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Climate Transition Risks and Bank Lending: Evidence from Colombia

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Climate Transition Risks and Bank Lending: Evidence from Colombia*

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Abstract

How is bank lending to fossil fuel firms affected when risks of stranded assets increase? Using loan-level data from the credit registry of the Colombian Superintendency of Finance, we examine how the introduction of the Paris agreement has affected lending to fossil firms, in a country highly dependent on them. We find evidence that the increased risk of stranded assets implied by the Paris agreement led to a 46% decrease in bank credit to fossil firms. However, banks have become more selective and have prioritised lending to large and well capitalised fossil firms. Additionally, there is suggestive evidence that "brown" banks (i.e., banks with large lending to fossil fuel firms) have become more selective with their clients: they decreased the size of loans to both fossil and non-fossil clients (-87%), whilst increasing the cost of loans to all clients (via an interest rate of 2.15 percentage point higher), but keeping on lending to large fossil fuel firms (+14.8%).

JEL Classification: G21, Q56
Keywords: Climate finance; banks; fossil fuel firms; Paris Agreement; stranded assets; sustainable lending

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Riesgos de Transición Climática y Crédito Bancario: Evidencia para Colombia*

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Resumen

¿Cómo se ve afectado el crédito bancario hacia las empresas de combustibles fósiles cuando aumentan los riesgos de activos varados? Utilizando datos a nivel de balances del registro de créditos comerciales de la Superintendencia Financiera de Colombia, examinamos cómo la introducción del acuerdo de París ha afectado el crédito a las empresas de combustibles fósiles en un país altamente dependiente de ellos. Encontramos evidencia de que el aumento del riesgo de activos varados implícito en el acuerdo de París llevó a una disminución del 46% en el crédito bancario a las empresas de combustibles fósiles. Sin embargo, los bancos se han vuelto más selectivos y han priorizado el préstamo a empresas de combustibles fósiles grandes y bien capitalizadas. Además, los resultados sugiere que los bancos "cafés" (i.e., aquellos con gran cantidad de préstamos a empresas de combustibles fósiles) se han vuelto más selectivos con sus clientes: disminuyeron el tamaño de los préstamos (-87%) y aumentaron el costo a través de la tasa de interés (2,15 pp.) a todos sus clientes en relación al resto de bancos, pero continuaron prestando a las grandes empresas de combustibles fósiles (+14,8%) relativo al resto de empresas.

Clasificación JEL: G21, Q56
Palabras clave: Financiamiento climático; bancos; empresas de combustibles fósiles; acuerdo de París; activos varados; créditos sostenibles.

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1 Introduction

World leaders have agreed to limit global warming to 2 degrees - and to strive to 1.5 degree - as part of the 2015 Paris Climate Change Agreement. Limiting global warming to 1.5 degree implies that 90% of coal and 60% of oil must remain unextracted by 2050 (Welsby et al., 2021; McGlade and Ekins, 2015), so that a large share of fossil fuels may become 'unburnable'. Emerging and developing economies with a large fossil fuel industry are heavily exposed to the risk of *stranded assets*, a decline in the value of fossil fuel assets ahead of their anticipated lifetime due to changes in legislation toward stringent climate policies. An important unresolved question is how financial institutions in emerging economies with a large fossil fuel industry are reacting to the implications of the Paris Agreement on the risk of stranded assets. Ignoring those risks could have broader implications for the financial and macroeconomic stability of these countries. A deterioration of firm's balance sheets and subsequent payment defaults and bankruptcies for fossil fuel firms could increase banks' credit risk exposure. Subsequently, the drying up of the bank-lending channel could cause a general credit crunch, thereby affecting the rest of the economy.

In this paper we investigate the impact of the Paris Climate Change Agreement on banks' lending behaviour in Colombia, a country where fossil fuels account for a major part of exports and a relevant portion of its GDP. The Paris Agreement served as an important signal to financial institutions, indicating that major importers of Colombia's fossil fuels would drastically reduce greenhouse gas emissions, leading to an important reduction in their consumption of oil and coal in the near future, exposing countries like Colombia to heightened risks of stranded assets. We use proprietary disaggregated data from the credit registry on Colombia banks' loans to commercial firms over the 2010-2019 period. Our empirical strategy considers a difference-in-differences estimation comparing credit balances between the treated group of fossil fuel firms with a control group of non-fossil firms after the discussion of the Paris Agreement in the Colombian parliament in the third quarter of 2016. We saturate the model with firm, bank and time fixed effects to absorb all possible demand and supply-side confounding factors.

Our baseline results suggest that the increased risk of stranded assets implied by the Paris agreement led to a 46% decrease in bank credit to fossil fuel firms in Colombia. Additional analysis shows that this fall in balances mostly impacted fossil fuel firms with a worse financial standing, as banks became more selective and prioritised lending to large and well capitalised fossil firms. Furthermore, even though all banks decreased their lending to fossil fuel firms, brown banks (banks with large lending to fossil fuel firms) have become more selective with their clients. They decreased the size of loans to all clients (-87%), whilst increasing the cost of loans to clients (via an interest rate of 2.15 percentage point higher, but keeping on lending to larger fossil fuel firms (+14.8% more than for the rest of firms). These results highlight that even though brown banks have readjusted their lending patterns, they remain highly exposed to credit in the fossil sector, and thus raises important financial stability consideration for these banks, and possibly for the country at large.

Our work relates to the literature at the crossroads of finance and environmental economics looking at how climate-transition related risks—and in particular the signature of the Paris Agreement—have affected financial markets both in equity and bank loan markets (Kacperczyk and Peydro, 2021; Mueller and Sfrappini, 2022; Nguyen and Phan, 2020; Benincasa et al., 2021). So far, most of the literature has looked at bank loan markets in developed countries or at the global level, mostly using data from syndicated loans. By contrast, our novel contribution is to examine specifically the implications of stranded assets for financial institutions in emerging economies where the fossil fuel sector is a large driver of economic activity—representing 10% of GDP in the case of

Colombia. It is unclear how financial institutions in such highly exposed countries might react to climate-transition risks.

We also add to the literature by examining banks' loan decisions using granular loan-level data from the national credit registry from a single country, rather than syndicated loans that have been widely used in the literature. For example, Delis et al. (2023) use data on corporate fossil fuel reserves matched with syndicated loans to examine whether banks price in the risk that fossil fuel reserves will become stranded. They find evidence that banks do charge a risk premium—albeit a very small one—on fossil fuel firms, but only after 2015 in the post-Paris Agreement period. Additionally, they find evidence that green banks charge more to fossil fuel firms (similar to Fard et al., 2020). Ehlers et al. (2022) considers how the Paris Agreement affected the loan risk premium of banks across various carbon-intensive industries. Combining syndicated loan data with borrowers' carbon emissions data, they find that the carbon risk goes beyond stranded assets and is also present for firms with high scope 1 emissions in a broader set of sectors than the sole fossil fuel industry. Green banks do not seem to put a higher price on carbon risk but they entirely screen out carbon-intensive companies from lending. Beyene et al. (2021) contrasts how bond and bank loan markets differently price the risk of stranded assets. While bond markets do price the risks, they find no evidence that banks do so. Finally, using again syndicated loans, Laeven and Popov (2023) find that the introduction of carbon taxes leads to a decline in bank lending to coal, oil and gas companies in domestic markets. Other strands of the literature study the importance of green firms and "brown" legacy clients of banks (Degryse et al., 2021, 2020).

Our study is structured as follows. Section 2 gives some contextual background on the relevance of the fossil fuel sector in the Colombian economy. Sections 3 and 4 present our data and empirical strategy, respectively. Section 5 discusses the results and section

6 concludes.

2 Context

We first provide some background on the fossil fuel sector in Colombia. We discuss the consequences of two major shocks on the industry in the mid-2010s namely: the collapse of world oil prices and the signature of the Paris Agreement on climate change, and their implications for banks' allocation of credits towards firms in the fossil fuel sector.

2.1 Fossil Fuels in Colombia

Colombia produces a sizeable amount of fossil fuels, mainly oil and coal, and gas. The country is South America's largest coal and second largest oil producer after Brazil.[1]. Extraction and production boomed in the 1990s and 2000s, when major reforms opened the mining sector to competition and foreign investments, resulting in the discovery of major fossil fuel fields. The oil industry is dominated by state-owned companies such as Ecopetrol, while the coal sector is in the hands of foreign multinational firms (e.g Glencore among others).

Fossil fuels are an important driver of national economic activity. In 2014, the oil and mining sector accounted for 10% of Colombia's GDP and taxes, royalties and dividends from the energy sector represented about a third of government revenues. Most of Colombia's fossil fuels are not consumed at home but are exported overseas. About three quarters of Colombia's electricity is from hydro power. Most of the country's greenhouse gas emissions come from land use and deforestation, rather than from burning fossil fuels as the bulk of coal and oil production is exported. As a result, Colombia's

[1]Source: EIA, 2022, https://www.eia.gov/international/analysis/country/COL

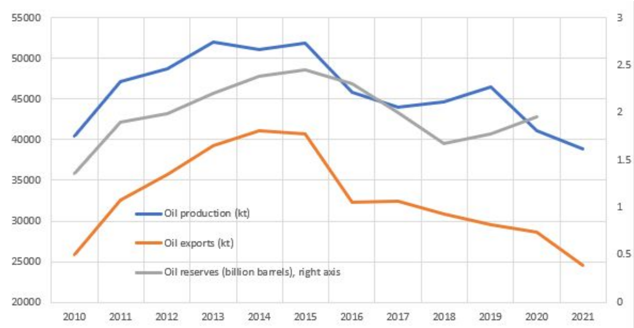
domestic climate policy is mainly concerned with limiting deforestation, other measures in agriculture and energy-efficiency. While a carbon tax has been imposed in 2016, its level has remained very low over the years. Close to 80% of the country's coal is exported to Europe, mainly Germany, the Netherlands and the UK, and 70% of Colombia's oil is shipped to China, US and India. Together, coal, petroleum and oil products accounted for 65% of Colombia's total exports in 2014, representing a major source of income and growth for the country.

Figure 1a plots the evolution of Colombia's oil production, exports (left-axis) and reserves (right-axis) over the last decade. Oil production and exports dropped in 2016 and remained stable in 2017. Oil extraction started to increase again in 2018, while exports remained low. Figure 1b shows that coal production and exports reached a peak in 2017 and then dropped sharply.

In the mid-2010s, two major shocks affected the profitability of the fossil fuel industry in Colombia, namely: the collapse of world oil prices in June 2014, and the signature of the Paris Agreement in December 2015 and its ratification by the Colombian congress. World oil prices declined sharply in June 2014 as shown in Figure 2, triggered by OPEC's strategy to reduce supply and by a weakening of global demand, in particular from China. As a result, the Colombian economy faced an important balance of payment shock, which affected the country's overall growth and led to lower government revenues.

While many sectors were affected, the shock particularly hit the balance sheets of oil companies in Colombia.[2] While we could expect Colombian's banks to have reallocated their credits away from oil companies after the plunge in oil prices, there are also reasons to believe that the banking system in oil-exporting countries may have been relatively resilient to oil price changes. First, prospects for a recovery of oil demand and thus prices were good, as suggested by future markets during the shock. Markets may be

[2] Especially those that have borrowed in dollars



(a) Oil production and exports (left-axis), reserves (right axis)

(b) Coal production and exports

Figure 1: fossil fuels production and exports, Colombia.
Source: IEA Energy Statistics.

able to perceive that, although low oil prices reduce short-term profits, they are not inherently bad news for the long-term profitability of the oil industry, as they contribute to reduce the market of alternative competing energy sources, such as renewable energy and biofuels. In addition, in times of lower prices and demand, oil reserves can replenish providing opportunities for extraction and sales in the future.In the case of Colombia, more specifically, the country also had previous experience with oil shocks and had established in 2008 the Fuel Stabilization Fund (Fondo de Estabilización de Precios de los Combustibles, FEPC) to cushion the economy against the volatility of oil prices.[3]

[3] At home, domestic prices of gasoline and diesel did not decrease because of taxes and surcharges.

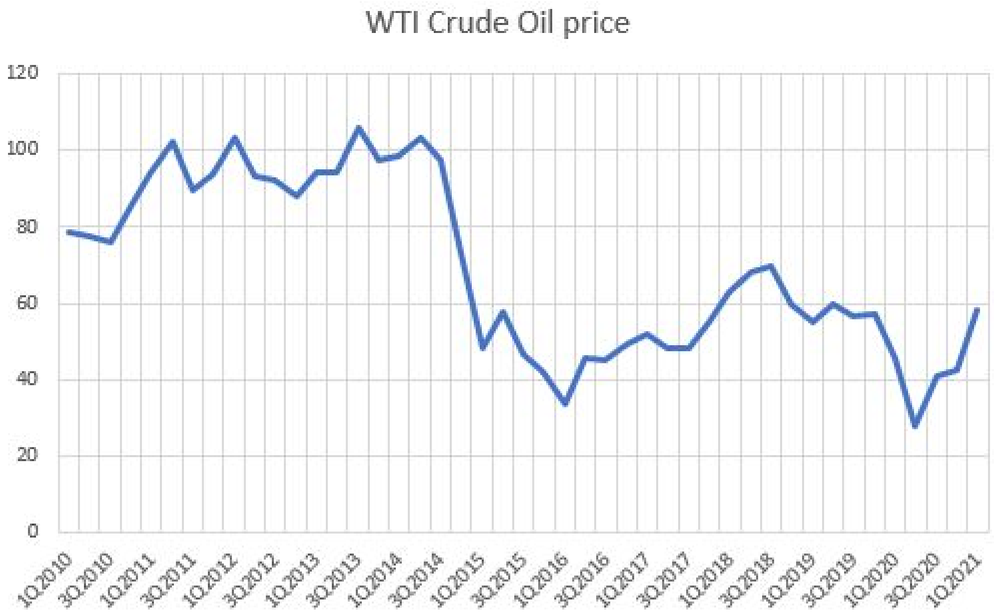


Figure 2: Evolution of WTI oil prices.
Source: IEA Energy Prices

A second important shock with potentially sizeable consequences for the Colombia's fossil fuel industry was the signature of the Paris Agreement on climate change. In December 2015, 195 countries committed in a legally binding agreement to reduce global greenhouse emissions to well below 2°C above pre-industrial levels. For fossil fuel markets, these stringent climate target implies that about one third of global oil reserves and 80% of coal reserves must remain in the ground in 2050, with coal being phased-out as a higher priority, raising concerns about whether fossil fuel assets would need to retire and loose their value before the end of their anticipated lifetime. For Latin America, Binsted et al. (2020) estimate for instance that meeting the Paris goals implies the stranding of assets worth $37-90 billion 2010 USD over the next thirty years. In concrete terms, limiting global warming to 1.5°C is equivalent to the premature retirement of about a third of existing power plants in Latin America, representing large financial losses for stakeholders in the fossil fuel industry (Binsted et al., 2020).

While the Paris Agreement was officially announced on December 12, 2015, Colombia officially signed it on April 22, 2016. In the following months and especially in the period July-September 2016 (2016Q3) several debates took place in the Colombian Parliament to pass the bill that would officially ratify the Paris Agreement. The Parliament approved the Agreement on July 14, 2017, and the Colombian government finally formally ratified the Paris Agreement to the United Nations on July 12, 2018.[4] In the remainder of our analysis, we test empirically whether the Paris Agreement raised Colombia's financial institution's awareness about the risks of stranded assets. The agreement served as a signal that the worlds' major oil and coal consumers would drastically reduce their greenhouse gas emissions – and consequently their imports of Colombia's oil and coal in the near future. We examine how the Paris agreement affected banks' credit allocation to fossil fuel firms in Colombia and in particular whether they sought to limit their exposure to the sector.

2.2 Paris Agreement and the Discussion at the Colombian Congress

Even though the signature of Colombia of the Paris agreement was a surprise, we argue that financial participants realised the full implications only during the debates that took place between the third quarter of 2016 and the second quarter of 2017 in the Colombian congress to ratify the Agreement. On the 15th of September of 2016, the Second Commission of the Senate had a first debate where they approved the project of passing a law to ratify Paris Agreement (cancilleria.gov). This debate is discussed in the press both nationally in newspapers such as El Tiempo, El Espectador and at the regional level with publications such as Crónica del Quindío reporting the news. On the 16th of September, El Tiempo published an article reporting the recent developments regarding the meeting of the Second Commission of the Senate. The article reports the

[4] Law 1844 of 2017 stipulate the approval.

approval of the ratification by the Second Commission of the Senate in a neutral way, it highlights the hopes of the Vice Minister of the Environment who sees this debate as a stepping stone in placing Colombia as a pioneer in climate change mitigation (El Tiempo, 2016).

During the same month, Bancolombia—one of the biggest commercial banks of the country—released a report assessing the implications of the Paris Agreement Implementation Plan (Grupo Bancolombia, 2016), shedding light on Colombia's role in climate change. The report underscores that Colombia's national emissions currently contribute to 0.46% of global greenhouse gas emissions, a figure on the rise. Bancolombia advocates for crucial steps to combat climate change, advocating for measures such as forging alliances to halt deforestation and fostering an economic shift toward climate adaptation and mitigation.

These factors highlight the important realisation to local and internal financial actors of how important the climate transition will need to be harness by the local economy, in order to reach the targets of the Paris agreement.

3 Data and Summary Statistics

3.1 Data Description

Loan data We use the *341 Format* from the Colombian Superintendency of Finance. This quarterly data set comprises the official registries of outstanding balances (i.e., regular loans, credit card balances, housing loans, leasing agreements) of banks (i.e., commercial banks, cooperatives, and leasing and financial corporations), beginning in 2002. The 341 Format also includes substantial information from debtors and characteristics of all the credits that have been granted (e.g., term, interest rate, credit rating, probability of default, amount in local and foreign currency). We only consider commercial loans for firms, since we want to focus on the effects of the increase in stranded asset risks on industrial activity. The dataset includes loans to state-owned companies such as Ecopetrol and their suppliers.

In this paper, we will focus on loans and credit balances emitted during the 2010-2019 period. A firm can hold several lines of credits at a single bank so we aggregate outstanding loan volumes (in 2018 constant prices) and average other variables of interest (i.e., interest rate, past due days, and probability of default) in each quarter for each firm-bank pair.

Identifying Fossil Fuel firms To classify firms according to their corresponding sector, we use the 4-digit ISIC code included in 341 Format. We classify firms active in the fossil fuel industry as firms in the following sectors: oil extracting or refining activities, petroleum coke, coal, and basic chemistry. All this sub-sectors comprise what we will call the treatment group in our econometric estimations. The rest of economic sectors correspond to the control group.

Banks' exposure to the Fossil Fuels sector We create a variable which capture a bank's exposure to the fossil fuel industry. This variable comes from estimating the share of a bank's total loans dedicated to the fossil fuel industry. To avoid potential endogeneity concerns, we build this bank-level exposure to fossil fuel firms over the period 2010-2013 (before the crash of international oil prices and the signature of the Paris Agreement). We then create an indicator variable, which splits the group by above and below the median of banks' exposure to the fossil fuel industry. The banks above the median exposure are classified as "brown banks", and those below the median as "non-brown banks".

Firms' characteristics For a sub-sample of firms, we have access to information on end-of-year balances from the Colombian Superintendency of Companies. According to the law, a firm is required to report its financial balances to the Superintendency due to its size (i.e., whether its yearly assets or income exceeded 30,000 monthly minimum wages), the nature of its transactions (i.e., trades goods or services in foreign currency), or its current financial and legal situation as well (e.g., the Superintendency establishes that a given firm could be under its oversight or control whether is under the risk of financial or legal troubles).[5] These data are publicly available for the years 1995 and onward.[6]. Hence, we match data on (annual) total assets, return on assets (ROA), liquidity ratio, total liabilities, and tangibility ratio for a sub-sample of lending firms. This allows us to control for credit-demand factors.(Jiménez et al., 2012; Khwaja and Mian, 2008; Jiménez et al., 2019).[7] For each firm, we calculate the average value for each one of the aforementioned variables for all years the firm is observed in the data during the period 2010–2013.[8] Then, for each financial variable, we create a indicator variable that takes the value of one whether the firm's value is above the median over all observed firms, zero otherwise.

3.2 Descriptive Statistics

Our final dataset is an unbalanced panel that comprises more than 6.8 million firm-bank-quarter observations, for the period 2010–2019. The dataset comprises about 1,600 firms belonging to the fossil fuel sector and more than 272,000 firms from the rest of economic sectors with credit balances at any point during the period of interest. Balances

[5]Law 22 of 1995, consulted at `https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=6739`

[6]`https://www.supersociedades.gov.co/web/asuntos-economicos-societarios/estados-financieros-historicos`

[7]Previous works like Gómez et al. (2020) and Morales et al. (2022) have used this data set.

[8]As with the classification of banks according to their exposure to fossil fuel firms, We restrict our calculations to this period to avoid any potential endogeneity that would come from the impact of the fall of international oil prices and the signature of the Paris Agreement on firms' balance sheets.

from fossil fuel firms represent about 3% of total loans.[9] Despite the small number of firms, the average value of outstanding credits in the sector is much larger than in other industries, as shown in Figure 3. Before the approval of the Paris Agreement by the United Nations in December 2015, fossil fuel firms started to experience a small reduction of their outstanding loans with commercial banks relative to the rest of the economy (for which the trend remains stable). In the 2015-2019 period, the average value of outstanding credits by firm-bank to the fossil fuel sector fell from 2,500 million COP (in 2018 constant prices) to to less than 2,000 million COP by the end of 2019. By contrast, the average value of outstanding credit by firm-bank for other economic sectors remained relatively stable around 1,000 million COP over the same period.

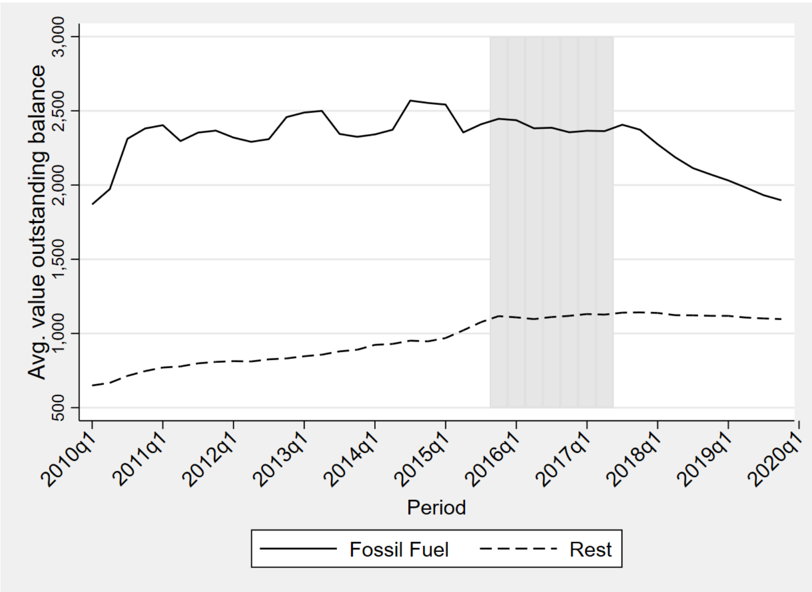
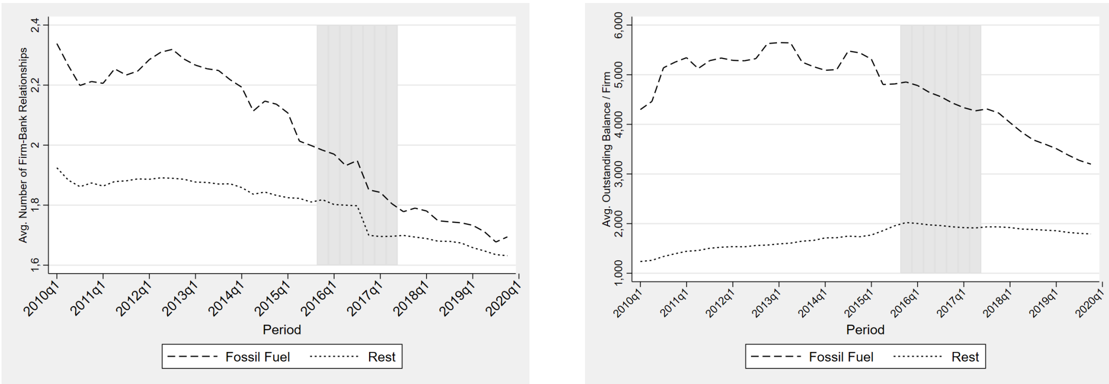


Figure 3: Average outstanding credit balance by firm-bank relationship (in 2018 constant Million COP)
Note: The shaded area corresponds to the period between the approval of the Paris Agreement by United Nations in December 2015 and the ratification by the Colombian congress in June 2017. Source: Colombian Superintendency of Finance

In Figure 4a we show that the average number of bank relationships for fossil fuel

[9]Similarly, using syndicated loans, Laeven and Popov (2023) find that in their sample 4.2% of loan tranches are to fossil fuel companies.

firms declined from 2 to 1.8 over the December 2015 - June 2017 period. The drop was less important for firms in other sectors. Likewise, Figure 4b reports the evolution of the average value of outstanding credit by firm. The trajectories for the treatment and control groups resemble the ones displayed in Figure 3.



(a) Bank relationships

(b) Outstanding credit (in 2018 Million COP)

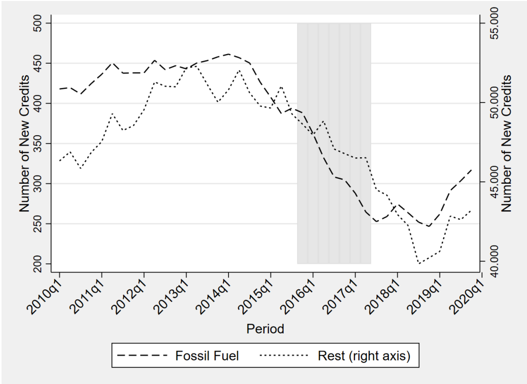
Figure 4: Evolution of the average number of bank relationships and average value of outstanding credit by firm

Note: The shaded area corresponds to the period between the approval of the Paris Agreement in December 2015 and the ratification by the Colombian congress in June 2017.

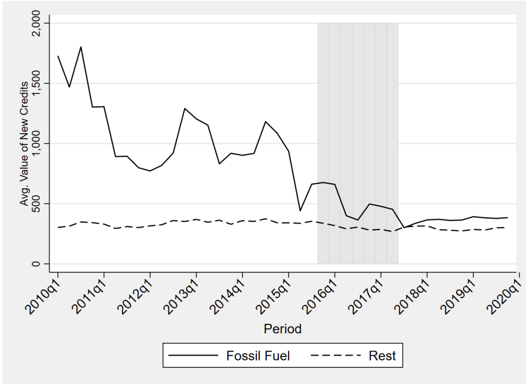
Source: Colombian Superintendency of Finance

While the graphs in Figures 3 and 4 provide visual evidence of a fall on the average value of outstanding credits by fossil fuel firms relative to the rest of the economic sectors, it remains unclear whether the Paris Agreement had implications on the cost of credit, the perception of heightened risks by banks, or an increase on credit lengths of borrowing firms. Figure 5 displays the evolution of the number of new credits, their average value and interest rare, as well as the average number of due days of all ongoing balances and their probability of default. Only the sharp increase in the average number of due days and average probability of default for fossil fuel firms relative to the rest of the Colombian economy provide suggestive evidence of a potential impact of the Paris Agreement.

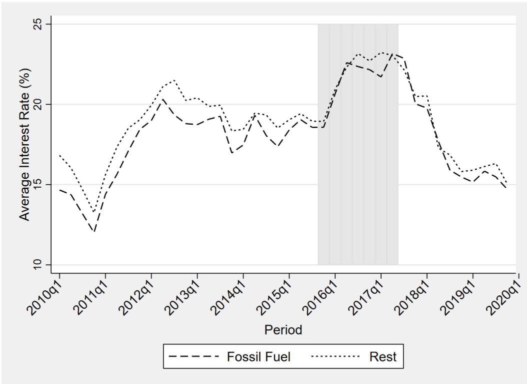
Since we also want to address the determinants of credit demand, we merge the



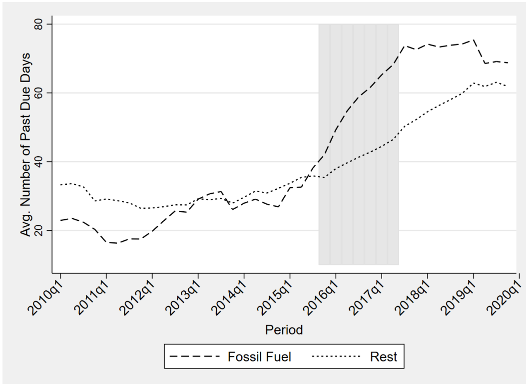
(a) Number of New Credits



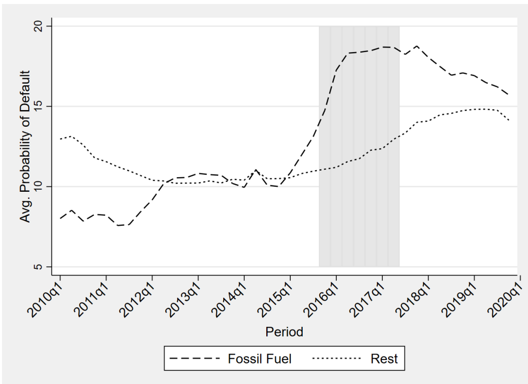
(b) Avg. Value new Credits (2018 Mill. COP)



(c) Average Interest Rate for New Credits (%)



(d) Average Number of Due Days



(e) Average Probability of Default (0–100)

Figure 5: Evolution of Other Credit-related variables

Source: Colombian Superintendency of Finance

credit registries with the end-of-year balances from the Superintendency of Companies. As explained above, not all firms are required to provide their financial statements.

Therefore, merging these two data sources draws a sub-sample of over 2.4 million firm-bank-quarter observations, from more than 28,000 firms (476 from the fossil fuel sector). Figure A.1 of the Appendix displays the evolution of the average value of outstanding credits by firm and firm-bank, as well as the average number of bank relationship by firm for this sub-sample of firms. As observed, the trends resemble the ones displayed in Figures 3 and 4.

4 Empirical Strategy

We aim to investigate how banks adjust their lending to fossil fuel firms in Colombia as a response to an increase in climate-transition risks. More specifically, we examine how the introduction of the Paris agreement impacted bank lending to fossil fuel firms. We define our treatment group as firms active in the fossil industry, while our control group consists of all other companies.

We implement a standard differences-in-differences (DID) approach to address the effect of the Paris agreement on credit. To claim casual effect from the estimates from Equation 1, we must ensure our treatment variable is plausibly exogenous. Given the high uncertainty around whether an agreement could be reached at the COP21 Paris Summit, the event and the ambitious outcome was unexpected and is suited as a exogenous 'surprise' shock. The regression model of interest is the following:

$$C_{ibt} = \alpha\Big(I[FossilFuel = 1] \times I[Paris = 1]\Big)_{it} + a_i + b_b + c_t + u_{ibt} \tag{1}$$

where C_{ibt} is the (log) outstanding balance of a given firm i owes to bank b in quarter t, $I[FossilFuel = 1]$ is an indicator variable equal to one whether the firm belongs to the fossil fuel sector (i.e., treatment group), zero otherwise; $I[Paris = 1]$ is an indicator variable equal to one for the Paris Agreement shock (2016Q3), zero otherwise; a_i, b_b and c_t, are firm, bank and time fixed effects, respectively, and u_{ibt} is an error term. In Equation 1, α corresponds to the coefficient of interest, since it captures the relative difference in average credit between fossil and non fossil fuel companies due to the starting of discussions of the Paris agreement in the Colombian congress in the summer of 2016.

An important assumption for identification is that pre-treatment parallel trends hold on the outcome of interest. That is, trends in average outstanding credit for both treatment and control groups should not have changed if the shock did not occurred. Therefore, we estimate the following event study model to account for dynamic effects that also allow us to identify for parallel trends:

$$
\begin{aligned}
C_{ibt} = & \sum_{\tau=-10}^{-2} \alpha_\tau (I[t=\tau] \times I[FF=1]) + \sum_{\tau=0}^{10} \beta_\tau (I[t=\tau] \times I[FF=1]) \\
& + a_i + b_b + c_t + u_{ibt}
\end{aligned} \tag{2}
$$

where $I[t = \tau]$ is an indicator variable equal to one if the corresponding quarter t is equal to τ, zero otherwise. We estimate Equation 2 using the quarter before the event (i.e., beginning of discussion of Paris Agreement by the Colombian Parliament) as the reference point. We expect to fulfil the pre-treatment parallel trends assumption if we fail to reject the null hypothesis of joint significance for all α_τ. An additional key challenge for identification is to isolate credit supply from credit demand. We will saturate our model with extensive fixed effects to address this concern.

5 Results

5.1 Bank Lending After Paris Agreement

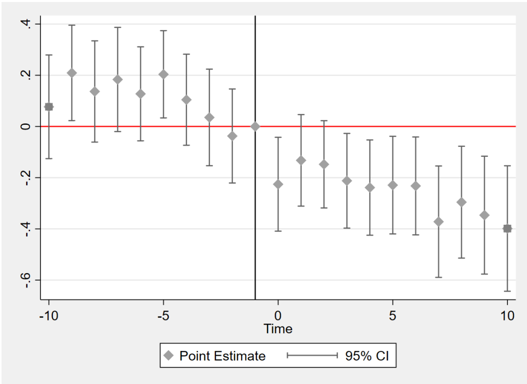
Table 1 reports the estimated coefficients of Equation 1 under different specifications of fixed effects. Firm's fixed effects control for the demand for credit, while bank fixed-effects control for bank-specific constant factors that can drive supply for credit. Moreover, we add bank-time fixed effects to capture time-varying differences across banks. The results in Table 1 show that fossil fuel firms overall experienced a large deleveraging effect from banks lending. On average, bank credits to fossil fuel firms declined by 35.5 to 46.2 percent, compared to non-fossil fuel firms after Paris Agreement.

	(1)	(2)	(3)
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.355***	-0.357***	-0.462***
	(0.040)	(0.040)	(0.037)
R-squared	0.517	0.520	0.668
No. Observations	6,859,461	6,859,456	6,832,601
Firm FE	Yes	Yes	Yes
Bank FE	Yes		
Period FE	Yes		Yes
Bank × Period FE		Yes	
Bank × Firm FE			Yes

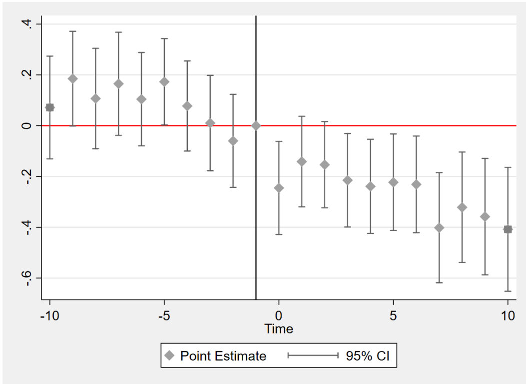
Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1: Credit to fossil fuel firms after Paris Agreement

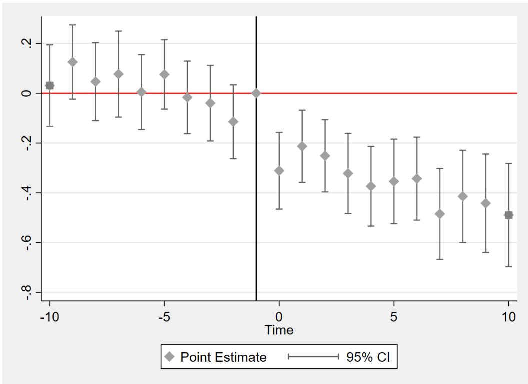
As stated in the previous section, we must hold the parallel trends assumption to claim causal effects from the regression estimates reported in Table 1. Thus, we estimate Equation 2 for these models. As displayed by Figure 6, estimates of these event studies for the baseline specification (i.e., with firm, bank, and period fixed effects) as well as for alternative combinations of fixed effects show that there is no significant difference in the pre-treatment period between the average volume of loans to fossil fuel vs. non fossil fuel firms. Moreover, as reported in Table A.1 of the Appendix, we fail to reject the hypothesis test of joint significance of leads for all models.[10]



(a) Firm + Bank + Period FE



(b) Firm + (bank × time) FE



(c) Firm + time +(Bank × Firm) FE

Figure 6: Event Study Plots

[10]Table A.2 of the Appendix reports the estimates of Equation 1 using standard error clustering at both firm and firm × bank levels, showing that the coefficients remain statistically significant. Likewise, Table A.3 and Figure A.2 provide evidence of holding the parallel trends assumption under these specifications.

5.2 Firm-level Heterogeneity

While the results from Table 1 are of interest by themselves, they do not allow us to separate which fossil-firms received less credit due to the increase in stranded asset risks. Therefore, for the sample of firms that had to report their yearly financial statements to the Colombian Superintendency of Companies, we use the controls for firms' characteristics described in Section 3 to identify which features are the most relevant to explain the observed reallocation of credit. Therefore, we estimate the following model:

$$C_{ibt} = \beta\Big(I[Paris = 1] \times I[FF = 1] \times I[balance = 1]\Big)_{it} + a_i + b_b + c_t + u_{ibt} \qquad (3)$$

where $I[balance = 1]$ is the corresponding balance-sheet indicator variable (e.g., total assets, ROA, liquidity ratio, total liabilities, and tangibility ratio) equal to one whether the firm is above the median value of the distribution, zero otherwise. In this equation, the coefficient β captures the average difference in outstanding balances between firms with a above-median value on a given balance-sheet variable and those below the median, due to the introduction of the Paris agreement.

Table 2 reports the regression estimates for Equation 3, using the baseline fixed effects (firm, bank, and period). The results indicate that large fossil fuel firms, proxied by total assets, have continued to receive 74 percent more credit than smaller firms. This increase is also present for well capitalised fossil fuel firms, which receive 34 percent more credit after the Paris shock. Liquid fossil fuel firms on the other hand, have experienced a reduction of credit of 21 percent compare to less liquid firms. Profitability results, proxied by return of assets (ROA), are not statistically significant across both fixed effect specifications. These results indicate that in time of an increase in stranded asset risks, banks decreased credit to all fossil firms, but less so to the ones with healthier financial stance or to firms which needs less credit (liquid ones). As reported by Table A.6, these results are consistent after including bank $\times$ period fixed effects (excepting profitability).[11]

[11] As a robustness check, in Table A.4 of the Appendix we report the difference-in-differences estimation for the sub-sample of firms for which we merged the balance sheet information from the Colombian Superintendency of Companies. The results are consistent from those of Table 1, and we fulfil the parallel trends assumption for the regression models that include firm + bank + period and firm + (bank $\times$ period) fixed effects, as displayed by Table A.5 and Figure A.3.

Table 2: The Effects of Paris Agreement on Credit for fossil fuel Firms, Controlling for Balance Sheet Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
I[high lassets = 1] × I[FF = 1] × Paris Agreement	0.739***					
	(0.134)					
I[high roa = 1] × I[FF = 1] × Paris Agreement		-0.177				
		(0.110)				
I[high liquidity = 1] × I[FF = 1] × Paris Agreement			-0.210*			
			(0.119)			
I[high capital_ratio = 1] × I[FF = 1] × Paris Agreement				0.338***		
				(0.112)		
I[high lliability = 1] × I[FF = 1] × Paris Agreement					0.716***	
					(0.137)	
I[high tangibility = 1] × I[FF = 1] × Paris Agreement						-0.021
						(0.151)
R-squared	0.354	0.355	0.354	0.354	0.354	0.354
No. Observations	2,139,358	2,139,358	2,139,358	2,139,358	2,139,358	2,139,358

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: All regression models include firm, bank, and period fixed effects.

5.3 Results on Banks' Exposure to Fossil Fuel Firms

Our attention now turns to disaggregate the type of banks into brown banks, those that have a higher-than-median share of loans lent to fossil fuel firms over total outstanding balances, and non-brown banks. More precisely, we want to assess whether brown banks had a different behaviour towards fossil fuel firms compared to non-brown banks. For such that purpose, we estimate the following regression model:

$$
\begin{aligned}
C_{ibt} = & \gamma_1 \Big(I[FossilFuel = 1] \times I[Paris = 1] \Big)_{it} + \gamma_2 \Big(I[Paris = 1] \times I[brown = 1] \Big)_{bt} \\
& + \gamma_3 \Big(I[FF = 1] \times I[brown = 1] \times I[Paris = 1] \Big)_{ibt} + a_i + b_t + c_{ib} + u_{ibt}
\end{aligned}
\tag{4}
$$

where γ_1 still captures the relative difference in balances between fossil fuel firms and the rest of the economy after Paris, γ_2 corresponds to the difference in credit between brown and non-brown banks after the signature of the Agreement, and γ_3 relates to how different the DiD estimator is between banks that were more exposed to lending to fossil fuel firms relative to the rest of sectors.

Table 3 reports very interesting results. First, as displayed in column 1, γ_3 is positive and statistically significant, suggesting that despite the overall reduction in balances on fossil fuel firms relative to the rest of sectors due to Paris Agreement, the former still get more credit in brown banks with respect to their peers in non-brown banks. On the other hand, γ_2 is negative and statistically significant, indicating that brown banks reduced overall credit relative to non-brown banks, regardless of the economic sector. Column 2 reports the regression estimates when using the value of new credits at the outcome of interest, and the results go in the same direction as with the ongoing balances, excepting for γ_3, for which the estimated coefficient is not statistically significant, suggesting that the DiD effect of Paris Agreement was not necessarily different among banks with different pre-event exposures to fossil fuel firms.

	(1) Ongoing Balance	(2) New Credits	(3) Interest Rate New Credits
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.493***	-0.332***	-0.245
	(0.052)	(0.092)	(0.274)
I[Brown bank = 1] × I[Paris Agreement = 1]	-0.866***	-0.101***	2.150***
	(0.006)	(0.010)	(0.032)
I[Fossil Fuel = 1] × I[Brown bank = 1] × I[Paris Agreement = 1]	0.148**	0.167	0.520
	(0.073)	(0.133)	(0.414)
R-squared	0.668	0.766	0.684
No. Observations	6,805,801	1,447,797	1,453,872
Firm FE	Yes	Yes	Yes
Period FE	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Brown Vs. Non-brown Bank Lending to Fossil Fuel Firms

Likewise, column 3 displays the regression estimates of Equation 4 using the interest rate as the dependent variable. The results show first that there is no difference in interest rates for fossil fuel firms relative to the rest of sectors due to Paris Agreement, regardless the type of bank. Nevertheless, the estimates show an increase in interest rates for all new credits from brown banks with respect to non-brown banks. Therefore, the estimates show suggestive evidence that brown banks reduced the supply of credit relative to non-brown banks after the signature of Paris Agreement, given their higher exposure of loans to fossil fuel firms. To summarize, the Paris agreement has seen brown-banks to become more selective with their clients, diminishing the size of their loans and increase the cost of loans to all clients, whilst continuing to finance fossil fuel firms to a smaller degree.

When considering the sub-sample of firms for which we have financial statements from the Superintendency of Companies of Colombia, the regression estimates of Equation 4 prevail, as reported by Table A.7 of the Appendix. Furthermore, for this sub-sample of firms, we find that Paris Agreement is related with an additional increase in interest rates in brown banks—compared with non-brown bank— for fossil fuel firms relative to the rest. Disaggregating further, Large fossil firms, proxied by assets, overall continued to benefit from getting credit from brown banks, as reported by Table A.8 of the Appendix.

5.4 Effects of Paris Agreement on Other Credit-related Outcomes

So far, we have presented evidence on the effects of the signature of Paris Agreement on outstanding balances of fossil fuel firms relative to the rest of economic sectors in Colombia. Due to the Agreement, the former sector experienced a reduction in their balances. Additionally, those banks that prior to the event were more exposed in lending credits to the fossil fuel sector reduced their credit supply in overall, with a subsequent increase in the interest rate for new credits.

Following an increase in climate risks, there are ample of alternatives where a bank can pass-on their increase in costs to their clients. They can do so through the size of their loans, but they can also do so through other channels such as the interest rate or risk-related measures. We estimate Equation 2 for a battery of outcomes that aim to capture the conditions of new loans (average value and interest rate), the composition of current loans (share on foreign currency), and risk-related measures of ongoing credits (share of balances with highest credit score and probability of default).[12] According to the estimates provided in Table A.5 of the Appendix and by the visual evidence presented in Figure A.4, we observe that only the estimated coefficients for the regression model that uses the interest rate for new credit as the outcome fulfil the parallel trends assumption, and according to the results there is no evidence of an impact for new loans

[12]Each bank estimates a probability of default for every ongoing loan, based on a model provided by the Colombian Superintendency of Finance.

to fossil fuel firms relative to the rest of sectors due to the Paris Agreement.

5.5 Falsification Tests

In this subsection, we present a battery of estimates under scenarios that would invalidate the plausibly causal effects we have presented before. We begin by modifying the treatment group to observe how sensitive the results presented in Table 1 are in terms of the estimated coefficients and the fulfilment of the parallel trends assumption. The regression estimates reported in Table 4 show that for different definitions of the treatment group there is still a negative effect of the Paris Agreement on ongoing balances to fossil fuel firms relative to the rest of sectors. Parallel trends holds for all regression models excepting for the one in which we only use oil firms as the treatment group (panel (a) of Figure A.5 of the Appendix). Moreover, the results from Table 4 also shows that coal and oil sectors were the most affected by the Signature: when either of the aforementioned sectors is excluded (columns 4 and 5), the estimated values of α are much smaller than those reported in Table 1.

	(1) Oil Only	(2) Coal Only	(3) No Chemistry	(4) No Coal	(5) No Oil
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.626***	-0.567***	-0.602***	-0.420***	-0.247***
	(0.051)	(0.070)	(0.040)	(0.043)	(0.055)
R-squared	0.668	0.668	0.668	0.668	0.668
No. Observations	6,809,740	6,794,110	6,825,440	6,817,839	6,801,271
Firm FE	Yes	Yes	Yes	Yes	Yes
Period FE	Yes	Yes	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes	Yes	Yes

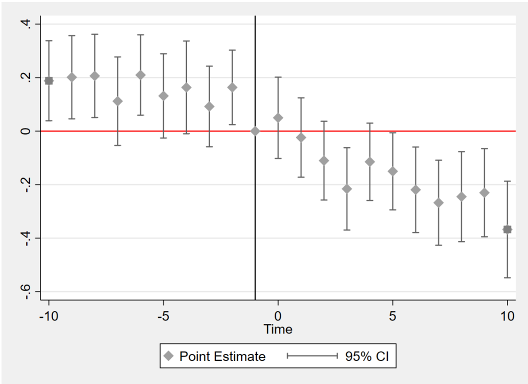
Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

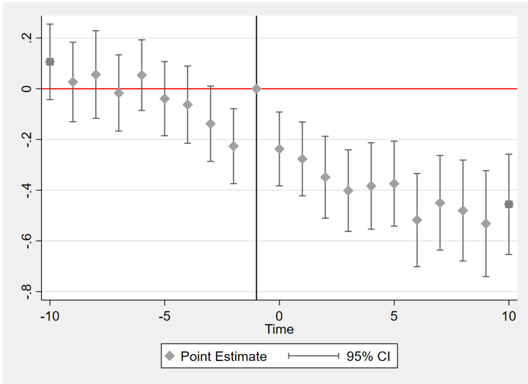
Table 4: Credit to fossil fuel firms after Paris Agreement, using alternative definitions of treatment group

As explained in section 2, the Colombian Congress started the discussion of the Agreement during the third quarter of 2016. We took this period as the event date because it served as a moment of understanding for local financial actors that Colombia will ratify the Paris agreement and, thus, will bring an increased risk of stranded asset costs to the local fossil fuel industry. Whether it could be unclear if the signature and implementation of the Agreement by UN members or the ratification of the by the Colombian congress had also implications on banks and firms' decisions on credit, we use these moments as alternative event dates to conduct falsification tests for our proposed initial date. Figure 7 displays the event study plots for the regression estimates of Equation 2 using 2015Q4 (signature of the agreement by UN members), 2016Q4 (when the Agreement is effective by UN), and 2017Q2 (after ratification by the Colombian congress) as event dates. The visual evidence provided by Figure 7 and the estimates reported in Table A.11 of the Appendix show that none of these alternative dates fulfil the parallel trends assumption, despite displaying a negative dynamic effect for the post-event periods.

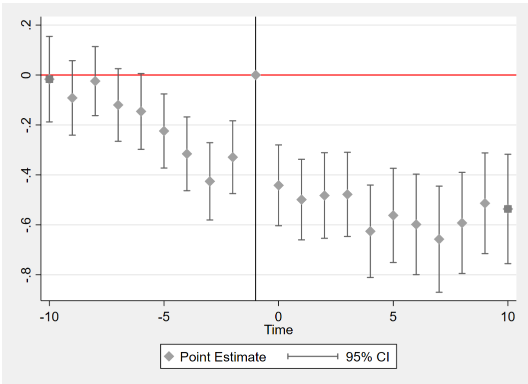
Finally, we test whether there is evidence on any potential effect on credit to fossil fuel firms that could be attributed to the fall in international oil prices. Considering Figure 2 We estimate Equation 2 for four different dates beginning with the third quarter of 2014, when the trend in international prices shifted downwards. The results displayed in Figure 8 and Table A.12 of the Appendix show that, first, parallel trends do not hold for these dates and, second, the point estimates are negative only several quarters after the event, getting closer to the signature of Paris Agreement.



(a) 2015Q4



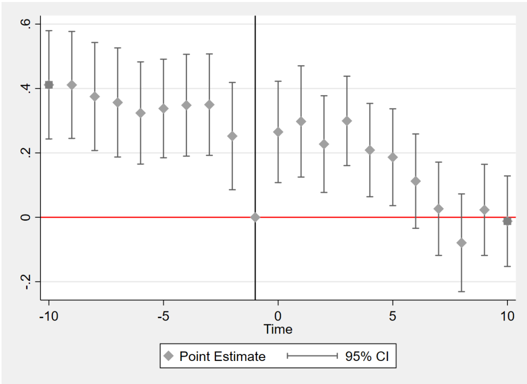
(b) 2016Q4



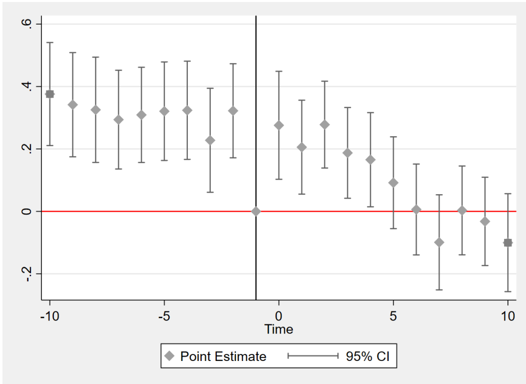
(c) 2017Q2

Figure 7: Event Study plots for estimates using alternative dates of Paris Agreement

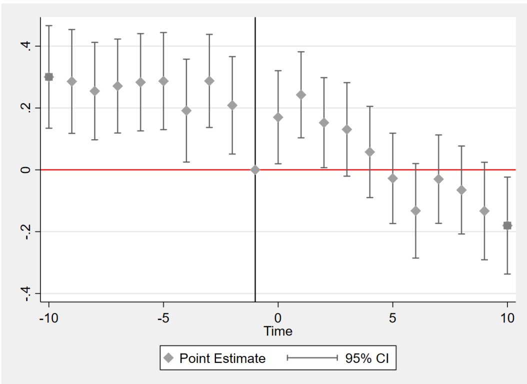
Note: All event studies were estimated including firm, period, and (bank $\times$ firm) fixed effects.



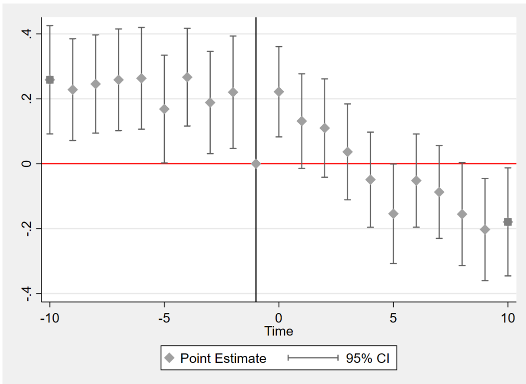
(a) 2014Q3



(b) 2014Q4



(c) 2015Q1



(d) 2015Q2

Figure 8: Event Study plots for estimates using the international oil price shock as event

Note: All event studies were estimated including firm, period, and (bank × firm) fixed effects.

6 Conclusions

How does bank lending to fossil fuel firms change after an increase in climate transition risks? Much of the literature has focused on countries importing such energies, but this study looks specifically at bank lending from a fossil fuel producing country. Our country of study is highly dependent on fossil fuel firms, and the borrowing behaviour of such firms differ from non-fossil fuel firms. Effects of pricing-in transition risks in a country so highly dependent on such reserves might be lower than the rest of the literature, and yet has been understudied.

The objective of this study was to investigate the impact of the Paris Climate Change Agreement on banks' lending behaviour in Colombia, where fossil fuels account for a major part of exports and GDP. Using a granular loan-level data set from the credit registry of the Colombian Superintendency of Finance, we examine how the introduction of the Paris agreement has affected lending of Colombian banks towards firms more exposed to the risk of stranded assets.

By separating fossil fuel firms from other firms, we find that an important deleveraging occurred in bank lending to fossil firms. In our preferred specification, our baseline results suggest that the increased risk of stranded assets implied by the Paris agreement led to a 46% decrease in credit balances of fossil fuel firms in the country. Subsequently, we control for balance sheet ratios of firms. We then find that fossil fuel firms that were in a better financial position, namely larger and more capitalised, could borrow more than their smaller and less capitalised fossil firms. Additionally, we find that brown banks remain largely exposed to fossil fuel firms by being more selective, and there is empirical evidence that they reduced the supply of credit relative to non-brown banks to all firms, but keep on lending to large fossil fuel firms. Brown banks thus remain highly exposed to fossil fuel firms, even after an increase in stranded assets risk, proxied by the

Paris Agreement.

Potential early policy recommendations would encourage authorities to develop policies to dissuade banks that remain exposed to stranded assets risk, and to fully price in long-term environmental risks in their financial activities. They could do this in two forms: develop green supporting factors, to make financing of green firms more attractive, and brown penalising factors, by penalising financing to fossil fuel firms and making such financing less profitable.

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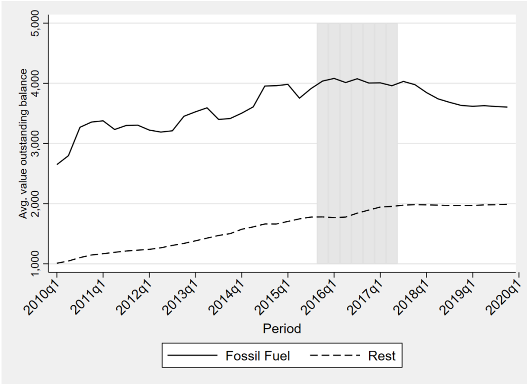
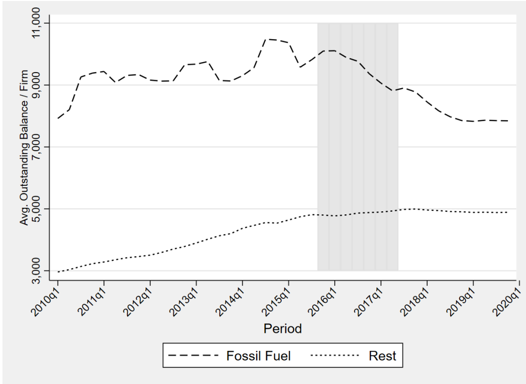
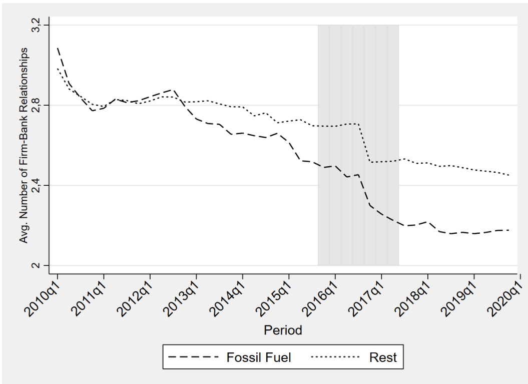
Appendix



(a) Avg. Oustanding Credit by Firm-Bank (2018 Mill. COP)



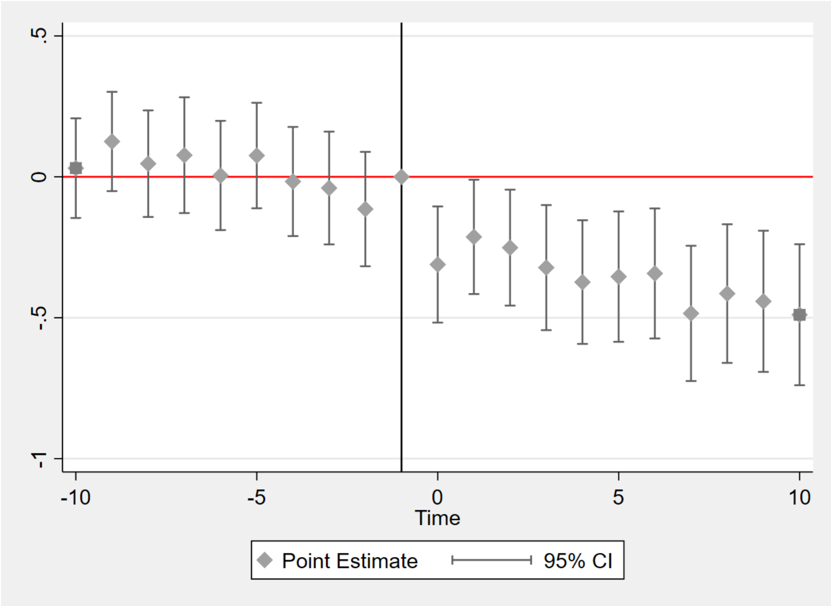
(b) Avg. Outstanding Credit by Firm (2018 Mill. COP)



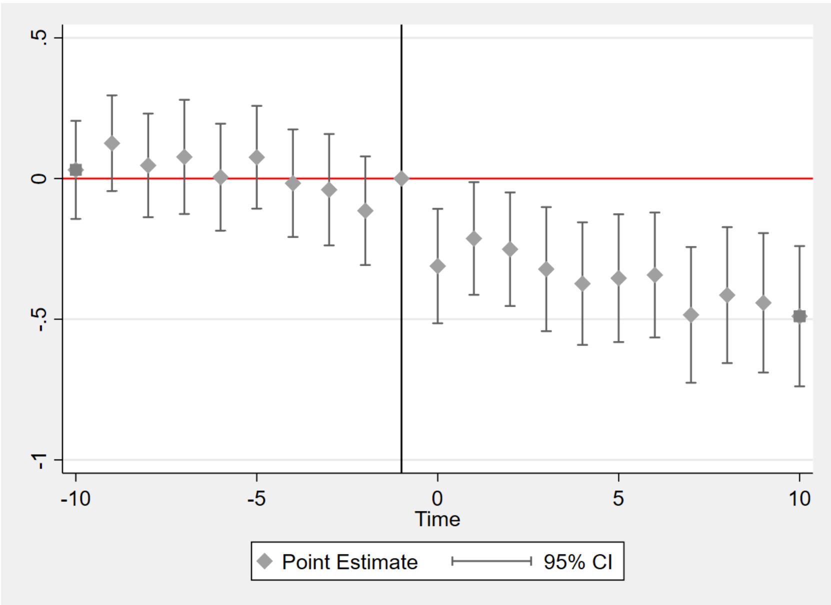
(c) Bank Relationships

Figure A.1: Evolution of Credit-related Variables for the Sub-sample of Firms with Balance Sheet Information

Source: Colombian Superintendency of Finance



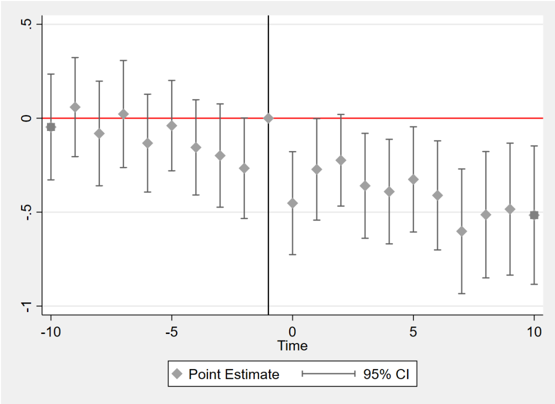
(a) Firm-level clustering



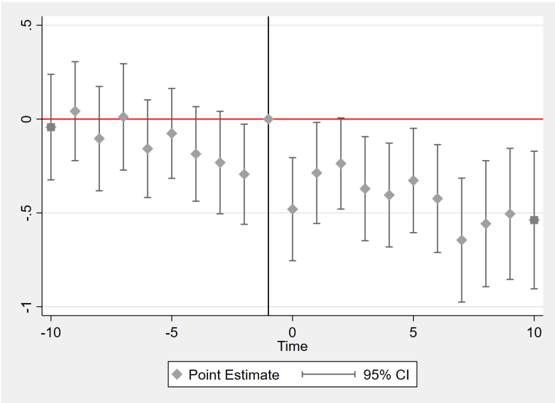
(b) Firm × bank-level clustering

Figure A.2: Event Study Plots, Baseline Regressions with Clustered SE

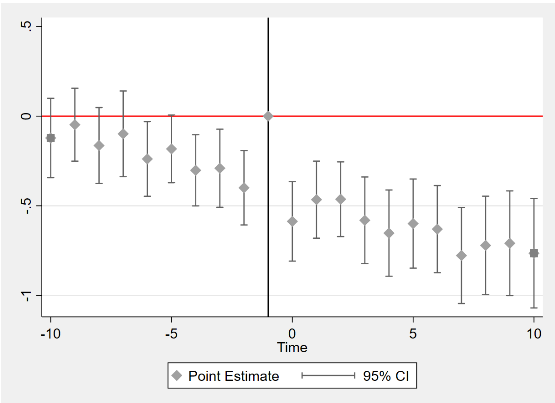
Source: Colombian Superintendency of Finance



(a) Firm + Bank + Period FE

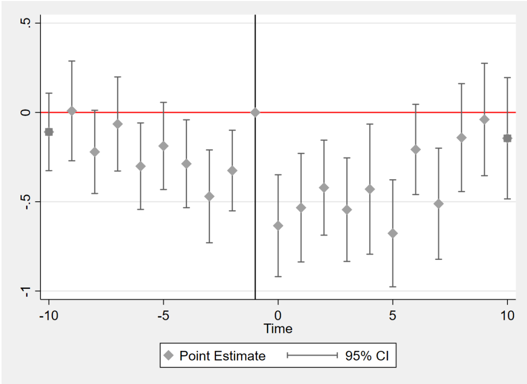


(b) Firm + (Bank X Period) FE

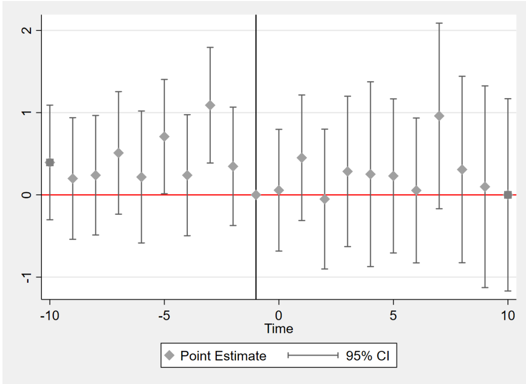


(c) Firm + Period + (Bank X Firm) FE

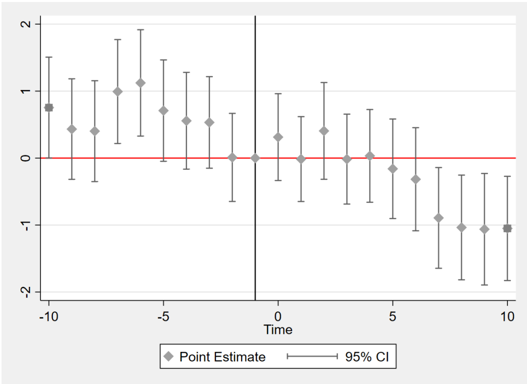
Figure A.3: Event Study Plots, balance sheet sub-sample estimates



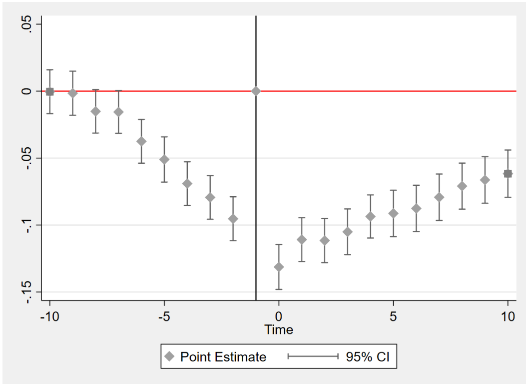
(a) Value of new credits



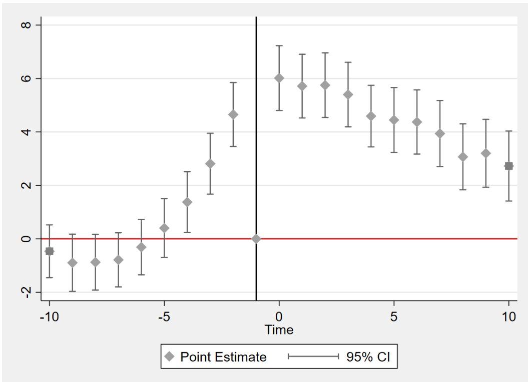
(b) Average Interest Rate for New Credits (%)



(c) Share ongoing balances on foreign currency



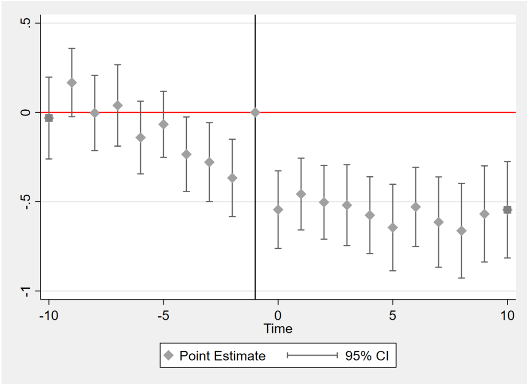
(d) Share of balances with credit score = A



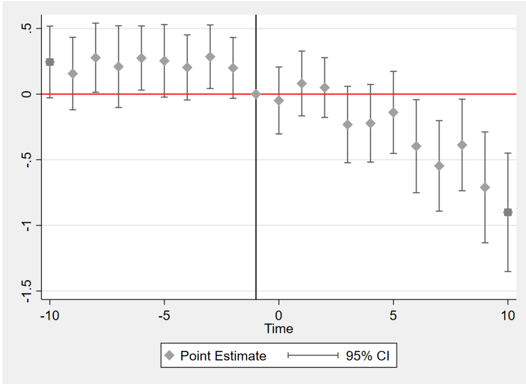
(e) Average Probability of Default (0–100)

Figure A.4: Event Studies for other banking-related variables.

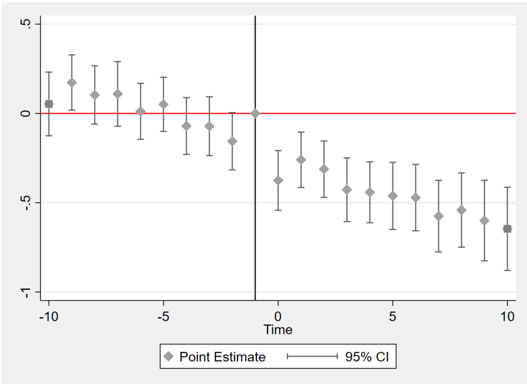
Note: All event studies were estimated including firm, period and (firm × bank) fixed effects



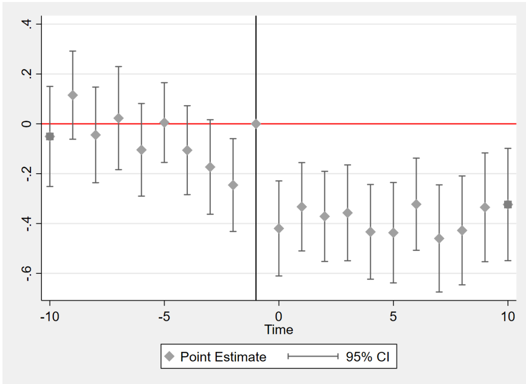
(a) Oil Only



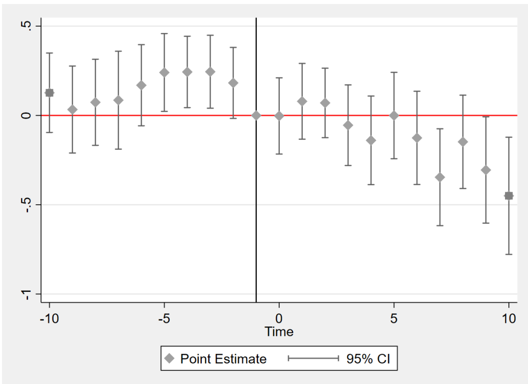
(b) Coal Only



(c) No Chemistry



(d) No Coal



(e) No Oil

Figure A.5: Event Studies for alternative definitions of treatment group

Note: All event studies were estimated including firm, period, and (bank × firm) fixed effects.

	(1)	(2)	(3)
lead10	0.077	0.071	0.031
	(0.103)	(0.103)	(0.084)
lead9	0.209**	0.185*	0.125*
	(0.095)	(0.095)	(0.076)
lead8	0.137	0.107	0.047
	(0.101)	(0.101)	(0.080)
lead7	0.184*	0.165	0.077
	(0.104)	(0.104)	(0.088)
lead6	0.128	0.104	0.005
	(0.094)	(0.094)	(0.077)
lead5	0.204**	0.173**	0.076
	(0.087)	(0.087)	(0.071)
lead4	0.104	0.078	-0.017
	(0.091)	(0.090)	(0.074)
lead3	0.035	0.010	-0.040
	(0.096)	(0.096)	(0.078)
lead2	-0.037	-0.060	-0.114
	(0.094)	(0.093)	(0.076)
lag0	-0.226**	-0.245***	-0.311***
	(0.094)	(0.094)	(0.079)
lag1	-0.132	-0.141	-0.213***
	(0.091)	(0.091)	(0.074)
lag2	-0.148*	-0.154*	-0.251***
	(0.087)	(0.087)	(0.074)
lag3	-0.212**	-0.215**	-0.322***
	(0.094)	(0.094)	(0.082)
lag4	-0.239**	-0.239**	-0.373***
	(0.095)	(0.095)	(0.082)
lag5	-0.229**	-0.223**	-0.354***
	(0.097)	(0.097)	(0.087)
lag6	-0.232**	-0.231**	-0.343***
	(0.098)	(0.097)	(0.085)
lag7	-0.372***	-0.402***	-0.485***
	(0.111)	(0.111)	(0.093)
lag8	-0.296***	-0.321***	-0.414***
	(0.111)	(0.111)	(0.095)
lag9	-0.346***	-0.358***	-0.442***
	(0.117)	(0.117)	(0.101)
lag10	-0.399***	-0.408***	-0.489***
	(0.125)	(0.125)	(0.106)
R-squared	0.517	0.520	0.668
No. Observations	6,859,461	6,859,456	6,832,601
Joint Leads Test P-value	0.119	0.264	0.519
Firm FE	Yes	Yes	Yes
Bank FE	Yes		
Period FE	Yes		Yes
Bank × Period FE		Yes	
Bank × Firm FE			Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.1: Event Study Estimates of Table 1

	(1) Firm Clustering	(2) Firm and Bank Clustering
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.462***	-0.462***
	(0.104)	(0.101)
R-squared	0.668	0.668
No. Observations	6,832,601	6,832,601
Firm FE	Yes	Yes
Period FE	Yes	Yes
Bank × Firm FE	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: Credit to fossil fuel firms after Paris Agreement, Using Clustered SE

	(1) Firm Clustering	(2) Firm and Bank Clustering
lead10	0.031	0.031
	(0.090)	(0.089)
lead9	0.125	0.125
	(0.090)	(0.087)
lead8	0.047	0.047
	(0.096)	(0.094)
lead7	0.077	0.077
	(0.105)	(0.104)
lead6	0.005	0.005
	(0.099)	(0.097)
lead5	0.076	0.076
	(0.096)	(0.093)
lead4	-0.017	-0.017
	(0.099)	(0.098)
lead3	-0.040	-0.040
	(0.102)	(0.101)
lead2	-0.114	-0.114
	(0.104)	(0.098)
lag0	-0.311***	-0.311***
	(0.105)	(0.104)
lag1	-0.213**	-0.213**
	(0.104)	(0.102)
lag2	-0.251**	-0.251**
	(0.105)	(0.103)
lag3	-0.322***	-0.322***
	(0.113)	(0.112)
lag4	-0.373***	-0.373***
	(0.112)	(0.111)
lag5	-0.354***	-0.354***
	(0.118)	(0.116)
lag6	-0.343***	-0.343***
	(0.118)	(0.113)
lag7	-0.485***	-0.485***
	(0.122)	(0.123)
lag8	-0.414***	-0.414***
	(0.126)	(0.123)
lag9	-0.442***	-0.442***
	(0.128)	(0.126)
lag10	-0.489***	-0.489***
	(0.128)	(0.127)
R-squared	0.668	0.668
No. Observations	6,832,601	6,832,601
Firm FE	Yes	Yes
Period FE	Yes	Yes
Bank × Firm FE	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.3: Event Study Estimates, Baseline Estimates Using Clustered SE

	(1)	(2)	(3)
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.405***	-0.419***	-0.623***
	(0.054)	(0.054)	(0.050)
R-squared	0.354	0.359	0.586
No. Observations	2,139,358	2,139,355	2,134,162
Firm FE	Yes	Yes	Yes
Bank FE	Yes		
Period FE	Yes		Yes
Bank × Period FE		Yes	
Bank × Firm FE			Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.4: Credit to Fossil Fuel Firms After Paris Agreement, Balance Sheet Sub-sample

	(1)	(2)	(3)
lead10	-0.047	-0.043	-0.122
	(0.144)	(0.144)	(0.113)
lead9	0.059	0.042	-0.048
	(0.135)	(0.135)	(0.104)
lead8	-0.081	-0.104	-0.164
	(0.142)	(0.142)	(0.108)
lead7	0.022	0.012	-0.099
	(0.145)	(0.145)	(0.122)
lead6	-0.133	-0.158	-0.239**
	(0.133)	(0.133)	(0.106)
lead5	-0.039	-0.076	-0.183*
	(0.123)	(0.122)	(0.096)
lead4	-0.155	-0.186	-0.302***
	(0.129)	(0.129)	(0.101)
lead3	-0.199	-0.232*	-0.290***
	(0.140)	(0.139)	(0.111)
lead2	-0.266*	-0.294**	-0.400***
	(0.137)	(0.136)	(0.106)
lag0	-0.452***	-0.480***	-0.587***
	(0.140)	(0.140)	(0.113)
lag1	-0.272**	-0.287**	-0.466***
	(0.138)	(0.137)	(0.110)
lag2	-0.224*	-0.237*	-0.463***
	(0.124)	(0.124)	(0.106)
lag3	-0.360**	-0.371***	-0.581***
	(0.142)	(0.141)	(0.123)
lag4	-0.390***	-0.405***	-0.652***
	(0.142)	(0.141)	(0.123)
lag5	-0.326**	-0.327**	-0.599***
	(0.143)	(0.142)	(0.127)
lag6	-0.411***	-0.424***	-0.630***
	(0.148)	(0.147)	(0.124)
lag7	-0.602***	-0.645***	-0.777***
	(0.169)	(0.169)	(0.137)
lag8	-0.514***	-0.558***	-0.721***
	(0.172)	(0.171)	(0.140)
lag9	-0.484***	-0.505***	-0.709***
	(0.179)	(0.178)	(0.149)
lag10	-0.516***	-0.538***	-0.765***
	(0.188)	(0.187)	(0.156)
R-squared	0.354	0.359	0.586
No. Observations	2,139,358	2,139,355	2,134,162
Joint Leads Test P-value	0.564	0.362	0.001
Firm FE	Yes	Yes	Yes
Bank FE	Yes		
Period FE	Yes		Yes
Bank × Period FE		Yes	
Bank × Firm FE			Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Event Study Estimates, Balance Sheet Sub-sample

	(1)	(2)	(3)	(4)	(5)	(6)
I[high lassets = 1] × I[FF = 1] × Paris Agreement	0.668^{***}					
	(0.133)					
I[high roa = 1] × I[FF = 1] × Paris Agreement		-0.230^{**}				
		(0.109)				
I[high liquidity = 1] × I[FF = 1] × Paris Agreement			-0.205^{*}			
			(0.118)			
I[high capital_ratio = 1] × I[FF = 1] × Paris Agreement				0.220^{**}		
				(0.111)		
I[high lliability = 1] × I[FF = 1] × Paris Agreement					0.663^{***}	
					(0.136)	
I[high tangibility = 1] × I[FF = 1] × Paris Agreement						-0.076
						(0.150)
R-squared	0.359	0.360	0.359	0.359	0.359	0.359
No. Observations	2,139,355	2,139,355	2,139,355	2,139,355	2,139,355	2,139,355

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: The Effects on Credit for Fossil fuel firms, Controlling for Balance Sheet Characteristics (Continued)

Note:All regression models include firm and (bank × period) fixed effects.

	(1) Ongoing Balance	(2) New Credits	(3) Interest Rate New Credits
I[Fossil Fuel = 1] × I[Paris Agreement = 1]	-0.687***	-0.133	-1.287***
	(0.072)	(0.128)	(0.432)
I[Brown bank = 1] × I[Paris Agreement = 1]	-0.917***	-0.051***	2.236***
	(0.011)	(0.015)	(0.053)
I[Fossil Fuel = 1] × I[Brown bank = 1] × I[Paris Agreement = 1]	0.185*	-0.115	1.912***
	(0.098)	(0.169)	(0.559)
R-squared	0.588	0.671	0.630
No. Observations	2,128,081	472,183	473,592
Firm FE	Yes	Yes	Yes
Period FE	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: Brown Vs. Non-brown Bank Lending to Fossil Fuel Firms, Balance Sheet Sub-sample

	Brown Banks						Non-brown banks					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I[high lassets = 1] × I[FF = 1] × Paris Agreement	0.566***						0.632***					
	(0.181)						(0.186)					
I[high roa = 1] × I[FF = 1] × Paris Agreement		0.237						-0.697***				
		(0.144)						(0.150)				
I[high liquidity = 1] × I[FF = 1] × Paris Agreement			-0.224						-0.398**			
			(0.150)						(0.168)			
I[high capital_ratio = 1] × I[FF = 1] × Paris Agreement				0.514***						-0.162		
				(0.147)						(0.158)		
I[high lliability = 1] × I[FF = 1] × Paris Agreement					0.628***						0.341*	
					(0.185)						(0.192)	
I[high tangibility = 1] × I[FF = 1] × Paris Agreement						0.082						-0.483**
						(0.192)						(0.222)
R-squared	0.395	0.395	0.394	0.394	0.394	0.394	0.474	0.476	0.474	0.474	0.474	0.474
No. Observations	1,252,182	1,252,182	1,252,182	1,252,182	1,252,182	1,252,182	880,119	880,119	880,119	880,119	880,119	880,119

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.8: The Effects on Credit for FF Firms, Controlling for Balance Sheet Characteristics (Brown Vs. Non-Brown Bank Lending)

Note:All regression models include firm and (bank × period) fixed effects.

	(1) Average value new loans	(2) Interest rate new credits	(3) Probability of default	(4) = 1 if credit score = A	(5) Share credit foreign currency
lead10	-0.109	0.394	-0.466	-0.000	0.754**
	(0.111)	(0.356)	(0.504)	(0.008)	(0.384)
lead9	0.009	0.199	-0.896	-0.002	0.433
	(0.142)	(0.377)	(0.546)	(0.008)	(0.383)
lead8	-0.221*	0.239	-0.875*	-0.015*	0.402
	(0.119)	(0.371)	(0.531)	(0.008)	(0.384)
lead7	-0.065	0.510	-0.786	-0.016*	0.993**
	(0.134)	(0.380)	(0.517)	(0.008)	(0.396)
lead6	-0.301**	0.217	-0.310	-0.037***	1.122***
	(0.124)	(0.410)	(0.529)	(0.008)	(0.405)
lead5	-0.188	0.709**	0.402	-0.051***	0.709*
	(0.125)	(0.355)	(0.562)	(0.009)	(0.386)
lead4	-0.287**	0.239	1.375**	-0.069***	0.557
	(0.126)	(0.376)	(0.581)	(0.008)	(0.369)
lead3	-0.470***	1.091***	2.812***	-0.079***	0.533
	(0.133)	(0.359)	(0.582)	(0.008)	(0.349)
lead2	-0.325***	0.347	4.652***	-0.095***	0.010
	(0.115)	(0.367)	(0.611)	(0.008)	(0.336)
lag0	-0.634***	0.057	6.016***	-0.131***	0.313
	(0.146)	(0.378)	(0.619)	(0.009)	(0.331)
lag1	-0.533***	0.451	5.716***	-0.111***	-0.015
	(0.155)	(0.390)	(0.608)	(0.008)	(0.323)
lag2	-0.421***	-0.051	5.751***	-0.112***	0.406
	(0.136)	(0.434)	(0.617)	(0.008)	(0.369)
lag3	-0.544***	0.285	5.400***	-0.105***	-0.015
	(0.148)	(0.467)	(0.616)	(0.009)	(0.342)
lag4	-0.430**	0.251	4.593***	-0.094***	0.033
	(0.186)	(0.573)	(0.588)	(0.008)	(0.353)
lag5	-0.677***	0.230	4.449***	-0.091***	-0.160
	(0.153)	(0.478)	(0.619)	(0.009)	(0.379)
lag6	-0.207	0.054	4.373***	-0.088***	-0.316
	(0.129)	(0.450)	(0.613)	(0.009)	(0.393)
lag7	-0.511***	0.960*	3.940***	-0.079***	-0.893**
	(0.159)	(0.576)	(0.632)	(0.009)	(0.384)
lag8	-0.141	0.308	3.069***	-0.071***	-1.036***
	(0.154)	(0.579)	(0.630)	(0.009)	(0.399)
lag9	-0.040	0.099	3.202***	-0.066***	-1.063**
	(0.161)	(0.626)	(0.648)	(0.009)	(0.425)
lag10	-0.145	0.000	2.725***	-0.062***	-1.051***
	(0.173)	(0.597)	(0.669)	(0.009)	(0.397)
R-squared	0.767	0.684	0.584	0.520	0.590
No. Observations	1,454,588	1,460,657	6,832,444	6,832,601	6,547,647
Joint Leads Test P-value	0.004	0.195	0.000	0.000	0.032
Firm FE	Yes	Yes	Yes	Yes	Yes
Period FE	Yes	Yes	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.9: Event Study Estimates, Using Other Banking-related Variables as Outcomes

	(1) Oil Only	(2) Coal Only	(3) No Chemistry	(4) No Coal	(5) No Oil
lead10	-0.031	0.245*	0.053	-0.051	0.127
	(0.117)	(0.139)	(0.091)	(0.102)	(0.114)
lead9	0.167*	0.157	0.173**	0.115	0.033
	(0.098)	(0.141)	(0.079)	(0.090)	(0.124)
lead8	-0.003	0.277**	0.103	-0.044	0.073
	(0.107)	(0.134)	(0.083)	(0.098)	(0.123)
lead7	0.039	0.209	0.109	0.023	0.085
	(0.116)	(0.159)	(0.092)	(0.106)	(0.140)
lead6	-0.140	0.275**	0.012	-0.104	0.169
	(0.104)	(0.125)	(0.080)	(0.095)	(0.116)
lead5	-0.066	0.253*	0.051	0.005	0.241**
	(0.094)	(0.141)	(0.077)	(0.082)	(0.111)
lead4	-0.234**	0.203	-0.070	-0.106	0.243**
	(0.107)	(0.127)	(0.081)	(0.091)	(0.102)
lead3	-0.278**	0.285**	-0.071	-0.173*	0.245**
	(0.113)	(0.123)	(0.084)	(0.097)	(0.104)
lead2	-0.367***	0.200*	-0.156*	-0.246***	0.182*
	(0.111)	(0.118)	(0.082)	(0.095)	(0.101)
lag0	-0.544***	-0.048	-0.375***	-0.420***	-0.003
	(0.111)	(0.130)	(0.085)	(0.097)	(0.109)
lag1	-0.457***	0.081	-0.259***	-0.333***	0.079
	(0.103)	(0.126)	(0.079)	(0.090)	(0.108)
lag2	-0.503***	0.050	-0.312***	-0.371***	0.070
	(0.105)	(0.116)	(0.080)	(0.092)	(0.099)
lag3	-0.519***	-0.232	-0.427***	-0.357***	-0.055
	(0.116)	(0.148)	(0.091)	(0.098)	(0.115)
lag4	-0.575***	-0.222	-0.441***	-0.433***	-0.139
	(0.110)	(0.151)	(0.087)	(0.097)	(0.127)
lag5	-0.644***	-0.139	-0.462***	-0.437***	-0.001
	(0.124)	(0.159)	(0.096)	(0.103)	(0.123)
lag6	-0.529***	-0.397**	-0.471***	-0.323***	-0.126
	(0.113)	(0.181)	(0.095)	(0.094)	(0.133)
lag7	-0.614***	-0.547***	-0.575***	-0.460***	-0.346**
	(0.129)	(0.176)	(0.102)	(0.110)	(0.138)
lag8	-0.662***	-0.387**	-0.541***	-0.428***	-0.148
	(0.135)	(0.178)	(0.106)	(0.111)	(0.133)
lag9	-0.569***	-0.710***	-0.600***	-0.335***	-0.305**
	(0.137)	(0.216)	(0.115)	(0.111)	(0.152)
lag10	-0.545***	-0.900***	-0.646***	-0.324***	-0.450***
	(0.138)	(0.230)	(0.119)	(0.115)	(0.167)
R-squared	0.668	0.668	0.668	0.668	0.668
No. Observations	6,832,601	6,832,601	6,832,601	6,832,601	6,832,601
Joint Leads Test P-value	0.003	0.105	0.104	0.140	0.119
Firm FE	Yes	Yes	Yes	Yes	Yes
Period FE	Yes	Yes	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.10: Event Study Estimates, Using Alternative Definitions of Treatment Group

	(1) 2015Q4	(2) 2016Q4	(3) 2017Q2
lead10	0.188**	0.106	-0.017
	(0.076)	(0.076)	(0.087)
lead9	0.201**	0.027	-0.092
	(0.079)	(0.080)	(0.076)
lead8	0.206***	0.056	-0.024
	(0.079)	(0.088)	(0.071)
lead7	0.112	-0.017	-0.120
	(0.084)	(0.077)	(0.074)
lead6	0.210***	0.054	-0.146*
	(0.077)	(0.071)	(0.077)
lead5	0.132	-0.039	-0.224***
	(0.080)	(0.075)	(0.076)
lead4	0.163*	-0.063	-0.316***
	(0.088)	(0.078)	(0.075)
lead3	0.092	-0.138*	-0.426***
	(0.077)	(0.076)	(0.079)
lead2	0.163**	-0.226***	-0.329***
	(0.071)	(0.075)	(0.074)
lag0	0.050	-0.237***	-0.442***
	(0.078)	(0.074)	(0.083)
lag1	-0.024	-0.277***	-0.499***
	(0.076)	(0.074)	(0.082)
lag2	-0.110	-0.349***	-0.482***
	(0.075)	(0.082)	(0.087)
lag3	-0.216***	-0.402***	-0.478***
	(0.079)	(0.082)	(0.086)
lag4	-0.115	-0.383***	-0.626***
	(0.074)	(0.087)	(0.094)
lag5	-0.150**	-0.374***	-0.562***
	(0.074)	(0.085)	(0.096)
lag6	-0.219***	-0.518***	-0.598***
	(0.082)	(0.094)	(0.103)
lag7	-0.268***	-0.450***	-0.658***
	(0.081)	(0.095)	(0.108)
lag8	-0.245***	-0.480***	-0.592***
	(0.086)	(0.101)	(0.103)
lag9	-0.230***	-0.532***	-0.514***
	(0.084)	(0.107)	(0.103)
lag10	-0.368***	-0.456***	-0.536***
	(0.092)	(0.101)	(0.112)
R-squared	0.668	0.668	0.668
No. Observations	6,832,601	6,832,601	6,832,601
Joint Leads Test P-value	0.006	0.049	0.000
Firm FE	Yes	Yes	Yes
Period FE	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.11: Event Study Estimates, Using Alternative Dates of Paris Agreement

	(1) 2014Q3	(2) 2014Q4	(3) 2015Q1	(4) 2015Q2
lead10	0.411***	0.376***	0.300***	0.259***
	(0.086)	(0.084)	(0.085)	(0.085)
lead9	0.411***	0.342***	0.286***	0.228***
	(0.085)	(0.085)	(0.086)	(0.080)
lead8	0.375***	0.325***	0.255***	0.246***
	(0.086)	(0.086)	(0.080)	(0.077)
lead7	0.357***	0.294***	0.271***	0.258***
	(0.086)	(0.081)	(0.077)	(0.080)
lead6	0.324***	0.309***	0.283***	0.263***
	(0.081)	(0.078)	(0.080)	(0.080)
lead5	0.338***	0.321***	0.287***	0.168**
	(0.078)	(0.081)	(0.080)	(0.085)
lead4	0.348***	0.324***	0.191**	0.267***
	(0.081)	(0.080)	(0.085)	(0.077)
lead3	0.350***	0.228***	0.288***	0.188**
	(0.080)	(0.085)	(0.077)	(0.080)
lead2	0.252***	0.322***	0.209***	0.220**
	(0.085)	(0.077)	(0.080)	(0.088)
lag0	0.265***	0.276***	0.170**	0.222***
	(0.080)	(0.088)	(0.077)	(0.071)
lag1	0.298***	0.206***	0.243***	0.131*
	(0.088)	(0.077)	(0.071)	(0.074)
lag2	0.227***	0.278***	0.152**	0.110
	(0.077)	(0.071)	(0.074)	(0.077)
lag3	0.299***	0.187**	0.131*	0.036
	(0.071)	(0.074)	(0.077)	(0.075)
lag4	0.209***	0.166**	0.058	-0.049
	(0.074)	(0.077)	(0.075)	(0.075)
lag5	0.187**	0.092	-0.028	-0.154**
	(0.077)	(0.075)	(0.075)	(0.078)
lag6	0.112	0.006	-0.133*	-0.052
	(0.075)	(0.074)	(0.078)	(0.073)
lag7	0.026	-0.099	-0.030	-0.087
	(0.074)	(0.078)	(0.073)	(0.073)
lag8	-0.079	0.003	-0.065	-0.155*
	(0.077)	(0.073)	(0.073)	(0.081)
lag9	0.023	-0.032	-0.133*	-0.203**
	(0.072)	(0.072)	(0.080)	(0.080)
lag10	-0.012	-0.100	-0.180**	-0.179**
	(0.072)	(0.080)	(0.080)	(0.085)
R-squared	0.668	0.668	0.668	0.668
No. Observations	6,832,601	6,832,601	6,832,601	6,832,601
Joint Leads Test P-value	0.000	0.000	0.000	0.000
Firm FE	Yes	Yes	Yes	Yes
Period FE	Yes	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.12: Event Study Estimates, Using the International Oil Price Shock as Event