Firms' Carbon Emissions and Monetary Policy

Olena Havrylchyk* Pedram Pourabbasvafa†

First draft: July 2023 Revised: December 2024

Abstract

This paper examines the role of carbon bias in the transmission of monetary policy shocks in the U.S. and euro area between 2005 and 2022. We employ an event-study design and Jorda's (2005) local projections to estimate the effects on stock prices and firm investment, respectively. In regressions excluding firm- and industry-level controls, we find that carbon emissions intensity strengthens monetary policy transmission in the U.S., but not in the euro area. We identify three mechanisms driving this carbon bias: (1) carbon-intensive industries are more reactive to monetary policy shocks, which is likely driven by the U.S. shale oil and gas revolution; (2) a strong correlation between carbon emissions intensity and capital tangibility, the latter being known to strengthen monetary policy transmission in the U.S.; and (3) transition risk that reflects the amount of investment needed to transition to zero-carbon economy. These effects are not observed in the euro area, which we attribute to differing energy and mining sector dynamics.

JEL Classification: E22, E44, E52, L71, L72, Q54, Q58

Keywords: Monetary Policy Transmission, Carbon bias, Sustainable Finance, Energy, Intangible capital

1

*University of Paris 1 Panthéon-Sorbonne, Centre d'Economie de la Sorbonne, CNRS, olena.havrylchyk@univ-paris1.fr

†University of Paris 1 Panthéon-Sorbonne, Centre d'Economie de la Sorbonne, pedram.pourabbasvafa@univ-paris1.fr

[1]We thank Jean-Bernard Chatelain, Thomas Renault, Jean-stephane Mesonnier, Gunther Capelle-Blancard, Jézabel Couppey-Soubeyran and Jesse Grabowski for their feedback and comments. We also appreciate the invaluable comments from the participants of the seminars, conferences, and workshops such as the 5th and 6th International Conference on European Studies by Centre for European Studies, Banque de France, Riksbank of Sweden, 38th and 39th International Symposium on Money, Banking and Finance, and the 71st Congress of the French Economic Association.

This work has been funded by a French government subsidy managed by the Agence Nationale de la Recherche under the framework of the Investissements d'avenir programme reference ANR-17-EURE-001

1 Introduction

Despite the principle of market neutrality [2] being a cornerstone of monetary policy, growing evidence suggests that some unconventional central bank policies, such as corporate bond purchases, are skewed towards sectors characterized by high carbon emissions as these industries tend to issue bonds more frequently (Matikainen et al., 2017; Papoutsi et al., 2021). These findings imply that the market neutrality principle may perpetuate preexisting market failures and result in the misallocation of resources (Schnabel, 2021). As a consequence, the ECB, the BoE, and Riksbank have pledged to decarbonize their corporate bond purchases and holdings and to enhance their climate risk assessment, management, and modeling [3]. In contrast, while the Financial Stability Oversight Council in the U.S. has identified climate change as a threat to financial stability (FSOC, 2021), the discussion regarding its implications for monetary policy has been limited.

In this paper, we contribute to these discussions by exploring the existence of a carbon bias in the transmission of all monetary policy tools, including both conventional and unconventional approaches. We rely on an event study to analyze the influence of carbon emissions intensity on the transmission of the monetary policy shocks to stock prices. To measure the broader real economic impact, we additionally use Jorda's (2005) local projections to estimate the effects on firms' investments. Our sample is limited to firms for which we have carbon emissions data either disclosed by firms or estimated by Trucost. In total, our dataset covers 1671 publicly traded non-financial firms in the U.S. and 696 firms in the euro area for the 2005-2022 period.

We define carbon bias in monetary policy transmission as the phenomenon whereby firms with higher carbon emissions intensity exhibit greater sensitivity to monetary policy shocks. This definition is unconditional: it does not rely on a ceteris paribus assumption and does not control for firm- or industry-level characteristics. It instead captures the raw differential effect of monetary policy linked to emissions intensity. This is the concept most frequently employed—explicitly or implicitly—in policy discussions regarding the interaction between climate risk and monetary policy. Controlling for firm and industry characteristics is essential for identifying the economic channels through which carbon bias operates, which in turn can inform the design of policy tools.

We hypothesize that brown and green firms may react differently to monetary policy shocks through three channels: (1) an industry reactivity channel, (2) a tangibility channel, and (3) a transition risk channel. First, brown and green firms tend to operate in different industries, and prior literature has shown that some industries—such as those producing durable goods—are more sensitive to monetary policy shocks than others (Dedola and Lippi, 2005; Peersman and Smets, 2002). Second, we find that carbon emissions intensity is strongly correlated with capital tangibility. Döttling and Ratnovski (2023) show that monetary policy has a weaker effect on firms with more intangible capital, due to a weaker credit transmission channel. These earlier findings suggest that capital tangibility and industry affiliation may act as confounding factors in the analysis of carbon bias in monetary policy transmission.

If carbon bias persists after controlling for firm- and industry-level characteristics, we interpret it as evidence of transition risk. This third channel is in line with a contemporaneous study by Döttling and Lam (2024) who show that U.S. firms with higher Scope 1 emissions are more responsive to changes in monetary policy, possibly because large emitters require greater investment—and thus more external financing—for their green transition in order to comply with carbon regulation.

[2] We refer to 'market neutrality' in context of monetary policy not benefiting some firms more than others (Schnabel, 2021).

[3] For ECB: https://www.ecb.europa.eu/mopo/implement/app/html/ecb.faq_cspp_climate_change.en.html ; For BoE: https://www.bankofengland.co.uk/markets/greening-the-corporate-bond-purchase-scheme ; For Riksbank: https://www.riksbank.se/en-gb/markets/the-riksbanks-securities-holdings/corporate-bonds/

To identify the causal impact of monetary policy, our analysis relies on monetary policy shocks estimated by Gürkaynak, Sack, and Swanson (2005) for the U.S. and Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019) for the euro area. These monetary policy shocks are two-dimensional: the first dimension represents surprises to the current policy rate (referred to as target factor), while the second-dimension captures revisions to expectations of future interest rates up to a year, such as forward guidance (referred to as path factor). To ensure the robustness of our results, we rely on several alternative measures of monetary policy shocks developed by Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2021) for the U.S. and Jarociński and Karadi (2020) and Kerssenfischer (2022) for the euro area.

To measure firms' carbon intensity, we divide the sum of firms' Scope 1 and Scope 2 CO2-equivalent emissions[4] by their CPI-adjusted operating revenue. The carbon emissions data is provided by Trucost, widely used by central banks, investors, and in the academic literature (Aswani et al., 2023; Papoutsi, Piazzesi, and Schneider, 2021; Hengge, Panizza, and Varghese, 2023; Bolton and Kacperczyk, 2021, 2023). Trucost collects firms' disclosures of carbon emissions and estimates emissions for firms that fail to provide sufficient information or whose data quality is questionable. In light of findings of Aswani et al. (2023), which show that estimated and disclosed emissions might yield different findings, we present our results using both types of data.

We define capital tangibility as the ratio of tangible capital to total tangible and intangible capital. Tangible capital, reported on firms' balance sheets as net property, plant, and equipment, is straightforward to measure. However, measuring intangible capital presents challenges, as balance sheets typically record only acquired intangible assets. In contrast, the majority of intangible capital is internally generated by firms and is instead reflected in research and development (R&D) expenses. We follow the methodology of Peters and Taylor (2017) to calculate firm's stock of knowledge capital by applying perpetual inventory method and industry specific depreciation rates to R&D expenses and 30% of SG&A expenses. To the best of our knowledge, this study is the first to estimate intangible capital using this method for the euro area.

Our study provides several novel findings. We begin by demonstrating that, in a regression with firm and time fixed effects but without firm- and industry-level controls, carbon emissions intensify monetary policy transmission in the U.S., but not in the euro area. To quantify this carbon bias, an average target factor shock and an average path factor shock in the U.S. have, respectively, 3.6 and 4.1 basis points larger impact on a firm with one standard deviation higher carbon emission intensity. To contextualize the magnitude of this carbon bias, we compare it to the average market reaction to monetary policy shocks, which are 9.6 and 12.9 basis points for the target and path factor shocks, respectively. Thus, carbon bias amounts to 37% and 31% of the stock market reaction to the average target factor and path factor shocks, respectively.

To understand the economic mechanisms behind the above carbon bias in the U.S., we introduce sequentially firm- and industry-level control variables. While the introduction of controls for firm size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment have no impact on the significance and magnitude of the carbon bias, controlling for firm capital tangibility and the inclusion of industry-event fixed effects lead to the disappearance of the carbon bias. The impact of capital tangibility and industry-event fixed effects on our coefficient of interest is in line with our capital tangibility and industry reactivity channels.

Next, we analyze the three channels for this carbon bias in more detail. Starting with the industry reactivity chan-

[4]The greenhouse gas emissions are the seven gases mandated under the Kyoto Protocol and are to be included in national inventories under the United Nations Framework Convention on Climate Change (UNFCCC): carbon dioxide (CO2), methane (CH4), nitrous oxide (N2), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3). For ease of accounting, these gases are usually converted to and expressed as carbon dioxide equivalents (CO2e). For simplicity, we use the term "carbon emissions".

nel, we demonstrate that the carbon bias in the U.S. is driven by a strong correlation between the industry reactivity to monetary policy shocks, which impact the future interest rates (path factor), and the carbon emissions intensity of those industries. In particular, the energy extraction and mining industries, which are highly carbon-intensive, exhibit higher sensitivity to the path factor of the monetary policy. In contrast, no such correlation exists for the target factor in the U.S. or for both factors in the euro area. We attribute the difference between findings for the U.S. and the Euro area to the differences in their energy sectors dynamics. While our U.S. sample includes 66 energy extraction firms, the euro area sample consists of only 7 firms. During the study period, the U.S. emerged as the only country in the world to exploit and produce shale gas and oil on a large scale (Hu et al., 2019), which generated positive spillover effects on other sectors of the economy (Feyrer et al., 2017). Therefore, the observed carbon bias can be attributed to the strong demand conditions in the U.S. energy sector and the subsequent spillover effects on other energy-intensive sectors.

Given that the carbon bias is explained by the strong demand within the U.S. energy sector, an important follow-up question arises: has this economic environment also influenced the impact of the U.S. monetary policy on clean energy stock prices? To address this question, we construct an industry called Clean Energy which includes firms from the Wilder Hill Clean Energy Index (ECO). This index encompasses firms from different sectors such as energy and manufacturing that work towards the green transition, and it is widely used by the literature investigating renewable energy stocks (Bondia et al., 2016; Dutta, 2017, Ferrer et al. 2018). In contrast to our results for the fossil fuel energy industry, we do not find that monetary policy transmission is different for the clean energy firms.

Concerning the tangibility channel, we begin by identifying a strong positive correlation of 74% between firms' carbon emission intensity and capital tangibility in the U.S. Döttling and Ratnovski (2023) show that monetary policy has a smaller impact on intangible-intensive firms because intangible assets have little collateral value, limiting the effect of credit transmission channel of monetary policy. Consequently, it is unsurprising that capital tangibility acts as a confounding variable for carbon bias. In an approach similar to Döttling and Ratnovski (2023), we show that carbon bias is evident only for financially constrained firms, even after controlling for industry effects, and it disappears after controlling for firm capital tangibility. This carbon bias exists solely for the target factor, which is associated with the credit transmission channel. As for the euro area, we find a similar strong correlation of 64% between emission intensity and capital tangibility, but we do not find evidence of carbon bias. Replicating the findings of Döttling and Ratnovski (2023) for the euro area, we do not find that intangible capital weakens monetary policy transmission, which explains the absence of carbon bias in this region.

To explore transition risk, we focus on Scope 1 emissions because they are better suited to capturing a company's exposure to transition risk, as they are directly controlled by the company and reflect its investment needs to transition to a low-emissions regime (Döttling and Lam, 2023). In regressions with a full set of controls, we find that firms with higher emissions intensity are more reactive to monetary policy shocks that affect current interest rates (target factor), but this result holds only for the largest polluters in the U.S. This is not surprising, as the largest polluters are more likely to be subjected to carbon regulation and, hence, to transition risk. Surprisingly, we do not find evidence of transition risk in the euro area.

Importantly, our three channels of carbon bias respond differently to various dimensions of monetary policy shocks, i.e. the target or path factor. The capital tangibility channel and transition risk channel react to monetary policy shocks that shape current interest rates (target factor). This is expected, as this factor is more associated with the credit transmission channel. In contrast, industry channel appears to react to monetary policy shocks that shape future interest rates, such as forward guidance (path factor). This aligns with the literature that shows that conventional and unconventional monetary policies operate through different channels (Lhuissier and

Szczerbowicz, 2022).

Finally, we demonstrate that carbon emissions intensity affects monetary policy transmission to firms' investments over the 12-quarter period following a monetary policy shock. Using firm-level data and Jorda's (2005) local projections, we apply a step-by-step approach similar to the event-study methodology. We first estimate the carbon bias in a regression without firm- and industry-level control variables, then sequentially introduce different control variables. Conforming our stock market results, we show to carbon bias in the investment is driven by capital tangibility and industry reactivity channels.

Our paper is contemporaneous with other papers that explore the interaction between monetary policy and carbon emissions in the U.S. (Döttling and Lam, 2024) and the euro area (Bauer et al., 2024). A key difference in our analytical framework is the exploration of the industry reactivity channel and capital tangibility channel for the carbon bias, while other papers focus on transition risk. As a result, our empirical approach is different. We start by measuring carbon bias in regressions without control variables, because we believe that this definition of carbon bias is important for policymakers irrespective of firm characteristics. We then introduce control variables to capture different channels through which monetary policy interacts with carbon emissions. Furthermore, we show the importance of using two-factor monetary policy measures, as different channels operate via different monetary policy tools. There are also important differences in the variable definitions and sample construction, which lead to different findings. In contrast to Döttling and Lam (2024), we show that transition risk is only relevant for the largest carbon emitters. In contrast to Bauer et al. (2024), we do not find evidence for the carbon bias in the euro area.

Our paper contributes to the three strands of the academic literature. First, it adds to the discussion about the interaction between climate change and monetary policy (Chan et al., 2024; Krogstrup and Oman, 2019; ECB, 2021; Macaire and Naef, 2021; Drudi et al., 2021; Bank of England, 2021; McKibbin et al. 2021; Schoenmaker, 2021; Ferrari and Nispi Landi, 2021; Hansen, 2022). One sub-strand of the literature uses data to explore the impact of the monetary policy on green bonds (Tufail et al., 2024), renewable energy consumption (Akan, 2024) and carbon emissions (Wu et al., 2024). While some authors consider that monetary policy should play a supporting role for fiscal measures (Hansen, 2022, Coenen et al., 2024), other authors discuss alternative monetary policy measures such as dual interest rates (Chan et al., 2024) or green quantitative easing (Ferrari and Nispi Landi, 2021).

In terms of methodology, our paper follows the literature that shows that monetary policy produces heterogenous effects on firms depending on their size (Gertler and Gilchrist, 1994), age (Cloyne et al. 2018), Tobin's Q (Ehrmann and Franzscher, 2004), financial constraints (Ozdagli, 2017; Chava and Hsu, 2020; Maio, 2014), asset intangibility (Dôttling and Ratnovski, 2023), cash holding (Jeenas, 2019), bank dependence (Ippolito et al. 2018), debt structure (Gürkaynak et al. 2022), leverage, default risk (Ottonello and Winberry, 2020) and industry effects (Peersman and Smets, 2005; Dedola and Lippi, 2005; Choi et al., 2024). As mentioned earlier, our paper is closely related to Dôttling and Ratnovski (2023) who find that the investment and stock prices of firms with relatively more intangible assets respond less to the monetary policy. Their paper gave us an initial idea that "brown" firms might be more responsive to the monetary policy because they have more tangible assets.

Finally, our paper also relates to the emerging and growing literature about "carbon premium", that is higher stock returns for companies with higher carbon footprint because markets expect higher compensation for higher climate risks. To explore "carbon premium", several papers attempt to compare the stock market performance of "green" versus "brown" stocks (Aswani et al., 2023; Bauer et al., 2022; Bolton, and Kacperczyk, 2021; Bolton and Kacperczyk, 2022; Oestreich and Tsiakas, 2015). The results depend on the definition of "greenness" (log of total

carbon emissions versus emissions intensities), the quality of the data (vendor-estimated versus disclosed), and the level of data aggregation (individual stocks versus portfolios). Our choice to focus on carbon emissions intensities and to distinguish between disclosed and estimated data is motivated by Aswani et al. (2023). While it is not the focus of the paper, we do not find "carbon premium", at least on the days of the monetary policy announcements. Our paper contributes to this literature by focusing on the interaction between emissions intensities and monetary policy announcements. More generally, our paper relates to the literature that explores the relationship between stock prices and environmental performance (Hsu et al., 2022; Pastor et al., 2022; Hong et al., 2021; Pedersen et al., 2021).

The remainder of this paper is structured as follows. In section 2, we present our data and descriptive statistics, Section 3 presents our methodology, Section 4 presents our event-study findings for the U.S. and the euro area and shows robustness tests, Section 5 explores the economic mechanisms behind the carbon bias, Section 6 analyzes the response of firm investment in the U.S., and Section 7 concludes.

2 Data and descriptive statistics

We obtain quarterly data on firm financials and stock prices from Capital IQ provided by S&P Global. We start with the full universe of Trucost-covered firms based in the U.S. and the euro area and, then follow sampling procedures that are standard in the corporate finance literature. We exclude firms in the utilities (SIC 4900-4999), financials (SIC 6000-6999) and government (SIC 9000-9999) sectors. We exclude firm-event observations with NPPE below \$5 million[5], market capitalization below \$50 million, and stock price below \$1 where all data are deflated based on 2015 CPI. We also exclude firm-event observations with missing values for variables used in the regressions. We exclude firms for which we only have 1 year of emissions data. Finally, we winsorize leverage, Tobin's q, cash holding, cash flow, emissions intensity, capital tangibility, and regulatory risk variables by 0.5%. Furthermore, we winsorize stock returns per each event date by 1%. This process leaves us with a total of 1671 unique firms for the U.S. and 696 for the euro area.

2.1 Measuring emissions intensity

Our firm-level carbon emissions data comes from Trucost, a data provider which is a part of S&P Global. Trucost's data is annual, and its coverage begins in 2004. Trucost collects emissions data disclosed by firms and estimates it for other (but not all) firms when credible data is not disclosed by the firm. Emissions data covers three scopes. Scope 1 covers emissions from sources directly owned or controlled by the firm. Scope 2 covers emissions from the production of the energy that the firm purchases for its operations, such as electricity and steam. Scope 3 covers emissions from sources not owned or controlled by the firm such as supply chain emissions or emissions produced from the in-use phase of the firm's products and services. To measure a firm's emissions intensity, we compute the ratio of the firm's scope 1 and scope 2 GHG emissions to its CPI-adjusted operating revenue. Given that a firm's revenue is reasonably well correlated with its scale of operations, it has become a standard emissions normalizing factor. We don't use scope 3 emissions because its quality is questionable. Evidence shows that while the correlations between scope 1 and scope 2 emissions provided by different data sources are high, the correlation of scope 3 data is low (Busch et al. 2021, Papadopoulos 2022).

[5] This is done in line with Peters and Taylor's procedure.

Figure 1 presents the number of firms covered by Trucost in the U.S. and the euro area. The coverage has increased over time, particularly in 2016 following the Paris Agreement. [6] Figures 8 and 9 in appendix A show how the 2016 jump in firm coverage impacts the median values of emissions intensity, size, age, capital tangibility and regulatory risk in our sample for the U.S. and the euro area. These figures show that the firms that disclose emissions are bigger, older, have higher emissions intensity and a larger capital tangibility, and their regulatory risk increases more at the end of our sample period. Trucost has chosen to estimate emissions for smaller and younger firms that have lower emissions intensity, capital tangibility and regulatory risk.

The difference between firms that disclose emissions and those for which they are estimated has already been highlighted by Aswani et al. (2023). They document that estimated emissions are correlated with financial fundamentals and show that estimated and disclosed emissions might yield different findings. Consequently, we do our analysis with two samples that include 1) disclosed and estimated data together, to which we refer as complete sample, and 2) only the disclosed data. [7] However, if we find different results for different samples, this does not automatically suggest that the difference comes from the poor quality of estimated emissions. The difference in findings might suggest that results depend on firm characteristics, because absolute carbon emissions are higher for disclosed sample due to higher transparency requirements for largest emitters. To test this hypothesis, when using both disclosed and estimated data, we control for the share of voluntarily disclosed emissions data with a variable called "disclosure ratio".

2.2 Measuring capital tangibility

To construct capital tangibility, we compute the ratio of the firm's stock of tangible capital to the sum of its tangible and intangible capital.[8] A firm's stock of tangible capital is measured by its net property, plant, and equipment (NPPE) reported on its balance sheet. Measuring intangible capital is more challenging because the intangible capital item on a firm's balance sheet mostly reports the externally purchased intangible capital. As a consequence, this item captures only 3% (19%) of the total intangible capital for the median (mean) U.S. firm according to the calculations of Peters and Taylor (2017). The lion's share of a firm's stock of intangible capital is internally developed and is reported as expenditures under SG&A expenses and R&D expenses. These expenses include advertising expenses that build brand value, R&D expenses that result in patents and software, employee training that builds human capital, and so on.

Following Peters and Taylor (2017), we use a perpetual inventory method and industry-specific depreciation rates of Li and Hall (2016) to approximate a firm's total stock of intangible capital in a given quarter from its R&D expenses and 30% of its SG&A expenses in previous and current periods. The resulting stock of intangibles calculated from R&D expenses is referred to as knowledge capital and the intangibles calculated from SG&A expenses is referred to as organizational capital. The sum of balance sheet intangible capital, knowledge capital, and organizational capital make up a firm's total stock of intangible capital. To our knowledge, we are the first ones to calculate intangible capital for the publicly traded firms in the euro area using this method. For the universe of Trucost firms

[6] Nevertheless, the share of firms for which we have data on emissions is not large. Not considering our sampling procedure and not excluding financial and utility industries, Trucost has emissions data on 57% (2894 firms) of all publicly traded firms based in the U.S. in 2021, of which 18% (943 firms) voluntarily disclosed their emissions. In the euro area, Trucost has emissions data on 40% (1175 firms) of all publicly traded firms for 2021, of which 23% (684 firms) voluntarily disclosed their emissions.

[7] The voluntarily disclosed emissions are identified by excluding emissions that contain "estimate" in their scope 1 disclosure source or scope 2 disclosure source on Trucost.

[8] Our measure is the exact reverse of the "intangible ratio" variable of Döttling and Ratnovski (2023), who divide firm's stock of intangible capital to the sum of its tangible and intangible capital.

in 2005-2022 period, not excluding any firms based on our sampling procedure, we find that intangible capital on firm's balance sheet reports 43% (46%) of the total stock of intangible capital for the median (mean) U.S. firm and 40% (42%) of total stock of intangible capital for the median (mean) euro area firm.

2.3 Descriptive statistics

Table 1 reports definitions and data sources for variables used in our analysis. Tables 2 and 3 present descriptive statistics for our variables in the U.S. and the euro area respectively. We present descriptive statistics separately for green and brown firms where firms with emission intensity below the median per given year are classified as green and firms above the median are classified as brown. The F-statistics of ANOVA test reported in the last columns of Tables 2 and 3 indicate that there are significant differences between brown and green firms in terms of financial characteristics. Green firms are smaller and younger, have lower leverage, higher Tobin's q, higher cash holding, lower cash flow, and pay dividends less often. These are characteristics that are associated with stricter financial constraints. It's important to note that brown firms have a higher emissions disclosure ratio and larger regulatory risk both in the U.S. and the euro area.

The largest difference between brown and green firms is in terms of intangible and tangible capital. Capital tangibility in the U.S. and the euro area is more than twice for brown firms compared to green firms. The distribution of capital tangibility reported in Figure 2, shows that most green firms have extremely low tangibility ratios, while brown firms exhibit much more evenly distributed capital tangibility. By construction, this means that green firms have a much higher share of intangible capital. To illustrate the difference, firms in the lowest quantile of carbon emission intensity in our U.S. (euro area) sample hold on average 85% (83%) of their capital in form of intangible capital, while the same number is roughly 40% (40%) in the top quantile. Moreover, the correlation between disclosed emissions intensity and capital tangibility is 74% for and 64% in the U.S. and the euro area, respectively (Tables 4 and 5). If capital tangibility impacts monetary policy's transmission (as it has been shown in Döttling and Ratnovski, 2023), these strong correlations should have important implications for how monetary policy transmission interacts with carbon emissions. Moreover, Tobin's q has a mild but consistently negative correlation with both emission intensity and capital tangibility in the U.S. and the euro area for both the complete and the disclosed sample. This is in line with findings of Peters and Taylor (2017) who argue that Tobin's q calculated based on balance sheet assets will be systematically higher for firms with more intangible capital because their intangible capital is not reported on their balance sheets but is valued by the market nonetheless.

2.4 Measuring monetary policy shocks

In order to capture the causal impact of monetary policy, its changes have to be unexpected. This is challenging because markets formulate expectations about the central bank announcements and these expectations are incorporated in interest rates and stock prices before the actual announcement. For example, markets could expect a significant tightening of monetary stance due to an inflationary episode, and stock prices would decrease prior to the actual announcement. A lower-than-expected increase in interest rates would translate into an expansionary monetary policy shock where markets would respond with a rally. Hence, we need an exogenous measure of unexpected changes in monetary policy.

Recent literature offers several measures of monetary policy shocks that summarize all policy changes into one or two factor. The general idea is to measure the high-frequency changes in outcome variables such as interest rates

in a narrow window around the central banks' announcements. Our preferred measure of monetary shocks is provided by Gürkaynak, Sack, and Swanson (2005). This measure is two-dimensional: the first dimension, referred to as the target factor, captures the unexpected changes in the current month's Federal Funds Futures contracts similar to Kuttner (2001), while the second dimension, referred to as the path factor, summarizes the revisions to the expectations of the future interest rates up to a year. The path factor is orthogonal to the target factor, and it captures unconventional monetary policies such as forward guidance.

For the euro area, we use monetary policy shocks estimated by Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019). Similar to the US shocks, euro area monetary shocks are two-dimensional shocks. The target factor is the same, however, the path factor in the euro only includes information on the forward guidance component of monetary policy and excludes quantitative easing. We still refer to this as path factor, but we denote it as MP-FG.

To ensure the robustness of our results, we use several alternative measures of monetary policy shocks developed by Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2021) for the U.S. and Jarociński and Karadi (2020) and Kerssenfischer (2022) for the euro area.

Table 6 provides descriptive statistics and correlations for the monetary shock series used in this paper. The correlations between different measures are not very high and depend on the similarity of interest rate maturities used in the construction of the measures. For example, the correlation between MP-BRW and MP-GSS-Target is 0.24 because the former measure is based on interest rates with long maturities of up to 30 years while the latter captures the immediate changes to the policy rate. This indicates that different monetary policy shocks summarize information on different monetary policies in distinct ways. This encourages us to use the two factor shocks. Our decisions is confirmed by our findings because we show that capital tangibility and transition risk channels (discussed in Sections 5.2. and 5.3.) interact with the target factor, while the industry reactivity channel (Section 5.1.) interacts with path factor. This distinction is not possible when using single factor policy shocks.

3 Methodology

We use two methodologies. As our main method, we use an event-study method to measure the heterogeneity of changes in the stock prices of firms with different emissions intensities in response to the unanticipated component of monetary policy announcements by the Fed or the ECB during the days on which these announcements were made. This is a standard methodology that has been recently used by Ozdagli (2018), Gürkaynak et al. (2022), Chava and Hsu (2020), and Döttling and Ratnovski, (2023). Second, we use Jorda's (2005) local projections to measure the real effects of monetary policy changes on the investment of green and brown firms. This methodology is used in similar studies of monetary policy by Ottonello and Winberry (2020), Döttling and Ratnovski, (2023), and Cloyne et al. (2023).

3.1 Event-study

Our event-study method uses the following model specifications:

$$R_{i,t} = \alpha + \beta_1 \times \Delta MP_t \times GHG_{i,t} + \beta_2 \times \Delta MP_t \times X_{i,t} + \beta_3 \times GHG_{i,t} + \beta_4 \times X_{i,t} + \beta_5 \times \Delta MP_t + \phi_{SIC,t} + \mu_i + \epsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the stock return for firm i on central bank announcement date t, ΔMP_t is a vector containing target and path factor monetary policy shocks at announcement t, $GHG_{i,t}$ denotes the emissions intensity of firm i in the year prior to the announcement date t, and $X_{i,t}$ is a vector of firm-specific financial characteristics lagged to the quarter or the year prior to the monetary announcement depending on the frequency of the variable. The control variables, depending on the specification of the regression, include capital tangibility, log assets, log age, leverage, Tobin's q, cash holding, cash flow, dividend payment dummy and emissions disclosure ratio. μ_i and $\phi_{SIC,t}$, denote firm fixed effects and 4-digit SIC × event date fixed effects respectively.
Our coefficients of interest are given in the vector β_1. When these two coefficients are statistically significant, we interpret this as evidence of a carbon bias, meaning that carbon emissions intensity influences monetary policy transmission. A negative sign corresponds to the stronger transmission for firms with higher carbon emissions intensity.

We run different specifications of the above model. We start our analysis with a regression that excludes control variables and industry-time fixed effects. This allows us to capture the carbon bias, irrespective of mechanisms behind it. This variable is of interest for central bankers and other policymakers who care about how monetary policies interact with carbon emissions. Next, to understand the mechanisms behind the carbon bias, we add different control variables one at a time. In particular, we are interested in the confounding factors, such as capital tangibility or industry effects, captured by industry-event fixed effects, that might impact both emissions intensity and monetary policy transmission. Our final specification in equation (1) includes a full set of controls. If our variable of interest is still statistically significant in this complete specification, this would suggest the evidence of the transition risk.

3.2 Jorda's (2005) local projections

We use Jorda's (2005) local projections to measure the real effect of monetary policy changes on firms by analyzing the change in their investments net of depreciation in quarters following the policy shock. The model specification is as follows:

$$y_{i,t+h} - y_{i,t-1} = \beta_1^h \times \Delta MP_t \times GHG_{i,t-1} + \beta_2^h \times \Delta MP_t \times X_{i,t-1}^f + \beta_3^h \times X_{t-1}^m \times GHG_{i,t-1} + \beta_4^h \times X_{t-1}^m \times X_{i,t-1}^f + \beta_5^h \times GHG_{i,t-1} + \beta_6^h \times X_{i,t-1}^f + \alpha_i + \phi_{SIC,t} + \epsilon_{i,t} \tag{2}$$

where $h = \{1,2,3,4,5,6,7,8,9,10,11,12\}$ denotes the estimation time horizon, $y_{i,t+h}$ is log of the ratio of NPPE at time $t+h$ to total assets at time $t-1$ for the firm i, and $y_{i,t-1}$ is log of the ratio of NPPE at time $t-1$ to total assets at time $t-1$ for the firm i. The term $y_{i,t+h} - y_{i,t-1}$ is the cumulative investment net of depreciation between $t+h$ and $t-1$ by firm i standardized by its total assets at time $t-1$. The regressions include firm fixed effects (α_i), 4-digit SIC × event date fixed effects ($\phi_{SIC,t}$), the target factor monetary policy shocks (ΔMP_t) that are summed up to quarter level, emissions intensity ($GHG_{i,t-1}$), and a vector of firm-level variables $X_{i,t-1}^f$ which consists of log assets, log age, leverage, Tobin's q, cash holding, cash flow, dividend payment dummy, indicators for firm fiscal quarters, capital tangibility, and emissions disclosure ratio.

We also control for GDP growth in the previous quarter, denoted as ($X_{i,t-1}^m$), to control for the differences in cyclical sensitivities across firms. The inclusion of macroeconomic variables should have no impact on our results as monetary policy shocks are exogenously identified. Considering that we estimate the impact on NPPE in 12 quarters

ahead, we drop firm-quarter-year observations with missing outcome variable for h = 10 when running regressions for h < 10 to ensure a stable sample through different values of h. This limits our study period to the period between 2005 and 2021. We also winsorize the dependent variables by 1% per each quarter. Our coefficients of interest is β_1^h and we report it for each h in figures with 90% confidence intervals. The confidence intervals are based on standard errors that are two-way clustered at firm and quarter-year levels.

Similar to an event-study, we run different specifications of the above model, starting with a regression that excludes control variables and industry-time fixed effects to measure carbon bias, and then adding different control variables one at a time to understand its mechanisms. Our final specification that includes a full set of controls would allow us to capture transition risk.

4 Empirical findings

Our main event-study results are reported in Table 7 for the U.S. and Table 8 for the euro area. Panel A reports findings for the complete sample, while Panel B reports findings for the sample of firms that disclose carbon emissions data. We begin by estimating a specification in which we measure carbon bias without controlling for firm- and industry-level characteristics. The results, presented in Table 7, Column (1), provide clear evidence of carbon bias in the U.S. Specifically, the stock prices of firms with higher carbon emissions intensity are more reactive to the unexpected changes in monetary policy.

This carbon bias is not only statistically significant, but also economically relevant. Results for the full sample in panel A show that 1 standard deviation increase in emissions intensity is associated with a 3.6 basis points larger reaction to an average target factor shock and 4.1 basis points larger reaction to an average path factor shock. To contextualize the magnitude of this carbon bias, we compare it to the weighted average market reaction to monetary policy shocks, which are 9.6 and 12.9 basis points for the average target and average path factor shocks, respectively. Thus, the carbon bias amounts to 37% and 31% of the stock market reaction to the average target factor and path factor shocks, respectively.

In columns (2) – (9), we sequentially add interactions of monetary policy shocks with firm-level characteristic to test whether their inclusion influences the significance and magnitude of the carbon bias. Our findings indicate that carbon bias remains robust when we control for size, age, leverage, Tobin's q, dividend payments, cash holdings and flows.

However, in column (2), when we introduce capital tangibility as control, we observe a noticeable reduction in the size of the carbon bias, specifically for the target factor. This finding suggests that capital tangibility acts as a confounding variable in our analysis due to its strong correlation (65%) with emissions intensity and its influence on monetary policy transmission. This is expected because Döttling and Ratnovski (2023) have shown that capital tangibility strengthens monetary policy transmission in the U.S., while capital intangibility mutes its transmission. They attribute this finding to the credit channel of monetary policy and the insensitivity of intangible-intensive firms to this channel. While tangible assets are a good source of collateral, intangible capital is hard to use as collateral because it is hard to price, is rarely re-deployable in other firms in case of bankruptcy, and cannot be sold in case of default (Rampini and Viswanathan, 2013; Falato et al., 2020). Our results are consistent with Döttling and Ratnovski and we will explore this channel in the section 5.2. with more detail.[9]

[9] Another variable that has a similar but smaller impact is Tobin's q which is negatively correlated with both capital tangibility and emissions intensity (see correlations in Table 4 and the explanation given at the end of Section 2.3.).

In columns 12 and 13, we allow for the heterogenous industry reaction to monetary policy shocks. To this end, we add 4-digit SIC industry × event fixed effects. This inclusion leads to the disappearance of the carbon bias in both full and disclosed samples. This result suggest that the carbon bias observed in earlier specifications can be partially attributed to differences in industry-level sensitivity to monetary policy shocks, with more sensitive industries being disproportionately more carbon-intensive. This is consistent with the industry reactivity channel that we will explore in greater detail in the Section 5.1.

It is important to note that even though the significance of the coefficients of interests disappeares in columns (12) and (13) when accounting for industry effects, differences in industry reactivity do not explain fully the carbon bias we observe in column (1). Part of this carbon bias is linked to the capital tangibility and the transition risk channels, which become evident when we analyze subsamples of our data which we will discuss further in the Sections 5.2. and 5.3.

Next, we replicate this analysis for the euro area. The results, displayed in Table 8, differ sharply from those observed for the U.S. When monetary policy shocks are measured by target factor shocks, we find no evidence of carbon bias across all specifications. The interaction of emissions intensity with the path factor is positive and significant at 5%, but disappears when we control for Tobin's q in column 6. Tobin's q appears to act as a confounding variable that influences monetary policy transmission and is correlated with carbon emissions (see correlations in Table 5). This positive coefficient is also not robust across different time periods or other measures of monetary policy shocks. The coefficient might be influenced by the ECB's announcement to incorporate firms' climate performance in its asset purchase programs, because the coefficient becomes positive only after 2020[10]. The results are similar across Panel A and B for the full and disclosed sample in euro area.

4.1 Robustness

We test the robustness of our main results for the U.S. and report the results in Appendix B. We start by replacing scope 1+2 emissions intensity with separately scope 1 and scope 2 emissions intensities. These results are reported on Table 14 for the U.S. We confirm our baseline result of the carbon bias in the U.S., showing that it diminishes when we control for the interaction of capital tangibility with monetary policy shock, and disappears if we include industry-event fixed effects. There is one exception to these results which is when our dependent variable of is Scope 1: in the specification with all control variables and industry effects, the interaction between target factor of the monetary policy shock and carbon emissions intensity variable remains statistically significant. This finding is commonly interpreted in the literature as reflecting transition risk, a topic that we will explore further in in Section 5.3.

Second, we test the robustness of our results with alternative monetary policy shock measures in the U.S.: Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2021). Results are reported on Table 15 in Appendix B. Our results for the U.S. remain robust.

We do similar robustness tests for the euro area. Table 16 in Appendix B presents results separately for Scope 1 and Scope 2 emissions intensity and Table 17 presents results with alternative measures of monetary policy shocks, provided by Jarocinski and Karadi (2018) and Kerssenfischer (2022). These results show that the positive interaction between carbon emissions intensity and path factor that we reported in Table 8 is not robust. Relying

[10] Refer to https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1~f104919225.en.html

on alternative monetary policy shocks, the interaction between monetary policy shocks and carbon emissions intensity is statistically insignificance.

To summarize our results so far, our findings indicate that firms' carbon emissions intensity influences monetary policy transmission in the U.S., but not the euro area. In the U.S., we find robust evidence of carbon bias in monetary policy transmission when firm and industry characteristics are not controlled for. However, this bias diminishes when controlling for capital tangibility and disappears entirely when controlling for differences in industries' reactivities to monetary policy shocks. In contrast, we do not find robust evidence of a carbon bias in the euro area.

5 Mechanisms for monetary policy's carbon bias

In this section, we will attempt to understand why our results differ for the U.S. and the euro area by further exploring different mechanisms for the potential carbon bias: 1) industry reactivity channel; 2) capital tangibility channel; and 3) the transition risk channel.

5.1 Industry reactivity channel

Past literature has already shown that some industries are more reactive to monetary policy shocks than others. In particular, industries that produce durable goods or heavy industries are more reactive to monetary policy shocks because demand for these goods can be postponed and, hence, is more procyclical (Dedola and Lippi, 2005; Peersman and Smets, 2002).

In this section, we explore industry-specific heterogeneity in the reaction to monetary policy shocks to understand if industry sensitivity to monetary policy is correlated with that industry's carbon emissions intensity. Identifying such a correlation could explain why the inclusion of industry × event fixed effects eliminates the observed carbon bias in the U.S. To do so, we replace 4-digit SIC industry-event fixed effects in Column 13 with the interaction of 11 aggregated industry dummies with the two monetary policy shocks: the target factor and path factor. We then plot the estimated coefficients and 95% confidence intervals for these interaction terms in Figure 3, where the color of each industry corresponds to its average carbon emissions intensity ranging from the lowest (in services) to the highest (energy extraction and mining). The reference group of our industry dummies is services, which is the industry with the lowest carbon emissions. Additionally, we show the number of firms in each industry, which is important for result interpretation because there is large heterogeneity between industry sizes.

Our findings for the U.S., presented in Figure 3, suggest that energy extraction, non-energy mining, and petroleum refining and pipelines appear to be both emissions intensive and very reactive to path factor of the monetary policy shocks, in both complete and disclosed sample (Panels C and D). We rely on the aggregated industries to simplify visual presentation, but we also present more granular results at 2-digit SIC industry level in the Appendix C. These disaggregated results confirm our findings that industries in the energy sector (coal mining, oil and gas extraction, pipelines) and industries that are energy-intensive (metal and non-metallic mining) react on average stronger to the path factor of monetary policy shocks than industries that are less emissions intensive. We do not observe the same result for the target factor of the monetary policy shocks.

Our findings for the euro area, reported in Figure 4, differ significantly from those the U.S. sample. First, we do not find that energy and mining industries react differently to monetary policy shocks (both target and path factors)

than the greenest industry. Second, energy and mining industries in the euro area are much smaller than in the U.S. sample. While there are 66 energy extraction firms in the full U.S. sample, there are only 7 energy extraction firms in the euro area (Figure 4). Moreover, euro area firms have on average smaller emissions intensity than the U.S. firms (515 TCO2e / $ million vs of 939 TCO2e / $ million), which suggests that energy extraction firms operate differently in the euro area compared to the U.S.

The data suggests differing dynamics in the energy extraction firms of the U.S. and the euro area. This divergence is expected, as during the analyzed period, the U.S. has become the only country in the world to exploit and produce shale gas and oil on a large scale (Hu et al., 2019). The energy sector was designated as one of the 16 sectors critical to the national security (Presidential Policy Directive 21, 2013) and has benefited from the bipartisan support. Feyrer et al. (2017) demonstrates that the shale revolution significantly boosted revenues and employment in the mining sector, but also had positive spillovers on other sectors of the economy. Hence, our finding of carbon bias in the U.S. could be partly explained by the strong demand conditions due to shale revolution and spillover effects on other energy-intensive sectors.

To validate our visual observations for the U.S and the euro area, Table 9 reports correlations between the estimated coefficients for industry's reactivity to monetary policy shocks and three key variables: 1) emissions intensity, 2) capital tangibility and 3) emissions-intensity with a correlation coefficient that is weighted by number of firms in each industry. We first report the correlations across all industries and then exclude energy and mining industries to understand how much of the correlation is driven by these industries. Specifically, we exclude metal mining, coal mining, oil and gas extraction, mining and quarrying of nonmetallic minerals, and oil pipelines.

Table 9 shows that higher emissions intensity is associated with a more negative reaction to path factor monetary policy shocks at the industry level in the U.S., but not in the euro area. In the U.S., the correlation between industries reaction to the path factor and emissions intensity is -24% and it increases to -35% if industries' emissions intensity is weighted by number of firms. These correlations are surprisingly high, given that our industry reaction coefficients are derived from regressions that already control for emissions intensities (and all other firm-level controls). In contrast, in the euro area, the correlation between industry's reactivity to monetary policy and emissions intensity is slightly positive but small (6-7%). When we exclude energy and mining industries, the correlations in the U.S decline to -16 and -19%. This drop is large considering that only 9 out of 238 4-digit SIC industries are removed (6.9% of firm-event observations in our full sample). Importantly, these findings do not hold for target factor, which suggests that the industry reactivity channel operates solely through the path factor (i.e. forward guidance and quantitative easing).

We repeat the same exercise for correlations between industry reactivity to monetary policy shocks and capital tangibility. While weaker, our results in the U.S. suggest that industries with higher capital tangibility are more reactive to monetary policy shocks. The correlation declines when we exclude energy and mining sectors, which is expected because energy and mining industries have high ratios of capital tangibility (Figure 5). In contrast, in the euro area, correlations are either small or positive, reinforcing the observation that monetary policy transmission differs between the U.S. and the euro area.

5.1.1 Clean energy

Since the traditional energy sector is more reactive to monetary policy shocks, the natural follow-up question is about the reactivity of the clean energy sector. On the one hand, one might expect that this sector reacts in the

same way as the traditional energy sector. On the other hand, this sector is different because it's characterized by high levels of intangible assets, in contrast to the oil and gas extraction that has lots of tangible assets (Figure 5), which impacts monetary policy transmission. In the context of carbon transition, one might expect that the demand for clean energy is less cyclical than the demand for oil and gas extraction.

To explore this question, we construct an industry called Clean Energy which includes firms from the Wilder Hill Clean Energy Index (ECO) for the U.S. This index encompasses firms from different sectors such as manufacturing that work towards the green transition (renewable energy, batteries, electric cars, etc.), and it is widely used in the literature investigating renewable energy stocks (Bondia et al., 2016; Dutta, 2017, Ferrer et al. 2018)[11]. For the Euro area, we construct our own Clean Energy industry based on firm's description of their business on Capital IQ, where we select firms referring to green technologies such as solar panels, wind turbines, batteries, EVs and so on.

Our findings in Figure 4 show that the clean energy sector reacts differently to monetary policy shocks than fossil energy sector in the U.S. Compared to the reference sector, clean energy does not react differently to path factor of the monetary policy shocks, while fossil energy sector has a strong negative reaction. As to the target factor, clean energy has a larger reaction (albeit not significant in the sample of disclosed data), compared to the reference sector, while results for fossil energy sector are mixed. In other words, clean energy reacts somewhat negatively to short-term monetary policy shocks, while fossil fuel industry reacts strongly and negatively to forward guidance. This larger reactivity of Clean Energy to the target factor can indicate the sensitivity of this industry to the credit transmission channel of monetary policy due to its growing need for investment. For the euro area, the relationship between monetary policy shocks and clean energy is not statistically significant, but still demonstrates a similar pattern where the estimated insignificant coefficient for the reactivity of Clean Energy sector to the target factor is amongst largest.

To summarize our results for Section 5.1., we show that in the U.S., energy extraction and energy intensive industries are more responsive to the path factor of the monetary policy shocks, likely driven by the shale revolution. In contrast, no evidence of this relationship is found in the euro area, where energy and mining industries are significantly smaller.

5.2 Capital tangibility channel

In this section, we continue the exploration of the capital tangibility channel. Döttling and Ratnovski (2023) have shown that capital tangibility/intangibility interacts with monetary policy shocks due to the credit transmission channel of the monetary policy and the lack of collateral value in intangible assets. To test the hypothesis of credit channel, they show that their results are driven by financially constrained firms that are more reliant on collateral. Financial constraints are proxied by the firm size, size and age, and cash holdings.

Given strong correlation between emissions intensity and capital tangibility, the results of Döttling and Ratnovski (2023) imply that carbon bias might be stronger in the sample of financially constrained firms if we do not control of capital tangibility. To test this hypothesis, we follow Döttling and Ratnovski (2023) methodology and split our sample based on age, age and size, and cash holding to divide firms into financially constrained (below median for age and size, and above 3rd quantile for cash holdings) and unconstrained (above median for age and size, and below 3rd quantile for cash holdings). We run regressions based on equation 1 with full firm-level controls, firm

[11] Please note that we dropped firms operating in utilities in our sampling procedure, hence, some ECO index firms that operate in utilities sector are not included in our study.

fixed effects, and 4-digit SIC industry × event fixed effects. The results for the U.S. are reported in Table 10. Please, note that our study period in this section is limited to 2016-2022 because Trucost starts to cover the small and young (financially constrained) firms needed for our analysis only after the Paris Agreement in 2015.

Columns 2 and 5 of Table 10 in all three Panels replicate the results of Döttling and Ratnovski (2023) for our sample by showing that capital tangibility is only significant among firms that are small, young and have high cash holding. In other words, capital tangibility amplifies monetary policy's credit channel only for financially constrained firms. Furthermore, capital tangibility is statistically significant only when using target factor of the monetary policy shocks. This is in consistent with the approach of Döttling and Ratnovski (2023) who use the unexpected changes in 3-months ahead Fed Fund future rates in a 30-minutes window around FOMC announcement. The correlation of their monetary policy shock measure with target factor is 86% and with path factor is 50% in our study period.

Columns 1 and 4 in Table 10 exclude capital tangibility and include emissions intensity. As expected, the results of these specifications suggest that target factor's carbon bias is present only for financially constrained firms. Columns 3 and 6 of Table 10 show that if we control for both tangibility and emissions intensity in the same regression, the coefficient of emissions intensity weakens or disappears. This result suggests that capital tangibility acts as a confounding variable, confirming our hypothesis of capital tangibility channel.

The coefficient for Panel C column 1 is not statistically significant due to very conservatively clustered standard errors, however, the coefficient is still large and negative specially when compared to financially unconstrained firms in column 4. It is worth noting that the size of these coefficients in all Panels of Table 10, Specifically in Column 1, is made smaller by the presence of Tobin's q which is correlated with capital tangibility and removing Tobin's q will yield even larger carbon bias in target factor among financially constrained firms. Moreover, the role of capital tangibility in the carbon bias of the monetary policy is likely to be underestimated in our sample because carbon emissions information is available for more established firms and our sample might not be sufficiently representative of smaller and younger firms. This is evident when comparing our sample size (1671 unique firms) to Döttling and Ratnovski's sample size (9863 unique firms).

To test the sensitivity of our results to changes in thresholds that define financially constrained firms based on age, size, and cash holding, we estimate the coefficients for emissions intensity's interaction with target factor from columns 1, 3, 4 and 6 while moving the threshold. We report these coefficients in Appendix D. Our findings show that the choice of the threshold is important and the carbon bias in target factor monetary shocks becomes larger as we move towards more financially constrained sample (i.e. younger age, smaller size, and higher cash holdings) and does not exist for unconstrained firms. Moreover, carbon bias decreases in significance when controlling for capital tangibility.

Next, we replicate the above analysis for the euro area. Capital tangibility and emissions intensity are also strongly correlated in the euro area (60-64%), even though to a lesser extent than in the U.S. (see correlations in Table 5). However, we do not find support for the capital tangibility channel in the euro area. In our sample of firms for which we have carbon emissions data, we fail to replicate the results of Döttling and Ratnovski (2023) for the euro area (Columns 2 and 5 in Table 11). Specifically, we do not find that capital tangibility influences monetary policy transmission for firms with higher financial constraints (as measured by size, age, and cash holdings). Given this result, we do not have any reason to expect that carbon intensity would impact the monetary policy transmission (Columns 1 and 4) or that capital tangibility would serve as a confounding factor (Columns 3 and 6).

One reason we cannot replicate the findings of Döttling and Ratnovski (2023) for the euro area could be due to the smaller sample size that is restricted to large firms with available carbon emissions data. Döttling and Ratnovski

(2023) demonstrate that their results are significant primarily for financially constrained firms, which are generally smaller. To address this problem, we extend our euro area sample to include firms for which we do not have carbon emissions data, increasing the number of firms from 696 to 1456. Despite this extension, our results, presented in Appendix F, fail to replicate Döttling and Ratnovski (2023) for the euro area.

To summarize our results in this sub-section, we show that capital tangibility channel, observed in the U.S. sample, manifests only for financially constrained firms. This finding aligns with the credit channel of the monetary policy transmission. We do not find any evidence of capital tangibility channel in the euro area.

5.3 Transition risk

When all firm/time/industry characteristics are controlled for, the significance of the carbon emissions intensity variable is interpreted as a proxy for transition risk and higher transition risks can be associated with higher sensitivity to monetary policy because of the investment needs to transition to a low-emission regime. Döttling and Lam (2023) argue that Scope 1 emissions are better suited to capture a company's exposure to transition risk because they are directly controlled by the company and reflect their carbon-reducing investment needs. Indeed, changing Scope 2 emissions does not require any additional investment because a firm would just need to change the electricity provider. In our robustness tests in Table 14 of Appendix B, where we focus only on Scope 1 emissions in Panel B, we find evidence of transition risk in the sample of disclosed firms, but not in the full sample. There are two potential explanations for the difference in findings. First, disclosed sample includes larger emitters of carbon for which transition risks might be larger because regulators aim to reduce total emissions and, hence, design policies that target firms above certain thresholds. As a rule, markets and regulators require these larger firms to disclose their emissions. Second, the results might be influenced by the inferior quality of the estimated data.

To further explore the first explanation, we split our complete sample into firms with absolute carbon emissions above and below the median (on a per year-basis) and re-estimate our baseline regressions. Since there is no agreement in the literature if transition risk should be proxied by an absolute value of emissions (log of Scope 1 emissions) or emissions intensity (log of the ratio between Scope 1 emissions and revenue), we interact monetary policy shocks with both variables. In Table 12, Columns 1 and 3 report our findings for emissions intensity, while columns 2 and 4 present results for absolute value of emissions. We estimate results for the full 2005-2022 period (Panel A) and for the post-2015 period (Panel B), because Paris COP21 Agreement in 2015 is considered as a wake-up calls for financial markets.

Results in Table 12 suggest that transition risk enhances the transmission of the monetary policy shocks (negative sign of the interaction term), but only for firms with carbon emissions above the median in absolute terms. This is because carbon regulatory risk is targeted at largest emitters of carbon in absolute terms. Our findings are robust to both definitions of transition risk: emissions' intensity (columns 1 and 3) and absolute emissions (column 2 and 4). Our results are similar in the full period (Panel A) and in the post-2015 sample (Panel B), but the economic magnitude of the result appears to be larger after the Paris Agreement because the standard deviation of both emissions and emission intensity remains unchanged in both periods while the average target factor shock increases by 70%. As expected, transition risk does not enhance monetary policy transmission for firms whose carbon emissions are below the median in absolute term. If anything, we find a positive sign, but this result is not robust across specifications. We also find that transition risk interacts with unexpected changes in current policy rate (target factor)

but does not interact with the unconventional monetary policies such as forward guidance (path factor). This is consistent with the credit transmission channel that appears to work via target factor.

When we repeat the same exercise for the euro area in Table 13. We find that emissions intensity appears to influence monetary policy transmission in the sample for firms with carbon emissions below the median in absolute terms. But this effect is weakened in the period after 2015. We also find that absolute carbon emissions influence monetary policy transmission in the sample for firms with smaller carbon emissions. Taken together, these findings are difficult to interpret as evidence of transition risk, because transition risk should be larger for firms with larger absolute carbon emissions.

To delve deeper into transition risk, we mobilize an alternative measure for the transition risk, developed by Sautner et al. (2023). This variable measures the proportion of the firms' earnings call transcripts that discuss topics related to regulatory risks associated with the green transition (referred to as Regulatory Risk by Sautner et al. (2023)). Since this variable is zero for majority of observations, we use a four-quarter rolling average of this variable and then transform it to a binary indicator that takes value of 1 for positive values and 0 otherwise. This yields zero for 98.9% and 97.6% of event-firm observations in the U.S. and euro area respectively. This variable has low correlation with emissions intensity and capital tangibility as reported in Tables 4 and 5, however the correlation slightly increases towards the end of our sampling period as attention to climate change increases through time.

We re-estimate our baseline results by adding an interaction of monetary policy shocks with Regulatory Risk in Appendix E. We present results for Scope 1+2 emissions intensity (Panel A for the full sample and Panel B for the disclosed sample) and Scope 1 emissions intensity (Panel C for the complete sample and Panel D for the disclosed sample). Our findings show that the inclusion of regulatory risk dummy does not impact our baseline results.

Our results suggest that regulatory risk impacts monetary policy transmission in several specifications, but results differ for the U.S. and the euro area. In the U.S., the interactions between Regulatory risk and monetary policy shocks loses its significance when we introduce industry-event fixed effects. In the euro area, Regulatory risk is significant even in the specification with the full set of controls. The magnitude of findings is similar in four Panels. Interestingly, regulatory risk appears to strengthen the transmission of target factor monetary policy shocks, but weakens the transmission of path factor monetary policy shocks.

6 The impact of emissions intensity on the monetary policy transmission to firms' investment

In this section, we rely on Jorda's (2005) local projections (equation 2) to test whether carbon emissions intensity impacts monetary policy transmission to firms' investment in tangible capital. Figures 6 and 7 present our coefficient of interest – the interaction of emissions intensity with target factor for the complete sample and the sample of firms that disclose carbon data, respectively. We use the target factor because it encompasses the credit transmission channel of monetary policy that is associated with the firm's investment.

Our findings on the impact of monetary policy on real investments closely align with our previous findings for stock market reactions. In plot A, when we control only for firm fixed effects and event fixed effects, we find evidence of a carbon bias: investment by emissions-intensive firms is more reactive to monetary policy shocks. In Plot B, where we include all control variables except capital tangibility, the significance and magnitude of the carbon bias

remain unaffected. However, in Plot C, when we additionally control for capital tangibility, the carbon bias decreases substantially and becomes only weakly significant, indicating that capital tangibility acts as a confounding variable. In Plot D, we remove capital tangibility and replace event fixed effects with 4-digit SIC industry × event fixed effects. Under this specification, our results show that carbon bias is weakly significant in the short term, highlighting an important role of industry heterogeneity in the reaction to monetary policy shocks. Finally, in Plot E, which incorporates a full set of firm and industry controls, carbon bias becomes statistically insignificant and effectively zero.

To explore the key role played by capital tangibility, in plot F, we replicate the results of Döttling and Ratnovski (2023) for our sample. Consistent with their findings, firms with higher capital tangibility exhibit higher investment sensitivity in the reaction to monetary policy shocks. While the impact of carbon emissions intensity on the monetary policy transmission disappears when we control for capital tangibility and industry × event, the impact of capital tangibility survives even in the specification with a full set of controls. In light of high correlation between carbon intensity and capital tangibility, the exclusion of capital tangibility might bias the results. Figure 7 presents results for the subsample of firms that disclose carbon data. These findings corroborate our findings for the full sample, but confidence intervals are much larger due to the smaller sample size that declines from 1784 to 434 firms.

To summarize our findings on investment, we find a strong carbon bias in the transmission of the monetary policy, but it weakens when we control for capital tangibility and disappears when we account for heterogeneous industry reactions to monetary policy shocks.

7 Conclusions

In this paper, we show that monetary policy has a carbon bias in the U.S. but not in the euro area. Specifically, we find that in regressions that exclude firm- and industry-level controls, Scope 1 and 2 carbon emissions have a larger impact on the stock prices and investments in response to monetary policy shocks. We show that the size of this impact is large and robust.

We identify three mechanisms underlying the carbon bias in the U.S. monetary policy: 1) industry reactivity channel; 2) capital tangibility channel; and 3) transition risk channel. For the first channel, we find that in the U.S., emission-intensive industries – such as energy and mining – are more reactive to the monetary policy shocks that affect the expectations about the future interest rates (path factor). This increased reactivity is likely driven by the shale revolution in the U.S. Controlling for the interaction of monetary policy shocks and industry dummies renders carbon bias statistically insignificant for the path factor. In contrast, the energy and mining industry is much smaller in the euro area, which could explain the absence of similar results.

Secondly, we provide evidence that carbon bias exists due to very strong correlation between carbon emissions intensity and capital tangibility. If we control for capital tangibility, our carbon bias is reduced in the U.S., particularly for monetary policy shocks that affect current interest rates (target factor). This is expected because Döttling and Ratnovski (2023) have shown that capital tangibility strengthens monetary policy transmission in the U.S. We show that findings of Döttling and Ratnovski's (2023) cannot be replicated in the euro area, which explains the absence capital tangibility channel.

As for the third channel, we show that the U.S. monetary policy interacts with transition risk, particularly for the largest carbon emitters. Our analysis reveals that these firms are more reactive to current policy rate (target factor)

but not to unconventional monetary policies such as forward guidance (path factor). This is consistent with the credit transmission channel that appears to work via target factor. Surprisingly, we do not find the interaction of monetary policy and transition risk in the euro area.

From the methodological perspective, we highlight the importance of reliance on two-factor monetary policy shocks. In particular, we demonstrate that capital tangibility channel and transition risk channel operate via target factor shocks (current policy rates), while industry reactivity channel operates via path factor shocks (unconventional monetary policies that influence future policy rates).

Finally, our findings underscore the need for further research in the euro area, as the results observed in the U.S. cannot be replicated due to differences in industry composition and economic dynamics.

8 References

- Acosta, M., 2022. The Perceived Causes of Monetary Policy Surprises. Working paper. https://www.acostamiguel.com/papers/acosta_jmp.pdf
- Akan, T., 2024. The impact of monetary policy on climate change through the mediation of sectoral renewable energy consumption. Energy Policy, Volume 192, 114244
- Altavilla, C., Brugnolini, L., Gürkaynak R. S., Motto, R., Ragusa G., 2019. Measuring euro area monetary policy. Journal of Monetary Economics Volume 108, Pages 162-179
- Aswani, J., Raghunandan, A., Rajgopal, S., 2023. Are Carbon Emissions Associated with Stock Returns? Review of Finance, Volume 28, Issue 1, Pages 75–106,
- Bank of England, 2021. Options for greening the Bank of England's Corporate Bond Purchase Scheme, BoE Discussion Paper
- Bauer, M., Offner, E., Rudebusch, G. D., 2024. Green Stocks and Monetary Policy Shocks: Evidence from Europe, CESifo Working Paper Series No. 11552, Available at SSRN: https://ssrn.com/abstract=5068004 or http://dx.doi.org/10.2139/ssrn.5068004
- Bolton, P., & Kacperczyk, M. 2021. Do investors care about carbon risk?. Journal of financial economics, 142(2), 517-549.
- Bolton, P., and Kacperczyk, M., 2022. Global Pricing of Carbon-Transition Risk. Journal of Finance, forthcoming.
- Bolton, Patrick, Kacperczyk, Marcin, 2023. Are Carbon Emissions Associated with Stock Returns? Comment, Review of Finance. rfad019, https://doi.org/10.1093/rof/rfad019
- Bondia, R., Ghosh, S., Kanjilal, K., 2016. International crude oil prices and the stock prices of clean energy and technology companies: Evidence from non-linear cointegration tests with unknown structural breaks, Energy, Volume 101, Pages 558-565
- Bu, C., Rogers, J., Wu, W., 2021. A unified measure of Fed monetary policy shocks. Journal of Monetary Economics 118, 331–349. https://doi.org/10.1016/j.jmoneco.2020.11.002
- Chava, S., Hsu, A., 2020. Financial Constraints, Monetary Policy Shocks, and the Cross-Section of Equity Returns. The Review of Financial Studies 33, 4367–4402. https://doi.org/10.1093/rfs/hhz140
- Cloyne, J., Ferreira, C., Froemel, M., Surico, P., 2018. Monetary Policy, Corporate Finance and Investment, NBER working paper series. National Bureau of Economic Research, Cambridge, Mass.
- Coenen, G., Lazej, M., Romanos, P., 2024. Macroeconomic effects of carbon transition policies: An assessment based on the ECB's New Area-Wide Model with a disaggregated energy sector. European Economic

Review, Volume 167, 104798

- Dedola, L., Lippi, F., 2005. The monetary transmission mechanism: Evidence from the industries of five OECD countries. Eur. Econ. Rev. 49 (6), 1543–1569.
- Döttling, R., Lam, A., 2023. Monetary Policy, Carbon Transition Risk, and Firm Valuation. Available at SSRN: https://ssrn.com/abstract=4582767 or http://dx.doi.org/10.2139/ssrn.4582767
- Döttling, R., Ratnovski, L., 2023 Monetary policy and intangible investment. Journal of Monetary Economics Volume 134, Pages 53-72. https://doi.org/10.1016/j.jmoneco.2022.11.001
- Drudi, F., Moench, E., Holthausen, C., Weber, P.F., Ferrucci, G., Setzer, R., Adao, B., Dées, S., Alogoskoufis, S., Téllez, M., 2021. Climate change and monetary policy in the euro area. Occasional Paper Series 271, European Central Bank.
- Dutta, A., 2017. Oil price uncertainty and clean energy stock returns: New evidence from crude oil volatility index, Journal of Cleaner Production, Volume 164, Pages 1157-1166
- Ehrmann, M., & Fratzscher, M. 2004. Taking Stock: Monetary Policy Transmission to Equity Markets. Journal of Money, Credit and Banking, 36(4), 719–737. http://www.jstor.org/stable/3839039
- Ferrari, A., Landi, V. N., 2020. Whatever it takes to save the planet? Central banks and unconventional green policy. ECB Working Paper, No 2500
- Ferrer, R., Shahzad, S. J. H., López, R., Jareño, F., 2018. Time and frequency dynamics of connectedness between renewable energy stocks and crude oil prices, Energy Economics, Volume 76, Pages 1-20
- Feyrer, J., Mansur, E. T., & Sacerdote, B. 2017. Geographic Dispersion of Economic Shocks: Evidence from the Fracking Revolution. The American Economic Review, 107(4), 1313–1334.
- FSOC, 2021. Report on Climate-Related Financial Risk
- Gertler, M., Gilchrist, S., 1994. Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms*. The Quarterly Journal of Economics 109, 309–340. https://doi.org/10.2307/2118465
- Gürkaynak, R. S., Sack., B., Swanson, E., 2005. The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models. American Economic Review, vol. 95, no. 1, (pp. 425–436)
- Gürkaynak, R. S., Karasoy-Can, H. G., Lee, S. S., 2022. Stock market's assessment of monetary policy transmission: the cash flow effect. J. Financ. 77 (4), 2375–2421. https://doi.org/10.1111/jofi.13163.
- Hansen, L. P., 2022. Central banking challenges posed by uncertain climate change and natural disasters, Journal of Monetary Economics, Elsevier, vol. 125(C), pages 1-15.
- Hengge, M., Panizza, U., Varghese, R., 2023. Carbon Policy Surprises and Stock Returns: Signals from Financial Markets. IMF Working Paper, WP/23/13
- Hsu, P. H., Li, K., Chi-Yang, T., 2022. The Pollution Premium. Journal of Finance, Forthcoming , Available at SSRN: https://ssrn.com/abstract=3578215 or http://dx.doi.org/10.2139/ssrn.3578215
- Hu, Haiqing & Wei, Wei & Chang, Chun-Ping, 2019. "Do shale gas and oil productions move in convergence? An investigation using unit root tests with structural breaks," Economic Modelling, Elsevier, vol. 77(C), pages 21-33.
- Ippolito, F., Ozdagli, A.K., Perez-Orive, A., 2018. The transmission of monetary policy through bank lending: The floating rate channel. Journal of Monetary Economics 95, 49–71. https://doi.org/10.1016/j.jmoneco.2018.02.001
- Jarociński, M., Karadi, P., 2020. Deconstructing Monetary Policy Surprises— The Role of Information Shocks. American Economic Journal: Macroeconomics 12, 1–43. https://doi.org/10.1257/mac.20180090
- Jeenas, P., 2019, Monetary Policy Shocks, Financial Structure, and Firm Activity: A Panel Approach, Available

at SSRN: https://ssrn.com/abstract=3043579 or http://dx.doi.org/10.2139/ssrn.3043579

- Jordà, O., 2005. Estimation and Inference of Impulse Responses by Local Projections. American Economic Review, vol. 95, no. 1, (pp. 161–182)
- Kerssenfischer, M., 2022. Information effects of euro area monetary policy. Economics Letters, Volume 216, 110570
- Krogstrup, S., Oman, W., 2019. Macroeconomic and Financial Policies for Climate Change Mitigation: A Review of the Literature. IMF Working Papers 2019/185, International Monetary Fund
- Kuttner, K.N., 2001. Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. Journal of Monetary Economics, 47 (3), 523–544.
- Lhuissier, S., Szczerbowicz, U., 2022. Monetary Policy and Corporate Debt Structure. Volume 84, Issue 3, Pages 497-515
- Li, W. C. Y., Hall, B. H., 2016, Depreciation of Business R&D Capital,
- Matikainen, S., E. Campiglio, and D. Zenghelis, 2017. "The Climate Impact of Quantitative Easing," Grantham Research Institute on Climate Change and the Environment.
- Macaire, C., & Naef, A., 2021. Greening Monetary Policy: Evidence from the People's Bank of China. Working papers 812, Banque de France.
- Maio, P., 2014. Another Look at the Stock Return Response to Monetary Policy Actions, Review of Finance, Volume 18, Issue 1, Pages 321–371
- McKibbin, W.J., Morris, A.C., Wilcoxen, P.J., Panton, A.J., 2020. Climate change and monetary policy: issues for policy design and modelling. Oxford Review of Economic Policy 36, 579–603. https://doi.org/10.1093/oxrep/graa040
- Oestreich, A.M. and Tsiakas, I. 2015. Carbon Emissions and Stock Returns: Evidence from the EU Emissions Trading Scheme. Journal of Banking & Finance, 58, 294-308.
- Ottonello, P., Winberry, T., 2020, Financial Heterogeneity and the Investment Channel of Monetary Policy. Volume88, Issue6, Pages 2473-2502
- Ozdagli, A.K., 2017. Financial Frictions and the Stock Price Reaction to Monetary Policy. The Review of Financial Studies. https://doi.org/10.1093/rfs/hhx106
- Papoutsi, M., M. Piazzesi, and M. Schneider. 2021. How Unconventional Is Green Monetary Policy?. Stanford University working paper, Stanford, CA.
- Pastor, L., Stambaugh, R., and Taylor, L. 2022. Dissecting green returns. Journal of Financial Economics 146 (2), 403-424.
- Peersman, G., Smets, F., 2005. The Industry Effects of Monetary Policy in the Euro Area, The Economic Journal, Volume 115, Issue 503, Pages 319–342, https://doi.org/10.1111/j.1468-0297.2005.00991.x
- Pedersen, L. H., Fitzgibbons, S., Pomorski, L., 2021. Responsible investing: The ESG-efficient frontier. Journal of Financial Economics 142(2), 572-597.
- Peters, R.H., Taylor, L.A., 2017. Intangible capital and the investment-q relation. Journal of Financial Economics 123, 251–272. https://doi.org/10.1016/j.jfineco.2016.03.011
- Presidential Policy Directive, Presidential Policy Directive 21 – Critical Infrastructure Security and Resilience(Washington, DC: Office of the Press Secretary, White House, 2013).
- Sautner, Z., Lent, L. V., Vilkov, G., Zhang, R., 2023. Firm-Level Climate Change Exposure. Volume78, Issue3, Pages 1449-1498
- Schnabel, I. 2021. From market neutrality to market efficiency, speech given at the ECB DG-Research Symposium. Climate change, financial markets and green growth. 14 June.

- Schoenmaker, D. 2021. Greening monetary policy. Climate Policy, Taylor & Francis Journals, vol. 21(4), pages 581-592, April.
- Tufail, S., Alvi, S., Hoang, V., Wilson, C., 2024/ The effects of conventional and unconventional monetary policies of the US, EU, and China on global green investment, Energy Economics, Volume 134, June 2024, 107549
- Wu, J., Yang, C., Chen, L., 2024. Examining the non-linear effects of monetary policy on carbon emissions, Energy Economics, Volume 131, March 2024, 107206

Table 1: Variable Definition

Variable	Definition	Source
Log asset	Log of balance sheet total assets deflated by Consumer Price Index for the U.S. firms and Harmonized Index of Consumer Prices for the euro area firms	Capital IQ & FRED
Log age	Log of quarters since the earliest year observed among firm's establishment year, incorporation year, IPO year, and first year of observation in Compustat	Capital IQ, Compustat
Leverage	Ratio of total debt to total assets	Capital IQ
Tobin's q	(Market capitalization + Total assets - Total common equity) / Total assets	Capital IQ
Cash holding	The ratio of cash and cash equivalents to total assets	Capital IQ
Cash flow	Four quarter rolling sum of EBITDA divided by lagged total assets	Capital IQ
Dividend dummy	Binary variable indicating if a firm paid out dividend in a fiscal year	Capital IQ
Capital tangibility	The ratio of net property, plant, and equipment (NPPE) to the sum of NPPE and total intangible capital à la Peters and Taylor (2017)	Capital IQ
Regulatory Risk	Binary variable indicating if a firm discussed climate-regulation risk in previous four quarters' earnings calls, equals 1 if regulatory risk calculated by SVVZ is positive for any of the previous 4 quarter earning calls	Sautner, Van Lent, Vilkov, and Zhang (2023)
Log scope 1+2 intensity	Log of the ratio of scope 1 and scope 2 emissions to deflated operating revenue	Trucost & Capital IQ
Scope 1 intensity	Log of the ratio of scope 1 emissions to deflated operating revenue	Trucost & Capital IQ
Scope 2 intensity	Log of the ratio of scope 2 emissions to deflated operating revenue	Trucost & Capital IQ
Disclosure ratio	Share of scope 1 emissions that is disclosed by the firm	Trucost
Stock return	Log of event day's closing stock price minus log of the closing price from the day before	Capital IQ
Investment	Change in NPPE to total assets between two periods	Capital IQ
MP-GSS-Target & MP-GSS-Path	Two factor Monetary shocks of Gürkaynak, Sack, and Swanson (2005) where target factor contains unexpected changes to current federal funds rate and path factor contains revisions to the expectations of future rates up to 1 year	Miguel Acosta's personal website
MP-BRW	Monetary shocks of Bu, Rogers, and Wu (2021) that include information from full spectrum of interest rates up to 30 years	Wenbin Wu's personal website
MP-JK	Monetary shocks of Jarociński and Karadi (2020) that is the first principal component of interest rates up to 1 year for U.S. and Euro area	Marek Jarociński's personal website
MP-Target & MP-FG	Monetary shocks of Altavilla et al. (2019) constructed in the spirit of Gürkaynak, Sack, and Swanson (2005) with similar definition for target factor MP-Target, however, MP-FG indicates forward guidance factor which is similar to the path factor but are adjusted to exclude quantitative easing shocks	Martin Baumgärtner's hfdshocks package
MP-K	The Kerssenfischer (2022) shocks that are the intraday change in 2-year German bond yields around ECB Governing Council meetings	Mark Kerssenfischer's Website

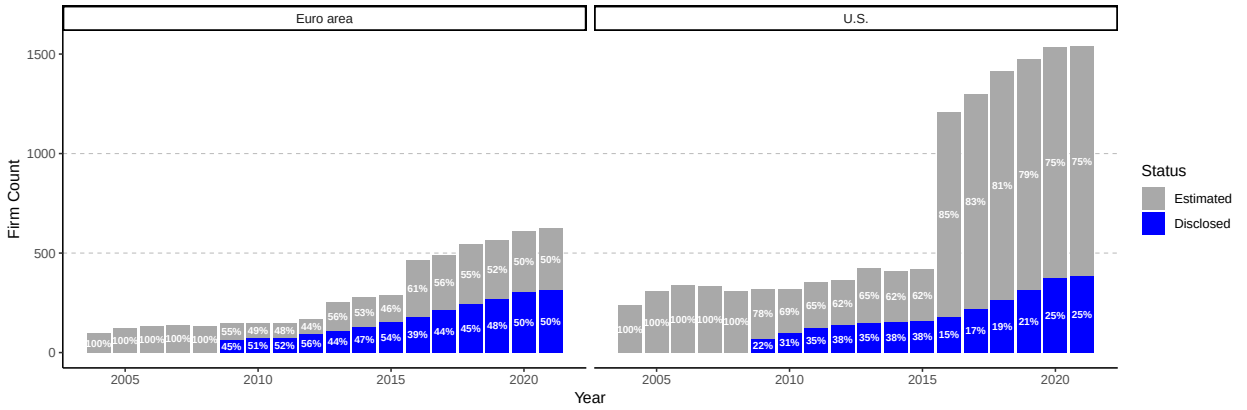


Figure 1: The Trucost sample size per year

This figure shows the number of firms with emissions data after data processing steps described in section 2. The colors indicate whether the emissions data is estimated by Trucost or disclosed by the firm.

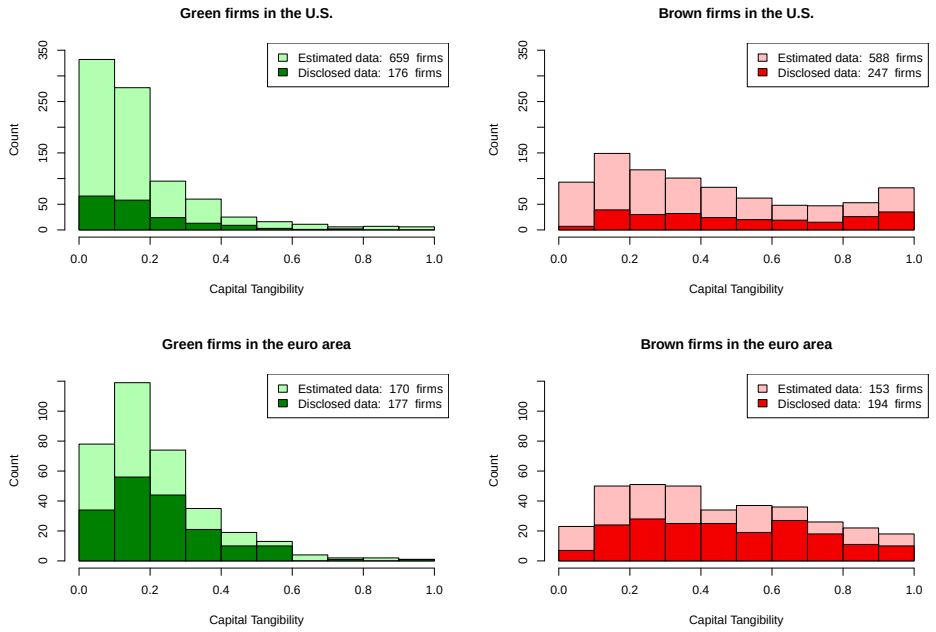


Figure 2: Histogram of capital tangibility for the green and brown firms in the U.S. [top] and Euro area [bottom]

Green (brown) refers to firms with average emission intensity below (above) the median for the 2005-2022 period. Capital tangibility is the ratio of tangible capital (NPPE) to the sum of tangible capital and intangible capital. Intangible capital refers to the sum of firm's knowledge capital, organizational capital, and balance sheet intangible capital estimated following Peters and Taylor (2017). Capital tangibility is averaged per firm for the 2005-2022 period.

Table 2: Summary Statistics, U.S. Firms

Panel A: Complete sample									
Type		Brown Firms				Green Firms			
Variable	N	Mean	SD	Median	N	Mean	SD	Median	Test
Scope 1 intensity	5850	261.46	1099.46	35.74	5843	10.67	7.47	9.5	F= 304***
Scope 2 intensity	5850	74.48	158.41	42.44	5843	14.01	7.45	12.89	F= 849***
Scope 1+2 intensity	5850	335.94	1160.86	88.02	5843	24.68	11.82	24.24	F= 420***
Scope 1	5850	2165.97	9850.41	108.66	5843	72.47	265.36	13.21	F= 263***
Disclosure ratio	5850	33.95	46.96	0	5843	26.52	43.05	0	F= 79***
Log asset	23391	14.91	1.68	14.87	23352	14.75	1.72	14.66	F= 114***
Log age	23391	5.25	0.84	5.31	23352	4.96	0.81	4.92	F= 1459***
Leverage	23391	0.31	0.22	0.29	23352	0.27	0.22	0.24	F= 491***
Tobin's q	23391	2.11	1.58	1.62	23352	2.9	2.3	2.12	F= 1868***
Cash holding	23391	0.1	0.12	0.06	23352	0.15	0.14	0.11	F= 1509***
Cash flow	23391	0.12	0.14	0.13	23352	0.1	0.16	0.11	F= 267***
Dividend dummy	5850	0.59	0.49	1	5843	0.43	0.5	0	F= 286***
Capital tangibility	23391	0.46	0.3	0.4	23352	0.19	0.18	0.13	F= 14037***
Regulatory risk	20612	0.02	0.12	0	20915	0.01	0.08	0	F= 86***
Stock returns	45944	0.28	2.89	0.11	45867	0.34	2.72	0.16	F= 8.15**
Panel B: Disclosed sample									
Scope 1 intensity	1236	489.69	1738.23	130.63	1231	7.09	7.23	4.61	F= 94***
Scope 2 intensity	1236	143.03	307.65	62.9	1231	16.15	10.58	14.06	F= 209***
Scope 1+2 intensity	1236	632.72	1870.11	256.06	1231	23.24	13.83	21.44	F= 130***
Scope 1	1236	5941.33	16809.46	785.54	1231	186.43	591.93	38.09	F= 144***
Disclosure ratio	1236	98.63	7.64	100	1231	93.2	18.85	100	F= 88***
Log asset	4955	16.31	1.34	16.43	4934	16.36	1.42	16.18	F= 2.19
Log age	4955	5.6	0.75	5.8	4934	5.33	0.79	5.33	F= 291***
Leverage	4955	0.33	0.16	0.31	4934	0.31	0.18	0.29	F= 53.7***
Tobin's q	4955	1.81	0.99	1.5	4934	2.92	1.89	2.32	F= 1343***
Cash holding	4955	0.07	0.06	0.06	4934	0.12	0.09	0.09	F= 855***
Cash flow	4955	0.13	0.08	0.13	4934	0.16	0.09	0.15	F= 162***
Dividend dummy	1236	0.77	0.42	1	1231	0.68	0.47	1	F= 22.6***
Capital tangibility	4955	0.56	0.29	0.57	4934	0.2	0.16	0.14	F= 5704***
Regulatory risk	4674	0.03	0.17	0	4815	0.01	0.12	0	F= 23.9***
Stock returns	9753	0.20	2.58	0.09	9709	0.18	2.20	0.06	F= 0.86

This table reports the descriptive statistics for firm-year and firm-quarter variables of the U.S. firms. The firms with emission intensity below (above) the median in each year are classified as 'green' ('brown'). The Test column reports the F-statistic from ANOVA test between the two groups. The number of observations for each variable corresponds to the frequency of that variable. Variable definitions are provided in Table 1.

Table 3: Summary Statistics, Euro Area Firms

Panel A: Complete sample									
Type		Brown Firms				Green Firms			
Variable	N	Mean	SD	Median	N	Mean	SD	Median	Test
Scope 1 intensity	2410	456.71	1182.8	58.87	2403	10.69	8.46	8.68	F= 341***
Scope 2 intensity	2410	100.4	219.97	48.33	2403	13.52	8.78	12.17	F= 374***
Scope 1+2 intensity	2410	557.11	1276.27	113.39	2403	24.22	13.26	22.07	F= 418***
Scope 1	2410	4091.71	16369.42	167.98	2403	77.58	244.25	12.27	F= 144***
Disclosure ratio	2410	61.76	47.29	98.45	2403	51.96	46.94	74.15	F= 52***
Log asset	9807	14.99	1.72	14.98	9771	14.82	1.75	14.72	F= 47.4***
Log age	9807	5.47	0.92	5.62	9771	5.31	0.87	5.32	F= 139***
Leverage	9807	0.28	0.15	0.27	9771	0.24	0.17	0.22	F= 284***
Tobin's q	9807	1.59	1.04	1.28	9771	2.06	1.38	1.6	F= 711***
Cash holding	9807	0.11	0.11	0.08	9771	0.13	0.11	0.1	F= 120***
Cashflow	9807	0.11	0.09	0.1	9771	0.12	0.09	0.11	F= 150***
Dividend dummy	2410	0.77	0.42	1	2403	0.81	0.39	1	F= 12.06***
Capial tangibility	9807	0.47	0.26	0.44	9771	0.22	0.18	0.17	F= 5764***
Regulatory risk	5604	0.03	0.18	0	6011	0.01	0.11	0	F= 68.8***
Stock returns	22224	-0.15	2.60	0	22118	-0.16	2.51	0	F= 0.24
Panel B: Disclosed sample									
Scope 1 intensity	1018	564.78	1383.24	72.03	1012	9.38	9.16	6.42	F= 163***
Scope 2 intensity	1018	129.28	195.76	55.86	1012	12.89	10.2	10.1	F= 356***
Scope 1+2 intensity	1018	694.06	1485.53	149.28	1012	22.28	13.77	20.43	F= 206***
Scope 1	1018	5862.18	19884.17	427.6	1012	119.79	347.8	19.17	F= 84***
Disclosure ratio	1018	97.81	8.94	99.98	1012	90.57	20.34	100	F= 108***
Log asset	4188	15.75	1.49	15.74	4164	15.48	1.56	15.29	F= 63.7***
Log age	4188	5.63	0.93	5.95	4164	5.55	0.75	5.67	F= 16.45***
Leverage	4188	0.3	0.13	0.29	4164	0.24	0.16	0.23	F= 289***
Tobin's q	4188	1.35	0.56	1.19	4164	1.98	1.2	1.56	F= 943***
Cash holding	4188	0.09	0.06	0.08	4164	0.12	0.09	0.09	F= 217***
Cashflow	4188	0.1	0.06	0.1	4164	0.12	0.07	0.11	F= 116***
Dividend dummy	1018	0.83	0.38	1	1012	0.87	0.34	1	F= 7.16***
Capial tangibility	4188	0.49	0.24	0.47	4164	0.23	0.18	0.18	F= 3164***
Regulatory risk	2952	0.04	0.21	0	3200	0.02	0.13	0	F= 41.2***
Stock return	9111	-0.15	2.58	0	9056	-0.14	2.54	0.02	F= 0.04

This table reports the descriptive statistics for firm-year and firm-quarter variables of the Euro firms. The firms with emission intensity below (above) the median in each year are classified as 'green' ('brown'). The Test column reports the F-statistic from ANOVA test between the two groups. The number of observations for each variable corresponds to the frequency of that variable. Variable definitions are provided in Table 1.

Table 4: Variable Correlations, U.S. Firms

	Log scope 1+2 intensity	Log scope 1 intensity	Log scope 2 intensity	Log scope 1	Log assets	Log age	Leverage	Tobin q	Cash flow	Cash holding	Dividend dummy	Disclosure ratio	Regulatory risk
Panel A: Complete sample													
Log scope 1 intensity	0.93												
Log scope 2 intensity	0.73	0.54											
Log scope 1	0.64	0.65	0.37										
Log assets	0.08	0.02	0.03	0.69									
Log age	0.17	0.16	0.15	0.42	0.34								
Leverage	0.09	0.05	0.11	0.12	0.15	0.05							
Tobin's q	-0.25	-0.22	-0.19	-0.28	-0.18	-0.21	-0.06						
Cash flow	0.07	0.06	0.05	0.44	0.35	0.3	-0.04	0.03					
Cash holding	-0.21	-0.2	-0.14	-0.46	-0.38	-0.32	-0.19	0.35	-0.36				
Dividend dummy	0.17	0.14	0.14	0.43	0.39	0.48	0.02	-0.15	0.33	-0.27			
Disclosure ratio	0.15	0.04	0.1	0.4	0.55	0.29	0.08	-0.08	0.17	-0.17	0.3		
Regulatory risk	0.09	0.09	0.05	0.07	0.03	0.04	0.01	-0.02	0.01	-0.02	0.03	0.06	
Capital tangibility	0.65	0.59	0.41	0.51	0.18	0.09	0.1	-0.21	0.2	-0.25	0.16	0.15	0.09
Panel B: Disclosed sample													
Log scope 1 intensity	0.93												
Log scope 2 intensity	0.7	0.53											
Log scope 1	0.76	0.85	0.39										
Log assets	0.02	0.04	-0.06	0.51									
Log age	0.15	0.23	0.13	0.3	0.12								
Leverage	0.09	0.12	0.09	0.1	0.03	0.08							
Tobin's q	-0.4	-0.38	-0.27	-0.36	-0.07	-0.16	0.03						
Cash flow	-0.11	-0.09	-0.05	0.02	0.08	0.02	-0.05	0.46					
Cash holding	-0.3	-0.35	-0.19	-0.41	-0.21	-0.23	-0.1	0.31	0.07				
Dividend dummy	0.08	0.14	0.08	0.31	0.3	0.37	0.04	-0.08	0.19	-0.19			
Regulatory risk	0.11	0.11	0.04	0.08	0.01	0.04	0.02	-0.03	-0.01	0	0.02		
Capital tangibility	0.74	0.69	0.39	0.63	0.1	0.01	0.06	-0.3	-0.03	-0.21	0.07		0.12

This table reports the Pearson's correlation coefficients across key variables used in this study. Panel A reports correlations for complete sample of U.S. firms and Panel B reports the correlations for disclosed sample.

Table 5: Variable Correlations, Euro Area Firms

	Log scope 1+2 intensity	Log scope 1 intensity	Log scope 2 intensity	Log scope 1	Log assets	Log age	Leverage	Tobin q	Cash flow	Cash holding	Dividend dummy	Disclosure ratio	Regulatory risk
Panel A: Complete sample													
Log scope 1 intensity	0.93												
Log scope 2 intensity	0.73	0.55											
Log scope 1	0.7	0.74	0.38										
Log assets	0.1	0.08	0.02	0.67									
Log age	0.09	0.1	0.08	0.29	0.29								
Tobin q	-0.23	-0.23	-0.13	-0.31	-0.24	-0.13	-0.2						
Cash flow	-0.06	-0.1	-0.01	0.03	0.02	0.07	-0.13	0.4					
Cash holding	-0.1	-0.09	-0.08	-0.34	-0.35	-0.21	-0.21	0.34	-0.1				
Dividend dummy	-0.03	-0.03	0	0.21	0.27	0.29	-0.12	-0.01	0.31	-0.25			
Disclosure ratio	0.13	0.08	0.06	0.37	0.49	0.27	0.1	-0.21	-0.03	-0.21	0.19		
Regulatory risk	0.12	0.12	0.05	0.13	0.08	0.04	0.04	-0.04	-0.01	-0.02	0.01	0.05	
Capital tangibility	0.6	0.55	0.38	0.46	0.14	0	0.26	-0.22	0.04	-0.15	0.02	0.18	0.1
Panel B: Disclosed sample													
Log scope 1 intensity	0.93												
Log scope 2 intensity	0.74	0.54											
Log scope 1	0.75	0.83	0.43										
Log assets	0.1	0.1	0.03	0.6									
Log age	0.09	0.12	0.07	0.2	0.15								
Leverage	0.21	0.14	0.2	0.13	0.16	-0.08							
Tobin's q	-0.33	-0.34	-0.21	-0.37	-0.19	-0.06	-0.21						
Cash flow	-0.12	-0.19	-0.02	-0.16	-0.1	-0.05	-0.16	0.53					
Cash holding	-0.14	-0.14	-0.15	-0.24	-0.21	-0.12	-0.13	0.33	0.11				
Dividend dummy	-0.06	-0.07	0.01	0.08	0.17	0.19	-0.15	0.07	0.24	-0.16			
Regulatory risk	0.14	0.15	0.05	0.15	0.08	0.03	0.04	-0.05	-0.02	-0.01	0		
Capital tangibility	0.64	0.58	0.41	0.46	0.05	-0.12	0.23	-0.22	-0.01	-0.08	-0.1		0.12

This table reports the Pearson's correlation coefficients across key variables used in this study. Panel A reports correlations for complete sample of Euro Area firms and Panel B reports the correlations for disclosed sample.

Table 6: Descriptive Statistics: Monetary Policy Shocks

Panel A: Fed Monetary Policy Shocks

	N	Mean	Median	SD	1st Q	3rd Q	Min	Max	MP-GSS-Path	MP-BRW	MP-JK
MP-GSS-Target	142	0.0001	0.0022	0.0306	-0.0025	0.0068	-0.1887	0.1222	0.06	0.25	0.66
MP-GSS-Path	142	0.0010	0.0024	0.0488	-0.0180	0.0200	-0.1465	0.1877		0.42	0.78
MP-BRW	142	-0.0038	-0.0055	0.0555	-0.0327	0.0275	-0.2087	0.2091			0.47
MP-JK	142	-0.0048	0.0000	0.0528	-0.0179	0.0137	-0.2463	0.1049			

Panel B: European Central Bank Monetary Policy Shocks

	N	Mean	Median	SD	1st Q	3rd Q	Min	Max	MP-FG	MP-JK	MP-K
MP-Target	183	-0.1293	-0.2966	2.2324	-0.5414	0.1175	-13.747	11.323	0.05	0.60	0.15
MP-FG	181	-0.0300	-0.1150	3.7266	-1.3282	1.0721	-25.726	14.366		0.43	0.75
MP-JK	184	0.0012	-0.0005	0.0416	-0.0088	0.0102	-0.1614	0.2002			0.73
MP-K	184	0.0005	-0.0033	0.0416	-0.0202	0.0141	-0.2580	0.2611			

This table reports the descriptive statistics and Pearson's correlation coefficients for monetary policy shocks used in this study. Panel A provides information on U.S. monetary policy shocks. MP-BRW denotes the monetary policy shocks provided by Bu, Rogers, and Wu (2021). MP-JK denotes the monetary policy shocks of Jarociński and Karadi (2018). MP-GSS-Target and MP-GSS-Path are the Target factor and Path factor of Gürkaynak, Sack, and Swanson (2005). Both MP-NS and MP-GSS are provided by Acosta (2023).
Panel B provides information on the European Central Bank's monetary policy shocks. MP-JK denotes the monetary policy shocks of Jarociński and Karadi (2018) and MP-K denotes shocks of Kerssenfischer (2022). MP-Target and MP-FG are the Target factor and Forward Guidance factor from Altavilla et al. (2019). Both Fed and ECB shocks cover the 2005-2022 period.

Table 7: Main results: Stock return reactions to monetary policy shocks across firms with different carbon emission intensities in the U.S.

	Dependent variable:												
Panel A: Complete sample	Stock returns on FOMC meeting day												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Log scope 1+2 intensity	0.044	0.043*	0.043	0.041	0.044	0.039	0.043	0.038	0.041	0.033	0.032	0.051*	0.050*
	(0.027)	(0.026)	(0.027)	(0.025)	(0.027)	(0.027)	(0.026)	(0.025)	(0.026)	(0.024)	(0.024)	(0.026)	(0.026)
MP-GSS-Target : Log scope 1+2 intensity	−1.980**	−1.141**	−1.969**	−2.038**	−2.012**	−1.701**	−1.871**	−1.977**	−1.958**	−1.645**	−0.993**	−0.817	−0.367
	(0.976)	(0.473)	(0.977)	(0.980)	(0.948)	(0.844)	(0.882)	(0.960)	(0.979)	(0.799)	(0.450)	(0.540)	(0.427)
MP-GSS-Path : Log scope 1+2 intensity	−1.012***	−0.768***	−1.032***	−0.947***	−1.009***	−0.777***	−0.898***	−0.984***	−0.945***	−0.686**	−0.586**	0.214	0.295
	(0.347)	(0.236)	(0.357)	(0.319)	(0.344)	(0.262)	(0.299)	(0.334)	(0.323)	(0.270)	(0.247)	(0.353)	(0.369)
MP-GSS-Target : Capital tangibility		−5.690									−4.446		−7.272**
		(4.575)									(3.804)		(3.427)
MP-GSS-Path : Capital tangibility		−1.766									−0.700		−1.365
		(2.005)									(1.411)		(1.285)
MP-GSS-Path : Log asset			0.267							0.652	0.765	0.437	0.445
			(0.449)							(0.471)	(0.525)	(0.520)	(0.518)
MP-GSS-Path : Log asset			−0.345							0.064	0.080	0.131	0.130
			(0.295)							(0.223)	(0.225)	(0.224)	(0.224)
MP-GSS-Target : Log age				0.710						1.433*	1.148*	1.448*	1.283*
				(1.161)						(0.796)	(0.681)	(0.785)	(0.731)
MP-GSS-Path : Log age				−0.886						−0.059	−0.100	−0.553	−0.580
				(1.160)						(0.542)	(0.537)	(0.706)	(0.707)
MP-GSS-Target : Leverage					1.388					1.567	1.460	−0.430	−1.033
					(3.300)					(3.296)	(3.339)	(2.939)	(3.104)
MP-GSS-Path : Leverage					0.186					0.586	0.581	−0.729	−0.819
					(1.923)					(1.914)	(1.909)	(1.568)	(1.604)
MP-GSS-Target : Tobin's q						1.085				1.642*	1.606*	0.993	1.010
						(0.777)				(0.907)	(0.890)	(0.683)	(0.686)
MP-GSS-Path : Tobin's q						0.680				0.700*	0.693*	0.530*	0.531*
						(0.433)				(0.389)	(0.384)	(0.300)	(0.299)
MP-GSS-Target : Cash holding							5.047			−0.850	−1.134	0.479	0.807
							(11.372)			(6.631)	(6.612)	(3.832)	(3.911)
MP-GSS-Path : Cash holding							7.503			2.500	2.441	2.250	2.285
							(6.820)			(3.022)	(2.968)	(1.808)	(1.814)
MP-GSS-Target : Cash flow								−6.452		−14.825	−13.265	−0.168	0.899
								(10.846)		(11.336)	(10.672)	(8.338)	(8.348)
MP-GSS-Path : Cash flow								−5.604		−4.955	−4.710	−6.856	−6.633
								(6.601)		(4.930)	(4.839)	(4.951)	(4.936)
MP-GSS-Target : Dividend payment									0.101	0.077	0.174	−0.348	−0.437
									(2.094)	(1.426)	(1.460)	(1.778)	(1.770)
MP-GSS-Path : Dividend payment									−1.972	−1.194	−1.185	−0.992	−1.010
									(2.142)	(1.237)	(1.239)	(1.136)	(1.140)
MP-GSS-Target : Disclosure ratio	0.023	0.022	0.018	0.019	0.023	0.025	0.024	0.025	0.022	0.008	0.006	0.010	0.011
	(0.023)	(0.022)	(0.019)	(0.019)	(0.023)	(0.023)	(0.022)	(0.021)	(0.020)	(0.014)	(0.013)	(0.015)	(0.015)
MP-GSS-Path : Disclosure ratio	−0.016	−0.015	−0.008	−0.011**	−0.015	−0.014	−0.012	−0.012*	−0.009*	−0.008	−0.008	−0.001	−0.001
	(0.010)	(0.010)	(0.007)	(0.005)	(0.011)	(0.010)	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Industry.Event FE												Yes	Yes
Event date FE	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	Yes
Observations	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811	91,811
Adjusted R^2	0.318	0.319	0.318	0.319	0.318	0.319	0.319	0.319	0.319	0.320	0.320	0.417	0.417

Panel B: Disclosed sample													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
log scope 1+2 intensity	0.175***	0.173***	0.177***	0.175***	0.177***	0.171**	0.178***	0.134**	0.171**	0.129**	0.128**	0.052	0.051
	(0.066)	(0.066)	(0.066)	(0.066)	(0.064)	(0.066)	(0.066)	(0.061)	(0.066)	(0.060)	(0.063)	(0.079)	(0.077)
MP-GSS-Target : Log scope 1+2 intensity	−4.668**	−3.250**	−4.623**	−4.914**	−4.958**	−4.551**	−5.143**	−4.836**	−4.641**	−4.983**	−4.075***	−2.363	−2.418
	(2.270)	(1.597)	(2.259)	(2.380)	(2.262)	(1.974)	(2.458)	(2.203)	(2.303)	(2.080)	(1.469)	(1.924)	(1.669)
MP-GSS-Path : Log scope 1+2 intensity	−1.439***	−1.402***	−1.469***	−1.393***	−1.495***	−1.243***	−1.372***	−1.451***	−1.436***	−1.277***	−1.330***	0.226	−0.007
	(0.430)	(0.339)	(0.433)	(0.461)	(0.422)	(0.396)	(0.483)	(0.421)	(0.433)	(0.429)	(0.354)	(0.420)	(0.339)
MP-GSS-Target : Capital tangibility		−11.002									−6.977		0.905
		(8.302)									(8.023)		(8.916)
MP-GSS-Path : Capital tangibility		−0.234									0.459		2.842
		(2.121)									(1.915)		(2.205)
MP-GSS-Target : Log asset			1.694							1.280	1.418	−0.075	−0.084
			(1.214)							(0.933)	(1.042)	(0.906)	(0.990)
MP-GSS-Path : Log asset			−0.754*							−0.535	−0.537	−0.785***	−0.800***
			(0.415)							(0.335)	(0.359)	(0.256)	(0.253)
MP-GSS-Target : Log age				4.266						4.077*	3.791*	0.774	0.813
				(3.281)						(2.380)	(2.169)	(2.162)	(1.944)
MP-GSS-Path : Log age				−0.943						−0.300	−0.273	−0.860	−0.719
				(1.236)						(0.800)	(0.754)	(0.908)	(0.814)
MP-GSS-Target : Leverage					28.373***					25.525***	25.316***	6.716	6.754
					(7.139)					(8.412)	(8.569)	(9.419)	(9.646)
MP-GSS-Path : Leverage					5.614*					5.619	5.602	0.687	0.912
					(3.206)					(3.429)	(3.452)	(3.478)	(3.564)
MP-GSS-Target : Tobin's q						0.383				1.657	1.553	0.383	0.392
						(1.229)				(1.491)	(1.420)	(1.001)	(0.989)
MP-GSS-Path : Tobin's q						0.506				0.660	0.665	0.360	0.371
						(0.380)				(0.464)	(0.459)	(0.438)	(0.440)
MP-GSS-Target : Cash holding							−33.014			−17.374	−16.049	−15.285	−15.475
							(25.453)			(19.567)	(18.938)	(12.118)	(12.492)
MP-GSS-Path : Cash holding							6.210			0.290	0.179	−2.576	−3.266
							(9.740)			(6.238)	(6.120)	(3.584)	(3.281)
MP-GSS-Target : Cash flow								−20.679		−38.668	−36.018	−33.733**	−34.006**
								(28.572)		(23.324)	(24.122)	(14.955)	(15.999)
MP-GSS-Path : Cash flow								−7.761		−9.357	−9.588	−10.976**	−11.508**
								(7.690)		(7.769)	(7.983)	(5.385)	(5.583)
MP-GSS-Target : Dividend payment									1.625	−0.611	−0.691	5.682	5.745
									(7.588)	(5.770)	(5.741)	(4.556)	(4.385)
MP-GSS-Path : Dividend payment									−3.052	−1.823	−1.816	−0.668	−0.598
									(2.515)	(1.579)	(1.575)	(1.270)	(1.219)
Industry.Event FE												Yes	Yes
Event date FE	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	Yes
Observations	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462	19,462
Adjusted R^2	0.363	0.364	0.364	0.364	0.364	0.364	0.364	0.364	0.364	0.367	0.367	0.549	0.549

This table reports the results for regressions of stock returns during FOMC meeting days on the interaction between monetary policy shocks and firm characteristics, including firms' emission intensities. Regression 1 controls only for firms' log scope 1+2 emission intensities and emissions disclosure ratio, and includes firm-level and event-level fixed effects. Regressions 2 to 9 add control variables for firm-level capital tangibility, log assets, log age, leverage, Tobin's q, cash holding, cash flow, and dividend payment dummy in that order. Regression 10 controls for the same variables all in a single regression, only excluding capital tangibility. Regression 11 adds the control for capital tangibility. Regression 12 removes capital tangibility and replaces the event-level fixed effects with a 4-digit SIC level industry × event fixed effects. Regression 13 controls for all firm-level characteristics and includes industry × event fixed effects. Emission intensity and disclosure ratio are lagged to the latest year and other variables are lagged to the latest quarter prior to the FOMC meeting. Log scope 1+2 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 plus scope 2 carbon emissions standardized by CPI-adjusted yearly operating revenue. Panel A reports the results for the complete Trucost sample, while Panel B includes only the firms that disclose both their scope 1 and scope 2 emissions. consequently, Panel B does not control for the emissions disclosure ratio. MP-GSS-Target and MP-GSS-Path refer to the target and path factors provided by Gürkaynak, Sack, and Swanson (2005) which cover 142 FOMC meetings between February 2005 and December 2022 in Panel A. Panel B includes monetary announcements between 2010 and 2022. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.

Table 8: Main results: Stock return reactions to monetary policy shocks across carbon emission intensities in the Euro area

	Dependent variable:												
Panel A: Complete sample	Stock returns on ECB announcement day												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Log scope 1+2 intensity	0.006	0.008	0.001	0.007	0.007	0.007	0.006	0.006	0.006	0.001	0.002	0.001	0.001
	(0.026)	(0.026)	(0.024)	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)	(0.026)	(0.023)	(0.023)	(0.024)	(0.024)
MP-Target : Log scope 1+2 intensity	−0.001	−0.001	−0.001	−0.0004	0.00002	0.004	−0.001	0.0002	−0.0001	0.004	0.003	0.005	0.003
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.007)	(0.008)	(0.009)	(0.009)
MP-FG : Log scope 1+2 intensity	0.009**	0.007*	0.009**	0.009**	0.009**	0.005	0.009**	0.009**	0.009**	0.005	0.003	0.003	0.003
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.002)	(0.002)
MP-Target : Capital tangibility		0.001									0.015		0.056*
		(0.024)									(0.022)		(0.030)
MP-FG : Capital tangibility		0.025									0.023		0.029
		(0.026)									(0.030)		(0.023)
MP-Target : Log asset			−0.010**							−0.010*	−0.010*	−0.002	−0.001
			(0.005)							(0.005)	(0.005)	(0.006)	(0.006)
MP-FG : Lo asset			−0.008**							−0.015***	−0.015***	−0.019***	−0.019***
			(0.003)							(0.003)	(0.003)	(0.004)	(0.005)
MP-Target : Log age				−0.001						−0.003	−0.002	−0.016*	−0.015
				(0.006)						(0.006)	(0.007)	(0.009)	(0.009)
MP-FG : Log age				0.009						0.010**	0.011**	0.006	0.007
				(0.005)						(0.004)	(0.004)	(0.004)	(0.004)
MP-Target : Leverage					−0.059					−0.039	−0.044	−0.042	−0.050
					(0.048)					(0.042)	(0.039)	(0.083)	(0.081)
MP-FG : Leverage					0.019					0.035*	0.028	0.015	0.011
					(0.024)					(0.021)	(0.025)	(0.026)	(0.027)
MP-Target : Tobin's q						0.027***				0.029**	0.030***	0.018*	0.019*
						(0.010)				(0.011)	(0.011)	(0.010)	(0.009)
MP-FG : Tobin's q						−0.022**				−0.030***	−0.029***	−0.026***	−0.026***
						(0.011)				(0.011)	(0.011)	(0.009)	(0.009)
MP-Target : Cash holding							−0.047			−0.171**	−0.171**	−0.121**	−0.125**
							(0.051)			(0.073)	(0.073)	(0.056)	(0.053)
MP-FG : Cash holding							−0.053			0.024	0.022	−0.005	−0.008
							(0.046)			(0.030)	(0.029)	(0.035)	(0.035)
MP-Target : Cash flow								0.157		−0.035	−0.039	0.070	0.051
								(0.128)		(0.083)	(0.083)	(0.076)	(0.073)
MP-FG : Cash flow								−0.057		0.083	0.074	0.088	0.081
								(0.045)		(0.061)	(0.064)	(0.059)	(0.059)
MP-Target : Dividend dummy									0.024	0.022	0.021	0.039*	0.039
									(0.028)	(0.026)	(0.026)	(0.023)	(0.024)
MP-FG : Dividend dummy									0.013	0.017	0.017	0.015	0.015
									(0.016)	(0.016)	(0.017)	(0.017)	(0.017)
MP-Target : Disclosure ratio	−0.0002	−0.0002	−0.00001	−0.0002	−0.0002	−0.0001	−0.0002	−0.0002	−0.0002	−0.00000	−0.00001	−0.0001	−0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
MP-FG : Disclosure ratio	−0.0001	−0.0001	0.0001	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001	0.00005	0.00003	0.00000	−0.00001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Industry.Event FE												Yes	Yes
Event date FE	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	Yes
Observations	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014	44,014
Adjusted R^2	0.411	0.411	0.411	0.411	0.411	0.412	0.411	0.411	0.411	0.414	0.414	0.470	0.471
Panel B: Disclosed sample													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
log scope 1+2 intensity	−0.014	−0.017	−0.027	−0.014	−0.013	−0.015	−0.016	−0.018	−0.018	−0.035	−0.035	−0.102	−0.102
	(0.060)	(0.060)	(0.058)	(0.060)	(0.060)	(0.059)	(0.060)	(0.058)	(0.058)	(0.053)	(0.054)	(0.062)	(0.062)
MP-Target : Log scope 1+2 intensity	−0.005	0.001	−0.003	−0.004	−0.003	0.007	−0.004	−0.002	−0.004	0.008	0.015	0.023	0.026
	(0.004)	(0.006)	(0.004)	(0.005)	(0.005)	(0.008)	(0.004)	(0.005)	(0.004)	(0.009)	(0.011)	(0.020)	(0.023)
MP-FG : Log scope 1+2 intensity	0.012**	0.010*	0.013**	0.012**	0.011**	0.005	0.011**	0.012**	0.012**	0.004	0.0002	−0.001	−0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.006)	(0.007)
MP-Target : Capital tangibility		−0.062*									−0.076**		−0.062
		(0.033)									(0.033)		(0.069)
MP-FG : Capital tangibility		0.018									0.041		0.020
		(0.029)									(0.029)		(0.032)
MP-Target : Log asset			−0.022***							−0.018**	−0.018**	−0.014	−0.016
			(0.008)							(0.008)	(0.008)	(0.009)	(0.011)
MP-FG : Log asset			−0.012**							−0.018***	−0.018***	−0.028***	−0.027***
			(0.006)							(0.005)	(0.005)	(0.005)	(0.006)
MP-Target : Log age				−0.008						−0.005	−0.009	−0.003	−0.003
				(0.008)						(0.008)	(0.009)	(0.007)	(0.006)
MP-FG : Log age				0.005						0.006	0.008	0.010	0.011
				(0.007)						(0.007)	(0.008)	(0.007)	(0.008)
MP-Target : Leverage					−0.109*					−0.017	−0.005	−0.093	−0.092
					(0.065)					(0.042)	(0.043)	(0.115)	(0.115)
MP-FG : Leverage					0.048					0.083***	0.076**	0.002	0.004
					(0.044)					(0.029)	(0.030)	(0.066)	(0.065)
MP-Target : Tobin's q						0.064**				0.065**	0.064**	0.051	0.052*
						(0.027)				(0.032)	(0.032)	(0.031)	(0.031)
MP-FG : Tobin's q						−0.037**				−0.049***	−0.049***	−0.041**	−0.042**
						(0.017)				(0.017)	(0.017)	(0.017)	(0.017)
MP-Target : Cash holding							0.184**			−0.104	−0.108	−0.038	−0.041
							(0.079)			(0.108)	(0.111)	(0.115)	(0.120)
MP-FG : Cash holding							−0.089			0.082	0.081	0.016	0.015
							(0.097)			(0.068)	(0.069)	(0.077)	(0.077)
MP-Target : Cash flow								0.425		−0.133	−0.096	0.048	0.072
								(0.296)		(0.228)	(0.231)	(0.309)	(0.288)
MP-FG : Cash flow								−0.050		0.166	0.149	0.133	0.133
								(0.146)		(0.119)	(0.120)	(0.115)	(0.111)
MP-Target : Dividend payment									0.025	0.035	0.032	−0.013	−0.015
									(0.033)	(0.032)	(0.032)	(0.026)	(0.026)
MP-FG : Dividend payment									0.044**	0.058**	0.061**	0.029	0.030
									(0.022)	(0.024)	(0.024)	(0.022)	(0.022)
Industry.Event FE												Yes	Yes
Event date FE	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	Yes
Observations	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167	18,167
Adjusted R^2	0.472	0.472	0.473	0.472	0.472	0.476	0.472	0.472	0.472	0.478	0.478	0.567	0.567

This table reports the results of regressions of stock returns during ECB announcement days on the interaction between monetary policy shocks and firm characteristics, including firms' emission intensities. Regression 1 controls only for firms' log scope 1+2 emission intensities and emissions disclosure ratio, and includes firm-level and event-level fixed effects. Regressions 2 to 9 add control variables for firm-level capital tangibility, Log assets, log age, leverage, Tobin's q, cash holding, cash flow, and dividend payment dummy. Regression 10 controls for the same variables all gathered in a single regression, only excluding capital tangibility. Regression 11 adds the control for capital tangibility. Regression 12 removes capital tangibility and replaces the event-level fixed effects with a industry × event fixed effects. Regression 13 includes all control variables and firm-level and industry × event fixed effects. The yearly variables are lagged to the latest year before the ECB announcement and quarterly variables are lagged by one quarter to address endogeneity concerns. Log scope 1+2 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 plus scope 2 carbon emissions standardized by CPI-adjusted yearly operating revenue. Panel A reports the results for the complete Trucost sample, while Panel B only includes firms that disclosed both their scope 1 and scope 2 emissions. consequently, Panel B does not control for the emissions disclosure ratio. MP-Target and MP-FG indicate the target and path factors of Altavilla et al. (2019) which cover 183 ECB announcements between February 2005 and December 2022 in Panel A. Panel B includes monetary announcements between 2010 and 2022. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and\ ***$ indicate significance on 0.1, 0.05, and 0.01.

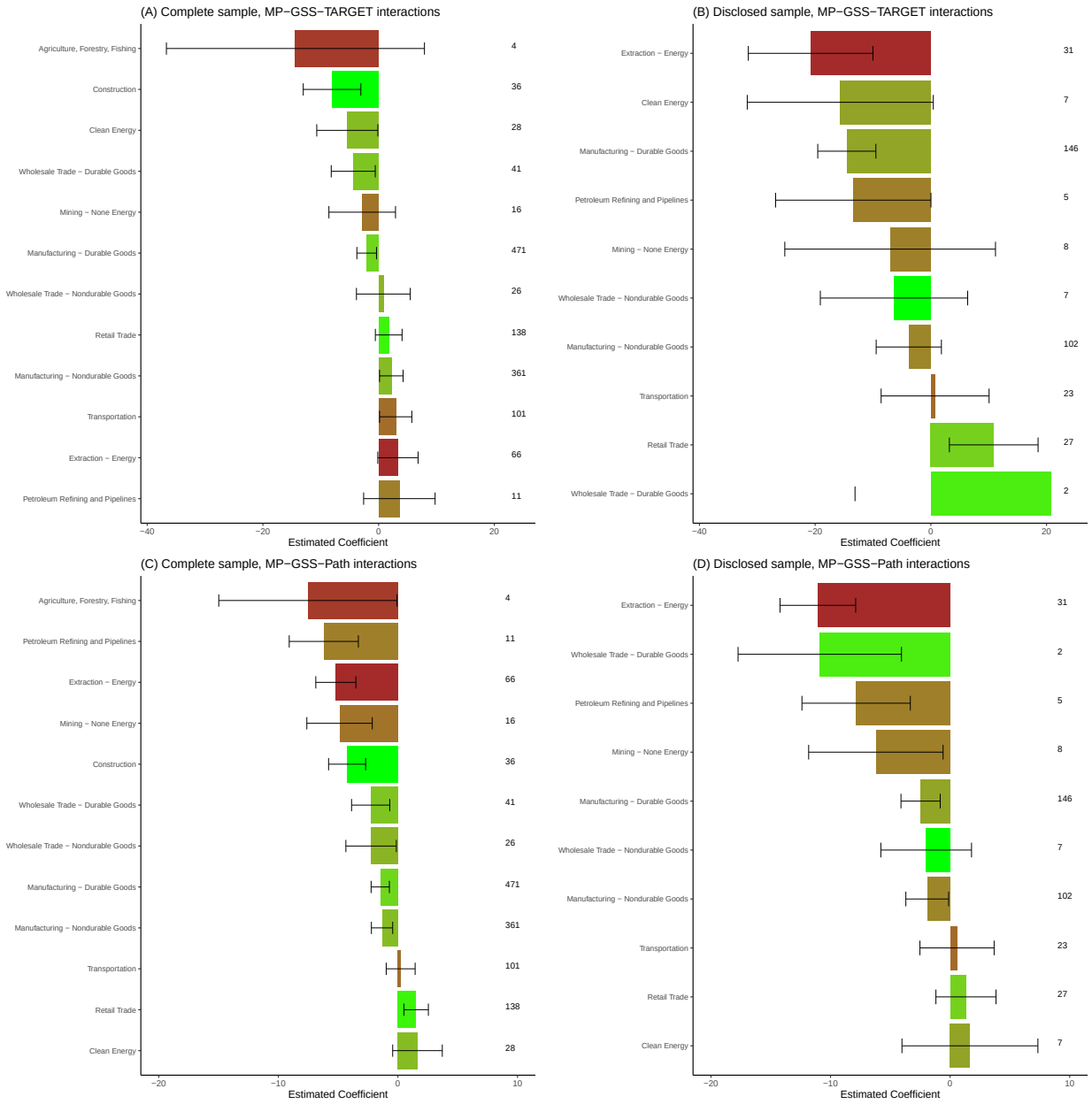


Figure 3: Emission intensity of industries and their reaction to monetary shocks in the U.S.

This figure reports the estimated coefficients for the interaction of industry dummies and monetary policy shocks in a regression that controls for all firm characteristics in the U.S., including capital tangibility and emission intensity. Colors correspond to the average industry log scope 1+2 emission intensity with green indicating the lowest and red indicating the highest emission intensity. Industries are defined based as 11 SIC major industries and we separate two groups of firms to add them as separate industries, namely Clean Energy industry which encompasses firms from Wilder Hill Clean Energy Index and the Petroleum refining and Pipelines that includes firms from 29 and 46 2-digit SIC codes. The reference industry for binary variables is the Services which has the lowest emission intensity. Plots (A) and (B) report the results for the interactions with the target factor shocks and Plots (C) and (D) report the results for the interactions with the path factor shocks. The complete sample regression includes all FOMC announcements between 2005 and 2022 and the disclosed sample regression includes the 2010 to 2022 period for the U.S. The reported 90% confidence intervals are constructed based on robust standard errors.

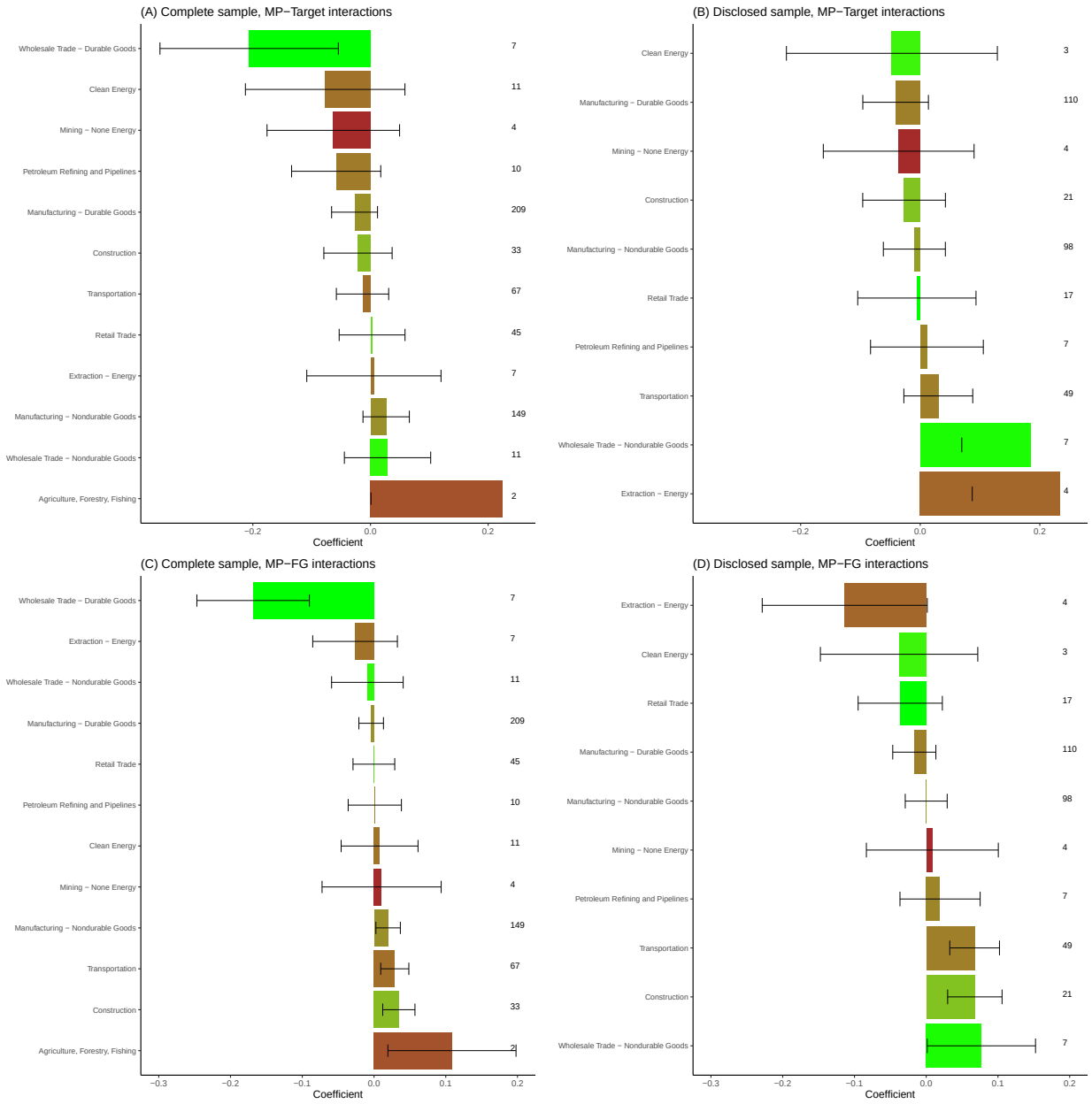


Figure 4: Emission intensity of industries and their reaction to monetary shocks in the euro area

This figure reports the estimated coefficients for the interaction of industry dummies and monetary policy shocks in a regression that controls for all firm characteristics in the euro area, including capital tangibility and emission intensity. Colors correspond to the average industry Log scope 1+2 emission intensity with green indicating the lowest and red indicating the highest emission intensity. Industries are defined based as 11 major SIC industries and we separate two groups of firms to add them as separate industries, namely Clean Energy industry which encompasses firms we select based on their activity description and the Petroleum refining and Pipelines that includes firms from 29 and 46 2-digit SIC codes. The reference industry for binary variables is the Services which has the lowest emission intensity. Plots (A) and (B) report the results for the interactions of with the target factor shocks and Plots (C) and (D) report the results for the interactions with the forward guidance shocks The complete sample regression includes ECB announcements between 2005 and 2022 and the disclosed sample regression includes the 2010 to 2022 period for the euro area. The reported 90% confidence intervals are constructed based on robust standard errors.

Table 9: Correlation of industry average emission intensity with industry's reactivity to monetary policy

		Emission intensity	Emission intensity (weighted)	Capital tangibility
Panel A: U.S.				
MP-GSS-TARGET	Complete industries	-0.11	-0.06	-0.07
	Without energy & mining	-0.11	-0.08	-0.06
MP-GSS-Path	Complete industries	-0.24	-0.35	-0.16
	Without energy & mining	-0.16	-0.19	-0.06
Panel B: Euro area				
MP-TARGET	Complete industries	-0.02	-0.05	-0.03
	Without energy & mining	-0.01	-0.01	-0.01
MP-FG	Complete industries	0.06	0.07	0.13
	Without energy & mining	0.07	0.09	0.15

This table reports the correlation and the weighted correlation between 4-digit SIC industry average emission intensities and the estimated coefficients for industries' reactivity to monetary policy shocks. The coefficients are estimated for the interactions of 4-digit SIC industry dummies with monetary shocks where we control for the full set of firm financial variables, including capital tangibility and emission intensity, and we include firm and time fixed effects. The number of observations per industry are used as weights for the weighted correlation. For each region and for each type of monetary policy shock, we first report the correlation for the full set of industries, and then we eliminate energy and mining industries and report correlations to show the impact of their exclusion on the correlation coefficients. Energy and mining industries refer to industries with 10, 12, 13, 14, 29, and 46 SIC codes. These industries represent 6.9% of our firm-event observations, equivalent to 9 out of 238 4-digit SIC codes. Panel A uses complete sample for the U.S. and Panel B uses complete sample for the euro area.

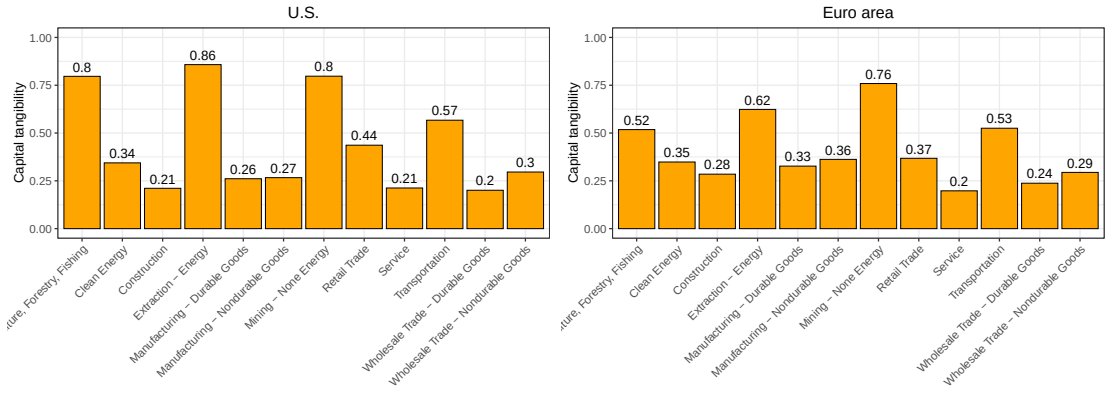


Figure 5: Capital tangiblity for general industries in the U.S. and the Euro area in our sample

Table 10: The emission intensity - capital tangibility and credit transmission channel of monetary policy for the U.S.

	Dependent variable:					
	Stock returns on FOMC meeting day					
Panel A: Split by age						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.010		0.008	0.057		0.055
	(0.054)		(0.055)	(0.041)		(0.043)
MP-Target : Log scope 1+2 intensity	−3.455**		−2.791*	−0.248		0.537
	(1.559)		(1.633)	(1.042)		(0.754)
MP-Path : Log scope 1+2 intensity	0.131		0.204	−0.092		0.150
	(0.564)		(0.662)	(0.300)		(0.285)
MP-Target : Capital tangibility		−15.638**	−12.509*		−14.786	−15.320
		(6.397)	(6.868)		(11.555)	(11.291)
MP-Path : Capital tangibility		−0.997	−1.294		−4.615**	−4.856***
		(2.665)	(3.195)		(1.928)	(1.781)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,989	31,989	31,989	32,795	32,795	32,795
Adjusted R^2	0.357	0.357	0.357	0.456	0.456	0.456
Panel B: Split by age and size						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	−0.087		−0.094	0.066*		0.066*
	(0.116)		(0.118)	(0.037)		(0.036)
MP-Target : Log scope 1+2 intensity	−5.320*		−4.192	−0.899		−0.347
	(3.075)		(2.948)	(0.728)		(0.600)
MP-Path : Log scope 1+2 intensity	−0.044		0.108	−0.086		0.015
	(1.100)		(1.298)	(0.274)		(0.269)
MP-Target : Capital tangibility		−28.558**	−26.079**		−10.568	−9.992
		(11.466)	(11.267)		(9.361)	(9.422)
MP-Path : Capital tangibility		−3.638	−3.658		−1.725	−1.821
		(5.351)	(5.946)		(1.429)	(1.395)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,143	20,143	20,143	44,641	44,641	44,641
Adjusted R^2	0.301	0.301	0.301	0.468	0.468	0.468
Panel C: Split by cash holding						
	Above 3rd quantile			Below 3rd quantile		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.047		0.038	0.055		0.055
	(0.114)		(0.109)	(0.043)		(0.041)
MP-Target : Log scope 1+2 intensity	−4.503		−3.533	−0.787		−0.113
	(3.023)		(3.452)	(0.863)		(0.711)
MP-Path : Log scope 1+2 intensity	−0.108		−0.179	0.212		0.305
	(0.917)		(1.140)	(0.363)		(0.364)
MP-Target : Capital tangibility		−20.214*	−15.255		−12.020	−11.765
		(10.538)	(12.914)		(9.084)	(9.059)
MP-Path : Capital tangibility		0.699	0.835		−1.132	−1.617
		(3.912)	(5.029)		(1.800)	(1.778)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,203	16,203	16,203	48,581	48,581	48,581
Adjusted R^2	0.309	0.309	0.309	0.426	0.427	0.427

This table reports the results that test the role of the correlation between emission intensity and capital tangibility in credit transmission channel's carbon bias for the U.S. Panel A splits the sample based on median age, Panel B splits based on median age and size, and Panel C splits based on third quantile of cash holding. This is to separate the financially constrained firms for which we proxy by age, size, and cash holding. This table limits the sample to 2016-2022 period to encompass sufficiently small and young firms. The splits are based on per event medians to avoid over representation of certain time periods in each split. All regressions reported include firm-level control variables such as size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment, and disclosure ratio, as well as firm fixed effects and 4-digit SIC industry × event fixed effects. Column 1 and 4 reports the results for a regression with emission intensity and without capital tangibility where the former column uses sample of financially constrained firms and the latter the sample of unconstrained firms. Columns 2 and 5 reports the regression that replaces emission intensity with capital tangibility. Columns 3 and 6 keep both variables. All control variables are lagged to latest period prior to FOMC meeting day based on their observation frequency. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.

Table 11: The emission intensity - capital tangibility nexus and credit transmission channel of monetary policy for the euro area

	Dependent variable:					
	Stock returns on ECB meeting day					
Panel A: Split by age						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.054		0.057	0.006		0.004
	(0.060)		(0.060)	(0.073)		(0.068)
MP-Target : Log scope 1+2 intensity	0.028**		0.029*	0.043		0.040
	(0.014)		(0.015)	(0.031)		(0.033)
MP-FG : Log scope 1+2 intensity	0.014***		0.011*	0.014		0.016
	(0.005)		(0.006)	(0.015)		(0.016)
MP-Target : Capital tangibility		0.019	−0.021		0.117***	0.075*
		(0.045)	(0.042)		(0.036)	(0.044)
MP-FG : Capital tangibility		0.092***	0.076***		−0.038	−0.056
		(0.027)	(0.028)		(0.034)	(0.042)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,969	12,969	12,969	13,197	13,197	13,197
Adjusted R^2	0.436	0.436	0.437	0.528	0.528	0.528
Panel B: Split by age and size						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.053		0.050	−0.002		0.001
	(0.081)		(0.082)	(0.058)		(0.054)
MP-Target : Log scope 1+2 intensity	0.043*		0.047*	0.020		0.016
	(0.022)		(0.027)	(0.021)		(0.021)
MP-FG : Log scope 1+2 intensity	0.006		0.004	0.005		0.006
	(0.009)		(0.011)	(0.010)		(0.010)
MP-Target : Capital tangibility		−0.061	−0.125		0.106***	0.086***
		(0.109)	(0.131)		(0.038)	(0.025)
MP-FG : Capital tangibility		0.083	0.075		−0.005	−0.012
		(0.056)	(0.061)		(0.025)	(0.023)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,410	8,410	8,410	17,756	17,756	17,756
Adjusted R^2	0.372	0.372	0.372	0.533	0.533	0.533
Panel C: Split by cash holding						
	Above 3rd quantile			Below 3rd quantile		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.034		0.028	0.016		0.019
	(0.112)		(0.114)	(0.048)		(0.047)
MP-Target : Log scope 1+2 intensity	0.024		0.025	0.012		0.012
	(0.027)		(0.030)	(0.009)		(0.010)
MP-FG : Log scope 1+2 intensity	−0.009		−0.006	0.010		0.010
	(0.012)		(0.014)	(0.008)		(0.008)
MP-Target : Capital tangibility		−0.017	−0.050		0.026	0.011
		(0.090)	(0.106)		(0.022)	(0.023)
MP-FG : Capital tangibility		−0.079	−0.068		0.025	0.008
		(0.054)	(0.067)		(0.037)	(0.036)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,548	6,548	6,548	19,618	19,618	19,618
Adjusted R^2	0.336	0.336	0.336	0.512	0.512	0.512

This table reports the results that test the role of the correlation between emission intensity and capital tangibility in credit transmission channel's carbon bias for the euro area. Panel A splits the sample based on median age, Panel B splits based on median age and size, and Panel C splits based on third quantile of cash holding. This is to separate the financially constrained firms for which we proxy by age, size, and cash holding. This table limits the sample to 2016-2022 period to encompass sufficiently small and young firms. The splits are based on per event medians to avoid over representation of certain time periods in each split. All regressions reported include firm-level control variables such as size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment, and disclosure ratio, as well as firm fixed effects and 4-digit SIC industry × event fixed effects. Column 1 and 4 reports the results for a regression with emission intensity and without capital tangibility where the former column uses sample of financially constrained firms and the latter the sample of unconstrained firms. Columns 2 and 5 reports the regression that replaces emission intensity with capital tangibility. Columns 3 and 6 keep both variables. All control variables are lagged to latest period prior to FOMC meeting day based on their observation frequency. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and *** $ indicate significance on 0.1, 0.05, and 0.01.

Table 12: Transition risk and monetary policy in the U.S.

	Dependent variable:			
	Stock returns on FOMC meeting day			
Panel A: Split based on total scope 1 emissions, full period	Below median		Above median	
	(1)	(2)	(3)	(4)
MP-GSS-Target : Log scope 1 intensity	0.918		-1.301^{*}	
	(0.870)		(0.727)	
MP-GSS-Path : Log scope 1 intensity	1.178^{***}		-0.199	
	(0.442)		(0.225)	
MP-GSS-Target : Log scope 1		1.344		-1.775^{**}
		(0.912)		(0.751)
MP-GSS-Path : Log scope 1		0.235		-0.192
		(0.275)		(0.191)
MP-GSS-Target : Capital tangibility	-4.893	-4.546	-6.763	-6.707
	(4.347)	(4.503)	(4.123)	(4.119)
MP-GSS-Path : Capital tangibility	-0.165	0.433	-1.653	-1.733
	(1.936)	(1.900)	(1.430)	(1.440)
Industry.Event FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
Observations	45,871	45,871	45,940	45,940
Adjusted R^2	0.351	0.351	0.498	0.498
Panel B: Split based on total scope 1 emissions, post-2015 period	Below median		Above median	
	(1)	(2)	(3)	(4)
MP-GSS-Target : Log scope 1 intensity	-0.139		-1.526^{*}	
	(1.744)		(0.844)	
MP-GSS-Path : Log scope 1 intensity	0.963^{*}		-0.143	
	(0.560)		(0.248)	
MP-GSS-Target : Log scope 1		1.033		-2.133^{**}
		(1.401)		(0.988)
MP-GSS-Path : Log scope 1		0.034		-0.096
		(0.358)		(0.200)
MP-GSS-Target : Capital tangibility	-16.212^{**}	-16.554^{**}	-10.974	-10.421
	(6.884)	(7.223)	(9.209)	(8.802)
MP-GSS-Path : Capital tangibility	-1.572	-1.100	-2.000	-2.094
	(2.202)	(2.243)	(1.875)	(1.838)
Industry.Event FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
Observations	32,379	32,379	32,405	32,405
Adjusted R^2	0.336	0.336	0.483	0.484

This table reports the results for the transition risk channel for monetary policy's carbon bias in the U.S. This table shows that the transition risk is only evident amongst largest polluters. Columns 1 to 4 regress the stock returns of FOMC meeting days on interaction of monetary policy shocks with full set of firm-level controls, such as firm size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment, disclosure ratio, capital tangibility and either log of scope 1 emission intensity or log of absolute scope 1 emissions. Regression 1 and 3 include the interaction of monetary shocks with log scope 1 emission intensity where the former uses the sample of firms with smaller absolute scope 1 emissions and the latter uses the sample of firms with largest absolute scope 1 emissions (split based on median where split is implemented per event). Regressions 2 and 4 include the interaction of monetary shocks with log scope 1 emissions in a similar format. All regressions include firm fixed effects and 4-digit SIC industry × event fixed effects. Panels A and B use the 2005-2022 period and 2016-2022 period respectively. Emission intensity, absolute emissions, and disclosure ratio are lagged to the latest year and other variables are lagged to the latest quarter prior to the FOMC meeting. MP-GSS-Target and MP-GSS-Path refer to the target and path factors provided by Gürkaynak, Sack, and Swanson (2005) which cover 142 FOMC meetings between February 2005 and December 2022. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.

Table 13: Transition risk and monetary policy in the Euro area

	Dependent variable:			
	Stock returns on ECB meeting day			
Panel A: Split based on total scope 1 emissions, full period	Below median		Above median	
	(1)	(2)	(3)	(4)
MP-Target : Log scope 1 intensity	-0.016^{***}		0.011	
	(0.006)		(0.010)	
MP-FG : Log scope 1 intensity	-0.004		-0.003	
	(0.004)		(0.004)	
MP-Target : Log scope 1		-0.029^{***}		0.003
		(0.006)		(0.009)
MP-FG : Log scope 1		-0.001		-0.005
		(0.005)		(0.004)
MP-Target : Capital tangibility	0.075	0.073	0.004	0.016
	(0.054)	(0.052)	(0.042)	(0.039)
MP-FG : Capital tangibility	-0.029	-0.029	0.044	0.047
	(0.031)	(0.031)	(0.032)	(0.034)
Industry.Event FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
Observations	21,955	21,955	22,059	22,059
Adjusted R^2	0.391	0.392	0.529	0.529
Panel B: Split based on total scope 1 emissions, post-2015 period	Below median		Above median	
	(1)	(2)	(3)	(4)
MP-Target : Log scope 1 intensity	-0.020^{*}		0.019^{*}	
	(0.011)		(0.011)	
MP-FG : Log scope 1 intensity	-0.007		0.001	
	(0.006)		(0.007)	
MP-Target : Log scope 1		-0.039^{***}		0.012
		(0.012)		(0.011)
MP-FG : Log scope 1		-0.001		-0.001
		(0.008)		(0.008)
MP-Target : Capital tangibility	0.063	0.073	0.023	0.034
	(0.049)	(0.047)	(0.033)	(0.033)
MP-FG : Capital tangibility	-0.007	-0.009	0.023	0.023
	(0.036)	(0.038)	(0.059)	(0.058)
Industry.Event FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
Observations	13,066	13,066	13,100	13,100
Adjusted R^2	0.404	0.404	0.545	0.544

This table reports the results for the transition risk channel for monetary policy's carbon bias in the euro area. Columns 1 to 4 regress the stock returns of ECB announcement days on interaction of monetary policy shocks with full set of firm-level controls, such as firm size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment, disclosure ratio, capital tangibility and either log of scope 1 emission intensity or log of absolute scope 1 emissions. Regression 1 and 3 include the interaction of monetary shocks with log scope 1 emission intensity where the former uses the sample of firms with smaller absolute scope 1 emissions and the latter uses the sample of firms with largest absolute scope 1 emissions (split based on median where split is implemented per event). Regressions 2 and 4 include the interaction of monetary shocks with log scope 1 emissions in a similar format. All regressions include firm fixed effects and 4-digit SIC industry × event fixed effects. Panels A and B use the 2005-2022 period and 2016-2022 period respectively. Emission intensity, absolute emissions, and disclosure ratio are lagged to the latest year and other variables are lagged to the latest quarter prior to the ECB meeting. MP-Target and MP-FG refer to the target and forward guidance factors. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.

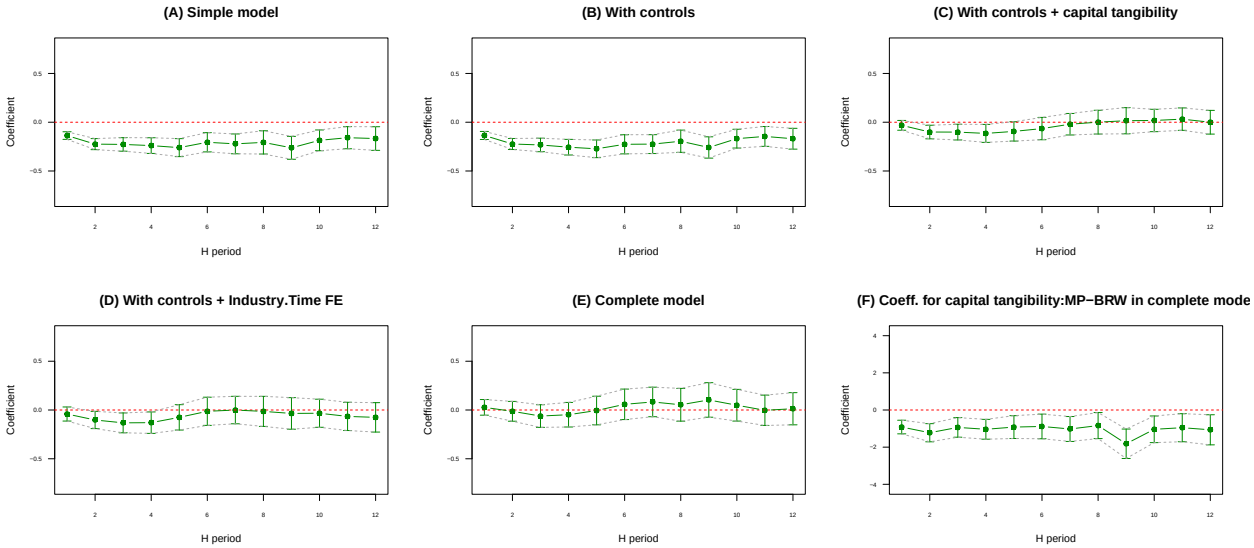


Figure 6: Emission intensity's effect on firm's investment response to monetary policy changes in the U.S., complete dataset

This figures plots the robustness check results for the estimated coefficients for the interaction of Log scope 1+2 emission intensity with MP-GSS-TARGET, β_3^h, for each h in h=1,2,3,4,5,6,7,8,9,10,11,12 in Plots A to E and also shows the estimated coefficient for the interaction of Capital Tangibility with MP-GSS-TARGET in Plot F. Plot (A) shows β_3^h for equation 1 with no firm-level controls and only firm FE and time FE. Plot (B) shows β_3^h for equation 2 with firm FE, time (quarter-year) FE, and the interaction of firm-level controls with monetary policy such as log asset, log age, leverage, Tobin's Q, cash holding, cash flow, and dividend payout dummy (excluding capital tangibility) all lagged to the previous quarter. Plot (C) shows β_3^h for equation 3 with firm FE, $Industry \times Time$ FE, and firm-level controls (excluding capital tangibility). Plot (D) shows β_3^h for equation 2 with firm FE, time FE, and firm-level controls including the interaction of capital tangibility with monetary policy shocks. Plot (E) shows β_3^h for equation 3 with firm FE, $Industry \times Time$ FE, and firm-level control variables including capital tangibility (complete specification). Plot (F) shows estimated coefficients for interaction of monetary policy shocks with capital tangibility in the same regression as Plot (E). In all regressions, the dependent variable is $log(NPPE_{i,t+h}/Asset_{i,t-1}) - log(NPPE_{i,t-1}/Asset_{i,t-1})$ where all variables used are deflated with 2015 CPI. We use 4-digit SIC as our industry classification. The reported 95% confidence intervals are based on standard errors that are two-way clustered on firm and $Industry \times Time$ levels. In all regressions, $X_{i,t-1}^m$ is GDP growth rate. These regressions use complete sample.

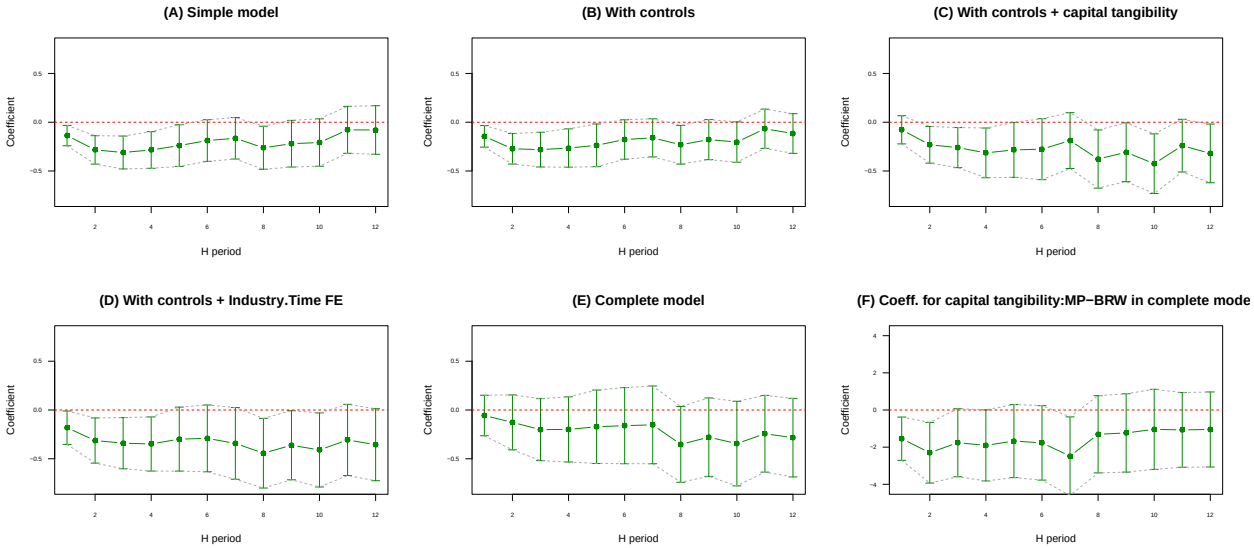


Figure 7: Emission intensity's effect on firm's investment response to monetary policy changes in the U.S., disclosed dataset

This figures plots the robustness check results for the estimated coefficients for the interaction of Log scope 1+2 emission intensity with MP-GSS-TARGET, β_3^h, for each h in h=1,2,3,4,5,6,7,8,9,10,11,12 in Plots A to E and also shows the estimated coefficient for the interaction of Capital Tangibility with MP-GSS-TARGET in Plot F. Plot (A) shows β_3^h for equation 1 with no firm-level controls and only firm FE and time FE. Plot (B) shows β_3^h for equation 2 with firm FE, time (quarter-year) FE, and the interaction of firm-level controls with monetary policy such as log asset, log age, leverage, Tobin's Q, cash holding, cash flow, and dividend payout dummy (excluding capital tangibility) all lagged to the previous quarter. Plot (C) shows β_3^h for equation 3 with firm FE, $Industry \times Time$ FE, and firm-level controls (excluding capital tangibility). Plot (D) shows β_3^h for equation 2 with firm FE, time FE, and firm-level controls including the interaction of capital tangibility with monetary policy shocks. Plot (E) shows β_3^h for equation 3 with firm FE, $Industry \times Time$ FE, and firm-level control variables including capital tangibility (complete specification). Plot (F) shows estimated coefficients for interaction of monetary policy shocks with capital tangibility in the same regression as Plot (E). In all regressions, the dependent variable is $log(NPPE_{i,t+h}/Asset_{i,t-1}) - log(NPPE_{i,t-1}/Asset_{i,t-1})$ where all variables used are deflated with 2015 CPI. We use 4-digit SIC as our industry classification. The reported 95% confidence intervals are based on standard errors that are two-way clustered on firm and $Industry \times Time$ levels. In all regressions, $X_{i,t-1}^m$ is GDP growth rate. These regressions use only disclosed emission intensities.

8.1 Appendix A: Descriptive statistics

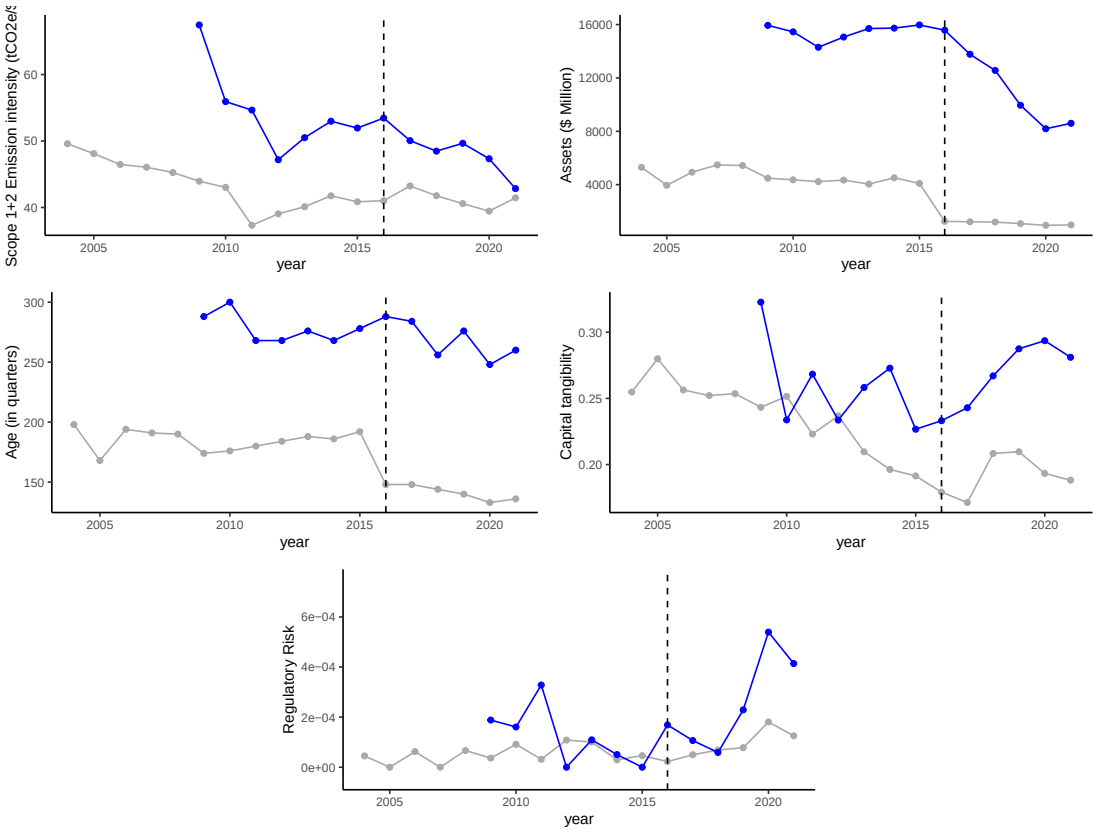


Figure 8: U.S., Median firm characteristics for disclosed data (blue) and estimated data (grey). The dashed line marks the year 2016 where the Trucost's firm coverage increased.

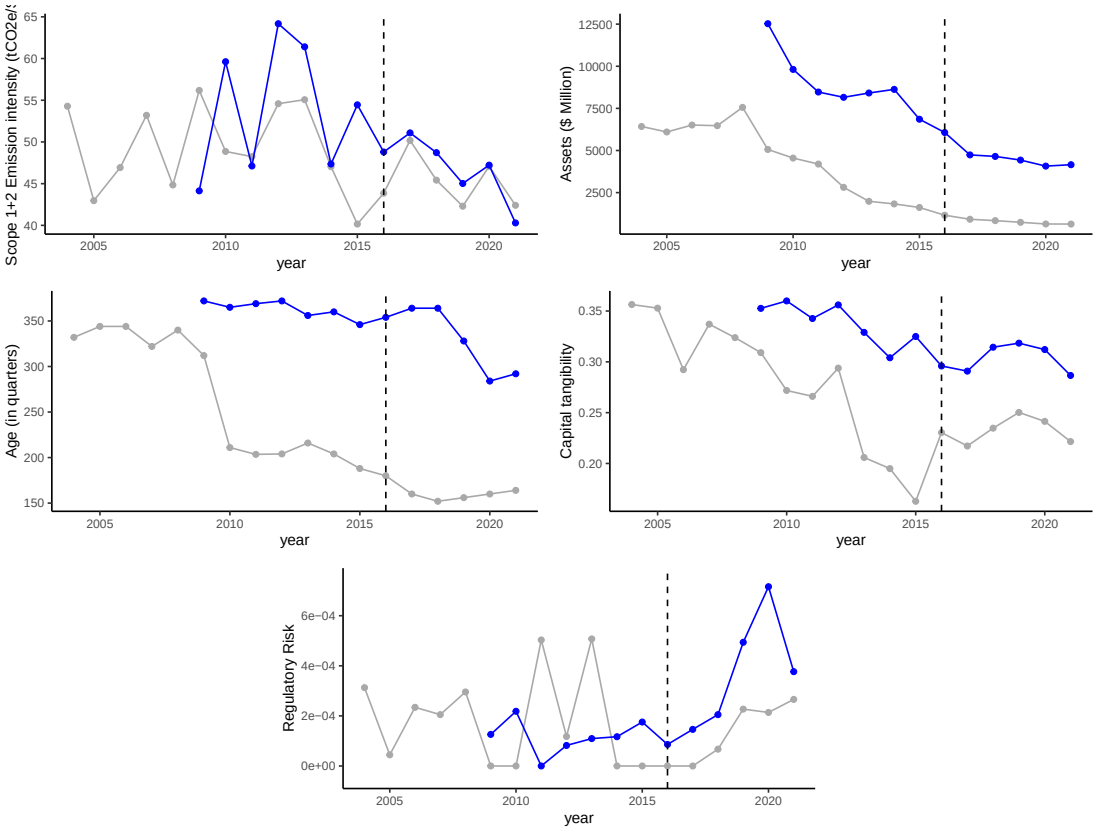


Figure 9: Euro Area, Median firm characteristics for disclosed data (blue) and estimated data (grey). The dashed line marks the year 2016 where the Trucost's firm coverage increased.

8.2 Appendix B: Robustness test of main results for the U.S.

Table 14: Robustness test: Using scope 1 and scope 2 emission intensities separately for U.S.

	Dependent variable:					
	Stock returns on FOMC meeting day					
Panel A: Complete sample, Log scope 1 intensity	(1)	(2)	(3)	(4)	(5)	(6)
MP-GSS-Target : Log scope 1 intensity	−1.477*	−0.842**	−1.234*	−0.750**	−0.598	−0.320
	(0.768)	(0.413)	(0.626)	(0.374)	(0.446)	(0.385)
MP-GSS-Path : Log scope 1 intensity	−0.811***	−0.650***	−0.569***	−0.517***	0.272	0.319
	(0.284)	(0.186)	(0.190)	(0.148)	(0.279)	(0.285)
MP-GSS-Target : Capital tangibility		−6.114		−4.721		−7.234**
		(4.328)		(3.572)		(3.435)
MP-GSS-Path : Capital tangibility		−1.640		−0.507		−1.257
		(1.758)		(1.303)		(1.193)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,811	91,811	91,811	91,811	91,811	91,811
Adjusted R^2	0.318	0.319	0.320	0.320	0.417	0.417
Panel B: Disclosed sample, Log scope 1 intensity	(1)	(2)	(3)	(4)	(5)	(6)
MP-GSS-Target : Log scope 1 intensity	−3.283**	−2.141**	−3.779***	−3.146***	−2.433*	−2.460**
	(1.510)	(1.073)	(1.403)	(0.943)	(1.430)	(1.222)
MP-GSS-Path : Log scope 1 intensity	−1.133***	−1.149***	−1.026***	−1.101***	0.214	0.090
	(0.298)	(0.301)	(0.289)	(0.235)	(0.386)	(0.329)
MP-GSS-Target : Capital tangibility		−12.984		−7.013		0.734
		(10.480)		(9.080)		(8.809)
MP-GSS-Path : Capital tangibility		0.230		0.890		2.620
		(2.718)		(2.191)		(2.062)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,462	19,462	19,462	19,462	19,462	19,462
Adjusted R^2	0.363	0.364	0.367	0.367	0.549	0.549
Panel C: Complete sample, Log scope 2 intensity	(1)	(2)	(3)	(4)	(5)	(6)
MP-GSS-Target : Log scope 2 intensity	−1.891**	−0.987**	−1.527**	−0.824	−0.435	−0.083
	(0.829)	(0.488)	(0.701)	(0.558)	(0.604)	(0.606)
MP-GSS-Path : Log scope 2 intensity	−0.989***	−0.647**	−0.638**	−0.452	0.010	0.050
	(0.351)	(0.253)	(0.302)	(0.274)	(0.324)	(0.341)
MP-GSS-Target : Capital tangibility		−7.596		−6.164		−7.564**
		(5.248)		(4.375)		(3.641)
MP-GSS-Path : Capital tangibility		−3.101		−1.774		−0.925
		(2.025)		(1.378)		(1.235)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,811	91,811	91,811	91,811	91,811	91,811
Adjusted R^2	0.318	0.318	0.320	0.320	0.417	0.417
Panel D: Disclosed sample, Log scope 2 intensity	(1)	(2)	(3)	(4)	(5)	(6)
MP-GSS-Target : Log scope 2 intensity	−2.850*	−0.964	−2.517*	−1.095	−0.316	−0.027
	(1.662)	(1.076)	(1.314)	(1.104)	(1.794)	(1.917)
MP-GSS-Path : Log scope 2 intensity	−1.192***	−0.797***	−0.924**	−0.670**	0.055	−0.139
	(0.398)	(0.285)	(0.381)	(0.313)	(0.405)	(0.395)
MP-GSS-Target : Capital tangibility		−22.825*		−20.764*		−4.934
		(12.324)		(11.349)		(11.009)
MP-GSS-Path : Capital tangibility		−4.641**		−3.574		3.189
		(2.296)		(2.159)		(2.514)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,462	19,462	19,462	19,462	19,462	19,462
Adjusted R^2	0.361	0.363	0.365	0.366	0.549	0.549

This table reports the results of regressions of stock returns during FOMC meeting days on the interaction between monetary policy shocks and firm characteristics, including firms' scope 1 emission intensities in Panels A and B and firms' scope 2 emission intensities in Paneb C and D. Regression 1 controls only for firms' emission intensities and emissions disclosure ratio, and includes firm-level and event-level fixed effects. Regression 2 adds a control for capital tangibility. Regression 3 replaces capital tangibility with controls for firm size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment. Regression 4 adds capital tangibility to these firm-level controls. Regression 5 removes capital tangibility and replaces event fixed effects with 4-digit SIC industry × event fixed effects. Regression 6 controls for capital tangibility again along with full set of firm-level controls, firm fixed effects, and industry × event fixed effects. The yearly variables are lagged to the latest year before the FOMC meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. Log scope 1 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 carbon emissions standardized by CPI-adjusted yearly operating revenue in Panel A and B and Log scope 2 intensity refers to firm's scope 2 carbon emissions standardized by the same revenue. Panel A and C report the results for the complete Trucost sample, while Panel B and D only includes firms that disclosed both their scope 1 and scope 2 emissions. consequently, Panel B does not control for the emissions disclosure ratio. MP-GSS-Target and MP-GSS-Path indicate the target and path factors provided by Gürkaynak, Sack, and Swanson (2005) which cover 142 FOMC meetings between February 2005 and December 2022 for complete sample. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and *** $ indicate significance on 0.1, 0.05, and 0.01.

Table 15: Robustness check: alternative measures of monetary policy shock for U.S.

	Dependent variable:					
	Stock returns on FOMC meeting day					
Panel A: Complete sample, MP-JK monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
MP-JK : Log scope 1+2 intensity	−1.564***	−1.033***	−1.098***	−0.786**	0.109	0.301
	(0.444)	(0.294)	(0.380)	(0.316)	(0.442)	(0.459)
MP-JK : Capital tangibility		−3.844		−2.285		−3.384**
		(2.402)		(1.886)		(1.637)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
control variables			Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,811	91,811	91,811	91,811	91,811	91,811
Adjusted R^2	0.318	0.318	0.319	0.320	0.416	0.416
Panel B: Disclosed sample, MP-JK monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
MP-JK : Log scope 1+2 intensity	−2.239***	−2.085***	−2.027***	−2.048***	0.196	−0.108
	(0.600)	(0.471)	(0.595)	(0.468)	(0.518)	(0.531)
MP-JK : Capital tangibility		−1.202		0.172		3.727
		(3.033)		(2.908)		(3.119)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,462	19,462	19,462	19,462	19,462	19,462
Adjusted R^2	0.363	0.363	0.364	0.364	0.548	0.548
Panel C: Complete sample, MP-BRW monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
MP-BRW : Log scope 1+2 intensity	−0.656***	−0.258	−0.583***	−0.109	−0.018	0.161
	(0.136)	(0.169)	(0.141)	(0.173)	(0.225)	(0.230)
MP-BRW : Capital tangibility		−2.895***		−3.485***		−3.216***
		(0.816)		(0.820)		(0.929)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
control variables			Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,811	91,811	91,811	91,811	91,811	91,811
Adjusted R^2	0.317	0.318	0.319	0.319	0.416	0.416
Panel D: Disclosed sample, MP-BRW monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
MP-BRW : Log scope 1+2 intensity	−0.892***	−0.287	−0.876***	−0.213	−0.264	−0.046
	(0.179)	(0.238)	(0.203)	(0.258)	(0.287)	(0.303)
MP-BRW : Capital tangibility		−4.571***		−4.871***		−2.673
		(1.420)		(1.416)		(1.698)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
control variables			Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,462	19,462	19,462	19,462	19,462	19,462
Adjusted R^2	0.361	0.361	0.361	0.362	0.548	0.548

This table reports the results for the robustness tests for the U.S. where we use alternative measures of monetary policy shocks. Panels A and B use monetary policy shocks of Jarociński and Karadi (MP-JK) and Panels C and D use shocks provided by Bu, Rogers, and Wu (MP-BRW). The dependent variable being stock returns on FOMC meeting days, Regression 1 controls only for firms' emission intensities and emissions disclosure ratio, and includes firm-level and event-level fixed effects. Regression 2 adds a control for capital tangibility. Regression 3 replaces capital tangibility with controls for firm size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment. Regression 4 adds capital tangibility to these firm-level controls. Regression 5 removes capital tangibility and replaces event fixed effects with 4-digit SIC industry × event fixed effects. Regression 6 controls for capital tangibility again along with full set of firm-level controls, firm fixed effects, and industry × event fixed effects. The yearly variables are lagged to the latest year before the FOMC meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. Log scope 1+2 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 and scope 2 carbon emissions standardized by CPI-adjusted yearly operating revenue. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level for MP-JK and at firm level for MP-BRW. $*, **, and *** $ indicate significance on 0.1, 0.05, and 0.01.

Table 16: Robustness test: Using scope 1 and scope 2 emission intensities separately for the euro area

	Dependent variable:					
	Stock returns on ECB announcement days					
Panel A: Complete sample, Log scope 1 intensity	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1 intensity	0.012	0.013	0.006	0.007	0.009	0.009
	(0.024)	(0.024)	(0.021)	(0.021)	(0.021)	(0.021)
MP-GSS-Target : Log scope 1 intensity	−0.002	−0.002	0.002	−0.0001	−0.005	−0.007*
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)
MP-GSS-Path : Log scope 1 intensity	0.007**	0.006*	0.004	0.002	0.003	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
MP-GSS-Target : Capital tangibility		0.009		0.025		0.067***
		(0.020)		(0.018)		(0.024)
MP-GSS-Path : Capital tangibility		0.025		0.022		0.029
		(0.025)		(0.030)		(0.023)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44,014	44,014	44,014	44,014	44,014	44,014
Adjusted R^2	0.411	0.411	0.414	0.414	0.470	0.471
Panel B: Disclosed sample, Log scope 1 intensity	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1 intensity	0.022	0.021	0.004	0.003	−0.037	−0.035
	(0.041)	(0.041)	(0.036)	(0.037)	(0.037)	(0.037)
MP-GSS-Target : Log scope 1 intensity	−0.006*	−0.003	0.004	0.007	−0.0004	0.0003
	(0.003)	(0.004)	(0.006)	(0.007)	(0.008)	(0.008)
MP-GSS-Path : Log scope 1 intensity	0.010**	0.008*	0.004	0.002	−0.004	−0.004
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
MP-GSS-Target : Capital tangibility		−0.045*		−0.052*		−0.022
		(0.026)		(0.027)		(0.045)
MP-GSS-Path : Capital tangibility		0.022		0.031		0.019
		(0.028)		(0.027)		(0.028)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,167	18,167	18,167	18,167	18,167	18,167
Adjusted R^2	0.472	0.472	0.478	0.478	0.566	0.566
Panel C: Complete sample, Log scope 2 intensity	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 2 intensity	0.014	0.016	0.013	0.015	−0.0001	−0.0002
	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)
MP-GSS-Target : Log scope 2 intensity	−0.003	−0.004	−0.001	−0.003	0.009	0.008
	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)	(0.008)
MP-GSS-Path : Log scope 2 intensity	0.005	0.002	0.0003	−0.002	0.004**	0.004*
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
MP-GSS-Target : Capital tangibility		0.006		0.031		0.052*
		(0.024)		(0.027)		(0.028)
MP-GSS-Oath : Capital tangibility		0.045		0.035		0.030
		(0.028)		(0.031)		(0.023)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44,014	44,014	44,014	44,014	44,014	44,014
Adjusted R^2	0.411	0.411	0.414	0.414	0.471	0.471
Panel D: Disclosed sample, Log scope 2 intensity	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 2 intensity	0.047	0.049	0.039	0.040	−0.009	−0.009
	(0.047)	(0.047)	(0.044)	(0.044)	(0.038)	(0.038)
MP-GSS-Target : Log scope 2 intensity	−0.008*	−0.005	0.0004	0.001	0.019	0.021
	(0.004)	(0.004)	(0.005)	(0.005)	(0.018)	(0.020)
MP-GSS-Path : Log scope 2 intensity	0.003	−0.0005	−0.006	−0.009*	−0.002	−0.002
	(0.006)	(0.005)	(0.004)	(0.005)	(0.006)	(0.006)
MP-GSS-Target : Capital tangibility		−0.046**		−0.016		−0.051
		(0.021)		(0.029)		(0.066)
MP-GSS-Path : Capital tangibility		0.066**		0.061*		0.016
		(0.030)		(0.034)		(0.028)
Industry.Event FE					Yes	Yes
Control Variables			Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,167	18,167	18,167	18,167	18,167	18,167
Adjusted R^2	0.471	0.472	0.478	0.478	0.567	0.566

This table reports the results of regressions of stock returns during ECB meeting days on the interaction between monetary policy shocks and firm characteristics, including firms' scope 1 emission intensities in Panels A and B and firms' scope 2 emission intensities in Paneb C and D. Regression 1 controls only for firms' emission intensities and emissions disclosure rates, and includes firm-level and event-level fixed effects. Regression 2 adds a control for capital tangibility. Regression 3 replaces capital tangibility with controls for firm size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment. Regression 4 adds capital tangibility to these firm-level controls. Regression 5 removes capital tangibility and replaces event fixed effects with 4-digit SIC industry × event fixed effects. Regression 6 controls for capital tangibility again along with full set of firm-level controls, firm fixed effects, and industry × event fixed effects. The yearly variables are lagged to the latest year before the ECB meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. Log scope 1 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 carbon

Table 17: Robustness check: alternative measures of monetary policy shock for the euro area

	Dependent variable:					
	Stock returns on ECB announcement days					
Panel A: Complete sample, MP-JK monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.012	0.013	0.009	0.010	0.004	0.005
	(0.027)	(0.027)	(0.024)	(0.024)	(0.024)	(0.024)
MP-JK : Log scope 1+2 intensity	−0.020	0.007	0.223	0.175	0.137	0.051
	(0.359)	(0.364)	(0.347)	(0.339)	(0.380)	(0.378)
MP-JK : Capital tangibility		−0.286		0.567		2.362**
		(1.535)		(1.400)		(1.195)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44,342	44,342	44,342	44,342	44,342	44,342
Adjusted R^2	0.417	0.417	0.419	0.419	0.477	0.477
Panel B: Disclosed sample, MP-JK monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.003	−0.002	−0.023	−0.030	−0.109**	−0.108
	(0.060)	(0.060)	(0.054)	(0.055)	(0.056)	(0.066)
MP-JK : Log scope 1+2 intensity	−0.524	−0.128	0.259	0.723	0.791	0.983
	(0.433)	(0.458)	(0.511)	(0.583)	(0.603)	(1.093)
MP-JK : Capital tangibility		−4.535**		−5.351***		−3.776
		(1.828)		(1.698)		(3.631)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,167	18,167	18,167	18,167	18,167	18,167
Adjusted R^2	0.471	0.471	0.476	0.476	0.565	0.565
Panel C: Complete sample, MP-K monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.006	0.008	0.0002	0.002	0.002	0.002
	(0.028)	(0.028)	(0.025)	(0.025)	(0.024)	(0.024)
MP-K : Log scope 1+2 intensity	0.346	0.209	0.169	0.054	0.039	−0.011
	(0.297)	(0.235)	(0.246)	(0.191)	(0.171)	(0.174)
MP-K : Capital tangibility		1.578		1.387		1.207
		(1.464)		(1.516)		(1.114)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44,342	44,342	44,342	44,342	44,342	44,342
Adjusted R^2	0.417	0.417	0.420	0.420	0.478	0.478
Panel D: Disclosed sample, MP-K monetary shock series						
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	−0.009	−0.011	−0.029	−0.032	−0.090*	−0.088
	(0.065)	(0.064)	(0.056)	(0.055)	(0.055)	(0.063)
MP-K : Log scope 1+2 intensity	0.204	0.144	−0.016	−0.121	−0.476	−0.413
	(0.365)	(0.337)	(0.228)	(0.189)	(0.339)	(0.289)
MP-K : Capital tangibility		0.700		1.195		−1.019
		(1.770)		(1.962)		(1.178)
Industry.Event FE					Yes	Yes
Event date FE	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,167	18,167	18,167	18,167	18,167	18,167
Adjusted R^2	0.471	0.471	0.474	0.474	0.564	0.564

This table reports the results for the robustness tests for the euro area where we use alternative measures of monetary policy shocks. Panels A and B use monetary policy shocks of Jarociński and Karadi (MP-JK) and Panels C and D use shocks provided of Kerssenfischer (MP-K). The dependent variable being stock returns on ECB meeting days, Regression 1 controls only for firms' emission intensities and emissions disclosure ratio, and includes firm-level and event-level fixed effects. Regression 2 adds a control for capital tangibility. Regression 3 replaces capital tangibility with controls for firm size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment. Regression 4 adds capital tangibility to these firm-level controls. Regression 5 removes capital tangibility and replaces event fixed effects with 4-digit SIC industry × event fixed effects. Regression 6 controls for capital tangibility again along with full set of firm-level controls, firm fixed effects, and industry × event fixed effects. The yearly variables are lagged to the latest year before the ECB meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. Log scope 1+2 intensity (tCO2e / $M operating revenue) refers to the firm's scope 1 and scope 2 carbon emissions standardized by CPI-adjusted yearly operating revenue. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and *** indicate significance on 0.1, 0.05, and 0.01.

8.3 Appendix C: Mechanisms

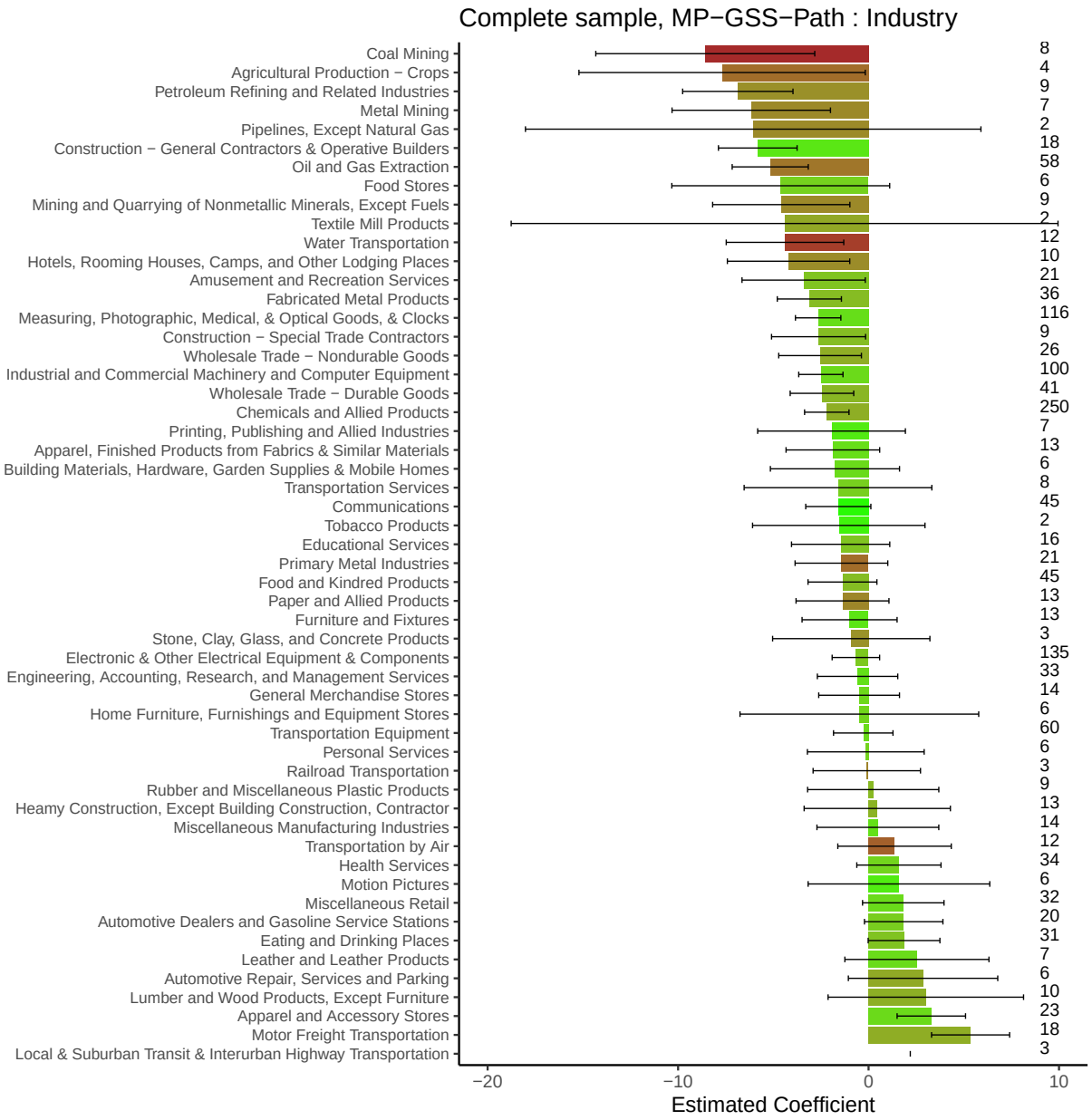


Figure 10: Emission intensity of 2-digit SIC industries and their reaction to Path factor in the U.S.

This figure shows the coefficients estimated for the interaction of 2-digit SIC industry dummies with path factor shocks in a regression that regresses stock returns on a complete set of interaction terms between target factor and path factor shocks and all firm-level characteristics, including emission intensity and capital tangibility. The regression includes firm fixed effects and event date fixed effects and covers 2005-2022 period for the U.S. 90

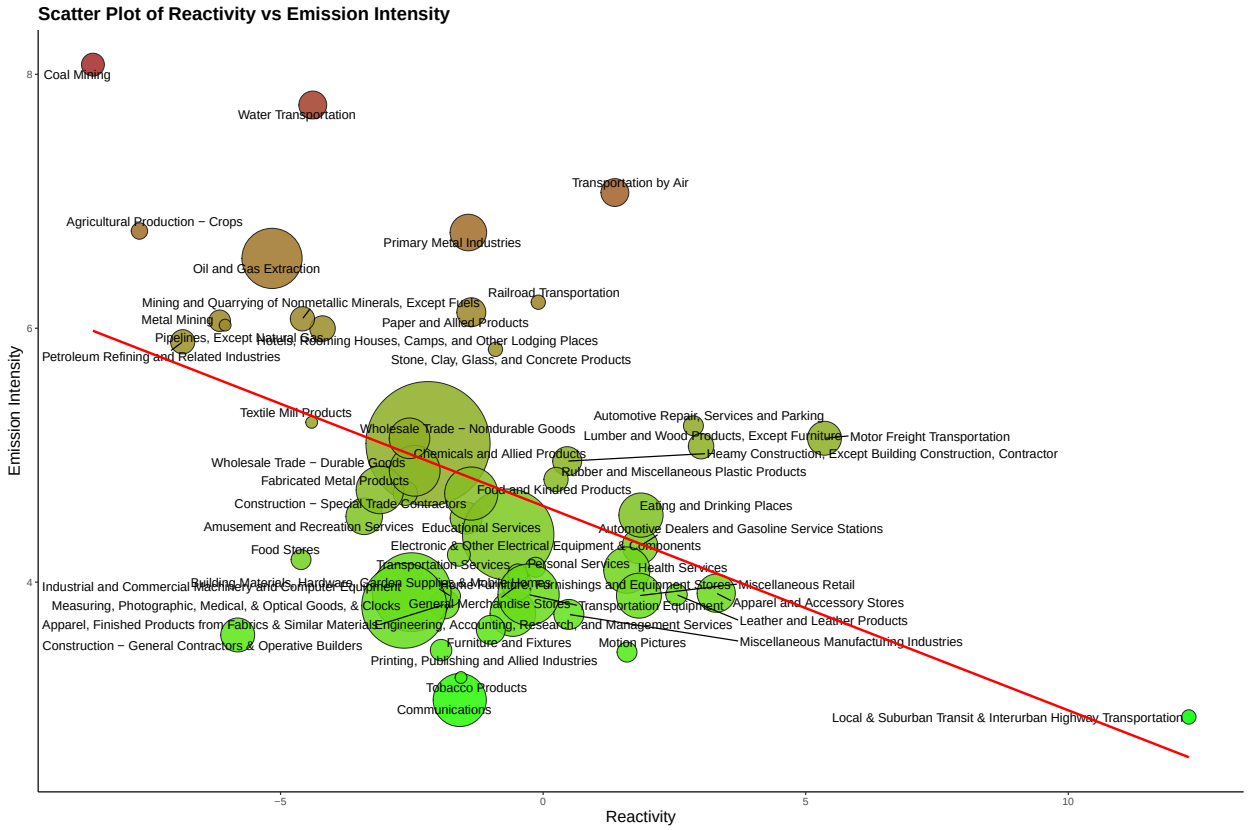


Figure 11: The correlation between emission intensity of 2-digit SIC industries and their reaction to Path factor in the U.S.

This figure shows the correlation between the 2-digit SIC industry-level average log scope 1+2 emission intensities and the coefficients estimated for the interaction of 2-digit SIC industry dummies with path factor shocks in a regression that regresses stock returns on a complete set of interaction terms between target factor and path factor shocks and all firm-level characteristics, including emission intensity and capital tangibility. The regression includes firm fixed effects and event date fixed effects and covers 2005-2022 period for the U.S. The reference group for industry dummies is Business Services (73) which is the industry with lowest emission intensity. The colors correspond to scope 1+2 emission intensity of the industry where green reflects lowest and red reflects the highest value. The size of the circles reflect the size of industries in terms of observations in our sample. This figure is related to Section 4.1. and shows that Energy and Mining industries are the industries driving the correlation between industry emission intensity and industry reactivity to path factor shocks.

8.4 Appendix D: Robustness of Carbon emission intensity - Capital tangibility channel

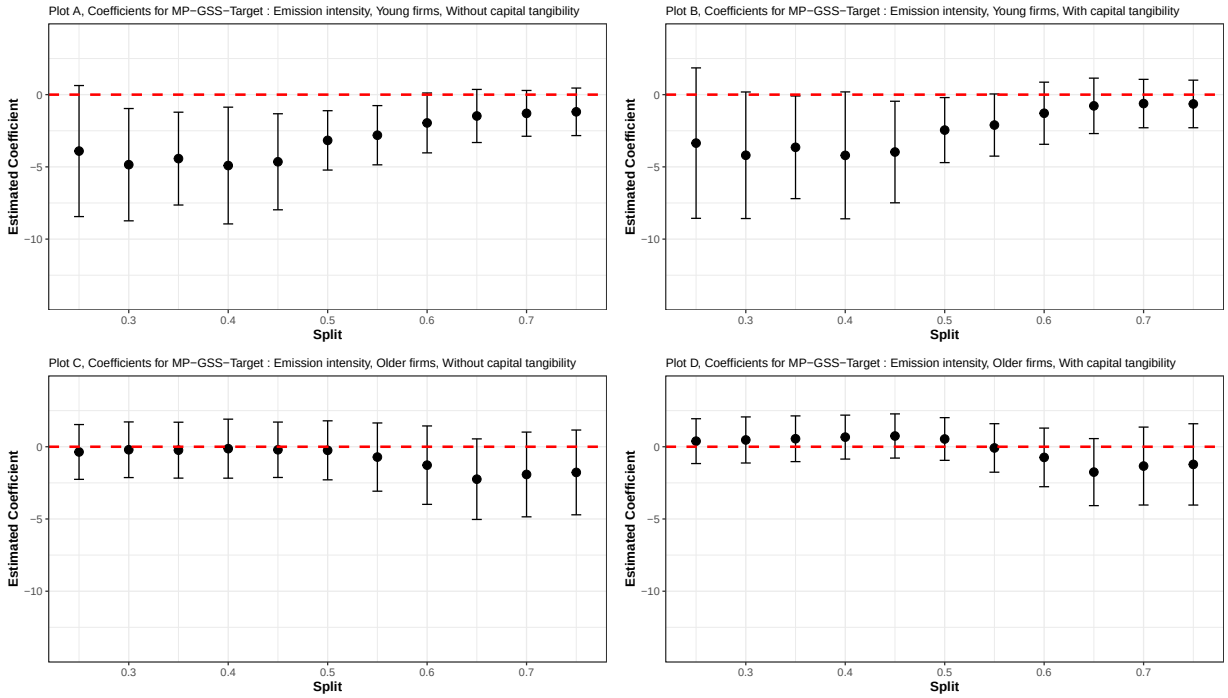


Figure 12: The credit transmission channel's impact on brown firms based on firm age

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm emission intensity** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm age. Younger age is a proxy for firm's financial constraint. Plot A and B use the sample of younger firms (age below the given percentile). Plot A uses the complete model excluding the control for capital tangibility. Plot B uses the complete model that includes capital tangibility. Plot C and D use the sample of older firms (age above the given percentile) where Plot C is based on the complete model excluding capital tangibility while Plot D is based on the complete model including the control for capital tangibility. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

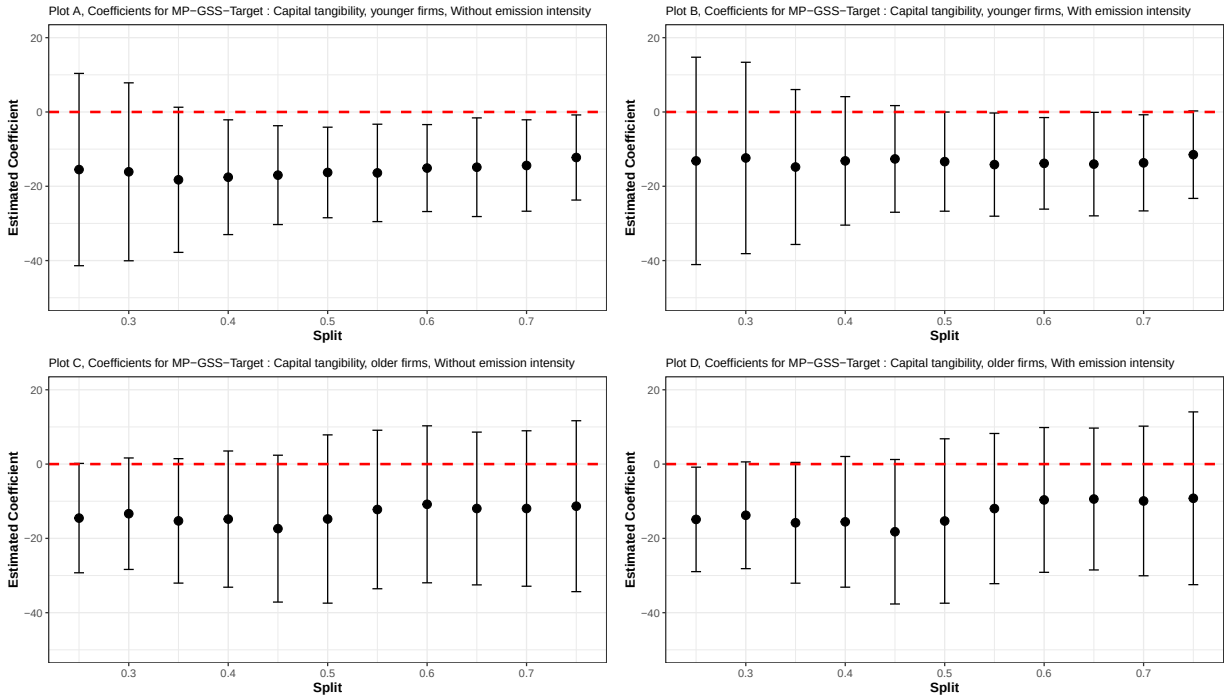


Figure 13: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm age

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm capital tangibility** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm age. Younger age is a proxy for firm's financial constraint. Plot A and B use the sample of younger firms (age below the given percentile). Plot A uses the complete model excluding the control for emission intensity. Plot B uses the complete model that includes emission intensity. Plot C and D use the sample of older firms (age above the given percentile) where Plot C is based on the complete model excluding emission intensity while Plot D is based on the complete model including the control for emission intensity. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

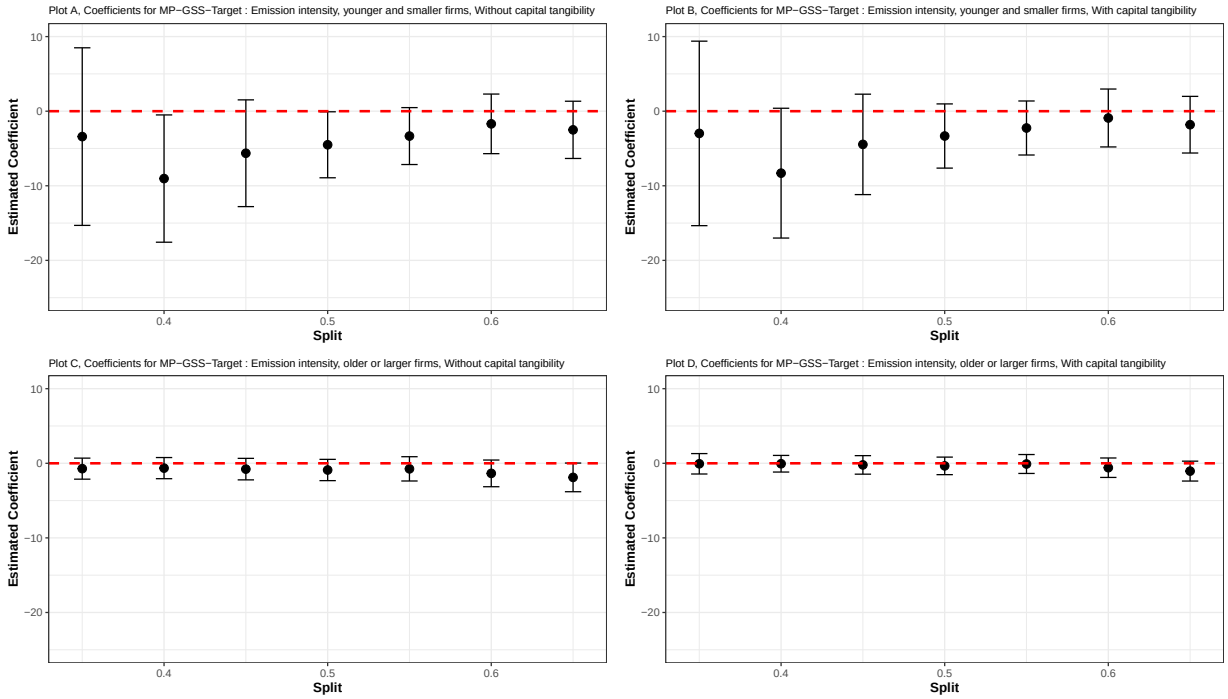


Figure 14: The credit transmission channel's impact on green and brown firms based on firm age and size

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm emission intensity** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm age and size. Younger age and smaller size are a proxies for firm's financial constraint. Plot A and B use the sample of younger and smaller firms (age and size below the given percentile). Plot A uses the complete model excluding the control for capital tangibility. Plot B uses the complete model that includes capital tangibility. Plot C and D use the sample of older or larger firms (age or size above the given percentile) where Plot C is based on the complete model excluding capital tangibility while Plot D is based on the complete model including the control for capital tangibility. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

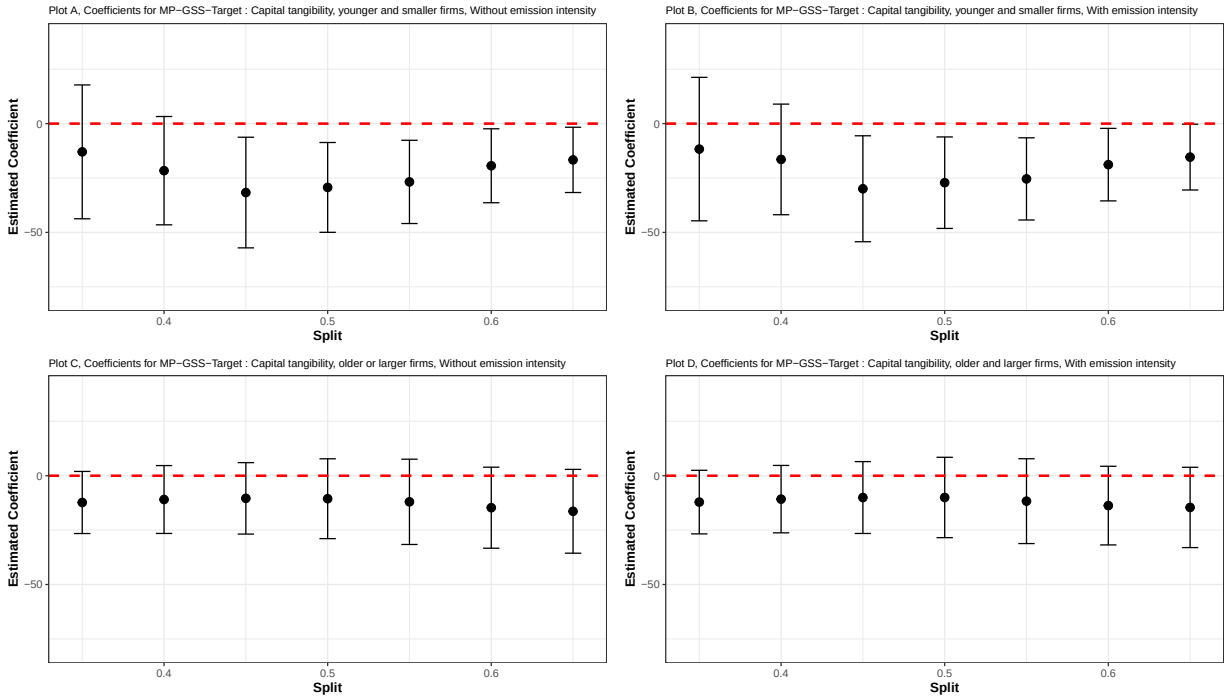


Figure 15: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm age and size

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm capital tangibility** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm age and size. Younger age and smaller size are a proxies for firm's financial constraint. Plot A and B use the sample of younger and smaller firms (age and size below the given percentile). Plot A uses the complete model excluding the control for emission intensity. Plot B uses the complete model that includes emission intensity. Plot C and D use the sample of older or larger firms (age or size above the given percentile) where Plot C is based on the complete model excluding emission intensity while Plot D is based on the complete model including the control for emission intensity. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

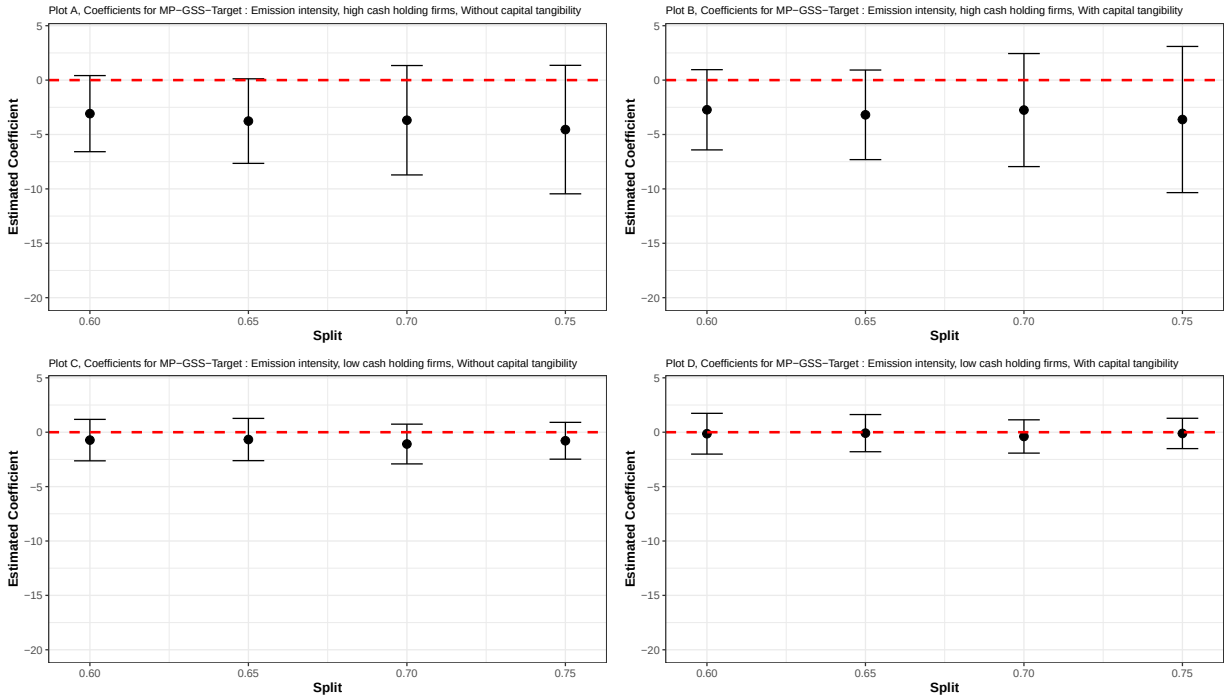


Figure 16: The credit transmission channel's impact on green and brown firms based on firm cash holding

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm emission intensity** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm cash holding. High cash holding is a proxy for firm's financial constraint. Plot A and B use the sample of firms with high cash holding (cash holding above the given percentile). Plot A uses the complete model excluding the control for capital tangibility. Plot B uses the complete model that includes capital tangibility. Plot C and D use the sample of firms with low cash holding (cash holding below the given percentile) where Plot C is based on the complete model excluding capital tangibility while Plot D is based on the complete model including the control for capital tangibility. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

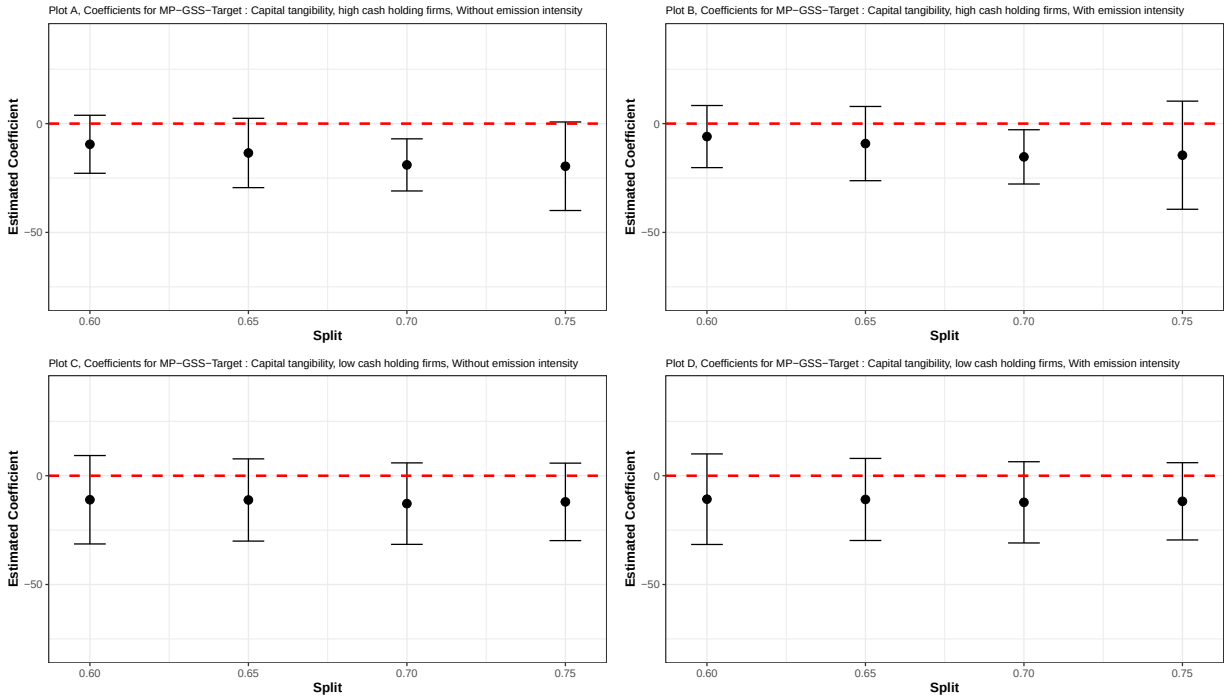


Figure 17: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm cash holding

The plots in this figure report the estimated coefficients for interaction of **MP-GSS-TARGET with firm capital tangibility** and its 95% confidence intervals across different samples. The X-axis reports the cutoff rate used for splitting the sample per event date based on firm cash holding. High cash holding is a proxy for firm's financial constraint. Plot A and B use the sample of firms with high cash holding (cash holding above the given percentile). Plot A uses the complete model excluding the control for emission intensity. Plot B uses the complete model that includes emission intensity. Plot C and D use the sample of firms with low cash holding (cash holding below the given percentile) where Plot C is based on the complete model excluding emission intensity while Plot D is based on the complete model including the control for emission intensity. All regressions control for firm size, age, leverage, cash flow, cash holding, dividend payment, and disclosure ratio. All regressions include firm fixed effects and 4 digit SIC (industry × event) fixed effects. Confidence intervals are based on standard errors clustered on firm and event level.

8.5 Appendix E: Transition risk proxied by earnings call transcripts discussions

Table 18: Transition risk with regulatory risk measure in the U.S.

	Dependent variable:						
	Stock returns on FOMC meeting day						
Panel A: Complete sample, Log scope 1+2 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-GSS-Target : Log scope 1+2 intensity	−1.980**	−1.998**	−1.145**	−1.698**	−1.033**	−0.575	−0.269
	(0.976)	(0.986)	(0.485)	(0.787)	(0.443)	(0.561)	(0.447)
MP-GSS-Path : Log scope 1+2 intensity	−1.012***	−1.048***	−0.813***	−0.716**	−0.596**	0.290	0.395
	(0.347)	(0.337)	(0.227)	(0.280)	(0.245)	(0.351)	(0.349)
MP-GSS-Target : Regulatory risk		−8.160*	−7.900*	−8.484*	−8.242*	−2.020	−1.709
		(4.383)	(4.438)	(4.513)	(4.542)	(3.751)	(3.761)
MMP-GSS-Path : Regulatory risk		−3.290**	−3.233**	−3.281**	−3.252**	0.251	0.303
		(1.321)	(1.282)	(1.298)	(1.280)	(0.663)	(0.660)
MP-GSS-Target : Capital tangibility			−5.767		−4.483		−5.402
			(4.520)		(3.972)		(3.688)
MP-GSS-Path : Capital tangibility			−1.686		−0.847		−1.864*
			(1.663)		(1.374)		(1.091)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	91,811	81,596	81,596	81,596	81,596	81,596	81,596
Adjusted R^2	0.318	0.328	0.328	0.329	0.329	0.432	0.432
Panel B: Disclosed sample, Log scope 1+2 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-GSS-Target : Log scope 1+2 intensity	−4.668**	−4.481**	−3.014*	−4.735**	−3.777***	−2.147	−2.063
	(2.270)	(2.146)	(1.524)	(1.943)	(1.403)	(1.833)	(1.634)
MP-GSS-Path : Log scope 1+2 intensity	−1.439***	−1.397***	−1.428***	−1.246***	−1.347***	0.281	0.061
	(0.430)	(0.415)	(0.348)	(0.428)	(0.358)	(0.513)	(0.444)
MP-GSS-Target : Regulatory risk		2.807	3.555	2.651	3.159	7.968	7.995
		(6.013)	(6.162)	(5.495)	(5.594)	(5.194)	(5.266)
MP-GSS-Path : Regulatory risk		−4.467**	−4.559**	−4.591**	−4.693**	0.005	−0.107
		(2.064)	(2.112)	(2.233)	(2.288)	(1.658)	(1.642)
MP-GSS-Target : Capital tangibility			−11.466		−7.410		−0.916
			(8.469)		(7.849)		(9.298)
MP-GSS-Path : Capital tangibility			0.312		0.865		2.638
			(2.257)		(1.965)		(2.433)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	19,462	18,676	18,676	18,676	18,676	18,676	18,676
Adjusted R^2	0.363	0.365	0.365	0.368	0.368	0.549	0.549
Panel C: Complete sample, Log scope 1 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-GSS-Target : Log scope 1 intensity	−1.477*	−1.458*	−0.788*	−1.237**	−0.712*	−0.355	−0.164
	(0.768)	(0.769)	(0.432)	(0.613)	(0.371)	(0.424)	(0.380)
MP-GSS-Path : Log scope 1 intensity	−0.811***	−0.823***	−0.658***	−0.577***	−0.502***	0.399	0.460
	(0.284)	(0.273)	(0.201)	(0.188)	(0.145)	(0.294)	(0.295)
MP-GSS-Target : Regulatory risk		−8.113*	−7.822*	−8.430*	−8.162*	−2.099	−1.754
		(4.351)	(4.432)	(4.488)	(4.538)	(3.748)	(3.761)
MP-GSS-Path : Regulatory risk		−3.215**	−3.151**	−3.208**	−3.186**	0.260	0.324
		(1.310)	(1.275)	(1.284)	(1.273)	(0.670)	(0.669)
MP-GSS-Target : Capital tangibility			−6.425		−5.059		−5.544
			(4.373)		(3.773)		(3.799)
MP-GSS-Path : Capital tangibility			−1.676		−0.754		−1.863
			(1.542)		(1.364)		(1.126)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	91,811	81,596	81,596	81,596	81,596	81,596	81,596
Adjusted R^2	0.318	0.328	0.328	0.329	0.329	0.432	0.432
Panel D: Disclosed sample, Log scope 1 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-GSS-Target : Log scope 1 intensity	−3.283**	−3.186**	−2.048*	−3.643***	−3.019***	−2.302*	−2.270*
	(1.510)	(1.419)	(1.057)	(1.305)	(0.918)	(1.367)	(1.166)
MP-GSS-Path : Log scope 1 intensity	−1.133***	−1.107***	−1.165***	−1.008***	−1.118***	0.311	0.202
	(0.298)	(0.287)	(0.316)	(0.288)	(0.246)	(0.417)	(0.344)
MP-GSS-Target : Regulatory risk		2.775	3.812	2.822	3.422	8.040	8.081
		(5.881)	(6.161)	(5.251)	(5.478)	(5.015)	(5.186)
MP-GSS-Path : Regulatory risk		−4.259**	−4.407**	−4.413**	−4.556**	0.063	−0.067
		(1.996)	(2.074)	(2.141)	(2.215)	(1.608)	(1.630)
MP-GSS-Target : Capital tangibility			−13.079		−6.988		−0.607
			(10.704)		(8.939)		(8.848)
MP-GSS-Path : Capital tangibility			0.723		1.299		2.293
			(2.870)		(2.239)		(2.184)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	19,462	18,676	18,676	18,676	18,676	18,676	18,676
Adjusted R^2	0.363	0.364	0.365	0.368	0.368	0.549	0.549

This table reports the results for regressions of stock returns on FOMC meeting days on interactions of monetary policy with firm-level control variables, including regulatory risk measure. Regulatory risk is a binary variable indicating if a firm discussed climate-regulation risk in previous four quarters' earnings calls and is provided by Sautner, Van Lent, Vilkov, and Zhang (2023). Panel A and B use log scope 1+2 emission intensity alongside regulatory risk and Panel C and D use log scope 1 emission intensity because scope 1 emissions reflects emissions directly controlled by the firm that increase the risk of carbon regulation to impact the firm. Firm-level controls are size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment dummy, and emission disclosure ratio. The yearly variables are lagged to the latest year before the FOMC meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and *** $ indicate significance on 0.1, 0.05, and 0.01.

Table 19: Transition risk with regulatory risk measure in Euro area

	Dependent variable:						
	Stock returns on ECB announcement day						
Panel A: Complete sample, Log scope 1+2 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-Target : Log scope 1+2 intensity	−0.001	−0.002	0.002	0.008	0.008	0.005	−0.001
	(0.005)	(0.005)	(0.007)	(0.009)	(0.010)	(0.009)	(0.009)
MP-FG : Log scope 1+2 intensity	0.009**	0.008*	0.005	0.004	0.002	−0.003	−0.006
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
MP-Target : Regulatory risk		−0.104***	−0.101***	−0.091***	−0.091***	−0.052**	−0.063**
		(0.036)	(0.037)	(0.030)	(0.031)	(0.025)	(0.024)
MP-FG : Regulatory risk		0.028	0.027	0.047*	0.046*	0.079***	0.074***
		(0.024)	(0.023)	(0.026)	(0.026)	(0.018)	(0.019)
MP-Target : Capital tangibility			−0.039		−0.005		0.096**
			(0.029)		(0.027)		(0.046)
MP-FG : Capital tangibility			0.033		0.030		0.045
			(0.030)		(0.033)		(0.030)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	44,014	26,526	26,526	26,526	26,526	26,526	26,526
Adjusted R^2	0.411	0.443	0.443	0.448	0.448	0.521	0.521
Panel B: Disclosed sample, Log scope 1+2 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-Target : Log scope 1+2 intensity	−0.005	−0.007*	−0.004	0.009	0.013	0.012	0.017
	(0.004)	(0.004)	(0.006)	(0.009)	(0.011)	(0.016)	(0.020)
MP-FG : Log scope 1+2 intensity	0.012**	0.011**	0.006	0.002	−0.005	−0.008	−0.010
	(0.005)	(0.005)	(0.006)	(0.007)	(0.006)	(0.007)	(0.010)
MP-Target : Regulatory risk		−0.117**	−0.110**	−0.097**	−0.090**	−0.077**	−0.066*
		(0.052)	(0.050)	(0.040)	(0.039)	(0.030)	(0.037)
MP-FG : Regulatory risk		0.030	0.027	0.056***	0.050***	0.058***	0.059***
		(0.019)	(0.018)	(0.016)	(0.016)	(0.018)	(0.020)
MP-Target : Capital tangibility			−0.043		−0.049		−0.084
			(0.040)		(0.044)		(0.109)
MP-FG : Capital tangibility			0.059*		0.081***		0.031
			(0.034)		(0.029)		(0.050)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	18,167	13,417	13,417	13,417	13,417	13,417	13,417
Adjusted R^2	0.472	0.494	0.494	0.501	0.502	0.599	0.599
Panel C: Complete sample, Log scope 1 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-Target : Log scope 1 intensity	−0.002	−0.002	−0.0005	0.005	0.005	−0.004	−0.008
	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.006)	(0.006)
MP-FG : Log scope 1 intensity	0.007**	0.007**	0.005*	0.004	0.002	−0.001	−0.002
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
MP-Target : Regulatory risk		−0.103***	−0.100***	−0.089***	−0.090***	−0.051**	−0.064**
		(0.036)	(0.036)	(0.029)	(0.029)	(0.026)	(0.025)
MP-FG : Regulatory risk		0.027	0.025	0.046*	0.044*	0.078***	0.073***
		(0.024)	(0.023)	(0.026)	(0.026)	(0.019)	(0.020)
MP-Target : Capital tangibility			−0.031		0.006		0.105**
			(0.025)		(0.026)		(0.045)
MP-FG : Capital tangibility			0.028		0.026		0.039
			(0.029)		(0.033)		(0.032)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	44,014	26,526	26,526	26,526	26,526	26,526	26,526
Adjusted R^2	0.411	0.443	0.443	0.448	0.448	0.521	0.521
Panel D: Disclosed sample, Log scope 1 intensity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP-Target : Log scope 1 intensity	−0.006*	−0.007*	−0.004	0.006	0.008	−0.008	−0.007
	(0.003)	(0.004)	(0.004)	(0.007)	(0.008)	(0.011)	(0.009)
MP-FG : Log scope 1 intensity	0.010**	0.009*	0.005	0.001	−0.003	−0.008	−0.008
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
MP-Target : Regulatory risk		−0.114**	−0.109**	−0.096**	−0.092**	−0.076**	−0.070**
		(0.052)	(0.050)	(0.039)	(0.038)	(0.031)	(0.034)
MP-FG : Regulatory risk		0.028	0.024	0.055***	0.050***	0.058***	0.058***
		(0.019)	(0.018)	(0.015)	(0.016)	(0.017)	(0.018)
MP-Target : Capital tangibility			−0.037		−0.032		−0.050
			(0.033)		(0.036)		(0.084)
MP-FG : Capital tangibility			0.062*		0.072***		0.022
			(0.032)		(0.027)		(0.043)
Industry.Event FE						Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event date FE	Yes	Yes	Yes	Yes	Yes		
Control Variables				Yes	Yes	Yes	Yes
Observations	18,167	13,417	13,417	13,417	13,417	13,417	13,417
Adjusted R^2	0.472	0.494	0.494	0.501	0.501	0.598	0.598

This table reports the results for regressions of stock returns on ECB meeting days on interactions of monetary policy with firm-level control variables, including regulatory risk measure. Regulatory risk is a binary variable indicating if a firm discussed climate-regulation risk in previous four quarters' earnings calls and is provided by Sautner, Van Lent, Vilkov, and Zhang (2023). Panel A and B use log scope 1+2 emission intensity alongside regulatory risk and Panel C and D use log scope 1 emission intensity because scope 1 emissions reflects emissions directly controlled by the firm that increase the risk of carbon regulation to impact the firm. Firm-level controls are size, age, leverage, Tobin's q, cash holding, cash flow, dividend payment dummy, and emission disclosure ratio. The yearly variables are lagged to the latest year before the ECB meeting and quarterly variables are lagged by one quarter to address endogeneity concerns. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and *** $ indicate significance on 0.1, 0.05, and 0.01.

8.6 Appendix F: Replication of Döttling and Ratnovski for Euro Area

Table 20: Replication of Döttling and Ratnovski for the euro area

	Dependent variable:	
	Stock returns on ECB meeting day	
Panel A: Split by age		
	Below median	Above median
	(1)	(2)
MP-Target : Capital tangibility	0.068*	0.058
	(0.040)	(0.037)
MP-FG : Capital tangibility	−0.010	−0.019
	(0.025)	(0.019)
Industry.Event FE	Yes	Yes
Firm FE	Yes	Yes
Control Variables	Yes	Yes
Observations	64,871	66,116
Adjusted R^2	0.222	0.276
Panel B: Split by age and size		
	Below median	Above median
	(1)	(2)
MP-Target : Capital tangibility	0.097	0.052
	(0.060)	(0.032)
MP-FG : Capital tangibility	0.025	−0.013
	(0.039)	(0.013)
Industry.Event FE	Yes	Yes
Firm FE	Yes	Yes
Control Variables	Yes	Yes
Observations	38,904	92,083
Adjusted R^2	0.199	0.299
Panel C: Split by cash holding		
	Above 3rd quantile	Below 3rd quantile
	(1)	(2)
MP-Target : Capital tangibility	0.064	0.037*
	(0.069)	(0.020)
MP-FG : Capital tangibility	−0.044	−0.010
	(0.028)	(0.012)
Industry.Event FE	Yes	Yes
Firm FE	Yes	Yes
Control Variables	Yes	Yes
Observations	32,766	98,221
Adjusted R^2	0.210	0.254

This table replicates the weaker transmission channel of monetary policy to intangible-intesive firms for the euro area following Döttling and Ratnovski's work for the U.S. This table regresses stock returns on ECB meeting days on interaction terms of monetary shocks and full set of firm-level controls, including capital tangibility. To increase the sample size, this table excludes emission intensity in order to encompass more firms and also eliminates the exclusion of firms based on market cap and stock price in its sampling procedure, which increases the number of unique firms from 696 to 1456. Panel A splits the sample based on median age, Panebl B splits the sample based on median age and size, and Panel C splits the sample based on the third quantile of cash holding, in order to separate financially constrained firms. MP-Target and MP-FG are the Target factor and Forward Guidance factor from Altavilla et al. (2019) and the analyzed period is 2005-2022. Firm-level control variables are size, age, leverage, Tobin's q, cash holding, cash flow, and dividend payment dummy. Firm fixed effects and 4-digit SIC industry × event date fixed effects are used. All firm-level variables are winsorized by 0.5%. The stock returns are winsorized by 1% per each event. Standard errors are clustered at firm and event level. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.