The Carbon Cost of Competitive Pressure*

Vesa Pursiainen† , Hanwen Sun‡, and Yue Xiang§

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Abstract

Higher exposure to competition – measured by product fluidity – is associated with higher carbon emissions. This result is robust to using instrumental variables to obtain exogenous variation in fluidity and also holds when using only reported emission data, excluding estimated emissions. The relationship between competition and carbon emissions is stronger for firms in areas less concerned about climate change and areas with weaker social norms. Short-termism does not explain the results, as the emissions-competition link is at least as strong for firms with longer-term-oriented shareholders. Our findings suggest that promoting competition may be at odds with climate change abatement.

JEL classification: D40, G30, M14, Q50

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†University of St.Gallen and Swiss Finance Institute, E-mail: vesa.pursiainen@unisg.ch

‡University of Bath, E-mail: h.sun@bath.ac.uk

§Durham University, E-mail: yue.xiang@durham.ac.uk

1 Introduction

Climate change presents a profound challenge to society, making carbon emissions reduction a critical global priority. Policymakers and regulators seek to align financial incentives with environmental objectives through carbon pricing, green financing, disclosure mandates, and many other policies.[1] At the same time, financial markets attempt to assess and price the risks related to climate change and carbon emissions. Most finance scholars, professionals, and policymakers argue that markets are more likely to underestimate than to overestimate climate risks.[2] Carbon reductions must also be globally coordinated, yet climate change effects vary significantly across regions, complicating mitigation efforts.[3]

At the same time, fostering competition is another supposed cornerstone of economic policy, driving efficiency, innovation, and consumer welfare. The public discourse about the importance of competition has become increasingly urgent as industries have grown more concentrated and profitable in recent decades, both in the U.S. (Covarrubias et al. (2019), Grullon et al. (2019)) and globally (De Loecker and Eeckhout (2018), Bae et al. (2021), Frésard (2010)), prompting calls for regulatory action to ensure competitive markets. However, the policy goals of carbon reduction and increasing competition may sometimes be in conflict.

In this paper, we study the role of competitive pressure in corporate carbon emissions, using data from Trucost. Our main measure of carbon intensity is the scope 1 GHG intensity, converted into CO_2 equivalent. As an alternative source of carbon emissions data, we use the self-reported carbon emissions from the Carbon Disclosure Project (CDP). To measure domestic competitive pressure, we use the product fluidity index of Hoberg et al. (2014). This index is based on textual analysis of the mandatory product descriptions in 10-K filings, capturing the similarity between a firm's products and the overall changes in the rivals' products. A greater product fluidity index means more overlap with competitors in product

[1] For discussions of carbon reduction policies, see, e.g., Gillingham and Stock (2018).
[2] See Stroebel and Wurgler (2021).
[3] See, e.g., Cruz and Rossi-Hansberg (2024).

space, implying higher levels of competitive pressure.[4] We construct a comprehensive sample of U.S. listed firms for the years 2002-2023.

We find that higher competitive pressure is associated with higher carbon emissions per unit of revenue. This finding is both statistically and economically significant and robust to controlling for a large number of firm characteristics as well as firm, industry-time and state-time fixed effects. A one-standard-deviation increase in product fluidity is associated with a 4-5% increase in carbon intensity, depending on the model specification. The results remain very similar when using the self-reported carbon emissions data from the CDP, suggesting that the findings are not driven by the Trucost methodology to estimate emissions.

To better establish causality between competition and carbon emissions, we use two instrumental variables to capture exogenous variation in product fluidity: changes in state-level trade-weighted foreign exchange rates (Li and Zhan (2019), Loncan (2023), Loncan and Valta (2024)) and the staggered introduction of Paid Sick Leave (PSL) laws (Loncan and Valta (2024), Maclean et al. (2024)). An appreciation in the state-level FX rate reduces the relative costs of imports, thus increasing local competition from foreign products. The passage of a PSL increases firm costs, presumably with a stronger effect for firms with less market power, and hence reduces competitive pressure. Similar to Loncan and Valta (2024), we confirm that both of these instruments strongly predict firm-level fluidity. Using either one of them or both simultaneously as instruments for fluidity, we confirm that increases in fluidity are associated with significant increases in carbon emissions. The economic magnitude of the IV estimates is substantially larger than our baseline OLS estimates.

Next, we explore the role of local climate attitudes and political views in moderating the effect of competitive pressure on carbon emissions.[5] We use county-level data on climate opinions from the Yale Climate Maps and find that the effect of fluidity on carbon emissions

[4] *Fluidity* is used by a number of recent studies to measure competitive threats in the product market (e.g., Li and Zhan (2019), Mattei and Platikanova (2017), Hoberg et al. (2014)).

[5] For example, Ramadorai and Zeni (2024) find that firms' beliefs about climate regulation strongly affect abatement. Several studies suggest that political views are correlated with preferences on sustainability, also in investments (Hong and Kostovetsky (2012), Gormley et al. (2024), Kempf and Tsoutsoura (2024)).

is significantly larger for firms headquartered in areas that consider climate action by corporations less important. The estimated relationship between fluidity and carbon emissions is also somewhat stronger for firms in Republican-voting areas, but the difference along political lines is economically small and not statistically significant. We also use corporate lobbying data from Leippold et al. (2024) and find that firms that spend more on lobbying Democrats (Republicans) exhibit a weaker (stronger) link between fluidity and carbon emissions.

Investing in carbon abatement may be partly driven by considerations of stakeholders other than shareholders. Hence, we might expect such investment to depend on the strength of social norms in the communities where the firms operate. To test this, we use three proxies for the strength of social norms. First, we use the *Social capital index* of Lin and Pursiainen (2022) to measure the strength of local social norms. Second, we use the local volunteering rate (Chetty et al. (2022a), Chetty et al. (2022b)), defined as the percentage of Facebook users who are members of a group which is predicted to be about "volunteering" or "activism" based on group title and other group characteristics in the county. Third, we classify the firms in our data into *Sin industry* and other industries, following Hong and Kacperczyk (2009). With all of these proxies for social norms, we find that the positive relationship between product fluidity and carbon emissions is stronger when social norms are weaker.

Many commentators (see, e.g., Paulson (2015), van Lierop (2024)) and some academic studies (e.g., Maeckle (2024), Wiersema et al. (2025)) have suggested that short-termism is a key obstacle to tackling carbon emissions. To explore whether short-termism plays a role in our findings, we use three proxies for investor short-termism: the churn ratio of Gaspar et al. (2005), the adjusted churn ratio of Yan and Zhang (2009), and the share of transient ownership by Bushee (1998).[6] Across all these measures, we find that the estimated positive relationship between product fluidity and carbon emissions is actually stronger for

[6]Churn ratio is an indicator of investor turnover for the firm, measured by a weighted average of the total portfolio churn rate of all institutional shareholders over the four quarters of the year. The transient investor defined by Bushee (1998) is based on factor analysis and cluster analysis of past investment behavior. Transient institutions have high portfolio turnover and engage in momentum trading strategies.

firms with longer-horizon shareholders, although this difference is not statistically significant. This contrasts with the results of Starks et al. (2023), who find that long-term institutional investors tilt their portfolios towards firms with better ESG profiles.

On the other hand, the estimated relationship between fluidity and carbon emissions is stronger for firms with lower institutional ownership in general, although this difference is also not statistically significant. This seems consistent with Azar et al. (2021), who find a negative association between Big Three ownership and subsequent carbon emissions among MSCI index constituents. Taken together, our results on ownership suggest that institutional ownership matters, but that the sensitivity of carbon emissions to competitive pressure is not driven by short-term owners.

To assess the importance of our findings for the aggregate carbon emissions in the economy, we perform further subsample analyses dividing our sample by firm size, age, and total carbon emissions.[7] We find that the results are broadly similar for firms regardless of their size, age, or total carbon footprint. This suggests that the relationship we document between competitive pressure and carbon emissions may be important for the total carbon emissions, as it also applies to the large emitters.

We make several contributions. First, we contribute to the rapidly growing literature on corporate carbon emissions and the role of markets in moderating them. Several studies focus on the pricing of climate risk and carbon and other emission risk in equity (Choi et al. (2020), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023), Aswani et al. (2024), Zhang (2025), Hsu et al. (2023)), debt (Duan et al. (2023b), Ginglinger and Moreau (2023), Ivanov et al. (2024)), and other financial markets (e.g., Ilhan et al. (2021), Giglio et al. (2021)). Some recent studies use earnings call transcripts to quantify firms' climate risk exposures (e.g., Li et al. (2024), Sautner et al. (2023)). A related literature focuses on the effects of carbon abatement policies. Hong et al. (2023) model the welfare consequences of mandates that restrict investors to hold firms with net-zero carbon emissions. Martinsson et al. (2024)

[7]For example, Fang et al. (2024) argue that under financial constraints, smaller and younger firms invest more in capital and engage less in pollution abatement.

and Andersson (2019) estimate that the Swedish carbon tax substantially reduced carbon emissions. A large literature discusses the social cost of carbon (e.g., Barnett et al. (2020), van den Bremer and van der Ploeg (2021)). Akey and Appel (2021) find that limitations in parent company environmental liability result in lower investment in abatement technologies. Shapiro and Walker (2018) show that between 1990 and 2008, air pollution emissions from U.S. manufacturing fell by 60 percent despite a substantial increase in manufacturing output, primarily driven by within-product changes in emissions intensity.

Our study is also related to the literature documenting unintended consequences of carbon reduction policies. Several studies focus on emissions leakage amid local restrictions (e.g., Fowlie (2009), Fowlie et al. (2016), Bartram et al. (2022)). Shapiro (2016) finds that the benefits of international trade exceed trade's environmental costs due to CO_2 emissions. In a study closely related to ours, Cenci et al. (2023) argue that competition induces firms to increase their sustainability efforts and invest in a broader spectrum of sustainability issues. This appears to somewhat contradict our empirical findings – although it is obviously possible that in the very long term competition would have the opposite effect to what we find in the contemporaneous setting.

We add to the large literature on the effects of competition. There are many studies suggesting that more competition is associated with lower prices (Dafny et al. (2012), Borenstein and Rose (1994), Brown and Goolsbee (2002)), better product quality Matsa (2011), and reduced governance problems (Lie and Yang (2023), Giroud and Mueller (2010, 2011)), as well as other broadly positive outcomes. von Meyerinck et al. (2024) show that competition is important for consumers' ability to discipline firms. Our findings suggest that competition may also have negative societal impacts in reducing firms' commitment to sustainability. Other studies finding negative societal as well as firm-level effects from competition include Autor et al. (2013), Autor et al. (2020), Pierce and Schott (2016), Frésard and Valta (2016), Valta (2012). Hombert and Matray (2018) find that innovative firms are less exposed to import competition. Frésard (2010), on the other hand, finds that financial strength can

lead to market share gains. The discussion about the effects of competition is increasingly important as industries have grown more concentrated and profitable in recent decades, both in the U.S. (Covarrubias et al. (2019), Grullon et al. (2019)) and globally (De Loecker and Eeckhout (2018), Bae et al. (2021), Frésard (2010)).

There is some prior work on the relationship between competition and different measures of sustainability. Flammer (2015) finds that tariff reductions are associated with increases in CSR, while Ding et al. (2022) provide international evidence that intensifying competition laws are associated with an increase in CSR. Duanmu et al. (2018) find that a reduction in protective tariffs at WTO entry is associated with worsening of environmental performance of Chinese manufacturing firms. Some related recent studies look at consumer responses to negative ESG incidents (Houston et al. (2023), Duan et al. (2023a)).

We also contribute to the literature on the role of ownership in corporate emissions (e.g., Shive and Forster (2020)). Our finding that firms with longer-term owners exhibit a stronger relationship between competitive pressure and carbon emissions is in contrast to Starks et al. (2023), who find that short-term owners are associated with poorer ESG profiles, and to Pursiainen et al. (2024), who show that the relationship between competition and ESG performance is more negative for firms with shorter-term shareholders. On the other hand, our result that institutional ownership is associated with a weaker link between competition and emissions appears consistent with prior studies suggesting that institutional ownership is associated with more investment in sustainability and more climate risk disclosures (Azar et al. (2021), Ilhan et al. (2023), Cohen et al. (2023)).

Finally, our study is related to the literature on the interaction between morals and markets. Falk and Szech (2013) present experimental evidence that market interaction erodes moral values. Similarly, Bartling et al. (2015) find that consumers in markets exhibit less social concern than subjects in a comparable individual choice context. In a more recent paper, Bartling et al. (2023) argue that it may not be markets per se, but rather playing repeatedly that leads to the erosion of moral values. Dewatripont and Tirole (2024) show

that intense market competition does not crowd out consequentialist ethics. Our findings provide nuance to this discussion, as the carbon emissions of firms that might be expected to be more "moral" indeed seem to be less sensitive to competitive pressure – but react nevertheless.

2 Data and methodology

2.1 Sample construction

To construct our sample, we start with all public U.S. firms over the period of 2002 to 2023. Our sample starts from 2002, as it is the beginning of carbon intensity data coverage in S&P Global Trucost. Product fluidity data are from the Hoberg and Phillips Data Library. Corporate financial and accounting data are from Compustat. Other data sources include disclosed carbon intensity data from Carbon Disclosure Project (CDP) and state-level exchange rate data from the Federal Reserve at Dallas. Climate opinion data are from Yale Climate Opinion Maps. Presidential election voting data are from MIT Election Lab. Lobbying data are from Leippold et al. (2024). Social capital data are from Lin and Pursiainen (2022) and Meta. Institutional ownership data are from Thomson Reuters Institutional (13f) Holdings. After dropping firms from the financial sector (SIC codes between 6000 and 6999) and deleting observations with missing data, we obtain a sample with 28,721 firm-year observations for 3,725 U.S. firms.

2.2 Measuring carbon intensity

We measure corporate carbon intensity using data provided by S&P Global Trucost, a database prevalent in recent studies (e.g., Azar et al. (2021), Bolton and Kacperczyk (2023), Cohen et al. (2023)). Trucost compiles emission data from publicly available sources, such as financial reports, CSR reports, CDP filings, and EPA filings. It categorizes carbon emissions related to corporate activities into different scopes. For each scope, Trucost quantifies car-

bon emissions in absolute tonnes of CO2 equivalent, as well as calculates emission intensity as the ratio of absolute tonnes to a firm's revenue in millions of U.S. dollars. Among them, emission intensity, i.e., carbon efficiency, reflects corporate operational scale and indicates its dependency on carbon emissions in generating revenue.

As an alternative source of carbon emissions data, we use the self-reported carbon emissions from the Carbon Disclosure Project (CDP). CDP annually distributes a questionnaire to firms and asks them to report their greenhouse gas emissions in accordance with the Greenhouse Gas Protocol. This database is one of the most widely used sources for reported firm-level climate data (e.g., Cohen et al. (2023)).

We focus on Scope 1 carbon emissions – emissions that come from direct emitting sources a firm owns or controls – because they are more directly controlled by firms, and they are more accurately quantified. We logarithmically transform the Scope 1 carbon intensity. Specifically, we define *ln(Scope 1 intensity)* as the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. Higher values indicate greater levels of carbon emissions.

2.3 Measuring competitive pressure

As the main measure for competitive pressure, we use the product fluidity index of Hoberg et al. (2014). This index (*Fluidity*) is based on textual analysis of the mandatory product descriptions in 10-K filings, capturing the similarity between a focal firm's products and the overall changes in the rivals' products. A higher product fluidity index means more overlap with opponents in product space, implying higher levels of competitive pressure. Fluidity is used by a number of recent studies to measure competitive threats in the product market (e.g., Li and Zhan (2019), Mattei and Platikanova (2017), Hoberg et al. (2014), Loncan (2023), Loncan and Valta (2024)).

The product fluidity index has four benefits. First, company-level product fluidity data contain firm-specific information that is not available in other competition dimensions, such

as national competition laws. The index reflects the actual competitive pressure that each company faces in the product market from both public companies and potential private firms. Second, product fluidity reflects the instability caused by the action of rivals rather than the diversification in self-products of the focal company. The launch of comparable products from opponents could intensify product market competition for firms with stationary product structures. Third, a potential endogeneity problem in investigating the association between product market competition and corporate ESG performance is that the CEO who formulates ESG policies also sets the competition strategies. Since product fluidity captures moves by rival firms competing in a focal company's product field, this measurement is more likely to be exogenous from a single firm's perspective (Hoberg et al. (2014)). Last, the fluidity data have comprehensive coverage for U.S. public companies across various industries, providing the same scope as the Compustat database and the CRSP database.

2.4 Control variables

Following previous literature, we control for a wide range of firm characteristics that might influence corporate carbon intensity(e.g., Azar et al. (2021), Bolton and Kacperczyk (2023), Cohen et al. (2023)).

The control variables include *ln(Total assets)*, measured by the natural logarithm of total assets; *Leverage*, measured by the ratio of book value of debt to total assets; *Cash*, measured by the ratio of cash and short-term investments to total assets; *Tangibility*, measured by the ratio of net property, plant and equipment to total assets; *Capital expenditure*, measured by the ratio of capital expenditures to total assets; *ln(1+N analysts)*, measured by the natural logarithm of one plus the number of analysts following a firm; *Sales growth*, measured by the one-year net sales growth rate; *R&D expenditure*, measured by the ratio of research and development expenditures to total sales, where missing R&D is set to zero; *Tobin's Q*, measured by the ratio of the market value of a firm plus total liability to total assets; *EBIT margin*, measured by the ratio of earnings before interest and taxes to total sales; *EBIT*

to total assets, measured by the ratio of earnings before interest and taxes to total assets; and *Foreign sales*, measured by a dummy variable that equals one if a firm reports foreign income. Detailed definitions of variables can be found in Appendix A. To avoid the effects of outliers, we winsorize all continuous variables at the 1% level.

2.5 Description of the data

Table 1 provides summary statistics for the key variables used in the analysis. The average Scope 1 carbon emission intensity (*Scope 1 intensity*) is 240.9 tonnes of CO2 equivalent per million dollars of revenue, with a standard deviation of 979.402. When log-transformed, the mean carbon intensity (*ln(Scope 1 intensity)*) is 3.288. Using CDP data as an alternative source, the mean Scope 1 intensity(*Scope 1 intensity (CDP)*) is 359.9, with a higher standard deviation of 1250.9, and a mean logged value of 3.090. It is worth noting that the number of observations with CDP data drop to 4,532. Product fluidity (*Fluidity*), the primary measure of competition, has an average value of 6.221 with a standard deviation of 3.661.

Firm size, measured by the logarithm of total assets, has a mean of 7.702. On average, firms finance 28.2% of their assets with debt, while cash holdings constitute approximately 19.7% of total assets. Capital expenditures account for 4.5% of total assets, and firms experience an average annual sales growth of 12%. Tobin's Q has a mean of 2.347. R&D expenditures represent around 12% of total sales, and 65% of firms report foreign income.

3 Main results

3.1 Product fluidity and carbon emissions

To examine the relationship between competitive pressure and corporate carbon emissions, we perform a regression analysis of the following form:

$$ln(Scope\ 1\ intensity)_{i,t} = \alpha + \beta Fluidity_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{i,t-1} \quad (1)$$

where i and t denote the firm and year, respectively. The dependent variable, *ln(Scope 1 intensity)*, is the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). X is a vector of controls. We include firm and year fixed effects throughout the paper, but also include alternative sets of fixed effects for robustness. All right-hand-side variables are lagged by one year. Standard errors are clustered by firm.

Table 2 presents the main results. Across all model specifications, the coefficients of *Fluidity* are positive and statistically significant at the 1% level, indicating a positive relationship between product fluidity and carbon emissions. This relationship is also economically meaningful:based on the specification with firm and year fixed effects, a one-standard-deviation increase in fluidity is associated with a 4.06% increase in carbon emissions per unit of revenue. This positive relationship remains robust even after controlling for firm characteristics, including size, leverage, cash holdings, and capital expenditure, as well as incorporating alternative sets of fixed effects including the industry-year, state-year, or state-industry-year levels.

To address concerns that the results might be driven by the methodology used by Trucost to estimate emissions (e.g., Aswani et al. (2024)), we replicate the analysis using self-reported carbon emissions from the Carbon Disclosure Project (CDP) as an alternative data source. The results, reported in Table 3, are highly similar. Despite the substantially smaller sample size, the estimated coefficients on *Fluidity* remain positive, statistically significant, and of comparable economic magnitude. These findings suggest that the observed relationship is not an artifact of the Trucost estimation methodology.

3.2 Lagged fluidity and carbon emissions

We further examine the dynamic relationship between product fluidity and carbon intensity by incorporating contemporaneous and lagged measures of fluidity into our regression model. This approach allows us to assess how past competitive pressure relates to current carbon

emissions intensity.

The results, presented in Table 4, show that higher product fluidity is consistently associated with higher carbon intensity in the short term, with the strongest positive coefficient observed for the one-year lagged fluidity in both model specifications. When multiple lags are included simultaneously, the one-year lag continues to exhibit the strongest association with carbon intensity. This pattern is intuitive, as firms' operational or investment responses to changes in competitive pressure may take time to materialize in observable emissions outcomes. These findings provide empirical support for our main specification, which uses one-year lagged fluidity in the baseline analyses.

3.3 Instrumenting product fluidity

To better address potential endogeneity concerns in the relationship between competitive pressure and carbon emissions, we employ two instrumental variables (IVs) to generate plausibly exogenous variation in product fluidity: changes in state-level trade-weighted foreign exchange rates (Li and Zhan (2019), Loncan (2023), Loncan and Valta (2024)) and the staggered adoption of Paid Sick Leave (PSL) mandates (Loncan and Valta (2024), Maclean et al. (2024)).

The first instrument, Δ *ln(FX)*, is defined as the growth rate of the real trade-weighted exchange rate at the state level. An appreciation of the state-level U.S. dollar is plausibly associated with increased local competition, as a stronger dollar reduces the relative price of imports and thereby intensifies competition faced by domestic firms. Since exchange rates are determined by aggregated, decentralized market transactions, the actions of individual firms are unlikely to materially influence state-level exchange rates. This supports the plausibility of the exclusion restriction, whereby the residual of the structural equation is uncorrelated with the exchange rate fluctuations.

The second instrument, *PSL*, is a dummy variable equal to one if a firm's headquarter

state has implemented a Paid Sick Leave mandate.[8] The implementation of PSL laws raises firms' labor costs by mandating paid compensation for employee sick leave, thus reducing profit margins. Firms with greater market power may be better positioned to absorb these higher costs, while firms with weaker market positions are likely to be disproportionately affected. As a result, PSL mandates may erode the competitive strength of less powerful firms, thereby reducing overall market competition. Since PSL mandates are policy decisions made at the state level, independent of firm-level competitive actions, it is plausible that the exclusion restriction holds, and that the policy shocks are exogenous with respect to firms' carbon emission behaviors.

By using the two instrumental variables, we assume that changes in state-level trade-weighted exchange rates (Δ *ln(FX)*) and the introduction of Paid Sick Leave mandates (*PSL*) are correlated with product market fluidity but do not directly affect firms' carbon emissions except through their impact on competition.

Table 5 presents the results of the instrumental variables (IV) estimation, using Δ *ln(FX)* and *PSL* as instruments for product fluidity. The table is organized into three panels: Panel A reports the ordinary least squares (OLS) estimates of the relationship between the instruments and carbon intensity; Panel B presents the first-stage regression results; and Panel C reports the second-stage IV estimates.

Panel A shows that a stronger U.S. dollar (Δ *ln(FX)*) is associated with higher carbon emissions, consistent with the notion that increased competitive pressure from cheaper imports may raise firms' emissions. Conversely, Paid Sick Leave mandates (*PSL*) are negatively associated with carbon intensity, suggesting that stricter labor regulations may reduce emissions, possibly by raising firms' operational costs and dampening competitive intensity.

Panel B confirms that both instruments are strongly correlated with product fluidity.

[8]Following Maclean et al. (2024), firms are assigned exposure to PSL mandates based on the location of their headquarters. States and jurisdictions adopting PSL mandates during the sample period include Arizona (2017), California (2015), Colorado (2021), Connecticut (2012), District of Columbia (2008), Massachusetts (2015), Maryland (2018), Minnesota (2024), New Jersey (2018), New Mexico (2022), New York (2021), Oregon (2016), Rhode Island (2016), Vermont (2017), and Washington (2018). Firms headquartered in these states are classified as being subject to PSL mandates from the respective effective year onward.

A stronger U.S. dollar significantly increases fluidity, indicating that exchange rate appreciations intensify product market competition by lowering the cost of imported goods. In contrast, the introduction of PSL mandates significantly reduces fluidity, consistent with higher labor costs deterring entry or expansion, particularly among smaller or less competitive firms (Loncan and Valta (2024)). The high first-stage F-statistics mitigate concerns about weak instruments and confirm the relevance of the instruments.

Panel C shows that instrumented product fluidity remains positively and significantly associated with carbon intensity. The magnitude of the IV estimates is larger than the corresponding OLS estimates, suggesting that OLS specifications may underestimate the true effect of competitive pressure on firms' emissions. Overall, the IV results reinforce the interpretation that greater competition is associated with higher carbon emissions.

3.4 Climate opinions, political views, and lobbying

Firms operate within broader societal and political contexts that influence their environmental decisions. Prior research suggests that corporate expectations regarding future climate regulation shape emissions strategies (Ramadorai and Zeni (2024)), while political ideology correlates with sustainability preferences, including in investment behavior (Hong and Kostovetsky (2012); Gormley et al. (2024); Kempf and Tsoutsoura (2024)).

Public climate opinions reflect societal expectations for corporate environmental responsibility and may moderate firms' ability to increase emissions in response to competitive pressure. Greater climate concern may generate stronger pressure from consumers, investors, and regulators, whereas weaker concern may allow firms to prioritize cost-cutting over sustainability efforts. Similarly, political ideology shapes regulatory environments: conservative-leaning regions typically impose less stringent environmental policies, providing firms with greater flexibility to raise emissions under competition, whereas progressive-leaning areas are associated with stricter oversight and higher reputational risks.

Panel A of Table 6 examines how public climate opinions and local political views mod-

erate the relationship between product fluidity and carbon intensity. We first partition the sample based on local climate concern, measured using the Yale Climate Opinion Maps (Howe et al. (2015); Baldauf et al. (2020)). *Climate concern* is defined as the share of county residents who believe corporations and industry should be doing more or much more to address global warming. Firms headquartered in counties with climate concern above the sample median are classified as *High*, and others as *Low*. The results show that the positive association between product fluidity and carbon intensity is significantly weaker in regions with higher climate concern, suggesting that stronger societal expectations may constrain firms' emissions responses to competition.

We next partition the sample based on county-level political ideology, proxied by the Republican vote share in the most recent Presidential election (MIT Election Lab). Firms headquartered in counties with Republican vote shares above the sample median are classified as *High*, and others as *Low*. The results indicate that firms in more conservative areas exhibit a somewhat stronger positive relationship between competition and carbon emissions, consistent with weaker regulatory or social constraints. However, the economic magnitude of the difference is small and not statistically significant.

Panel B of Table 6 examines whether firm-level lobbying expenditures moderate the relationship between product fluidity and carbon intensity. *Democratic* is measured by the Democratic-leaning lobbying expenses of Leippold et al. (2024). *Republican* is measured by the Republican-leaning lobbying expenses of Leippold et al. (2024). Firms with *Democratic* or *Republican* above sample medians each year are classified as *High*, otherwise as *Low*.

The results show that firms that lobby Democrats more heavily exhibit a weaker relationship between competition and carbon intensity. Although it is not statistically significant, the results suggest that engagement with Democratic policymakers, who generally support stronger environmental regulations, may constrain firms from increasing emissions even under competitive pressure. In contrast, firms that lobby Republicans more heavily exhibit a stronger positive relationship between competition and carbon intensity, implying

that lobbying efforts directed toward Republican policymakers, who typically advocate for deregulation, allow firms greater flexibility to increase emissions in response to competitive pressures.

3.5 Social norms

Firms' carbon abatement decisions are shaped not only by financial incentives but also by social norms, which reflect community expectations regarding corporate responsibility. In regions with stronger pro-environmental norms, firms may face greater public pressure to maintain sustainability efforts, limiting their ability to increase emissions in response to competition. By contrast, firms operating in areas with weaker social norms may experience less stakeholder scrutiny, allowing them to prioritize cost-cutting over environmental considerations when competitive pressures intensify.

Table 7 presents the results examining how social norms moderate the relationship between product fluidity and carbon intensity. Firms are partitioned based on three proxies for local social norms. First, we use the *Social capital* index of Lin and Pursiainen (2022), which measures the strength of community relationships and trust networks that impose behavioral norms. Higher levels of social capital imply stronger informal governance structures. Second, we use *Volunteering*, measured by the share of Facebook users in a county who belong to groups associated with volunteering or activism, based on group titles and other group characteristics (Chetty et al. (2022a); Chetty et al. (2022b)). Third, we classify firms based on whether they operate in a *Sin industry*, following Hong and Kacperczyk (2009). Sin industries—including alcohol, tobacco, gambling, and weapons—are often perceived as less ethical. Firms are assigned to Sin industries based on specific SIC and NAICS codes: 2100–2199, 2080–2085 (SIC) and 7132, 71312, 713210, 71329, 713290, 72112, and 721120 (NAICS). For *Social capital* and *Volunteering*, firms are classified as *High* if above the sample median in a given year, and *Low* otherwise. Firms in Sin industries are classified as *Yes*; others as *No*.

The results show that firms headquartered in areas with higher social capital or greater volunteering activity exhibit a weaker positive association between product fluidity and carbon intensity. This suggests that stronger community values and civic engagement function as informal constraints on firms' emissions responses to competitive pressure. Conversely, firms in low social capital and low volunteering regions face fewer social constraints and exhibit a stronger competition-emissions relationship. In addition, firms operating in Sin industries display a somewhat stronger positive association between competition and emissions intensity, although the difference is not statistically significant. Overall, the evidence suggests that social norms play a moderating role in shaping how firms adjust environmental practices in response to increased competition.

3.6 Ownership and investor horizion

Many commentators (see, e.g., Paulson (2015), van Lierop (2024)) and academic studies (e.g., Maeckle (2024), Wiersema et al. (2025)) have suggested that short-termism is a major barrier to corporate carbon reduction efforts. Short-term-oriented investors, who frequently trade stocks and prioritize immediate financial returns, may pressure firms to focus on cost-cutting and short-term profitability at the expense of long-term sustainability goals. In contrast, long-term investors, such as pension funds and large institutional shareholders, often advocate for corporate policies that enhance long-term value, including environmental responsibility. In this case, we would expect firms with longer-term shareholders to be less likely to increase carbon emissions in response to competitive pressure.

To test this conjecture, we perform subsample analyses using a number of proxies for investor short-termism: *Churn ratio* is measured by the weighted average portfolio churn rate of institutional shareholders over four quarters (Gaspar et al. (2005)); *Adjusted churn ratio* is the refined measure of *Churn ratio*(Yan and Zhang (2009)); and *Transient ownership* is calculated as the share of transient institutional owners relative to total institutional ownership(Bushee (1998)). Shareholders of firms with higher *Churn ratio*, *Adjusted churn*

ratio and *Transient ownership* are more likely to have shorter investment horizons. We also include a subsample analysis based on overall institutional ownership.

Table 8 presents the regression results for subsamples by investor horizon. Firms are categorized into high and low groups based on the sample median for each measure each year. Across all measures, the positive relationship between product fluidity and carbon emissions is, if anything, slightly stronger for firms with longer-horizon shareholders. This pattern contrasts somewhat with the findings of Starks et al. (2023), who document that long-term institutional investors are more likely to allocate capital toward firms with stronger ESG profiles.

We also find that the relationship between product fluidity and carbon emissions is more pronounced for firms with lower institutional ownership. Institutional ownership, defined as the share of outstanding equity held by institutional investors, appears to attenuate firms' emissions responses to competitive pressure. This result is consistent with Azar et al. (2021), who document that Big Three ownership is associated with lower subsequent carbon emissions among MSCI index constituents.

Taken together, the results suggest that institutional ownership may play a moderating role in firms' environmental responses to competition. However, they provide limited support for the view that short-term investor pressure drives the sensitivity of carbon emissions to competitive pressure. If anything, the emissions-competition link appears at least as strong among firms with longer-term-oriented shareholders, suggesting that short-termism is unlikely to be the primary explanation for the observed patterns.

3.7 Firm size, age, and total carbon emissions

We also examine how firm characteristics—specifically size, age, and total carbon emissions—moderate the relationship between product fluidity and carbon intensity. Prior research suggests that smaller and younger firms, particularly those facing financial constraints, may prioritize capital investment over pollution abatement (Fang et al. (2024)). By analyzing

firms across different size and age groups, we assess whether competition-induced increases in emissions are concentrated among certain types of firms or represent a broader trend across the corporate sector. In addition, examining heterogeneity based on total carbon emissions allows us to evaluate whether competitive pressure disproportionately affects high-emission firms, which contribute most to aggregate carbon output, or whether the effects are more uniformly distributed.

Table 9 presents the subsample regression results. Firms are categorized into high and low groups each year based on the sample median for three variables: *Total assets* (as a proxy for firm size), *Firm age* (measured as the number of years since first appearance in the CRSP monthly return files), and *Total Scope 1 emissions* (capturing absolute emissions rather than emissions intensity). This categorization allows us to assess whether larger, older, or high-emitting firms exhibit different sensitivities to competitive pressure with respect to carbon intensity.

The results show that product fluidity is positively associated with carbon intensity across all subsamples. However, the differences between the high and low groups are economically small and statistically insignificant. This suggests that firm size, firm age, and total emissions do not materially alter the relationship between competition and emissions intensity. Overall, the findings indicate that competitive pressure is associated with increased carbon emissions across a broad range of firms, rather than being driven by particular types of firms.

4 Conclusion

This paper examines how competitive pressure, measured by product fluidity, influences firms' carbon emission intensity. Across a range of specifications, we find that greater competition is consistently associated with higher carbon emissions relative to firm revenue. The results are robust to addressing endogeneity with instrumental variables and to using alternative emissions data from the Carbon Disclosure Project (CDP).

Our findings suggest that competitive pressure may create incentives for firms to deprioritize carbon abatement, highlighting an underexplored tension between market competition and environmental sustainability. Although public climate concern and social norms modestly attenuate this relationship, and institutional ownership exerts some moderating effect, these forces are insufficient to fully offset the pressures competition imposes on corporate environmental behavior. Political ideology and firm-level lobbying orientation show directional patterns consistent with expectations but have limited economic and statistical significance.

Importantly, we find no evidence that short-term investor pressure explains the link between competition and emissions; in fact, firms with longer-term investors exhibit at least as strong a sensitivity to competition. Moreover, the positive association between competition and emissions holds across firms of different sizes, ages, and baseline emissions levels, indicating that the effect is broad-based rather than confined to specific firm types.

Overall, these results offer a nuanced perspective on the drivers of corporate carbon behavior. Policies promoting competition may inadvertently undermine climate objectives unless accompanied by complementary regulatory or market-based mechanisms that realign firms' environmental incentives. Future efforts to design effective climate policies must therefore account for how competitive dynamics interact with firms' sustainability decisions.

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Appendix A: Definitions of variables

Variable	Definition
Scope 1 intensity	The ratio of Scope 1 carbon emissions to revenue in millions of dollars.
ln(Scope 1 intensity)	The natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars.
Scope 1 intensity (CDP)	The ratio of disclosed Scope 1 carbon emissions to revenue in millions of dollars.
ln(Scope 1 intensity (CDP))	The natural logarithm of one plus the ratio of disclosed Scope 1 carbon emissions to revenue in millions of dollars.
Fluidity	The product fluidity index of Hoberg et al. (2014).
ln(Total assets)	The natural logarithm of total assets.
Leverage	The ratio of book value of debt to total assets.
Cash	The ratio of cash and short-term investments to total assets.
Tangibility	The ratio of net property, plant and equipment to total assets.
Capital expenditure	The ratio of capital expenditures to total assets.
ln(1+N analysts)	The natural logarithm of one plus the number of analysts following a firm.
Sales growth	The one-year net sales growth rate.
R&D expenditure	The ratio of research and development expenditures to total sales, where missing R&D is set to zero.
Tobin's Q	The ratio of the market value of a firm plus total liability to total assets.
EBIT margin	The ratio of earnings before interest and taxes to total sales.
EBIT to total assets	The ratio of earnings before interest and taxes to total assets.
Foreign sales	A dummy variable that equals one if a firm reports foreign income.
Δ ln(FX)	The growth rate of real trade-weighted state-level exchange rates.
PSL	A dummy variable that equals one if a state adopts Paid Sick Leave mandates.
Climate concern	The ratio of population who think corporations and industry should be doing more or much more to address global warming.
Republican vote	The ratio of residents in a county that vote for the Republican party in the Presidential election.
Democratic	The Democratic-leaning lobbying expenses of Leippold et al. (2024).
Republican	The Republican-leaning lobbying expenses of Leippold et al. (2024).
Social capital	The social capital index of Lin and Pursiainen (2022).
Volunteering	The ratio of Facebook users who are members of a group which is predicted to be about volunteering or activism based on group title and other group characteristics.
Sin industry	A dummy variable that equals one if a firm is sin industries (SIC codes: 2100-2199, 2080-2085; NAICS codes: 7132, 71312, 713210, 71329, 713290, 72112, and 721120).
Inst. ownership	The ratio of shareholdings by all institutional investors to total shares outstanding.
Churn ratio	The weighted average churn ratio of Gaspar et al. (2005).
Adj. churn ratio	The adjusted weighted average churn ratio of Yan and Zhang (2009).

Transient ownership	The ratio of shareholdings of transient institutional investors to the total institutional ownership.
Total assets	The number of total assets.
Firm age	The number of years since a firm first appeared in the CRSP monthly stock return files.
Total scope 1 emissions	Firm-level yearly emissions capturing absolute carbon output.

Table 1
Summary statistics

This table presents the descriptive statistics for the main variables used in our analyses. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level.

	Mean	Std	p25	p50	p75	N
Carbon emissions						
Scope 1 intensity	240.916	979.402	8.464	17.501	46.906	28,721
ln(Scope 1 intensity)	3.288	1.740	2.248	2.918	3.869	28,721
Scope 1 intensity (CDP)	359.854	1250.895	2.466	12.633	91.607	4,532
ln(Scope 1 intensity (CDP))	3.090	2.294	1.243	2.612	4.528	4,532
Competition						
Fluidity	6.221	3.661	3.482	5.303	8.028	28,721
Controls						
ln(Total assets)	7.702	1.801	6.492	7.771	8.934	28,694
Leverage	0.282	0.222	0.109	0.261	0.402	28,582
Cash	0.197	0.229	0.036	0.105	0.265	28,692
Tangibility	0.271	0.244	0.081	0.181	0.408	28,680
Capital expenditure	0.045	0.049	0.014	0.030	0.057	28,662
ln(1+N analysts)	2.291	0.815	1.792	2.398	2.890	28,721
Sales growth	0.120	0.243	-0.014	0.075	0.203	28,147
R&D expenditure	0.119	0.285	0.000	0.004	0.082	28,478
Tobin's Q	2.347	1.862	1.253	1.719	2.698	28,661
EBIT margin	-0.064	0.573	0.020	0.091	0.165	28,478
EBIT to total assets	0.029	0.201	0.016	0.069	0.120	28,692
Foreign sales	0.652	0.476	0.000	1.000	1.000	28,721
N	28,721					

Table 2
Carbon intensity and product fluidity

This table presents regression results of the relationship between product fluidity and carbon intensity. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Fluidity	0.0612***	0.0587***	0.0111***	0.0108***	0.0123***
	(0.0081)	(0.0072)	(0.0032)	(0.0034)	(0.0038)
ln(Total assets)		0.1126***	-0.0995***	-0.0675***	-0.0749***
		(0.0243)	(0.0182)	(0.0187)	(0.0218)
Leverage		-0.6092***	-0.0039	-0.0113	0.0128
		(0.0932)	(0.0464)	(0.0477)	(0.0535)
Cash		-0.4871***	0.1297**	0.0731	0.0534
		(0.1236)	(0.0616)	(0.0627)	(0.0701)
Tangibility		4.5108***	0.2423*	0.1952	0.0622
		(0.1803)	(0.1260)	(0.1271)	(0.1688)
Capital expenditure		-3.3139***	-0.4428**	0.1541	0.3647
		(0.5863)	(0.2045)	(0.2090)	(0.2722)
ln(1+N analysts)		-0.2647***	0.0273	0.0436**	0.0125
		(0.0391)	(0.0186)	(0.0196)	(0.0209)
Sales growth		0.1037***	0.0165	-0.0019	0.0019
		(0.0397)	(0.0181)	(0.0192)	(0.0214)
R&D expenditure		-0.1234	-0.1153*	-0.0529	-0.0523
		(0.1154)	(0.0640)	(0.0634)	(0.0718)
Tobin's Q		-0.0470***	-0.0093*	-0.0047	-0.0121**
		(0.0084)	(0.0052)	(0.0051)	(0.0056)
EBIT margin		-0.0493	-0.0624**	-0.0279	-0.0232
		(0.0679)	(0.0246)	(0.0242)	(0.0272)
EBIT to total assets		-0.1578	-0.0696	-0.0278	-0.0338
		(0.1393)	(0.0626)	(0.0619)	(0.0706)
Foreign sales		-0.1207**	0.0437	0.0324	0.0801*
		(0.0601)	(0.0390)	(0.0357)	(0.0456)
Year FE	No	No	Yes	No	No
Industry-Year FE	No	No	No	Yes	No
State-Year FE	No	No	No	Yes	No
State-Industry-Year FE	No	No	No	No	Yes
Firm FE	No	No	Yes	Yes	Yes
N	28,721	27,926	27,537	26,291	19,944
R^2	0.017	0.431	0.931	0.942	0.955

Table 3
CDP reported carbon emissions and product fluidity

This table presents regression results of the relationship between product fluidity and disclosed carbon intensity, using data from the Carbon Disclosure Project (CDP). The dependent variable is *ln(Scope 1 intensity (CDP))*, measured by the natural logarithm of one plus the ratio of disclosed Scope 1 carbon emissions to revenue in millions of dollars from CDP. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
Fluidity	0.1963***	0.0752***	0.0165***
	(0.0322)	(0.0214)	(0.0060)
Controls	No	Yes	Yes
Year FE	No	No	Yes
Firm FE	No	No	Yes
N	4,532	4,518	4,399
R^2	0.064	0.615	0.980

Table 4
Carbon intensity and lagged product fluidity

This table presents regression results of the relationship between product fluidity in different periods and carbon intensity. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Fluidity(t)	0.0061*					0.0023
	(0.0031)					(0.0028)
Fluidity		0.0111***				0.0090***
		(0.0032)				(0.0022)
Fluidity(t-2)			0.0094***			0.0041*
			(0.0032)			(0.0022)
Fluidity(t-3)				0.0069**		0.0026
				(0.0035)		(0.0023)
Fluidity(t-4)					0.0049	0.0020
					(0.0038)	(0.0032)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	26,905	27,537	26,347	25,268	24,272	23,581
R^2	0.931	0.931	0.931	0.932	0.932	0.932

Table 5
Instrumenting product fluidity with FX and PSL

This table presents the IV regression results of the relationship between product fluidity and carbon intensity. *ln(Scope 1 intensity)* is the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. Δ *ln(FX)* is the growth rate of real trade-weighted state-level exchange rates. *PSL* is a dummy variable that equals one if a state adopts Paid Sick Leave mandates. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). Panel A is the regressions estimated with OLS. Panel B and Panel C are estimated with 2SLS and we instrument for *Fluidity* with Δ *ln(FX)* and *PSL*. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: FX and PSL – OLS regression

	Scope 1 intensity		
	(1)	(2)	(3)
Δ ln(FX) (t-2)	0.1391**		0.1329**
	(0.0670)		(0.0667)
PSL (t-2)		-0.1099***	-0.1032***
		(0.0358)	(0.0358)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	26,246	26,590	26,246
R^2	0.931	0.932	0.932

Panel B: First stage – FX and PSL

	Fluidity		
	(1)	(2)	(3)
Δ ln(FX) (t-2)	1.6980***		1.6745***
	(0.2567)		(0.2559)
PSL (t-2)		-0.3729***	-0.3966***
		(0.0902)	(0.0901)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	26,246	26,590	26,246
R^2	0.819	0.819	0.820

Panel C: Second stage – instrumented fluidity

	Scope 1 intensity		
	(1)	(2)	(3)
Fluidity	0.0819**	0.2947**	0.1993***
	(0.0411)	(0.1195)	(0.0692)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	26,246	26,590	26,246
R^2	-0.040	-0.839	-0.362
F-stat	43.762	17.102	29.651

Table 6
Climate opinions, political views, and lobbying

This table presents subsample regression results by local climate opinions and political views, as well as firm political lobbying. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). Panel A reports the regression results of the effect of product fluidity on carbon intensity by local climate opinions and political views. *Climate concern* is measured by the ratio of population who think corporations and industry should be doing more or much more to address global warming. *Republican vote* is measured by the ratio of residents in a county that vote for the Republican party in the Presidential election. Firms in counties with *Climate concern* or *Republican vote* above sample medians are classified as *High*, otherwise as *Low*. Panel B reports the regression results of the effect of product fluidity on carbon intensity by firm political lobbying. *Democratic* is measured by the Democratic-leaning lobbying expenses of Leippold et al. (2024). *Republican* is measured by the Republican-leaning lobbying expenses of Leippold et al. (2024). Firms with *Democratic* or *Republican* above sample medians each year are classified as *High*, otherwise as *Low*. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Local climate opinions and political views

	Climate concern		Republican vote	
	(1)	(2)	(3)	(4)
	High	Low	High	Low
Fluidity	0.0011	0.0163***	0.0097**	0.0092*
	(0.0050)	(0.0045)	(0.0045)	(0.0051)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	12,436	12,764	12,545	12,599
R^2	0.923	0.934	0.929	0.933
Diff. high-low	-0.0177	.	0.0006	.
p-value	0.0000	.	0.4360	.

Panel B: Firm political lobbying

	Democratic		Republican	
	(1) High	(2) Low	(3) High	(4) Low
Fluidity	0.0092	0.0160**	0.0162*	0.0061
	(0.0079)	(0.0076)	(0.0083)	(0.0073)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	3,074	3,920	3,452	3,562
R^2	0.959	0.953	0.956	0.959
Diff. high-low	-0.0068	.	0.0101	.
p-value	0.2120	.	0.1360	.

Table 7
Social norms

This table presents subsample regression results by social norms. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). *Social capital* is measured by the social capital index of Lin and Pursiainen (2022). *Volunteering* is measured by the ratio of Facebook users who are members of a group which is predicted to be about volunteering or activism based on group title and other group characteristics. *Sin industry* is measured by a dummy variable that equals one if a firm is sin industries (SIC codes: 2100-2199, 2080-2085; NAICS codes: 7132, 71312, 713210, 71329, 713290, 72112, and 721120). Firms with *Social capital* or *Volunteering* above sample medians each year are classified as *High*, otherwise as *Low*. Firms in the *Sin industry* are classified as *Yes*, otherwise as *No*. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Social capital		Volunteering		Sin industry	
	(1)	(2)	(3)	(4)	(5)	(6)
	High	Low	High	Low	Yes	No
Fluidity	0.0071	0.0159***	0.0066	0.0165***	0.0161***	0.0091**
	(0.0048)	(0.0046)	(0.0050)	(0.0046)	(0.0062)	(0.0039)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12,944	12,047	12,589	12,689	4,704	22,833
R^2	0.932	0.932	0.931	0.929	0.937	0.930
Diff. high-low	-0.0088	.	-0.0098	.	0.0070	.
p-value	0.0400	.	0.0080	.	0.1500	.

Table 8
Ownership and investor horizon

This table presents subsample regression results by ownership and investor horizon. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). *Inst. ownership* is measured by the ratio of shareholdings by all institutional investors to total shares outstanding. *Churn ratio* is measured by the weighted average churn ratio of Gaspar et al. (2005). *Adj. churn ratio* is measured by the adjusted weighted average churn ratio of Yan and Zhang (2009). *Transient ownership* is measured by the ratio of shareholdings of transient institutional investors to the total institutional ownership. Firms with *Inst. ownership*, *Churn ratio*, *Adj. churn ratio* or *Transient ownership* above sample medians each year are classified as *High*, otherwise as *Low*. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Inst. ownership		Churn ratio		Adj. churn ratio		Transient ownership	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High	Low	High	Low	High	Low	High	Low
Fluidity	0.0094*	0.0121***	0.0093**	0.0125***	0.0083*	0.0127***	0.0058	0.0123***
	(0.0048)	(0.0040)	(0.0044)	(0.0047)	(0.0045)	(0.0047)	(0.0045)	(0.0047)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	13,667	13,030	11,353	11,520	11,374	11,501	11,462	11,459
R^2	0.918	0.954	0.939	0.939	0.935	0.942	0.935	0.944
Diff. high-low	-0.0027	.	-0.0031	.	-0.0043	.	-0.0065	.
p-value	0.3000	.	0.3380	.	0.2400	.	0.1020	.

Table 9
Firm size, age, and total carbon emissions

This table presents subsample regression results by firm size, age, and total scope 1 emissions. The dependent variable is *ln(Scope 1 intensity)*, measured by the natural logarithm of one plus the ratio of Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). *Total assets* are the number of total assets. *Firm age* is the number of years since a firm first appeared in the CRSP monthly stock return files. *Total scope 1 emissions* are firm-level yearly emissions capturing absolute carbon output. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Total assets		Firm age		Total scope 1 emissions	
	(1)	(2)	(3)	(4)	(5)	(6)
	High	Low	High	Low	High	Low
Fluidity	0.0082*	0.0073**	0.0099**	0.0080*	0.0111**	0.0103***
	(0.0049)	(0.0031)	(0.0046)	(0.0043)	(0.0053)	(0.0037)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	14,013	13,248	13,490	13,466	12,379	11,887
R^2	0.946	0.931	0.941	0.932	0.938	0.858
Diff. high-low	0.0008	.	0.0019	.	0.0008	.
p-value	0.4120	.	0.3200	.	0.4620	.

Internet appendix

IA.1 CDP reported emissions and lagged product fluidity

Table IA.1 examines the relationship between product fluidity and carbon intensity using self-reported emissions data from the Carbon Disclosure Project (CDP), rather than the Trucost-based carbon intensity measures used in the main analyses. Specifically, we incorporate contemporaneous and multiple lagged measures of product fluidity to assess how competition in different periods relates to firms' current carbon emissions.

The results, reported in Table IA.1, are broadly consistent with those presented in Table 4. Across specifications, higher product fluidity is positively associated with greater carbon intensity, and the relationship remains robust when fluidity measures are lagged by one or more years. The one-year lagged fluidity again exhibits the strongest positive association with carbon intensity, suggesting that firms' emissions responses to increased competition may materialize with a short delay. These findings reinforce the evidence of a persistent and economically meaningful link between competitive pressure and corporate carbon emissions, and demonstrate that the results are not driven by the specific emissions data source.

Table IA.1
CDP reported emissions and lagged product fluidity

This table presents regression results of the relationship between product fluidity in different periods and carbon intensity, using data from the Carbon Disclosure Project (CDP), instead of the Trucost data we use for carbon intensity in other analyses. The dependent variable is *ln(Scope 1 intensity (CDP))*, measured by the natural logarithm of one plus the ratio of disclosed Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Fluidity(t)	0.0116**					0.0068
	(0.0053)					(0.0050)
Fluidity		0.0159***				0.0117**
		(0.0061)				(0.0049)
Fluidity(t-2)			0.0094			0.0011
			(0.0060)			(0.0044)
Fluidity(t-3)				0.0092		0.0023
				(0.0056)		(0.0045)
Fluidity(t-4)					0.0139***	0.0120***
					(0.0051)	(0.0043)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	4,606	4,638	4,579	4,523	4,461	4,404
R^2	0.978	0.978	0.978	0.978	0.978	0.978

IA.2 CDP reported emissions, climate opinions, and political views

Table IA.2 examines how public climate opinions and political views moderate the relationship between product fluidity and carbon intensity, using emissions data from the Carbon Disclosure Project (CDP) rather than the Trucost data employed in the main analyses. Columns (1) and (2) partition the sample based on county-level climate concern, measured as the share of the population in the firm's headquarter county who believe that corporations and industry should be doing more or much more to address global warming. Columns (3) and (4) partition the sample based on county-level political ideology, proxied by the share of residents voting for the Republican party in the most recent Presidential election.

The results are consistent with those presented in Table 6 using Trucost data. Specifically, we find that the positive association between product fluidity and carbon intensity is weaker in regions with higher public concern about climate change, suggesting that stronger societal expectations constrain firms' emissions responses to competition. In addition, firms headquartered in more politically conservative areas—measured by higher Republican vote shares—exhibit a stronger positive relationship between competition and carbon emissions, consistent with a less stringent regulatory and social environment. Overall, the findings confirm that the moderating role of public opinion and political ideology is robust to the use of an alternative emissions data source.

Table IA.2
CDP reported emissions, climate opinions, and political views

This table presents subsample regression results by local climate opinions and political views, using data from the Carbon Disclosure Project (CDP), instead of the Trucost data we use for carbon intensity in other analyses. The dependent variable is *ln(Scope 1 intensity (CDP))*, measured by the natural logarithm of one plus the ratio of disclosed Scope 1 carbon emissions to revenue in millions of dollars. *Fluidity* is the text-based product fluidity index of Hoberg et al. (2014). *Climate concern* is measured by the ratio of population who think corporations and industry should be doing more or much more to address global warming. *Republican vote* is measured by the ratio of residents in a county that vote for the Republican party in the Presidential election. Firms in counties with *Climate concern* or *Republican vote* above sample medians each year are classified as *High*, otherwise as *Low*. All variables are defined in Appendix A. All continuous variables are winsorized at the 1% level. Standard errors shown in parentheses are clustered by firm. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Climate concern		Republican vote	
	(1)	(2)	(3)	(4)
	High	Low	High	Low
Fluidity	-0.0092*	0.0289***	0.0296***	-0.0063
	(0.0055)	(0.0102)	(0.0112)	(0.0052)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	2,002	2,071	1,999	2,082
R^2	0.979	0.975	0.974	0.981
Diff. high-low	0.0208	.	0.0359	.
p-value	0.1320	.	0.0020	.