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Pablo Anaya Longaric, Vasileios Kostakis,
Laura Parisi, Francesca Vinci

Oil shocks and firm investment on the two sides of the Atlantic

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Abstract

Europe's lack of energy independence raises concerns about its vulnerability to external energy shocks, such as Russia's 2022 invasion of Ukraine. This paper examines how energy shocks impact firm-level investment, comparing European and US firm responses. Using global oil supply news shocks, S&P's Compustat data, and a local projections approach, the study reveals that European firms significantly cut capital and R&D expenditures after an oil shock, unlike US firms. The disparity is primarily driven by financially constrained firms in energy-intensive sectors. Additionally, differences in capital market structures play a role, as European firms relying more on market-based financing reduce investment by less. Lastly, our analysis confirms that the US shale revolution was a contributing factor in shaping Europe's relative vulnerability. These findings highlight the need for national and EU policies to secure the energy supply, lower prices, and deepen capital markets, enhancing resilience and future competitiveness amid energy volatility.

Keywords: Oil shocks, corporate investment, energy, competitiveness

JEL Codes: D22, E22 F15, Q43

Non-technical Summary

Europe's reliance on fossil fuel imports remains elevated, raising concerns over the continent's vulnerability to external energy shocks, such as the significant price increases following Russia's invasion of Ukraine in 2022. Energy shocks threaten Europe's economic competitiveness as they lead to increased production costs, affecting firms' investment strategies, productivity, and ability to compete both domestically and internationally.

This paper explores the response of European firms' investment to energy shocks, in comparison to US firms, specifically focusing on oil shocks, which in turn affect gas and electricity prices. It addresses two main questions: to what extent do energy shocks influence firm investment decisions and whether European firms are more vulnerable to these shocks compared to their US counterparts. We conduct the analysis using global oil supply news shocks as a proxy for energy shocks and apply local projection methods, leveraging rich balance sheet data from publicly listed companies between 1989 and 2023.

The findings reveal that European firms significantly reduce their capital and R&D expenditures in response to oil shocks, unlike their US counterparts, indicating a potential loss in productivity and competitiveness for European firms. This difference is particularly pronounced for firms in energy-intensive sectors, which also face financial constraints. Moreover, the analysis reveals that European firms that rely relatively more on market financing compared to bank financing reduce investment by less following an oil shock. This suggests differences in market financing structures between Europe and the US, with European firms relying more on debt and less on equity financing, may partly explain the observed disparities. Lastly, our findings indicate that the US shale revolution contributed to Europe's relative vulnerability.

Overall, the results underscore the importance of reducing Europe's vulnerability to energy shocks to maintain its competitiveness. Policy recommendations include securing Europe's energy supply, mitigating firms' exposure to future energy shocks to safeguard current and future economic prosperity. Moreover, while national interventions are best suited to address country-specific issues, EU actions should be aimed at tackling shared problems and fostering cross-country collaboration.

In the short term, key measures include strengthening the joint procurement of energy products to enhance the market power of the EU and expanding the use of long-term electricity contracts to provide price stability. In the medium term, advancing the green transition is crucial to reduce external dependencies. This requires accelerating and simplifying permitting processes, strategically directing EU funds, and supporting cross-border projects to scale up renewable energy generation. In addition, targeted support for energy-intensive industries is needed to maintain their competitiveness while advancing decarbonization goals.

Finally, deepening the capital markets union is essential to ease firms' access to financing and support investments in energy efficiency. A comprehensive clean industrial deal for Europe, combining short- and long-term measures to achieve energy independence, as currently envisaged by the European Commission, is necessary to build resilience against future shocks and strengthen the long-term competitiveness of the European economy.

1 Introduction

The energy shock triggered by Russia's invasion of Ukraine has reignited concerns about energy security, economic resilience and competitiveness, particularly in Europe. Unlike the United States—which became a net energy exporter in recent years thanks to the shale revolution—European economies remain heavily dependent on energy imports. The EU's energy import dependency rate, defined as the share of energy consumption not met by domestic production, reached 67.2% in 2023, up from around 50% in 1990. By contrast, the US recorded a negative dependency rate of -9.7% in 2023, reflecting a structural shift toward energy self-sufficiency. Within Europe, dependency is especially pronounced for oil and petroleum products, where the rate remains as high as 98.6%.[1] This suggests European firms may be more exposed to energy shocks than US firms.

Energy shocks, understood as exogenous changes in energy prices, lead to a rise in unit production costs for firms, putting downward pressure on production and economic activity. They can affect firms' investment strategies, with implications for future production capacity and overall productivity, and thus competitiveness. Investment in fixed capital and research and development (R&D) is at the heart of productivity growth, which is, in turn, directly related to the ability of firms to compete in international markets (Romer, 1986, 1990). Thus, if European firms were to reduce their investment to a greater extent compared to international competitors, the existing competitiveness differentials stemming from higher energy prices in Europe could be further exacerbated.

Energy price increases can influence firms' investment behaviour through various channels. First, by depressing economic activity and tightening financing conditions, energy shocks can reduce aggregate demand and decrease firm profitability, prompting firms to adopt a more cautious approach to investment expenditure in the short term. This cautiousness is particularly evident when producers cannot fully pass the shock on to consumers, often due to higher demand elasticity (Matzner & Steininger, 2024). Additionally, energy shocks can have a more pronounced effect on firms that are financially constrained or have limited financing sources, as these firms may struggle to incur debt to finance investment projects. Furthermore, sectors with higher

[1] Source: Energy Information Administration.

energy intensity in production may experience more significant impacts on their investment activities.

Against this background, this paper investigates how European firms respond to energy price shocks, focusing on investment behaviour. By examining firm-level responses, we seek to answer two questions: How do energy shocks affect corporate investment decisions? And are European firms more vulnerable to these shocks than their US counterparts? Despite their relevance, these research questions have not been adequately explored in the existing literature, and a comprehensive analysis of European firms' investment strategies in the face of energy shocks and a comparative assessment of EU firms relative to their US counterparts are warranted. Moreover, this paper also assesses the channels through which energy price shocks affect investment. Survey data from the European Investment Bank (EIB) consistently highlight across multiple years that important barriers to investment for European firms include high energy prices and financial constraints (EIB, 2024). To investigate these issues, we examine how firms operating in industries with varying levels of energy intensity respond to energy shocks. Additionally, we analyse the extent to which financing constraints, along with the structure of corporate liabilities - such as the reliance on bond and equity issuance versus bank credit - impact firms' investment decisions. Furthermore, we assess how these firm-specific characteristics influence investment responses differently in the US and Europe. Lastly, the paper explores the role of the US shale revolution as a structural factor that has mitigated the vulnerability of American firms to energy price fluctuations.

Previous studies, such as those by Caraiani (2022) and Lee et al. (2011), have empirically studied the effects of oil shocks on firm investment in the US. However, this has not been investigated for European firms, nor has there been a systematic comparison of their responses to those of US firms. This study aims to fill that gap by being the first to estimate the effects of oil shocks on firm investments across both regions, focusing on capital expenditures and R&D. Additionally, this is the first paper to examine the dynamic response of firm investment to oil shocks using the local projection methodology proposed by Jordà (2005) and Jordà & Taylor (2025), and applied to firm level data by Cloyne et al. (2023), Durante et al. (2022), and Döttling & Ratnovski (2023). By relying on extensive firm-level data from S&P's Compustat and applying a consistent methodology, this paper also provides an in-depth exploration of the underlying transmission channels and considers the role of firm heterogeneity.

For our analysis, we use oil supply shocks as a proxy for energy shocks for several reasons. First, oil prices are global, enabling direct comparisons between the US and the EU. Second, oil accounts for a significant portion of the energy consumed by the industrial sectors in both the EU and US. Third, the prices of other energy sources, like gas, are influenced by oil prices. Lastly, due to the historical significance of oil shocks, they have been more extensively studied in academic literature, providing numerous reliable estimates.

To answer our research questions, we estimate how corporate investment responds to exogenous increases in oil prices in the EU and the US. To consistently capture the variation in oil prices and their impact, we employ global oil supply news shocks (Känzig, 2021) and use local projections (Cloyne et al., 2023, Jordà & Taylor, 2025, Jordà, 2005) to estimate their impact on the real economy over the following years. These shocks reflect changes in future oil supply and prices, through OPEC+ announcements, and are estimated within a SVAR that uses these announcements as external instruments. There is academic consensus that turbulence in oil prices impacts the real economy, and as Engemann et al. (2011) show, oil price shocks increase the probability of recession in a number of countries, with repercussions for investment as well. In order to understand the transmission of oil shocks to corporate investments, we investigate the extent to which firm characteristics—such as energy intensity in production, financial constraints, and the preference for debt versus market financing—affect firms' responses to these shocks. Additionally, we explore the influence of the shale revolution, as experienced by the US. The analysis relies on balance sheet data of publicly listed companies from Standard & Poor's Compustat, as well as Standard & Poor's Capital IQ.

Our baseline results show that European firms reduce their capital and R&D expenditure significantly in response to an oil shock, while US firms do not. Moreover, the difference in the response between the two continents is found to be statistically significant, supporting the hypothesis of a possible loss in productivity and competitiveness following a common oil shock. This difference is particularly pronounced for firms in energy-intensive sectors who also face financial constraints. Moreover, the analysis reveals that European firms that rely relatively more on market financing compared to bank financing reduce investment by less following an oil shock. This suggests that differences in market financing structures between Europe and the US, with European firms relying more on debt and less on equity financing, may partly explain the observed disparities.

Lastly, we examine the extent to which technological innovations in US oil production associated with the shale revolution have contributed to the observed disparities. Our findings provide suggestive evidence that these innovations have been a significant contributing factor.

These findings are consistent with a large body of literature documenting the negative macroeconomic effects of oil shocks and confirm the importance of reducing the vulnerability of the EU to such shocks, to protect its competitiveness in comparison to international partners. As energy shocks put greater downward pressure on European investment, and to the extent that investment slowdowns can lead to a decline in productivity, the EU is at risk of gradually losing competitiveness compared to the US. This may threaten not only current but also future prosperity. Policy measures at both national and European level should therefore aim to secure the energy supply, lower energy prices both in the short- and long-run and mitigate the exposure of firms to future energy shocks, as well as deepening firms' access to capital markets to mitigate financing constraints.

The rest of the paper is organised as follows. Section 2 reviews the literature on oil price shocks and investment. Section 3 presents the data, and Section 4 discusses the empirical model and results. Section 5 presents robustness checks and Section 6 concludes.

2 Related Literature

This paper contributes to various strands of the literature. First, this paper contributes to the well-established literature relating to the impact of oil shocks on the real economy. This specific literature was widely developed in the US, with early contributions by Hamilton (1983, 1996, 2003) identifying a negative impact of oil price shocks on economic activity. Consistent results also stemmed from studies conducted for some EU countries' GDP (Lardic & Mignon, 2006; Raduzzi & Ribba, 2020), inflation (Zivkov et al., 2019) and industrial production indexes (Cunnado & de Gracia, 2003).

Second, the paper contributes to the body of literature investigating how firms adjust their investment in face of oil shocks. Some existing studies addressed this question with panel data methods employing Compustat data for the US, while, to the best of our knowledge, the European case remains unexplored. For instance, Caraiani (2022) explores the impact of global oil shocks on publicly listed US firms from Compustat, exploring the importance of production networks, which amplify the effect. He finds that a 10% increase in the price of oil is associated with a 0.5% drop in the investment rate of US companies, with production network effects explaining almost 73% of the effect.[2] Similarly, and also using US Compustat firm-level data, Lee et al. (2011) find that oil price shocks decrease firm investment in the short-term, due to the uncertainty that they create, while long-term effects are also present for shocks of greater magnitude. While the findings of this paper are broadly aligned with these contributions for the US economy, we are the first to draw a systematic comparison between European and American firms, providing insights into their investment behaviour under oil supply disruptions.

Third, we contribute to the large body of literature investigating how firms' responses to energy price shocks affect their competitiveness. Most contributions focus on price competitiveness, while we explore the role of the investment channel. Notably, Fontagné et al. (2024) analyse the behavior of French firms over the period 1996–2019 and find that firms adjust to an energy price shock by reducing energy demand, while only a small share of the fall in energy demand comes from a fall in production, as energy efficiency increases at the firm level. However, they also find that manufacturing firms pass through the full impact of energy costs increases into their export prices, which then reduces their competitiveness and entails a fall in demand for their products. Moreover, several papers investigate the degree of energy cost pass-through and its effects on inflation, see for example Lafrogne-Joussier et al. (2023), Emter et al. (2023) and Dedola et al. (2021).[3]

[2] The main differences with our paper are: i) Different methodology, as Caraiani is using spatial panel regressions instead of state dependent local projections; ii) Different time dimension, spanning 1983 to 2017 on a quarterly rather than annual basis from 1989 to 2023; iii) Different sectoral coverage and iv) Different choice of dependent variable, as he uses the investment rate rather than the change in the investment rate.

[3] In Appendix J we briefly explore the role that heterogeneity based on markups might play, considering its extensive coverage in the literature. In short, we find that firms with higher mark-ups have a similar investment response to the oil shock with lower mark-up firms both in the EU and the US. In line with the results from the rest of the paper, the statistically significant difference remains with the US for both firms with low and high markups, meaning that following a common oil supply shock, American firms decrease their capital expenditure by less in comparison to European firms.

Fourth, the methodology we employ in this paper draws from the recent literature applying local projection methods à la Jordà (2005) to firm level panels, to shed light on the importance of the differential impact of shocks across various firm characteristics. In particular, we follow the approach of Cloyne et al. (2023) who estimate the effects of monetary policy shocks on Compustat firms' investment decisions in the United States using state dependent local projections, and find that financial frictions play an important role in the transmission of monetary policy. Similarly, Durante et al. (2022) explore the same research question for European firms from Orbis and find that firms react differently to monetary policy changes depending on two key factors: financing constraints and their production sector. We contribute to this emerging literature by expanding the scope of the analysis to oil shocks.

3 Data

3.1 Firm-level dataset

Our analysis employs balance-sheet data from Compustat North America and Compustat Global, which includes annual data for publicly listed companies. Standard & Poor's Compustat dataset is a widely used source for detailed financial data on publicly listed companies globally, providing annual information on balance sheet and income statement variables. This dataset is particularly valuable due to its broad coverage, which consistently spans a large number of firms since the mid-1980s for American firms and from 1989 also for the European firms. As the ultimate aim of the paper is to draw comparisons in the response of the American and European sample to energy shocks, we restrict the sample to the years with good coverage for both groups, i.e. 1989-2023.

We restrict our sample to firms incorporated in the US, in EU countries, and in the UK, converting all variables to euros through the conversion tables provided by Compustat.

To assess how representative the firm-level data on capital expenditures and R&D is, we aggregate the microdata for each region, i.e. Europe (including the UK) and the US. We then compare these aggregated figures to the gross fixed capital formation and R&D expenditures reported at the regional level. The LHS of Figure 1 compares the aggregated Compustat data as a share of the corresponding macroeconomic aggregates. For Europe, the Compustat is equivalent to 16% of capital expenditure and 59% of R&D expenditure, on average over our sample. Instead, for the US, the same figures stand at 30% and 45%, for CAPEX and R&D respectively.

While the coverage for capital expenditure appears to be lower compared to R&D, the RHS of Figure 1 shows strong co-movement between the Compustat data and gross fixed capital formation, especially after 2000, with a correlation equals to 0.47 over the whole sample, and 0.63 after the turn of the millennium. Such co-movement was found for capital expenditure and R&D also by Döttling & Ratnovski (2023), focusing on the United States.

Figure 1: Coverage of aggregated firm level capital and R&D expenditures

Notes: LHS: Aggregated capital expenditure and R&D reported in Compustat as a share of macroeconomic aggregates, for both the EU28 and the US. RHS: Co-movement of aggregated capital expenditure reported in Compustat, and of its macroeconomic aggregate, expressed through year-on-year growth rates. Sources: Eurostat, Haver Analytics and Compustat. As Eurostat reports annual data primarily after 1995, for earlier estimates we use data from the Global Macro Database, by K. Müller et al. (2025)

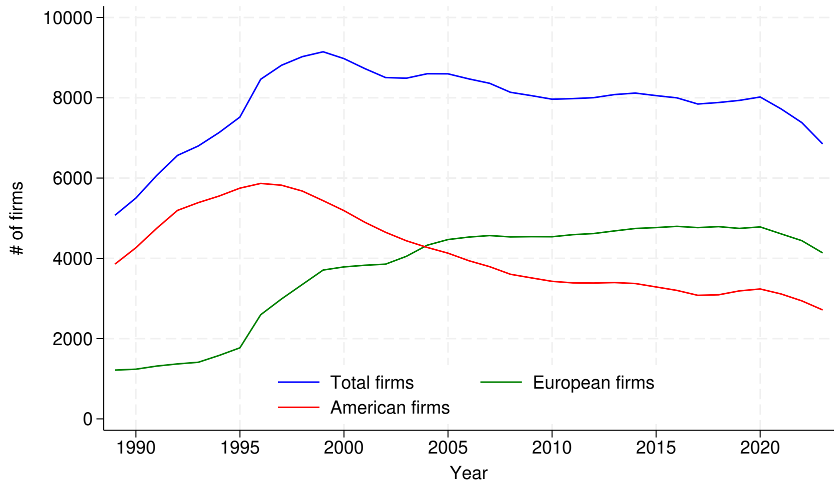
Finally, following the literature, we exclude firms from specific sectors (financial, utilities, and government) and those with missing or negative values in key financial metrics, including assets, property, plant and equipment, and sales. Moreover, we also exclude industries pertaining to the energy sector, defined as NACE sectors classified under Eurostat's MIG-energy industrial classification, and their equivalent NAICS sectors.[4] We do so to capture the behaviour of industries that are energy price takers, thus not benefitting directly from increases in oil prices. As Compustat does not report NACE industry codes, we match Compustat to ORBIS identifiers.[5]

[4] We specifically excluded sectors K, L, and O as defined by NACE section and sectors 52, 53, and 92 based on NAICS2 divisions. Moreover, MIG energy division based on Eurostat are the NACE 4-digit divisions 0510, 0520, 0610, 0620, 1910, 1920, 3511, 3512, 3513, 3521, 3522, 3530, 3600 and their equivalents are NAICS-2 digits 21,22, NAICS-3 digit 324, and NAICS 6-digits 325110, and 325194

[5] The match of the two datasets relies on ISIN codes, which we reconstructed for US firms through the CUSIP identifier, augmented by including the 2-digit country ISO code in front.

Similarly, we retrieved the firm's year of incorporation through Orbis, excluding firms reporting data in Compustat prior to their year of incorporation.

Figure 2: Number of firms in the final dataset



Sources: Compustat, Eurostat, BEA, ONS and authors' calculations. As Eurostat reports annual data primarily after 1995, for earlier estimates we use data from the Global Macro Database, by K. Müller et al. (2025)

The resulting dataset, deflated to real 2015 euros, contains an average of 7963 firms over our sample period, as shown in Figure 2. Focusing on the different coverage of European and American firms, we see an increasing amount of firms in the dataset for Europe and a decreasing amount for the US, with their average being fairly similar, at 4143 firms for Europe and 4367 for the US. Regarding the concentration of capital expenditure by sector and country, most of the publicly listed firms included in our sample belong to the manufacturing sector, where most capital (43% in EU and 25% in the US) and $R\&D$ expenditure (81% in EU and 73% in the US) are concentrated. For what concerns the distribution of capital expenditure across European countries, the UK, Germany, and France account for the largest share of capital and $R\&D$ expenditure. Detailed descriptive statistics are on Table 1.

4 Empirical model and results

4.1 Oil shock

To estimate the effects of oil price shocks on investment in the EU and US, we employ oil supply news shocks identified by Känzig (2021). These shocks are particularly suitable for

Table 1: Descriptive Statistics

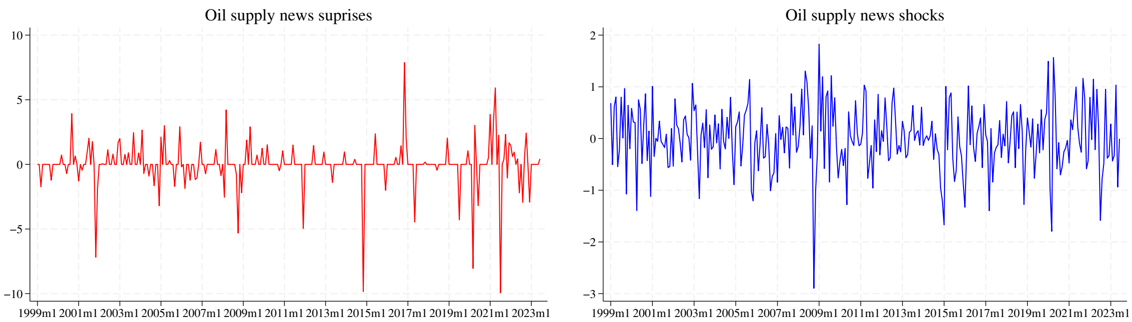
	Observations	Means	Standard Deviations	Minimum	Maximum
Kenzig OPEC surprise	274846	-0.23	5.11	-9.37	12.0
Kenzig oil shock	274846	-0.056	1.79	-3.77	4.78
Capital Expenditure	244081	94.2	625.9	-1093.4	49768.9
Research and Development	129038	84.9	619.0	-123.3	63008.8
Investment Rate	217138	0.99	49.5	-3500	14005.2
Profit margin	254993	0.28	1.62	-77.8	1
Liquidity ratio	264553	0.68	1.57	0	24.4
Equity to debt	229794	18.4	89.6	-18.6	1922.0
Sales_growth	240627	0.095	0.35	-2.26	2.64
Assets	266524	1459.5	4697.8	0.13	34319.4
Oil intensity in US (naics3)	74257	0.00000087	0.0000034	0	0.000016
Oil intensity in Europe and UK (nace2)	63137	0.27	1.07	0	19.0
Years since incorporation (age)	221164	27.1	28.4	0	153
Leverage ratio	264840	0.83	53.0	0	17660
Cashflow (financing activities/ assets)	246182	0.18	12.5	-5467	976.7
Policy rate	274709	4.67	58.2	-0.75	1889.4
Growth in GDP	259590	0.023	0.024	-0.16	0.22
Employees	220411	8.32	38.4	0	2300

examining investment effects in these regions because they are global, capturing the worldwide implications of OPEC's oil supply announcements. OPEC's significant influence over global oil production ensures that their announcements reflects changes in oil supply that have broad market implications, thus providing a comprehensive lens through which to analyse how such shocks impact investment behaviours in major economies like the EU and US.

The identification of these shocks follows the high-frequency identification strategies originally developed for monetary policy analysis. Känzig (2021) computes oil news surprises by calculating the changes in daily oil price futures within a narrow window of time around OPEC meetings. By focusing on this narrow window, the method isolates exogenous variations in oil prices attributed to unexpected supply changes, thereby limiting the influence of concurrent economic events that could confound the analysis, e.g. those related to economic uncertainty or demand shocks. Reverse causality, i.e. the idea that the global economic outlook influences oil prices within the narrow time frame surrounding the OPEC decision, can be ruled out, as this factor is already considered at the time of the announcement, and the global economic outlook is unlikely to change within such a brief period. In a second step, Känzig (2021) uses these surprises as an instrument in a Vector Autoregression (VAR) model to estimate oil supply news shocks, which we ultimately use in our analysis.

This identification strategy ensures that the analysis remains centred on the impact of supply news, highlighting their forward-looking nature. Given that oil price futures are inherently anticipatory, these shocks reflect changes in expectations about future oil production and pricing rather than immediate disruptions. This forward-looking aspect is particularly pertinent for investment decisions, as firms adjust their strategies based on anticipated fluctuations in oil prices, which in turn affect production costs and economic conditions. Unlike other oil shocks examined in the literature, which focus on current supply disruptions, the oil supply news shocks identified by Känzig (2021) capture market expectations of future supply constraints, which are crucial for firms' forward-looking investment decisions. For instance, companies might alter their investment plans in response to anticipated oil price volatility, influencing both tangible and intangible capital accumulation. Moreover, since these shocks have been shown to significantly affect macroeconomic variables such as inflation, industrial production, and consumer prices, they offer a robust framework for analysing how oil supply expectations drive broader economic activity and corporate investment behaviour.

Figure 3: The oil supply series and oil supply shocks



Notes: LHS: The surprise series, constructed from changes in futures prices. RHS: The corresponding oil supply news shocks series. Sources:Känzig (2021).

Figure 3 shows the oil news surprises (left) and the oil supply news shocks (right). The largest spikes in the series fit well with narrative evidence around key historical episodes, such as the decrease in prices following OPEC decisions after the September 11 attacks, or a downward revision in prices at the start of the global financial crisis.[6]

The identification of the oil news shocks is based on WTI oil future contracts. WTI serves as the benchmark for the US light oil market and originates from US oil fields, whereas Brent crude, the benchmark for European markets, originates from the North Sea and widely used by OPEC. This distinction could be problematic, since, following technological advancements from the shale revolution, WTI has become cheaper than Brent — a shift from past trends. Despite this, the global integration of oil markets generally leads to synchronized price movements, with a

[6]For further details, see Känzig (2021)

very high correlation, for our sample > 0.99. Moreover, Gao et al. (2023) further show through variance decomposition that idiosyncratic factors significantly contribute to price divergence over longer forecast horizons in both markets. Given that Känzig (2021) uses maturities ranging from one month to a year to identify the shock, the differences between Brent and WTI should not severely affect the shock identification. Another concern arises from the differences in the responses of WTI and Brent prices during geopolitical upheavals, potentially widening their spread due to WTI's landlocked nature within the US. However, such geopolitical episodes are unlikely to impact the shock identification, due to the tight time window around which surprises are calculated.

4.2 Empirical model

In line with the empirical approach of Cloyne et al. (2023), we estimate local projections that allow for heterogeneous effects to study the effects of oil news shocks on firm-level capital and *R&D* expenditures. The estimation is initially performed separately for European and US firms, following the specification below:[7]

$$\widehat{y_{j,h}} = \alpha_h + \beta_g^h \cdot \mathbb{I}[Z_{i,t-1} \in g] \times s_t + \Xi_h x_{j,t-1} + \varepsilon_{j,t+h}, \quad h = 0...3 \tag{1}$$

where s_t is the series of oil news shocks by Känzig (2021), aggregated at an annual level. Following Känzig (2021), a unit increase in the shock represents a 10% increase in oil prices. Our dependent variable is $\widehat{y_{j,h}}$, defined as the h-year forward difference in the investment rate by firm j, that is $y_{j,t+h} - y_{j,t-1}$.[8] For *R&D*, where the stock of innovation is not available to construct the innovation rate, we specify this variable as $\widehat{y_{j,h}} = \frac{y_{j,t+h} - y_{j,t-1}}{y_{j,t-1}}$, capturing the cumulative change, h- years forward in *R&D* by firm j. The horizon h, spans from impact to three years after impact.

$Z_{i,t-1}$ represents a set of firm characteristics, and the indicator function takes a value of 1 if the firm characteristic falls in a particular "bin" of the distribution, i.e. group g. β_h represents

[7] At a later stage of the analysis, the US and EU datasets are treated together to investigate differences between the EU and US for the main variables of interest.

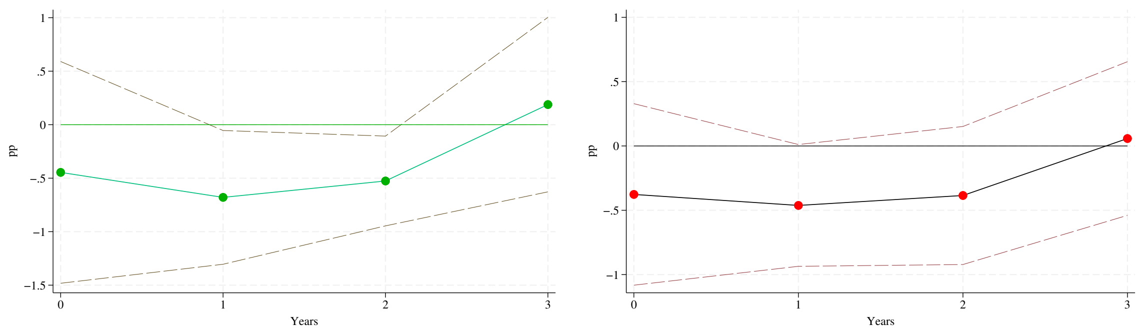
[8] The investment rate is defined as capital expenditure divided by the lagged net property plant and equipment.

a cumulative impulse response function. The control variables included in $x_{j,t-1}$ are selected to account for a firm's financing conditions—measured by its equity-to-debt ratio and liquidity ratio (defined as liquid assets over total liabilities)—its performance, proxied by sales growth, its size (measured by its total assets) and age. We also take into account the macroeconomic environment, captured by the GDP growth of the country where the firm is incorporated and the corresponding central bank policy rate. Fixed effects are applied at the firm level and Standard errors are clustered by firm and time using the Driscoll & Kraay (1998) approach, to address the potential issue of serial correlation in forecast errors.

4.3 Baseline results

The impulse response functions resulting from the estimation of equation 1 for the full sample, i.e. not distinguishing across firm groups g, are depicted in Figures 4 and 5, where estimation results for European firms appear on the left and the results for US firms on the right. As shown in Figure 4, investment rates decline significantly at the 90% confidence level in Europe, following a shock that increases oil prices by 10%. The effect is significant one and two years after impact, reaching a trough of -0.526 percentage points one year after impact. Conversely, the negative effect is statistically insignificant for US firms. Lastly, as we discuss in more detail in section 4.5 the difference between the response of European and US firms following a 10% increase in oil prices is statistically significant a year after impact (see Figure 10).

Figure 4: Effects of oil price shocks on the investment rate in Europe (left) and the US (right)

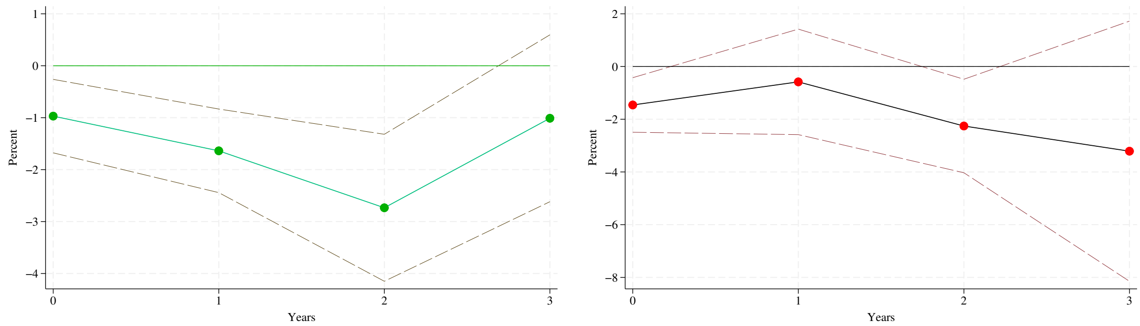


Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Similarly, R&D expenditure is negatively affected in Europe following a 10% increase in oil prices, which reaches a trough of -1.96 percent two years after the shock, with the response of US firms being more volatile, and experiencing statistically significant drops on impact and two years after the shock.[9]

As the investment rate is not directly comparable to R&D expenditure in terms of magnitude, Figure 17 in the appendix plots the response of capital expenditure in the EU and the US. The response of R&D in comparison to capital expenditure is lower in magnitude (See figure 17), which is not surprising due to the typically lower volatility of R&D over the business cycle, both at the firm and the macro level. In fact, R&D expenditure is less responsive to shocks compared to capital expenditure, as it is driven by longer term planning, as seen through the lower standard deviation that it has in our dataset (0.09 vs 0.14) but also the aggregate dataset (0.07 vs 0.09). In the following section, we will be delving further into certain firm characteristics that might be behind such result. [10]

Figure 5: Effects of oil price shocks on R&D in Europe (left) and the US (right)



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

4.4 The role of firm heterogeneity

In order to estimate state-dependent local projections and hence, to capture the differential impact of the oil shock based on firm characteristics, we re-estimate Equation 1 distinguishing

[9]The amount of firms that report research and development expenditure is much smaller than the amount of firms reporting capital expenditure. Thus, we were only able to draw conclusions for the response of research and development expenditure following an oil shock for our baseline specification, that does not break down firms based on their energy intensity and financial constraints.

[10]The breakdown analysis is performed only with the investment rate as a dependent variable since R&D expenditure is not reported by enough firms to yield results when broken down in categories. Out of the around 7000 firms reporting data in 2023, only approximately 2800 firms report research and development expenditure (around 1400 in the EU, and around 1400 in the US). That number is even lower, when restricting to the sectors of Manufacturing and construction (1800 total firms) as it is necessary due to the data availability of oil consumption.

groups g. In particular, we aim at understanding how oil shocks affect investment depending on firm characteristics that stem from energy intensity, financial conditions, and their joint impact.

4.4.1 Energy intensity

Energy shocks directly increase the unit input costs of production, with the impact especially pronounced for firms in energy-intensive sectors. As shown in Bijnens et al. (2023), following the energy shock in 2022, input costs increased across the board, but energy-intensive firms were affected more than non-energy-intensive firms.

Thus, we group firms by their energy intensity to assess whether investment responses to oil shocks vary according to a firm's energy intensity. However, as we do not observe energy intensity at the firm level, we rely on the measures of energy intensity at the sectoral level. For European firms, we use data from Eurostat on energy consumption at the NACE2 level, scaled by the value added of the sector, to create a measurement of energy intensity. A direct implication of this classification approach is that the analysis focuses on the manufacturing and construction sectors, where consistent information is available over time. Instead, for UK firms, we rely on ONS data, which are reported at 2-digit SIC level. Lastly, for American firms, the same approach is used to classify firms from the manufacturing and construction sector, but employing data at a NAICS3 level provided by the US Energy Information Administration. For both sides of the Atlantic, we classify a firm as energy intensive if it belongs to a sector whose energy intensity is above the median for each given year. Figure 13 in the Appendix presents the results of this classification for firms in both the US and the EU. The results show that, while our approach does not yield a strictly binary classification across industries, sectors typically considered energy intensive (EII)—such as chemicals and chemical products (C20), basic metals (C24), and other non-metallic mineral products, including glass, cement, and clay (C23)—are consistently classified as oil intensive in the EU. Similarly, in the US, industries such as NAICS 322 (Paper Manufacturing), 331 (Primary Metal Manufacturing), 327 (Nonmetallic Mineral Products Manufacturing), and 321 (Wood Products Manufacturing) are consistently categorized as oil intensive.

4.4.2 Financial Constraints

Financial constraints play an important role in the transmission of energy shocks to the economy. Recent survey data has suggested that firms that self-identify as financially constrained consider increases in energy costs as more of an impediment than their non-financially constrained counterparts (EIB, 2024). Moreover, financial constraints have been found to magnify drops in investment following monetary policy shocks (Cloyne et al., 2023 ; Durante et al., 2022). Hence, it is likely that they also play a role following energy price increases, as the latter can constitute a non-negligible increase in input costs and thus financing needs.

Despite the extensive body of literature offering various definitions of financial constraints, the concept remains inherently unobservable and difficult to measure. For example, Gertler & Gilchrist (1994) suggest using firm size as a proxy for financing constraints, arguing that smaller firms typically face greater financial challenges due to higher information frictions—especially younger firms or those with higher idiosyncratic risk and limited collateral.

Other measures of financial constraints stem from the contribution of Ferrando & Mulier (2015) who find that firms more likely to face financial constraints are usually more leveraged (with leverage defined as total debt over assets), less liquid, and in line with previous literature, smaller in size. Notably, high leverage can signal two opposing conditions: it may reflect a firm's ability to access debt markets and thus a lack of financing constraints, or it may indicate financial constraints as high debt levels make it more difficult and costly to secure additional funding. Thus, relying solely on the leverage ratio as a proxy for financing constraints might be misleading. Moreover, the leverage ratio is not exogenous with respect to firm performance, as the underlying variables fluctuate with shocks and over the business cycle. Cloyne et al. (2023) and Durante et al. (2022) address this concern and propose a novel approach by combining information on leverage with an additional variable: age. The latter is exogenous to firm performance while capturing financial constraints as younger firms can lack established credit histories, collateral, and proven revenue streams, making lenders more cautious when lending to them, thus limiting firms' ability to secure affordable external financing. Cloyne et al. (2023) try different measures of financial constraints and conclude that younger firms not paying dividends adjust their investment significantly more than older firms paying dividends following a monetary policy shock. They thus define a firm as financially constrained if it is less than 15 years old and does not pay out dividends, focusing on a sample of US firms. However, as the dividend variable is not as well populated in the European dataset, we cannot rely on the same measure.

For these reasons, we rely on a definition of financing constraints that hinges on two variables: age and leverage. We consider financially constrained firms who are younger than 20 years and whose leverage ratio is above the median of the sample in the previous year.[11] All comparisons are made within continents, so that classification on a constrained or non-constrained group is performed separately for Europe and the US, facilitating comparisons between the two regions. In Appendix C we also consider the implications of considering measures based on age and leverage separately.

4.4.3 Structural differences across groups

To identify how investment behaviour varies across firms in different groups, it is important to examine potential underlying structural differences that could influence their responses to external shocks. These differences may arise from firm-specific characteristics such as size, sector, financial health, or performance. To investigate this, we estimate a probit model with group membership as the dependent variable. The model incorporates key firm-specific covariates to identify factors significantly associated with these group distinctions. This approach enables us to assess the likelihood of firms belonging to one group over another and to determine whether structural differences may contribute to heterogeneity in investment behaviour.

Table 2 presents the results of the probit analysis for firms in three groups: high energy intensity, financially constrained, and the combined group of energy-intensive and financially constrained firms. The analysis is conducted separately for EU and US firms. The findings reveal that structural differences across the groups exist, especially pertaining to size, age, financing structure and performance. Hence we account for these differences by including appropriate controls in our baseline specification.[12]

[11] The age of 20 was chosen as it is the median age in the European dataset, to maximise sample size in the breakdown of the sample per firm characteristic, however we tested different thresholds around the median for robustness purposes for both the age and leverage ratio variable, with the results reported in Appendix F for the

Table 2: Probit Analysis for EU28 and US

	(1) (EU28) EnergyIntense	(2) (EU28) FinCon	(3) (EU28) IntenseFinCon	(4) (US) EnergyIntense	(5) (US) FinCon	(6) (US) IntenseFinCon
$\text{Liquidity}_{i,t}$	-0.0229			-0.0583***		
	(0.0254)			(0.0137)		
$\text{Equity to current and long term debt}_{i,t}$	-0.000460***			-0.000107		
	(0.000155)			(0.000114)		
$\text{Sales growth}_{i,t}$	-0.0265	0.324***	0.0814*	-0.0000135	0.352***	0.109***
	(0.0271)	(0.0234)	(0.0417)	(0.0212)	(0.0214)	(0.0363)
$\text{Age}_{i,t}$	0.00230***			0.00362***		
	(0.000840)			(0.00113)		
$\text{Real assets}_{i,t}$	0.0528***	-0.0409***	-0.0149	0.0310***	-0.00607	0.0382***
	(0.0149)	(0.00936)	(0.0185)	(0.0109)	(0.00815)	(0.0128)
Country F.E.	YES	YES	YES	NO	NO	NO
Cluster Firm	YES	YES	YES	YES	YES	YES
Number of obs.	42,143	46,602	21,186	42,010	44,001	22,760
Pseudo R^2	0.133	0.034	0.083	0.013	0.006	0.005
Log-likelihood	-25053	-31030	-8438	-26205	-29400	-10770

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.4.4 Results based on firm heterogeneity

Figure 6 confirms that following an oil supply news shock, European firms tend to decrease their investment independently of their financial constraints or energy intensity status, but the significance and timing of the effects vary across groups. Firms that are financially constrained and in energy intensive sectors are particularly affected. Another result arising from the figure is that financially constrained firms that are not energy intensive appear to significantly reduce their capital expenditure after 1 year, while the same holds for non financially constrained firms operating in energy intensive sectors. To assess formally the statistical difference between the different groups, we modify our estimation strategy, pulling data across groups and making the non financially constrained firms in non energy intensive sectors our base category, thus estimating the deviation of the other groups from it. Figure 7 presents the results of this approach. The investment rate responds significantly differently, both in impact and after one year, compared to the base group for European firms that are financially constrained, regardless of whether they operate in energy-intensive sectors. In contrast, among firms not facing financial constraints, there is no statistically significant difference in investment responses between energy-

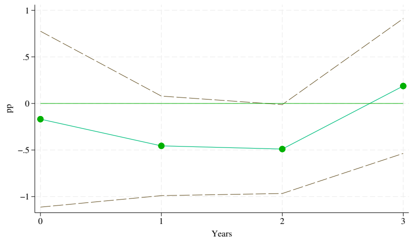
figure that points to the statistical difference between European and American firms.

[12] As an additional check, we interacted the firm-level controls with the category variables used in the analysis, energy intensity and financial constraints, as well as the dummy for whether a firm is based in the EU28 or the US, and all the results of the paper maintain sign and significance. Figure 24 in Appendix I demonstrates how the results for the difference in the response of investment to an oil shock between the US and the EU maintains sign and significance.

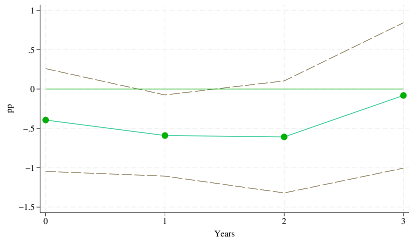
intensive and non-energy-intensive firms.[13]

Figure 6: Effects of oil price shocks on the investment rate based on firm characteristics

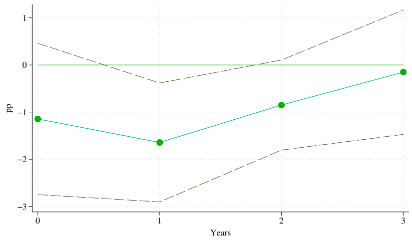
(a) Non-constrained & non-intensive



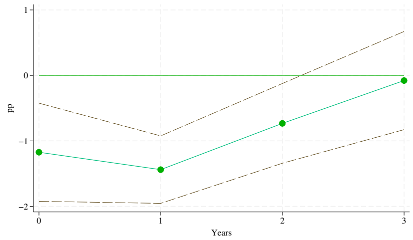
(b) Non-constrained & intensive



(c) Constrained & non-intensive



(d) Constrained & intensive



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

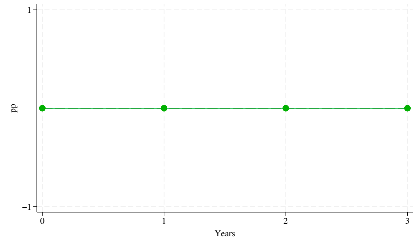
Replicating the same approach for US firms, we find that not all types of firms are impacted following the oil news shock. As shown in figure 8, following the oil supply news shock, mainly firms that are financially constrained reduce their investment rate on impact, with figure 9 demonstrating that there is no statistical difference between the four groups.[14] Overall, these results support the hypothesis that European and US firms may exhibit different behavioural responses, even when they share similar characteristics.

[13]To account for the possibility that other year-specific shocks may jointly drive oil prices and investment dynamics, we conduct a robustness check by re-estimating the analysis with the inclusion of year fixed effects. This extended analysis, presented in Appendix G, confirms the robustness of our results. While the inclusion of time fixed effects was previously unfeasible due to the annual frequency of the oil shock, it becomes appropriate in this section where the shock is interacted with firm characteristics. In this specification, the shock is not absorbed by the fixed effects, allowing us to isolate its heterogeneous impact across firms.

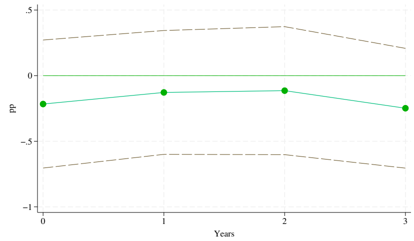
[14]In appendix H, we report resulting figures when splitting the sample only along financial constraints and only along energy intensities. Figures 21 and 22, report the results based on splitting the sample only along financial constraints or only according to whether a firm is part of an energy intensive sector.

Figure 7: Relative effects of oil shock on the investment rate based on firm characteristics

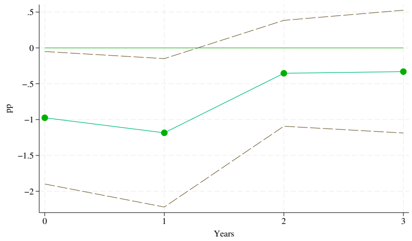
(a) Non-constrained & non-intensive



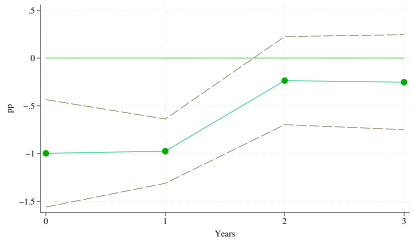
(b) Non-constrained & intensive



(c) Constrained & non-intensive



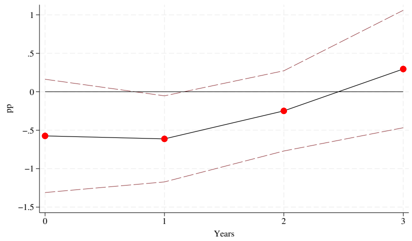
(d) Constrained & intensive



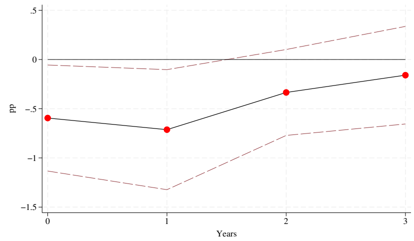
Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Figure 8: Impact of oil shock on Investment rate based on firm characteristics

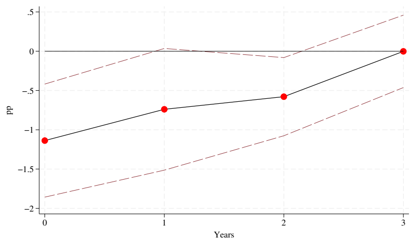
(a) Non-constrained & non-intensive



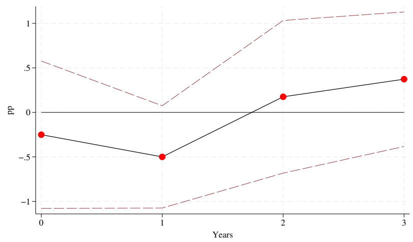
(b) Non-constrained & intensive



(c) Constrained & non-intensive



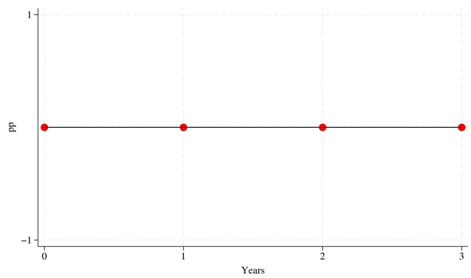
(d) Constrained & intensive



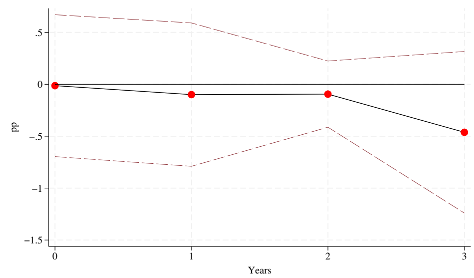
Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Figure 9: Impact of oil shock on Investment rate based on firm characteristics

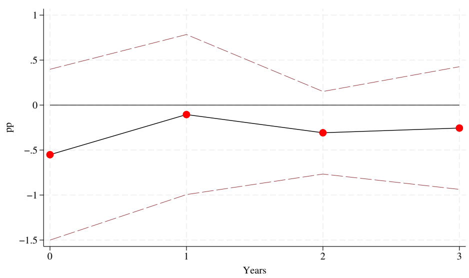
(a) Non-constrained & non-intensive



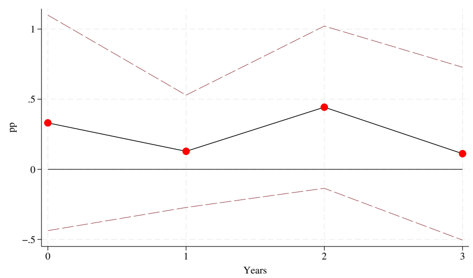
(b) Non-constrained & intensive



(c) Constrained & non-intensive



(d) Constrained & intensive

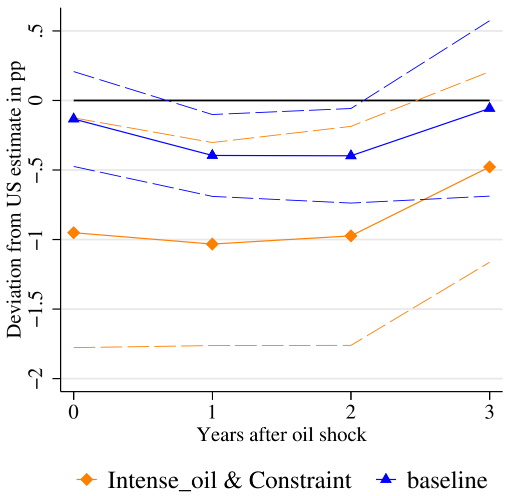


Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

4.5 Comparison with the US

In this section, we further investigate whether significant differences exist between EU and US firms in their responses to a common oil supply news shock. To this end, we extend our baseline specification by including an interaction term between the oil shock and a dummy variable indicating whether a firm is based in Europe or in the US. Moreover, as we also aim to understand to what extent energy intensity and financial constraints drive such results, we also interact those firm characteristics and identify the relative differences between groups. We find a statistically significant difference between Europe and the US in the first two years after the shock, consistently with our baseline results in section 4.3 (Figure 10). Moreover, a statistically significant difference between European and US firms is also observed when focusing on financially constrained firms in energy-intensive sectors. Among the two firm characteristics, financial constraints appear to be the primary factor driving the divergence from US firms. As shown in Figure 23 in Appendix H, only European firms that qualify solely as financially constrained decrease their investment significantly more in comparison to their American counterparts. This suggests that financing conditions across the two sides of the Atlantic might play a role in driving differences in behaviour.

Figure 10: Impact of oil shock on Investment Rate based on firm characteristics - Europe versus US



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

4.5.1 The role of market financing

The structure of financial markets in the US and Europe differs substantially. These structural differences may influence firms' access to finance, the transmission of monetary and energy shocks, and ultimately their investment behaviour. One of the most salient differences lies in the depth and integration of capital markets. The US financial system is characterised by a well-developed, centralised market infrastructure with a high degree of legal and regulatory cohesion. In contrast, European capital markets remain highly fragmented along national lines. This fragmentation hinders cross-border investment, reduces market liquidity, and imposes higher transaction costs. These structural features contribute directly to Europe's reliance on a more bank-based financial system, in contrast to the more market-based system of the US. Market-based finance, and particularly equity financing, is associated with more productive firms that exhibit greater resilience to economic shocks. Unlike debt financing, equity does not impose fixed payment obligations, allowing firms to reinvest profits and weather downturns without the pressure of debt servicing. This flexibility encourages long-term investments in innovation and R&D (Carpenter & Petersen, 2002; Brown et al., 2012; E. Müller & Zimmermann, 2009). Furthermore, equity markets facilitate risk sharing between investors and firms, enabling firms to undertake riskier but potentially more rewarding projects. This is particularly crucial when firms face disrupting shocks, such as oil price shocks, as equity-financed firms are better positioned to absorb shocks and adapt to changing market conditions. This suggests that access to market-based financing, as opposed to bank financing, might constitute a mitigating factor, lessening financial constraints. We test this hypothesis using data on European firms, examining whether those with a higher reliance on market-based financing were better able to absorb the effects of the oil shock compared to firms more dependent on bank debt.

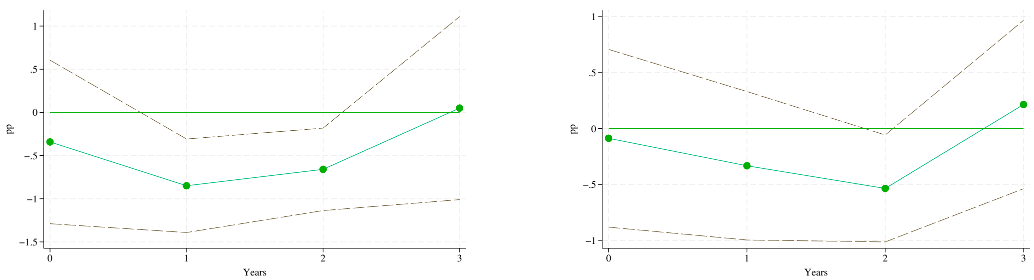
To test this hypothesis,we integrate data from Capital IQ in our Compustat sample. Capital IQ provides granular data on firms' debt structures, detailing various types of debt, including credit lines, term loans, capital leases, senior bonds, subordinated bonds, and commercial paper. In some cases, it also includes specific terms such as interest rates and maturities for each debt type.

We use this dataset to compare the behaviour of firms that rely more heavily on market-based financing with those that depend primarily on bank financing. To facilitate this comparison, we construct a firm-level variable measuring the ratio of market to bank financing. Following Darmouni & Papoutsi (2022), total market financing is defined as the aggregate of three categories of debt securities reported in Capital IQ: senior bonds, subordinated bonds, and commercial paper. Bank financing, on the other hand, is a readily available variable from Capital IQ. Higher values of this ratio indicate a greater reliance on market-based financing. Consistently with the methodology used throughout the paper, we use this measure to classify firms by splitting the sample at the median: firms below the median are considered more bank-financed, while those above are classified as more market-financed.

Figure 11 below demonstrates the differential impact of the oil shock between market financed and bank financed European firms. Firms with a higher market financing ratio appear to respond better to the oil supply news shock, meaning that they decrease their capital expenditure by less, with the difference between the two groups being statistically significant one year after the shock. This result supports the hypothesis that a higher degree of market-based financing can mitigate the decline in investment observed among European firms following an oil shock. It may also help explain, at least in part, the differential impact of such shocks on European versus US firms.

Figure 11: Impact of oil shock on Capital Expenditure based on market financing

(a) Bank-financed **(b)** Market-financed



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level. Controls applied are the same as in the main text, while due to the merging of Capital IQ with Compustat, the sample of firms is lower by 800 firms in Europe and the US.

4.5.2 The role of the shale revolution

The shale revolution significantly reshaped the global energy landscape by sharply increasing US energy production and reducing reliance on imports. This transformation likely induced a structural shift in how oil shocks are transmitted to the US economy. Historically, oil price increases were viewed as classic negative supply shocks for the US, dampening output through higher input costs. However, the shale boom repositioned the US as a leading oil producer, altering this narrative. Oil price increases became increasingly associated with positive demand shocks for oil-producing states and sectors, spurring investment, employment, and income.

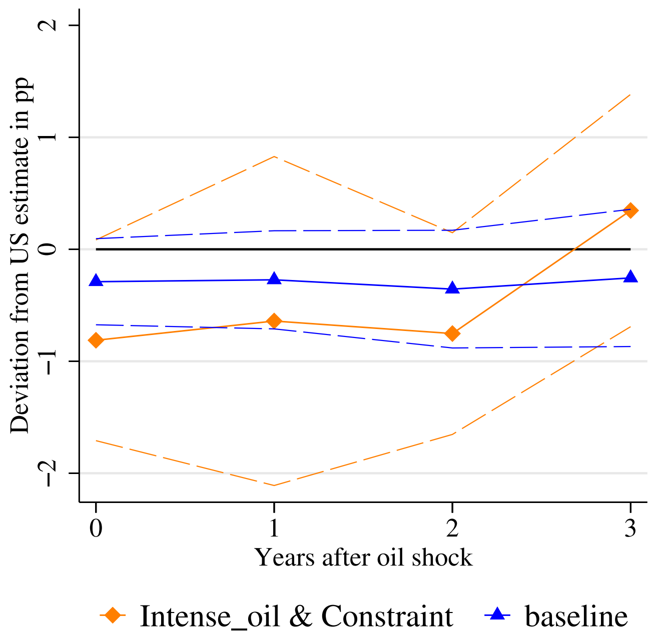
Using a time-varying factor-augmented VAR model, Bjørnland & Skretting (2024) show that oil-specific shocks after 2011 had a markedly positive impact on industrial production and employment in resource-rich states such as Texas and North Dakota. This contrasts with pre-shale dynamics, where similar shocks primarily imposed economic burdens through higher energy costs. Complementary evidence from Gilje et al. (2016) highlights the broader regional spillovers of the shale boom, with increased activity in oil production also benefiting non-mining sectors and amplifying aggregate economic gains.

Nonetheless, these positive effects were geographically and sectorally concentrated, underscoring the uneven distribution of benefits. States with substantial shale and conventional oil resources experienced strong employment growth, particularly in mining and related industries. For example, oil price increases triggered rapid job creation in shale-intensive states like North Dakota, where new extraction technologies enabled quick production scaling. However, as noted by Baumeister & Kilian (2016), energy-intensive sectors such as automotive manufacturing continued to face cost pressures, illustrating the persistence of negative effects for energy consumers. This divergence reveals a dual structure in the US economy: oil-producing regions thrived, while energy-dependent industries remained exposed to input cost inflation. In short, while the shale revolution reshaped oil price dynamics for producers, its benefits were less apparent in states and sectors reliant on energy consumption.

By contrast, oil supply news shocks in the European Union continue to operate as traditional negative supply shocks, consistent with the pre-shale paradigm. These contrasting responses support the hypothesis that the shale revolution may partially explain the divergent investment behaviour of US and European firms in response to a common oil supply shock.

Identifying the precise contribution of the shale revolution is difficult, so we adopt a pragmatic strategy. First, we leverage the findings of Bjørnland & Skretting (2024), who identify industries and US states where the shale revolution altered the response of employment, GDP, and investment to oil supply shocks. Based on their classification, we exclude from our sample firms operating in industries that exhibited a post-shale behavioural shift in the US.[15] Second, we exclude firms located in US states where Bjørnland & Skretting (2024) document significant post-shale changes in economic responsiveness.[16] By restricting our analysis to firms operating in states and industries unaffected by the shale revolution, we isolate the pre-shale transmission channels.

Figure 12: Difference EU-US: for the industries and states not affected by the shale revolution



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Following this restriction, our baseline result—showing a differential investment response to oil supply news shocks—loses statistical significance, as shown in Figure 12. While this

[15] Specifically, we exclude firms in the following NAICS sectors: chemicals; electrical equipment, appliances and components; petroleum and coal products; aerospace; fabricated metal products; and machinery.

[16] These include: Alaska, Kansas, Louisiana, New Mexico, North Dakota, Oklahoma, Pennsylvania, Texas, Wyoming, Colorado, South Dakota, Minnesota, Nebraska, Illinois, Iowa, Wisconsin, Ohio, New York, Connecticut, Vermont, Massachusetts, and North Carolina.

restriction implies a large reduction in our sample, which could also affect statistical power, this outcome offers suggestive evidence that the shale revolution may be an important factor underpinning the divergence in investment responses between US and European firms. More broadly, it highlights how structural differences in energy markets conditions can drive firms' vulnerability to global energy shocks.

5 Robustness

5.1 Propensity score matching

The analysis presented in the previous section concludes that European firms reduce investment more severely compared to their US counterparts. However, this result might be driven by underlying structural differences across firms incorporated in the two regions. Appendix B provides a comparative analysis of the characteristics of firms in Europe and the US through a probit model. The data reveal that European firms in our sample tend to be smaller and older relative to their US counterparts. Additionally, these firms demonstrate slower growth rates, and lower liquidity levels on their balance sheets. Recognizing these structural disparities, we implement propensity score weighting in our estimations as a robustness check, to ensure that our results are not driven by these inherent differences.

The results, as shown in figure 14 in Appendix B, remain robust when applying the propensity score matching procedure. The statistical difference between European and US firms persists in both the baseline sample and among energy-intensive and financially constrained firms, losing significance only on impact. The exercise is explained more in depth in appendix B.

5.2 Age as an indicator of financial constraints

In the preceding section, we identified firms as financially constrained based on two key characteristics—youth and high leverage—consistent with prevailing methodologies in the academic literature. As a robustness exercise, we employ firm age as a stand-alone proxy for financial constraints, on the grounds that age is arguably the most exogenous measure available. In Appendix C we combine age with energy intensity, and find that the results in our main analysis hold once we change the definition of financing constraints. Under the same section of the Appendix, we also present a break down of the effect for each sub-group of our financial constraint definition, and observe as expected no statistically significant difference between the four groups.

5.3 Other checks

Our main estimations are based on the investment rate as a dependent variable, which is a widely used measure to capture firm investment, and available for all industries. In Appendix D we report results using the percentage change in capital expenditure at different horizons as a dependent variable, for which the sample remains of similar size, while keeping the same specification (1). Results are fully consistent, as European firms significantly reduce their capital expenditure following the oil shock, and we still observe a significant difference between Europe and the United States one year after impact.

We conduct an additional robustness check, replicating the preferred specification of Jordà & Taylor (2025) for local projections. This implies adding the lag of the first difference of the dependent variable as a control in equation 1. As shown in Appendix E, the difference with the US maintains sign and significance, for both the baseline and the group of financially constrained firms in energy intensive sectors.

We also check whether the choice of adopting the median to split our sample based on firm characteristics affects the sign and statistical significance of our results. In Appendix F, we use 4 different thresholds around the median and demonstrate how the statistical difference with the US can still be observed even under different choices of thresholds.

Lastly, we also take into account time fixed effects and investigate the separate impact of energy intensities and financial constraints in Appendix G and H, with consistent results.

6 Conclusion and policy implications

In this paper, we examine how European and US firms adjust their investment in response to oil supply shocks, finding significant differences in their responses. European firms, particularly those that are financially constrained and operate in energy-intensive sectors, sharply reduce their capital and R&D expenditures following oil shocks. In contrast, US firms appear largely unaffected, benefiting from structural advantages such as the shale revolution and a greater reliance on market-based financing. The findings indicate that Europe's dependence on imported energy, especially oil and gas, increases firms' exposure to global energy price fluctuations. Furthermore, Europe's fragmented, bank-based financial systems limit financial flexibility, potentially exacerbating the impact of these shocks on energy-intensive industries.

The results underscore the vulnerability of European firms to energy price volatility, which poses risks to productivity and competitiveness, particularly in critical sectors. To address these challenges, policymakers in Europe may need to prioritise measures that enhance financial flexibility, deepen capital markets, and strengthen energy resilience. In addition, this study sheds light on the broader economic implications of energy shocks and highlights the importance of firm-specific characteristics and macroeconomic structures in shaping their impact. Future research could build on these findings by exploring how energy shocks affect small and medium-sized enterprises (SMEs), firm productivity, and broader business dynamism, offering a more comprehensive understanding of the long-term consequences of energy price volatility.

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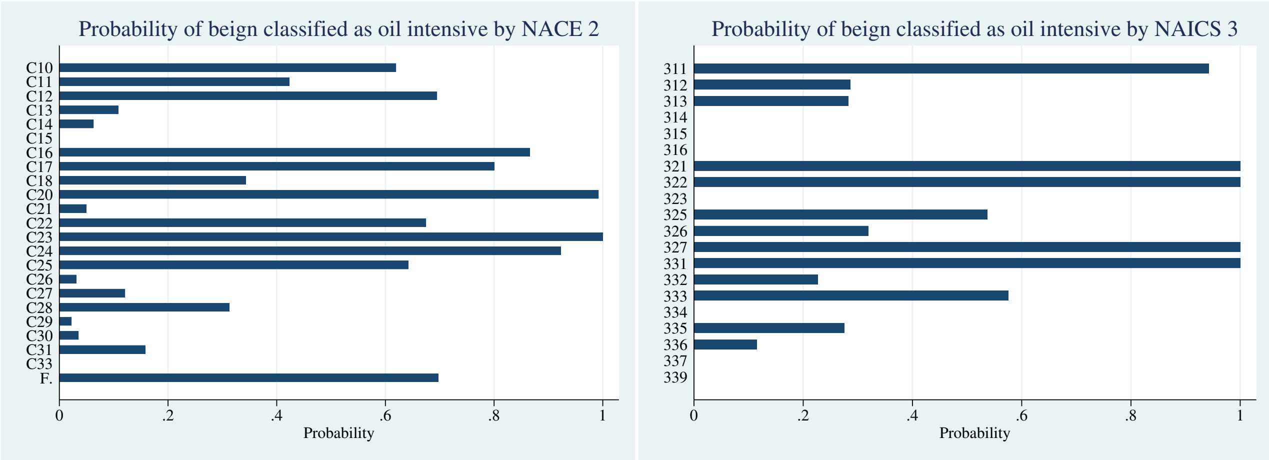
Appendix

A Oil intensity classification

Figure 13: Probability of being classified as oil intensive.



Notes: The reported probability reflects the proportion of observations in which firms belonging to a given industry were classified as oil intensive within our sample.

B Propensity Score Matching

Table 3: Probit Analysis: EU28 vs US

	(1) EU28
Liquidity ratio	-0.127***
	(0.00868)
Equity to current and long term debt	0.0000919
	(0.0000578)
Sales growth$_{i,t}$	-0.0533***
	(0.0113)
Age$_{i,-t}$	0.0114***
	(0.000553)
Real assets $_{i,t}$	-0.115***
	(0.00584)
Number of obs.	172,717
Pseudo R^2	0.064
Log-likelihood	-111730

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

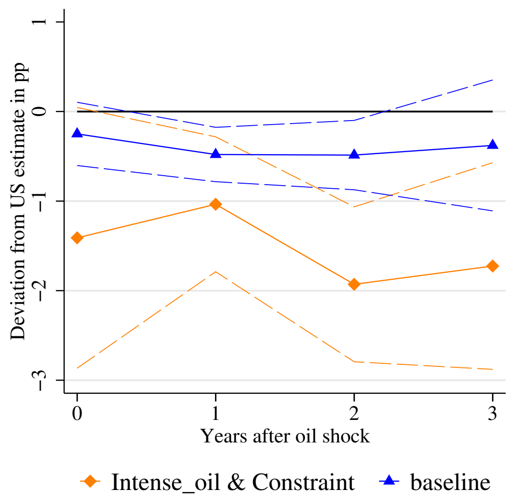
We employ the propensity score matching technique as introduced by (Rosenbaum & Rubin, 1983), based on a probit estimation of the likelihood that a firm is located in the EU28 group, as predicted by firm characteristics such as size, age, and financing conditions—measured by the equity-to-debt ratio and the liquidity ratio—as well as firm performance, proxied by sales growth. We restrict our sample to units with propensity scores within the common support. As demonstrated in Table 4, the application of propensity score matching effectively aligns firm characteristics between European and U.S. firms, significantly reducing sample bias in our analysis.

Table 4: Matching Results

Sample	**Ps R2**	**LR chi2**	**p > chi2**	**MeanBias**	**MedBias**	**B**	**R**
Unmatched	**0.035**	8434.28	0.000	18.3	14.7	**44.5***	1.52
Matched	**0.001**	277.54	0.000	2.4	0.5	7.8	1.08

Notes: Balance statistics before and after matching. Where B represents the average of the absolute standardized biases (i.e., % bias column), while R represents the Variance Ratio (EU28 / US). * denotes a significance discrepancy, arising if $B > 25\%$, R outside [0.5; 2]

Figure 14: Propensity Score Matching



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

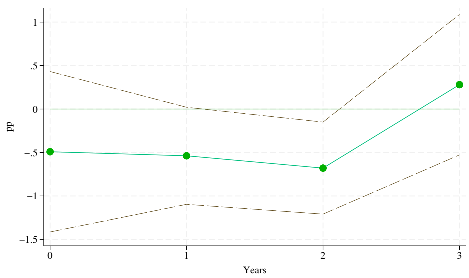
C Separate impact of age and leverage

In this section, we are focusing on our indicator of financial constraints. Since we are combining age and leverage ratio to produce the indicator of financial constraint, it can be a good idea to see whether there is a significant difference between the four groups that are created by splitting our firms on median age and median leverage ratio. In line with the baseline, we observe a negative and significant effect for most of the groups, but there is no statistically significant difference between the four subcategories as presented in figure 15. Thus, combining the two characteristics does not obscure the result presented in section 4.4.4.

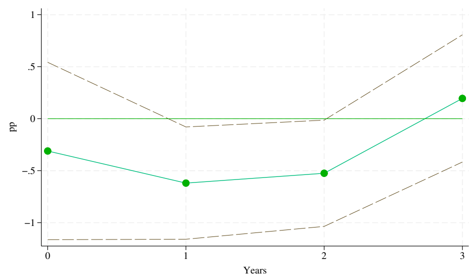
Such an exercise is necessary due to the long-standing view in the corporate finance literature that it is mainly age that is a good predictor of financial constraints (Durante et al., 2022, Cloyne et al., 2023). Figure 16 demonstrates also the differential effect based on energy intensity and financial constraints, using only age as a predictor of financial constraints. In line with the literature, age alone also appears to be a good predictor of financial constraints, for the purposes of this paper.

Figure 15: Impact of oil shock on Investment Rate based on firm characteristics

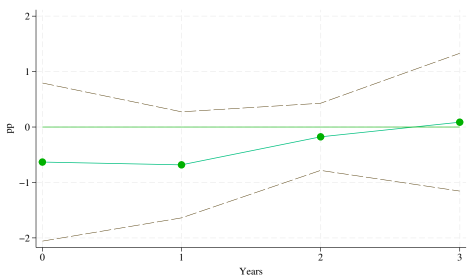
(a) Old & non-leveraged



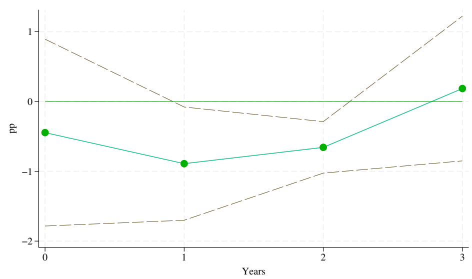
(b) Old & leveraged



(c) Young & non-leveraged



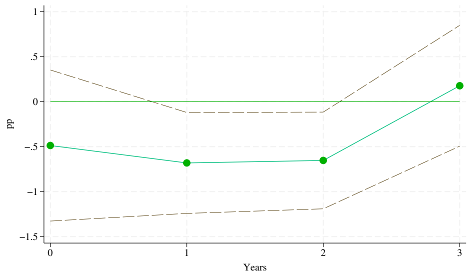
(d) Young & leveraged



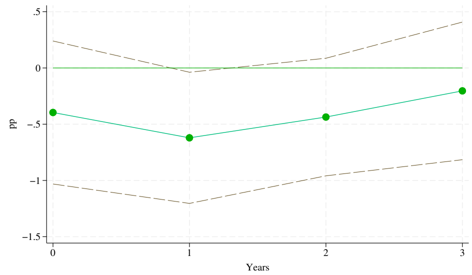
Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Figure 16: Impact of oil shock on investment rate based on age and energy intensity

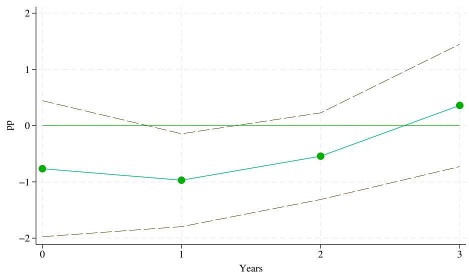
(a) Old & non-energy intensive



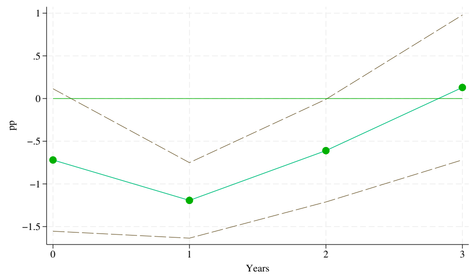
(b) Old & energy intensive



(c) Young & non-energy intensive



(d) Young & energy intensive



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

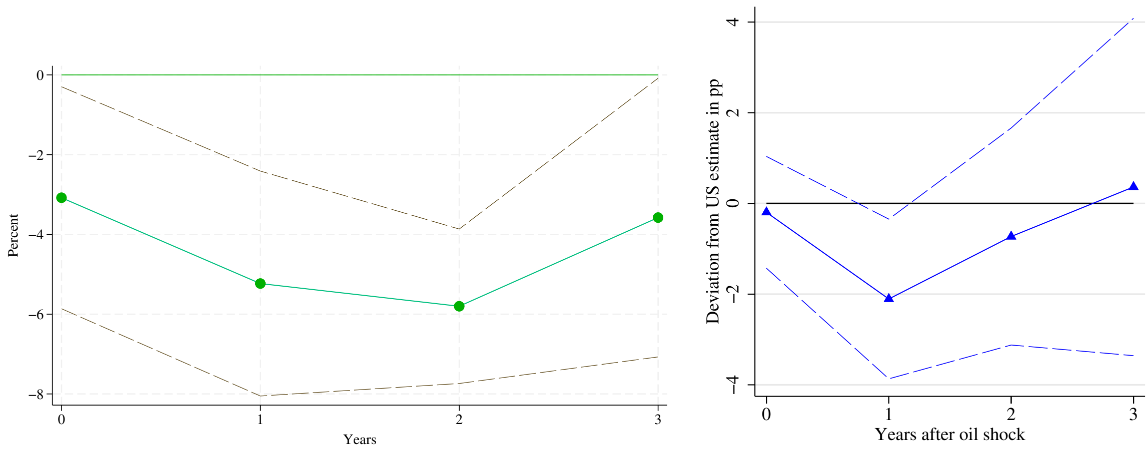
D Using Capital Expenditure as a dependent variable

As a robustness check, we repeat the analysis using the change in capital expenditure as the dependent variable, instead of the investment rate. The baseline result remains statistically significant, and the difference with the US becomes statistically significant only in the year following the impact.

E Controlling for the lagged dependent variable

In the local projection literature, some contributions support the inclusion of the lagged dependent variable as control (Jordà, 2005). This has the benefit of allowing the computation of a VAR-equivalent impulse response, but it raises significant Nickell bias concerns in a panel regression. For this reason, in our baseline specification we follow the approach of Cloyne et al. (2023). Nevertheless, as a robustness check, we assess the impact of including the lagged first difference of the dependent variable on the right-hand side of our specification. As observed in

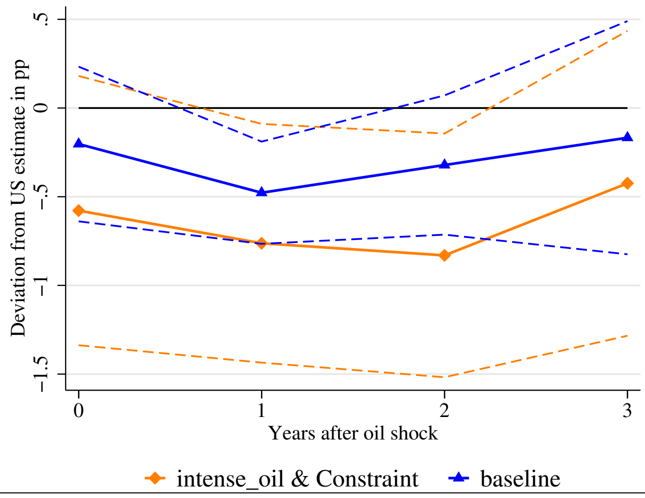
Figure 17: Difference between EU-US Robustness: Capital Expenditure as dependent variable



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

figure 18, the results keep magnitude and significance for both specifications.

Figure 18: Difference between EU-US Robustness with lagged dependent variable as control: Investment Rate



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

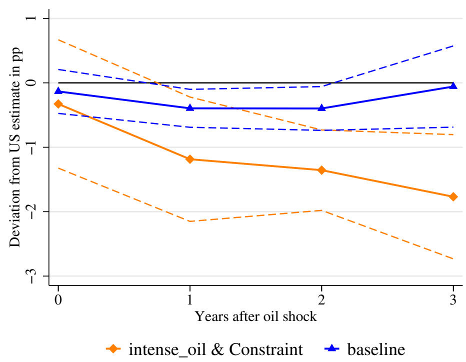
F Alternative thresholds for group classifications

In the previous sections, we used the median as the threshold to classify both financially constrained firms and energy-intensive sectors. As a robustness check, we now explore four alternative classification thresholds. The results are presented in Figure 19. Panel a defines financially constrained firms as those younger than 25 years and with leverage above the 60th percentile. Energy-intensive sectors are those above the 40th percentile in oil intensity. Panel b retains the financial constraint definition from panel a but raises the energy intensity threshold to the 60th percentile. Panel c adopts a stricter financial constraint definition—firms younger than 15 years with leverage above the 40th percentile—while energy intensity reverts to the 40th percentile threshold. Lastly, Panel d keeps the definition from panel c for financial constraints, but classifies sectors as energy intensive if they fall above the 60th percentile in energy intensity.

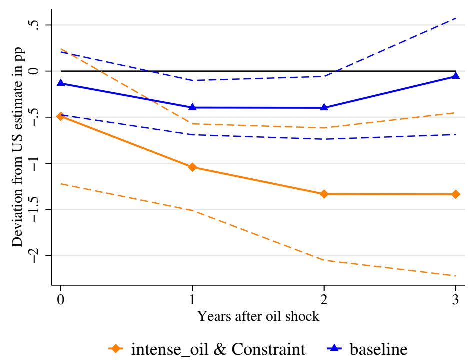
The statistically significant difference between US and European firms consistently holds across all classification thresholds for both the baseline specification and the subgroup of financially constrained firms in energy intensive sectors.

Figure 19: Significant differences present for different thresholds

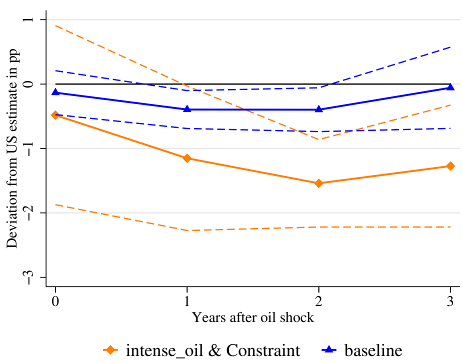
(a) Panel a



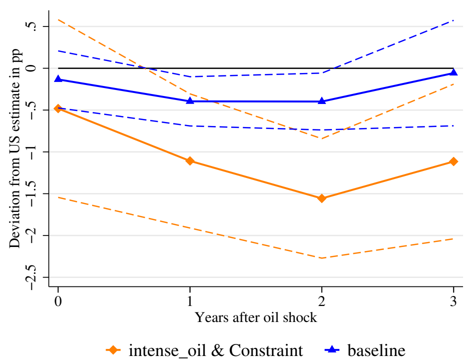
(b) Panel b



(c) Panel c



(d) Panel d



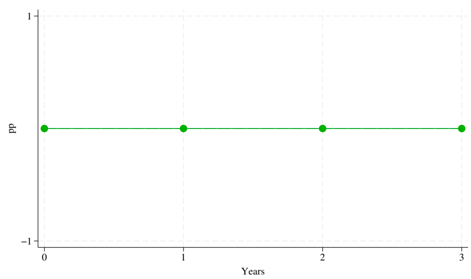
Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

G Including Year Fixed Effects in Shock-Firm Characteristic Interactions

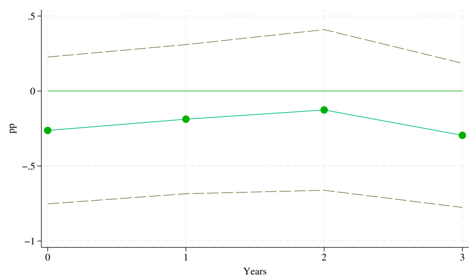
Due to the global nature of the oil shock used in the analysis, the inclusion of year fixed effects in the main part of the analysis would lead to the omission of the shock variable, as there is no cross-section variation. However, when interacting the oil shock with firm characteristics, the inclusion of the year fixed effects would not lead to the omission of our shock variable. Thus we report the results for the main breakdown in the firm characteristics of energy intensity and financial constraints in Figure 20. The main conclusions are not affected.

Figure 20: Impact of oil shock on Investment Rate based on firm characteristics, including year fixed effects

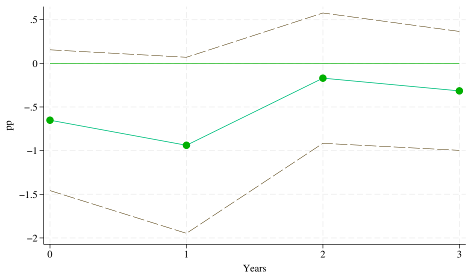
(a) Non-constrained & non-intensive



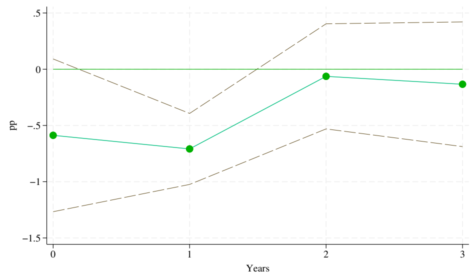
(b) Non-constrained & intensive



(c) Constrained & non-intensive



(d) Constrained & intensive

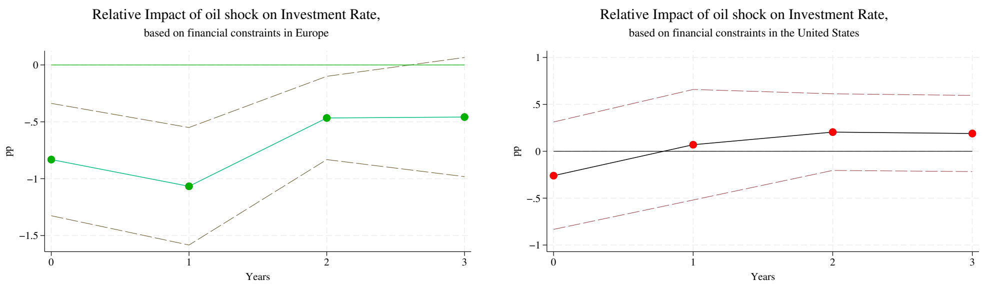


Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

H Separate impact of energy intensities and financial constraints

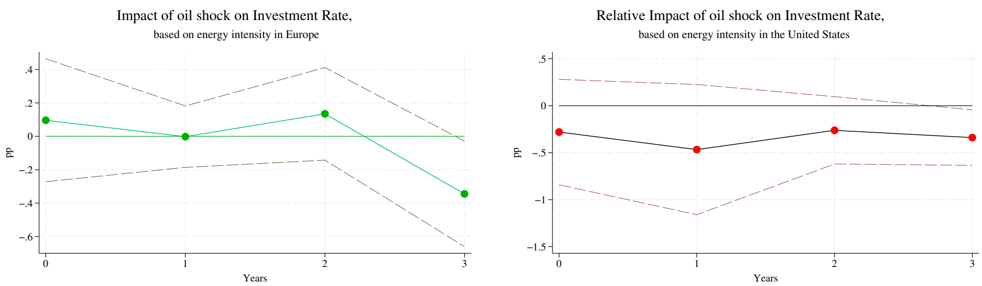
In this section, we explore what drives the statistical difference between the EU28 and the US as identified in earlier parts of the analysis. In order to do so, we divide the sample based on financial constraints and oil intensity separately. Firstly, we observe in Figure 21 that financial constraints in isolation play a significant role for European Firms,but not for US firms. Secondly, we find in Figure 22 that energy intensive in isolation does not lead to a significant deterioration in investment, at least in the short term.

Figure 21: Impact of oil shock on Investment Rate based on financial constraints



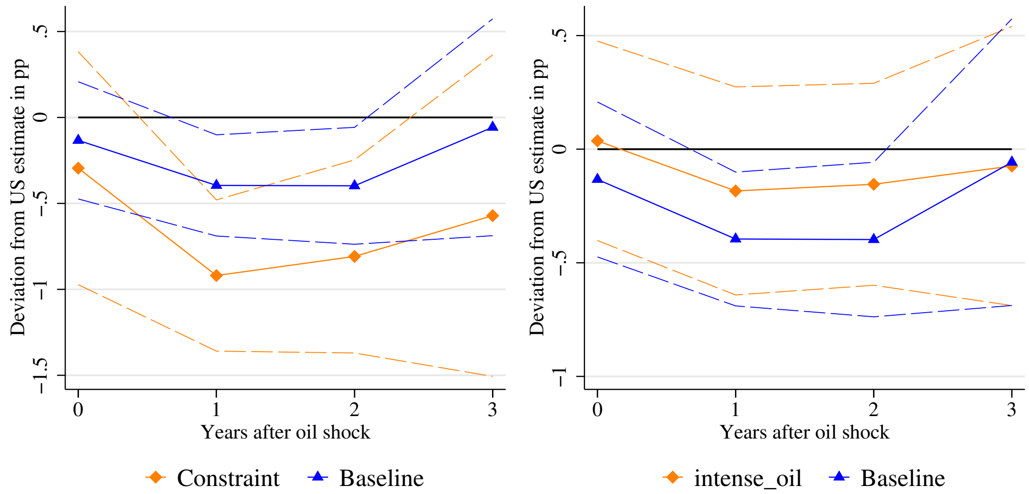
Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Figure 22: Impact of oil shock on Investment Rate based on energy intensity



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

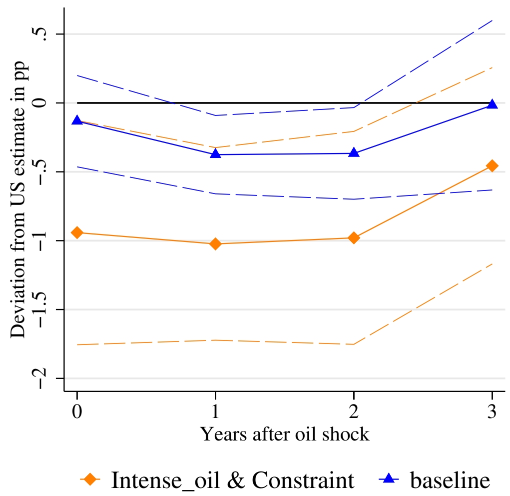
Figure 23: Impact of oil shock on Investment Rate based on energy intensity (LHS) and financial constraints (RHS) separately



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

I Interacting controls with categorical variables

Figure 24: Difference between EU-US Robustness with interaction of controls and continent



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

J The role of mark-ups

In this section, we explore the potential role that markups might play in the response of a firm's investment to an oil shock. Markups are commonly defined as the ratio between prices and marginal costs:

$$\mu_{i,t} = \frac{p_{i,t}}{mc_{i,t}} \tag{2}$$

In this equation, $p_{i,t}$ represents the price set by firm i at time t, $\mu_{i,t}$ is the corresponding markup, and $mc_{i,t}$ denotes the marginal cost. Since both prices and marginal costs are not directly observable, we estimate markups by employing the methodology developed by De Loecker & Warzynski (2012), and extended to Compustat firms in De Loecker & Eeckhout (2017). They calculate markups as the ratio of sales to cost of goods sold, multiplied by the elasticity of output with respect to cost of goods sold. This allows markups to be calculated without data on firm-level prices and marginal costs.

To compute firm-level markups, we follow a cost-share approach where variable input cost shares are combined with deflated revenue and cost measures. The markup formula used is:

$$\mu_{i,t} = \left(\frac{\text{COGS}_{i,t}}{\text{COGS}_{i,t} + UC_t \cdot K_{i,t}}\right) \cdot \left(\frac{\text{Sales}_{i,t}}{\text{COGS}_{i,t}}\right) \tag{3}$$

where:

- $\text{Sales}_{i,t}$ is real sales: Sales in $\text{euro}_{i,t}/\text{GDP deflator}_t \times 100$
- $\text{COGS}_{i,t}$ is real cost of goods sold
- $K_{i,t}$ is real capital stock: Property, Plant, and Equipment in $\text{euro}_{i,t}/\text{GDP deflator}_t \times 100$
- UC_t is the user cost of capital:

$$UC_t = \frac{r_t - \pi_t + 12}{100} \tag{4}$$

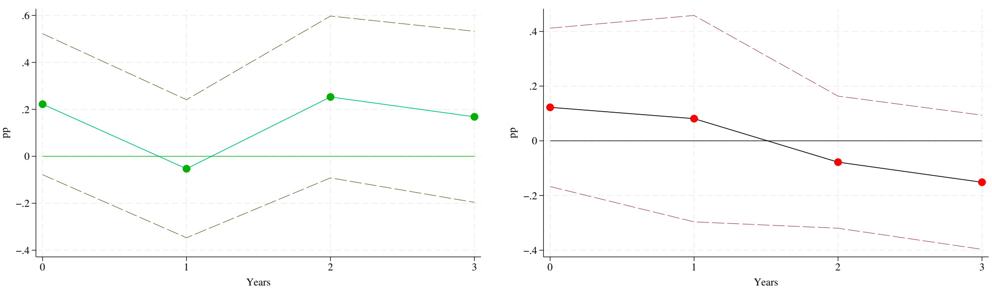
with r_t being the nominal interest rate and π_t the inflation rate.

The first term in Equation 3 reflects the cost share of COGS relative to the sum of variable inputs, and the second term adjusts this share by the output-to-input ratio, capturing the markup over marginal cost. The selling, general and administrative expenses are excluded from the cost base, thus treating only capital and cost of goods sold as variable inputs

Then, in line with the methodology followed in the rest of the paper, we split the firms in a high/low markup group based on whether the firm is above/below the median markup of the industry that it is part of (NACE2, NAICS3) for the specific year.

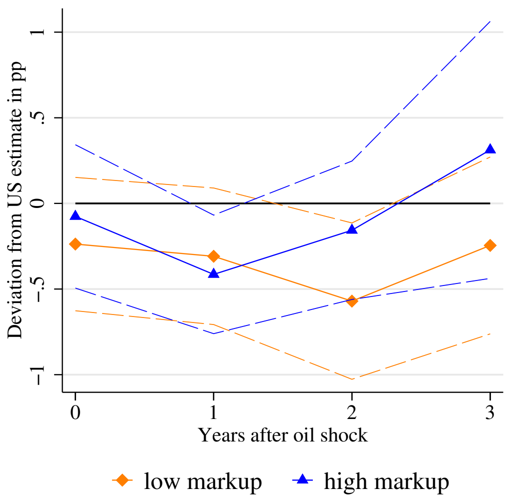
As shown in figure 25 there is no statistical difference between the low and high markup groups neither for the EU(LHS) nor for the US (RHS). Then, in line with the rest of the paper, the statistically significant difference in the response to a common oil supply shock between American and European firms remains, independent of whether firms have high or low markups. Figure 26 shows that two years after the impact of the oil shock European firms with low markup are still more affected than their US counterparts, while European firms with high markup demonstrate a statistically significant difference with the US only a year after impact.

Figure 25: Impact of oil shock on Investment Rate based on markups



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

Figure 26: Difference between EU-US based on markups



Notes: The dotted lines represent 90% confidence bands, while standard errors are clustered by firm and time following Driscoll & Kraay (1998). Fixed effects are applied at the firm level.

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Pablo Anaya Longaric
European Central Bank, Frankfurt am Main, Germany; email: Pablo.Anaya_Longaric@ecb.europa.eu

Vasileios Kostakis
European Central Bank, Frankfurt am Main, Germany; email: Vasileios.Kostakis@ecb.europa.eu

Laura Parisi
European Central Bank, Frankfurt am Main, Germany; email: Laura.Parisi@ecb.europa.eu

Francesca Vinci
European Central Bank, Frankfurt am Main, Germany; email: Francesca_Romana.Vinci@ecb.europa.eu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

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