Energy Policy 181 (2023) 113720

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Cash flow investment, external funding and the energy transition: Evidence from large US energy firms

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ARTICLE INFO

JEL classification:
Q40
C22
G32
O13

Keywords:
Ecological transition
External debt
Internal funding
Constrained energy firms

ABSTRACT

We examine the relationship between cash flow and investment in the US energy sector from 1988 to 2020. Our analysis incorporates firms' financial constraints and the type of energy production in which they are engaged, distinguishing between brown and green generation. Our findings reveal a positive relationship between investment and cash flow for green energy firms, which behave similarly to constrained energy firms. While traditional brown energy firms tend to use higher cash flow to increase dividend payments and repurchase equity, green and constrained firms use it to repay debt and to fund investment. Our results suggest that policies aimed at strengthening the linkages between financial intermediaries and green firms could unlock cash flow resources for investment and innovation, facilitating the scaling up of operations during the energy transition. To ensure the sustainability of the transition, it is critical to reduce the reliance of green energy firms on internally generated cash flow, which is subject to volatility and cyclical macroeconomic conditions.

1. Introduction

We study the relationship between investment and funding decisions of US firms in the energy sector, specifically exploring the sensitivity of investment to internally generated cash flow. Theoretically, this relationship is expected to be positive, as external funds are generally more expensive than internal funds due to information asymmetries between firms and potential investors/creditors. Managers tend to exhaust their internal funds before seeking external funding. Hence, investment opportunities tend to be sized up in periods of higher cash flow (see for instance the works by Hennessy et al. (2007), Almeida et al. (2011), and Lewellen and Lewellen (2016)).

We aim to test whether these theoretical hypotheses hold for the energy sector and emphasize the differences that are expected to arise when considering a firm's engagement with "green" or "brown" generation technologies. The expected heterogeneity follows from the dissimilar levels of innovation and risk that such technologies involve, as well as the different levels of access to capital markets and informational asymmetries about firms' investment projects and related risks (Mazzucato and Semieniuk, 2018; Jalonen, 2011; Rout et al., 2009). We emphasize a largely unmeasured financing risk that affects the energy transition: one that comes down to the company level, resulting from the larger financing constraints generally faced by green energy companies in comparison with brown companies. We also propose some policy avenues to reduce this financing risk and seek to complement the more macro-view adopted by previous studies, such as the one by Rashid (2013).

To analyze the uses of cash flow and assess investment-cash flow sensitivity, we follow the methodology proposed by Lewellen and Lewellen (2016). Their approach introduces a novel cash flow measure that outperforms the commonly used indicator of income before extraordinary items plus depreciation. This conventional measure often contains significant noise and incorporates various non-cash expenses, such as asset write-downs or deferred taxes, which ideally should be excluded from cash flow calculations. Lewellen and Lewellen's framework also allows us to analyze how investment relates to both, lagged and current cash flow. Although the inclusion of lagged variables is not universally practiced in corporate finance models that analyze investment decisions, as evident in prior research (Alti, 2003; Baghat et al., 2005; Attig et al., 2012), it allows us to explore the distributed effect over time of the investment cash flow relationship. This expands our analysis beyond the contemporaneous association between variables, revealing relevant information about the decision-making dynamics that occur during the investment process.

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https://doi.org/10.1016/j.enpol.2023.113720
Received 16 November 2022; Received in revised form 24 June 2023; Accepted 13 July 2023
Available online 20 July 2023

Our analysis aims to be comprehensive, considering all potential uses of cash flow for energy firms. This includes increasing cash holdings or working capital, acquiring new fixed assets, repaying debt, buying back equity, paying dividends, and acquiring other firms.

We use data from the financial statements of US energy firms listed on the stock market in at least one year from 1988 to 2020, included in Wharton Research Data Services (WRDS). Following Lewellen and Lewellen (2016) and Fama and French (2012) to take advantage of all the data in our sample, we conduct yearly cross-sectional regressions that use an increasing number of firms over time, starting with 30 large energy firms in 1988 and ending with 200 firms in 2020.

Our baseline results, for the whole sample of energy firms, indicate that cash flows are positively related with investment (specifically measured as capital expenditures- CAPX1): one additional dollar of cash flow translates into $0.086 increase in CAPX1, after controlling for other investment opportunities. Interestingly, higher cash flow induces an overall increase of debt ($0.39), an increase of dividend payments ($0.36) and a large reduction of share issuance ($-0.49). The relationship between debt and cash flow reverses for financially constrained firms, which reduce debt when an increase in cash flow is observed ($-0.42), according to expectations. In the same line, the relationship between cash flow and investments is more statistically and economically significant for constrained energy firms compared to the unconstrained ones. For instance, an additional dollar of cash flow induces a $0.20 increase in CAPX1. This implies that, for example, if a firm generates a cash flow of $100,000, it will allocate $20,000 towards financing investment processes.[1]

Regarding the distinction between green and brown energy firms, the most significant difference is found at the association between cash flow and CAPX3 (all purchase of fixed assets) which is more pronounced for green ($0.40) than non-green firms, for which it is not even statistically significant. Also, unlike brown firms, green firms tend to reduce debt when cash flow increases (around -$0.16). The results emphasize that green firms frequently rely on cash flow to fund their investments and pay off debt obligations. In order to support these firms' expansion and innovation, the government could explore methods to create alternative financing options and enhance the development of capital markets. This would enable these companies to free up cash flow resources that could be channeled towards their growth and development initiatives, instead of being used solely for debt repayment.

Our study on investment decisions in the energy sector makes a significant contribution to the literature on the subject, which has mainly focused on the manufacturing sector. Specifically, our research sheds light on the challenges faced by green firms in securing financing during the global energy transition. We found that green energy firms are financially constrained and rely heavily on cash flow to finance growth opportunities. In contrast, brown firms can secure financing through debt. This difference poses a particular challenge for green innovation and the financial consolidation of sustainable companies, given their weaker relationship with financial intermediaries[2], the nature of their balance sheet and credit scores, which may limit their access to capital markets. Furthermore, our study implies that green firms' investment reliability on cash flow and dependence on yearly performance and business cycles create significant hurdles to achieving sustained growth in investment levels. To sever this link, policy measures should be oriented to provide increased equity and debt finance specifically for green tech energy projects. This is necessary due to the market's failure to adequately address the challenges posed by information asymmetries and uncertainty.

To address this issue, policymakers should implement a range of complementary policies. Firstly, they should focus on facilitating stable, competitive, and efficient financial markets by considering the relaxation of regulations to enable greater participation of institutional investors. Additionally, the creation of standardized debt structure contracts and the adoption of homogeneous project evaluation methodologies across investor types and sectors are also essential steps. It is worth noting that energy agencies such as the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) have repeatedly emphasized the significance of these measures.

The remainder of this document is organized as follows. Section 2 presents a literature review on the cash flow-investment sensitivity. Section 3 provides a brief description of a basic investment model in a frictionless market and its implications for cash flow – investment relationship and presents our regression framework. Section 4 describes our dataset and the variables used in our regressions. In Section 5, we present and discuss our results. Finally, we provide concluding remarks and policy implications.

2. Background and literature review

Corporate finance research has extensively examined the connection between investment and financing decisions. It is widely documented that the financing choices of a company can influence its investment decisions due to factors such as taxes, issuance costs, agency conflicts, and information asymmetries related to debt and equity markets. These factors may have an impact on the company's cost of capital, creating a significant difference between the cost of internal and external funds (e.g., Kraus and Litzenberger, 1973; Myers, 1984; Myers and Majluf, 1984).

Such differences imply a sensitivity of corporate investment to internally generated cash flow. Fazzari et al., (1988) argued that firms may be constrained in their ability to raise funds externally, making investment spending sensitive to the availability of internal funds. According to the authors, this sensitivity is stronger for small firms compared to large firms. Numerous studies have examined this relationship and explored the factors that might influence it.

In order to systematize and organize the literature on investment-cash flow sensitivity analysis, we have classified the analyses into five categories based on the study's hypotheses and factors examined. These categories include the analysis of investment-cash flow sensitivity in response to market imperfections and financial constraints, the examination of the impact of firm-specific characteristics on investment cash flow sensitivity, managerial and governance implications regarding financial constraints, external factors influencing cash flow-investment sensitivity, and firms' investment decisions in the energy sector (see Table 1).

Regarding the first category (Table 1, Panel a), Gilchrist and Himmelberg (1995), Shin and Stulz (1998), Pawlina and Renneboog (2005), Lewellen and Lewellen (2016), among others, find a positive relationship between investment and firm cash flow, and interpret it as an indicator of financial constraints, which are related to informational asymmetries. In contrast, Kaplan and Zingales (1997), Alti (2003) and Chen and Chen (2012) argue that the sensitivity of corporate investment is not exclusive to financially constrained firms and may even occur in frictionless markets.

As shown in Table 1 (Panel b), past studies have also investigated how investment-cash flow sensitivity is linked to individual firms' characteristics. For instance, Kadapakkam et al. (1998) and Carpenter and Guariglia (2008) show that cash flow-investment sensitivity vary

[1] Our estimates are consistent with the investment-cash flow sensitivities documented by Kadapakkam et al. (1998) for U.S. firms. However, as the author points out, caution should be exercised when comparing estimates from different analyses, considering the differences in variable definitions, time periods studied, and data sources.

[2] Renewable energy companies face various challenges when they try to secure financing in capital markets, apart from issues related to weaker collateral in their balance sheet structure compared to traditional brown companies. These challenges involve information asymmetries regarding project execution, high risk perception, insufficient liquidity and market size that does not meet the criteria of institutional investors, and a scarcity of comprehensive information and risk analyses that guide private sector decision-making (IEA, 2020; IRENA, 2023).

Table 1
Investment cash flow sensitivity literature review summary.

Research Classification	Related Literature	Findings
Panel a		
Investment-cash flow sensitivity hypothesis		
	Gilchrist and Himmelberg (1995)	Investment is excessively sensitive to cash flow fluctuations.
	Shin and Stulz (1998)	Investment of highly diversified firms is less sensitive to its cash flow.
	Pawlina and Renneboog (2005)	Investment-cash flow sensitivity results mainly from the agency costs of free cash flow.
	Lewellen and Lewellen (2016)	Financing constraints and free-cash flow problems are important for investment decisions.
	Kaplan and Zingales (1997)	Higher investment-cash flow sensitivities cannot be interpreted as an indicator of financial constraints.
	Alti (2003)	Investment-cash flow sensitivity is not exclusive of imperfect markets.
	Chen and Chen (2012)	Investment-cash flow sensitivity cannot be a good measure of financial constraints.
Panel b		
Firm-specific characteristics associated to the investment-cash flow sensitivity		
	Kadapakkam et al. (1998)	Cash flow-investment sensitivity is generally highest in the large firm size group and smallest in the small firm size group.
	Carpenter and Guariglia (2008)	The significance of cash flow in explaining investment stems from its role in capturing the effects of credit frictions.
	Goergen and Renneboog (2001)	Large institutional holdings reduce the positive link between investment spending and cash flow relation
	Boyle and Guthrie (2003)	The sensitivity of investment to cash flow can be greatest for high-liquidity firms.
	Chang et al. (2014)	Financially constrained firms transitory allocate cash flow to cash savings and direct less toward investment.
	Denis and Sibilkov (2010)	Greater cash holdings are associated with higher levels of investment for constrained firms.
	Bhagat et al. (2005)	Investment of financial distressed firms with operation profits is sensitive to cash flow changes.
	Wei and Zhang (2008)	Investment-cash flow sensitivity increases with degree of divergence between the control and cash-flow rights of the largest shareholders.
	Hovakimian and Hovakimian (2009)	Investment-cash flow sensitivity is nonmonotonic to financial constraints, cash flows, and growth opportunities.
Panel c		
Managerial implications - corporate governance		
	Cull et al. (2015)	Government connections are associated with substantially less severe financial constraints.
	Ding et al. (2013)	Active management of working capital helps firms to alleviate the effects of financing constraints.
	Francis et al. (2013)	Better corporate governance lowers the dependence of emerging market firms on internally generated cash flows.
Panel d		
External factors affecting investment -cash flow sensitivity		
	Gupta and Mahakud (2020)	Good economic condition (period of high GDP growth rate) reduces the investment-cash flow sensitivity, principally of small firms.
	Mclean and Zhao (2014)	Recessions and low sentiment increase external finance costs.
	Baum et al. (2009)	Uncertainty is an important determinant of firms' investment behavior, controlling for firm-specific features.
	Attig et al. (2012)	Investment-cash flows sensitivity decreases in the presence of institutional investors with long-term investment horizons.
	Colombo et al. (2013)	The reception of public subsidies by small firms is associated to a higher investment rate and lower investment-cash flow sensitivity.
Panel e		
Firms' investment decisions in the energy sector		
	Chang et al. (2019)	Firm-specific characteristics, credit policy and financial constraints impact R&D investments in the renewable energy industry.
	Liu et al. (2020)	Economic policy uncertainty significantly inhibits traditional energy enterprises' investment.
	Sung et al. (2023)	Non-research and development subsidies affect overinvestment positively through leverage and affect it negatively through free cash flow interactions

according to firms' size. In particular, small firms tend to rely on internally generated funds to finance their investments. Other firm-specific factors that have been analyzed include firms' investment policies (Goergen and Renneboog, 2001), liquidity (Boyle and Guthrie, 2003), cash holdings (Chang et al., 2014; Denis and Sibilkov, 2010), financial distress (Bhagat et al., 2005), ownership structure (Wei and Zhang, 2008), growth opportunities (Hovakimian and Hovakimian, 2009), and government connections (Cull et al., 2015), all of which impact firms' access to external financing and reduce information asymmetries. Corporate governance practices have also been shown to impact the investment-cash flow relationship, as proper working capital management reduces dependence on internally generated resources (Ding et al., 2013) and could contribute to a more efficient allocation of investment (Francis et al., 2013).

In addition to firm-specific factors, previous research has investigated the influence of external factors (Table 1, Panel d), including the financial and macroeconomic environment. For instance, Gupta and Mahakud (2020) demonstrated that during a robust economic expansion, small and independent firms tend to exhibit a reduced sensitivity of investment to cash flow, in contrast to larger companies or those belonging to business groups. Moreover, their study finds that the state of the economy has a positive and significant effect on investment decisions. These results are consistent with the results of Mclean and Zhao (2014), who suggest that economic recessions increase external financing costs strengthening the investment-cash flow relationship.

Other external factors studied by the literature include, uncertainty, investment rates, public subsidies, and investor characteristics. In fact, Baum et al. (2009) have shown that uncertainty plays a relevant role in firms' investment decisions, by enhancing the role of cash flow. Regarding to investor characteristics, Attig et al. (2012) point out that the presence of institutional investors with long-term investment horizons contributes to reducing firms' investment dependence on cash flows. Policy interventions also play a role in the relationship between investment and cash flow. Colombo et al. (2013) has demonstrated that public subsidies negatively affect the sensitivity of investment to cash flow, especially in the case of small firms.

While the sensitivity of investment to cash flow has been extensively analyzed, most studies have focused on firms in the manufacturing sector. However, due to the urgent need for an energy transition, understanding investment decisions within the energy sector is increasingly important. Recent studies by Chang et al. (2019), Liu et al. (2020), Sung et al. (2023) have investigated the investment decisions of energy firms, revealing that factors such as financial constraints, credit policies, public subsidies, political uncertainty, and the specific features of firms can significantly impact investment levels (Table 1, Panel e). They observe different effects for renewable energy and traditional energy companies.

Building on this research, we analyze the relationship between investment and internally generated funds for US energy firms between 1988 and 2020. Our analysis considers not only firms' financial constraints and size but also the type of operation and generation activities they carry out, whether green or brown. By examining a large sample over a long-time span, our findings contribute to a greater understanding of investment dynamics in the energy sector. Our results also contribute to clarify investment decisions and sources within the energy sector, which is crucial for designing policies and incentives to ensure sustained private investment necessary to achieve the energy transition.

3. Regression framework

Our analysis discusses the relationship between companies' cash flow and their investment levels. This relationship has been a central issue in corporate finance literature and has been analyzed using different regression frameworks. We follow the regression framework presented by Lewellen and Lewellen (2016), which considers the various potential allocations of a firm's cash flow.

The departing point is given by the following accounting identities:

$$Net\ Assets_{i,t} = Cash_{i,t} + NWC_{i,t} + PPE_{i,t} + Other\ fixed\ assets_{i,t}, \tag{1}$$

Where for all t, the firm i's net asset must equal its cash holdings ($Cash_i$), plus its net working capital (NWX_i), its fixed assets in form of property, plant and equipment (PPE_i), and other fixed assets ($Other\ fixed\ assets_i$)..

According to the balance sheet accounting identity, it must hold that, for all t, firm i's net assets are equal to its debt and equity. This implies that the financing of firm i's assets occur through either debt or equity.

$$Net\ Assets_{i,t} = Debt_{i,t} + Equity_{i,t}, \tag{2}$$

In our analysis, we also consider the firm's cash flow, which takes into account both cash inflows and outflows within a specific period. In addition to finance its capital expenditures, a firm i can use its cash flow to increase its cash holdings ($\Delta Cash$), to invest in working capital (ΔNWC), to pay down its debt ($\Delta Debt$), to repurchase share ($Issues$) or to pay dividends (Div). The latter can be summarized by the following identity:

$$CF_{i,t} = \Delta Cash_{i,t} + \Delta NWC_{i,t} + CAPX_{i,t} - \Delta Debt_{i,t} - Issues_{i,t} + Div_{i,t}\ . \tag{3}$$

Due to the accounting identities presented in equations (1) and (2), equation (3) holds. These accounting identities enable us to not only analyze the investment decisions of firms but also provide a comprehensive understanding of how energy companies allocate their cash flow.

Cash flow is measured as income before extraordinary items plus depreciation, which aligns with the traditional method of measurement. However, following Lewellen and Lewellen (2016), we have incorporated adjustments to account for the influence of extraordinary items, deferred taxes, equity in net loss of unconsolidated subsidiaries, losses from the sales of property, plant, and equipment, as well as other funds from operations. These adjustments ensure a comprehensive assessment of the firm's cash flow, allowing for a more accurate representation of its financial position.

We use three different measures of investment in our regression framework. The first indicator, $CAPX1$, focuses on net capital expenditures, but it does not account for a firm's spending on additional fixed assets, such as acquired patents or cash used for acquisitions. Our second indicator, $CAPX2$, incorporates these "investing activities" as reported in the statement of cash flows. Our indicator of long-term investment, $CAPX3$, is derived from changes in fixed assets on the balance sheet over the course of a year.

Using equation (3) and considering the three measures of investment, we conduct eight complementary cross-sectional regressions for each year in the sample. Our objective is to examine the relationship between firms' cash flow and its and its different uses. We estimate two different model specifications.

Model 1 is the most basic investment model, with $CF_{i,t}$ and $MB_{i,t-1}$ as the only regressors. We use the lagged market to book ratio following the convention in the literature (e.g., Alti, 2003; Baum et al., 2009; Hovakimian and Hovakimian, 2009). The complementary cross-sectional regression equations for each year t can be expressed as follows:

$$Y_{i,t} = b_{1,t}CFi_{,t} + b_{2,t}MBi_{,t-1} + e_{i,t}, \tag{4}$$

where $t = 1,\ldots,33$, and $Y_{i,t}$, the dependent variable, varies in each yearly complementary cross-sectional regression and stands for the different uses of a firm's cashflow as explained in (3). Specifically, it corresponds to either: the changes in cash holdings ($\Delta Cash$), investments in working capital (ΔNWC), $CAPX1$, $CAPX2$, $CAPX3$, changes in debt ($\Delta DEBT$), share issuance ($ISSUES$), and dividends (DIV); $e_{i,t}$ is an error term and captures the unexplained variation in the dependent variable. It is a sequence of independent and identically distributed random variables with a mean of zero and constant variance.

Model 2 introduces lagged cash flow, cash holdings, and debt as regressors in the analysis. Our objective is to examine whether investments exhibit a delayed response to cash flow. By including debt and cash, we aim to investigate their effect on investment and to control for the influence of lagged cash flow through its impact on the firm's financial position.[3] The model also considers current and lagged stock returns to control for market dynamics.

$$\begin{aligned} Y_{i,t} = {} & b_{1,t}CF_{i,t} + b_{2,t}CF_{i,t-1} + b_{3,t}MB_{i,t-1} + b_{4,t}Return_{i,t} + b_{5,t}Return_{i,t-1} \\ & + b_{6,t}Return_{i,t-2} + b_{7,t}Cash_{i,t-1} + b_{8,t}Debt_{i,t-1} + e_{i,t} \end{aligned} \tag{5}$$

Where the variables are defined as above and $Return_{i,t}$ is the variation in the log of stock market prices in year t.

Our findings are based on the average slopes obtained from 33 annual cross-sectional regressions conducted over the period 1988 to 2020. Cross-sectional regressions conducted on a yearly basis offer an advantage in that they do not require firms to survive for long periods. This makes our results less susceptible to survivorship bias and enables the inclusion of a larger number of firms compared to time-series and panel regressions. In the spirit of Fama and Macbeth (1973), we report standard errors based on the time series variation of the slopes, using a Newey and West (1987) correction with 3 lags to account for possible autocorrelation. This methodology allows for investment-cash flow sensitivities to vary over time and effectively corrects for both time series and cross-sectional dependencies in the data, as outlined by Fama and French (1998, 2002, 2012).

Notice that we do not conduct a panel-regression. In this way, we prevent the imposition of survivorship requirements on the firms included in our sample. Second, it is well-documented in Stambaugh (1999) that including fixed effects in regressions with a limited number of observations per firm can result in biased estimates, which was a remarkable concern given the limited information available for energy firms in the green sector in the early years of our sample.

Our analysis is structured into three distinct stages. Firstly, we

[3] As robustness exercise, we have estimated a model specification that considers current and lagged returns as regressors, in order to account for financial market dynamics and its potential effect on financial decisions. For instance, this model specification is given by $Dependen_{Y_{i_t}} = b_{1,t}CF_{i,t} + b_{2,t}MB_{i,t-1} + b_{3,t}Return_{i,t} + b_{4,t}Return_{i,t-1} + b_{5,t}Return_{i,t-2} + e_{i,t}$ and was estimated for the entire sample, considering financial constraints and type of operation. The results are presented in Appendix 3.

examine the investment-cash flow sensitivity within the U.S. energy sector, considering both financially constrained and unconstrained firms, as well as green and brown firms, without differentiation. Subsequently, we proceed to the second phase of our analysis, which focuses exclusively on the investment-cash flow sensitivity of financially constrained firms within the energy sector. Finally, we investigate the investment-cash flow sensitivity specifically for green firms.

It is crucial to highlight that establishing the similarity between the behavior of green firms and financially constrained firms requires conducting a thorough analysis of the investment-cash flow sensitivity observed in financially constrained firms. By adopting this approach, we aim to provide a robust and comprehensive understanding of the investment-cash flow dynamics within the energy sector.

4. Data

Our database consists of annual cross-sectional observations on publicly traded energy firms in the United States during 1988–2020. We classify the companies in our sample into two groups, "green" and "brown", according to the main activity reported in Refinitiv by each company. Companies reporting main activities related to exploitation of non-renewable resources were considered into the "brown" companies' group, while companies reporting activities dedicated to the development of RE technologies, RE production, electric vehicle and supporting technologies as battery development, were classified into the "green" companies' group. Besides, companies whose operating activities are diversified and involve both the exploitation of non-renewable resources and green energy generation and technologies, were classified into a specific group according to the size of their brown or green operations.

Most of the companies considered in our analysis demonstrate a primary focus on a single sector. Nevertheless, a notable trend highlighted by the IEA reveals that companies engaged in non-renewable resource exploration and production are increasingly diversifying their operations to incorporate renewable energy projects. It is crucial to acknowledge, though, that the majority of their activities still remain concentrated within the non-renewable "brown" sector. For instance, investments in low-emissions energy sources by the oil and gas industry account for less than 5% of its total upstream investment (IEA, 2023).

Fig. 1 shows the yearly number of brown and green companies considered in our sample. The total number of companies included in the sample is presented in Appendix 1.

Our estimation framework also considers firms' classification according to the financial constraints they face while operating. Following, Lewellen and Lewellen (2016), such classification is based on the firms' expected cash flow approximated as the firm's forecasted cash flow. This is motivated by the fact that expected cash flow may be more relevant than realized cash flow for investment decisions. This is especially true in the energy sector, where large capital investments are required.

The firm i's expected cash flow was estimated according to the following regression:

$$CF_{i,t} = CF_{i,t-1} + Return_{i,t-1} + CAPX1_{i,t-1} + CAPX4_{i,t-1} + DIV_{i,t-1} + Debt_{i,t-1} + MB_{i,t-1} + Sales_{i,t-1} + PPE_{i,t-1} + Dpr_{i,t-1} + Cash_{i,t-1} + \varepsilon_{i,t}, \tag{6}$$

where CF is the firm i's cash flow, $Return_t$ stands for the market returns of the company, $CAPX1_i$ is the capital expenditures, $CAPX4_i$ is change year over year in fixed assets plus depreciation, DIV_i corresponds to the firm's dividends payouts, $Debt_i$ is the company's liabilities, MB_i is the market-to-book ratio, $Sales_i$ corresponds to the company's revenues due to its operational activities, PPE_i stands for property, plant and equipment, Dpr_i corresponds to firm's asset depreciation, $Cash_i$ are the company's cash holdings. The estimation of expected cash flow is derived from a cross-sectional regression of firms' cash flow on lagged firm characteristics.

Based on the fitted values obtained from estimating Equation (6), we classified firms into constrained and unconstrained. Firms within the lower tercile of forecasted cash flows are considered financially constrained. Taking into consideration that our empirical strategy is based on cross-sectional regressions, firms can change their classification each year according to the changes in their forecasted cash flow. Fig. 2 shows the yearly number of constrained and unconstrained firms included in the sample.

As information on market variables such as stock prices is needed to analyze investment decisions, listing on the stock market is a requirement imposed by our theoretical framework. As it can be observed in Figs. 1 and 2, each yearly dataset has different sizes and might contain different energy companies (green and brown, constrained, and unconstrained) according to information availability. We include both types of companies, those reporting information for the full sample and those reporting information only for certain years of the sample period.

Raw data were retrieved from Compustat- WRDS. The variables used for the analysis were constructed according to the definitions recommended by Lewellen and Lewellen (2016) and Gatchev et al. (2010). The variables used within our analysis are defined as follows and their construction from financial statements is explained in Appendix 2.

- ΔCash: changes in cash holdings.
- ΔNWC: investments in working capital.
- Long term investments: capital expenditures (CAPX1), all investing activities (CAPX2), all purchases of fixed assets (CAPX3).
- ΔDebt: changes in debt.
- Issues: share issuance.
- DIV: dividend payment.
- CF: firms' cash flow.
- MB: market to book ratio.

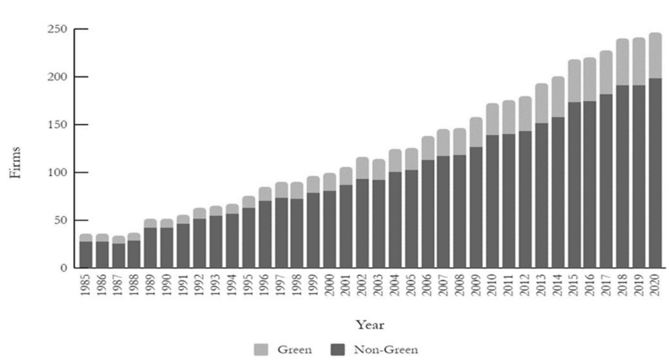

Fig. 1. Number of green and non-green firms included for each year of the sample.
Source: own elaboration, yearly data from WRDS for the period 1988–2020.

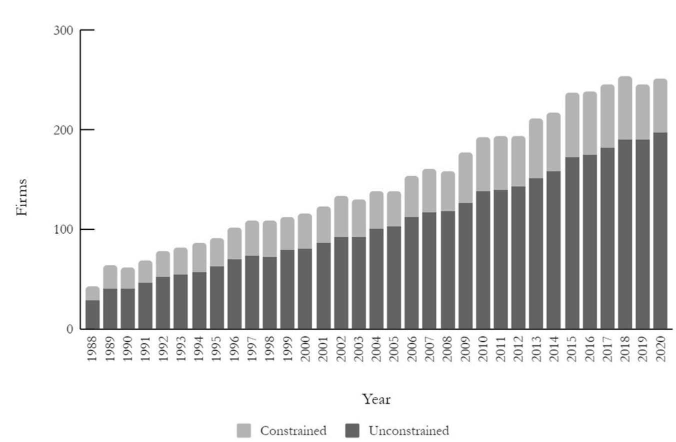

Fig. 2. Number of constrained and unconstrained companies in the sample.
Source: own elaboration. Classification made following equation 10.

Table 2 presents the summary statistics of the variables used in our regressions, as well as their average for the sample period grouped by the type of firm: brown or green. For instance, on average, all investments activities (CAPX3) of a brown firm represent 72.82% of its assets, cash holdings represent 7.2% of assets, and dividend payments correspond to 2.9% of its assets. When focusing on green companies, our data indicate that investment activities (CAPX3) represent 67.22% of their assets, cash holdings are, on average, 9.08% of assets, and dividend payments correspond, on average, to 1% of its assets. In terms of internal generated cash flow (CF1 and CF2), for an average brown firm, it represents 12% of its assets while for a green firm; it corresponds to 2% of its assets. Regarding funding sources, the table indicates that debt constitutes the most important source of finance for both brown and green energy firms, representing 51.88% and 61.82% of firm's assets, respectively. Equity issuance presents a negative sign, equalizing a reduction of 9.2% in the case of brown firms, and it seems to have no relevance as a source of funding for green firms (less than 1% of the firms' assets). This capital structure is consistent with the results of Frank et al. (2003) and Restrepo et al. (2020).

Table 2 reports summary statistics for the variables considered within our regression framework grouped by type of firm: green or brown. All variables are scaled using the total assets (except for market-to-book ratio and returns). Financial statements were retrieved from Compustat and returns from CRSP. The sample consists of energy firms, green and brown, reporting operational activities in the USA and with available data as required for the construction of the variables. ΔCash = changes in cash holdings, ΔNWC = changes in net working capital, CAPX1 = capital expenditures., CAPX2 = capital expenditures + investing activities, CAPX3 = change year over year in fixed assets, ΔDebt = changes in total debt, equity issuance = change in total equity, DIV = dividends payouts. CF1 = income before extraordinary items plus depreciation, CF2: Income before extraordinary items + extraordinary items and discontinued operations + depreciation and amortization + deferred taxes + equity in net loss of unconsolidated subsidiaries + sale of Property, Plant and Equipment and Investments - Gain (Loss)+ (funds from operations-other). Debt = current liabilities + long-term liabilities, cash = cash holdings, MB = Market-to-book ratio.

Table 2
Regression variables descriptive statistics (1988–2020).

Variables	Mean	Median	Std. Dev.	Max.	Min.	Obs.
Green Companies						
ΔCash	0.002	0.000	0.014	0.261	−0.059	811
ΔNWC	0.000	0.000	0.017	0.118	−0.286	811
CAPX1	0.055	0.047	0.042	0.337	0.000	811
CAPX2	0.000	−0.001	0.112	1.684	−0.527	811
CAPX3	0.672	0.765	0.244	0.969	0.002	811
ΔDebt	0.001	0.000	0.008	0.100	−0.054	811
EquityIssuance	0.001	0.000	0.030	0.803	−0.112	811
DIV	0.012	0.007	0.015	0.100	0.000	811
CF1	0.010	0.058	0.172	1.114	−1.654	811
CF2	0.028	0.064	0.138	0.323	−1.148	811
Debt	0.618	0.629	0.350	3.166	0.014	811
Cash	0.099	0.043	0.142	0.985	0.000	811
MB	2.303	1.564	4.789	65.152	−22.693	811
Returns	0.014	0.021	0.255	1.049	−1.376	811
Forecasted CF	−0.039	−0.011	0.138	0.562	−1.204	811
Brown Companies						
Variables	Mean	Median	Std. Dev.	Max.	Min.	Obs.
ΔCash	0.025	0.000	0.409	14.870	−0.263	2859
ΔNWC	−0.005	0.000	0.396	13.782	−10.701	2859
CAPX1	0.126	0.097	0.112	1.293	−0.008	2859
CAPX2	0.011	0.004	0.107	1.233	−0.994	2859
CAPX3	0.729	0.776	0.191	0.984	0.007	2859
ΔDebt	0.011	0.000	0.382	20.202	−0.374	2859
EquityIssuance	−0.093	−0.005	0.321	0.032	−6.932	2859
DIV	0.030	0.007	0.141	3.946	−0.703	2859
CF1	0.084	0.104	0.263	3.773	−4.606	2859
CF2	0.126	0.118	0.145	2.181	−1.047	2859
Debt	0.519	0.511	0.320	5.037	0.001	2859
Cash	0.072	0.038	0.099	0.993	−0.003	2859
MB	1.700	1.724	15.717	78.502	−70.764	2859
Returns	−0.012	0.003	0.291	3.486	−2.451	2859
Forecasted CF	−0.048	−0.019	0.204	1.475	−2.439	2859

5. Results

5.1. Cash flow against investment: full sample results

To explore the different uses of a firm's cash flow, we conduct a series of eight yearly cross-sectional regressions. These regressions are built upon the accounting identity presented in equation (3). This strategy allows us to analyze the different uses of a firm's cash flow, which is preferable to restricting the attention exclusively to the investment expenses the firm executes from year to year.

Our analysis comprises two distinct models. The first model embodies the fundamental investment framework, incorporating cash flow and the market-to-book ratio (represented as a proxy for q) as explanatory variables, as presented in equation (4). Additionally, the second model (equation (5)) expands upon this framework by introducing lagged cash flow, cash holdings, and debt as additional regressors. To control for stock market dynamics, the model also includes lagged returns as regressors. Our objective is to examine whether investments exhibit a delayed response to cash flow. By including debt and cash, we aim to investigate their effect on investment and to control for the influence of lagged cash flow through its impact on the firm's financial position.

After obtaining yearly coefficients, we estimate average slopes and t-statistics. These results are reported in Table 3. Both, the slopes, and t-statistics are the result from time-series regressions of the annual coefficients incorporating a Newey-West correction with 3 lags to consider possible non-spherical disturbances in the errors of our estimates.[4]

The first panel presents the estimations of a basic investment model, in which the only explanatory variables considered are the firms' cash flow and their lagged market to book ratio. Our estimates indicate that cash flow is a significant variable in debt, equity issuance and dividend regressions. For instance, a dollar of cash flow is associated with an increase of $0.39 of debt, a reduction of share issuance in $0.49 and an increment in dividends by $0.36. On the other hand, lagged market to book ratio appears as economically and statistically non-significant in the regressions.[5]

The second panel presents the regressions results adding lagged cash flow, beginning of year cash holdings, debt, and current and lagged returns to account for stock market dynamics. The objective of this model specification is to test whether investment reacts with delay to cash flow, considering possible dynamics into the investment and financing decision. The results point out that cash flow is significant in cash regression, net working capital, equity issuance and dividends.

[4] Different model specifications were used for robustness. These specifications include two proxies for internal generated cash flow, Cash flow 1 (CF1): Income before extraordinary items plus depreciation and Cash flow 2 (CF2): Income before extraordinary items (IBC) + XIDOC (extraordinary items and discontinued operations) + DPC (depreciation and amortization) + TXDC (deferred taxes)+ ESUBC (equity in net loss of unconsolidated subsidiaries) + SPPIV (losses from the sale of PPE) also known as "Sale of Property, Plant and Equipment and Investments - Gain (Loss)" + FOPO (funds from operations-other). The main implications of our analysis hold for these additional two model specifications. In Table 2, we present the results considering CF1 as a regressor.

[5] As part of our robustness analysis, we augmented the basic investment model by incorporating lagged stock returns to capture the influence of financial market dynamics. Importantly, the results obtained in this subsection remained unchanged, supporting the same conclusions. For detailed information on the estimated coefficients, please refer to Appendix 3, Panel A.

Table 3
Full sample regression estimates.

	Dependent Variable							
	ΔCash	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDebt	Issues	Div
Panel A. Model 1								
CF_t	0.0236	0.0256	0.0568	−0.0508	0.0364	0.3912	−0.4922	0.3633
	0.7550	0.5241	2.0212	−1.1580	0.2454	2.8924	−2.6115	4.1993
MB_{t-1}	0.0018	−0.0023	−0.0009	0.0011	−0.0087	0.0004	−0.0076	0.0054
	0.8942	−0.3421	−0.8017	0.5145	−2.9999	1.3182	−1.9951	2.0690
Panel B. Model 2								
CF_t	0.2885	0.2345	0.0858	0.0634	0.0357	0.0120	−0.2883	0.2089
	1.7817	0.8334	3.2093	1.1736	0.7710	0.4930	−2.7110	3.6112
CF_{t-1}	−0.1322	−0.3902	−0.0283	−0.1353	0.0614	0.1942	−0.1633	0.1798
	−1.4702	−1.1041	−0.8836	−2.3068	1.3514	2.6301	−1.9725	3.4683
MB_{t-1}	−0.0025	−0.0003	−0.0008	0.0033	−0.0056	−0.0021	−0.0047	0.0028
	−1.5676	−0.0439	−1.0724	1.1903	−2.1981	−2.6056	−1.3352	1.5189
$Cash_{t-1}$	−0.2401	−0.0320	−0.1127	0.0537	−0.9224	−0.0606	−0.5055	0.1491
	−1.8525	−0.2539	−4.0366	2.2103	−27.6443	−2.0102	−4.3674	3.0345
$Debt_{t-1}$	0.0134	0.0064	−0.0392	0.0429	0.0818	−0.0488	0.1036	0.0012
	0.2713	0.1395	−3.0241	6.1601	4.8331	−3.6976	4.0984	0.1359
$Return_t$	−0.1252	−0.2249	0.0282	−0.0092	−0.0476	0.0227	0.0135	−0.0159
	−0.9437	−1.1162	1.2766	−0.6852	−2.0085	3.1913	0.2712	−1.8079
$Return_{t-1}$	0.0303	−0.3487	0.0431	−0.0338	−0.0212	0.0100	0.0699	−0.0343
	0.6946	−1.4904	3.5929	−1.9341	−0.6784	1.7978	1.5290	−2.2814
$Return_{t-2}$	0.1171	0.2206	0.0659	−0.0208	0.0250	−0.0187	0.0548	−0.0324
	2.0310	1.0994	6.4651	−1.5731	0.7672	−2.3404	1.9322	−2.9173

Note: Table 3 reports average slopes and t-statistics from annual cross-sectional regressions (intercepts are included specifications). The table's top row displays the dependent variables for the eight estimated regressions, which provide an explanation for the diverse applications of cash flow, as detailed in section 3. The right column indicates the regressor variables employed in each model, as outlined by equations (14) and (15). T-statistics reported for the estimated coefficients are based on the time-series variability of the estimates, incorporating a Newey and West (1987) correction with 3 lags. Total assets divide all variables, except for returns and market-to-book ratio (MB). Data were retrieved from Compustat. The sample consists of USA energy firms dedicated to brown and green energy generation. Variable definitions are presented in section 3.

Namely, an additional dollar of cash flow represents an increase of $0.28 in cash holdings, a $0.08 raise in CAPX1, a reduction of $0.28 in share issuance, and a $0.20 raise in dividends.

Past cash flow is statistically significant in CAPX2, debt equity issuance and the dividends regression. On the other hand, lagged cash holdings are significant in all regressions. The slope estimates indicate that an additional dollar of cash reduces the investment in net working capital by $0.24, reduces investment in CAPX1 and CAPX3 by $0.11 and $0.9, respectively. It also reduces equity issuance by $0.5 and has a positive effect on dividends: a dollar of cash increases dividends by $0.14. In addition to these responses, lagged debt is significant in CAPX1, CAPX2, CAPX3, debt and equity issuance regressions. The fact that lagged variables such as cash flow, cash holdings, and debt are significant suggest that firms' past performance influences current firms' investment and financing decisions, and the latter are not fully determined by the firm's current situation.

5.2. Cash flow against investment: constrained and unconstrained firms

To analyze whether investment – cash flow sensitivity is related to the level of financial constraints faced by energy firms, we estimate equations (4) and (5) differentiating between constrained and unconstrained firms. Drawing from the approach outlined in Lewellen and Lewellen (2016), firms were classified based on their expected cash flow, as described in section 4. Expected cash flow values were estimated for each year within our sample period, enabling us to account for the dynamic nature of a firm's financial performance. It is important to note that a firm's financial constraint status can vary over time; a firm may be financially constrained in one year but not necessarily in subsequent years. To capture this distinction, we constructed a binary variable called "C", which takes the value of 1 if the firm is financially constrained and 0 otherwise. Specifically, firms falling within the lower tercile[6] were considered financially constrained.[7]

To ensure that our analysis accounts for any potential impact of firm size on the relationship between investment and cash flow, we incorporated a dummy variable "BIG" in our regression framework. Previous research has indicated that small firms may face financial constraints, as noted by Gertler and Gilchrist (1993), Gertler et al. (1994) and Gupta et al. (2021), which could affect their investment decisions. The "BIG" variable is assigned a value of 1 for large firms and 0 for all other firms. In order to determine which firms are classified as large, we used the method described by Kadapakkam et al. (1998) and Gupta and Mahakud (2020), which involved dividing firms based on the natural logarithm of their total assets. Specifically, we identified firms in the upper tercile as large. To assess the impact of firm's size on investment sensitivity to cash flow, we included the "BIG" variable in our regression models, as well as its interaction with the cash flow variable.

Table 4 summarizes our results when considering financial constraints and controlling for firms' size. The first panel in Table 4 presents the estimates of the basic investment model, including the interaction of variable C and the explanatory variables cash flow and market to book ratio. Our results indicate that cash flow significantly affects CAPX2, changes in debt, equity issues, and dividends. The most significant impact is on debt; a one dollar increase in cash flow leads to a $0.43

[6] We estimate the regressions using equations (4) and (5) while considering the firms in the bottom 50% as financially constrained. The results obtained confirm the relationship between cash flow and investment for energy companies facing financial constraints, evidencing the robustness of our estimates.

[7] To prevent sample splitting, we included a dummy variable to analyze investment-cash flow sensitivity for financially constrained firms. We did not employ quantile regression as it primarily focuses on quantiles of the dependent variable, whereas our regression framework treats cash flow as a regressor.

Table 4
Regression estimates for constrained and unconstrained firms.

	Dependent Variable							
	ΔCash	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDebt	Issues	Div
Panel A. Model 1								
CF_t	0.0662	0.1066	0.0600	0.0644	0.0641	0.4314	−0.6967	0.5281
	1.9309	1.5479	1.5618	2.0468	0.6603	2.9601	−2.4500	4.9013
MB_{t-1}	−0.0004	−0.0071	−0.0013	−0.0012	−0.0101	−0.0007	0.0005	0.0039
	−0.2375	−1.3915	−1.0190	−0.9831	−2.5397	−1.1872	0.0843	2.2370
$CF_t * C$	−0.1185	−1.0126	0.2032	−0.1972	0.1743	−0.4216	0.7465	−0.5017
	−0.5995	−1.4088	3.0187	−1.7110	2.5305	−3.0006	2.0480	−5.1424
$MB_{t-1} * C$	−0.0047	0.0951	0.0013	−0.0002	−0.0052	−0.0024	−0.0089	−0.0034
	−0.4571	1.3073	0.3433	−0.0579	−0.3805	−2.0382	−0.9267	−3.9190
C	0.0276	−0.0848	0.0333	0.0279	0.0225	0.0585	−0.0751	0.0511
	0.5309	−1.4760	3.6234	2.3899	1.4579	3.3915	−1.9456	4.0815
$CF_t * BIG$	0.0451	−0.0514	0.3649	0.0260	−0.2220	−0.4038	0.4704	−0.3937
	0.3148	−1.3900	4.4145	0.4825	−1.5106	−2.9278	2.8971	−4.5919
BIG	−0.0530	0.0331	−0.0617	−0.0139	0.1389	0.0463	0.0714	0.0465
	−2.3832	1.4838	−6.1970	−1.5187	7.1740	2.7169	5.5724	3.7736
Panel B. Model 2								
CF_t	0.4624	0.0594	0.1044	0.1845	0.0002	−0.0710	−0.4040	0.2375
	1.7374	0.2051	3.6322	2.4295	0.0027	−2.0893	−2.2564	5.9214
CF_{t-1}	−0.2024	−0.3439	−0.0042	−0.1552	0.3374	0.2474	−0.3150	0.3206
	−1.1614	−1.2804	−0.0764	−1.9436	3.3896	2.8418	−1.8105	4.5718
MB_{t-1}	−0.0021	−0.0038	−0.0022	0.0007	−0.0123	−0.0018	0.0005	0.0024
	−0.9669	−0.9616	−1.2031	0.6336	−2.1360	−1.9203	0.0962	2.0427
$Cash_{t-1}$	−0.4409	0.1055	−0.1545	0.0015	−0.8576	−0.0333	−0.1886	0.0739
	−2.1825	1.0053	−6.2099	0.0660	−17.0577	−1.6921	−1.6489	3.2704
$Debt_{t-1}$	0.0159	0.0056	−0.0243	0.0576	0.0838	−0.0295	0.0735	0.0018
	0.3615	0.2383	−2.8249	4.1910	4.4533	−3.9191	2.0687	0.2953
$Return_t$	−0.1367	−0.0396	0.0134	−0.0060	−0.0500	−0.0006	0.0415	−0.0070
	−0.8830	−0.7411	0.5757	−0.4498	−1.9524	−0.1144	1.9408	−1.8745
$Return_{t-1}$	0.0126	−0.4007	0.0261	−0.0308	−0.0269	0.0154	0.0122	−0.0155
	0.4209	−1.4919	2.2404	−2.4483	−0.9818	1.5512	0.7362	−1.9780
$Return_{t-2}$	0.1028	0.1016	0.0632	−0.0116	0.0103	0.0033	0.0233	−0.0207
	1.8546	0.7018	6.2716	−1.2455	0.3343	0.8142	0.8282	−3.2305
$CF_t * C$	−0.3716	−0.4074	0.0655	−0.2990	0.0578	0.0406	0.5273	−0.1890
	−1.3487	−1.0116	1.2447	−2.3313	0.4831	0.8177	2.0054	−6.0995
$CF_{t-1} * C$	−0.0261	0.8420	0.0092	0.1675	−0.2090	−0.1923	0.4880	−0.2749
	−0.1023	2.6689	0.0921	1.5605	−1.0133	−2.1690	2.2264	−4.2643
$MB_{t-1} * C$	−0.0235	0.1056	0.0074	0.0012	0.0028	−0.0018	−0.0151	0.0001
	−1.0858	1.2097	1.5072	0.2456	0.2072	−1.2819	−1.6933	0.0828
C	0.1064	−0.2219	0.0356	0.0260	0.0707	0.0214	−0.0647	0.0370
	1.5477	−1.3722	2.5877	2.2348	4.1999	1.7739	−1.1312	3.3274
$CF_t * BIG$	0.0306	0.6425	0.1860	−0.0570	0.1131	−0.0375	0.4498	−0.2207
	0.1176	2.7481	3.6507	−0.7036	1.1478	−1.0121	3.9681	−4.6281
$CF_{t-1} * BIG$	−0.0981	−0.3759	0.1843	0.1608	−0.5053	−0.0961	0.1087	−0.1611
	−0.4812	−2.5438	2.2744	2.5382	−2.4217	−1.8021	0.6592	−2.7487
BIG	−0.0300	−0.0395	−0.0609	−0.0223	0.1080	0.0084	0.0504	0.0412
	−1.6546	−1.1553	−5.3814	−2.4986	4.9138	1.4901	2.2003	2.9390

Note: Table 4 shows average slopes and t-statistics from annual cross-sectional regressions with intercepts, including variable C (1 if the firm is financially constrained and 0 otherwise) and controlling for firms' size including variable BIG (1 if the firm is large and 0 otherwise). The table's top row displays the dependent variables for the eight estimated regressions, which provide an explanation for the diverse applications of cash flow, as detailed in section 3. The right column indicates the regressor variables employed in each model, as outlined by equations (14) and (15). T-statistics are based on the time-series variability of the estimates, incorporating a Newey and West (1987) correction with 3 lags. Total assets divide all variables except for stock returns and the market-to-book ratio (MB). Data retrieved from Compustat. The sample consists of USA energy firms. Variable definitions are provided in section 3.

increase in debt, a $0.70 decrease in equity issuance, and a $0.53 increase in dividends.[8]

For constrained firms, our analysis shows that cash flow is significant in all the regressions, except for the cash holdings and net working capital regressions. Specifically, our findings reveal that cash flow has a negative impact on debt for constrained firms; a one dollar increase in cash flow reduces debt by $0.42. Furthermore, our estimates suggest that constrained firms finance their investments using cash flow. For example, a one dollar increases in cash flow results in an increase of $0.20 in CAPX1 and $0.17 in CAPX3.

Panel B in Table 4 presents the results of model 2 that adds lagged cash flow, beginning of year cash holdings, debt, and current and lagged returns to control for stock market dynamics. The estimates indicate that firms' cash flow is a statistically significant factor in explaining CAPX1 and CAPX2. Specifically, an increase of one dollar in cash flow corresponds to a $0.10 and $0.18 increase in CAPX1 and CAPX2, respectively. Regarding external sources of funds, a one dollar increase in a firm's cash flow corresponds to a $0.10 reduction in debt and a $0.24 increase in dividends, which might indicate the existence of a pecking order when an energy firm decides to finance new investments and growth opportunities. The latter is in line with suggestions found in the seminal work of Myers and Majluf (1984) and has been extensively scrutinized in recent corporate finance literature (e.g., Graham et al., 2001; Byoun

[8] As robustness analysis, we extended the basic investment model by incorporating lagged stock returns to capture the influence of financial market dynamics. Notably, the results obtained in this subsection provide evidence of a positive investment-cash flow relationship, specifically for financially constrained firms. These findings support the results documented in this subsection. For detailed information on the estimated coefficients, please refer to Appendix 3, Panel B.

et al., 2008; Fama and French, 2012).

We document this effect for the first time in the energy sector. Lagged cash holdings are also significant in explaining CAPX1, CAPX3, and dividends. Notably, lagged cash holdings have a negative relationship with investments, specifically one dollar increase in lagged cash holdings corresponds to a \$0.15 reduction in CAPX1 and a \$0.86 reduction in fixed investments (CAPX3). This suggests that a firm's decision to hold cash comes at the cost of sacrificing fixed asset investments, which is largely relevant to understand how energy projects are carried out. In the case of constrained firms, lagged cash flow displays, on average, a negative relationship with changes in debt. A dollar increase in cash flow reduces debt by 0.19. It also exhibits a negative relationship with dividends (0.27 reduction). The latter provide evidence that past financial performance is relevant for current firms' financing decisions in the energy sector.

Regarding the variables associated to the dummy variable BIG and its interaction with cash flow, included in our models to control for possible financial constraints associated to firms' size, our results indicate that cash flow from large companies is statistically significant in explaining the changes in net working capital, CAPX1, equity issuance and dividends. Remarkably, we find a positive relationship between cash flow and CAPX1, where an additional dollar of cash flow corresponds to a \$0.19 increase in CAPX1. Additionally, our estimates indicate a negative relationship between cash flow and dividend payments, indicating that each additional dollar of cash flow results in a \$0.22 reduction in dividends.

Moreover, when considering the lagged cash flow of big firms, it remains statistically significant in explaining investment decisions and dividend payments. Specifically, for a big firm, a one dollar increase in cash flow corresponds to a \$0.18 increase in capital expenditures

Table 5
Regression estimates for brown and green companies.

	Dependent Variable							
	ΔCash	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDebt	Issues	Div
Panel A. Model 1								
CF_t	0.0012	0.1302	0.0373	0.0066	−0.0827	0.4085	−0.4723	0.4068
	0.0257	1.1280	0.7993	0.1830	−0.6775	2.9090	−2.4938	4.4474
MB_{t-1}	0.0025	−0.0038	−0.0013	0.0013	−0.0037	−0.0005	−0.0087	0.0065
	1.0130	−0.4247	−0.6055	0.5821	−1.0817	−0.7901	−1.7552	1.9305
$CF_t * G$	0.0713	0.1679	0.0204	−0.3483	0.4012	−0.1628	−0.1913	−0.3177
	0.8178	0.5682	0.3664	−3.7710	2.3231	−2.6783	−0.8483	−4.0627
$MB_{t-1} *$ G	−0.0028	0.0078	−0.0021	−0.0033	−0.0156	−0.0024	0.0118	−0.0037
	−0.9166	0.7342	−1.0202	−0.7788	−1.4877	−2.3689	2.0402	−1.6754
G	−0.0254	−0.0206	−0.0567	0.0145	0.0111	0.0222	0.0499	0.0400
	−3.0506	−0.4526	−4.0866	1.1452	0.3011	2.5746	2.1743	2.6913
$CF_t * BIG$	−0.0648	−0.0775	0.1838	0.0285	−0.2314	−0.3261	0.6795	−0.2862
	−1.5672	−0.9815	2.5542	0.7559	−1.6622	−3.0056	3.3449	−2.9068
BIG	−0.0266	0.0060	−0.0513	−0.0110	0.0727	0.0268	0.0286	0.0322
	−2.4899	0.2714	−6.6715	−1.9088	4.7528	2.6875	2.3027	2.8883
Panel B. Model 2								
CF_t	0.3512	0.1076	0.0614	0.1150	−0.0282	−0.0004	−0.1873	0.2412
	1.55852	0.4263	1.5235	2.4896	−0.3824	−0.0131	−1.6086	3.5779
CF_{t-1}	−0.1378	−0.2240	0.0070	−0.0850	0.1230	0.2198	−0.2527	0.1965
	−1.1455	−0.7699	0.2445	−1.7492	2.0798	2.7006	−1.7225	3.1218
MB_{t-1}	−0.0020	0.0020	−0.0010	0.0012	−0.0050	−0.0016	−0.0076	0.0040
	−0.6088	0.4115	−0.5834	0.5646	−1.2710	−1.7256	−1.6106	1.6768
$Cash_{t-1}$	−0.3756	−0.0151	−0.1412	0.0278	−0.9208	−0.1170	−0.3303	0.0854
	−2.0228	−0.1388	−5.0119	1.2471	−18.6909	−2.6623	−2.7843	1.8950
$Debt_{t-1}$	0.0294	0.0307	−0.0168	0.0717	0.0831	−0.0545	0.0945	−0.0068
	0.6155	0.9811	−1.4490	5.8025	3.7008	−3.7527	2.9493	−0.8236
$Return_t$	−0.1305	−0.2261	0.0301	0.0026	−0.0277	0.0305	0.0407	−0.0098
	−0.9409	−1.1722	1.3227	0.1802	−1.1023	3.4011	0.7686	−0.9926
$Return_{t-1}$	0.0347	−0.3308	0.0445	−0.0281	−0.0078	0.0052	0.0715	−0.0277
	0.7937	−1.5031	4.8020	−1.5739	−0.2464	0.9858	1.7307	−1.7267
$Return_{t-2}$	0.1505	0.2363	0.0674	−0.0194	0.0181	−0.0492	0.0437	−0.0285
	1.9320	1.2130	5.6567	−1.5279	0.5043	−2.6663	1.6090	−3.1114
$CF_t * G$	0.3995	−0.1881	0.0015	0.0588	−0.1338	−0.0421	−0.6258	−0.1817
	0.9367	−0.2363	0.0167	0.2868	−0.3577	−0.3518	−1.5778	−1.9759
$CF_{t-1} *$ G	−0.3154	0.4718	−0.0186	−0.3689	0.4515	−0.5632	0.7411	−0.1910
	−1.0604	0.6989	−0.2518	−1.7120	1.2788	−2.9306	2.2120	−2.2689
$MB_{t-1} *$ G	0.0202	0.0447	−0.0001	−0.0007	0.0018	−0.0665	0.0254	−0.0154
	2.6296	2.9358	−0.0586	−0.1235	0.1444	−3.0417	3.1479	−3.7364
G	−0.0586	−0.0727	−0.0466	−0.0027	−0.0072	0.1364	0.0042	0.0561
	−3.0136	−1.6774	−4.7932	−0.1622	−0.3093	3.0995	0.1465	4.0993
$CF_t * BIG$	−0.4620	0.2264	0.1776	−0.1649	0.4202	0.6713	0.2462	−0.0836
	−1.7233	0.4513	2.2082	−1.7540	3.4311	2.8866	1.7944	−1.0344
$CF_{t-1} * BIG$	0.1481	−0.1498	−0.0130	0.2226	−0.8635	−0.8869	0.3777	−0.1824
	0.5458	−0.3299	−0.1362	2.1527	−4.3716	−2.9377	2.4233	−2.4985
BIG	−0.0110	−0.0121	−0.0471	−0.0175	0.0418	0.0197	0.0086	0.0333
	−3.1502	−1.1157	−5.1538	−4.5375	2.3655	2.8468	0.5222	2.2162

Note: Table 5 reports average slopes and t-statistics from annual cross-sectional regressions (with intercepts) based on yearly cross-sectional estimation including the variable dummy G, which equals 1 if the firm is dedicated to the production and developments related to green energy and 0 otherwise) and controlling for firms' size including variable BIG (1 if the firm is large and 0 otherwise). The table's top row displays the dependent variables for the eight estimated regressions, which provide an explanation for the diverse applications of cash flow, as detailed in section 3. The right column indicates the regressor variables employed in each model, as outlined by equations (14) and (15). T-statistics reported for the estimated coefficients are based on the time-series variability of the estimates, incorporating a Newey and West (1987) correction with 3 lags. All variables, but stock returns and the market-to-book ratio (MB), are scaled by assets. Accounting data was retrieved from Compustat. The sample consists of USA energy firms dedicated to brown and green energy production and related. Variable definitions are presented in section 3.

(CAPX1). These findings suggest that past firm performance plays a role in influencing investment and financing decisions.

5.3. Cash flow uses: brown against green companies

We classify companies in our sample in "green" and "brown", according to the main activity reported in Refinitiv. Companies involved in both non-renewable exploitation and green generation, were classified according to the size of their brown or green operations. To differentiate the investment and financing decisions from green companies, we construct a dummy variable, G. This variable takes the value of one if the company is classified as green or 0 if the company is mainly involved in brown activities. We considered the interaction of the binary variable with cash flow and the market to book ratio as well.

To control for any possible influence of firm size on the cash flow-investment sensitivity in our analysis, we included a dummy variable named "BIG" and its interaction with cash flow in our regression models. We followed the same approach used in the analysis of constrained and unconstrained firms. The "BIG" dummy variable takes a value of 1 if the firm is classified as large and 0 if it is not.

Table 5 presents the estimates obtained for the regressions of the two model specifications discussed in subsection 4.1 but considers the differentiated effect on green companies. Panel A shows the estimates corresponding to the basic investment model. In this regression, cash flow is statistically significant in explaining changes in debt, equity issuance and dividends. For instance, a dollar increase in cash flow implies a $0.47 reduction in equity issuance as well as an increase of $0.41 in dividends. In terms of debt, a dollar increase in cash flow has a positive effect on debt ($0.41 increase).

When analyzing green companies, it is important to consider cash flow as a significant factor in explaining the variables CAPX2, CAPX3, changes in debt, and dividends. Specifically, our findings indicate that cash flow exhibits a positive relationship with CAPX3, with each additional dollar in cash flow resulting in a $0.40 increase in fixed asset investment. Additionally, we find a negative relationship between cash flow and changes in debt ($0.16 reduction) and dividends ($0.32 reduction), suggesting that green companies prefer to fund their investment activities using internally generated funds rather than debt.[9]

Panel B contains the estimates of the regressions when considering lagged cash flow, beginning of year cash holdings, debt, and current and lagged returns as regressors and their interactions with the dummy variable G.

The estimated coefficients reveal that current cash flow is statistically significant in CAPX3 and dividends. In terms of lagged cash flow, it exhibits a positive relationship with changes in debt (with an increase of $0.22) and dividends (with an increase of $0.19). Additionally, lagged cash holdings have a negative effect on CAPX1 and CAPX3. Specifically, a one dollar increase in lagged cash holdings is associated with a $0.14 reduction in CAPX1 and a $0.92 reduction in CAPX3. This suggests that the decision to hold cash implies a sacrifice of investment, particularly in fixed assets.

In case of green companies lagged cash flow appears to be significant in explaining debt, equity issuance and dividends. For instance, a dollar increase in lagged cash flow implies a reduction of $0.57 in debt, which point out that green companies have a preference to use internally generated funds rather than issuing debt. This dependency on internally generated funds to finance investment implies that such investments are at risk of not being sustained, since they indirectly depend on the firm's past financial performance, which depends on economic conditions (see Restrepo et al., 2020).

In order to account for possible financial constraints related to firms' size, our models include variables associated with the "BIG" dummy variable and its interaction with cash flow. Our findings suggest that for larger firms, cash flow is a statistically significant factor in explaining changes in debt, equity issuance, and dividends. Specifically, an increase of one dollar in cash flow leads to a $0.32 reduction in debt, a $0.28 reduction in dividend payments, and a $0.68 increase in equity issuance.

6. Conclusions and policy implications

We examine the relationship between financially constrained firms' cash flow and their level of investment in the energy sector. We consider financial constraints energy firms may face, alongside the type of energy production in which they are involved, namely brown or green energy generation. We contrast our working hypotheses using data from US Energy firms listed on the stock market, from 1988 to 2020. We use a robust measure of cash flow, superior to the most used indicators of income before extraordinary items plus depreciation. Our framework also allows us to analyze how investment relates to both, lagged cash flow and current cash flow.

Our baseline results show that cash flows are positively related with investment: one additional dollar of cash flow translates into an increase in CAPX1. Specifically, higher cash flow induces an overall increase of debt, an increase of dividend payments and a large reduction of share issuance. The relationship between debt and cash flow reverts for constrained firms, in which case debt reduces when an increase in cash flow is observed. In the same line, the relationship between cash flow and investments is more significant and its effect economically larger for constrained energy firms than for the unconstrained ones.

Regarding the distinction between green and brown energy firms, the most significant difference is related to the association between cash flow and purchase of fixed assets, which is more pronounced for green than non-green firms. Also, unlike brown firms, green firms tend to reduce debt when cash flow increases. These results highlight the use of cash flow to fund investment opportunities and repay debt in the green energy sector.

The difference between green and non-green companies in terms of how they fund their operations is crucial, since it may highlight a significant risk for green innovation and the financial consolidation of sustainable companies, and hence, for the ongoing energy transition. Policy efforts must focus on financial intermediaries, to encourage a closer relationship between those intermediaries and green energy firms, similar to that found with traditional companies in the fuels' sector. This could be done, for instance, by regulators requiring a certain proportion of commercial banks' assets invested in credits for the RE sector. This must be complemented with allowing more liberal portfolio composition regarding public institutional investors with respect to green energy firms, which generally face greater risk, but which are crucial for long-term production in the world economy, even though their benefits might not be accurately priced by the market in the short term.

Our results imply that new resources available in the form of credit for green firms will likely translate into greater investment in fixed assets, as liberated cash flow will not be required to repay debt. Finally, it becomes clear that policies intended to reduce the volatility of green energy projects' cash flow (e.g., tariff, prices) can contribute to more sustained investments in the sector, since we document an actual dependence between cash flow and investment in the green energy sector.

While our study offers valuable insights into investment decisions in the US energy sector, some limitations should be considered. Firstly, our analysis relies on cross-sectional regressions and assumes a linear relationship between investment and cash flow. Alternative approaches, such as assuming different functional forms and empirical strategies like

[9] As robustness exercise, we expanded the basic investment model by including lagged stock returns to account for the impact of financial market dynamics. Importantly, the results also indicate a positive relationship between investment and cash flow, particularly for green firms. These results support the findings documented in this subsection and can be further explored in Appendix 3, Panel C.

panel data analysis, could be explored to investigate this relationship further. For instance, panel data analysis controls for unobserved heterogeneity and potentially increase estimators' efficiency. However, its implementation requires a larger amount of data compared to cross-sectional regressions. Consequently, implementing panel data would require a reduction in the analyzed period. Furthermore, it is important to acknowledge that conducting panel data analysis in this context would impose survival restrictions on the firms under scrutiny, which may introduce biases in the estimated relationships.

Secondly, our analysis is limited to US energy firms, which may restrict the generalizability of our findings as firms from other countries may be exposed to different capital market dynamics. Additionally, our analysis is based on publicly available and standardized information from firms that trade in financial markets. This may limit the generalizability of our results to smaller firms. However, Fazzari et al. (1988) argue that the relationship between investment levels and internally generated cash flow likely holds for smaller firms as well, given the deepening of information asymmetries. Lastly, our analysis focuses solely on investment decisions made within firms and does not take into account the broader macroeconomic and regulatory context in which these decisions are made. Future research in this area should address these limitations by examining firms from different countries, including smaller firms in the analysis, and considering the macroeconomic and financial context in which firms operate.

CRediT authorship contribution statement

Natalia Restrepo: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Jorge M. Uribe:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

The Universidad del Valle provided financial support for this research through the internal research grant 124.

Data availability

The authors do not have permission to share data.

Appendix 1

Energy companies in the sample.

Company	GVKEY	Ticker
ADAMS RESOURCES & ENERGY INC	1121	AE
HESS CORP	1380	HES
NABORS INDUSTRIES LTD	1661	NBR
APA CORP	1678	APA
BAKER HUGHES INC	1976	BKR
BARNWELL INDUSTRIES	2052	BRN
VALARIS LTD	2270	VAL
BP PLC	2410	BP
MASTEC INC	2497	MTZ
CHEVRON CORP	2991	CVX
CONTINENTAL RESOURCES INC	3469	CLR
DAWSON GEOPHYSICAL CO	3806	DWSN
DORCHESTER MINERALS -LP	4045	DMLP
WEATHERFORD INTL PLC	4367	WFRD
EQT CORP	4430	EQT
EXXON MOBIL CORP	4503	XOM
NEXTERA ENERGY INC	4517	NEE
HALLIBURTON CO	5439	HAL
HELMERICH & PAYNE	5581	HP
HOLLYFRONTIER CORP	5667	HFC
IDACORP INC	5870	IDA
PRIMEENERGY RESOURCES CORP	6311	PNRG
RANGE RESOURCES CORP	6788	RRC
MARATHON OIL CORP	7017	MRO
MARINE PETROLEUM TRUST	7034	MARP
MEXCO ENERGY CORP	7309	MXC
ALLETE INC	7437	ALE
MURPHY OIL CORP	7620	MUR
NEWPARK RESOURCES	7882	NR
XCEL ENERGY INC	7977	XEL
OCCIDENTAL PETROLEUM CORP	8068	OXY
OCEANEERING INTERNATIONAL	8079	OII
BRISTOW GROUP INC	8092	VTOL
OVERSEAS SHIPHOLDING GROUP	8210	OSG
OWENS CORNING	8214	OC
PG&E CORP	8264	PCG
GOODRICH PETROLEUM CORP	8387	GDP
PENN VIRGINIA CORP	8440	PVAC
PDC ENERGY INC	8512	PDCE
CONOCOPHILLIPS	8549	COP

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Company	GVKEY	Ticker
RPC INC	8901	RES
U S LIME & MINERALS	8947	USLM
SCHLUMBERGER LTD	9465	SLB
AMERICAN STATES WATER CO	9849	AWR
SOUTHWESTERN ENERGY CO	9904	SWN
SILVERBOW RESOURCES INC	10221	SBOW
TIDEWATER INC	10565	TDW
U S ENERGY CORP/WY	10938	USEG
AVISTA CORP	11304	AVA
OVINTIV INC	11781	OVV
NOBLE CORPORATION	11925	NE
MPLX LP	12294	MPLX
WORLD FUEL SERVICES CORP	12471	INT
DELEK LOGISTICS PARTNERS LP	12833	DKL
SUNOCO LP	12892	SUN
BHP GROUP LTD	13312	BBL
BERRY CORP	13431	BRY
SUMMIT MIDSTREAM PARTNERS LP	13871	SMLP
TRANSGLOBE ENERGY CORP	14010	TGA
PIONEER NATURAL RESOURCES CO	14359	PXD
DEVON ENERGY CORP	14934	DVN
CALLON PETROLEUM CO/DE	15060	CPE
VALERO ENERGY CORP	15247	VLO
WESTERN MIDSTRM PRTNRS LP	16225	WES
EOG RESOURCES INC	16478	EOG
PHILLIPS 66 PARTNERS LP	17933	PSXP
FRANK'S INTL NV	17956	FI
CLEARWAY ENERGY INC	18293	CWE
ANTERO RESOURCES CORP	18465	AR
HALLADOR ENERGY CO	19129	HNR
CYPRESS ENERGY PARTNERS LP	19184	CELP
SIEMENS AG	19349	SIEG
PHX MINERALS INC	19433	PHX
ATLANTICA SUSTAINABLE INFRA	20130	AY
SUPERIOR DRILLING PRODUCTS	20147	SDPI
GASLOG PARTNERS LP	20179	GLOP
NOW INC	20235	DNO
VIPER ENERGY PARTNERS LP	20534	VNO
CABOT OIL & GAS CORP	20548	COG
DENBURY INC	20653	DEN
NEXTERA ENERGY PARTNERS LP	20655	NEP
SHELL MIDSTREAM PARTNERS LP	20944	SHLX
INDEPENDENCE CONTRACT DRLLNG	21165	ICD
TETRA TECHNOLOGIES INC/DE	21237	TTI
CALIFORNIA RESOURCES CORP	21431	CRC
MAMMOTH ENERGY SERVICES INC	21834	TUSK
CONTANGO OIL & GAS CO	22053	MCF
SMART SAND INC	22284	SND
PAR PACIFIC HOLDINGS INC	22447	PARR
EARTHSTONE ENERGY INC	22671	ESTE
CKX LANDS INC	22861	CKX
SOLAREDGE TECHNOLOGIES INC	23119	SEDG
BLACK STONE MINERALS LP	23433	BSM
COVANTA HOLDING CORP	23485	CVA
NOKIA CORP	23671	NOK
ION GEOPHYSICAL CORP	23810	IO
ABRAXAS PETROLEUM CORP/NV	24005	AXAS
TOTAL ENERGIES SE	24625	TTE
AMERICAN SUPERCONDUCTOR CP	24795	AMSC
SUNRUN INC	24905	RUN
FUELCELL ENERGY INC	25430	FCEL
SM ENERGY CO	26013	SM
GULFPORT ENERGY CORP	26069	GPOR
AVANGRID INC	26658	AGR
AZURE POWER GLOBAL LTD	26676	AZRE
VAALCO ENERGY INC	27199	EGY
TPI COMPOSITES INC	27574	TPIC
EXTRACTION OIL & GAS INC	27677	XOG
CHESAPEAKE ENERGY CORP	27786	CHK
CREE INC	27794	CREE
ALPHA METALLURGICAL RESOURCE	27841	AMR
TRANSOCEAN LTD	28338	RIG
FLOTEK INDUSTRIES INC	28347	FTK
YACIMIENTOS PETE FISCALES SA	28520	YPF
BALLARD POWER SYSTEMS INC	28724	BLDP
ENEL AMERICAS SA	29039	ENIA

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Company	GVKEY	Ticker
PATTERSON-UTI ENERGY INC	29108	PTEN
NEXTIER OILFIELD SOLUTNS INC	29524	NEX
RAMACO RESOURCES INC	29670	METC
SELECT ENERGY SERVICES INC	29680	WTTR
KIMBELL ROYALTY PARTNERS LP	29760	KRP
PROPETRO HOLDING CORP	30145	PUMP
TELLURIAN INC	30241	TELL
SOLARIS OILFIELD IF INC	30547	SOI
TECHNIPFMC PLC	30923	FTI
NCS MULTISTAGE HLDG INC	31005	NCSM
MAGNOLIA OIL & GAS CORP	31252	MGY
OASIS MIDSTREAM PARTNR	31442	OMP
RANGER ENERGY SERVICES	31845	RNGR
NEXTDECADE CORP	32244	NEXT
BP MIDSTREAM PARTNERS	32413	BPMP
ENI SPA	61616	E
CORE LABORATORIES NV	61759	CLB
ELLOMAY CAPITAL LTD	62498	ELLO
EVOLUTION PETROLEUM CORP	62626	EPM
NOV INC	63892	NOV
GENESIS ENERGY -LP	64063	GEL
GULF ISLAND FABRICATION INC	64568	GIFI
COPEL-CIA PARANAENSE ENERGIA	64577	ELP
EDP-ENERGIAS DE PORTUGAL SA	64910	EDP
HELIX ENERGY SOLUTIONS GROUP	65006	HLX
ARCHROCK INC	65009	AROC
DRIL-QUIP INC	65671	DRQ
SASOL LTD	100465	SSL
PLAINS ALL AMER PIPELNE -LP	116029	PAA
CNX RESOURCES CORPORATION	120093	CNX
ULTRAPAR PARTICIPACOES SA	124617	UGP
PLUG POWER INC	125604	PLUG
PETROCHINA CO LTD	133870	PTR
BROOKFIELD RENEWABLE PRTS LP	136684	BEP
CAPSTONE GREEN ENERGY CORP	137373	CGRN
CHINA PETROLEUM & CHEM CORP	140756	SNP
MAGELLAN MIDSTREAM PRTNRS LP	142230	MMP
OIL STATES INTL INC	142260	OIS
NORTHERN OIL & GAS INC	142337	NOG
PEABODY ENERGY CORP	142460	BTU
HOUSTON AMERN ENERGY CORP	146659	HUSA
MARTIN MIDSTREAM PARTNERS LP	150201	MMLP
NATURAL GAS SERVICES GROUP	150562	NGS
CIMAREX ENERGY CO	150699	XEC
NATURAL RESOURCE PARTNERS LP	150837	NRP
WHITING PETROLEUM CORP	155393	WLL
ADVANCED EMISSIONS SOLUTIONS	156578	ADES
W&T OFFSHORE INC	160341	WTI
ORMAT TECHNOLOGIES INC	160913	ORA
AEMETIS INC	162453	AMTX
CRESTWOOD EQUITY PARTNERS LP	162894	CEQP
CAMBER ENERGY INC	163596	CEI
GLOBAL PARTNERS LP	163935	GLP
GRAN TIERRA ENERGY INC	164046	GTE
SUNPOWER CORP	165051	SPWR
CALUMET SPECIALTY PRODS -LP	165846	CLMT
DELEK US HOLDINGS INC	166563	DK
DIAMONDBACK ENERGY INC	170750	FANG
PHILLIPS 66	170841	PSX
FORUM ENERGY TECH INC	171059	FET
BATTALION OIL CORP	174169	BATL
EVOLVE TRANSITION INFRAST LP	175271	SNMP
FIRST SOLAR INC	175404	FSLR
CANADIAN SOLAR INC	175982	CSIQ
CLEAN ENERGY FUELS CORP	176343	CLNE
PROFIRE ENERGY INC	176346	PFIE
RING ENERGY INC	176840	REI
SANDRIDGE ENERGY INC	176899	SD
BLUEKNIGHT ENERGY PRTNRS LP	177945	BKEP
COSAN LTD	178084	CZZ
CVR ENERGY INC	178672	CVI
RECON TECHNOLOGY LTD	180690	RCON
GREEN PLAINS INC	181269	GPRE
CSI COMPRESSCO LP	181745	CCLP
U S SILICA HOLDINGS INC	181989	SLCA
VERTEX ENERGY INC	183704	VTNR

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Company	GVKEY	Ticker
DAQO NEW ENERGY CORP	184155	DQ
JINKOSOLAR HOLDING CO	184182	JKS
OASIS PETROLEUM INC	184442	OAS
AMYRIS INC	184717	AMRS
TESLA INC	184996	TSLA
AMERESCO INC	185128	AMRC
ENSERVCO CORP	185323	ENSV
TORCHLIGHT ENERGY RESOURCES	186013	TRCH
KOSMOS ENERGY LTD	186276	KOS
GEVO INC	186437	GEVO
MARATHON PETROLEUM CORP	186989	MPC
ENPHASE ENERGY INC	187450	ENPH
RENEWABLE ENERGY GROUP INC	187692	REGI
BONANZA CREEK ENERGY INC	187698	BCEI
SPRAGUE RESOURCES LP	187709	SRLP
MATADOR RESOURCES CO	187812	MTDR
LAREDO PETROLEUM INC	187961	LPI
AMPLIFY ENERGY CORP	194755	AMPY
PBF ENERGY INC	196159	PBF
ELETROBRAS-CENTR ELETR BRAS	201792	EBR
ENEL SPA	201794	ENLA
EQUINOR ASA	220546	EQNR
PETROLEO BRASILEIRO SA- PETR	222111	PBR
CIA ENERGETICA DE MINAS	222357	CIG
GOLAR LNG LTD	249158	GLNG
OCEAN POWER TECHNOLOGIES INC	260737	OPTT
CPFL ENERGIA SA	269005	CPL
GEOPARK LTD	278151	GPRK
RENESOLA LTD	279431	SOL
ECOPETROL SA	287882	EC

Appendix 2

Cash flow 1: Income before extraordinary items plus depreciation
Cash flow 2: Income before extraordinary items (IBC) + XIDOC (extraordinary items and discontinued operations) + DPC (depreciation and amortization) + TXDC (deferred taxes)+ ESUBC (equity in net loss of unconsolidated subsidiaries) + SPPIV (losses from the sale of PPE) also known as "Sale of Property, Plant and Equipment and Investments - Gain (Loss)" + FOPO (funds from operations-other)
CAPX1 capital expenditures
CAPX2 capital expenditures + investing activities
CAPX 3 change year over year in fixed assets (Assets – Current Assets)
CAPX 4 change year over year in fixed assets + depreciation
ΔCASH: year over year change in cash holdings (cash)
ΔNWC: year over year change in working capital (working capital)
DEBT: short-term debt (Current Liabilities) + long term debt and other long-term liabilities.
Long-term debt: total debt-current liabilities
Other long-term liabilities: other liabilities – other current liabilities
Once you have constructed debt, estimate ΔDEBT.
Dividends: dividends paid to common + dividends paid to preferred.
Equity issuance: change in total equity + change in retained earnings.

Appendix 3. Robustness assessment. Investment and cash flow uses regressions augmented with stock returns

	Dependent Variable							
	ΔCash	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDebt	Issues	Div
Panel A. Full sample								
CF_t	0.0606	0.0340	0.0424	−0.0448	0.0414	0.4010	−0.4773	0.3727
	2.4554	0.5258	2.3393	−1.0249	0.2541	2.8891	−2.5531	4.2680
MB_{t-1}	−0.0028	0.0001	−0.0011	0.0019	−0.0083	−0.0010	−0.0096	0.0055
	−1.0923	0.0247	−1.0820	0.8551	−2.6809	−2.2265	−2.2965	2.3122
$Return_t$	−0.1537	−0.1747	0.0309	−0.0081	−0.0571	−0.0951	0.0438	−0.0486
	−1.2045	−1.2312	1.4072	−0.6502	−2.5630	−2.8382	0.8781	−3.9285
$Return_{t-1}$	0.0070	−0.2493	0.0437	−0.0397	−0.0190	0.0439	0.0682	−0.0372
	0.1334	−1.4879	3.3272	−2.5771	−0.6810	2.9923	1.0211	−1.6367
$Return_{t-2}$	0.1132	0.1854	0.0670	−0.0257	0.0158	0.0418	0.0446	−0.0221
	2.3990	1.0577	6.4890	−1.7076	0.6060	2.8722	1.2300	−1.7024
Panel B. Constrained and Unconstrained								

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	Dependent Variable							
	ΔCash	ΔNWC	CAPX1	CAPX2	CAPX3	ΔDebt	Issues	Div
CF_t	0.0774	0.0489	0.0587	0.0724	0.0802	0.4349	−0.6499	0.5292
	1.6785	1.3294	2.0326	2.3084	0.8001	2.9518	−2.4760	4.9880
MB_{t-1}	−0.0034	−0.0048	−0.0018	−0.0005	−0.0106	−0.0006	−0.0029	0.0043
	−1.2668	−1.3181	−1.2260	−0.4128	−2.1887	−1.0547	−0.5470	2.5767
$Return_t$	−0.1861	0.0435	0.0152	−0.0094	−0.0740	−0.0415	0.0202	−0.0203
	−1.3052	0.9994	0.6300	−0.5827	−2.9490	−2.6002	0.8174	−2.9087
$Return_{t-1}$	0.0020	−0.3199	0.0349	−0.0339	−0.0287	0.0363	0.0259	−0.0186
	0.0528	−1.2724	2.7614	−2.0845	−1.1849	3.1910	1.1542	−1.5685
$Return_{t-2}$	0.0913	0.1290	0.0611	−0.0161	0.0154	0.0079	0.0609	−0.0237
	2.4914	0.9180	7.3930	−1.1501	0.6809	1.4410	1.7759	−1.7846
$CF_t * C$	−0.0777	−0.6841	0.1656	−0.1715	0.2058	−0.3986	0.7128	−0.4808
	−0.3979	−1.6618	2.9295	−1.5268	2.3598	−3.0402	2.2051	−5.0372
$MB_{t-1} * \mathrm{C}$	−0.0165	0.1193	0.0026	0.0022	−0.0034	−0.0089	−0.0119	−0.0038
	−1.0005	1.2000	0.6201	0.4556	−0.2122	−3.2780	−1.1783	−2.5456
C	0.0396	−0.1344	0.0339	0.0225	0.0173	0.0649	−0.0699	0.0511
	0.6711	−1.2837	3.1549	2.2822	1.2345	3.4297	−1.9349	4.5451
$CF_t * BIG$	0.1205	0.2863	0.3307	0.0303	−0.1891	−0.3977	0.4357	−0.3775
	0.4735	1.0767	4.5820	0.5352	−1.2280	−3.0141	2.7641	−4.6778
BIG	−0.0527	−0.0256	−0.0565	−0.0132	0.1336	0.0442	0.0772	0.0418
	−1.8231	−0.7992	−5.2405	−1.3691	6.5271	2.7757	5.2548	3.6160
Panel C. Green vs Brown								
CF_t	0.0463	0.1044	0.0349	0.0155	−0.0781	0.4136	−0.4404	0.4068
	1.1097	0.8754	0.8861	0.4172	−0.6668	2.9035	−2.3034	4.5052
MB_{t-1}	−0.0027	0.0007	−0.0019	0.0017	−0.0042	−0.0014	−0.0104	0.0066
	−1.2121	0.1194	−0.8959	0.7334	−1.1357	−2.2013	−1.9265	1.9718
$Return_t$	−0.1596	−0.1993	0.0281	−0.0007	−0.0399	−0.1096	0.0535	−0.0343
	−1.1904	−1.2707	1.3428	−0.0486	−1.7638	−2.7596	1.1223	−2.4312
$Return_{t-1}$	0.0120	−0.2599	0.0404	−0.0431	−0.0075	0.0453	0.0675	−0.0278
	0.2220	−1.4376	3.7111	−2.5903	−0.3190	2.9934	1.1572	−1.2761
$Return_{t-2}$	0.1228	0.2175	0.0576	−0.0319	0.0004	0.0385	0.0506	−0.0188
	2.4088	1.2112	6.5190	−2.0032	0.0141	2.9295	1.5343	−1.6297
$CF_t * G$	0.0491	0.1054	−0.0434	−0.3949	0.3830	−0.0296	−0.1333	−0.2230
	0.3065	0.7816	−0.6580	−3.2624	2.2988	−0.9724	−0.6330	−3.7681
$MB_{t-1} * \mathrm{G}$	0.0022	0.0139	0.0004	−0.0025	−0.0118	0.0010	0.0097	−0.0027
	0.8724	1.2430	0.1764	−0.4396	−1.0124	1.5926	1.4259	−1.1227
G	−0.0190	−0.0328	−0.0496	0.0144	0.0112	0.0100	0.0597	0.0281
	−1.5361	−0.7743	−3.3622	1.1034	0.3809	2.0994	2.7153	1.6649
$CF_t * BIG$	−0.0871	0.1507	0.1570	0.0347	−0.1989	−0.2932	0.6046	−0.2778
	−1.2944	0.7320	2.4132	1.0589	−1.3794	−2.9864	3.7121	−2.8014
BIG	−0.0234	−0.0118	−0.0440	−0.0097	0.0663	0.0123	0.0340	0.0273
	−1.8559	−0.6105	−5.2726	−1.7656	3.9210	2.2419	2.6926	2.0042

Note: Appendix 3 reports average slopes and t-statistics from annual cross-sectional regressions (with intercepts) based on yearly cross-sectional estimation for an investment model augmented by stock returns to account for market dynamics. The table's top row displays the dependent variables for the eight estimated regressions, which provide an explanation for the diverse applications of cash flow, as detailed in section 3. The right column indicates the regressor variables employed in each model, as outlined by equations (14) and (15). Each panel presents the model estimated considering the entire sector, financially constrained and green firms. T-statistics reported for the estimated coefficients are based on the time-series variability of the estimates, incorporating a Newey and West (1987) correction with 3 lags. All variables, but stock returns and the market-to-book ratio (MB), are scaled by assets. Accounting data was retrieved from Compustat. The sample consists of USA energy firms dedicated to brown and green energy production and related. Variable definitions are presented in section 3.

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