27	12.10	0.05	2.33
Environmental score	40	34.71	19.30	1,379	38.48	16.05	3.76	3.03
MultinationalGroup	40	0.78	0.42	1,379	0.78	0.41	0.01	-1.25
EuroForeignGroup	40	0.57	0.50	1,379	0.39	0.49	-0.19	2.26
NoEuroForeignGroup	40	0.22	0.42	1,379	0.36	0.48	0.13	-1.42
FrenchGroup	40	0.15	0.36	1,379	0.25	0.44	0.10	-0.38

**Table 2.6: Impact of being considered as high polluting group in the relationship between pollution abatement effort and environmental scores**

This table reports the OLS regression estimates studying the relationship between *pollution abatement effort* and environmental scores depending on whether the group is perceived as high polluting. The dependent variable is the group environmental scores, and *pollution abatement effort* could be a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $1(Inv.Green)$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $Log(Inv.Green + 1)$ ). *Pollutingincident* is a dummy of one if the group experiences at least one polluting incident in one plant during the period of interest and if the year is after the incident. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 763 establishments, 465 firms, and 195 groups from 2009 to 2018. Standard errors are clustered at the plant level. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score					
PollutingIncident_Log(Inv.Green +1)	-0.14 (0.12)	-0.28** (0.14)	-0.32** (0.16)			
PollutingIncident_1(Inv.Green)				1.28* (0.68)	0.98 (0.78)	1.18 (0.89)
PollutingIncident	-3.33*** (1.08)	-2.24* (1.16)	-1.76 (1.26)	-5.37*** (1.03)	-4.73*** (1.11)	-4.79*** (1.20)
Log(Inv.Green +1)	0.13** (0.05)	0.11* (0.06)	0.13* (0.08)			
1(Inv.Green)				-0.30* (0.18)	-0.39* (0.21)	-0.46* (0.26)
Size	-0.06 (0.11)	1.69* (0.98)	-0.48 (0.66)	0.03 (0.08)	1.73** (0.75)	-0.22 (0.49)
Tang.Asset	0.69 (1.08)	-1.18 (4.16)	-0.21 (4.41)	0.69 (0.89)	-0.01 (3.42)	0.98 (3.54)
Capex.Asset	-3.22 (3.55)	-4.64 (4.52)	-5.27 (4.76)	-4.66 (3.01)	-6.12 (3.81)	-6.08 (3.97)
Cash.Asset	0.08 (1.89)	-0.42 (3.58)	-0.20 (3.82)	-0.81 (1.31)	-1.19 (2.59)	-1.14 (2.67)
SubInvDum	-0.43* (0.22)	-1.67*** (0.60)	-1.59** (0.63)	-0.45** (0.18)	-1.36*** (0.51)	-1.41*** (0.52)
NoEuroForeignGroup	-0.65 (0.74)	-1.29 (0.91)	-1.10 (0.94)	-0.88 (0.61)	-1.44* (0.77)	-1.37* (0.80)
FrenchGroup	2.34*** (0.87)	3.82*** (1.12)	3.75*** (1.20)	2.21*** (0.83)	3.40*** (1.11)	3.32*** (1.13)
MultinationalGroup	-1.34** (0.60)	-1.52** (0.65)	-1.55** (0.68)	-1.25** (0.53)	-1.33** (0.56)	-1.32** (0.58)
Employees.Plant	0.04 (0.08)	-0.04 (0.11)	0.01 (0.23)	0.02 (0.06)	0.01 (0.09)	0.04 (0.20)
Industry X Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Yes	No	No	Yes	No	No
Firm FE	No	Yes	No	No	Yes	No
Plant FE	No	No	Yes	No	No	Yes
Observations	3,979	3,979	3,979	5,501	5,501	5,501
Adjusted R <sup>2</sup>	0.90	0.89	0.89	0.90	0.89	0.89

**Table 2.7: Summary statistics – High and low polluting groups – MSCI**

This table summarizes the characteristics of the firm-year, the plant-year, and the group-year by high and low polluting groups. Panel A presents summary statistics at the company level, Panel B at the plant level, and Panel C at the group level. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by MSCI, excluding missing values and the energy sector. In total, the dataset includes 643 establishments, 426 firms, and 187 groups from 2009 to 2018. High.Polluting groups are groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining. Variable definitions are in the appendix.

	High.Polluting			Low.Polluting				
<b>Panel A: Firm characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
Size	592	11.62	1.16	878	11.70	1.20	0.08	1.26
Cash.Asset	592	0.02	0.06	878	0.03	0.07	0.01	2.29
Capex.Asset	592	0.06	0.05	878	0.06	0.05	-0.002	-0.61
Tang.Asset	592	0.27	0.18	878	0.24	0.17	-0.03	-3.39
SubInvDum	592	0.36	0.48	878	0.32	0.47	-0.04	-1.57
NbrPlants	591	4.17	6.94	861	4.26	6.96	0.09	0.23
	High.Polluting			Low.Polluting				
<b>Panel B: Plant characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
1 (Inv.Green)	936	0.75	0.43	1,316	0.69	0.46	-0.06	-3.03
Inv.Green (keuros)	702	262.28	372.18	911	227.22	342.98	-35.07	-1.94
Log(Inv.Green +1)	702	4.49	1.66	911	4.28	1.69	-0.20	-2.41
Employees.Plant	936	5.82	1.14	1,316	6.24	1.25	0.41	8.18
	High.Polluting			Low.Polluting				
<b>Panel C: Group characteristics</b>	N	Mean	SD	N	Mean	SD	Diff	t.stat
ESG score	293	5.94	2.75	341	5.90	2.46	-0.04	-0.18
Environmental score	293	5.99	2.01	341	6.71	2.11	0.72	4.37
Social score	293	4.67	1.98	341	4.94	1.76	0.26	1.75
Governance score	293	5.95	1.94	340	5.76	1.96	-0.19	-1.21
MultinationalGroup	293	0.75	0.43	341	0.79	0.41	0.04	1.04
EuroForeignGroup	293	0.33	0.47	341	0.38	0.48	0.05	1.26
NoEuroForeignGroup	293	0.52	0.50	341	0.33	0.47	-0.19	-4.84
FrenchGroup	293	0.13	0.33	341	0.30	0.46	0.17	5.40

**Table 2.8: Differences between high and low polluting groups in the relationship between pollution abatement effort and environmental scores – MSCI**

This table reports the OLS regression estimates studying the relationship between *pollution abatement effort* and environmental scores depending on whether the group is perceived as high polluting. The dependent variable is the group environmental scores, and *pollution abatement effort* could be a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $\mathbb{1}(Inv.Green)$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $\text{Log}(Inv.Green + 1)$ ). The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by MSCI, excluding missing values and the energy sector. In total, the dataset includes 643 establishments, 426 firms, and 187 groups from 2009 to 2018. Standard errors are clustered at the plant level. High.Polluting groups are groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), coking, and refining. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score			
High.Polluting_Log(Inv.Green +1)	-0.18*** (0.07)	-0.17** (0.07)		
High.Polluting_1(Inv.Green)			0.15 (0.19)	0.19 (0.19)
Log(Inv.Green +1)	0.05 (0.04)	0.05 (0.04)		
1(Inv.Green)			0.09 (0.12)	-0.01 (0.11)
Size	0.06 (0.06)	0.06 (0.07)	0.03 (0.06)	0.04 (0.06)
Tang.Asset	0.39 (0.50)	0.16 (0.53)	0.95** (0.46)	0.79 (0.50)
Capex.Asset	4.91*** (1.31)	5.43*** (1.41)	3.01*** (1.15)	3.69*** (1.27)
Cash.Asset	-2.27* (1.17)	-2.64** (1.23)	-1.13 (0.86)	-1.50* (0.90)
SubInvDum	-0.07 (0.13)	-0.05 (0.14)	-0.04 (0.12)	-0.03 (0.13)
NoEuroForeignGroup	-0.06 (0.22)	-0.01 (0.22)	-0.03 (0.19)	0.04 (0.19)
FrenchGroup	0.80*** (0.18)	0.92*** (0.20)	0.76*** (0.16)	0.91*** (0.18)
MultinationalGroup	-0.66*** (0.20)	-0.77*** (0.21)	-0.62*** (0.17)	-0.91*** (0.18)
Employees.Plant	0.06 (0.06)	0.03 (0.06)	0.07 (0.05)	0.04 (0.05)
Year FE	Yes	No	Yes	No
Industry FE	Yes	No	Yes	No
Industry X Year FE	No	Yes	No	Yes
Observations	1,613	1,613	2,252	2,252
Adjusted R <sup>2</sup>	0.16	0.27	0.16	0.28

# Appendix



## Variables definitions

The table shows the names and definitions of the variables

Variable name	Definition
<i>Source: FARES/LIFI</i>	
<i>Firm characteristics</i>	
Size	Logarithm of total assets
Cash.Asset	Cash over total assets
Capex.Asset	Capital expenditures over total assets
Tang.Asset	Tangible asset over total assets
SubInvDum	Dummy of one if the company receives investment subsidies
NbrPlants	Number of plants owned by the firm
<i>Source: ANTIPOL</i>	
<i>Plant characteristics</i>	
1 (Inv.Green)	Dummy of one if the plant invests in pollution abatement
Inv.Green	Annual amount spent by a plant in pollution abatement
Log(Inv.Green +1)	Log(Inv.Green +1)
Employees.Plant	Number of employees range of establishments
<i>Source: V.E</i>	
<i>Group characteristics</i>	
ESG score	"Overall", weighted average of Environmental score, Social score and Governance Score
Environmental score	"ESG ENV Score"
MultinationalGroup	Dummy of one if the group is a multinational group
EuroForeignGroup	Dummy of one if the group is part of an european group
NoEuroForeignGroup	Dummy of one if the group is part of a non-european group
FrenchGroup	Dummy of one if the group is part of a French group
High.Polluting	The groups perceived as high polluting belong to the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), and coking and refining

**Table A1: Impact of having a polluting incident on environmental scores**

This table reports the OLS regression estimates studying the impact of experiencing a polluting incident on environmental scores at the firm level. The dependent variable is the group environmental scores. *Pollutingincident* is a dummy of one if the group experiences at least one polluting incident in one plant during the period of interest and if the year is after the incident. The sample contains all French industrial firms owning plants with more than 250 employees that belong to a group covered by V.E, excluding missing values and the energy sector. In total, the dataset includes 465 firms and 195 groups from 2009 to 2018. Standard errors are clustered at the firm level. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score				
PollutingIncident	-14.27*** (4.68)	-15.91*** (2.69)	-16.74*** (3.14)	-2.65*** (0.98)	-2.55** (1.14)
Size		1.69*** (0.47)	1.63*** (0.52)	0.01 (0.09)	1.39* (0.83)
Tang.Asset		18.35*** (3.57)	14.94*** (4.00)	1.09 (1.13)	1.23 (3.78)
Cash.Asset		-17.19** (8.53)	-19.83** (8.34)	-1.25 (1.81)	-1.52 (3.52)
Capex.Asset		-10.91 (8.07)	-3.60 (8.60)	-3.32 (3.67)	-3.98 (4.86)
SubInvDum		0.75 (1.07)	0.72 (1.11)	-0.14 (0.23)	-0.67 (0.70)
NoEuroForeignGroup		-7.83*** (1.59)	-7.87*** (1.63)	-0.44 (0.64)	-0.62 (0.81)
FrenchGroup		12.32*** (1.32)	11.50*** (1.44)	1.13 (0.93)	1.95 (1.52)
MultinationalGroup		-3.70*** (1.05)	-4.32*** (1.15)	-1.24* (0.66)	-1.39* (0.74)
Year FE	Yes	Yes	No	No	No
Industry X Year FE	No	No	Yes	Yes	Yes
Groupe FE	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes
Observations	3,394	3,394	3,394	3,394	3,394
Adjusted R <sup>2</sup>	0.03	0.32	0.34	0.89	0.89

**Table A2: Summary statistics - MSCI**

This table summarizes the characteristics of the firm-year, the plant-year, and the group-year. Panel A presents summary statistics at the company level, Panel B at the plant level, and Panel C at the group level. The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by MSCI, excluding missing values and the energy sector. In total, the dataset includes 643 establishments, 426 firms, and 187 groups from 2009 to 2018. Variable definitions are in the appendix.

<b>Panel A: Firm characteristics</b>	N	Mean	SD	P25	Median	P75
Size	1,473	11.67	1.19	10.81	11.59	12.82
Cash.Asset	1,473	0.03	0.07	0.0001	0.002	0.02
Capex.Asset	1,473	0.06	0.05	0.02	0.04	0.08
Tang.Asset	1,473	0.25	0.18	0.10	0.22	0.39
SubInvDum	1,473	0.34	0.47	0	0	1
NbrPlants	1,455	4.23	6.95	1	2	4
<b>Panel B: Plant characteristics</b>	N	Mean	SD	P25	Median	P75
1 (Inv.Green)	2,256	0.72	0.45	0	1	1
Inv.Green (keuros)	1,615	242.29	356.12	21.35	87	280.50
Log(Inv.Green +1)	1,615	4.37	1.68	3.11	4.48	5.64
Employees.Plant	2,256	6.06	1.22	5	6	7
<b>Panel C: Group characteristics</b>	N	Mean	SD	P25	Median	P75
ESG score	636	5.92	2.60	3.89	6.20	7.81
Environmental score	636	6.37	2.09	5.60	6.60	7.60
MultinationalGroup	636	0.77	0.42	1	1	1
EuroForeignGroup	636	0.35	0.48	0	0	1
NoEuroForeignGroup	636	0.42	0.49	0	0	1
FrenchGroup	636	0.22	0.41	0	0	0

**Table A3: Relationship between pollution abatement effort and environmental scores – MSCI**

This table reports the OLS regression estimates studying the relationship between *pollution abatement effort* and environmental scores. The dependent variable is the group environmental scores, and *pollution abatement effort* could be a dummy equal to one if the plant invests in reducing pollution for extensive margins ( $1(Inv.Green)$ ) and the logarithm of the amount spent to invest in pollution abatement plus one for intensive margins ( $Log(Inv.Green + 1)$ ). The sample contains all French industrial establishments with more than 250 employees that belong to a group covered by MSCI, excluding missing values and the energy sector. In total, the dataset includes 643 establishments, 426 firms, and 187 groups from 2009 to 2018. Standard errors are clustered at the plant level. Variable definitions are in the appendix. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Environmental score							
Log(Inv.Green + 1)	-0.04 (0.03)	-0.04 (0.03)	-0.03 (0.03)	-0.03 (0.03)				
1(Inv.Green)					0.07 (0.10)	0.07 (0.10)	0.15 (0.09)	0.07 (0.09)
Size	-0.02 (0.07)	-0.02 (0.07)	0.04 (0.06)	0.05 (0.07)	-0.03 (0.06)	-0.02 (0.06)	0.03 (0.06)	0.05 (0.06)
Tang.Asset	-0.28 (0.45)	-0.04 (0.45)	0.47 (0.49)	0.22 (0.52)	0.16 (0.42)	0.35 (0.42)	0.97** (0.45)	0.78 (0.49)
Capex.Asset	6.42*** (1.26)	5.87*** (1.25)	4.64*** (1.28)	5.22*** (1.39)	5.18*** (1.18)	4.84*** (1.15)	3.03*** (1.13)	3.73*** (1.26)
Cash.Asset	-1.18 (1.35)	-1.27 (1.33)	-2.17* (1.17)	-2.53** (1.23)	-0.14 (1.00)	-0.16 (0.99)	-1.10 (0.86)	-1.49* (0.90)
SubInvDum	-0.21 (0.14)	-0.18 (0.13)	-0.08 (0.13)	-0.06 (0.14)	-0.20 (0.12)	-0.18 (0.12)	-0.04 (0.12)	-0.03 (0.13)
NoEuroForeignGroup	0.02 (0.21)	0.02 (0.21)	-0.07 (0.22)	0.001 (0.22)	0.03 (0.19)	0.02 (0.19)	-0.04 (0.19)	0.04 (0.19)
FrenchGroup	0.59*** (0.17)	0.72*** (0.17)	0.81*** (0.18)	0.91*** (0.19)	0.65*** (0.15)	0.76*** (0.15)	0.77*** (0.16)	0.91*** (0.17)
MultinationalGroup	-0.32** (0.15)	-0.50*** (0.19)	-0.64*** (0.20)	-0.76*** (0.21)	-0.33** (0.13)	-0.49*** (0.17)	-0.63*** (0.17)	-0.92*** (0.18)
Employees.Plant	0.14*** (0.04)	0.13*** (0.04)	0.08 (0.06)	0.04 (0.06)	0.15*** (0.04)	0.13*** (0.04)	0.07 (0.05)	0.04 (0.05)
Year FE	No	Yes	Yes	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No	No	Yes	No
Industry X Year FE	No	No	No	Yes	No	No	No	Yes
Observations	1,615	1,615	1,615	1,615	2,256	2,256	2,256	2,256
Adjusted R <sup>2</sup>	0.06	0.09	0.15	0.26	0.05	0.08	0.16	0.28



## **Chapter 3**

### **To Treat or Prevent Pollution?**

This paper investigates the effect of financial constraints on pollution abatement methods. Using unique plant-level data from the French manufacturing sector between 2011 and 2018, I provide strong evidence that capital constraints discourage pollution prevention and have no impact on pollution treatment without environmental laws. First, financially constrained firms are less likely to invest in pollution prevention but not in pollution treatment. Second, by applying a staggered difference-in-differences methodology, I find that a negative shock to firms' cash flows reduces the amount spent on pollution prevention. Finally, my results show that financially constrained firms increase their investments in pollution treatment relative to unconstrained firms after the implementation of an environmental regulation. Overall, my findings suggest that financial constraints lead to reduced pollution prevention and encourage treatment when environmental laws are enforced.

## 3.1 Introduction

Manufacturing activities are among the most polluting on the planet, along with agriculture, transportation, and energy production. Indeed, industrial companies<sup>1</sup> generate waste and air, water, and soil pollution through their production process, generating negative externalities that harm the environment, human health, and biodiversity. For this reason, governments, the public, and investors have pressured such companies to reduce pollution throughout the 20th century, doing so more actively in recent decades.<sup>2</sup> However, there are several ways to reduce pollution. The most common method is pollution treatment. In this case, pollution is generated during production and then treated. Another way to reduce pollution is to prevent it, that is, to prevent its creation. Environmental agencies have increasingly emphasized pollution prevention to protect public health and the environment.<sup>3</sup> Moreover, the distinction between pollution prevention and pollution treatment is beginning to be mentioned in certain legislation that promotes prevention over treatment, increasing the transition risk for companies that invest in treatment.<sup>4</sup> Pollution treatment and prevention investments do not require the same amount of financial resources, and access to these financial resources plays a key role in pollution reduction (Bartram et al., 2022; Cohn and Deryugina, 2018; Goetz, 2018; Kim and Xu, 2022; Levine et al., 2019). Therefore, understanding how financial constraints affect the mix of pollution reduction investments is fundamental to understanding how firms will respond to these potential new laws.

This paper sheds light on how financial constraints impact the choice made by manufacturing companies between treating and preventing pollution. My results suggest that financial constraints decrease the probability that these companies will be environmentally proactive by preventing pollution. Instead, constrained firms comply with environmental regulations only

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<sup>1</sup>In this paper, the terms "manufacturing" and "industrial" are used interchangeably.

<sup>2</sup>See the extensive development of green legislation (<https://www.msci.com/who-will-regulate-esg>) and sustainable and impact investing (<https://www.eurosif.org/wp-content/uploads/2018/11/European-SRI-2018-Study.pdf>).

<sup>3</sup>The EPA (the United States Environmental Protection Agency) launched the Pollution Prevention program (P2) in 1990: <https://www.epa.gov/p2>. See the report: <https://www.eea.europa.eu/publications/signals-2020> for the EEA. (European Environmental Agency).

<sup>4</sup>For example, in the EU Action Plan - Towards Zero Pollution for Air, Water and Soil by 2021 - it is stated that "The main objective of this action plan is to provide a compass for including pollution prevention in all relevant EU policies." The EPA's Pollution Prevention Act of 1990 states that "pollution shall be prevented or reduced at the source whenever practicable." Finally, Executive Order 14057 on Catalyzing American Clean Energy Industries and Jobs Through Federal Sustainability, which was signed in 2021, states that "each agency shall minimize waste, including the generation of waste requiring treatment and disposal[, and] advance pollution prevention."

when forced to do so and opt for treatment. I argue that this preference to treat pollution stems from the fact that such investments require less capital in the short term. In contrast, investments aimed at directly reducing pollution at its source are initially more expensive but can generate profits that make them less costly, or even profitable, in the long run. Therefore, companies with sufficient financial resources prioritize investments intended to prevent pollution, while those with greater financial constraints choose to treat pollution only if they are required to do so.

I use the NPV framework to evaluate how financial constraints impact the methods used by firms to reduce pollution. Notably, this paper focuses on chronic pollution.<sup>1</sup> Since financial constraints significantly affect investments intended to decrease toxic emissions, they should also impact the methods used if they do not have the same financial requirements. Pollution treatment and prevention differ in terms of both costs and benefits. In their paper, [Cagno et al. \(2005\)](#) explain that the prevention approach is "based on the idea that the generation of pollutants can be reduced or eliminated by increasing the efficiency of the use of raw materials, energy, water, and other resources."<sup>2</sup> By improving the use of resources, pollution prevention reduces costs, and by reducing the generation of pollution, it reduces the need for treatment. As pollution prevention is cost-effective, investing in pollution prevention generates some benefits and improves the performance of companies ([King and Lenox, 2002](#); [Petraru et al., 2010](#); [Porter and Van Der Linde, 1995b](#); [Shen, 1995](#); [Schoenherr, 2012](#)). Since pollution prevention generates benefits, prevention investments have a potentially positive NPV. On the other hand, end-of-pipe treatment investments are not profitable and do not improve the financial performance of companies ([Brião and Tavares, 2007](#)).<sup>3</sup> If pollution treatment does not generate profits in the absence of reputational and regulatory costs, the NPV of the associated treatment investments is negative. In designing my hypothesis, I neglect reputational costs for simplicity and because they impact both prevention and treatment investments. If the impact is different, it will be in

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<sup>1</sup>Chronic pollution is caused by the usual activities of firms and is positively correlated with production, in contrast to accidental pollution resulting from an event such as an explosion or leak.

<sup>2</sup>Pollution prevention investments can be investments made to switch from a closed circuit to an open circuit or any type of investment necessary for the modification of machines or processes to decrease the pollution they generate. Preventing pollution also involves using cleaner raw materials, so an investment in prevention can also be an investment required for the use of these cleaner raw materials.

<sup>3</sup>For instance, treatment investments include catalytic oxidizers, filters, water treatment plants, drainage systems, electrostatic precipitators, air or wet scrubbers, pumps and compressors, waste storage and incineration facilities, and stelling tanks.



favor of prevention investments. Moreover, if prevention and treatment investments do not lead to the same financial performance, they will not require the same investment. Investments in chronic pollution prevention are more complicated to implement than investments in pollution treatment because they involve a reorganization of the production process and often require employee training (Hart and Ahuja, 1996; Hart, 1995; Sarkis and Cordeiro, 2001). Thus, in the short term, pollution prevention investments are more costly than treatment investments (Kim and Xu, 2022).<sup>1</sup> Consistent with the NPV framework, the hypothesis of this paper is that if companies have no obligation to invest in reducing pollution, firms that are not financially constrained invest in pollution prevention if they perceive that the NPV of such investments is positive. In contrast, financially constrained companies do not invest in pollution abatement. In other words, financial constraints reduce prevention investments but have no impact on treatment investments.<sup>2</sup>

My empirical specification uses plant-level data from the French administrative database ANTIPOL, which provides the amount of investment made by 3,223 French manufacturing plants to reduce pollution from 2011 to 2018. This unique dataset allows me to analyze and understand the investment behavior of companies regarding pollution reduction. I begin my study by using multivariate regression analysis to investigate the correlation between financial constraints and pollution abatement investments. To this end, I create three different measures of financial constraints based on three different indexes, and with these three indexes, I rank the firms in terciles by year and industry. The first index is based on company size because larger

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<sup>1</sup>For example, Shick Manufacturing in Verona produces razor blades and steel tools. As part of its production process, Shick needed to use trichloroethylene (TCE), a degreasing solvent, to clean metal parts. Most of the TCE used was recycled on-site through carbon absorption and distillation, and the waste generated was shipped off-site as hazardous waste for treatment. Treating pollution requires investments in collecting, storing and shipping hazardous waste off-site. Due to increasing costs (TCE, waste disposal, and energy required for distillation) and increasing regulatory risk, Shick decided to eliminate TCE from its production process by investing in aqueous "wash boxes" and using an alcohol-based cleaner as a substitute. The procedures had to be tested several times, and employees had to be trained in the new process. This investment in pollution prevention resulted in a cost reduction of \$250,000 per year due to reduced energy, material and hazardous waste disposal costs. See Worku (2018) for more examples.

<sup>2</sup>In developing my hypothesis, I assume that the discount rate, which is the weighted average cost of capital (WACC), is the same for each firm and project. This assumption is not realistic. Firms and projects have very different WACCs depending on their economic risk, which could impact their choice between investments to prevent pollution and those to treat it. Firms or investments with higher WACCs underweight potential future benefits, which leads them to favor treatment investments over prevention investments if the benefits of pollution prevention are not great enough to balance the differences between the amounts of prevention and treatment investments. In other words, the riskier a project is, the more hesitant firms are and the less obvious the choice of prevention over treatment is. Conversely, firms with a low WACC overweight the benefits of prevention, making the choice of prevention versus treatment investments more obvious. In summary, differences in the WACC across firms and projects could impact my results.

companies have greater access to external capital (Hennessy and Whited, 2007). The second is based on a rating methodology inspired by Mulier et al. (2016) that includes company size, cash flow, and dividends (Almeida et al., 2004). Finally, the last measure is based on the Whited-Wu (WW) index (Whited and Wu, 2006). All three financial constraint measures are accounting measures due to data limitations. In line with the literature, constrained firms are found to be less likely to invest in pollution abatement and, more specifically, in pollution prevention. In contrast, financial constraints are not correlated with the probability of treating pollution. This suggests that firms with good access to financial resources are more likely to invest in pollution prevention. The findings regarding the amount spent are less striking. Capital constraints negatively impact each pollution reduction investment type, even if the coefficients are economically lower for treatment. These results are robust to the inclusion of firm- and plant-level controls for potential omitted variables and to the inclusion of industry fixed effects at the plant level and industry-year fixed effects at the firm level to control for industry purpose and technology evolution.

One of the main endogeneity problems entailed in a simple OLS model is omitted variables. For instance, poor management could drive the negative relationship between financial constraints and pollution abatement investments because it decreases cash flow, firm size, and pollution abatement investments (Cohn and Deryugina, 2018). Moreover, my previous results may suffer from reverse causality. By improving their environmental performance, companies gain better access to finance (Cheng et al., 2014). To address these endogeneity issues, I use a negative shock to firms' cash flows that reduces their investments, and this approach allows me to analyze the causal relationship between financial constraints and pollution abatement investments.<sup>1</sup> More precisely, I exploit firms' differential exposure to an increase in the local tax rate by employing a staggered difference-in-difference (DID) methodology. A critical identifying assumption is that an increase in the tax rate increases the amount of tax paid by a firm, thereby reducing its free cash flow. Since investments are closely related to cash flow, firms with fewer internal resources prioritize operational investments over pollution reduction investments (Fazzari et al., 1987). In addition, a decrease in cash flows reduces access to external financing

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<sup>1</sup>Cash flow shocks are widely used in the literature on financial constraints (Lamont, 1997). The most widely used shock is the American Jobs Creation Act (Almeida et al., 2021; Cohn and Wardlaw, 2016; Kim and Xu, 2022).

by, for example, reducing the probability of debt repayment [Mulier et al. \(2016\)](#). This shock to cash flow is a shock to internal and external access to finance. In France, firms must pay a local tax called the Company Property Assessment (CFE) on the buildings and land that they own. The tax rate is determined at the municipality level. I aggregate the CFE tax rate to which a firm is subject at the firm level using an average weighted by the number of employees in the establishment. My estimates indicate that after the tax rate increase, firms decrease the amounts they invest in preventing pollution, while investments in pollution treatment are unaffected. I add firm-level and establishment-level controls, as well as firm-level industry-year fixed effects and establishment fixed effects. Furthermore, my setting is robust to a placebo test, the use of a different threshold for the tax increase, and the use of two alternative estimators ([Callaway and Sant'Anna, 2021](#); [Sun and Abraham, 2021](#)), as suggested in [Baker et al. \(2022\)](#). Overall, this implies that financial constraints decrease investments in pollution prevention at its source but do not decrease those in pollution treatment.

In two additional subsections, I investigate whether be owned by a listed or high-polluting group impacts my results. Regarding listed and private groups, the results show that listed groups invest more in pollution prevention, although financial constraints similarly reduce pollution prevention investments for both listed and private groups. For high-polluting groups, financial constraints are also negatively correlated with pollution prevention investments. In addition, high-polluting groups impacted by a cash flow decline increase their treatment investments because they need to reduce the pollution they generate.

Nevertheless, many countries are implementing increasingly stringent green regulations to encourage companies to reduce their pollution emissions. ([Farzin and Kort, 2000](#); [Goetz, 2018](#); [Shapiro and Metclaf, 2021](#); [Shapiro and Walker, 2018](#)). These regulations could alter the effect of financial constraints on the choice between treatment and prevention because they introduce regulatory costs for firms that do not comply with the corresponding laws. Because of these regulatory costs, the NPV of both treatment and prevention investments increase, and both could become positive, although the NPV of prevention investments is still higher on average than that of treatment investments. Constrained firms rationally choose the least costly pollution abatement investment in the short run and thus invest in pollution treatment. On the other hand, some

firms that are not constrained may have an incentive to develop environmental policies before the implementation of such a law to capture the corresponding rent (de Bettignies et al., 2020), while those that have not already invested at the time of the law's adoption prioritize the investments with the highest NPV. Therefore, the second hypothesis of this paper is that after the implementation of environmental legislation, constrained firms begin to invest in pollution treatment, while unconstrained firms reduce their investment in pollution abatement or increase the amount spent on pollution prevention. To study how such new environmental regulations can change firms' choice between pollution prevention and treatment and how constrained firms respond to these regulations, this paper exploits the implementation of the Industrial Emissions Directive (IED)<sup>1</sup>. Again, company- and plant-level controls as well as industry-year and plant fixed effects are included. The results show that the IED increased the percentage of companies investing in pollution abatement and impacted the mix of methods used to reduce pollution. Indeed, after the implementation of the law, among the plants that invested in dedicated pollution abatement equipment, plants subject to the IED invested less in pollution prevention. However, this effect can be explained by the increased investments in pollution prevention undertaken by non-IED firms due to their increased regulatory risk. This impact on the pollution reduction mix also depends on whether a firm is financially constrained. Indeed, financially unconstrained firms reduced their investments in treatment, while financially constrained firms maintained them. In summary, implementing an environmental law impacts the decision between treatment and prevention because it encourages financially constrained firms to invest more in treatment than unconstrained firms.

In the last section, I study the decision to treat and prevent pollution in the case of accidental pollution. I argue that in this context, the impact of financial constraints on the decision between prevention and treatment is relatively unclear because the benefits of prevention are greater but must be weighted by the probability of a polluting incident. Moreover, environmental laws aimed at reducing accidental pollution are more oriented toward prevention, while for chronic pollution, the choice is up to the firm. I test this hypothesis using the SEVESO 3<sup>2</sup> implementation. The nonsignificant estimates confirm that financial constraints play a lesser role

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<sup>1</sup>Directive 2010/75/UE

<sup>2</sup>Directive 2012/18/UE

in choosing prevention and treatment in the case of accidental pollution.

This article is related to the emerging literature that examines the factors that affect corporate investments in pollution abatement, including governance (Dyck et al., 2023), limited liability (Akey and Appel, 2021), corporate internationalization (Choi et al., 2019), and equity market development (De Haas and Popov, 2019). Specifically, my paper contributes to the growing field concerning how financial constraints affect pollution reduction investments. Cohn and Deryugina (2018) highlight a negative relationship between cash flows and environmental spills. Bartram et al. (2022) document that after the implementation of the cap-and-trade program in California, financially constrained firms relocated their resources, shifting their pollution emissions from California to other states due to regulatory costs. Kim and Xu (2022) and Goetz (2018) find that a reduction in financial constraints decreases polluting emissions, especially under weak regulations. Levine et al. (2019) show that credit constraints increase toxic emissions. Finally, Dang et al. (2020) propose a theoretical framework to explain this negative relationship. As a complement to these studies, I find that financial constraints reduce investments in pollution reduction, but more importantly, they impact how firms decide to reduce pollution. Using the unique ANTIPOD dataset, I directly examine investment amounts and their breakdown between treatment and prevention. I show that financial constraints discourage firms from investing in pollution prevention but have no effect on treatment. I explain this difference based on the fact that pollution prevention requires more resources in the short run but generates higher benefits in the long run.

Second, this paper may have policy implications, as it is also closely related to the literature on the impact of environmental regulations (Porter and Van Der Linde, 1995a; Farzin and Kort, 2000; Shapiro and Walker, 2018; Shapiro and Metclaf, 2021) and how financially constrained firms respond to their implementation (Bartram et al., 2022). My results highlight that constrained firms respond to environmental regulations by treating toxic emissions. However, if we follow the recommendations of the EPA and the EEA, implementing environmental regulations could be counterproductive because instead of promoting pollution prevention, they encourage constrained firms to treat pollution.

Finally, the results of this study contribute to the debate on the effects of environmental in-

vestments on firm value and risk (Konar and Cohen, 2001; Oikonomou et al., 2012; Albuquerque et al., 2019; Hoepner et al., 2018). To my knowledge, this is the first paper in the field of finance to distinguish between pollution treatment and prevention, as this distinction has been explored only in other fields (Porter and Van Der Linde, 1995a,b; Cagno et al., 2005; Shen, 1995). The results suggest that pollution abatement investments vary considerably depending on whether they are aimed at treating or preventing pollution. Pollution prevention investments are initially more costly but ultimately generate benefits, leading to a positive NPV, while treatment investments are less costly but represent only a cost to firms and thus have a negative NPV. Since negative NPV destroys firm value while positive NPV increases it, these differences in NPV between treatment and prevention investments may explain the mixed results on the link between firm valuation and environmental policies (see Margolis et al. (2009) for a review).

## 3.2 Data

### 3.2.1 Environmental data

The survey on environmental protection studies and investments (ANTIPOL)<sup>1</sup> is a French survey with the objective of increasing knowledge on the amount and nature of investments undertaken by manufacturing plants to protect the environment. Data are collected yearly by the official French statistical service.<sup>2</sup> ANTIPOL exists to examine current expenditures for pollution reduction, but the survey is only conducted every four years, and these types of expenditures may be insignificant for companies. The inclusion threshold is 100 employees but can be reduced to 50 or 20 for a polluting plant. However, the survey is mandatory for only establishments with more than 250 employees. The investments concerned are purchases of buildings, land, machinery, or equipment dedicated to the treatment, measurement, control, or limitation of generated pollution. ANTIPOL provides a breakdown of these investments into two distinct types: specific and integrated. The latter concerns all environmentally efficient equipment purchases, while the former refers to equipment entirely dedicated to pollution reduction. Specific investments are classified into four categories. Treatment refers to pollution removal. Prevention relates to any

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<sup>1</sup>ANTIPOL has been used by Dechezleppêtre et al. (2016) and Goerger (2021), among other researchers.

<sup>2</sup>*Institut National de la Statistique et des Études Économiques (INSEE).*

facilities or equipment designed to reduce pollution at its source. Recycling involves the sorting and valorization of waste. Finally, measuring concerns the monitoring of toxic emissions and waste. The survey is a multipage document in which companies are asked to enter the amount spent each year on environmental protection. However, there are only two pages regarding specific investments and breakdowns by method. Since environmental institutions, such as the EPA with the Pollution Prevention Act and the EEA, encourage prevention rather than treatment, I choose to focus on treatment and prevention.

### **3.2.2 Financial data**

I obtain accounting data from *Fichier Approché des Résultats d'Ésane* (FARE). FARE is a database compiled by the official French statistical service and the French Ministry of Finance that provides all administrative data regarding tax bundles, including financial statements. Ownership data are taken from *Liaisons Financières entre sociétés* (LIFI). LIFI identifies the direct and indirect financial links between companies, allowing me to identify groups, their parent companies, and their nationalities.

### **3.2.3 Sample**

First, I clean the datasets separately. Since the ANTIPOL survey is mandatory for plants with more than 250 employees and those belonging to the most heavily polluting sectors, I keep only plants with more than 250 employees to obtain a relatively balanced and representative sample. In France, the *Système d'Identification du Répertoire des Entreprises* number (SIREN) is a unique 9-digit number that identifies companies. Similarly, plants are identified by specific 14-digit numbers called *Système d'Identification du Répertoire des Établissements* (SIRET) numbers. Each SIRET number is composed of two parts. The first nine digits correspond to the SIREN of the company that owns the establishment, and the last five are specific to the plant. I find the SIREN of the firm that owns each plant via the SIRET number and then match the ANTIPOL data to the LIFI and FARE data using the SIREN and the year. My sample has a high percentage of private firms, which could cause the data to be less accurate (Brav, 2009). Therefore, I winzorize the data at the 95th percentile to prevent extreme ratios. I drop any data

for firms with total assets or sales less than zero and plants that are in the database for less than three years. In addition, I remove observations with missing data from each regression. I define industries according to the first two digits of the relevant NAF (*Nomenclature des Activités Françaises*) code, which is similar to American Standard Industrial Classification (SIC) codes. Companies that produce energy have a specific business model. Because of their strategic activities, they are heavily subsidized; however, because they are heavy polluters, they are also strictly regulated by environmental legislation. As their specificity may impact and bias the results, companies belonging to this industry are removed from the sample. My final sample contains 21,827 plant-year observations, including 3,223 plants, 2,578 firms, and 64 different industries. Figure 3.1 displays the percentage of plants with pollution reduction investments and the split between treatment and prevention investments. The percentage of plants investing in pollution abatement remains stable over the years, and slightly more plants are investing in pollution prevention than in treatment. Figure 3.2 shows the differences in the amounts invested in prevention and treatment by industry. In most industries, the amount spent per year by each plant on prevention is higher than the amount spent on treatment, and this result confirms that investments in pollution prevention are more costly than those in treatment. The fact that the differences are negative for some industries could be because ANTIPOLE does not provide the number of investments undertaken; moreover, in some industries, firms have to invest in several pollution treatment projects that cannot be replaced by prevention. Table 3.1 shows the percentage of plants that invest in pollution reduction by sector. This time, I use the NAF code 38-sector classification for readability. The vast majority of plants in each industry invest in specific pollution abatement equipment, either to treat or prevent pollution, with the exception of the textile, clothing and leather sector. This result could be explained by the fact that the French factories in this industry are relatively clean and outsource or relocate their polluting activities. To complete the statistical analysis, Table 3.2 provides summary statistics. Consistent with Figure 3.1, 52% of plants invest in specific facilities to abate pollution, of which 64% reduce it at its source, and 49% treat it. The average amount invested in specific facilities is 148,600 euros, 117,830 euros for prevention and 121,970 euros for treatment. Regarding firm and group characteristics, the summary statistics are relatively standard.



## 3.3 Baseline analysis

Firms do not randomly choose how they protect the environment. This section investigates how financial constraint measures correlate with each type of pollution abatement investment. First, I describe how I measure financial constraints, and then I discuss the results.

### 3.3.1 Measuring financial constraints

Correctly measuring financial constraints is difficult, as they are not observable (Farre-Mensa and Ljungqvist, 2016). Several proxies have been created in the literature, such as the Kaplan-Zingales (KZ) index (Kaplan and Zingales, 1997; Lamont et al., 2001), the WW index (Whited and Wu, 2006), the SA index (Hadlock and Pierce, 2010), and textual measures (Hoberg and Maksimovic, 2015; Bodnaruk et al., 2015). However, data availability limits the choice of financial constraint measures, as only accounting data are available. I do not have access to capital market data (e.g., market capitalization, returns, or credit ratings) or 10-K filings, and this prevents me from using indexes such as the KZ index, text-based measures, or credit ratings. In the end, I use three measures of financial constraints. The first measure is based on firm size because larger firms can more easily access external capital and face lower external financing costs, whether private or public (Hennessy and Whited, 2007). To classify firms, I compute size terciles by industry and year.<sup>1</sup> Constrained firms are in the lowest tercile, and unconstrained firms are in the highest tercile. Second, many of the firms in my sample are private firms, and private and public firms do not face the same financial constraints. Private firms are more likely to suffer from information asymmetry and agency costs (Schauer et al., 2019). Thus, I create a composite measure based on a scoring methodology inspired by Mulier et al. (2016). I include company size, cash flow, and dividend payouts in this score. As explained earlier, large companies, whether public or private, are easier for financial institutions to value and have better access to external financing. Fazzari et al. (1987) were the first to identify a relationship between cash flow and financial constraints. Their paper argues that the sensitivity of cash flow to investment is a good measure of financial constraints. Constrained firms reduce their investment when cash

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<sup>1</sup>This time, the industries are not classified by the first two digits of their NAF codes. I use a less granular classification to have enough firms from each industry yearly. Specifically, I use a classification method that divides firms into 38 sectors.

flow decreases because they depend more heavily on internal resources than other firms. However, their measure has been strongly criticized by [Kaplan and Zingales \(1997\)](#), launching an important debate. [Almeida et al. \(2004\)](#) proposed a new measure of financial constraints involving the sensitivity of cash to cash flow. Firms facing high financial constraints hold more cash to invest now or in the future. However, as pointed out by [Erel et al. \(2015\)](#), cash sensitivity reflects a manager's view of his or her firm's financial constraints and future investment opportunities. Since, in my hypothesis, I consider a firm that makes investment decisions based on its current financial constraints, I choose to focus on cash flows. However, while the sensitivity of cash flow to investment is a criticized measure, the fact that higher cash flow promotes investment and enables better access to external capital is more consensual ([Mulier et al., 2016](#)). Finally, I focus on dividends because whether firms are public or private, a dividend payout indicates that the corresponding firm has generated cash flow that exceeds its investment opportunities ([Almeida et al., 2004](#)). I do not include leverage, which is often mentioned in the literature on financial constraints, because my sample contains many group subsidiaries, and the debt of firms may not reflect their actual debt but the way parent companies inject cash into their subsidiaries. In summary, the score is constructed as follows: a firm receives one point if its size is greater than the yearly median, one point if its cash flow ratio is greater than the yearly median, and one point if it distributes a dividend during the year. I do not make assumptions about the importance of these measures in terms of financial constraints, and using a scoring method allows me not to assign weights to different variables. While interpreting a sum of zero or three points is straightforward, knowing whether a firm is financially constrained with a score between these two values is more complicated. Therefore, I choose to compute the terciles by industry and year. Companies in the lowest tercile are constrained, and companies in the highest tercile are unconstrained. Finally, 25% of the groups in my sample are publicly listed. Therefore, I use the regression coefficients provided by [Whited and Wu \(2006\)](#) to construct the WW index (see the definitions of the variables in the appendix for more details). Again, I compute terciles by industry and year. The companies in the highest tercile are constrained, and those in the lowest tercile are unconstrained.

### 3.3.2 Baseline results

I analyze the correlation between financial constraints and pollution reduction investments by estimating the following OLS model:

$$PolAbatInv_{p,t} = \alpha + \beta_1 FinancialConstraint_{i,t} + \beta_2 X_{i,t} + \beta_3 W_{g,t} + \beta_4 Z_{p,t} + \mu_{j,t} + \theta_k + \varepsilon_{p,t} \quad (1)$$

where  $PolAbatInv_{p,t}$  represents one of my pollution abatement investment measures for plant  $p$  belonging to firm  $i$  in year  $t$ , that is,  $\mathbb{1}(Prevention)$  or  $\mathbb{1}(Treatment)$  for extensive margins and  $\text{Log}(Prevention + 1)$  or  $\text{Log}(Treatment + 1)$  for intensive margins.  $FinancialConstraint_{i,t}$  is a generic term representing *Score.Constraint*, *Size.Constraint*, or *W.W.Constraint*.  $X_{i,t}$  is a vector of firm-level controls, which includes *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, and *FirmAge*.  $W_{g,t}$  includes group-level controls such as *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, or *Listed*.  $Z_{p,t}$  represents plant-level controls and is composed of only *Employees*. I include industry-year fixed effects at the firm level and industry fixed effects at the plant level to examine the variation across firms controlling for time and industry heterogeneity. Firm fixed effects are not included to study the differences across firms. Table 3.3 shows the results for specific investments. Financial constraints exhibit a strong and negative correlation with pollution abatement investments. Consistent with the recent literature, the estimates suggest that constrained firms are less likely to invest in specific facilities to reduce pollution and invest smaller amounts. Table 3.4 presents the results of the distribution of specific investments between treatment and prevention investments. Panel A reports the results regarding the probability of investing, and Panel B reports those regarding the amounts invested. The probability of investing in pollution prevention is more affected by financial constraints than that of investing in pollution treatment. The estimates in Panel A are strongly negative and significant for prevention investments. Among the plants that invest in specific equipment designed to reduce pollution, plants owned by constrained firms are between 4% and 8% less likely to invest in preventing toxic emissions. In contrast, none of the coefficients are significant for treatment investments. These results suggest that firms with more capital are more likely to reduce pollution directly at the source, while constrained and unconstrained firms invest the same proportion in treatment

investments, supporting the idea that firms behave differently in terms of pollution reduction depending on their financial resources. For intensive margins, the results are less striking. Firms with few capital resources invest smaller amounts in all environmental investments. However, the effect is economically stronger for prevention, with coefficients ranging from  $-0.55$  to  $-0.20$  and from  $-0.24$  to  $-0.06$  for treatment. These results confirm that financial constraints are major determinants of pollution reduction investments, especially when these investments are based more on firms' own decisions rather than on legislation.

### 3.4 Identification: local tax rate

In the next section, I evaluate the impact of a decrease in cash flows on pollution abatement investments to identify a causal relationship between financial constraints and the types of environmental investments.

#### 3.4.1 Background and methodology

The Company Property Assessment tax (CFE)<sup>2</sup> is a French local tax on companies and individuals who are self-employed. They are liable for the CFE in each municipality where they own buildings and land. More specifically, the amount of the tax is equal to the product of the rental value of the real estate subject to property tax (in year  $t - 2$ ) and the CFE tax rate established by each municipality (in year  $t$ ). Data regarding the CFE tax rate are publicly available and can be easily downloaded from the appropriate French government website.<sup>1</sup> CFE tax rates are at the plant level, and the shock of financial constraints must be at the company level because companies decide budget allocations. Therefore, I have to aggregate the CFE data on the company level. However, ANTIPOL is mandatory for only plants with more than 250 employees, and my sample does not contain all the French establishments owned by firms. To address this challenge, I use the *Déclaration Annuelle de Données Sociales* (DADS) database, which gives me access to the details of all plants, including their number of employees.<sup>2</sup> After merging my

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<sup>2</sup>Cotisation Foncière des Entreprises in French

<sup>1</sup><https://www.data.gouv.fr/fr/datasets/impots-locaux/>.

<sup>2</sup>See [Beaumont et al. \(2021\)](#) and [Schmalz et al. \(2017\)](#) for the use of the data.

sample with the DADS and CFE data, I calculate the average tax rate for each firm by taking the weighted average of all the CFE tax rates to which the company is exposed (plant in a municipality in year  $t - 2$ ). The weight used is the number of employees at the focal plant over the total number of employees in the corresponding firm, and this is used to control for the plant size relative to the company size. In this framework, identification comes from the local variation in the CFE tax rate over time. Regarding the setting, the treatment firms have experienced an increase in the average CFE tax rate of more than 8% in a year. In contrast, the control firms have not experienced an increase or a decrease in the CFE tax rate of more than 4% over the period. For more details, Figure A1 in the appendix shows the distribution of the growth rate of the CFE tax rate. The choice of the threshold is motivated by [Heider and Ljungqvist \(2015\)](#), who studies the impact of taxes on firm leverage. Their identification framework uses the staggered increase in the corporate tax rate of different U.S. states, and the average growth rate of this tax rate is 13.8%. Consistently, with a threshold of 8%, the median growth rate of the CFE tax rate is 14.17%. Notably, the main difference between these two studies concerns the tax base. Indeed, the CFE tax is calculated based on the rental value of buildings and land, while pretax income is used for income tax. However, the rental value of the buildings and land held by manufacturing firms tends to be more important than income before taxes, meaning that company cash flows are more sensitive to the CFE than the income tax rate. Table A1 reports the summary statistics for both the treatment and control groups. The companies are similar and differ mostly in terms of cash and size. I control for these characteristics in my baseline regression to prevent selection bias. Figure 3.3 presents a graphical illustration of the impact of an increase in the CFE tax rate on cash flows. Figure 3.4 shows the same graph but for pollution reduction investments. We observe a clear common trend before the year of the CFE tax rate increase and a decrease in cash flows and pollution prevention amounts for treated firms afterward. The parallel trend hypothesis is supported, which allows me to causally interpret the negative relationship between the increase in the CFE tax rate and prevention investments.

To implement staggered differences-in-differences methodology, I define *IncreaseCFE* as a dummy variable equal to one if the focal firm experiences an increase of more than 8% for that year and any subsequent years; otherwise, it is equal to zero. Specifically, I estimate the

following equation:

$$PolAbatInv_{p,t+1} = \alpha + \beta_1 IncreaseCFE_{i,t} + \beta_2 X_{i,t} + \beta_3 W_{g,t} + \beta_4 Z_{p,t} + \mu_{j,t} + \delta_p + \varepsilon_{p,t} \quad (2)$$

where  $PolAbatInv_{p,t+1}$  represents one of my pollution abatement investment measures for plant  $p$  belonging to firm  $i$  in year  $t + 1$ , that is,  $1(Prevention)$  or  $1(Treatment)$  for extensive margins and  $Log(Prevention + 1)$  or  $Log(Treatment + 1)$  for intensive margins. All the other variables are similar to those used in the previous section. I add fixed effects,  $\mu_{j,t}$ , to control for firm industry and time heterogeneity, and plant fixed effects,  $\delta_p$ , to address omitted variable concerns. Standard errors are clustered at the firm level. Equation (2) tests whether a decrease in cash flows affects the probability of investing or the amounts invested in treating or preventing pollution.

### 3.4.2 Results

Table 3.5 shows the results of the regression. To study variations within firms and plants, I add firm fixed effects in columns (1) and (3) and plant fixed effects in columns (2) and (4). The coefficients for extensive margins are nonsignificant, meaning that a decrease in cash flows does not encourage firms to disinvest completely from pollution prevention or treatment. Notably, the coefficient is negative for prevention and positive for treatment. For intensive margins, the point estimates range from 0.28 to 0.24 and are statistically significant at the 10% level for prevention. In other words, plants owned by firms that experience a decline in cash flows decrease the amount of their pollution prevention investments by 21% ( $100 * (\exp(-0.24) - 1)$ ). In contrast, they do not change their behavior toward pollution treatment. I interpret my results as follows. After a decrease in internal resources, firms reduce their investment dedicated to prevention because it requires a higher initial amount of capital in the short run. Specifically, as previously found, prevention investments are undertaken by unconstrained firms when there are no environmental regulations. Since prevention investments are not mandatory, after a decrease in cash flow, firms choose to not undertake the more expensive investments. The results are robust to a placebo test at year  $t - 4$ , a new threshold of a 10% increase in the CFE tax rate for the treatment group, and two alternative estimators (the Callaway and Sant'Anna estimator and the Sun and Abraham

estimator). In conclusion, this framework allows for a causal interpretation, reinforcing that financial constraints are a barrier to pollution prevention.

### 3.4.3 Listed groups

Listed and private companies differ both in terms of financial constraints and in terms of environmental regulation. While there is a consensus in the literature that listed firms have easier access to external capital, which reduces the impact of financial constraints (Brav, 2009), the literature is relatively mixed regarding corporate environmental policies. On the one hand, listed firms may be driven by myopic investors to increase profits in the short term, which may reduce innovation (Acharya and Xu, 2017) and investments in pollution reduction (Kim and Xu, 2022), while private firms with more long-term investors are more environmentally friendly (Bellon, 2020). On the other hand, listed companies, pressured by institutional investors and regulations demanding more transparency (De Haas and Popov, 2019; Dyck et al., 2019), sell their dirty assets on the private market. Therefore, understanding whether financial constraints are a key factor of environmental policy development for private and/or public firms remains an open question. To answer this question, I use the same models as before, adding an interaction term if the plant is publicly owned. Table 3.6 presents the results. The coefficients are negative and significant for prevention investments made by private firms and nonsignificant for the interaction term, meaning that plants owned by financially constrained firms and listed groups are also less likely to invest in pollution prevention than those owned by private groups. Interestingly, the coefficients are positive and significant for unconstrained firms owned by listed groups in terms of the amount spent on prevention, meaning that they invest more in pollution prevention. Regarding the cash flow shock, for private groups, the coefficients are positive for treatment and negative for prevention, suggesting that private groups are shifting their investments to treatment; however, the estimates are nonsignificant, preventing me from drawing any conclusions. In addition, the coefficients of the interaction term are negative but not significant. It is, therefore, impossible to conclude that listed companies significantly reduce their investment in prevention compared to private companies. Overall, although listed groups invest more in prevention, financial constraints are negatively correlated with pollution prevention for both listed and private

groups.

### **3.4.4 Polluting groups**

Being a high- or low-polluting company can also impact the sensitivity of utilized pollution reduction methods to financial constraints. Indeed, high-polluting companies are more impacted by environmental regulations and face higher levels of transition risk; thus, they are encouraged to be more proactive on the environmental front. To test the hypothesis that financial constraints have less impact on the prevention investments of high-polluting firms, I consider high-polluting groups as groups belonging to one of the following industries: food and beverage production, chemicals, rubber, plastics, other nonmetallic mineral products, metallurgy and metal products (including equipment and machinery), and coking and refining. For the listed firms, I use the same models used previously with the addition of an interaction term. Table 3.7 presents the results. In terms of the correlation analysis across firms, plants owned by financially constrained firms and low-polluting groups are less likely to invest in pollution prevention than those owned by unconstrained firms, especially in terms of the amount spent. However, since the interaction term estimates are nonsignificant among financially constrained firms belonging to the high-polluting groups, they are neither more nor less likely to invest in pollution prevention than those belonging to low-polluting groups. The coefficients of the interaction term for treatment investments are positive but not significant, which could imply that financially constrained firms belonging to high-polluting groups invest more in treatment than low-polluting groups. Regarding the impact of the increase in the local tax rate, it is interesting to note that the coefficients of the interaction terms are positive for treatment investment, which means that after the decrease in cash flow, high-polluting firms invested more in treatment than low-polluting firms. Although firms that are part of high-polluting groups are more constrained, they must control the pollution they generate. For listed firms, the estimates are nonsignificant for prevention investments; however, this time, the difference in magnitude is greater, meaning that high-polluting firms do not reduce their prevention investments more than low-polluting firms.



## 3.5 Environmental regulation implementation

### 3.5.1 IED Directive

In the next section, I investigate the impact of the implementation of a more stringent environmental law, the IED Directive, on the decision to treat or prevent pollution. The objective of the IED Directive is to reduce industrial emissions and the risk of chronic pollution. The European Union adopted the directive in 2010, and it was transposed into French law in two stages. More precisely, the legislative part was implemented in 2012, and the regulatory part was implemented in 2013. In France, industrial installations representing a risk to the environment are classified. If an establishment owns a classified installation, it must follow a set of rules and submit to inspections to operate according to the installation classification. In this classification, the IED directive created the 3000 category, but there are four categories: Substance (1000), Activity (2000), IED (3000), and Seveso (4000). It is important to note that an installation can be classified into one or several categories. Regarding the 3000 category, a plant whose installation is classified in this way must follow a Best REFerence document (BREF). This document indicates the best available techniques (BAT) to reduce pollution and the associated emission limit values. If the installation does not comply with the law, administrative sanctions are applied through a formal notice that can be accompanied by a monetary deposit corresponding to the amount of work to be done, the execution of the work or the suspension of the operation of the installation. In the case of severe law violations, penalties can be imposed, with fines ranging from 1,500 to 150,000 euros with two years of imprisonment for individuals and from 7,500 to 750,000 euros for a legal entity. BREF documents can apply to all classified installations in the 3000 category or to only one sector. To identify the companies affected by the IED directive, I download a dataset listing all installations classified for environmental protection in France and the regulations to which they are subjected from the French governmental website G eorisques. Furthermore, BREFs are generally created for each industry, and not all BREFs were published in 2013. However, the relevant date for companies is the date of BREF publication because once a BREF is published, companies have four years to comply with the law. I hand-collected data about BREF publications from the European Commission website.

In Figure 3.5, I plot coefficient estimates from an event study to examine the impact of the IED on pollution reduction investments. Both plots highlight that this environmental law increases both the probability of pollution reduction investment and the amount invested to reduce pollution, although the investment amount coefficients are not significant. To examine how this affects the pollution reduction investment mix, I do the same analysis with treatment and prevention investments using a sample that includes only plants that invest in specific pollution abatement equipment. The results in Figure 3.6 are very different for the two types of investments. Unexpectedly, the share devoted to pollution treatment is not affected, while the share devoted to pollution prevention increases in the first year and then decreases. A potential interpretation could be that firms that had not invested in prevention before the law invested during the first year to comply, while those that had invested before the law and were therefore in line with the regulations decided to reduce their investment, as they no longer benefited from the positive signal of being more environmentally friendly (de Bettignies et al., 2020).

### 3.5.2 Constrained firms and environmental regulation

Studying the effect of the IED directive on pollution abatement investments allows me to understand which type of investments financially constrained firms choose to undertake if they are forced to reduce their polluting emissions. More specifically, I estimate the following model:

$$PolAbatInv_{p,t+1} = \alpha + \beta_1 DummyIED_{i,t} \times FinancialConstraint_{i,t} + \beta_2 FinancialConstraint_{i,t} + \beta_3 DummyIED_{i,t} + \beta_4 X_{i,t} + \beta_5 W_{g,t} + \beta_6 Z_{p,t} + \mu_{j,t} + \delta_p + \varepsilon_{p,t} \quad (4)$$

where  $PolAbatInv_{p,t+1}$  represents one of my pollution abatement investment measures for plant  $p$  belonging to firm  $i$  in year  $t + 1$ , that is,  $\mathbb{1}(Prevention)$  or  $\mathbb{1}(Treatment)$  for extensive margins and  $\text{Log}(Prevention + 1)$  or  $\text{Log}(Treatment + 1)$  for intensive margins.  $FinancialConstraint_{i,t}$  is a generic term for firms that are financially constrained in the year of the implementation of the law or in the previous. Since I use a staggered difference-in-differences methodology, I cannot determine whether control firms are constrained in the year of the shock or in the previous year. Therefore, for this analysis, I use a sample that includes only plants impacted by the IED.

$DummyIED_{i,t}$  is a dummy variable equal to one if the focal plant is subject to the IED Directive for years after the BREF was published. All the other variables are similar to those in the previous sections. I add firm-level industry-year fixed effects,  $\mu_{j,t}$ , and plant fixed effects,  $\delta_p$ . Since the BREFs are closely related to the plants' industries, the standard errors are clustered at the plant-industry level. Table 3.8 shows that the constrained and unconstrained firms do not react similarly to BREF publications.

First, Table 3.8 shows that in this subsample, plants belonging to financially constrained firms invest more often and invest larger amounts in pollution treatment, while the coefficients are negative but not significant for prevention investments. Regarding the impact of the IED, the coefficients are positive but nonsignificant for prevention investments, suggesting that the decrease in the share of prevention investments observed in the previous section comes from increased prevention investments made by firms not subject to the IED; their intention in doing so could be to capture the rent produced either by a good signal or by increasing regulatory risk. For treatment investments, the coefficients are negative for unconstrained firms and positive and significant for the interaction terms, suggesting that after the implementation of the law, plants owned by financially constrained firms that invested in specific equipment to reduce pollution became more likely to invest in treatment than those owned by financially unconstrained firms. Overall, this table shows that the implementation of the IED did not fundamentally change the pollution reduction mix of IED plants. However, if plants owned by unconstrained firms decide to reduce their investments in pollution treatment, constrained firms maintain their levels. Therefore, I claim that in the case of environmental legislation implementation, financial constraints encourage pollution treatment.

### **3.6 Accidental pollution**

This paper focuses primarily on chronic pollution. However, this is not the only type of pollution generated by the industrial sector. Indeed, manufacturing firms could harm the environment if they have to use or produce toxic substances and a polluting incident such as a leak or an explosion occurs. Companies can invest in treatment and prevention to prevent this type of pollution. A treatment investment for accidental pollution can involve any pollutant capturing device,

such as a hydrocarbon absorber, while prevention investments can involve a higher level of pipe protection, a double-shell tank, or a retention basin. The main differences between accidental pollution and chronic pollution are that relevant investments can be delayed because accidental pollution is uncertain. Therefore, companies have no rational reason to invest in treatment without environmental legislation. Companies are better off if they retain the ability to invest in the event of a polluting incident. Prevention investments are affected in two ways. First, the benefits of prevention are greater because of the negative correlation between accidental pollution and firm output. Second, in the NPV calculation, the benefits are weighted by the probability of a pollution incident. It is not clear which effect will dominate the other. Without environmental laws, if the probability of a pollution incident is high, many unconstrained firms and even some constrained firms invest in pollution prevention. Conversely, if the probability of a pollution incident is low, even unconstrained firms do not invest in pollution prevention. Overall, investment in accidental pollution prevention is determined more by the probability of a polluting incident than by financial constraints. Environmental laws aimed at reducing chronic and accidental pollution are slightly different in terms of enforcement. Because accidental pollution hurts business sales and operations and can cause human and environmental disasters, regulations focus more on prevention. Therefore, companies, constrained or not, need to increase their investment in prevention if they have not already done so.

To study how financial constraints impact the choice of treatment and prevention investments in case of accidental pollution, I exploit the implementation of the SEVESO 3 directive in Europe. This law was introduced in 2012 and transposed into French law in June 2015. It is the third in a series of laws intended to prevent and better manage major incidents with toxic products. This revision creates a fourth classification category for polluting facilities, thus modifying the scope of the law. In addition, the law increases the obligations of companies in terms of public information and control of facilities. The SEVESO 3 directive is not the first law to regulate companies regarding accidental pollution prevention, meaning that firms were already under the obligation to invest. Nevertheless, by reinforcing existing measures designed to reduce accidental pollution, the SEVESO 3 directive should impact pollution abatement investments. The results are presented in Table 3.9. None of the coefficients are significant, meaning that no con-

clusions can be drawn. In summary, the difference in the impact of financial constraints on the prevention and treatment of accidental pollution is less evident than that for chronic pollution. In the absence of regulation, most firms have no incentive to invest in pollution treatment. When environmental legislation is implemented, companies are obliged to prevent pollution unless there is no technology available, in which case they must invest in treating it.

## **3.7 Robustness tests**

### **3.7.1 General robustness tests**

#### **Strict definition of treatment and prevention investments**

The decision to treat or prevent pollution is not a binary choice. Companies can also choose to do both. Potentially, my results could be driven in some way by firms that decide to both treat and prevent. Thus, I rerun the regressions using the strict definition of treated or prevented pollution to test this hypothesis. More precisely, I consider that plants only treat (prevent) pollution if they do not invest in prevention (treatment) during the same year. Plants that use both methods to reduce their pollution are treated as those that do not invest in either method. This approach allows me to more clearly highlight the characteristics of firms that invest in each type of pollution reduction investment. Table A5 in the appendix reports the results. The estimates are similar to the baseline results in terms of economic magnitude and statistical significance, meaning that my results are not biased by companies that treat and prevent pollution at the same time. Furthermore, the regression coefficients of financial constraints are positive for the treatment investments, although mostly nonsignificant. This suggests that the most constrained firms choose to only treat pollution.

#### **Relocalization**

Many industrial companies are large multinational groups that can relocate their production to a less environmentally friendly country if they perceive that their environmental regulation costs are too high ([Bartram et al., 2022](#)). This phenomenon may bias my results if only the least polluting groups choose to stay in France. To test the impact of this phenomenon on my

results, I rerun the main regression, but this time, I keep only firms that maintain the same number of plants in my sample. Table A6 reports the estimates. Again, the results are similar to those previously found, except for those regarding the cash flow shock, where the estimates for prevention investments are nonsignificant despite a negative sign. Overall, those three tables confirm that my results are not driven by the reallocation of assets to a less environmentally friendly country.

### **Relative analysis**

To better understand how firms allocate their financial resources between treatment and prevention investments, I study the relationship between financial constraints and pollution reduction investments using the amount spent on pollution prevention relative to the total amount spent on pollution prevention and treatment as the dependent variable. Table A7 presents the results. Financially constrained firms spend a smaller percentage of their investments on prevention. However, the estimates are significant for only the two financial constraint measures, namely, *Size.Constraint* and *WW.Constraint*. This decrease in significance could be explained by the fact that constrained firms are not significantly less likely to invest in treatment, but they invest significantly smaller amounts. Moreover, after the decrease in cash flow, the plants significantly reduced the share of prevention investments. These findings suggest that my previous results are robust.

### **Dynamic process**

The investment decision process is dynamic, with investments in one year influencing those in subsequent years. Thus, the combination of pollution abatement investments may impact the future investment behavior of firms. To test this idea, I study the relationship between the current ratio of prevention investments to the sum of prevention and treatment investments and the ratio in the previous year. The estimate in Table A9 shows that the ratio of prevention investment to previous total investment is strongly and positively correlated with the current ratio when industry-factory fixed effects are added, suggesting that firms that invest heavily in prevention continue to do so. Potential explanations for this phenomenon could involve corporate culture or

technological limitations. Interestingly, when firm fixed effects are included, the significance of the coefficient decreases, meaning that just because a firm increases its investment in prevention does not mean that it will do so again the following year. Finally, regarding plant fixed effects, the coefficients are negative and highly significant, so logically, if a plant invests heavily in prevention during one year, it will not need to reinvest the following year.

### **3.7.2 Staggered difference-in-difference robustness tests**

#### **Different thresholds**

Even if the choice of threshold for the CFE tax rate is not arbitrary (Heider and Ljungqvist, 2015), it could impact the results. To ensure that my results are not affected by the threshold choice, I rerun my baseline regression using a 10% threshold instead of an 8% threshold. Table A9 shows the results. Overall, the estimates are similar to those in Table 3.5, meaning that my findings are robust. Furthermore, the coefficients are even higher and more significant for the amounts invested in pollution prevention, meaning that the greater the decrease in cash flow that firms experience, the more they will reduce their investments in pollution prevention.

#### **Placebo test**

Another potential concern regarding my empirical specification is that the increase in prevention investment amounts might not come from a decrease in cash flow but from some other change affecting the treated firms over time. To overcome this bias, I implement a placebo test by replicating my baseline specification around a pseudoevent year that does not occur in year  $t$  but in year  $t-4$ . Table A10 presents the results. None of the estimates are significant, meaning that my results do not stem from spurious changes in the treated firms.

#### **Alternative estimators**

In their paper, [Baker et al. \(2022\)](#) explain that the estimates obtained from two-way fixed effects difference-in-difference regressions are variance-weighted averages of many different 2\*2 difference-in-difference regressions, which could bias the results because early-treated units are used as controls for late-treated units. They show that this bias is particularly strong for dynamic

treatment effects, staggered treatment timing, and treatment effect heterogeneity. In my case, I have staggered treatment timing and treatment effect heterogeneity. Diagnosing dynamic treatment effects is relatively complex because the aggregate CFE tax rate changes differently for each firm after the shock. Nevertheless, to test the robustness of my results, I use two alternative estimators as suggested by [Baker et al. \(2022\)](#). The first estimator is the Callaway and Sant'Anna estimator ([Callaway and Sant'Anna, 2021](#)), and the second is the Sun and Abraham estimator ([Sun and Abraham, 2021](#)). Table A11 shows the results. Both are significant, meaning that the results of the staggered difference-in-difference regression are robust.

### 3.8 Conclusion

By exploiting a unique dataset giving me access to the pollution abatement investments of French manufacturing firms, I provide strong evidence supporting a relationship between financial constraints and firm pollution abatement behavior and investments. Specifically, I exploit the decomposition of pollution abatement investments into treatment and prevention. Firms with poorer access to external and internal capital are less likely to invest in pollution prevention but are not less likely to invest in pollution treatment. After a decline in cash flow, firms choose to decrease pollution prevention investments, while treatment investments are not affected; this suggests that financial constraints reduce pollution prevention. Being part of a listed firm or a high-polluting group does not change the sensitivity of the pollution reduction mix to financial constraints. Second, I show that financially constrained firms respond to environmental regulation by increasing their investments in pollution treatment relative to unconstrained firms. One possible explanation for these results is that firms' willingness and potential benefits motivate investments in prevention, while treatment investments result from regulation. I argue that financially constrained firms treat pollution when they are obliged to do so, as this involves small short-term investments. In contrast, companies with higher financial resources are more proactive and opt for prevention since it allows them to generate long-term profits.

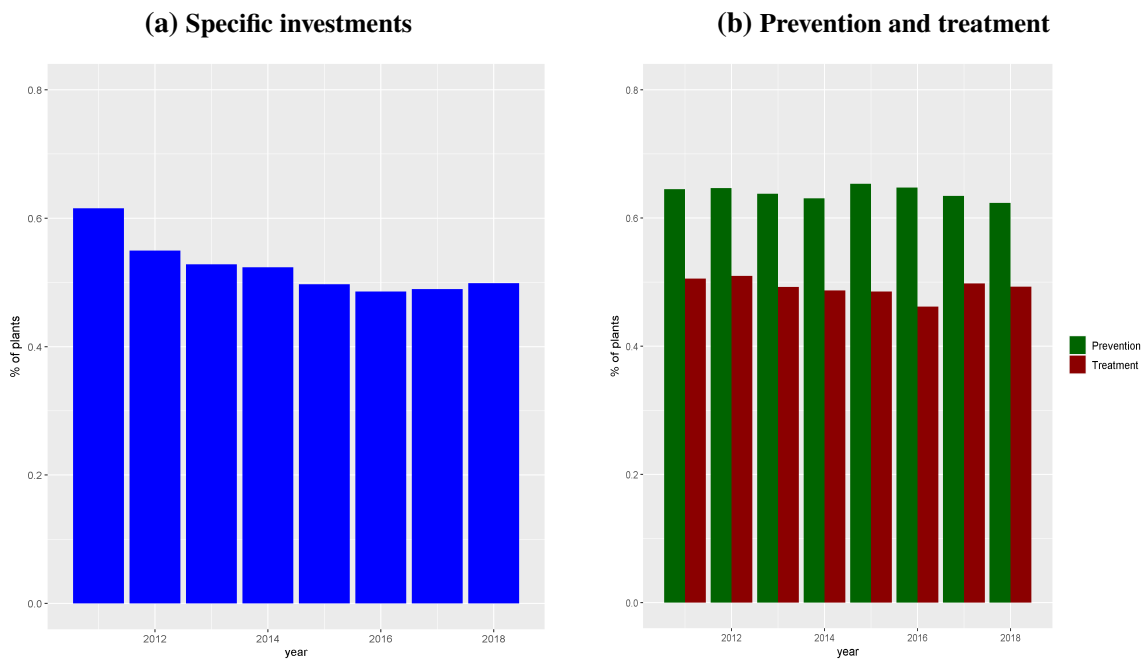
My paper has several implications. First, it contributes to the understanding of the impact of financial constraints on pollution abatement. In addition to reducing investments in pollution abatement, financial constraints impact the choice of pollution abatement method. In terms of



policy, if policymakers wish to increase pollution abatement investments, particularly in terms of encouraging prevention over treatment, they should pay particular attention to the financial constraints firms bear. Prevention investments are more costly in the short run, and without public support and an explicit mention of prevention, environmental policies could be counterproductive. In addition, this paper helps reveal the extensive debate on the relationship between business valuation and environmental policies. Indeed, pollution reduction investments are diverse and have different impacts on firms. Specifically, investments in pollution treatment destroy firm value because treatment investments have a negative NPV. Conversely, investments in pollution prevention could create value because of their positive NPV. Promoting prevention rather than treatment seems to be in the interest of shareholders as well as the environment and public health.

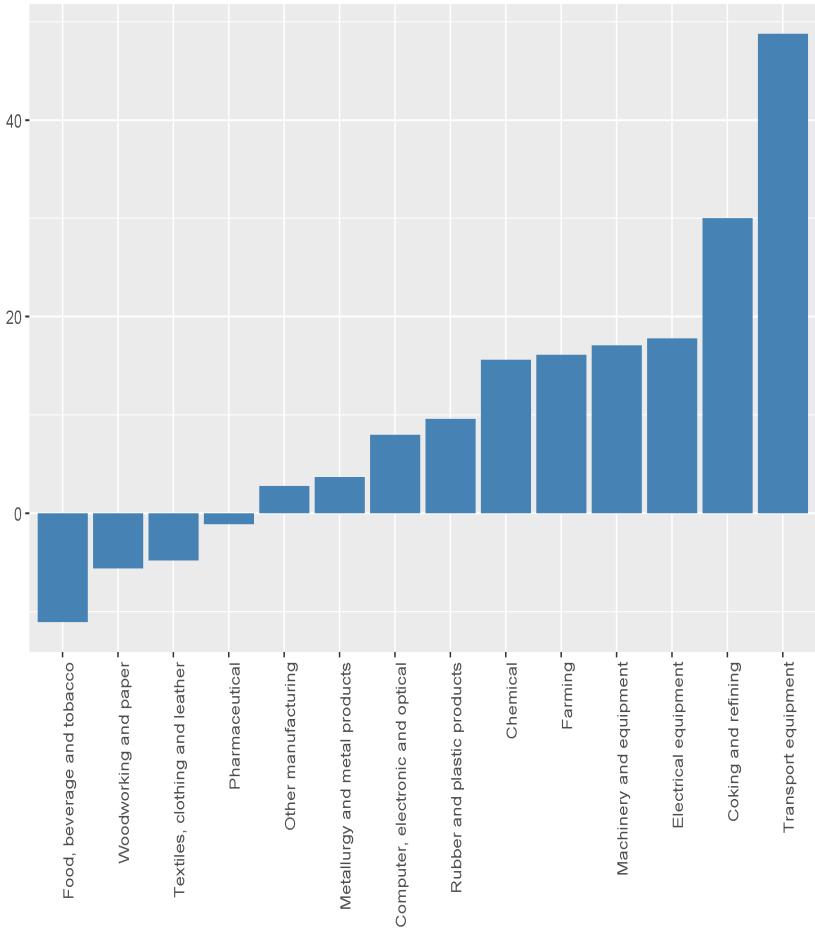
**Figure 3.1: Percentage of plants investing in pollution abatement**

This figure shows the annual percentage of plants investing in pollution abatement over the period 2011-2018. Figure a presents the percentage of plant investing in specific equipment to reduce pollution among the sample and Figure b the percentage of plants investing in prevention and treatment among plants that invest in specific equipment. The sample includes all the plants covered by ANTIPOL and FARES with more than 250 employees, excluding observations with missing values.



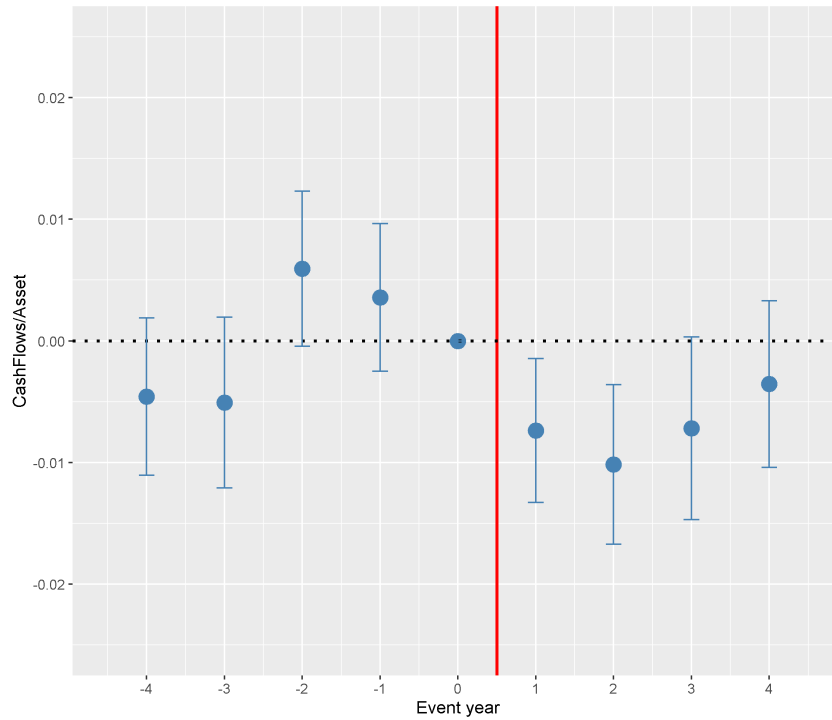
**Figure 3.2: Difference between amounts invested in pollution prevention and amounts invested in pollution treatment by industry**

This figure shows the difference between the amounts invested in prevention and treatment over the 2011-2018 period. Differences are calculated by area, year, and industry, and then aggregated by industry. The sample includes all plants covered by ANTIPOL and FARES with more than 250 employees, excluding observations with missing values.



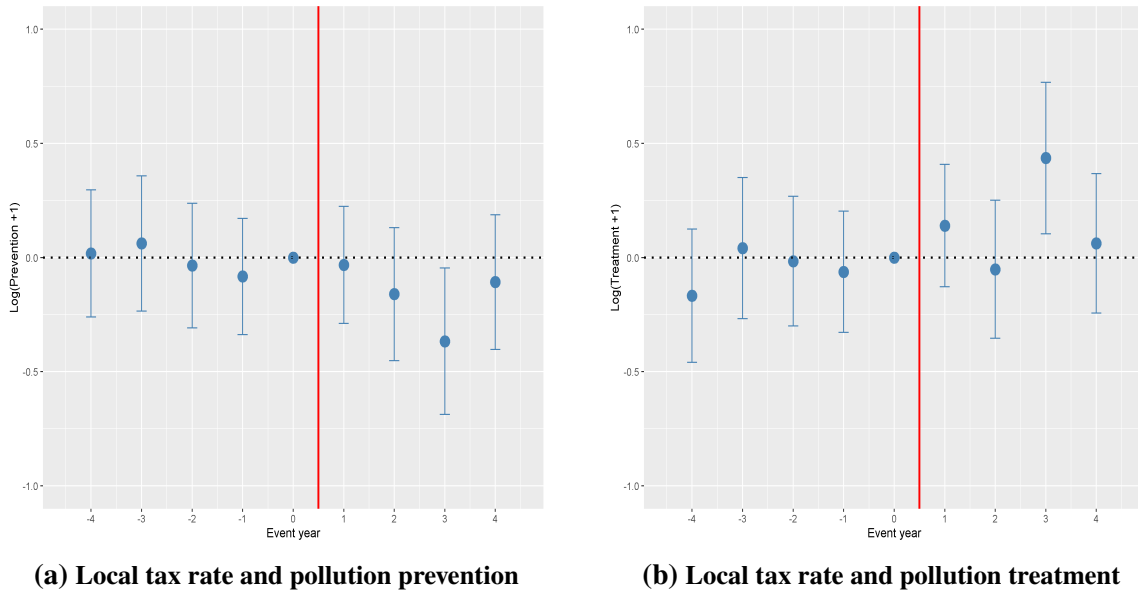
**Figure 3.3: Impact of local tax rate increase on cash-flows**

This figure shows the dynamics of the coefficients for the cash flows around the increase in the local tax rate. Specifically, I use the following regression:  $Y_{p,t+1} = \alpha + \sum_{k=-4}^{-1} \phi_k \cdot Treated_{i,k} 1[Time = k] + \sum_{k=1}^4 \phi_k \cdot Treated_{i,k} 1[Time = k] + \beta_1 X_{i,t} + \beta_2 W_{g,t} + \beta_3 Z_{p,t} + \mu_{j,t} + \delta_p + \varepsilon_{p,t}$  with  $\mu_{j,t}$ , and  $\delta_p$  industrial year and plant fixed effects.  $Y_{p,t+1}$  represents cash flows on assets,  $Treatment_{i,k}$  a dummy variable equal to one if the firm experiences an increase in the local tax rate greater than 8%, and  $1[Time = k]$  a dummy variable equal to one for each year around the increase.  $X_{i,t}$  is a vector of firm-level controls,  $W_{g,t}$  of group-level controls, and  $Z_{p,t}$  of plant-level controls. Observations more than four years after treatment are grouped in one bin and observations less than four years before treatment in another bin. The sample contains all plants owned by firms in the control or treated group over the period 2011-2018, excluding observations with missing values. The base year is the year of the shock. Confidence intervals are reported at the 10% level.



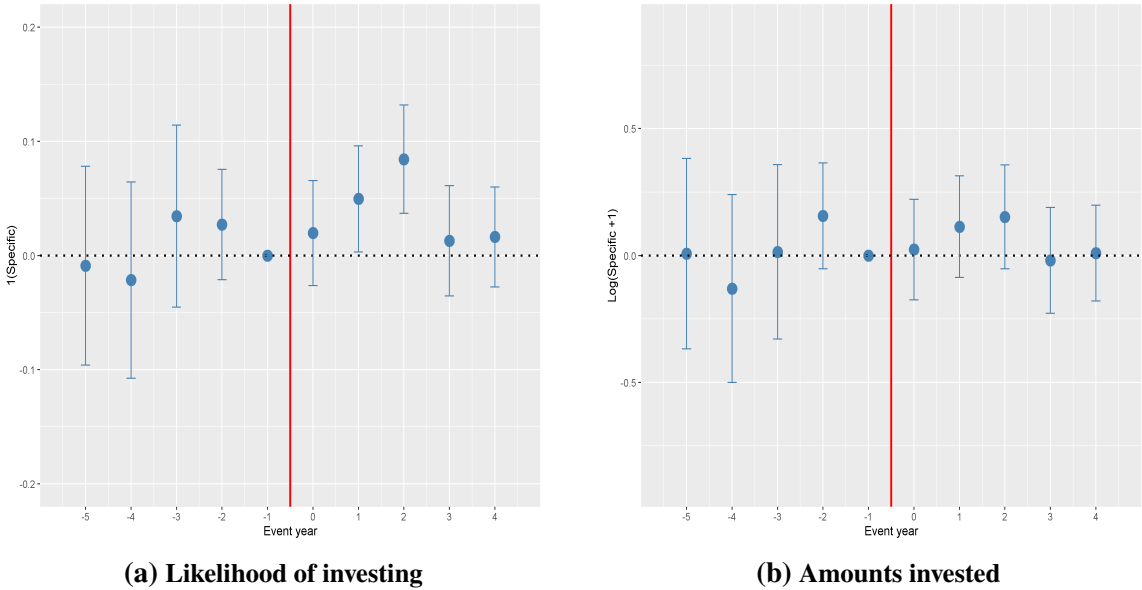
**Figure 3.4: Impact of local tax rate increase on pollution abatement investments**

This figure shows the dynamics of the coefficients for the pollution abatement investments around the increase in the local tax rate. Specifically, I use the following regression:  $Y_{p,t+1} = \alpha + \sum_{k=-4}^{-1} \phi_k \cdot Treated_{i,k} 1[Time = k] + \sum_{k=1}^4 \phi_k \cdot Treated_{i,k} 1[Time = k] + \beta_1 X_{i,t} + \beta_2 W_{g,t} + \beta_3 Z_{p,t} + \mu_{j,t} + \delta_p + \varepsilon_{p,t}$  with  $\mu_{j,t}$ , and  $\delta_p$  industrial year and plant fixed effects.  $Y_{p,t+1}$  represents the logarithm of the amount invested in pollution treatment or prevention +1.  $Treatment_{i,k}$  a dummy variable equal to one if the firm experiences an increase in the local tax rate greater than 8%, and  $1[Time = k]$  a dummy variable equal to one for each year around the increase.  $X_{i,t}$  is a vector of firm-level controls,  $W_{g,t}$  of group-level controls, and  $Z_{p,t}$  of plant-level controls. Observations more than four years after treatment are grouped in one bin and observations less than four years before treatment in another bin. The sample contains all plants owned by firms in the control or treated group over the period 2011-2018 that invest in specific equipment to reduce pollution, excluding observations with missing values. The base year is the year of the shock. Confidence intervals are reported at the 10% level.



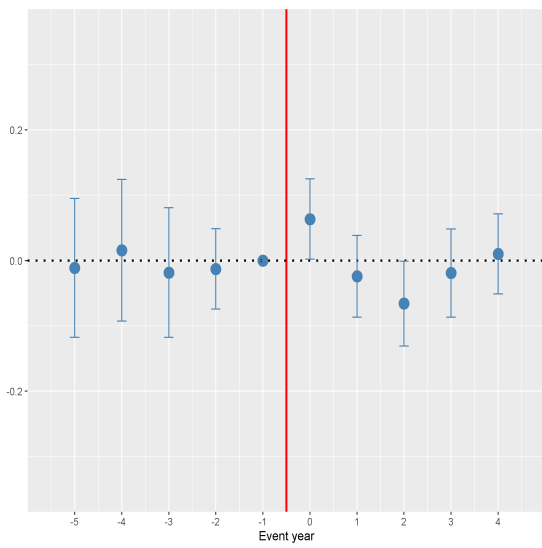
**Figure 3.5: Impact the IED directive on investments specifically to protect the environment**

This figure shows the dynamics of the coefficients for the investments specifically to protect the environment around the BREF publication. Specifically, I use the following regression:  $Y_{p,t+1} = \alpha + \sum_{k=-5}^{-1} \phi_k \cdot Treated_{i,k} 1[Time = k] + \sum_{k=0}^4 \phi_k \cdot Treated_{i,k} 1[Time = k] + \beta_1 X_{i,t} + \beta_2 W_{g,t} + \beta_3 Z_{p,t} + \mu_{j,t} + \delta_p + \epsilon_{p,t}$  with  $\mu_{j,t}$ , and  $\delta_p$  industrial year and plant fixed effects.  $Y_{p,t+1}$  represents a dummy of one if the plant invest in specific equipment to reduce pollution in Figure (a) and the logarithm of the amount invested in +1 in Figure (b).  $Treatment_{i,k}$  a dummy variable equal to one if the plant is subject to the IED directive, and  $1[Time = k]$  a dummy variable equal to one for each year around the BREF publication.  $X_{i,t}$  is a vector of firm-level controls,  $W_{g,t}$  of group-level controls, and  $Z_{p,t}$  of plant-level controls. Observations more than four years after treatment are grouped in one bin, and observations less than five years before treatment in another bin. The sample contains all plants owned by firms in the control or treated group over the period 2011-2018, excluding observations with missing values. The base year is the year before the shock. Confidence intervals are reported at the 10% level.

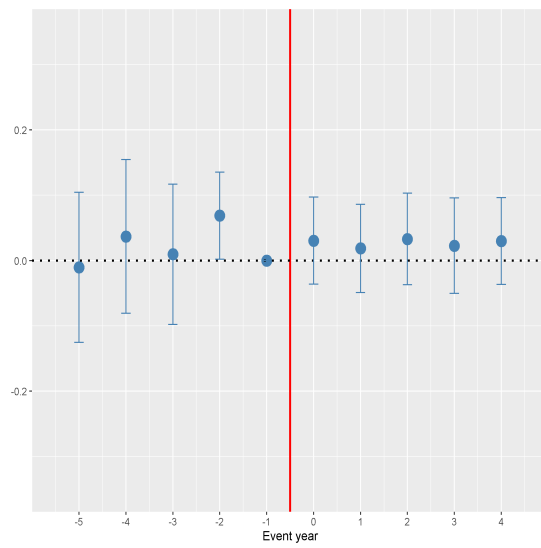


### Figure 3.6: Impact the IED directive on pollution abatement investment

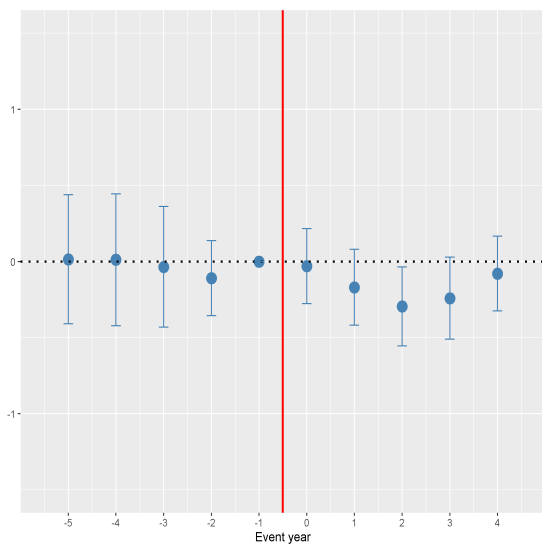
This figure displays the coefficient dynamics for pollution abatement investments around the BREF publication. Specifically, I use the following regression:  $Y_{p,t+1} = \alpha + \sum_{k=-5}^0 \phi_k \cdot Treated_{i,k} 1[Time = k] + \sum_{k=0}^4 \phi_k \cdot Treated_{i,k} 1[Time = k] + \beta_1 X_{i,t} + \beta_2 W_{g,t} + \beta_3 Z_{p,t} + \mu_{j,t} + \delta_p + \varepsilon_{p,t}$  with  $\mu_{j,t}$ , and  $\delta_p$  industrial year and plant fixed effects.  $Y_{p,t+1}$  represents a dummy of one if the plant invest in pollution treatment or prevention in Figure (a) and (c), and the logarithm of the amount invested +1 in Figure (b) and (d).  $Treatment_{i,k}$  a dummy variable equal to one if the plant is subject to the IED directive, and  $1[Time = k]$  a dummy variable equal to one for each year around the BREF publication.  $X_{i,t}$  is a vector of firm-level controls,  $W_{g,t}$  of group-level controls, and  $Z_{p,t}$  of plant-level controls. Observations more than four years after treatment are grouped in one bin, and observations less than five years before treatment in another bin. The sample contains all plants owned by firms in the control or treated group over the period 2011-2018 that invest in specific equipment to reduce pollution, excluding observations with missing values. The base year is the year before the shock. Confidence intervals are reported at the 10% level.



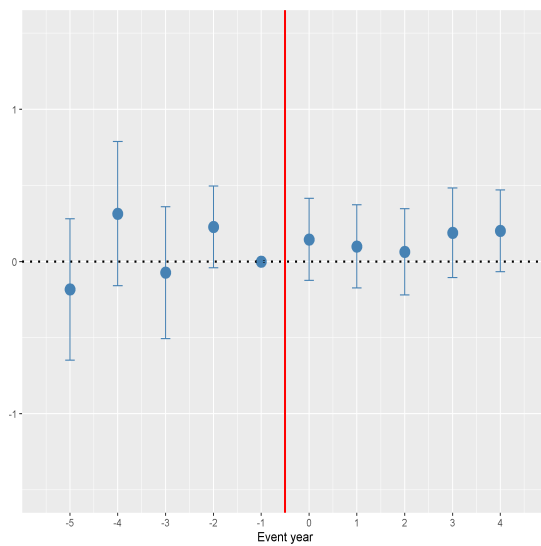
(a) Likelihood of investing in pollution prevention



(c) Likelihood of investing in pollution treatment



(b) Amounts invested in pollution prevention



(d) Amounts invested in pollution treatment

**Table 3.1: Percentage of plants investing in pollution abatement per industry**

The table presents the percentage of plants investing in each type of pollution abatement investment by industry. Industry corresponds to the NAF classification into 38 sectors. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees over the period 2011-2018, excluding observations with missing values.

Industry	N	Specific	Treatment	Prevention
Food, beverage and tobacco	5194	0.55	0.53	0.57
Metallurgy and metal products	3568	0.5	0.49	0.65
Rubber and plastic products	3331	0.49	0.49	0.64
Woodworking and paper	2140	0.39	0.51	0.58
Chemical	1630	0.73	0.56	0.74
Transport equipment	1285	0.65	0.44	0.76
Other manufacturing	995	0.41	0.38	0.57
Textiles, clothing and leather	912	0.25	0.46	0.51
Machinery and equipment	871	0.63	0.38	0.73
Electrical equipment	694	0.55	0.39	0.67
Pharmaceutical	571	0.62	0.50	0.67
Computer, electronic and optical	500	0.57	0.46	0.64
Farming	78	0.63	0.59	0.71
Coking and refining	51	0.78	0.6	0.82



**Table 3.2: Summary statistics**

The table summarizes firm-year, plant-year and group-year characteristics. Panel A reports summary statistics at the firm level, Panel B at the plant level and Panel C at the plant level. The definitions of the variables are in the appendix.

<b>Panel A: Firm characteristics</b>	N	Mean	SD	P25	Median	P75
Size	17,345	10.70	1.34	9.77	10.62	11.62
ROA	17,345	0.05	0.09	- 0.001	0.04	0.10
CashFlow/Asset	17,345	0.08	0.09	0.03	0.08	0.14
Cash/Asset	17,345	0.07	0.09	0.002	0.02	0.10
Capex/Asset	17,345	0.06	0.05	0.02	0.04	0.08
Debt/Asset	17,345	0.15	0.15	0.01	0.10	0.24
Tang/Asset	17,345	0.24	0.15	0.11	0.21	0.34
InvestSubsidies	17,345	0.41	0.49	0	0	1
Dividend	17,345	0.42	0.49	0	0	1
FirmAge	17,345	34.11	16.51	20	31	49
NbrPlant	17,139	3.03	5.29	1	1	3
<b>Panel B: Plant characteristics</b>	N	Mean	SD	P25	Median	P75
1 (Specific)	21,827	0.52	0.50	0	1	1
1 (Prevention)	11,406	0.64	0.48	0	1	1
1 (Treatment)	11,406	0.49	0.50	0	0	1
Specific (keuros)	21,827	148.60	887.82	0	1.60	50.30
Prevention (keuros)	11,406	117.83	781.52	0	4.7	45.54
Treatment (keuros)	11,406	121.97	643.80	0	0	39.9
Employees	21,827	5.36	1.15	5	5	6
<b>Panel C: Group characteristics</b>	N	Mean	SD	P25	Median	P75
Group	11,187	0.88	0.33	1	1	1
EuroForeignGroup	11,187	0.22	0.42	0	0	0
NoEuroForeignGroup	11,187	0.11	0.31	0	0	0
Listed	11,187	0.25	0.43	0	0	1

**Table 3.3: Financial constraints and investments specifically to protect the environment**

The table presents estimates from OLS regressions. The dependent variable is a dummy of one if the plant invests in a specific equipment to reduce pollution in columns (1)-(3), and the log of the amount invested to reduce pollution + 1 in columns (4)-(6). The sample contains all the plants included both in ANTIPOL and FARES with more than 250 employees, excluding observations with missing values. Standard errors are clustered at the firm level. The appendix provides the definition of variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	1 (Specific)			Log(Specific +1)		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.18*** (0.02)			-0.85*** (0.08)		
Score.Constraint		-0.05*** (0.02)			-0.29*** (0.07)	
WW.Constraint			-0.14*** (0.01)			-0.66*** (0.07)
InvestSubsidies	0.02* (0.01)	0.04*** (0.01)	0.03*** (0.01)	0.19*** (0.07)	0.26*** (0.07)	0.27*** (0.07)
Tang/Asset	0.20*** (0.05)	0.20*** (0.05)	0.20*** (0.05)	1.27*** (0.29)	1.03*** (0.28)	1.04*** (0.28)
Capex/Asset	0.33*** (0.13)	0.34*** (0.13)	0.28** (0.13)	1.98*** (0.62)	2.02*** (0.58)	1.79*** (0.62)
Cash/Asset	-0.01 (0.08)	-0.09 (0.08)	-0.08 (0.08)	-0.12 (0.35)	-0.47 (0.36)	-0.62* (0.35)
FirmAge	0.0000 (0.0004)	0.0002 (0.0004)	0.0002 (0.0004)	0.003 (0.002)	0.003* (0.002)	0.003 (0.002)
EuroForeignGroup	0.02 (0.02)	0.03** (0.02)	0.04*** (0.02)	0.10 (0.09)	0.16* (0.09)	0.18 (0.09)
NoEuroForeignGroup	0.06*** (0.02)	0.09*** (0.02)	0.09*** (0.02)	0.27*** (0.11)	0.33*** (0.11)	0.31*** (0.11)
Group	-0.03 (0.02)	0.01 (0.02)	-0.01 (0.02)	-0.15* (0.09)	-0.003 (0.09)	-0.14 (0.09)
Listed	0.03* (0.02)	0.05*** (0.02)	0.03* (0.02)	0.26*** (0.09)	0.35*** (0.09)	0.23*** (0.09)
Employees	0.08*** (0.01)	0.10*** (0.01)	0.08*** (0.01)	0.44*** (0.03)	0.56*** (0.03)	0.47*** (0.03)
Observations	15,571	14,540	15,376	15,571	14,540	15,376
Adjusted R <sup>2</sup>	0.18	0.15	0.16	0.24	0.21	0.23
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes

**Table 3.4: Financial constraints and pollution abatement investments**

The table presents the estimates from OLS regressions to test the link between financial constraints and pollution reduction investments. Panel A presents the results for the likelihood of investing and panel B for the amounts invested. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(3), and a dummy equal to one if plants invest in pollution treatment in columns (4)-(6). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(3), and the log of amounts invested in pollution treatment + 1 in columns (4)-(6). The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed* and *Employees*. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees that invest in a specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the firm level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood of investing</b>	<b>1 (Prevention)</b>			<b>1 (Treatment)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.08*** (0.02)			0.003 (0.02)		
Score.Constraint		-0.04*** (0.02)			-0.01 (0.02)	
WW.Constraint			-0.05*** (0.02)			-0.01 (0.02)
Observations	8,322	7,511	8,185	8,322	7,511	8,185
Adjusted R <sup>2</sup>	0.04	0.04	0.03	0.02	0.02	0.03
<b>Panel B: Amounts invested</b>	<b>Log(Prevention +1)</b>			<b>Log(Treatment +1)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.55*** (0.09)			-0.24*** (0.08)		
Score.Constraint		-0.20*** (0.08)			-0.06 (0.07)	
WW.Constraint			-0.43*** (0.08)			-0.19*** (0.07)
Observations	8,322	7,511	8,185	8,322	7,511	8,185
Adjusted R <sup>2</sup>	0.11	0.10	0.10	0.06	0.05	0.06
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Table 3.5: Local tax rate increase and pollution abatement investments**

The table presents the estimates of the staggered differences-in-differences regressions that test the impact of an increase in the CFE rate on the pollution reduction investments mix. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(2), and a dummy equal to one if plants invest in pollution prevention in columns (3)-(4). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(2), and the log of amounts invested in pollution treatment + 1 in columns (3)-(4). *IncreaseCFE* is a dummy variable of one if the firm experiences an increase in the CFE tax rate of more than 8% in one year and for subsequent years. The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed* and *Employees*. The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the firm level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood</b>	$\mathbb{1}(\text{Prevention})_{t+1}$		$\mathbb{1}(\text{Treatment})_{t+1}$	
	(1)	(2)	(3)	(4)
Increase.CFE	-0.06 (0.04)	-0.05 (0.04)	0.02 (0.04)	0.02 (0.04)
Observations	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.21	0.26	0.15	0.19
<b>Panel B: Amounts</b>	$\text{Log}(\text{Prevention} + 1)_{t+1}$		$\text{Log}(\text{Treatment} + 1)_{t+1}$	
	(1)	(2)	(3)	(4)
Increase.CFE	-0.28** (0.14)	-0.24* (0.14)	0.14 (0.15)	0.14 (0.16)
Observations	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.29	0.34	0.19	0.24
IndustryFirm x Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes

**Table 3.6: Listed groups**

The table analyzes the impact of being listed on the sensitivity of financial constraints on pollution reduction investments. Panel A presents estimates from OLS regressions. The dependent variable is a dummy equal to one if the plant invests in pollution prevention or treatment for the probability of investing, and the log of amounts invested in pollution prevention or treatment + 1 for the amounts invested. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees that invest in specific equipment to protect the environment, excluding observations with missing values. Panel B presents the estimates of the staggered difference regressions. The dependent variable is a dummy variable equal to one if the plant invests in pollution prevention or treatment in columns (1)-(4), and the log of the amounts invested in pollution prevention or treatment + 1 in columns (5)-(8). The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Financial constraints and pollution abatement investments**

Likelihood of investing	1 (Prevention)			1 (Treatment)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_Listed	-0.01 (0.04)	0.03 (0.03)	0.03 (0.04)	-0.04 (0.04)	0.01 (0.03)	-0.06 (0.04)
Financial.Constraint	-0.08*** (0.02)	-0.05*** (0.02)	-0.06** (0.02)	0.01 (0.02)	-0.01 (0.02)	0.01 (0.02)
Listed	0.03 (0.02)	0.04* (0.02)	0.03 (0.02)	0.01 (0.02)	-0.02 (0.02)	-0.02 (0.02)
Adjusted R <sup>2</sup>	0.04	0.04	0.03	0.02	0.02	0.03
Amounts invested	Log(Prevention + 1)			Log(Treatment + 1)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_Listed	-0.19 (0.15)	0.02 (0.16)	-0.09 (0.15)	-0.06 (0.17)	0.17 (0.14)	-0.04 (0.15)
Financial.Constraint	-0.50*** (0.11)	-0.21** (0.10)	-0.40*** (0.10)	-0.22** (0.09)	-0.13 (0.08)	-0.18** (0.08)
Listed	0.20** (0.10)	0.29*** (0.10)	0.20* (0.10)	0.07 (0.09)	-0.02 (0.10)	-0.02 (0.09)
Adjusted R <sup>2</sup>	0.11	0.10	0.10	0.06	0.05	0.06
Observations	8,322	7,511	8,185	8,322	7,511	8,185
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Panel B: Local tax rate increase and pollution abatement investments**

	1 (Prevention) <sub>t+1</sub>		1 (Treatment) <sub>t+1</sub>		Log(Prevention + 1) <sub>t+1</sub>		Log(Treatment + 1) <sub>t+1</sub>	
Increase.CFE_Listed	-0.04 (0.07)	-0.05 (0.08)	-0.02 (0.07)	-0.04 (0.07)	-0.18 (0.25)	-0.23 (0.28)	0.03 (0.27)	-0.06 (0.30)
Increase.CFE	-0.04 (0.05)	-0.03 (0.05)	0.03 (0.05)	0.04 (0.05)	-0.20 (0.16)	-0.14 (0.18)	0.13 (0.20)	0.16 (0.22)
Listed	-0.54 (0.58)	-0.45 (0.50)	0.26 (0.41)	0.15 (0.38)	-1.44 (2.05)	-0.78 (1.62)	-0.04 (1.65)	-0.22 (1.73)
Observations	5,073	5,073	5,073	5,073	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.22	0.27	0.15	0.20	0.29	0.34	0.19	0.24
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

**Table 3.7: High polluting groups**

The table analyzes the impact of being highly polluting on the sensitivity of financial constraints on pollution reduction investments. Panel A presents estimates from OLS regressions. The dependent variable is a dummy equal to one if the plant invests in pollution prevention or treatment for the probability of investing, and the log of amounts invested in pollution prevention or treatment + 1 for the amounts invested. The sample contains all plants included in both ANTIPOLE and FARES with more than 250 employees that invest in specific equipment to protect the environment, excluding observations with missing values. Panel B presents the estimates of the staggered difference regressions. The dependent variable is a dummy variable equal to one if the plant invests in pollution prevention or treatment in columns (1)-(4), and the log of the amounts invested in pollution prevention or treatment + 1 in columns (5)-(8). The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Financial constraints and pollution abatement investments**

Likelihood of investing	1 (Prevention)			1 (Treatment)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_HighPolluting	-0.04 (0.04)	0.01 (0.03)	-0.02 (0.04)	0.04 (0.04)	-0.01 (0.03)	0.04 (0.04)
Financial.Constraint	-0.05 (0.03)	-0.05* (0.03)	-0.04 (0.03)	-0.03 (0.04)	0.005 (0.03)	-0.03 (0.03)
HighPolluting	-0.21 (0.19)	-0.07 (0.30)	-0.98*** (0.13)	0.24 (0.26)	-0.11 (0.27)	1.09*** (0.15)
Adjusted R <sup>2</sup>	0.04	0.04	0.03	0.02	0.02	0.03
Amounts invested	Log(Prevention + 1)			Log(Treatment + 1)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_HighPolluting	0.02 (0.16)	0.16 (0.15)	0.13 (0.16)	0.04 (0.16)	-0.15 (0.15)	0.07 (0.15)
Financial.Constraint	-0.56*** (0.15)	-0.31*** (0.12)	-0.53*** (0.13)	-0.26* (0.15)	0.05 (0.12)	-0.24* (0.14)
HighPolluting	-1.12 (0.93)	-0.73 (1.20)	-0.51 (0.64)	1.74* (1.02)	-0.75 (1.43)	4.67*** (0.86)
Adjusted R <sup>2</sup>	0.11	0.10	0.10	0.06	0.05	0.06
Observations	8,322	7,511	8,185	8,322	7,511	8,185
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Panel B: Local tax rate increase and pollution abatement investments**

	1 (Prevention) <sub>t+1</sub>		1 (Treatment) <sub>t+1</sub>		Log(Prevention + 1) <sub>t+1</sub>		Log(Treatment + 1) <sub>t+1</sub>	
Increase.CFE_HighPolluting	-0.03 (0.08)	-0.03 (0.08)	0.15* (0.08)	0.16* (0.09)	-0.03 (0.28)	-0.09 (0.28)	0.62** (0.30)	0.64** (0.33)
Increase.CFE	-0.04 (0.07)	-0.03 (0.07)	-0.09 (0.07)	-0.10 (0.07)	-0.26 (0.24)	-0.17 (0.22)	-0.31 (0.25)	-0.33 (0.26)
HighPolluting	-1.96*** (0.28)	-1.94*** (0.28)	0.10 (0.32)	0.01 (0.33)	-4.54*** (1.19)	-4.33*** (1.15)	2.06* (1.22)	1.54 (1.34)
Observations	5,073	5,073	5,073	5,073	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.22	0.27	0.15	0.20	0.29	0.34	0.19	0.24
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

**Table 3.8: Environmental regulation and pollution abatement investments**

The table presents the estimates from OLS regressions to test the effect of environmental regulation on pollution reduction investments. Panel A presents the results for the likelihood of investing and panel B for the amounts invested. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(3), and a dummy equal to one if plants invest in pollution treatment in columns (4)-(6). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(3), and the log of amounts invested in pollution treatment + 1 in columns (4)-(6). *DummyIED* is a dummy variable of one if the plant is subject to the IED directive after the BREF publication and for subsequent years. The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. The sample contains all plants subject to the IED directive that invest in specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the industry level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood</b>	1 (Prevention)			1 (Treatment)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
<b>of investing</b>						
Financial.Constraint_DummyIED	0.03 (0.05)	-0.06 (0.10)	0.04 (0.05)	0.09*** (0.02)	0.10* (0.06)	0.09* (0.05)
Financial.Constraint	-0.70 (1.58)	-1.06*** (0.25)	-0.32 (0.69)	1.74*** (0.28)	0.29*** (0.10)	0.64*** (0.18)
DummyIED	0.01 (0.08)	-0.01 (0.06)	-0.01 (0.05)	-0.12* (0.07)	-0.18** (0.09)	-0.12* (0.07)
Adjusted R <sup>2</sup>	0.28	0.30	0.26	0.20	0.21	0.18
<b>Panel B: Amounts</b>	Log(Prevention +1)			Log(Treatment +1)		
<b>invested</b>	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_DummyIED	0.32* (0.18)	-0.25 (0.37)	0.30 (0.24)	0.30** (0.15)	0.34* (0.19)	0.27 (0.19)
Financial.Constraint	-5.14 (4.46)	-3.30*** (0.66)	-0.86 (2.17)	7.89*** (0.87)	2.33*** (0.54)	2.98*** (0.48)
DummyIED	0.48 (0.59)	0.19 (0.61)	0.21 (0.50)	-0.03 (0.27)	-0.47 (0.44)	-0.40 (0.27)
Adjusted R <sup>2</sup>	0.37	0.38	0.35	0.24	0.25	0.23
Observations	2,162	1,803	2,091	2,162	1,803	2,091
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Table 3.9: SEVESO directive and accidental pollution abatement investments**

The table presents the estimates from difference-in-differences regressions to test the effect of financial constraints on accidental pollution reduction investments. Panel A presents the results for the likelihood of investing and panel B for the amounts invested. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(3), and a dummy equal to one if plants invest in pollution treatment in columns (4)-(6). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(3), and the log of amounts invested in pollution treatment + 1 in columns (4)-(6). *SEVESO* is a dummy variable of one if the facility is subject to the SEVESO directive and *Post* if the year is 2015 and for subsequent years. The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Listed*, *Group* and *Employees*. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees that invest in a specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the industry level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood</b>	1 (Prevention)			1 (Treatment)		
	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
<b>of investing</b>						
Financial.Constraint_Post_SEVESO	-0.05 (0.08)	0.05 (0.09)	0.03 (0.06)	0.11 (0.07)	-0.06 (0.09)	-0.05 (0.12)
Financial.Constraint_Post	0.04 (0.05)	0.01 (0.07)	0.06 (0.05)	-0.04 (0.06)	-0.01 (0.04)	0.01 (0.04)
SEVESO_Post	0.02 (0.03)	0.01 (0.04)	-0.01 (0.03)	-0.07 (0.06)	0.02 (0.08)	-0.02 (0.06)
Adjusted R <sup>2</sup>	0.26	0.26	0.24	0.19	0.20	0.19
<b>Panel B: Amounts</b>	Log(Prevention + 1)			Log(Treatment + 1)		
<b>invested</b>	Size.C	Score.C	WW.C	Size.C	Score.C	WW.C
Financial.Constraint_Post_SEVESO	-0.05 (0.29)	0.11 (0.33)	0.12 (0.26)	0.57** (0.26)	-0.13 (0.45)	-0.26 (0.44)
Financial.Constraint_Post	0.27* (0.15)	0.11 (0.25)	0.12 (0.19)	-0.12 (0.22)	-0.01 (0.18)	0.12 (0.18)
SEVESO_Post	-0.12 (0.14)	-0.25 (0.22)	-0.12 (0.14)	-0.25 (0.29)	0.09 (0.40)	-0.002 (0.29)
Adjusted R <sup>2</sup>	0.34	0.34	0.32	0.24	0.24	0.22
Observations	4,239	3,893	4,178	4,239	3,893	4,178
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes



# Appendix

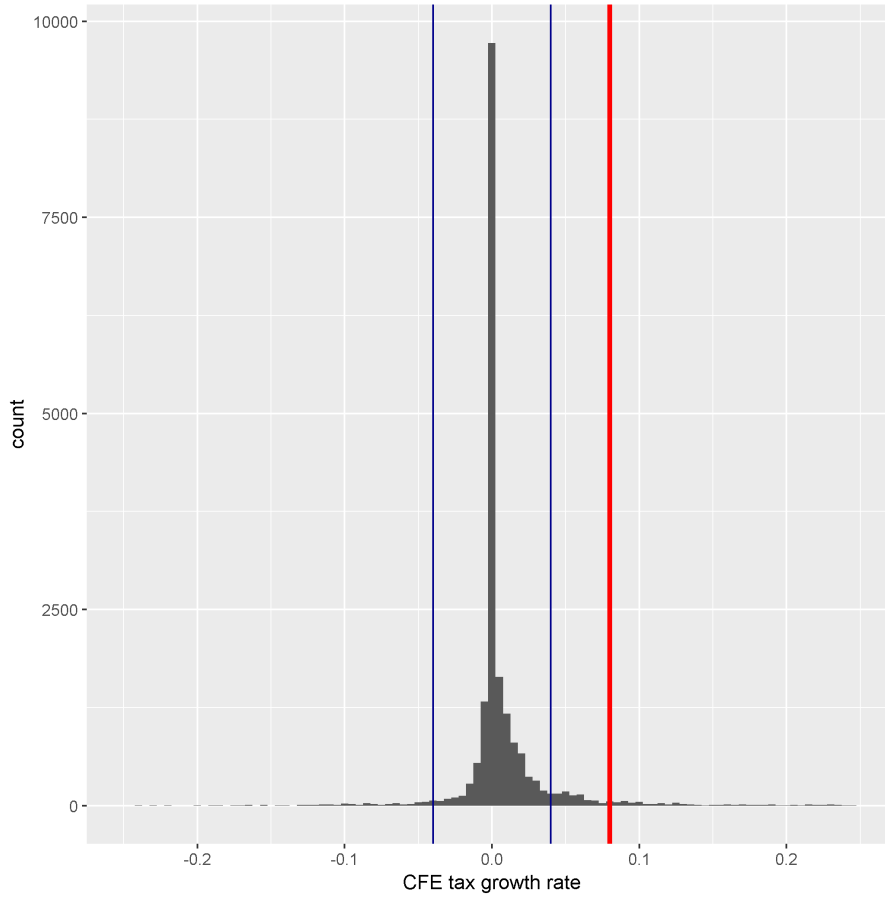
## Variables definitions

The table shows the names and definitions of the variables

Variable name	Definition
<i>Firm characteristics</i> <span style="float: right;"><i>Source: FARES/LIFI</i></span>	
Size	Logarithm of total assets
ROA	Pre-tax earnings over total assets
CashFlow/Asset	EBITDA over total assets
Cash/Asset	Cash over total assets
Capex/Asset	Capital expenditures over total assets
Debt/Asset	Debt over total assets
Tang/Asset	Tangible asset over total assets
InvestSubsidies	Dummy of one if the company receives investment subsidies
Dividend	Dummy of one if the company distributes a cash dividend
FirmAge	Age of the firm
Nbr.plant	Number of establishments owned by the company
Size.Constraint	Dummy of one if the company is in the lowest tercile of Size. The dummy is equal to zeros if the company is in the highest tercile The tercile is computed by year and industry.
Score.Constraint	Dummy equal to one if the company is in the lowest tercile of the Score index and equal to zeros if the company is in the highest tercile. The tercile is computed by year and industry. The Score index is calculated as of: a firm has one point if the size is above the median for the year of interest, one point if the firm distributes a dividend during the year, and one point if cash-flows are above the median for the year
WW.Constraint	Dummy equal to one if the company is in the highest tercile of the WW Index and equal to zeros if the company is in the lowest tercile. The tercile is computed by year and industry. The WW Index is calculated as of: $-0.091 \times \text{CashFlow} - 0.062 \times \text{Dividend} + 0.021 \times \text{Debt} - 0.044 \times \text{Size} + 0.102 \times \text{InduSalesGrowth} - 0.035 \times \text{SalesGrowth}$
<i>Plant characteristics</i> <span style="float: right;"><i>Source: ANTIPOL</i></span>	
1 (Specific)	Dummy of one if the plant invests in at least one specific facility to reduce pollution
1 (Prevention)	Dummy of one if the plant invests in at least one facility to prevent pollution
1 (Treatment)	Dummy of one if the plant invests in at least one facility to treat pollution
Specific	Annual amount spent by a plant on specific facilities to reduce pollution
Prevention	Annual amount spent by a plant on facilities to prevent pollution
Treatment	Annual amount spent by a plant on facilities to treat pollution
Log(Specific +1)	Log(Specific +1)
Log(Prevention +1)	Log(Prevention +1)
Log(Treatment +1)	Log(Treatment +1)
Employees.Plant	Number of employees range of establishments
<i>Group characteristics</i> <span style="float: right;"><i>Source: Source: FARES/LIFI</i></span>	
Group	Dummy of one if the company is part of a group
EuroForeignGroup	Dummy of one if the group is an european group
NoEuroForeignGroup	Dummy of one if the group is an non-european group
Listed	Dummy of one if the group is listed
HighPolluting	Dummy of one if the group belongs to one of the following industries: food and beverage production, chemicals, rubber, plastics, and other non-metallic mineral products, metallurgy and metal products (including equipment and machinery), and coking and refining.

### Figure A1: Distribution of the local tax growth rate

The figure shows the distribution of the growth rate of the average local tax rate to which the firms are exposed over the period 2011-2018. The average local rate is calculated with the average of the local tax rate for each plant weighted by the number of employees of the plant. The red line corresponds to the 8% threshold and the blue line to the 4% threshold.



**Table A1: Comparison between treated and control groups - Increase CFE**

The table summarizes firm-year, plant-year and group-year characteristics for control and treated group. Panel A reports summary statistics at the firm level, Panel B at the plant level and Panel C at the plant level. The sample contains all plants owned by firms in the control or treatment group, excluding observations with missing values. Standard errors are clustered at the firm level. The definitions of the variables are in the appendix.

<b>Panel A: Firm characteristics</b>	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
Size	2,875	10.85	1.33	4,675	11.15	1.27	0.30	9.70
ROA	2,875	0.05	0.09	4,675	0.05	0.09	-0.003	-1.59
CashFlow/Asset	2,875	0.09	0.09	4,675	0.08	0.09	-0.002	-0.98
Cash/Asset	2,875	0.07	0.09	4,675	0.06	0.09	-0.01	-4.00
Capex/Asset	2,875	0.05	0.05	4,675	0.06	0.05	0.001	1.01
Debt/Asset	2,875	0.14	0.15	4,675	0.14	0.15	-0.002	-0.55
Tang/Asset	2,875	0.25	0.16	4,675	0.24	0.16	-0.003	-0.87
InvestSubsidies	2,875	0.40	0.49	4,675	0.43	0.49	0.03	2.52
Dividend	2,875	0.41	0.49	4,675	0.44	0.50	0.03	2.59
FirmAge	2,875	33.71	16.94	4,675	34.60	16.52	0.89	2.23
NbrPlant	2,857	3.80	6.79	4,675	3.33	6.40	-0.47	-2.96

<b>Panel B: Plant characteristics</b>	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
1 (Specific)	4,260	0.55	0.50	6,123	0.58	0.49	0.03	3.31
1 (Prevention)	2,345	0.65	0.48	3,571	0.67	0.47	0.02	1.62
1 (Treatment)	2,345	0.49	0.50	3,571	0.48	0.50	-0.01	-0.47
Specific (keuros)	4,260	134.32	552.72	6,123	200.59	1,059.86	66.26	4.15
Prevention (keuros)	2,345	102.35	449.05	3,571	133.47	793.53	31.12	1.92
Treatment (keuros)	2,345	104.87	491.65	3,571	154.86	832.23	49.98	2.90
Employees	4,260	5.27	1.06	6,123	5.84	1.12	0.57	26.46

<b>Panel C: Group characteristics</b>	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
Group	1,792	0.90	0.29	2,894	0.90	0.30	-0.004	-0.47
EuroForeignGroup	1,792	0.27	0.45	2,894	0.26	0.44	-0.01	-0.75
NoEuroForeignGroup	1,792	0.11	0.31	2,894	0.16	0.37	0.05	4.97
Listed	1,792	0.26	0.44	2,894	0.35	0.48	0.09	6.81

**Table A2: Comparison between treated and control groups - IED directive**

The table summarizes firm-year, plant-year and group-year characteristics for control and treated group. Panel A reports summary statistics at the firm level, Panel B at the plant level and Panel C at the plant level. The sample contains all plants owned by firms in the control or treatment group, excluding observations with missing values. The definitions of the variables are in the appendix.

	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
<b>Panel A: Firm characteristics</b>								
Size	3,577	11.28	1.14	13,764	10.55	1.34	-0.73	-32.79
ROA	3,577	0.05	0.08	13,764	0.05	0.09	-0.002	-1.27
CashFlow/Asset	3,577	0.09	0.08	13,764	0.08	0.09	-0.01	-8.12
Cash/Asset	3,577	0.05	0.08	13,764	0.07	0.09	0.02	13.85
Capex/Asset	3,577	0.06	0.05	13,764	0.05	0.05	-0.01	-10.65
Debt/Asset	3,577	0.16	0.16	13,764	0.14	0.15	-0.01	-4.21
Tang/Asset	3,577	0.30	0.16	13,764	0.22	0.15	-0.08	-27.70
InvestSubsidies	3,577	0.57	0.50	13,764	0.36	0.48	-0.20	-21.70
Dividend	3,577	0.39	0.49	13,764	0.42	0.49	0.03	3.76
FirmAge	3,577	33.55	16.06	13,764	34.26	16.62	0.71	2.34
NbrPlant	3,522	2.92	3.54	13,613	3.05	5.66	0.14	1.76
<b>Panel B: Plant characteristics</b>								
	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
1 (Specific)	4,927	0.67	0.47	16,895	0.48	0.50	-0.19	-25.19
1 (Prevention)	3,315	0.48	0.48	8,086	0.64	0.48	-0.002	-0.22
1 (Treatment)	3,315	0.49	0.50	8,086	0.46	0.50	-0.12	-11.56
Specific (keuros)	4,927	322.11	1,278.76	16,895	98.03	728.14	-224.09	-11.76
Prevention (keuros)	3,315	188.77	1,039.39	8,086	88.81	644.87	-99.96	-5.15
Treatment (keuros)	3,315	230.99	894.00	8,086	77.35	500.21	-153.64	-9.32
Employees	4,927	5.64	1.01	16,895	5.28	1.17	-0.32	-21.60
<b>Panel C: Group characteristics</b>								
	Treated			Control			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
Group	1,865	0.90	0.30	9,318	0.87	0.33	-0.03	-3.87
EuroForeignGroup	1,865	0.29	0.45	9,318	0.21	0.41	-0.08	-7.08
NoEuroForeignGroup	1,865	0.15	0.36	9,318	0.10	0.30	-0.05	-5.45
Listed	1,865	0.30	0.47	9,318	0.24	0.43	-0.08	-7.09

**Table A3: Comparison between listed and private groups**

The table summarizes firm-year, plant-year and group-year characteristics for control and treated group. Panel A reports summary statistics at the firm level, Panel B at the plant level and Panel C at the plant level. The sample contains all plants included in both ANTIPOLO and FARES with more than 250 employees, excluding observations with missing values. The definitions of the variables are in the appendix.

	Listed			Private			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
<b>Panel A: Firm characteristics</b>								
Size	5,557	11.39	1.21	11,788	10.37	1.27	-1.02	-51.01
ROA	5,557	0.05	0.09	11,788	0.05	0.09	-0.01	-5.72
CashFlow/Asset	5,557	0.09	0.09	11,788	0.08	0.09	-0.005	-3.12
Cash/Asset	5,557	0.04	0.08	11,788	0.08	0.10	0.04	30.56
Capex/Asset	5,557	0.06	0.05	11,788	0.06	0.05	0.001	1.72
Debt/Asset	5,557	0.13	0.17	11,788	0.16	0.14	0.03	10.48
Tang/Asset	5,557	0.25	0.16	11,788	0.24	0.15	-0.01	-3.39
InvestSubsidies	5,557	0.37	0.48	11,788	0.42	0.49	0.05	6.36
Dividend	5,557	0.39	0.49	11,788	0.43	0.49	0.04	4.89
FirmAge	5,557	34.64	16.68	11,788	33.86	16.42	-0.78	-2.88
Nbr.plant	5,513	3.91	7.19	11,626	2.61	4.03	-1.31	-12.61
<b>Panel B: Plant characteristics</b>								
	Listed			Private			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
1 (Specific)	7,923	0.62	0.49	13,904	0.47	0.50	-0.15	-21.77
1 (Prevention)	7,923	0.43	0.49	13,904	0.28	0.45	-0.15	-22.08
1 (Treatment)	7,923	0.30	0.46	13,904	0.23	0.42	-0.06	-9.92
Specific (keuros)	7,923	224.56	1,004.63	13,904	105.31	810.65	-119.25	-9.02
Prevention (keuros)	7,923	94.31	601.13	13,904	42.92	547.37	-51.39	-6.27
Treatment (keuros)	7,923	96.41	605.78	13,904	45.12	368.48	-51.29	-6.85
Employees	7,923	5.75	1.15	13,904	5.14	1.09	-0.61	-38.09
<b>Panel C: Group characteristics</b>								
	Listed			Private			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
Group	2,826	0.96	0.20	8,361	0.85	0.36	-0.11	-19.66
EuroForeignGroup	2,826	0.36	0.48	8,361	0.17	0.38	-0.19	-19.25
NoEuroForeignGroup	2,826	0.33	0.47	8,361	0.04	0.19	-0.29	-32.47

**Table A4: Comparison between high and low polluting groups**

The table summarizes firm-year, plant-year and group-year characteristics for control and treated group. Panel A reports summary statistics at the firm level, Panel B at the plant level and Panel C at the plant level. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees, excluding observations with missing values. The definitions of the variables are in the appendix.

	High Polluting			Low Polluting			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
<b>Panel A: Firm characteristics</b>								
Size	11,289	10.69	1.24	6,056	10.72	1.50	0.04	1.56
ROA	11,289	0.05	0.09	6,056	0.05	0.09	-0.004	-2.68
CashFlow/Asset	11,289	0.09	0.09	6,056	0.08	0.09	-0.01	-7.41
Cash/Asset	11,289	0.06	0.09	6,056	0.08	0.10	0.02	10.18
Capex/Asset	11,289	0.06	0.05	6,056	0.05	0.05	-0.01	-8.68
Debt/Asset	11,289	0.16	0.15	6,056	0.13	0.15	-0.03	-10.62
Tang/Asset	11,289	0.25	0.15	6,056	0.21	0.15	-0.04	-16.54
InvestSubsidies	11,289	0.44	0.50	6,056	0.34	0.47	-0.10	-13.21
Dividend	11,289	0.42	0.49	6,056	0.41	0.49	-0.01	-0.64
FirmAge	11,289	34.07	16.26	6,056	34.18	16.96	0.11	0.42
Nbr.plant	11,144	2.75	4.03	5,995	3.53	7.04	0.78	7.89
<b>Panel B: Plant characteristics</b>								
	High Polluting			Low Polluting			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
1 (Specific)	14,421	0.55	0.50	7,406	0.47	0.50	-0.07	-10.46
1 (Prevention)	14,421	0.35	0.48	7,406	0.31	0.46	-0.04	-5.85
1 (Treatment)	14,421	0.28	0.45	7,406	0.22	0.41	-0.06	-10.16
Specific (keuros)	14,421	171.68	1,013.73	7,406	103.64	564.83	-68.04	-6.36
Prevention (keuros)	14,421	71.66	672.77	7,406	41.92	262.57	-29.74	-4.66
Treatment (keuros)	14,421	74.82	531.41	7,406	42.16	314.15	-32.66	-5.69
Employees	14,421	5.27	1.01	7,406	5.54	1.37	0.27	15.22
<b>Panel C: Group characteristics</b>								
	High Polluting			Low Polluting			Diff	t.stat
	N	Mean	SD	N	Mean	SD		
Group	6,937	0.89	0.32	4,250	0.86	0.35	-0.03	-3.95
EuroForeignGroup	6,937	0.24	0.43	4,250	0.19	0.39	-0.05	-6.25
NoEuroForeignGroup	6,937	0.11	0.31	4,250	0.12	0.32	0.01	1.65
Listed	6,937	0.25	0.43	4,250	0.26	0.44	0.01	1.36

**Table A5: Strict definition**

The table analyzes the impact of financial constraints on pollution reduction investments. Panel A presents estimates from OLS regressions. The dependent variable is a dummy equal to one if the plant invests in only pollution prevention or treatment for the probability of investing, and the log of amounts invested only in pollution prevention or treatment +1 for the amounts invested. The sample contains all plants included in both ANTIPOL and FARES with more than 250 employees that invest in specific equipment to protect the environment, excluding observations with missing values. Panel B presents the estimates of the staggered difference regressions. The dependent variable is a dummy variable equal to one if the plant invests only in pollution prevention or treatment in columns (1)-(4), and the log of the amounts invested only in pollution prevention or treatment + 1 in columns (5)-(8). The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Financial constraints and pollution abatement investments**

<b>Likelihood of investing</b>	<b>1 (Inv.Prev)</b>			<b>1 (Inv.Treat)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.03 (0.02)			0.06*** (0.02)		
Score.Constraint		-0.01 (0.01)			0.03** (0.01)	
WW.Constraint			-0.003 (0.02)			0.04*** (0.02)
Adjusted R <sup>2</sup>	0.02	0.02	0.02	0.03	0.03	0.02
<b>Amounts invested</b>	<b>Log(Inv.Prev +1)</b>			<b>Log(Inv.Treat +1)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.24*** (0.06)			0.07 (0.06)		
Score.Constraint		-0.11** (0.05)			0.07 (0.04)	
WW.Constraint			-0.19*** (0.05)			0.08 (0.05)
Adjusted R <sup>2</sup>	0.02	0.02	0.02	0.02	0.02	0.02
Observations	8,322	7,511	8,185	8,322	7,511	8,185
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Local tax rate increase and pollution abatement investments**

	<b>1 (Inv.Prev)<sub>t+1</sub></b>		<b>1 (Inv.Treat)<sub>t+1</sub></b>		<b>Log(Inv.Prev +1)<sub>t+1</sub></b>		<b>Log(Inv.Treat +1)<sub>t+1</sub></b>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Increase.CFE	-0.05* (0.03)	-0.05 (0.04)	0.02 (0.03)	0.02 (0.03)	-0.25** (0.11)	-0.22* (0.12)	0.10 (0.10)	0.09 (0.11)
Observations	5,177	5,177	5,177	5,177	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.11	0.13	0.07	0.09	0.08	0.11	0.08	0.10



**Table A6: Constant number of plants**

The table analyzes the impact of financial constraints on pollution reduction investments. Panel A presents estimates from OLS regressions. The dependent variable is a dummy equal to one if the plant invests in pollution prevention or treatment for the probability of investing, and the log of amounts invested in pollution prevention or treatment +1 for the amounts invested. The sample contains all plants owned by firms with the same number of plants during all the period sample, that invest in specific equipment to protect the environment, excluding observations with missing values. Panel B presents the estimates of the staggered difference regressions. The dependent variable is a dummy variable equal to one if the plant invests in pollution prevention or treatment in columns (1)-(4), and the log of the amounts invested in pollution prevention or treatment + 1 in columns (5)-(8). The sample contains all plants owned by firms with the same number of plants during all the period sample, that are in the control or treatment group and invest in specific equipment to protect the environment, excluding observations with missing values. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Financial constraints and pollution abatement investments**

<b>Likelihood of investing</b>	<b>1 (Inv.Prev)</b>			<b>1 (Inv.Treat)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.10*** (0.03)			0.02 (0.03)		
Score.Constraint		-0.07*** (0.02)			-0.01 (0.02)	
WW.Constraint			-0.05* (0.02)			0.01 (0.02)
Adjusted R <sup>2</sup>	0.05	0.04	0.04	0.03	0.03	0.03
<b>Amounts invested</b>	<b>Log(Inv.Prev +1)</b>			<b>Log(Inv.Treat +1)</b>		
	(1)	(2)	(3)	(4)	(5)	(6)
Size.Constraint	-0.62*** (0.11)			-0.16 (0.11)		
Score.Constraint		-0.35*** (0.08)			-0.09 (0.08)	
WW.Constraint			-0.35*** (0.10)			-0.12 (0.10)
Adjusted R <sup>2</sup>	0.11	0.10	0.10	0.08	0.07	0.07
Observations	4,154	4,051	4,084	4,154	4,051	4,084
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

**Panel B: Local tax rate increase and pollution abatement investments**

	<b>1 (Inv.Prev)<sub>t+1</sub></b>		<b>1 (Inv.Treat)<sub>t+1</sub></b>		<b>Log(Inv.Prev +1)<sub>t+1</sub></b>		<b>Log(Inv.Treat +1)<sub>t+1</sub></b>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Increase.CFE	-0.02 (0.05)	-0.02 (0.05)	0.02 (0.05)	0.001 (0.05)	-0.11 (0.30)	-0.09 (0.33)	0.07 (0.22)	0.05 (0.24)
Observations	2,624	2,624	2,624	2,624	2,565	2,565	2,565	2,565
Adjusted R <sup>2</sup>	0.23	0.26	0.18	0.20	0.30	0.33	0.22	0.24

**Table A7: Relative analysis**

The table analyzes the impact of financial constraints the amount spent on pollution prevention relative to the total amount spent on pollution prevention and treatment. The sample contains all plants that invest in pollution treatment or prevention, excluding observations with missing values. Panel B presents the estimates of the staggered difference regressions. The sample contains all plants that are in the control or treatment group and invest in pollution treatment or prevention, excluding observations with missing values. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Financial constraints and pollution abatement investments**

	Percentage.Prevention					
Size.Constraint	-0.06***	-0.05**				
	(0.02)	(0.02)				
Score.Constraint			-0.02	-0.01		
			(0.02)	(0.02)		
WW.Constraint					-0.03*	-0.02
					(0.02)	(0.02)
Observations	7,336	7,336	6,576	6,576	7,184	7,184
Adjusted R <sup>2</sup>	0.03	0.03	0.03	0.03	0.02	0.03
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls plant and firm-level	Yes	Yes	Yes	Yes	Yes	Yes
Controls group-level	No	Yes	No	Yes	No	Yes

**Panel B: Local tax rate increase and pollution abatement investments**

	Percentage.Prevention <sub>t+1</sub>			
Increase.CFE	-0.09*	-0.09*	-0.09*	-0.09*
	(0.04)	(0.04)	(0.05)	(0.05)
Observations	3,105	3,105	3,105	3,105
Adjusted R <sup>2</sup>	0.23	0.22	0.30	0.30
IndustryFirm x Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes
Controls plant and firm-level	Yes	Yes	Yes	Yes
Controls group-level	No	Yes	No	Yes

**Table A8: Dynamic process**

The table analyzes the impact of the previous pollution abatement investment on the current pollution abatement investment. The sample contains all plants that invest in pollution treatment or prevention, excluding observations with missing values. The dependant variable is the amount spent on pollution prevention relative to the total amount spent on pollution prevention and treatment. Controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed*, and *Employees*. Standard errors are clustered at the firm level. The appendix provides the definitions of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

	Percentage.Prevention					
Percentage.Prev <sub>t-1</sub>	0.30*** (0.01)	0.03 (0.02)	-0.07*** (0.02)	0.30*** (0.01)	0.03 (0.02)	-0.07** (0.02)
Observations	5,768	5,768	5,768	5,768	5,768	5,768
Adjusted R <sup>2</sup>	0.11	0.23	0.28	0.11	0.23	0.28
IndustryFirm x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryPlant FE	Yes	No	No	Yes	No	No
Firm FE	No	Yes	No	No	Yes	No
Plant FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes

**Table A9: 10% threshold**

The table presents the estimates of the staggered differences-in-differences regressions that test the impact of an increase in the CFE rate on the pollution reduction investments mix. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(2), and a dummy equal to one if plants invest in pollution prevention in columns (3)-(4). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(2), and the log of amounts invested in pollution treatment + 1 in columns (3)-(4). *IncreaseCFE* is a dummy variable of one if the firm experiences an increase in the CFE tax rate of more than 10% in one year and for subsequent years. The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed* and *Employees*. The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the firm level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood</b>	$\mathbb{1}(\text{Prevention})_{t+1}$		$\mathbb{1}(\text{Treatment})_{t+1}$	
	(1)	(2)	(3)	(4)
Increase.CFE	-0.07*	-0.06	0.03	0.03
	(0.04)	(0.04)	(0.04)	(0.04)
Observations	4,669	4,669	4,669	4,669
Adjusted R <sup>2</sup>	0.22	0.26	0.15	0.18
<b>Panel B: Amounts</b>	$\text{Log}(\text{Prevention} + 1)_{t+1}$		$\text{Log}(\text{Treatment} + 1)_{t+1}$	
	(1)	(2)	(3)	(4)
Increase.CFE	-0.30**	-0.28*	0.17	0.18
	(0.15)	(0.16)	(0.16)	(0.17)
Observations	4,580	4,580	4,580	4,580
Adjusted R <sup>2</sup>	0.29	0.34	0.18	0.23
IndustryFirm x Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes

**Table A10: Local tax rate increase and pollution abatement investments - Placebo test**

The table presents the estimates of the staggered differences-in-differences regressions that test the impact of an increase in the CFE rate on the pollution reduction investments mix. In Panel A, the dependent variable is a dummy equal to one if the plant invests in pollution prevention in columns (1)-(2), and a dummy equal to one if plants invest in pollution prevention in columns (3)-(4). In Panel B, the dependent variable is the log of the amounts invested in pollution prevention + 1 in columns (1)-(2), and the log of amounts invested in pollution treatment + 1 in columns (3)-(4). *IncreaseCFE* is a dummy variable of one if the firm experiences an increase in the CFE tax rate of more than 8% four years before the year of the shock and for subsequent years. The controls include *InvestSubsidies*, *Tang/Asset*, *Cash/Asset*, *Capex/Asset*, *FirmAge*, *EuroForeignGroup*, *NoEuroForeignGroup*, *Group*, *Listed* and *Employees*. The sample contains all plants owned by firms in the control or treatment group that invest in specific equipment to protect the environment, excluding observations with missing values. Standard errors are clustered at the firm level. The appendix provides the definition of the variables. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

<b>Panel A: Likelihood</b>	$\mathbb{1}(\text{Prevention})_{t+1}$		$\mathbb{1}(\text{Treatment})_{t+1}$	
	(1)	(2)	(3)	(4)
<b>of investing</b>				
Increase.CFE	0.05 (0.04)	0.05 (0.05)	-0.02 (0.05)	-0.02 (0.05)
Observations	5,177	5,177	5,177	5,177
Adjusted R <sup>2</sup>	0.21	0.26	0.15	0.19
<b>Panel B: Amounts</b>	$\text{Log}(\text{Prevention} + 1)_{t+1}$		$\text{Log}(\text{Treatment} + 1)_{t+1}$	
	(1)	(2)	(3)	(4)
<b>invested</b>				
Increase.CFE	0.11 (0.16)	0.10 (0.16)	0.02 (0.18)	0.02 (0.19)
Observations	5,073	5,073	5,073	5,073
Adjusted R <sup>2</sup>	0.29	0.34	0.19	0.24
IndustryFirm x Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
Plant FE	No	Yes	No	Yes

**Table A11: Alternative estimators**

The table shows two alternative estimators for the staggered-difference-in-differences. Panel A represents the average total treatment effect obtained by using the estimator provided by Callaway and Sant’Anna. Control firms are never treated firms. The estimation method used is simple regression. Standard errors are computed using the multiplier bootstrap. Panel B shows the average total treatment effect obtained by using the estimator provided by Sun and Abraham. The estimation method used is simple regression. Standard errors are clustered by plants. Stars indicate significance levels \*\*\* 1%, \*\* 5%, and \*10%.

**Panel A: Callaway and Sant’Anna estimator**

ATT	Std.Error	[90% Conf.Int.]
-0.2387	0.143	-0.4739 -0.0034 *
Control Group:	Never Treated	
Estimation Method:	Outcome Regression	

**Panel B: Sun and Abraham estimator**

Dependent Variable:	$\text{Log}(\text{Prevention} + 1)_{t+1}$
Model:	(1)
<i>Variables</i>	
ATT	-0.27* (0.14)
<i>Fixed-effects</i>	
Plant	Yes
year	Yes
<i>Fit statistics</i>	
Observations	5,072
R <sup>2</sup>	0.50723
Within R <sup>2</sup>	0.00809



# Conclusion

Ces dernières décennies, la crise environnementale et la prise de conscience de nouveaux enjeux sociaux ont questionné le rôle de la finance et des entreprises au sein de la société. Aujourd'hui la finance durable est un pan important de cette dernière, mettant de plus en plus sous pression les entreprises pour qu'elles prennent en compte toutes les parties prenantes dans leur stratégie. Cependant, toutes les entreprises ne développent leurs politiques RSE de la même manière. Or, il est primordial d'étudier ce qui motive les entreprises à investir de manière responsable afin de comprendre l'impact que ce nouveau paradigme a sur elles et pour développer un monde plus durable. C'est pourquoi, cette thèse explore certaines des barrières et incitations à la mise en place de ces politiques environnementales et sociales.

Le premier chapitre met en lumière l'impact positif des femmes administratrices sur les performances environnementales et sociales des entreprises, suggérant que si l'investisseur souhaite inciter l'entreprise à développer sa RSE, nommer des administrateurs femmes pourrait être une solution. Les résultats sont obtenus en exploitant l'implémentation de la loi Copé Zimmermann en France. Cette loi impose des quotas de genre au sein des conseils d'administration français. Cette conséquence positive de la nomination des femmes peut être expliquée par différents canaux. Premièrement, à la suite de la mise en place de la loi, les entreprises françaises sont plus susceptibles d'avoir un comité RSE. Deuxièmement, les femmes sont davantage membres des comités du conseil d'administration, suggérant qu'elles ont plus de pouvoir dans celui-ci. Sachant que les femmes ont plus d'expériences relatives aux problématiques RSE et plus d'autorité après la mise en place des quotas, elles sont plus à même de promouvoir les politiques environnementales et sociales.

Le deuxième chapitre étudie la relation entre les scores environnementaux des notes ESG et les efforts entrepris par les entreprises afin de réduire la pollution. Aujourd'hui, les notes ESG sont utilisées massivement par les gestionnaires d'actifs lors de la constitution de portefeuille ESG. Cependant, il n'y a pas de consensus sur ce que devrait mesurer ces notes. Doivent-elles refléter le stock de pollution émis par l'entreprise dans le but d'agir comme une incitation pour



les entreprises les plus polluantes ou doivent-elles représenter le flux de pollution et les efforts faits par les entreprises afin de rendre compte d'une certaine performance environnementale ? Les efforts entrepris sont mesurés au moyen des investissements des établissements industriels français et les scores environnementaux proviennent de la base de donnée V.E. (anciennement Vigeo Eiris). Les résultats montrent une faible corrélation entre les scores et les efforts entrepris lorsqu'on considère l'échantillon dans son ensemble. A contrario, si la distinction est faite entre les entreprises faisant partie des industries hautement et faiblement polluantes, les résultats changent. La relation devient négative pour les entreprises des industries hautement polluantes, signifiant que les scores environnementaux représente davantage un stock et agissent comme une incitation. Ce résultat pourrait être problématique si à la place de participer à la transition écologique, ces scores orientaient seulement l'argent des épargnants vers les entreprises qui ont le moins besoin de capital et pénalisaient celles qui en aurait le plus besoin.

En effet, réduire la pollution à un coût et toutes les entreprises n'ont pas le même accès aux ressources financières. C'est pourquoi ce dernier chapitre analyse l'impact des contraintes financières sur les méthodes utilisées par les entreprises pour réduire la pollution. L'article fait ici la distinction entre les investissements de traitement et de prévention. Les résultats montrent que les contraintes financières ont un impact négatif sur les investissements de prévention et encouragent les investissements de traitement si une loi environnementale est mise en place. Dans le cas du traitement, la pollution est générée, collectée puis traitée. À l'inverse, la prévention évite la création de la pollution. En évitant la génération de la pollution, les investissements de prévention peuvent générer des bénéfices à long terme et avoir un impact positif sur la performance de l'entreprise. A contrario, ils sont plus coûteux à implémenter que ceux pour traiter la pollution. C'est pourquoi, seules les entreprises non contraintes vont investir dans les investissements de prévention s'ils peuvent créer de la valeur. Les entreprises contraintes vont préférer utiliser leurs ressources financières pour les projets liés à leurs activités. Lors de l'implémentation de la loi environnementale, les entreprises contraintes vont être dans l'obligation de réduire la pollution, elles vont donc choisir d'investir dans la méthode la moins coûteuse à court terme, c'est-à-dire le traitement.

Si cette thèse se concentre sur certaines barrières et incitations, elle n'est en aucun cas exhaustive et il reste de nombreux champs à étudier. Comprendre quelle information communiquer aux gestionnaires d'actifs et aux investisseurs ainsi que comment la mesurer pour financer au mieux la transition environnementale est crucial.

Cette thèse apporte plusieurs éclairages intéressants à destination des professionnels de la finance ou des instances politiques. Premièrement, la mise en place de quotas de genre peut avoir des conséquences positives dans le contexte actuel. Deuxièmement, les scores environnementaux peuvent être contreproductifs, réduire la pollution à un coût et certaines entreprises structurellement polluantes n'ont pas assez de moyen pour entreprendre tous les investissements nécessaires. Les pénaliser en augmentant leur coût du capital pourrait réduire leurs efforts. Troisièmement, lorsque les entreprises ont suffisamment de capital et qu'un investissement de prévention rentable est disponible, elles entreprennent d'elle-même ces investissements. Il est donc primordial d'inciter l'innovation verte dans la prévention.



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## RÉSUMÉ

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Cette thèse explore les incitations et les barrières à la mise en place des politiques environnementales et sociales des entreprises. Dans un premier article, elle montre l'effet positif des femmes administratrices sur les performances environnementales et sociales en exploitant la mise en place de quotas de genre dans les conseils d'administration en France. Les résultats sont premièrement expliqués par l'augmentation du nombre de comités RSE. Deuxièmement, du fait de l'instauration des quotas, les femmes ont plus d'autorités au sein des conseils d'administration. Disposant d'une expérience plus importante dans le domaine de la RSE, elles sont donc plus à même d'imposer leur expérience et de promouvoir les politiques environnementales et sociales. Le deuxième chapitre étudie les relations entre les scores environnementaux des scores ESG et les investissements de réduction de la pollution. Il montre que les scores environnementaux reflètent davantage le stock de pollution, propre à une logique d'incitation, plutôt que les efforts entrepris par les entreprises qui se rapprocherait plus d'une logique de mesure de la performance environnementale. Enfin, le troisième article étudie l'impact des contraintes financières sur la méthode utilisée par les entreprises afin de réduire la pollution. Les résultats indiquent que les contraintes financières ont un impact négatif sur les investissements de prévention de la pollution et encouragent les investissements de traitement lorsqu'une loi environnementale est mis en place.

## MOTS CLÉS

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Finance durable, Pollution, Genre, Finance d'entreprise, Gouvernance, ESG

## ABSTRACT

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This thesis explores the incentives and barriers to the implementation of corporate environmental and social policies. In the first article, it shows the positive effect of women directors on environmental and social performance by exploiting the implementation of gender quotas in French boards of directors. The results are firstly explained by the increase in the number of CSR committees. Second, the introduction of quotas has given women more authority on boards of directors. With more experience in CSR, they are therefore better able to impose their experience and promote environmental and social policies. The second chapter examines the relationship between ESG environmental scores and pollution reduction investments. It shows that environmental scores reflect more the stock of pollution, which is specific to a logic of incentive, rather than the efforts undertaken by companies, which would be closer to a logic of measuring environmental performance. Finally, the third article studies the impact of financial constraints on the method used by firms to reduce pollution. The results indicate that financial constraints have a negative impact on pollution prevention investments and encourage treatment investments when an environmental law is implemented.

## KEYWORDS

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Sustainable Finance, Pollution, Gender, Corporate finance, Governance, ESG