Firms' Carbon Emissions and Monetary Policy

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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. Our findings contribute to the discussion on integrating climate considerations into monetary policy.

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[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.

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 explore the potential existence of the carbon bias in the transmission of all monetary policy tools. Specifically, 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.

Brown and green firms might react differently to monetary policy shocks via three channels. First, brown and green firms belong to different industries and past literature has already shown that some industries (e.g., those that produce durable goods) are more reactive to monetary policy shocks than others because their consumption can be postponed (Dedola and Lippi, 2005; Peersman and Smets (2002). We refer to this as the industry channel. Second, carbon emissions intensity is correlated with capital tangibility. Döttling and Ratnovski (2023) show that monetary policy has a weaker impact on firms with more intangible capital relative to tangible capital due to the weaker credit transmission channel. Their results imply that capital tangibility might act as a confounding factor in the analysis of the carbon bias of the monetary policy transmission. We refer to this as capital tangibility channel. Finally, in a contemporaneous study, Döttling and Lam (2024) show that U.S. firms with larger scope 1 emissions are more reactive to changes in monetary policy because larger carbon emitters are more prone to transition risk. We refer to this as transition risk channel.

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, 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)

[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/

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 for the euro area.

Our study provides several novel findings. We begin by demonstrating that, in a regression without firm- and industry-level controls, emissions intensity affects monetary policy transmission in the U.S., but not in the euro area. One standard deviation increase in emissions intensity is associated with a 3.6 basis point larger reaction to the average target factor shock and a 4.1 basis point larger reaction to the average path factor shock in our U.S. sample. 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, the 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 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, the introduction of interactions of monetary policy shocks with 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 channels.

To further explore the industry channel, we demonstrate that carbon bias in the U.S. is driven by a strong correlation between the industry reactivity to monetary policy shocks that impact the future interest rates (path factor)

[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".

and the carbon emissions intensity of those industries. In particular, the energy extraction and mining industries 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 contains only 7 firms. During the study period, the U.S. emerged as the only country 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 monetary policy on U.S. 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.

Next, we show capital tangibility channel in the U.S is driven by strong correlation of 74 percent between firms' carbon emissions intensity and capital tangibility. Since Döttling and Ratnovski (2023) demonstrate that capital tangibility strengthens the transmission of monetary policy to current interest rates (target factor), it is unsurprising that including this variable in our model reduces the magnitude of the carbon bias in the U.S. In other words, capital tangibility acts as a confounding variable. Consistent with Döttling and Ratnovski (2023), we show that this effect is more pronounced for financially constrained firms, measured by age, size and cash holding, aligning with the credit channel of monetary policy transmission. In the euro area, we also observe a strong correlation of 64 percent between firms' carbon emissions intensity and their capital tangibility. However, when replicating the findings of Döttling and Ratnovski (2023) for the euro area, we do not find that capital tangibility strengthens 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 capture a company's exposure to transition risk as they are directly controlled by the company and reflect their 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 only holds for the largest polluters in the U.S. This is not surprising, because largest polluters are more likely to be subjected to carbon regulation.

Importantly, our three channels of carbon bias respond differently to various dimensions of monetary policy shocks, i.e. target or path factor. Industry channel appears to react to monetary policy shocks that shape future interest rates, such as forward guidance and quantitative easing (path factor). In contrast, capital tangibility channel and transition risk channel react to monetary policy shocks that shape current interest rates (target factor). This

is in line 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 firm investment 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 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). However, our paper is the only that attempts to apply the same methodology for both regions. Moreover, our approach is different. We start by measuring carbon bias in regressions without control variables, because we believe that its size is important for policy makers interested in the transition to zero-carbon economy. Then, we introduce control variables to explore three different channels (industry reactivity channel, capital tangibility, transition risk). Other studies appear to focus on transition risk or carbon premium that can be measured only in regressions with a full set of controls. There are also differences in the variable definition and sample construction.

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 emissions or 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 emissions intensities and to distinguish between disclosed and estimated data is motivated by Aswani et al. (2023), and, while it is not the focus of the paper, we also 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 market data 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, 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 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 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).

Figure 1 presents the number of firms covered by Trucost in the U.S. and the euro area. The coverage has increased over time, in particular in 2016, in the wake of the Paris Agreement, when Trucost increased the coverage of its emissions estimations. [5] 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 the U.S. and the euro area. Firms that disclose emissions are bigger, older, have higher emissions intensity, capital tangibility and regulatory risk 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, to which we refer as complete sample, and 2) only the disclosed data. 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. 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.[6] 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 only 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 (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.

[5] Nevertheless, the share of firms for which we have data on emissions is low. Even at the end of the analyzed period, only around 10% of listed firms disclosed their emissions and Trucost estimated emissions data for an additional 22% of euro area firms and 38% of the U.S. firms.

[6] 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.

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 from its R&D expenses and 30% of its SG&A expenses. 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 euro area. We find that intangible capital on a firm's balance captures 17% (26%) of the total intangible capital for the median (mean) euro area firm for universe of Trucost firms in euro area, which is higher than in the U.S. sample.

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 emissions 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 slightly 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. 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 emissions intensity and capital tangibility in the U.S. and the euro area for complete and 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 refers to the unexpected changes in the current month's Federal Funds Futures contracts similar to Kuttner (2001), while the second dimension refers to the changes in the perception of the future interest rates (up to 1 year), such as forward guidance. Following Gürkaynak, Sack, and Swanson (2005), we refer to them as target and path factors of the monetary policy.

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: target factor and path factor. However, unlike the path factor in the US that includes forward guidance and quantitative easing, the euro area path factor includes only forward guidance.

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. In light of this challenge, it's important to provide robustness tests with different definitions of monetary policy shocks.

3 Methodology

We use two methodologies. First, 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 effect 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 variables of interest are the two interactions between monetary policy shocks (target and path factors) with the logarithm of emissions intensity. When these interaction terms 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, while a positive sign suggests a weaker transmission to these firms.

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 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:

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

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), industry*quarter 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 95% 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 results are reported in Table 7 for the U.S. and Table 8 for the euro area. Panel A reports findings for the full sample, while Panel B 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 Column (1), provide clear evidence for carbon bias. 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 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, 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 carbon bias in the reaction to the target factor of monetary policy. 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, because tangible assets are a good source of collateral, while intangible capital 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 in consistent with carbon capital tangibility channel that we will explore in more detail in the section 5.2. [7]

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 attributed to differences in industry-level reactivity to monetary policy shocks, with more carbon-intensive industries being disproportionately sensitive. This is consistent with industry channel that we will explore in greater detail in the next section.

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. The interaction between emissions intensity and the target factor remains statistically insignificant across all specifications. The interaction of emissions intensity with the path factor is positive and significant at 5%, but carbon bias 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

[7] 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).

Table 5). This positive coefficient is also not robust across different time periods or other measures of monetary policy shocks. 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. 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 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. This result only holds when using Scope 1, but not Scope 2 emissions intensity. More importantly, when we rely on alternative monetary policy shocks, the interaction between monetary policy shocks and carbon emissions intensity loses significance.

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 different industry reactivity to monetary policy shocks. In contrast, we do not find robust evidence of a carbon bias in the euro area.

5 Mechanisms

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 heterogeneity; 2) emissions intensity – capital tangibility channel; 3) transition risk.

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 reactivity is correlated with 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 types of monetary policy shocks: the target factor and path factor. We then plot these interaction variables, where the color of each industry corresponds to its carbon emissions intensity ranging from the lowest (in services) to the highest (energy extraction and mining). Our reference group is services, 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 full and disclosed sample. 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 path factor of the monetary policy shocks than industries that are less emissions intensive. We also confirm findings from the past literature that industries that produce or trade durable goods are more reactive to monetary policy shocks. 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 same industry names might include different types of firms.

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 8 reports correlations between industry's reactivity to monetary policy shocks and three key variables: 1) emissions intensity, 2) capital tangibility and 3) emissions-intensity weighted by number of firms in each industry. We first report the correlations across all industries and then exclude energy and mining industries. Specifically, we exclude metal mining, coal mining, oil and gas extraction, mining and quarrying of nonmetallic minerals, and oil pipelines.

Panel A and B in the Table 8 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. 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 observations in our full sample). Importantly, these findings do not hold for target factor, which suggests that the industry 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. 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 energy sector is associated with high reactivity 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 traditional energy sector. On the other hand, this sector is different because it's characterized by high level 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 utilities and 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)[8]. 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 negative 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. For the euro area, the relationship between monetary policy shocks and clean energy is mostly not statistically significant.

To summarize our results in this sub-section, 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 for 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 channel of the monetary policy transmission. 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 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 extending the analysis to earlier periods would result in a sample of very large firms that began reporting emissions prior to the Paris Agreement.

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.

[8]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.

In other words, capital tangibility amplifies monetary policy transmission 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 carbon bias is present only for financially constrained firms. If we control for both control tangibility and emissions intensity, 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 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.

The role of capital tangibility in the carbon bias of the monetary policy is likely to be underestimated in our sample that is restricted to larger firms that disclose carbon emissions or for which carbon emissions are estimated by Trucost. Consequently, our sample of 1671 firms is much smaller than that of Döttling and Ratnovski(2023) who analyze a sample of 9863 firms. Importantly, our sample does not include many smaller and younger firms that are more likely to be financially constrained.

To test the sensitivity of our results to changes in thresholds that define financially constrained firms based on age, size, and chas 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 carbon bias in the reaction to the target factor monetary policy shock 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 emissions intensity – capital tangibility channel. 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). 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. 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 investment needs to transition to a low-emissions regime. 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 firms 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 full sample into firms with absolute carbon emissions above and below the median 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 Scope 1 emissions/revenues), 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 period (Panel A) and for the post-2015 period, because Paris COP21 Agreement is considered as a wake-up calls for financial markets (Panel B).

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. 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 98.8% 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 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 full sample and the sample of firms that disclose carbon data, respectively.

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 a 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 fullest specification. 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 collaborate our findings for the full sample, but confidence intervals are much larger due to the smaller sample size that declines from 1795 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 to different measures of monetary policy shocks.

To understand the difference in findings for the U.S. and euro area, we explore three potential mechanisms that might lead to the carbon bias in the monetary policy transmission: 1) industry channel; 2) capital tangibility channel; and 3) transition risk. First, 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. 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.

Finally, we provide evidence that firms with higher transition risk in the U.S. 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.

From the methodological perspective, we show the importance of reliance on two-factor monetary policy shocks. In particular, we show that capital tangibility channel and transition risk channel operate via target factor (current policy rates), while industry channel operates via path factor (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, September 2024, 114244
- Aswani, J., Raghunandan, A., Rajgopal, S., Are Carbon Emissions Associated with Stock Returns?, Review of Finance, 2023
- Bank of England, 2021. Options for greening the Bank of England's Corporate Bond Purchase Scheme, BoE Discussion Paper
- Barth, M.J., Ramey, V.A., 2002. The cost channel of monetary transmission. In: NBER Macroeconomics Annual 2001. In: NBER Chapters, vol. 16, National Bureau of Economic Research, Inc, pp. 199–256.
- Bernanke, B. S., M. Gertler, and S. Gilchrist. 1996. The financial accelerator and the flight to quality. Review of Economics and Statistics 78:1–15.
- Bernanke, B. S., 1999. The financial accelerator in a quantitative business cycle framework. In Handbook of macroeconomics, eds. J. B. Taylor and M. Woodford, 1341–93. Amsterdam, the Netherlands: Elsevier.
- Bernanke, B.S., Kuttner, K.N., 2005. What Explains the Stock Market's Reaction to Federal Reserve Policy? The Journal of Finance 60, 1221–1257. https://doi.org/10.1111/j.1540-6261.2005.00760.x
- 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
- 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
- Chan, Ying Tung & Punzi, Maria Teresa & Zhao, Hong, 2024. "Green transition and financial stability: The role of green monetary and macroprudential policies and vouchers," Energy Economics, Elsevier, vol. 132(C).
- 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, August 2024, 104798
- Crouzet, N. and J. C. Eberly. 2019. Understanding weak capital investment: The role of market concentration and intangibles. NBER Working Paper 25869.
- Dedola, L., Lippi, F., 2005. The monetary transmission mechanism: Evidence from the industries of five OECD countries. Eur. Econ. Rev. 49 (6), 1543–1569.
- Dell'Ariccia, G., D. Kadyrzhanova, C. Minoiu, and L. Ratnovski,. 2020. Bank lending in the knowledge economy. Review of Financial Studies forthcoming.
- Döttling, R., Ratnovski, L., 2022. Monetary policy and intangible investment. Journal of Monetary Economics S0304393222001337. 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.
- Durante, E., Ferrando, A., Vermeulen, P., 2022. Monetary policy, investment and firm heterogeneity. European Economic Review 148, 104251. https://doi.org/10.1016/j.euroecorev.2022.104251
- 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
- FSOC, 2021. Report on Climate-Related Financial Risk
- 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.
- Ganley, J., Salmon, C., 1996. The industrial impact of monetary policy. Bank of England Quarterly Bulletin Q3, 288–298.
- Goldstein, I., 2023. Information in Financial Markets and Its Real Effects, Review of Finance, Volume 27, Issue 1, February 2023, Pages 1–32,
- 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, Refet S., Karasoy-Can, Hatice Gökçe, Lee, Sang Seok, 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.
- Hall, B. H. and J. Lerner, 2010. The financing of R&D and innovation. In Handbook of the Economics of Innovation, Volume 1, pp. 609–639. Elsevier.
- 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.
- Harrison. H., Li, F. W., and Xu, J., 2019. Climate Risks and Market Efficiency. Journal of Econometrics, 208(1): 265-281.
- Hengge, Martina, Panizza, Ugo, Varghese, Richard, 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., The Pollution Premium (May 10, 2022). 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
- Kaplan, S. N., and L. Zingales. 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? Quarterly Journal of Economics 112:169–215.
- Kiyotaki, N., and J. Moore. 1997. Credit cycles. Journal of Political Economy 105:211–48.
- 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.
- 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, January 2014, 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 Nakamura, E., Steinsson, J., 2018. High Frequency Identification of Monetary NonNeutrality. Quarterly Journal of Economics, 133 (3), 1283–1330.

- 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.
- 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).
- Rigobon, R., Sack, B., 2004. The impact of monetary policy on asset prices. Journal of Monetary Economics 51, 1553–1575. https://doi.org/10.1016/j.jmoneco.2004.02.004
- Rogers, J., Scotti, C., Wright, J.H., 2018. Unconventional monetary policy and international risk premia. J. Money Credit Bank. 50 (8).
- 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.
- Sharpe, Steven A., and Alex X. Zhou (2020). "The Corporate Bond Market Crises and the Government Response," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, October 07, 2020,https://doi.org/10.17016/2380-7172.2769.
- Swanson, E., 2018. Measuring the effects of federal reserve forward guidance and asset purchases on financial markets. NBER Working Paper No. 23311.
- 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
- Whited, T. M., and G. Wu. 2006. Financial constraints risk. Review of Financial Studies 19531–59. -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 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 NPPE to the sum of NPPE and total intangible capital à la Peters and Taylor	Capital IQ
Regulatory Risk	Binary variable indicating if a firm discussed climate-regulation risk in previous four quarters' earnings 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	% 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)	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

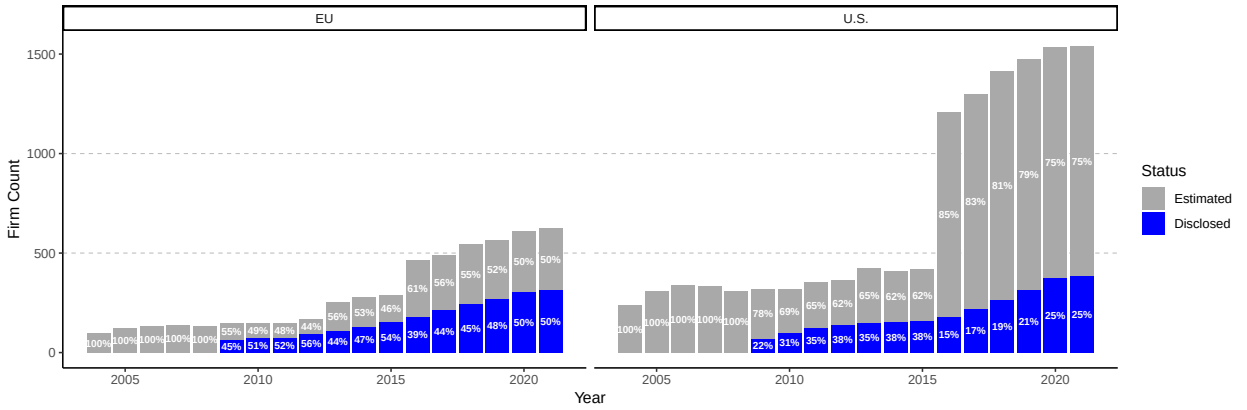


Figure 1: The Trucost sample size per year

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.

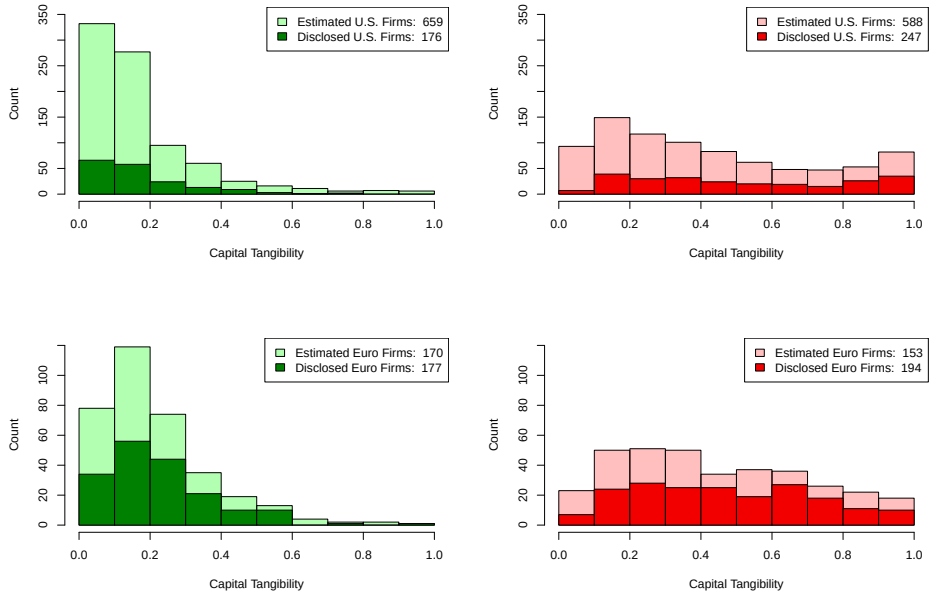


Figure 2: Histogram of capital tangibility for the green and brown firms in the U.S. [top] and Euro area [bottom]

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. 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 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 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.

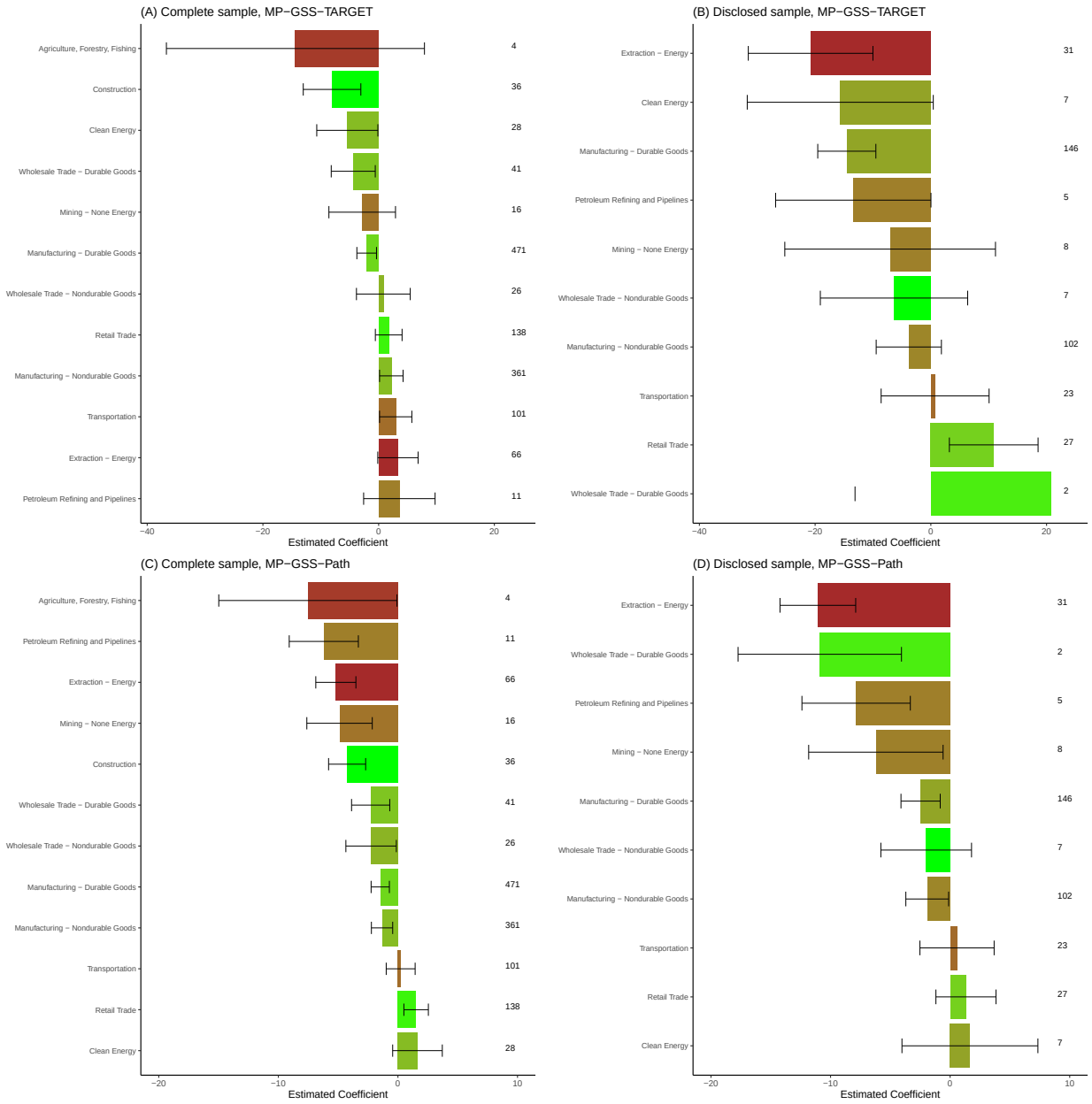


Figure 3: Emission intensity of industries and their reaction to monetary shocks in the U.S.

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. Industries are defined based as 11 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. Colors correspond to the average industry log scope 1+2 emission intensity with green indicating the lowest and red indicating the highest emission intensity. Plots (A) and (B) report the results for target factor shocks and Plots (C) and (D) report the results for the path factor. 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.

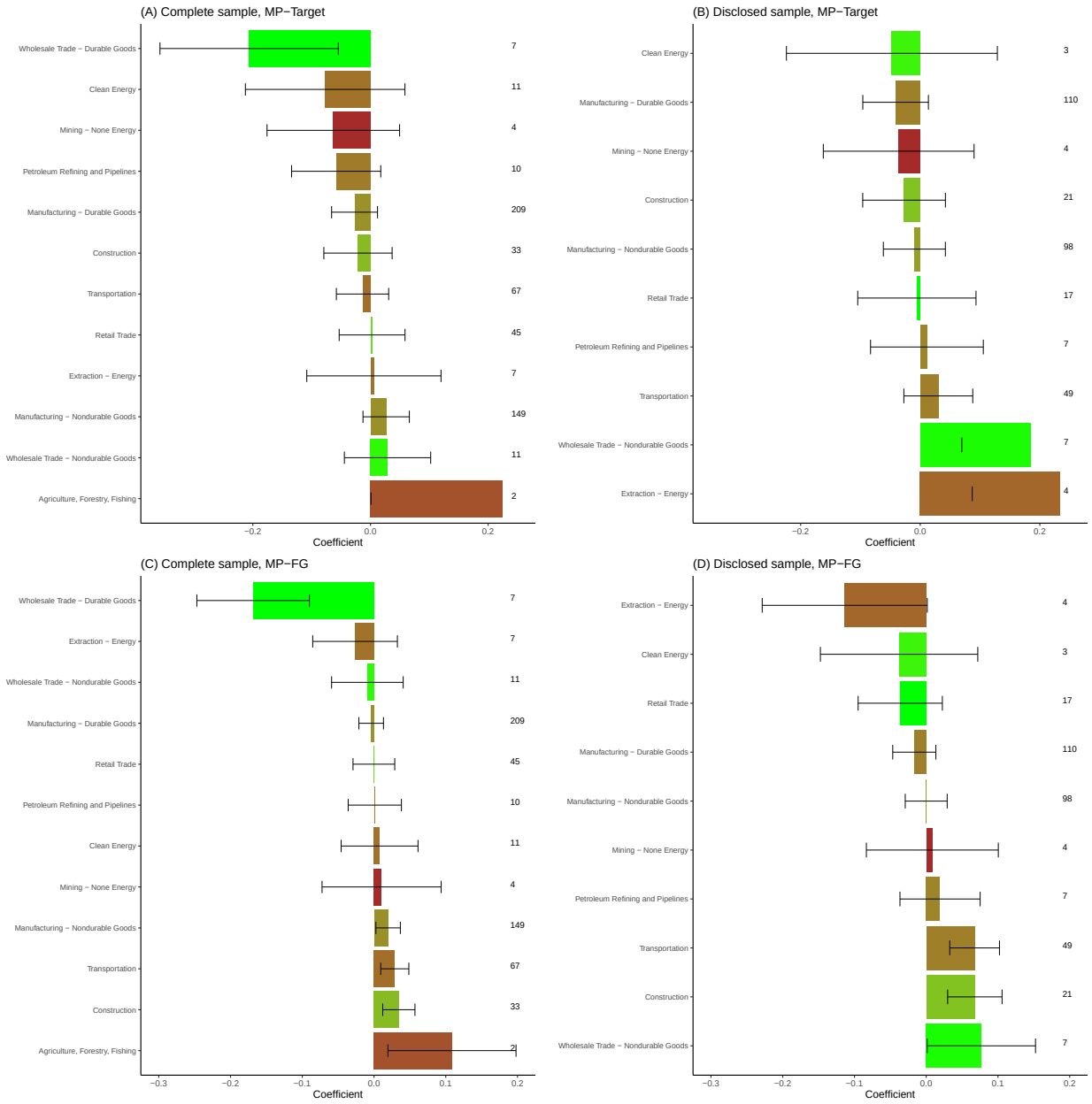


Figure 4: Emission intensity of industries and their reaction to monetary shocks in the Euro area

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. Industries are defined based as 11 major 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. Colors correspond to the average industry Log scope 1+2 emission intensity with green indicating the lowest and red indicating the highest emission intensity. Plots (A) and (B) report the results for target factor shocks and Plots (C) and (D) report the results for the forward guidance factor. 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

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

This table reports the correlation and weighted correlation between industry average emission intensity and industry reactivity to monetary policy shocks. This reactivity is the estimated coefficients for the interaction of industry dummies with monetary shocks. The model specification, additional to the interaction of monetary shocks and 4-digit SIC industry dummies, has complete firm-level control variables, including capital tangibility and emission intensity, and firm and event fixed effects. We also include the correlation between industry reactivity and industry average capital tangibility. The weights in weighted correlation are number of observations per each industry for our complete sample. Energy and mining industries refer to industries with 10, 12, 13, 14, 29, and 46 2-digit SIC codes. These industries represent 6.9% of our firm-event observations, equivalent of 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.

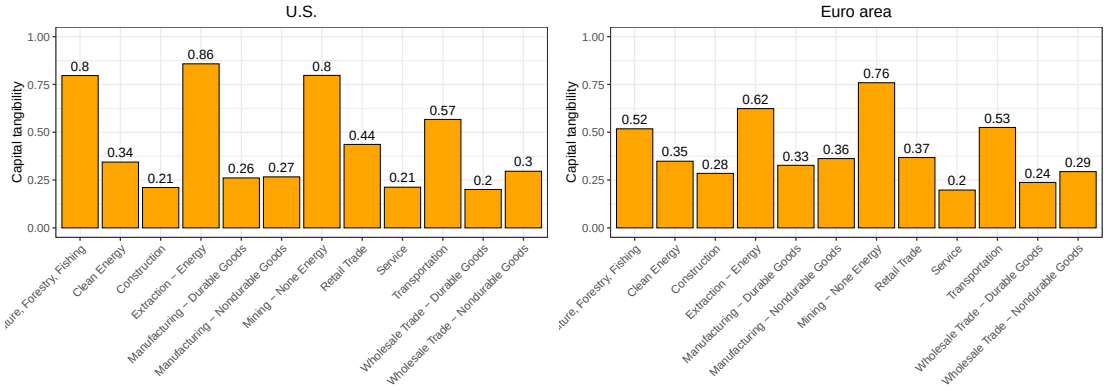


Figure 5: Capital tangiblity for general industries in the U.S. and the Euro area in our sample

Table 10: The emission intensity - capital tangibility nexus 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 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.

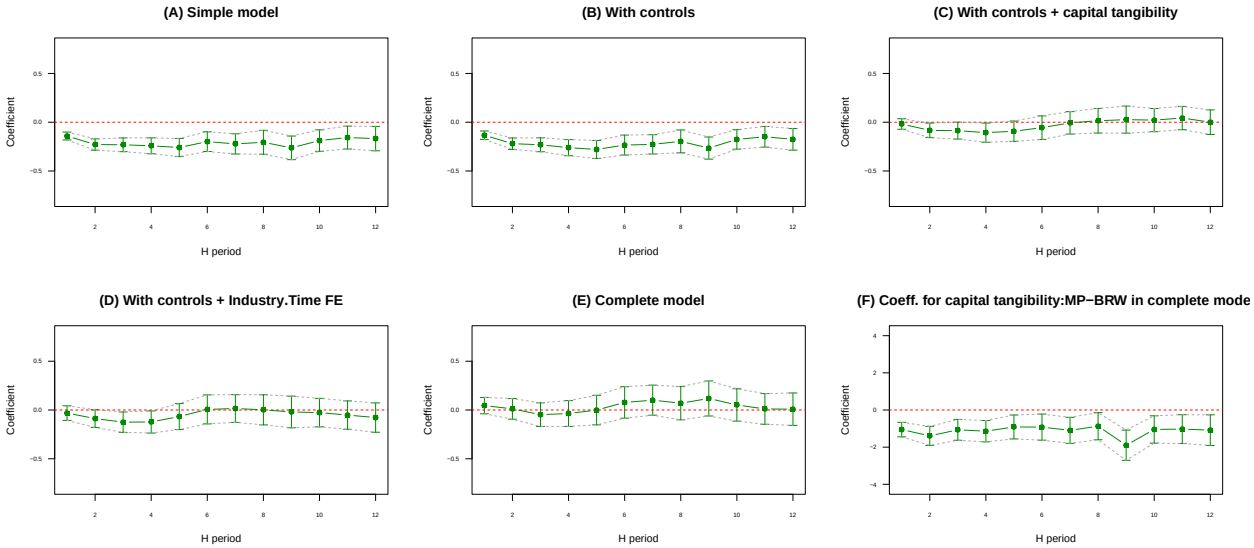


Figure 6: Robustness check: Alternative monetary policy shocks with MP-GSS-TARGET for Emission intensity's effect on firm investment response to monetary policy changes, U.S., Complete Dataset

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.

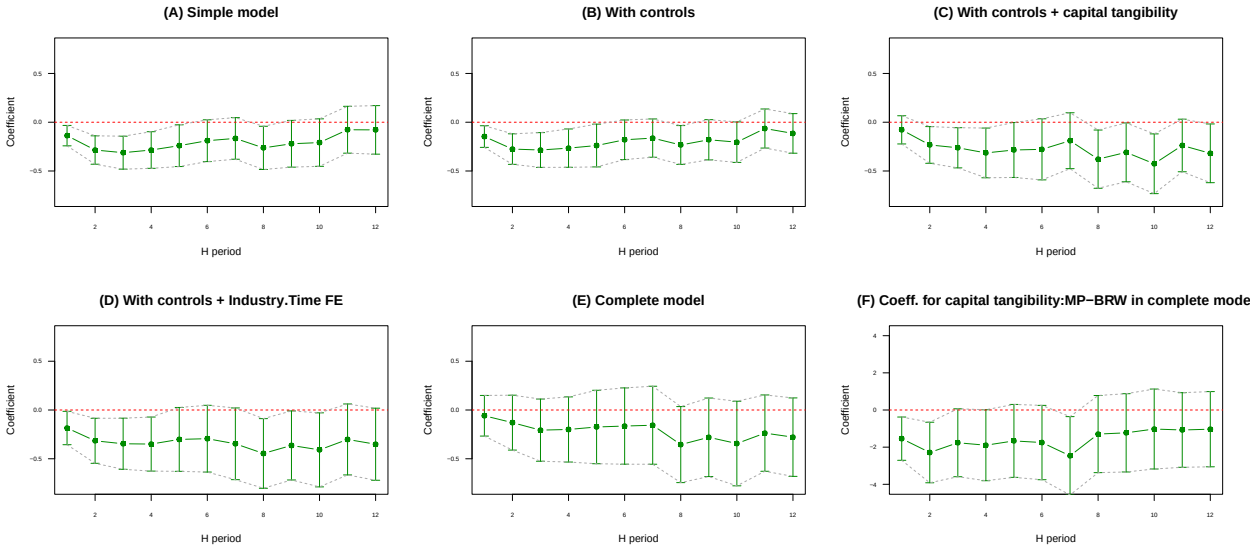


Figure 7: Robustness check: Alternative monetary policy shocks with MP-GSS-TARGET for Emission intensity's effect on firm investment response to monetary policy changes, U.S., Disclosed Dataset

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

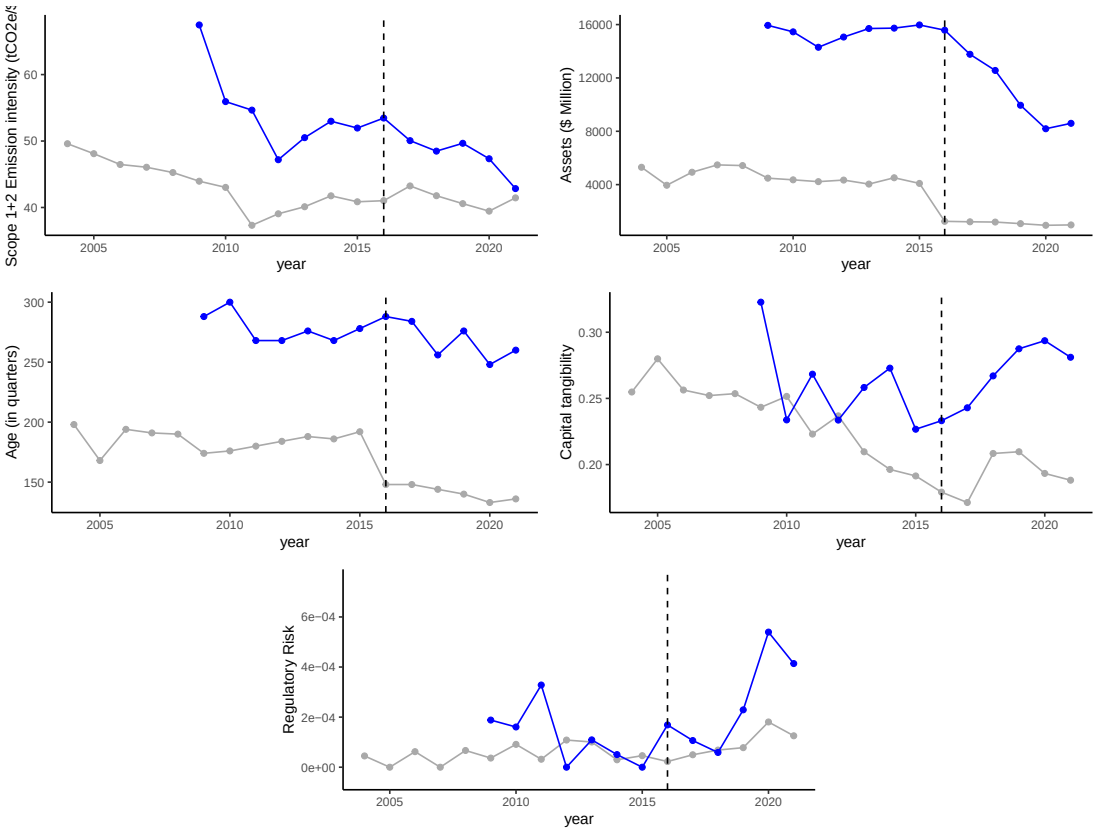


Figure 8: U.S., Median firm characteristics for disclosed data (blue) and estimated data (grey). The dashed line marks the year 2016 where the Trucost's firm coverage increased.

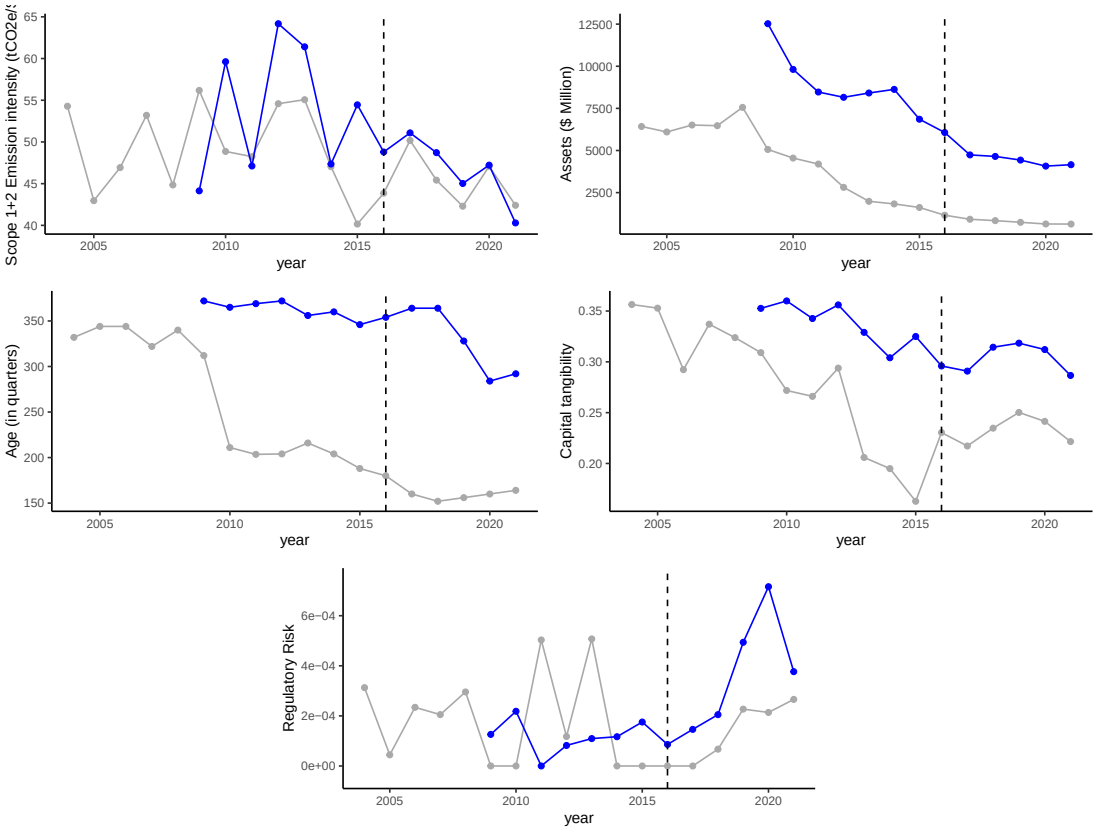


Figure 9: Euro Area, Median firm characteristics for disclosed data (blue) and estimated data (grey). The dashed line marks the year 2016 where the Trucost's firm coverage increased.

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)
Log scope 1 intensity	0.011	0.007	0.007	0.016	0.016	
	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)
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)
Log scope 1 intensity	0.081*	0.079*	0.054	0.053	0.006	0.004
	(0.047)	(0.046)	(0.045)	(0.047)	(0.060)	(0.063)
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)
Log scope 2 intensity	0.021	0.020	0.010	0.010	0.026	0.028
	(0.024)	(0.022)	(0.021)	(0.020)	(0.023)	(0.023)
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)
Log scope 2 intensity	0.113*	0.107*	0.071	0.064	0.001	−0.003
	(0.063)	(0.062)	(0.063)	(0.066)	(0.053)	(0.057)
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)
Log scope 1+2 intensity	0.040	0.042	0.031	0.033	0.057**	0.060**
	(0.027)	(0.026)	(0.025)	(0.025)	(0.027)	(0.027)
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		
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)
Log scope 1+2 intensity	0.168**	0.168**	0.125**	0.124**	0.050	0.045
	(0.065)	(0.065)	(0.060)	(0.060)	(0.051)	(0.067)
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)
Log scope 1+2 intensity	0.028	0.029	0.021	0.022	0.057**	0.059**
	(0.026)	(0.026)	(0.027)	(0.026)	(0.027)	(0.027)
MP-BRW : Log scope 1+2 intensity	−0.656	−0.258	−0.583	−0.109	−0.018	0.161
	(0.548)	(0.327)	(0.414)	(0.281)	(0.308)	(0.310)
MP-BRW : Capital tangibility		−2.895		−3.485**		−3.216**
		(2.313)		(1.726)		(1.267)
Industry.Event FE					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	0.317	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)
Log scope 1+2 intensity	0.145**	0.147**	0.103*	0.103*	0.042	0.039
	(0.065)	(0.065)	(0.060)	(0.060)	(0.051)	(0.066)
MP-BRW : Log scope 1+2 intensity	−0.892	−0.287	−0.876	−0.213	−0.264	−0.046
	(0.700)	(0.618)	(0.667)	(0.589)	(0.314)	(0.425)
MP-BRW : Capital tangibility		−4.571**		−4.871**		−2.673
		(1.918)		(2.039)		(2.361)
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	0.361	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. $*, **, and ***$ indicate significance on 0.1, 0.05, and 0.01.

Table 16: Robustness test: Using scope 1 and scope 2 emission intensities separately for 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 rate, 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 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

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

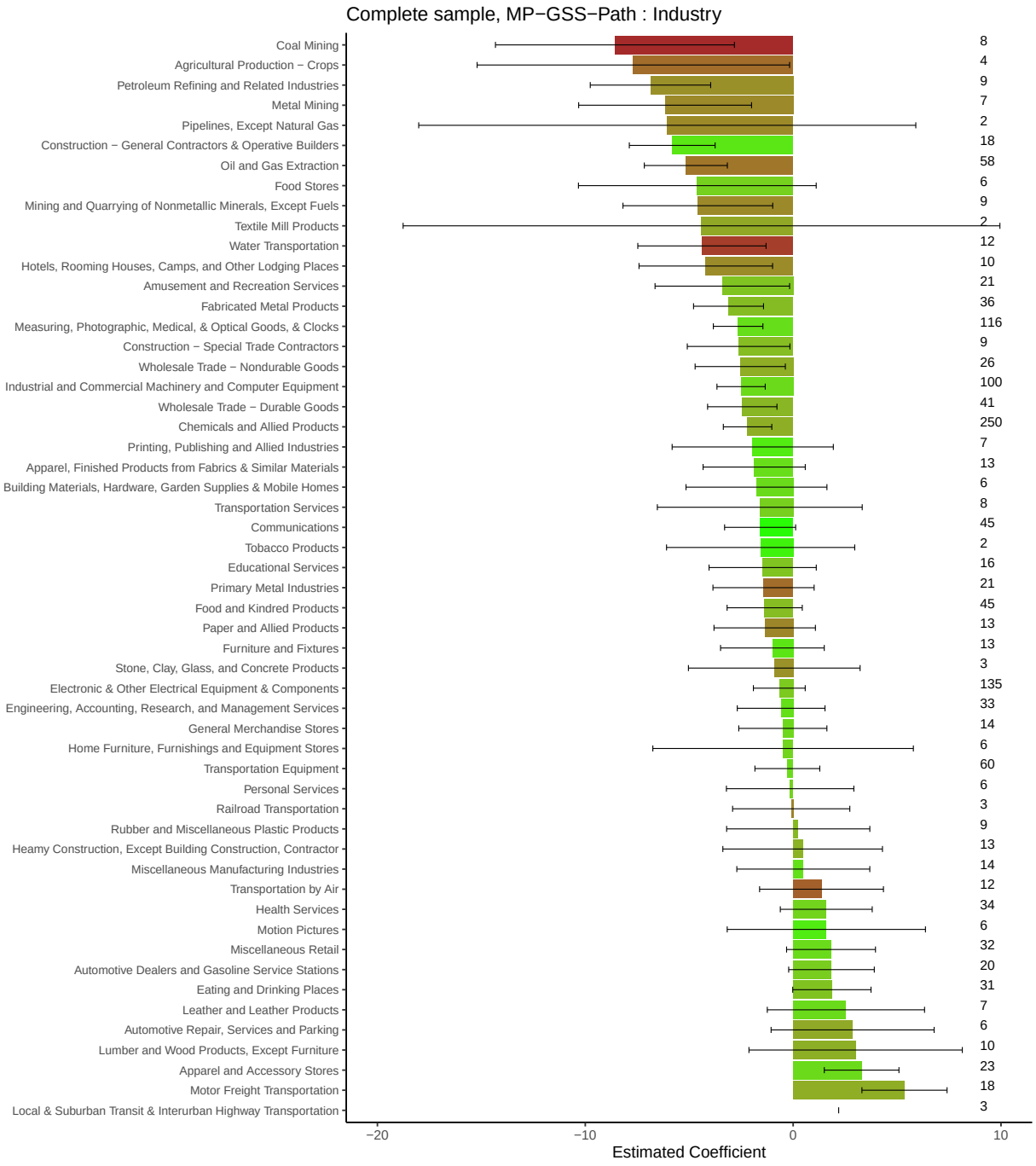


Figure 10: Emission intensity of 2-digit SIC industries and their reaction to Path factor in the U.S.

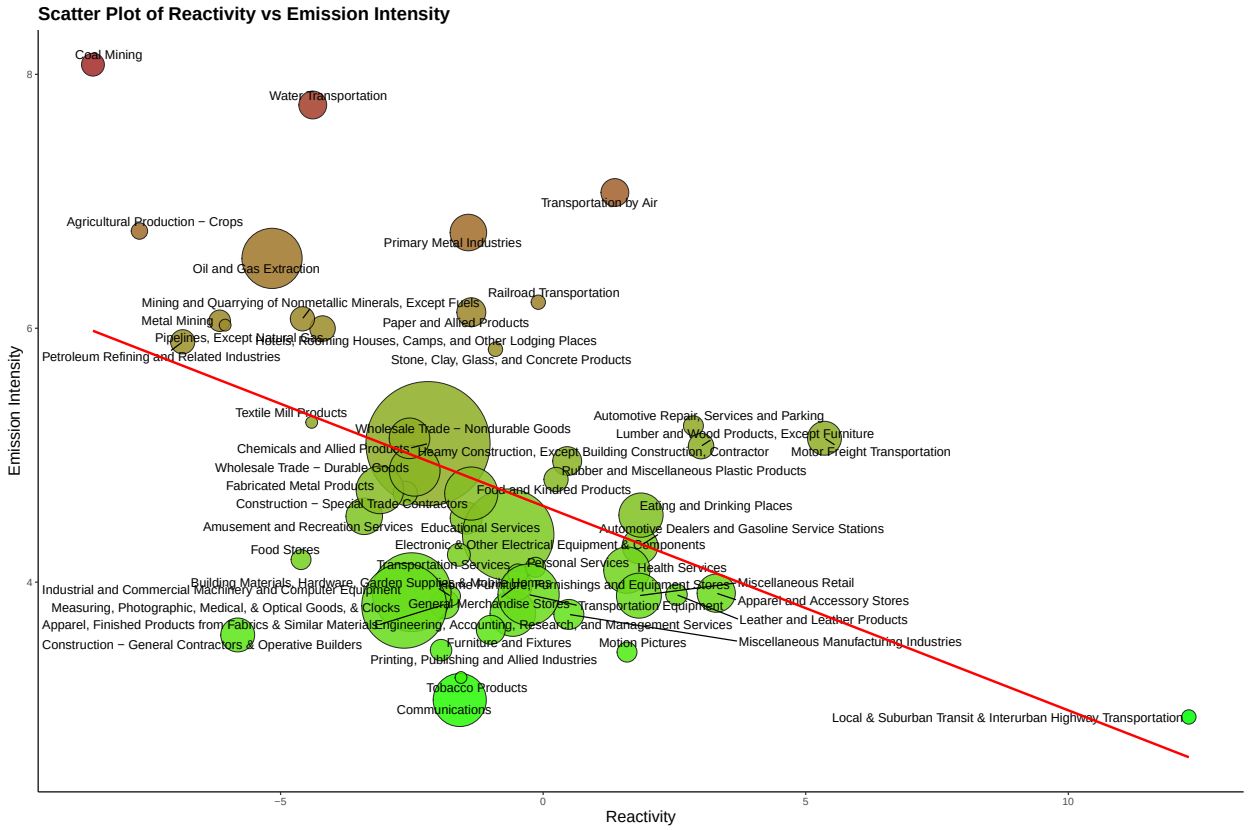


Figure 11: The correlation between emission intensity of 2-digit SIC industries and their reaction to Path factor in the U.S.

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

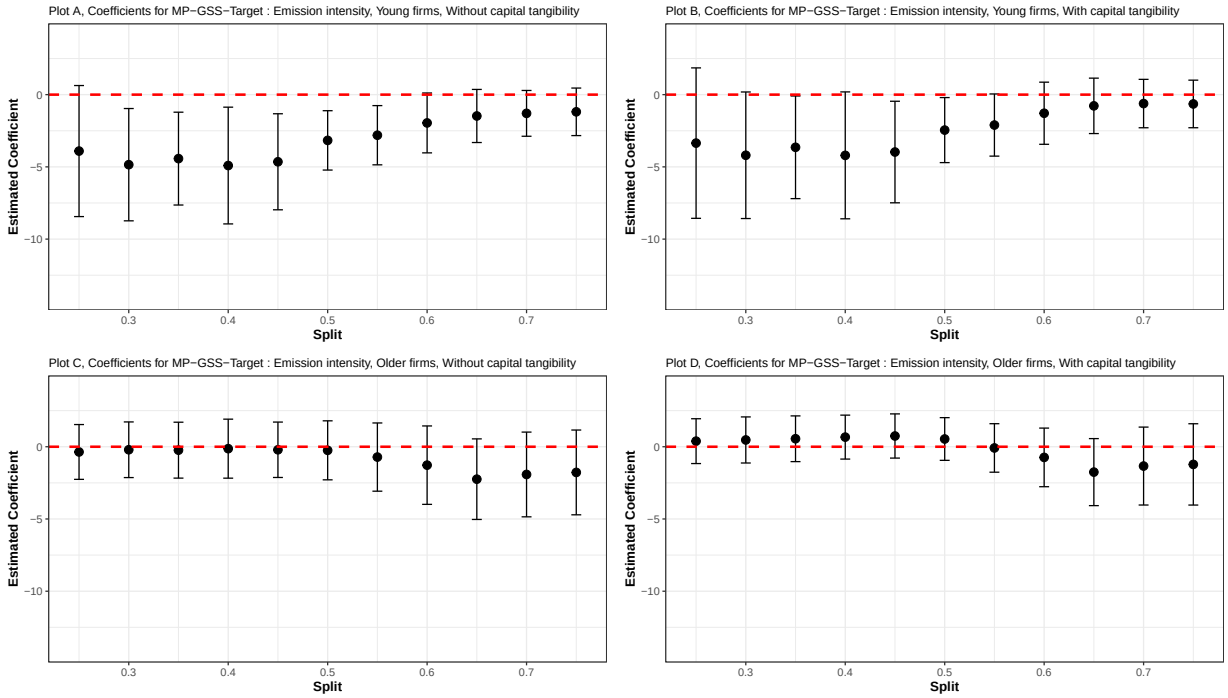


Figure 12: The credit transmission channel's impact on brown firms based on firm age

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.

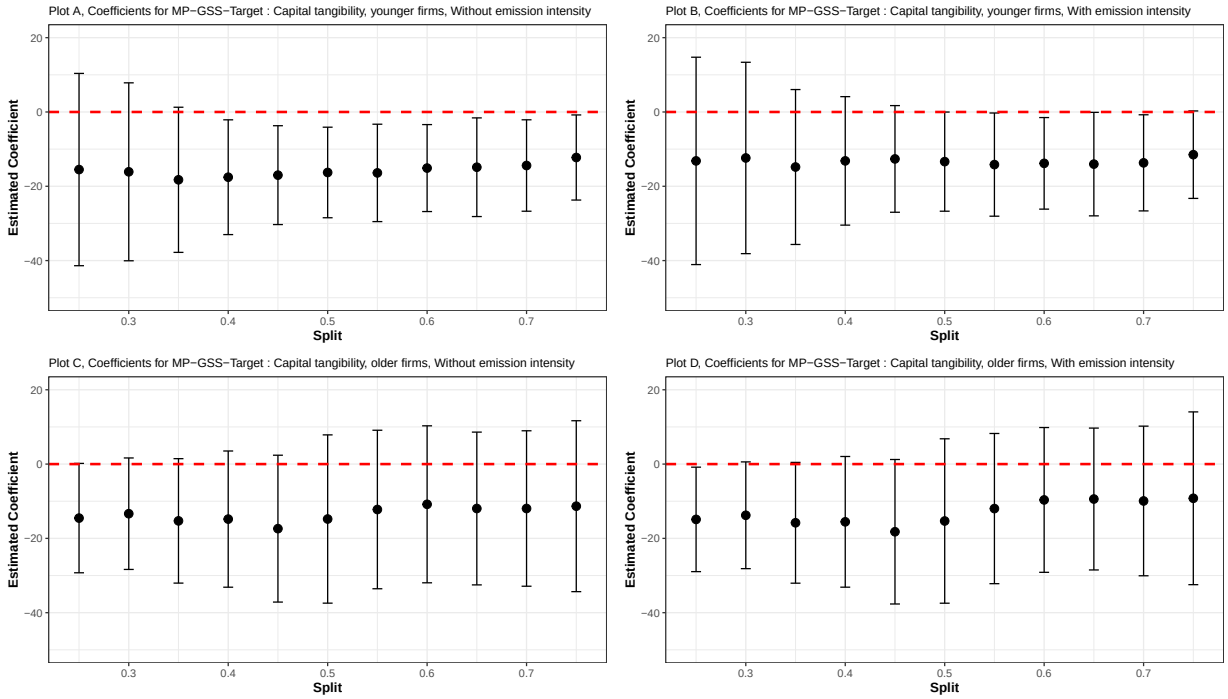


Figure 13: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm age

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.

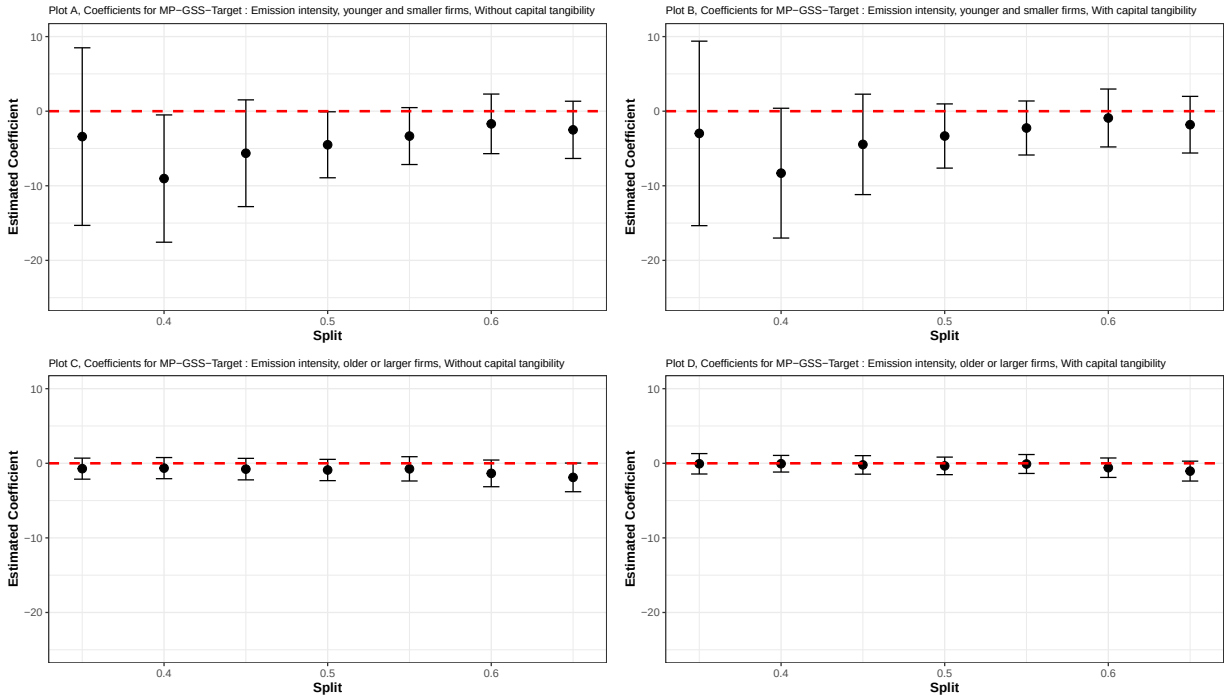


Figure 14: The credit transmission channel's impact on green and brown firms based on firm age and size

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.

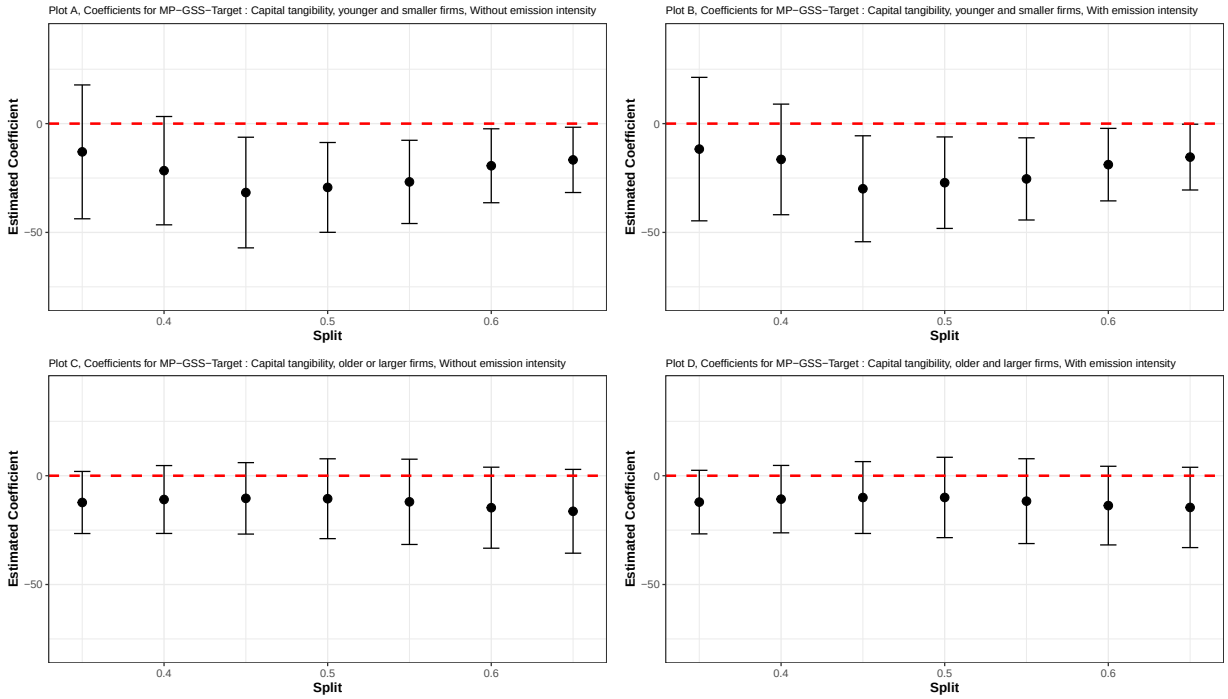


Figure 15: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm age and size

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.

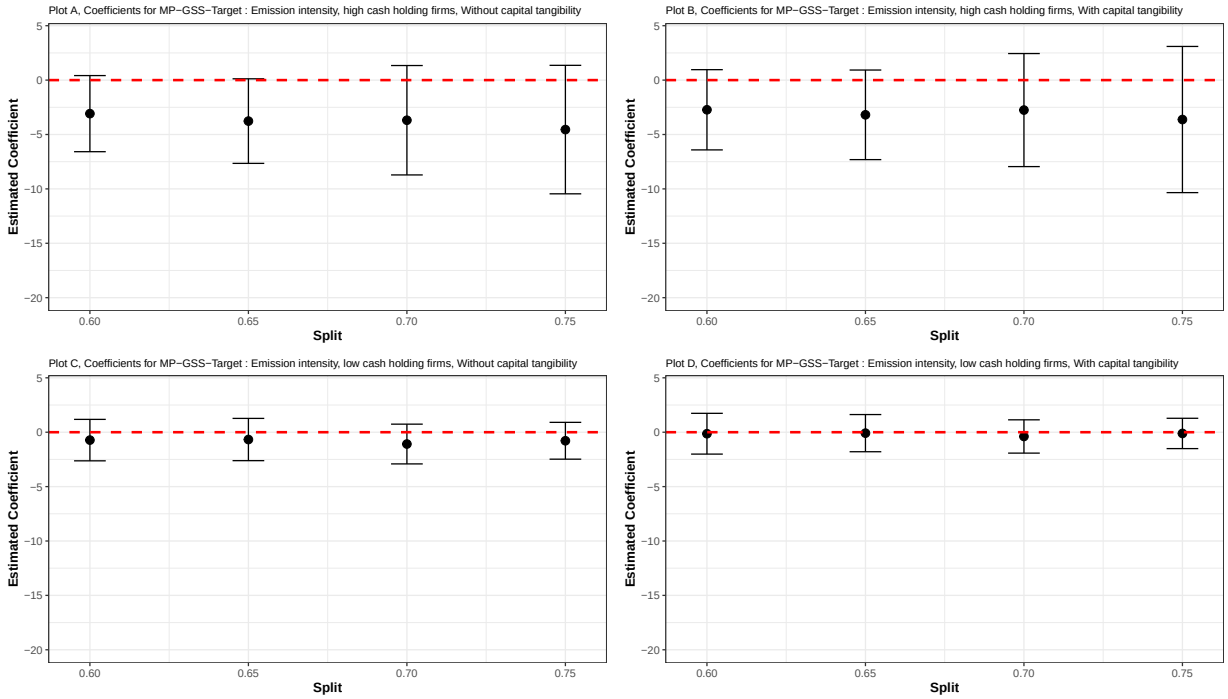


Figure 16: The credit transmission channel's impact on green and brown firms based on firm cash holding

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.

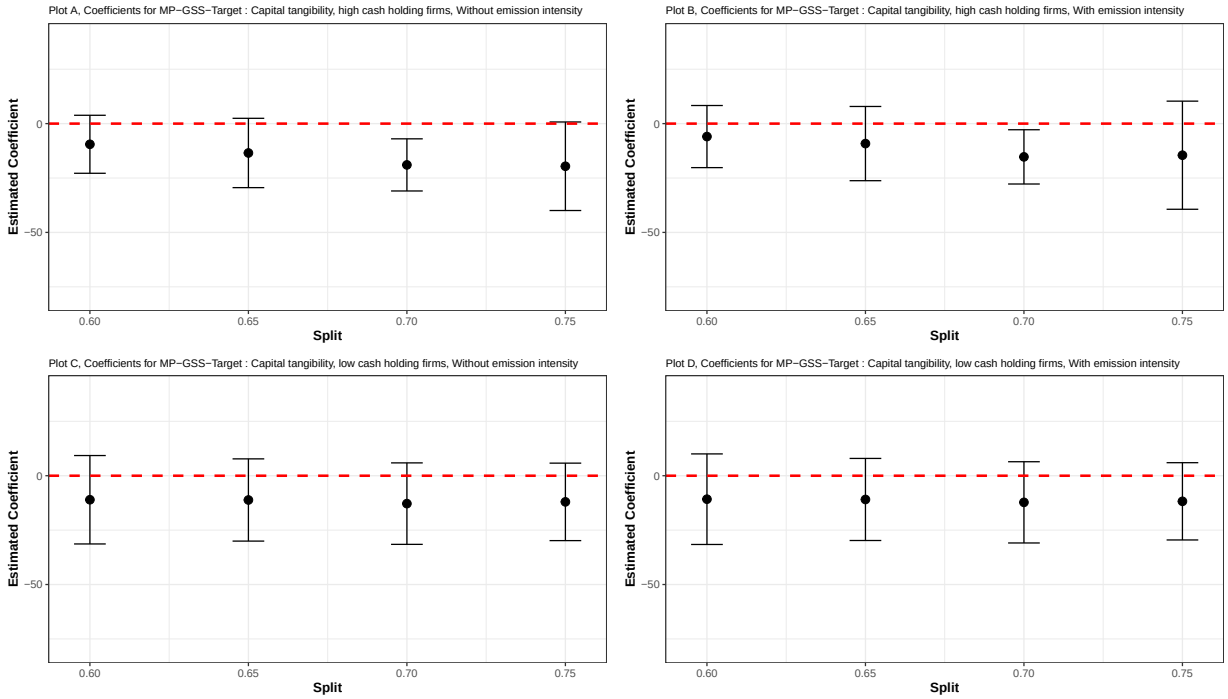


Figure 17: The credit transmission channel's impact on tangible-intensive and intangible-intensive firms based on firm cash holding

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 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.