# Capital Structure Adjustment Speed in European Oil and Gas Firms: Evidence from the 2014–2016 Oil Price Plunge

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## Abstract

This study employs a partial adjustment model to examine the effects of the oil price plunge from 2014 to 2016 on the speed of adjustment (SOA) among European oil and gas firms during the second decade of the 21st century.

Following Dang et al.'s (2014) approach, a dummy variable, Oil_Plunge_DUM, is included to indicate the years of the oil price plunge from 2014 to 2016. An interaction term is used to assess the combined effect of this dummy variable with the lagged growth rate of oil prices and the lagged market leverage ratio. My model finds evidence that the plunge in oil prices from 2014 to 2016 negatively affects the SOA.

To robust my findings, I segment the dataset into oil importers and exporters. The results indicate that the oil price plunge from 2014 to 2016 negatively affects SOA in oil-importing nations, while no significant impact is observed for oil exporters.

Additionally, since the study sample period includes the initial year of the COVID-19 pandemic, I further analyze this year's effect on SOA. However, the analysis reveals insufficient evidence of significant impacts on SOA during that year.

Lastly, when using an alternative measure, the book leverage ratio, I find no evidence that the oil price plunge affects the overall SOA of the sample.



**Keywords:** Capital structure, Leverage, Oil price plunge, Speed of adjustment, Target


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## Resumo

Este estudo emprega um modelo de ajustamento parcial para examinar os efeitos da queda do preço do petróleo de 2014 a 2016 na velocidade de ajustamento (SOA) entre as empresas europeias de petróleo e gás durante a segunda década do século 21.

Seguindo a abordagem de Dang et al. (2014), é incluída uma variável binária, Oil_Plunge_DUM, para indicar os anos da queda do preço do petróleo de 2014 a 2016. É utilizado um termo de interação para avaliar o efeito combinado desta variável binária,com a taxa de crescimento desfasada dos preços do petróleo e o rácio de alavancagem do mercado desfasado. O meu modelo encontra provas de que a queda dos preços do petróleo de 2014 a 2016 afecta negativamente o SOA.

Para robustecer as minhas conclusões, segmentei o conjunto de dados em importadores e exportadores de petróleo. Os resultados indicam que a queda dos preços do petróleo de 2014 a 2016 afecta negativamente o SOA nos países importadores de petróleo, enquanto não se observa um impacto significativo nos exportadores de petróleo.

Além disso, uma vez que o período de amostragem do estudo inclui o ano inicial da pandemia de COVID-19, analiso ainda o efeito deste ano no SOA. No entanto, análise não revela provas suficientes de impactos significativos no SOA durante esse ano.

Por último, ao utilizar uma medida alternativa, o rácio de alavancagem contabilística, não encontro provas de que a queda do preço do petróleo afecte o SOA global da amostra.



**Palavras-chave:** Alavancagem, Alvo, Estrutura de Capital, Queda dos preços do petróleo, Velocidade de ajustamento


**Título:** Velocidade de Ajustamento da Estrutura de Capital em Empresas Europeias de Petróleo e Gás: Evidência da Queda dos Preços do Petróleo de 201432016


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# Table of Contents

## List of Tables

## Abbreviations

| Abbreviation | Description |
|---|---|
| Blev | Book Leverage Ratio |
| ECB | European Central Bank |
| Lev | Market Leverage Ratio |
| OLS | Ordinary Least Squares |
| QE | Quantitative Easing |
| R&D | Research and Development |
| SOA | Speed of Adjustment |
| TRBC | The Refinitiv Business Classification |

# 1. Introduction

The oil and gas industry is one of the largest and most complex sectors globally, with revenue contributions exceeding $5 trillion (Forbes, 2022).

The unique characteristics of firms in this industry lead to specific implications for the relationship between leverage and capital structure compared to other sectors. Oil-related projects are often associated with high levels of risk, requiring substantial capital investments. This capital intensity typically results in elevated borrowing levels, which increase debt exposure. Generally, oil companies depend heavily on external financing due to the constraints of internal financing options, which are often limited by liquidity and cash flow challenges, especially in the context of medium to large-scale projects (Kim and Choi, 2019).

Research shows that oil price shocks affect the economy through several channels. These include increased production costs for goods and services that rely on oil as a vital input, resulting in inflationary effects, reduced demand for essential consumption and investment goods, wealth transfer dynamics from oil consumers to producers, and negative impacts on consumer confidence and financial markets (Hamilton, 1996, 2008; Hammoudeh and Li, 2005).

The existing literature extensively examines the effects of oil price volatility on macroeconomic variables, such as economic growth, inflation, and stock returns within the oil and gas sector. However, there remains a significant deficiency in understanding how fluctuations in oil prices impact the capital structure adjustments of firms in this industry. While studies by Kim and Choi (2019) and Narayan and Nasiri (2020) document some capital structure changes in the oil and gas sector, this area of research still needs exploration, particularly regarding the historical oil crisis shocks.

My study contributes to the current literature by addressing a significant gap by examining the impacts of the oil price plunge from 2014 to 2016, one of the most recent oil shocks, on the capital structure adjustments of firms operating within Europe's oil and gas industry. I analyze publicly listed European oil and gas firms from 2010 to 2020. To estimate the SOA, I employ a partial adjustment model that considers firm-specific characteristics, oil and macroeconomic variables. Referring to Dang et al. (2014), I include a dummy variable, Oil_Plunge_DUM, to indicate the years of significant oil price plunge from 2014 to 2016. Additionally, I incorporate an interaction term with the oil plunge dummy variable, as well as the lagged oil spot price growth and the lagged market leverage ratio, to evaluate the impact of the oil price plunge on

SOA during those years. The analysis reveals an SOA of 36.91% for the whole sample, and I find that the SOA is negatively affected by the oil price plunge from 2014 to 2016.

I further divide the dataset into oil-importing and oil-exporting countries. My analysis reveals empirical evidence of the adverse effects of the oil price plunge between 2014 and 2016 on the SOA for oil-importing nations. In contrast, I observe no significant impact for oil-exporting nations regarding their adjustment speed towards the target level during the same period.

The remainder of this paper is organized as follows: Section 2 reviews the literature related to the research topic. Section 3 presents the methodology used in the study, and Section 4 details the dataset employed. In Section 5, I report the estimates of the target leverage and assess the impact of the oil price plunge from 2014 to 2016 on the SOA. I analyze the robustness of my results in Section 6. In Section 7, I discuss the study's limitations and suggest areas for further research. Lastly, Section 8 concludes with the main findings.

# 2. Literature Review

## 2.1 Literature review on capital structure

Following the foundational work of Modigliani and Miller (1958), which demonstrates that capital structure decisions do not affect a firm's value, examining financing choices becomes a key area of investigation in corporate finance literature. Over the years, several traditional theories have articulated this phenomenon, with the trade-off theory and the pecking order theory being among the most prominent. The trade-off theory posits that firms aspire to achieve an optimal leverage ratio that strikes a balance between the various costs associated with debt, such as financial distress costs and agency conflicts between stockholders and bondholders, and the benefits it affords, including tax advantages and reduced agency costs between managers and shareholders (Graham and Leary, 2011). Conversely, the pecking order theory proposed by Myers and Majluf (1984) argues that firms maintain a specific hierarchy regarding financing. Firms prioritize internal capital, specifically retained earnings, followed by debt issuance. Issuing equity is considered the least favorable option, as it can worsen issues related to asymmetric information.

Graham and Harvey (2001) conducted a comprehensive survey of corporate finance officers, revealing that 81% of firms consider target leverage ratios when formulating their capital structure decisions. In contrast, Baker and Wurgler (2002) claim that capital structure decisions mainly reflect historical efforts to time the equity market. This approach entails issuing equity shares at inflated prices when prior equity valuations are momentarily high. Supporting Baker and Wurgler's assertion that firms generally lack target leverage ratios, Welch (2004) found that stock returns are the primary determinant influencing capital structure decisions. Approximately 60% of the variations in firms' debt levels can be attributed to their issuance activities.

The pecking order and market timing theories[1] indicate that managers generally do not see changes in leverage as significantly affecting a company's value. Hence, they are not likely to actively try to adjust or correct changes in leverage ratios. In contrast, the trade-off theory suggests that market inefficiencies connect leverage and firm value, encouraging companies to address discrepancies from their ideal leverage ratios (Graham and Leary, 2011). The speed of adjustment refers to the rate at which a firm rectifies the disparity between its actual leverage and target leverage within a given year, a process influenced by adjustment costs. Fisher, Heinkel, and Zechner (1989) posited that firms are inclined to modify their leverage only when the anticipated benefits of such adjustments outweigh the corresponding costs associated with realigning to the target leverage. Under negligible adjustment costs, the trade-off theory asserts that firms should maintain their optimal leverage ratio without deviation. In contrast, when transaction costs are excessively high, one would expect a complete absence of movement toward the target leverage ratio.

Previous literature provides substantial evidence indicating a sluggish response to discrepancies between actual and target leverage ratios. Utilizing ordinary least squares (OLS) estimation models devoid of fixed effects, researchers including Fama and French (2002) and Kayhan and Titman (2007) documented a relatively slow SOA, measuring between 7% and 18%, with Kayhan and Titman reporting an adjustment speed of approximately 10%. Additionally, Huang and Ritter (2009) applied a mean differencing OLS estimator within their partial adjustment model, resulting in an estimated SOA of 17%. Conversely, other scholars such as Flannery and Rangan (2006) and Lemmon et al. (2008) highlighted higher adjustment speeds in their

[1] Market timing theory is based on empirical evidence indicating that firms frequently initiate equity issuance after appreciations in their stock prices. Conversely, they are prone to repurchase shares after declines in stock price valuations. This behavior suggests that prevailing market conditions influence firms' financial decision-making processes.

respective studies. Initially aligning with the findings of Fama and French (2002), Flannery and Rangan (2006) utilized a simple pooled OLS estimator, resulting in a modest SOA of 13%. However, Lemmon et al. (2008) reported a slightly higher adjustment speed of 17%. Notably, when fixed effects were introduced into the conventional leverage determinants, significant increases in the adjusted $R^2$ were observed, leading to considerably faster adjustment speeds of 38% and 39% for Flannery and Rangan and Lemmon et al., respectively.

## 2.2 Literature review on capital structure within the oil and gas industry

The unique characteristics of firms in the oil and gas industry necessitate a distinct application of traditional models. A typical investment project for these companies is an oil rig, which represents a complex and inseparable investment that is difficult to liquidate. Cash flows from an oil rig are generated after construction is completed, impacting capital structure decisions differently than in companies outside the oil and gas sector.

Tsyplakov (2008) introduced a dynamic capital structure model that accounts for investment frictions, emphasizing factors such as the time required for construction and the lumpiness of investments. Given the nature of projects within the oil and gas industry, this model serves as an appropriate framework for evaluation, as capital expenditures frequently entail large-scale investments.

Using a regression analysis based on Flannery and Rangan's partial adjustment model (2006) to measure the SOA, Tsyplakov found that firms facing heightened investment frictions have an SOA of 36%, while those experiencing minimal frictions have an SOA of 24%. This suggests a positive correlation between the investment friction level and the adjustment speed. In alignment with Tsyplakov's findings, Flannery and Rangan (2006) posited that smaller firms tend to adjust their leverage targets more rapidly than their larger counterparts. Furthermore, Fama and French's (2002) research indicates that non-dividend-paying firms, often smaller enterprises facing more significant frictions, demonstrate a higher actual leverage adjustment speed when juxtaposed with dividend-paying firms. Conversely, Fischer, Heinkel, and Zechner (1989) contend that adjustment rates should be slower for small firms due to their encountering proportionally greater transaction costs.

Narayan and Nasiri (2020) were pioneers in studying the capital structure of energy firms. Their analysis shows that the SOA for firms not affected by oil market dynamics ranges between 27.5% and 66.4%. In contrast, when rising oil prices influence firms, the SOA increases to between 51.1% and 72.4%. Additionally, when the oil market's liquidity is considered, the SOA accelerates further, with estimates ranging from 40.9% to 76.1%. The authors conclude that while increasing oil prices tends to slow leverage adjustment, improved market liquidity allows energy firms to adjust more quickly.

Fan, Zhang and Zhao (2021) investigate the intricate relationship between oil price uncertainty and capital structure decisions among corporations. Their analysis reveals a nonlinear relationship between oil price uncertainty and corporate leverage using a dataset of financial statements from publicly traded firms in China from 2007 to 2019. Specifically, they identify a U-curve characteristic: initially, as oil price uncertainty increases, corporate leverage diminishes up to a certain threshold, after which it begins to rise. In contrast, other studies, such as those by Hatzinikolaou et al. (2002), Rashid (2013), and Wang et al. (2017), argue for a predominantly negative relationship between oil price volatility and leverage.

The period between 2014 and 2016 represented one of the most significant episodes of oil price uncertainty in recent history. As reported by Grigoli, Herman, and Swiston (2019), crude oil prices plummeted from over $100 per barrel to below $50 per barrel within a matter of months.

Wang (2021) analyzed the repercussions of the oil price collapse on local U.S. banks with substantial exposure to oil-dependent regions from 2010 to 2016. Employing a difference-in-differences regression model akin to the methodology of Beck, Levine, and Levkov (2010), Wang found that before the oil price shock, the banking institutions exhibited comparable trends regarding demand deposits and loan charge-offs. However, in the aftermath of the oil price collapse, banks with substantial operations in oil-centric areas experienced significant liquidity challenges, as evidenced by a marked decline in demand deposits, an uptick in withdrawals from client credit lines, and a rise in delinquency and default rates on loan repayments.

Despite some studies exploring the decline of oil prices from 2014 to 2016 and the capital structure in the oil and gas sector, the literature still needs to be expanded. A more comprehensive investigation into these topics is necessary to enhance our understanding. This gap presents a significant opportunity for contribution to the scholarly discourse. Therefore, this study aims to analyze how the oil price plunge from 2014 to 2016 affected the capital structure adjustments of firms operating within the oil and gas industry.

# 3. Methodology

The methodology employed in this study is the partial adjustment model of leverage developed by Flannery and Rangan (2006). This model assumes firms gradually adjust their leverage to an optimal level due to adjustment costs. Building on the work of Dang et al. (2014), I extend this approach to analyze heterogeneity in SOA across firms.

To investigate the SOA's cross-sectional asymmetry, I analyze a range of firm-specific, oil, and macroeconomic variables that may influence adjustment costs.

## 3.1 Target leverage

The ongoing debate regarding the appropriate leverage ratios within capital structure research highlights the necessity for a more cohesive framework regarding using book- or market-value debt ratios.

As accounting metrics, book ratios operate independently of external factors beyond the direct influence of the firm management (Thies and Klock, 1992; Fama & French, 2002). In contrast, market ratios reflect a forward-looking perspective, incorporating the fluctuations and dynamics of the market environment.

Conventional finance theory tends to diminish the relevance of book-value debt ratios, as prior research has concentrated mainly on market-valued debt ratios, as evidenced by influential studies conducted by Hovakimian et al. (2001), Hovakimian (2003), Welch (2004), Flannery and Rangan (2006), and Kayhan and Titman (2007)

As mentioned above, this study adopts the methodology established by Flannery and Rangan (2006), utilizing the market leverage ratio as the principal measure of leverage.

$$Lev\ i,t \ = \frac{Di,t}{Di,t+\ Si,t\ Pi,t}\ , \qquad (1)$$

where Di,t represents the book value of firm i9s interest-bearing debt at time t, Si,t signifies the number of common shares outstanding at time t, and Pi,t indicate the price per share at time t.

The findings from previous analyses indicate general comparability between the results of both market and book leverage ratios. In subsequent sections, I will also incorporate the book leverage ratio to assess its robustness in the context of my analysis results.

Given the inherent variability in target leverage ratio among diverse firms and across different temporal contexts, I developed a conceptual framework characterized by the following formulation:

$$Lev^{7}_{i,t+1} = \beta X_{i,t} + \eth Oil_{i,t} + \theta Macro_{i,t}, \qquad (2)$$

Where $Lev^{7}_{i,t+1}$ is the target leverage ratio for the firm i at time t+1, modeled as a linear function of three lagged vectors: firm-specific characteristics $X_{i,t},$ oil variables $O_{i,t}$, and macroeconomic variables $Macro_{i,t}$, with the respective coefficient vectors $\beta$, ð and $\theta$.

## 3.2 Determinants of the target leverage

### 3.2.1 Firm- specific characteristics

The determination of firm-specific characteristics for modeling the target debt ratio is firmly rooted in established academic literature, with foundational contributions from Rajan and Zingales (1995), Hovakimian et al. (2001), Hovakimian (2003), Fama and French (2002), and Flannery and Rangan (2006). This section describes these variables and outlines their anticipated effects on the target debt ratio.

**EBIT_TA**: Profitability is assessed by computing the ratio of earnings before interest and taxes (EBIT) to total assets. According to the pecking order theory established by Myers and Majluf (1984), there is an inverse relationship between profitability and leverage. Firms that exhibit higher levels of profitability typically maintain lower debt ratios, as they tend to favor financing their growth through retained earnings instead of relying on external debt sources. Conversely, empirical evidence presented by Hovakimian et al. (2001) indicates that firms that increase their leverage often experience a more significant rise in operating income than those that opt to decrease their leverage. Furthermore, Flannery and Rangan (2006) elaborate on this issue by proposing that firms with substantial earnings relative to their asset base may strategically adopt a lower or higher degree of financial leverage. For instance, while considerable retained earnings allow firms to reduce their reliance on debt, higher leverage levels may reflect the firm's capability to fulfil debt obligations through its positive cash flows. Graham and Leary (2011) further complicate this relationship between profitability and leverage by pointing out that many researchers have found a negative correlation between the two, challenging the traditional trade-off model. The trade-off model asserts that all else being equal, more profitable firms should ideally prioritize the tax-shield advantages inherent in debt financing.

**MB**: The market-to-book ratio of assets serves as an essential indicator of a firm's potential future growth opportunities. The relationship between the MB ratio and leverage ratios has been the subject of various academic perspectives. Baker and Wurgler (2002) assert that historical market timing, reflected in an externally weighted aggregate of previous MB ratios, demonstrates a robust negative correlation with leverage ratios, even after adjusting for current firm-specific attributes. In contrast, the frameworks advanced by Flannery and Rangan (2006) and Graham and Leary (2011) also highlight an inverse relationship between leverage and the MB ratio, though they emerge from distinct theoretical perspectives. Flannery and Rangan (2006) contends that a higher MB ratio reflects superior growth prospects, compelling firms to adopt a conservative leverage stance to preserve these opportunities. Similarly, Graham and Leary (2011) argue that low growth are susceptible to heightened agency conflicts between management and shareholders, whereas firms endowed with substantial growth options experience greater vulnerability to the implications of debt overhang.

**DEP_TA**: The ratio of depreciation to total assets. Research by DeAngelo and Masulis (1980) and Flannery and Rangan (2006) identifies a negative relationship between depreciation and leverage. As a non-debt tax shield, depreciation diminishes the marginal benefits of debt-related tax shields, leading to reduced interest deductions and lowering taxable income.

**LnTA**: The natural logarithm of a firm's total assets is utilized as a proxy for assessing the impact of firm size on financial leverage. According to the trade-off theory, a positive correlation exists between firm size and leverage. Larger firms are often positioned to utilize greater leverage due to increased transparency and reduced asset volatility. These characteristics will likely result in a reduced probability of bankruptcy and improved accessibility to public debt markets.

**FA_TA**: Collateral is evaluated through the property, plant, and equipment (PPE) ratio to total assets**.** Companies with more tangible assets are generally better positioned to secure debt financing. Frank and Goyal (2003) emphasize that tangible assets are essential as collateral because they help mitigate bankruptcy costs for firms. This relationship underscores the significance of physical assets in enhancing financial stability and minimizing the risks of potential insolvency.

**R&D_TA**: The ratio of research and development expenditures relative to total assets. The relationship between leverage and research and development (R&D) expenditures is characterized by a negative correlation. Firms that engage heavily in R&D and possess significant intangible assets are more likely to favor an equity financing structure because intangible assets cannot serve as collateral. Consequently, reliance on debt financing may be perceived as more costly and risky for these firms, leading them to prioritize equity as a means of capitalization (Flannery and Rangan, 2006).

**R&D_DUM**: The R&D dummy variable equals one when a firm did not report R&D expenditures and zero otherwise.

**Ind_median**: The firm9s industry median debt ratio, using TRBC[2] oil and gas industry groups definitions. According to the findings of Hovakimian et al. (2001) and Roberts (2002), the industry median debt ratio mitigates the influence of omitted variables while also controlling for industry characteristics that may not be adequately addressed by other explanatory variables. In the oil and gas sector, research conducted by Barrachina-Fernández and Sogorb-Mira (2024) on an international sample comprising 200 oil and gas companies across 16 European and North American countries found compelling evidence that the market leverage of peers exerts a significant and positive influence on a company's own market leverage.

### 3.2.2 Oil variables

Narayan and Nasiri (2020) identified that oil market activities influence the capital structure of energy firms. However, their investigation yielded no evidence indicating that such oil dynamics impose similar influences on the capital structure decisions of non-energy firms. In light of this, this study incorporates Brent crude oil prices to assess the impact of oil-related variables on the speed of capital structure adjustment within oil and gas firms. Specifically, I introduce two oil variables to model the target leverage ratio: GRSOP and Oil_DUM.

**GROSP (Growth rate of Oil Spot Price**): The percentage change in the Brent oil spot price from one period to the next. Existing literature suggests that fluctuations in oil prices can significantly impact firms' capital structures. For example, Narayan and Nasiri (2020) demonstrated that a one-standard-deviation increase in oil prices could result in a decline of at least 10% in market leverage ratios. Furthermore, research conducted by Amin and Mollick

2 The Refinitiv Business Classification

(2021) corroborated these findings, indicating that elevated oil prices adversely affect stock returns, thereby introducing additional risks to the capital structure of energy firms.

**Oil_DUM:** In this study, the variable Oil_DUM is a dummy variable that assumes a value of one when the price of Brent crude oil equals or exceeds the median price[3] and takes on a value of zero in all other instances.

### 3.2.3 Macroeconomic variables

Macroeconomic variables significantly influence a firm's leverage ratio and its trajectory toward an optimal leverage target, as evidenced by the findings of Cook and Tang (2010), Drobetz and Wanzenried (2006), and Hackbarth et al. (2006). Hackbarth et al. (2006) provide a theoretical framework demonstrating that firms tend to adjust their leverage ratios more frequently during periods of economic expansion compared to economic recessions. To examine the influence of macroeconomic conditions on the speed of capital structure adjustment, I include the GDP growth rate and inflation rate to model the target debt ratio.

**GDP_Growth:** Real Gross Domestic Product (GDP) growth is defined as the annual percentage change in a nation's gross domestic product. A positive relationship is anticipated between GDP growth and a nation's capital structure. Previous studies by De Jong, Kabir, and Nguyen (2008) indicate that firms operating in economies with high GDP growth rates exhibit a greater propensity to leverage debt to finance their investments.

**Inflation_Rate:** The percentage change in the price level of goods and services within an economy, as measured by the GDP deflator. Inflation is expected to have a positive correlation with leverage. DeAngelo and Masulis (1980) provide empirical evidence showing that inflationary environments tend to reduce the real cost of debt, thereby positively affecting firms' debt ratios.

## 3.3 Partial adjustment model

The trade-off theory posits that market imperfections establish a relationship between leverage and firm value, prompting firms to implement corrective measures to address deviations from their optimal debt levels. The speed at which firms return to their target leverage ratios is

3 The median price is defined as the median value of the Brent crude oil spot price during the analyzed period from 2010 to 2020.

contingent upon the adjustment costs of altering their capital structure. In a theoretical context characterized by frictionless markets and zero adjustment costs, the trade-off theory suggests that firms should consistently maintain their optimal leverage ratios without deviation. Conversely, in a scenario where transaction costs are prohibitively high, one would expect to observe a complete absence of movement toward target leverage levels.

To empirically evaluate the trade-off theory9s assertion that firms actively adjust their capital structure to align with target leverage ratios, I employ a partial adjustment model of leverage, as delineated in the work of Flannery and Rangan (2006).

$$Lev_{i,t+1}\ 2\ Lev_{i,t} = \lambda(Lev^{7}_{i,t+1}\ 2\ Lev_{i,t}) + \epsilon_{i,t+1} \qquad (3)$$

The fluctuations observed in leverage ratios can be attributed, in part, to the recalibration of firms' target leverage ($Lev^{7}_{i,t+1}$) relative to the previously established leverage ratios ($Lev_{i,t}$). The following equation represents this dynamic adjustment:

$$Adjustment_{i,t+1} = Lev^{7}_{i,t+1}\ 2\ Lev_{i,t} \qquad (4)$$

The SOA, signified by ($\lambda$) the parameter, quantifies the trade-off between adjustment costs and the expenses incurred from deviating from the optimal capital structure. It is typically observed that a firm rectifies a proportion ($\lambda$) of the discrepancy between its actual leverage and its target leverage annually.

The value ($\lambda$) ranges from 0 to 1, reflecting the degree of the SOA. A value of zero indicates a complete lack of managerial action to reconcile the firm's leverage with its designated target, whereas a value of one signifies that the firm endeavors to eliminate the divergence between observed leverage at time (t) and the target leverage at time (t+1) on a yearly basis.

By substituting equation (2) into equation (3) and reorganizing the terms, I obtain the following partial adjustment model:

$$Lev_{i,t+1} = (1\ 2\ \lambda)Lev_{i,t} + (\lambda\beta)\,X_{i,t} + (\lambda ð)Oil_{i,t} + (\lambda\theta)Macro_{i,t} + \epsilon_{i,t+1} \qquad (5)$$

In alignment with the methodology delineated by Flannery and Rangan (2006), the regressions employed to predict target leverage (2) and execute a partial adjustment model (5) incorporate OLS regression enhanced by fixed effects. To address potential endogeneity concerns stemming from unobserved variables that could impact both the explanatory variables and the leverage ratio, all explanatory variables are systematically lagged by one year.

# 4. Data

In this study, I gather data on specific variables from the Thomson Reuters database for all publicly listed European oil and gas companies from 2010 to 2020. The second decade of the 21st century serves as my sample period, which is reasonable because it covers the oil price plunge from 2014 to 2016, allowing me to examine the effects of the oil price collapse on capital structure adjustments. I started the sample in 2010 to avoid the repercussions of the global financial crisis (2007-2009). I concluded it in 2020 to ensure a balanced timeframe, providing equal representation of years from both the periods before and after the plunge years. Additionally, since 2020 marks the beginning of the COVID-19 pandemic, I will isolate this year later to assess its impact on the robustness of my analysis results.

The sampled firms are categorized according to TRBC industry classification and encompass six distinct industry groups: Oil and Gas Exploration, Oil-Related Services and Equipment, Integrated Oil and Gas, Oil and Gas Refining and Marketing, Oil and Gas Transportation Services, and Oil and Gas Drilling. Moreover, I exclude firms without at least two consecutive years of data and any observations with missing information. Thus, the sample consists of 49 firms from 18 different European countries. In this research, Brent crude oil prices serve as a proxy for the oil spot market, underpinning the construction of two variables, the Growth rate of Oil Spot Price (GROSP) and the Oil Dummy (Oil_DUM), as detailed in the preceding sections. Data about these variables is sourced from the U.S. Energy Information Administration. In addition to the oil market data, macroeconomic variables, namely GDP growth and inflation rates, are procured from the World Bank Database Online.

## 4.1 Summary Statistics

**Table 1- Target Leverage Determinants Summary Statistics**

Summary statistics for all target leverage variables showing the central tendencies and variability across observations. All variables were winsorized at the 1st and 99th percentiles, to eliminate outliers.

| Variable | Obs. | Mean | Median | St. Dev. | Min. | Max |
|---|---|---|---|---|---|---|
| **Lev** | 539 | 0.4762 | 0.4392 | 0.2804 | 0.0221 | 0.9993 |
| **EBIT_TA** | 539 | 0.1066 | 0.0589 | 0.3290 | -0.1343 | 2.4360 |
| **MB** | 539 | 0.8412 | 0.7670 | 0.4367 | 0.1849 | 2.8363 |
| **DEP_TA** | 539 | 0.0478 | 0.0436 | 0.0232 | 0.0084 | 0.1700 |
| **LnTA** | 539 | 22.4446 | 22.2967 | 2.0381 | 17.8701 | 26.4702 |
| **FA_TA** | 539 | 0.5370 | 0.5227 | 0.2232 | 0.0390 | 1.1715 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **RD_TA** | 539 | 0.0547 | 0.0662 | 0.0239 | 0.0002 | 0.0662 |
| **RD_DUM** | 539 | 0.7959 | 1.0000 | 0.4034 | 0.0000 | 1.0000 |
| **Ind_median** | 539 | 0.4931 | 0.5107 | 0.2076 | 0.1805 | 0.9219 |
| **GROSP** | 539 | 0.4494 | -2.7502 | 26.8101 | -47.1355 | 39.7563 |
| **Oil_DUM** | 539 | 0.4545 | 0.0000 | 0.4984 | 0.0000 | 1.0000 |
| **GDP_Growth** | 539 | 0.6970 | 1.4038 | 2.9949 | -10.3599 | 4.9782 |
| **Inflation_Rate** | 539 | 2.1197 | 1.7433 | 2.4372 | -1.5448 | 15.5344 |

# 5. Results and Discussion

## 5.1 Target leverage

As outlined in subsection 3.3, this thesis employs OLS regression to predict the target leverage ratio. Table 2 presents the OLS estimates derived from equation (2) concerning the market leverage ratio, utilizing a fixed-effect model from 2010 to 2020.

The decade from 2010 to 2020 includes the oil shock between 2014 and 2016, during which oil prices fell from over $100 a barrel to below $50 a barrel in just a few months (Wang, T. 2021). This event may have disrupted the analytical framework discussed in subsection 3.2. Notably, the expected influence of MB, FA_TA, RD_TA, GDP_Growth and Inflation_Rate on leverage doesn't align with the anticipated outcomes. However, all other variables are aligned with the predicted effects.

The results presented in Table 2 demonstrate that the MB and LnTA coefficients exhibit a positive correlation with the market leverage ratio at the 1% significance level. According to traditional finance theory outlined in sub-subsection 3.2.1, leverage is typically expected to be negatively associated with MB. However, the increased MB ratios observed during this period reflect strong market optimism regarding future profitability or recovery after the oil price decline 2014, thus increasing these companies' borrowing capacity. Particularly in capital-intensive sectors such as oil and gas, the requisite financing for large-scale projects often compels firms to rely predominantly on debt rather than equity. Larger firms are better positioned to exploit greater leverage due to heightened transparency and diminished asset volatility. Larger firms can sustain operational stability and effectively manage costs during oil price decline and are typically endowed with more significant financial surpluses than their smaller counterparts. This justifies the positive relationship between LnTA (firm size) and leverage.

The coefficients for FA_TA and RD_TA exhibit negative and positive correlations with leverage, respectively, contradicting the previously outlined theoretical frameworks. The relationship between FA_TA and leverage is often expected to be positive, as tangible assets serve as significant collateral for securing debt financing, as highlighted in sub-subsection 3.2.1. However, the prolonged decline in market prices within the petroleum sector has triggered substantial impairments (PwC, 2017). The oil price plunge from 2014 to 2016 led to increased impairment testing for tangible assets, raising the likelihood of recognizing impairment losses, which decrease the recoverable amount of tangible assets, thus reducing their value as collateral for debt financing. The decreasing effectiveness of tangible assets as collateral weakens the usual positive relationship with leverage. As a result, during this time frame, a negative correlation between FA_TA and leverage is observed in the oil and gas sector. According to traditional theories, leverage is negatively correlated with R&D investments, as intangible assets can be more averse to recovery in default than tangible assets. Thus, firms prefer to finance these expenditures with equity. Nevertheless, in the years following the oil crash, firms needed to adapt and innovate to remain competitive. As a result, significant R&D investments were undertaken, such as improved drilling methods and offshore exploration techniques, to lower extraction costs or even investments in alternative energy resources, including renewables. In addition, it is important to note that, under International Financial Reporting Standards (IFRS), capitalized R&D expenditures are classified as assets (PwC, 2017). While tangible assets decrease their value as collateral due to the impairment losses caused by the oil price plunge and R&D investments gaining importance, the oil and gas industry takes a different financing approach, as mentioned above. Therefore, firms are more willing to prioritize R&D investments through debt financing than tangible assets.

Regarding macroeconomic variables, firms are more receptive to using debt to finance their investment decisions during periods of higher GDP growth. However, fluctuations in oil prices can significantly disrupt these dynamics. Although lower energy costs tend to boost household consumption, with a small positive impact on overall economic activity, the effects on oil and gas firms differ. Firms9 financial cash flows are highly significantly affected when oil prices decrease, forcing companies to reduce their investments, delay projects, and lower their capital expenditures. Therefore, they become less reliant on debt financing, even in an economy of higher GDP growth. One well-known example is the North Sea oil industry, which reportedly neared collapse by 2014 (BBC, 2014).

From 2014 to 2016, Russia, as the second-largest oil exporter globally, experienced unique dynamics that challenged conventional ideas about inflation and leverage. In 2015, inflation reached an impressive 15.53%. According to previous literature by De Angelo and Masulis

(1980), high inflation rates typically reduce the actual cost of debt, encouraging borrowing. However, the simultaneous and significant decline in oil prices during this time overshadowed this potential benefit. The drop in oil prices led to decreased oil revenues, negatively impacting investment decisions, especially in capital-intensive industries like oil and gas. In turn, firms became less willing to leverage debt, even in high inflation. Notably, this inflationary context was only experienced across some firms within the sample study. For instance, firms within the Eurozone were grappling with deflation during the same timeframe. This divergence resulted in an increased nominal cost of debt, further discouraging leverage. The observed negative relationship between inflation and leverage in the Russian context can be attributed to the unique macroeconomic conditions at the time, which significantly influenced the overall dynamics of the whole sample.

**Table 2 – Target Leverage Ratio**

Estimation of the market target leverage $(Lev_{i,t+1)}^{7}$ ) using lagged firm-specific characteristics $(X_{i,t})$ oil variables $(Oil_{i,t})$ and macroeconomic variables $(Macro_{i,t})$. The independent variables utilized in this regression are defined as follows: EBIT_TA represents the ratio of earnings before interest and taxes to total assets. MB: the market-to-book ratio of the firm's assets. DEP_TA: this variable measures depreciation expense as a proportion of total assets. LnTA: the natural logarithm of total assets. FA_TA: the ratio of PPE to total assets. R&D_TA: this variable denotes R&D expenditures as a proportion of total assets. R&D_DUM: a dummy variable indicating whether the firm did not report any research and development expenses, coded as 1 for firms without reported R&D costs and 0 otherwise. Ind_median: the median debt ratio of firms classified within the oil and gas industry according to the TRBC. GROSP: the growth rate of the Oil Spot Price, reflecting fluctuations in oil market dynamics. Oil_DUM: a dummy variable that takes the value of one if the oil price is equal to or greater than the median value and zero otherwise. GDP_Growth: the annual growth rate of gross domestic product (GDP). Inflation_Rate: the percentage change in the price level of goods and services within an economy, as measured by the GDP deflator, capturing the inflation rate. ***, **, and * indicate 1%, 5%, and 10% significance levels respectively, and robust standard errors are reported in parenthesis below.

| | **Lev** |
|---|---|
| **EBIT_TA** | 0.1652 |
| | (0.1284) |
| **MB** | 0.2024*** |
| | (0.0495) |
| **DEP_TA** | -0.6020 |
| | (0.5029) |
| **LnTA** | 0.2435*** |
| | (0.0412) |
| **FA_TA** | -0.0052 |

| | |
|---|---|
| | (0.0542) |
| **RD_TA** | 1.2630 |
| | (2.1044) |
| **RD_DUM** | 0.0000 |
| | (.) |
| **Ind_median** | 0.1236 |
| | (0.2401) |
| **GROSP** | -0.0002 |
| | (0.0002) |
| **Oil_DUM** | -0.0079 |
| | (0.0160) |
| **GDP_Growth** | -0.0011 |
| | (0.0017) |
| **Inflation_Rate** | -0.0027 |
| | (0.0019) |
| **Constant** | -5.3895*** |
| | (0.9084) |
| **FE** | Yes |
| **N (Observations)** | 105 |
| **R-sq (within)** | 0.536 |

## 5.2 The impact of the Oil Plunge 2014-2016

In subsection 3.3, I develop a partial adjustment model (equation 5), wherein the SOA is posited to vary cross-sectionally based on several firm-specific characteristics, oil and macroeconomic variables. These variables and their linear combinations proxy the degree to which a firm may be financially constrained and the associated costs of leverage adjustments. Given the significant decline in oil prices between 2014 and 2016, which could significantly impact how companies adjust their capital structures, the SOA is expected to exhibit temporal variability. To rigorously investigate the impact of the oil plunge on the SOA, I adhere to the methodological framework established by Dang et al. (2014) while extending this approach to account for heterogeneity in SOA across firms. Specifically, I incorporate a dummy variable, Oil_Plunge_DUM, into the partial adjustment model. This variable takes the value of one if the year in question is a plunge year, between 2014 and 2016, and zero otherwise.

Additionally, I introduce an interaction term that multiplies the oil plunge dummy variable (Oil_Plunge_DUM) by the lagged growth rate of the oil spot price (GROSP) and the lagged market leverage ratio (Lev). This methodology seeks to more precisely analyze the effects of declining oil prices on SOA during the oil plunge from 2014 to 2016. The equation used to estimate the impartial adjustment model, especially regarding the impact of the Oil Plunge 2014-2016, is represented as follows:

$$Lev_{i,t+1} = (1\ 2\ \lambda)Lev_{i,t} + (\lambda\beta)\ X_{i,t} + (\lambda ð)Oil_{i,t} + (\lambda\theta)Macro_{i,t} + (\ \lambda\phi 1)Oil\_Plunge\_DUM + (\lambda\phi 2)Oil\_Plunge\_DUM\ 7\ GROSP_{i,t}\ 7\ Lev_{i,t} + \epsilon_{i,t+1} \quad (6)$$

## 5.2.1 Speed of Adjustment (SOA)

Table 3 presents the findings from the partial adjustment model, detailing the results yielded by the OLS regression, as outlined in equation 6. The SOA is derived by calculating one minus the coefficient of the lagged market leverage ratio. The SOA for the complete data sample is recorded at 36.91%. This figure suggests that firms can close 36.91% (1- 0.6309) of the gap between their current and target leverage ratios within a year. At this adjustment rate, it is projected to take approximately 1.50[4] years to reduce half of the gap between a typical firm9s current and desired leverage ratios. The observed adjustment rate among European oil and gas firms during this period is in line with the findings reported by Flannery and Rangan (2006) and Lemmon et al. (2008). These prior studies, which employed a panel data model with firm fixed effects, yielded 38% and 39% SOA, respectively.

In contrast, the current analysis reveals that the annual adjustment speed appears to be slower when compared to the work of Narayan and Nasiri (2020), who found that the SOA for energy firms responding to fluctuations in oil price growth ranges from 51.1% to 72.4%. This divergence in adjustment rates within the oil and gas sector may be attributed to the repercussions of the oil crash between 2014 and 2016, which is included in the present study's sample. Narayan and Nasiri's (2020) time-split research also incorporate the initial two years of this oil shock. However, because their sample spans from 1988 to 2015, the crash's impact was more diluted in their analysis than in my study, which focuses on a shorter time frame, specifically from 2010 to 2020. Furthermore, while Narayan and Nasiri (2020) included a global sample of firms, my analysis is confined to European firms. This distinction may lead to differential impacts stemming from the varying specializations and operational contexts characterizing firms within the oil and gas industry.

[4] The half-life is calculated using the formula log (0.5) /log (1 - SOA). This metric represents the duration, measured in years, required for companies to reduce to half of the gap between their actual leverage and target leverage.

The interaction term (Oil_Plunge_DUM*GROSP$i, t$*Lev$i, t$) exhibits a positive and statistically significant coefficient at the 5% significance level. Considering that the coefficient for the lagged leverage ratio is represented as (1-$\lambda$), where $\lambda$ denotes the SOA, a positive relationship in the interaction term, which includes the oil price plunge dummy, the lagged growth rate of oil spot prices, and the previous leverage ratio, implies that during the oil price plunge, firms adjusted their leverage more slowly toward their target leverage.

**Table 3 - Regression Results for the Complete Dataset**

Table 3 presents the findings from a partial adjustment model employing OLS regression augmented by fixed effects. The primary objective of this model is to estimate the SOA concerning various lagged variables, which encompass the market leverage ratio ($Lev_{i,t}$), firm-specific characteristics ($X_{i,t}$), and determinants related to oil variables ($Oil_{i,t}$) and macroeconomic variables ($Macro_{i,t}$). Additionally, an oil plunge dummy variable (Oil_Plunge_DUM) is incorporated, which assumes a value of one for years classified as plunge years (specifically between 2014 and 2016) and zero otherwise. To further explore the dynamics of this phenomenon, an interaction term is introduced that multiplies the oil plunge dummy variable (Oil_Plunge_DUM) by both the lagged growth rate of the oil spot price (GROSP$i, t$) and the lagged market leverage ratio ($Lev_{i,t}$). This interaction term aims to evaluate the impact of declining oil prices on the speed of adjustment during the specified oil plunge period from 2014 to 2016 (refer to equation (6)). The calculation of SOA is derived by subtracting the coefficient lagged market leverage ratio from one. The significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels of significance, respectively, with robust standard errors provided in parentheses beneath the coefficients.

| | |
|---|---|
| **SOA** | **36.91%** |
| **Half-life(years)** | **1.50** |
| **Lev** | 0.6309** |
| | (0.2202) |
| **EBIT_TA** | 0.1436 |
| | (0.1034) |
| **MB** | 0.0100 |
| | (0.0442) |
| **DEP_TA** | -0.4714 |
| | (0.4211) |
| **LnTA** | 0.0242 |
| | (0.0740) |
| **FA_TA** | -0.0055 |
| | (0.0353) |
| **RD_TA** | 2.1304 |
| | (1.6992) |
| **RD_DUM** | 0.0000 |
| | (.) |
| **Ind_median** | 0.0433 |
| | (0.1590) |

| | |
|---|---|
| **GROSP** | -0.0001 |
| | (0.0002) |
| **Oil_DUM** | -0.0233** |
| | (0.0099) |
| **GDP_Growth** | -0.0000 |
| | (0.0020) |
| **Inflation_Rate** | -0.0014 |
| | (0.0019) |
| **Oil_Plunge_DUM** | 0.0407*** |
| | (0.0096) |
| **Oil_Plunge_DUM*GROSP* Lev** | 0.0023** |
| | (0.0009) |
| **Constant** | -0.4080 |
| | (1.6388) |
| **FE** | Yes |
| **N (Observations)** | 105 |
| **R-sq (within)** | 0.6711 |

## 6. Robustness Checks

In this section, I examine the robustness of firm adjustment speeds by analyzing differences between importers and exporters, the impact of the COVID-19 pandemic, and alternative leverage measures, explicitly utilizing the book leverage ratio.

### 6.1. Sample Split Between Importers and Exporters

The decline in oil prices observed between 2014 and 2016 resulted in a pronounced division among European economies, categorizing them into winners and losers. The Eurozone, which exhibits a substantial dependence on external energy supplies, importing approximately 88% of its oil (Financial Times, 2014), experienced an economic impact due to this reduction in oil prices. The decrease led to lower consumer transportation and energy costs, increasing household incomes. This financial relief enabled families to either allocate their savings towards other goods and services or to bolster their savings, thereby exerting a slight stimulative effect on the economies of oil-importing nations. Central to the ramifications of declining oil prices is the substantial redistribution of wealth, favoring oil-importing countries (consumers) at the expense of oil-exporting nations (producers). For firms classified as net oil importers, the decrease in oil prices resulted in diminished energy and transportation expenditures, enhancing profitability and operational cash flow. Conversely, firms reliant on oil exports faced considerable challenges from reduced revenue streams. This sample thesis examines two oil-exporting countries[5](Norway and Russia). The differing effects of the decline in oil prices from 2014 to 2016 illustrate a scenario where oil importers generally reaped benefits while exporters encountered significant adverse outcomes. Furthermore, the impact of the shock on SOA's oil and gas firms may vary significantly between these two categories. To address potential biases and enhance the robustness of the analysis, I will delineate these categories[6] within my sample as part of the methodological rigors.

**Table 4 – Mean leverage across importers and exporters**

Columns 1 and 2 present the mean market leverage ratio from 2010 to 2020 for oil-importing and oil-exporting nations, respectively. The last rows of each column provide the mean for the market debt ratio across these two subsamples.

| | (1) | | (2) |
|---|---|---|---|
| | **Importers** | | **Exporters** |
| **Country** | **Lev** | **Country** | **Lev** |
| **Austria** | 0.32 | **Norway** | 0.73 |
| **Belgium** | 0.52 | **Russia** | 0.37 |
| **Bulgaria** | 0.50 | **Sample mean** | **0.55** |
| **Finland** | 0.14 | | |
| **France** | 0.39 | | |
| **Greece** | 0.59 | | |
| **Italy** | 0.56 | | |
| **Luxemburg** | 0.34 | | |
| **Netherlands** | 0.38 | | |
| **Poland** | 0.32 | | |
| **Republica of Serbia** | 0.36 | | |
| **Romania** | 0.04 | | |
| **Slovenia** | 0.27 | | |
| **Spain** | 0.52 | | |
| **Switzerland** | 0.82 | | |
| **United Kingdom** | 0.44 | | |
| **Sample mean** | **0.41** | | |

5 Despite its domestic oil extraction activities in the North Sea, I characterized the United Kingdom as an oil-importing nation. Aberdeen, Scotland, is particularly significant for deep-sea oil extraction. However, the UK as a whole is traditionally viewed as an oil-importing nation.

6 Table 4 classifies the countries of the firms in this study as either importers or exporters.

Table 5 presents the regression results corresponding to Equation 6 for two subsamples: oil importers and exporters. The SOA is recorded at 65.06% for the oil importer subsample, in contrast to 89.98% for the oil exporter subsample. This variation yields an estimated half-life of leverage deviation of 0.66 years for oil importers and 0.30 years for oil exporters. The findings presented herein correspond with the proposition by Fischer, Heinkel, and Zechner (1989), which asserts that the adjustment rate is likely to be slower for smaller firms, attributable to their relatively higher transaction costs. This notion gains further validity in the context of oil-exporting firms, which are generally larger in scale compared to their oil-importing counterparts.

Within the oil importer sample, the coefficient associated with the interaction term, comprising the oil price plunge dummy, the lagged growth rate of oil spot prices, and the lagged leverage ratio, achieved statistical significance at the 1% level. This coefficient's positive[7] nature indicates that during declining oil prices, oil-importing nations exhibit a slower adjustment towards their target leverage ratios. Such an effect aligns with the expectations articulated in Section 5.2.1, wherein the interaction term's impact aligns with the broader sample trends, predominantly of oil-importing countries[8]. As previously indicated, importers stand to benefit from decreasing oil prices. A reduction in fuel costs generally leads to an increase in household disposable income, which, in turn, stimulates overall consumption levels. Additionally, lower fuel expenses result in decreased costs associated with industrial production and the transportation of goods, fostering broader economic benefits. European Central Bank (ECB) President Mario Draghi underscored the paradoxical consequences of decreasing oil prices within the context of the Eurozone[9]. The slowdown in SOA during the decline in oil prices from 2014 to 2016 can be primarily attributed to the distinctive macroeconomic and market conditions that prevailed in the Eurozone during this timeframe. Significantly, inflation rates within the Eurozone persisted well below the ECB's established target, and the reduction in oil

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7 The positive interaction between the oil price plunge dummy, the lagged growth rate of oil spot prices and the lagged leverage ratio slowed the adjustment speed. This interpretation emerges from the fact that the coefficient associated with the lagged debt ratio is expressed as (1- $\lambda$), where $\lambda$ represents the speed of adjustment (SOA).

8 Approximately 73% of the firms in the sample are classified as oil-importing nations.

9 All oil-importing nations are members of the European Union, with the exceptions of the Republic of Serbia and Switzerland. The United Kingdom ended its membership on January 31, 2020, having been a member during the oil plunge between 2014 and 2016.

prices triggered a deflationary environment.[10] (Eni Spa, 2015). Firms anticipating further price declines often defer investment decisions to secure more favorable terms later in the year. This prudent strategy is especially evident within the oil and gas industry, where capital expenditures frequently depend on significant debt financing. As a result, the inclination to delay investments likely caused firms to temporarily stray from their optimal leverage targets, thereby exacerbating the slowdown in the speed of adjustment.

In light of the prevailing deflationary pressures, the ECB implemented a markedly accommodative monetary policy, exemplified by initiating the comprehensive Quantitative Easing (QE) program on January 22, 2015. This program involved the systematic acquisition of sovereign bonds alongside ongoing private-sector asset purchase initiatives to mitigate the risks associated with an extended period of subdued inflation (European Central Bank, ECB, 2015). The QE measures continued until the end of 2016, suggesting that the ramifications of this monetary policy are expected to unfold primarily in the post-2016 period. By examining these dynamics, it is evident that while falling oil prices can offer immediate benefits such as increased household income and improved industrial efficiency, the overall economic context and companies' expectations regarding future price movements are crucial in shaping their investment behaviors. This, in turn, affects the adjustments made toward achieving target levels. Conversely, within the sample of oil-exporting firms, the interaction term coefficients failed to achieve statistical significance. This suggests a lack of conclusive evidence to affirm that the plunge in oil prices between 2014 and 2016 significantly influenced the speed of adjustment. The inclusive impact of the oil plunge on SOA oil-exporting firms may be attributable to the varying magnitudes of this effect in Norway and Russia. Norway is positioned favorably among oil-exporting nations, mainly due to its substantial sovereign wealth fund, which enables the country to mitigate the effects of prolonged downturns in oil prices. This fund allows Norway to finance any deficits and rebalance its balance sheets from such economic challenges. Furthermore, Fitch Ratings has indicated that the Norwegian oil industry will be able to remain competitive only if prices do not drop below $40 per barrel. (Financial Times, 2014; Eni Spa, 2015.)

In contrast, Russia's situation presents a different narrative, as the country's economy is heavily reliant on oil and gas exports. The decline in oil prices exacerbates an already precarious

10 According to data from the European Commission, inflation rates between 2014 and 2016 fluctuated considerably, ranging from 0.3% to 0.8%. Notably, the lowest recorded rate occurred in January 2015, when inflation fell to -0.6%.

economic context, further strained by sanctions imposed due to the Ukrainian conflict in 2014. Stress tests conducted by Fitch Ratings have revealed that Russia's current fiscal break-even price stands at approximately $105 per barrel, placing the economy in a substantially vulnerable position relative to Norway (Financial Times, 2014).

**Table 5 – Regression Results for Oil-Importing and Oil-Exporting Nations**

Table 5 presents the findings from a partial adjustment model employing OLS regression augmented by fixed effects. The primary objective of this model is to estimate the SOA concerning various lagged variables, which encompass the market leverage ratio ($Lev_{i,t}$), firm-specific characteristics ($X_{i,t}$), and determinants related to oil variables ($Oil_{i,t}$) and macroeconomic variables ($Macro_{i,t}$). Additionally, an oil plunge dummy variable (Oil_Plunge_DUM) is incorporated, which assumes a value of one for years classified as plunge years (specifically between 2014 and 2016) and zero otherwise. To further explore the dynamics of this phenomenon, an interaction term is introduced that multiplies the oil plunge dummy variable (Oil_Plunge_DUM) by both the lagged growth rate of the oil spot price (GROSP$i,\ t$) and the lagged market leverage ratio ($Lev_{i,t}$). This interaction term aims to evaluate the impact of declining oil prices on the speed of adjustment during the specified oil plunge period from 2014 to 2016 (refer to equation (6)). Column (1) presents the findings for oil-importing nations, while column (2) delineates the results for oil-exporting nations. The calculation of SOA is derived by subtracting the coefficient lagged market leverage ratio from one. The significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels of significance, respectively, with robust standard errors provided in parentheses beneath the coefficients.

| | **(1)** | **(2)** |
|---|---|---|
| | **Importers** | **Exporters** |
| **SOA** | **65.06%** | **89.98%** |
| **Half-life (years)** | **0.66** | **0.30** |
| **Lev** | 0.3494* | 0.1002 |
| | (0.1899) | (0.3590) |
| **EBIT_TA** | 0.0652 | 0.2149 |
| | (0.1014) | (0.3267) |
| **MB** | -0.0465 | 0.1156 |
| | (0.0494) | (0.3027) |
| **DEP_TA** | -0.7911** | -4.7460 |
| | (0.3511) | (12.6078) |
| **LnTA** | 0.0851 | -0.0689 |
| | (0.0674) | (0.5279) |
| **FA_TA** | 0.0197 | 0.8878 |
| | (0.0353) | (0.9233) |
| **RD_TA** | 2.8739* | 6.9470 |
| | (1.5827) | (20.0769) |
| **RD_DUM** | 0.0000 | 0.0000 |

| | | |
|---|---|---|
| | (.) | (.) |
| **Ind_median** | -0.1476 | 0.7320 |
| | (0.1900) | (2.3459) |
| **GROSP** | -0.0002 | 0.0000 |
| | (0.0002) | (0.0048) |
| **Oil_DUM** | -0.0261 | -0.0197 |
| | (0.0151) | (0.3098) |
| **GDP_Growth** | -0.0018 | 0.0005 |
| | (0.0016) | (0.0718) |
| **Inflation_Rate** | 0.0010 | -0.0074 |
| | (0.0032) | (0.0179) |
| **Oil_Plunge_DUM** | 0.0356** | -0.0018 |
| | (0.0127) | (0.2065) |
| **Oil_Plunge_DUM*GROSP*Lev** | 0.0017*** | -0.0006 |
| | (0.0005) | (0.0163) |
| **Constant** | -1.5665 | 1.6117 |
| | (1.4836) | (12.9068) |
| **FE** | Yes | Yes |
| **N (Observations)** | 86 | 19 |
| **R-sq (within)** | 0.7018 | 0.9753 |

## 6.2. The Impact of the Initial Year of COVID-19

This study's sample period includes the first year impacted by the COVID-19 pandemic, which could significantly affect the dynamics of capital structure within the oil and gas industry.

This section aims to determine whether oil and gas firms adjust their capital structures more rapidly or gradually during the initial year of the COVID-19 pandemic. A dummy variable (COVID_DUM) is incorporated into the sample regression model (equation 5). In this model, observations from 2020 are assigned a value of one, while all other years are attributed a value of zero. Furthermore, an interaction term between the COVID-19 dummy variable, the lagged growth rate of the oil spot price, and the lagged debt ratio is introduced to understand better the pandemic's impact on these firms' SOAs. An analysis of the results presented in Table 6 reveals that the coefficient for the interaction term lacks statistical significance. This finding suggests that there is insufficient evidence to support the hypothesis that the initial year of the COVID-19 pandemic significantly affects the rate of capital structure adjustments among oil and gas firms in these sample studies.

The COVID-19 pandemic led to a significant decline in oil prices, from \$64.30 per barrel in 2019 to \$41.96 per barrel in 2020. This decline is anticipated to have substantial implications for the debt financing of oil and gas companies. However, the lack of statistical significance associated with the interaction term indicates that the effects of this drastic price reduction are delayed. These effects will likely become more apparent in the following year, 2021. In this context, the observed SOA associated with the interaction term linked to COVID-19 (41.89%) surpasses the SOA observed during the oil price plunge of 201432016 (36.91%). This discrepancy is attributed to the fact that, following the earlier decline in oil prices, the oil and gas industry enters a phase of recovery during which business operations stabilize. In contrast, the repercussions of the COVID-19 crisis are anticipated to have more impact in 2021.

**Table 6 – Results of the Regression Analysis for the First Year of COVID-19**

Table 6 presents the findings from a partial adjustment model employing OLS regression augmented by fixed effects. The primary objective of this model is to estimate the SOA concerning various lagged variables, which encompass the market leverage ratio ($Lev_{i,t}$), firm-specific characteristics ($X_{i,t}$), and determinants related to oil variables ($Oil_{i,t}$). and macroeconomic variables ($Macro_{i,t}$). Additionally, a COVID-19 dummy variable (COVID_DUM) is incorporated, which assumes a value of one for the initial years of COVID-19 years (2020) and zero otherwise. To further explore the dynamics of this phenomenon, an interaction term is introduced that multiplies the COVID-19 dummy variable (COVID_DUM) by both the lagged growth rate of the oil spot price (GROSP$i,\ t$ )and the lagged market leverage ratio ($Lev_{i,t}$). This interaction term aims to evaluate the impact of the initial year of COVID-19 on the speed of adjustment. The significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels of significance, respectively, with robust standard errors provided in parentheses beneath the coefficients.

| **SOA** | **41.89%** |
|---|---|
| **Half-life(years)** | **1.28** |
| **Lev** | 0.5811*** |
| | (0.1904) |
| **EBIT_TA** | 0.1573 |
| | (0.1056) |
| **MB** | 0.0251 |
| | (0.0303) |
| **DEP_TA** | -0.4134 |
| | (0.4502) |
| **LnTA** | 0.0504 |
| | (0.0718) |
| **FA_TA** | -0.0144 |
| | (0.0419) |
| **RD_TA** | 2.3210 |
| | (1.8731) |
| **RD_DUM** | 0.0000 |
| | (.) |
| **Ind_median** | 0.0398 |

| | |
|---|---|
| | (0.1775) |
| **GROSP** | -0.0001 |
| | (0.0002) |
| **Oil_DUM** | -0.0004 |
| | (0.0113) |
| **GDP_Growth** | -0.0011 |
| | (0.0017) |
| **Inflation_Rate** | -0.0040 |
| | (0.0027) |
| **Covid_DUM** | 0.0307 |
| | (0.0262) |
| **Covid_DUM*GROSP*Lev** | 0.0048 |
| | (0.0043) |
| **Constant** | -1.0025 |
| | (1.5749) |
| **FE** | Yes |
| **N (Observations)** | 105 |
| **R-sq (within)** | 0.6299 |

## 6.3 Book Leverage Ratio

As previously mentioned in Section 3.1, considering the ongoing discourse concerning the optimal leverage ratios within capital structures, I examine the robustness of my findings against a different definition of leverage ratio. To this end, I utilize the book leverage ratio frequently employed in academic literature and re-estimate the partial adjustment model. According to Baker and Wurgler (2002), the book leverage ratio is defined as follows:

$BLev\ i,t\ = \frac{SDi,t+\ LDi,t}{TAi,t};$

where the expression SDi,t + LDi,t illustrates the aggregate book value of interest-bearing debt, encompassing both short-term (SD) and long-term (LD) liabilities associated with the firm i at time t. Additionally, TAi,t designates the book value of total assets held by firm i at the same point in time (t).

Table 7 shows the results from the partial adjustment model, which are based on the OLS regression using the book leverage ratio. The SOA is reported at 61.49% for the whole sample, significantly higher than the 36.91% noted when the market leverage ratio is used. These results contradict my expectations outlined in section 3.1, as prior analyses suggested a general comparability between the results obtained using both market and book leverage ratios. These findings align more closely with the research conducted by Yin and Ritter (2019). They discovered that the SOA is higher for book leverage than market leverage, particularly when proper adjustments are made. Their analysis suggests that existing estimates of market SOA may be significantly overstated due to passive influences from fluctuations in stock prices. When accounting for this bias, their SOA estimates are 16% for book leverage and 10% for market leverage.

In addition to the accelerated adjustment toward the target level, the interaction term (Oil_Plunge_DUM*GROSP*Lev) does not exhibit statistical significance when employing book market values. An analysis of the Swiss bank UBS on historical oil shocks reveals that during the oil supply shocks of 1986 and 1990, a 10 per cent decline in oil prices was associated with a 2 per cent increase in earnings for quoted European companies (Eni SpA, 2015). Historical occurrences highlight that when oil prices decline, the stock prices of many European firms especially importers, often rise due to reduced output costs and improved profitability. This increase in earnings consequently boosts stock valuations, particularly for oil-importing companies. This observed dynamic can explain the significance of the interaction term about market leverage, as opposed to book leverage. Specifically, for market leverage, the plunge in oil prices exacerbated stock price volatility for oil and gas companies. Market anticipations regarding future profitability and operational performance, especially in the context of heightened volatility in oil prices, markedly shape these firms' valuations. Consequently, fluctuations in stock prices create bias in the estimates of the SOA for market leverage ratios. Market values reflect short-term economic advantages for oil importers, even in a volatile market environment. Conversely, book leverage is based on stable, accounting-derived metrics that remain primarily unaffected by stock price volatility or fluctuations in investor sentiment. Therefore, the decline in oil price impact on book leverage measures is minimal, leading to an insignificant interaction term.

**Table 7 – Regression Results with Book Leverage Ratio**

Table 7 presents the findings from a partial adjustment model employing OLS regression augmented by fixed effects. The primary objective of this model is to estimate the SOA concerning various lagged variables, which encompass the book leverage ratio ($BLev_{i,t}$), firm-specific characteristics ($X_{i,t}$), and determinants related to oil variables ($Oil_{i,t}$) and macroeconomic variables ($Macro_{i,t}$). Additionally, an oil plunge dummy variable (Oil_Plunge_DUM) is incorporated, which assumes a value of one for years classified as plunge years (specifically between 2014 and 2016) and zero otherwise. To further explore the dynamics of this phenomenon, an interaction term is introduced that multiplies the oil plunge dummy variable (Oil_Plunge_DUM) by both the lagged growth rate of the oil spot price (GROSP$i,\ t$) and the lagged book leverage ratio ($BLev_{i,t}$). This interaction term aims to evaluate the impact of declining oil prices on the speed of adjustment during the specified oil plunge period from 2014 to 2016 (refer to equation (6)). The calculation of SOA is derived by subtracting the coefficient lagged market leverage ratio from one. The significance levels are denoted by ***, **, and * for 1%, 5%, and 10% levels of significance, respectively, with robust standard errors provided in parentheses beneath the coefficients.

| | |
|---|---|
| **SOA** | **61.49%** |
| **Half-life(years)** | **0.73** |
| **BLev** | 0.3851*** |
| | (0.1014) |
| **EBIT_TA** | 0.1768 |
| | (0.1171) |
| **MB** | -0.1363 |
| | (0.0929) |
| **DEP_TA** | -0.6853 |
| | (0.4991) |
| **LnTA** | 0.0874* |
| | (0.0470) |
| **FA_TA** | -0.0018 |
| | (0.0409) |
| **RD_TA** | 1.8842 |
| | (1.7743) |
| **RD_DUM** | 0.0000 |
| | (.) |
| **Ind_median** | 0.1239 |
| | (0.2050) |
| **Grosp** | 0.0001 |
| | (0.0002) |
| **Oil_DUM** | -0.0298** |
| | (0.0131) |
| **GDP_Growth** | -0.0023 |
| | (0.0014) |
| **Inflation_Rate** | -0.0043** |
| | (0.0015) |
| **Oil_Plunge_DUM** | 0.0368*** |
| | (0.0116) |
| **Oil_Plunge_DUM*GROSP*BLev** | 0.0017 |
| | (0.0012) |
| **Constant** | -1.6152 |
| | (1.0774) |
| **FE** | Yes |
| **N (Observations)** | 105 |
| **R-sq (within)** | 0.6435 |

## 7 - Limitations and Further Research

This empirical study presents some limitations that warrant consideration in future investigations.

One notable limitation is the sample size, which is inherently linked to the focus on European firms. Specifically, the study concentrates on two European exporters, Russia and Norway, who experienced significant adverse effects of the oil price plunge. This narrow scope limits the generalizability of the findings. Future research could greatly benefit from expanding the sample to include firms from a global context, particularly integrating OPEC member countries, which play a pivotal role in the oil industry

Additionally, while the partial-adjustment models developed in this thesis are dynamic, I implicitly assume that the capital structure decisions made in each period directly result from comparing actual leverage to target leverage. The regression results predominantly rely on linear predictions. Future research could explore integrating a more comprehensive partial-adjustment model of leverage alongside a two-stage estimation approach. This would provide insights into the varying speeds at which firms adjust towards their target leverage, enhancing our understanding of capital structure dynamics.

Moreover, this study's analysis utilizes OLS regression with firm fixed effects. Future research should examine the robustness of these findings through alternative estimation techniques. Exploring different methodologies could yield richer insights and substantiate the conclusions drawn from the initial analysis.

## 8 - Conclusion

The inaugural study addressing capital structure within energy firms was conducted by Narayan and Nasiri in 2020. A pressing need exists for further exploration into the dynamics of capital structure adjustments specific to the oil and gas industry. Notably, while some research, such as that conducted by Wang (2021) and other scholars, begins to enhance the understanding of the implications stemming from the oil price decline experienced between 2014 and 2016, a significant gap remains in the literature regarding the impact of this oil crash on firms' speed of adjustment towards their target capital structures. In response to this gap, the present study investigates the effects of the oil price plunge between 2014 and 2016 on the SOA among

European oil and gas firms. Moreover, it aims to elucidate how these oil shocks, which occurred within the second decade of the 21st century, disrupt the dynamics of capital structure adjustments within this industry.

I obtain several significant findings from analyzing publicly listed European oil and gas firms from 2010 to 2020. Initially, I developed a partial adjustment model to estimate the SOA based on an array of firm-specific characteristics, oil and macroeconomic variables. Drawing upon the foundational work of Dang et al. (2014), I incorporate a dummy variable designated as Oil_Plunge_DUM into the partial adjustment model. This variable is assigned a value of one for years, classified as plunge years, specifically from 2014 to 2016, and zero otherwise. Additionally, I introduce an interaction term that multiplies the oil plunge dummy variable by both the lagged growth rate of the oil spot price and the lagged market leverage ratio. This methodology allows for a more detailed examination of how the oil price plunge from 2014 to 2016 on firm impacted SOA, focusing on how sensitive SOA is within this specific context. The analysis shows a documented SOA of 36.91% for the entire sample, and I find evidence of the negative impact of the oil price plunge from 2014 to 2016 on the SOA.

Subsequently, recognizing that approximately 73% of the firms in my sample are from oil-importing nations and acknowledging the disparate repercussions of the oil plunge on oil-importing versus oil-exporting nations, I seek to enhance the robustness of my partial adjustment findings by segregating my dataset into oil importers and exporters. The results provide statistical evidence that the plunge in oil prices from 2014 to 2016 negatively impacted SOA for oil-importing nations. In contrast, I find no significant evidence to support the hypothesis that the decline in oil prices from 2014 to 2016 significantly influences the SOA for oil exporters.

Considering that my sample period encompasses the initial year of the COVID-19 pandemic (2020), I extend my research to develop a modified partial adjustment model that includes a COVID dummy variable as well as an interaction term similar to the approach used to assess the impact of the oil plunge. However, the investigation focusing on the first year of the COVID-19 pandemic reveals insufficient evidence to endorse the hypothesis that the onset of COVID-19 significantly affects the rate of capital structure adjustments among the sampled oil and gas firms. I attribute this lack of significance to the context of post-oil plunge recovery within the industry, which leads to stabilized business operations and suggests that the more pronounced effects of the COVID-19 crisis are likely to materialize in subsequent years, particularly in 2021. Finally, as share price fluctuations can have a short-term impact on market leverage ratios, as noted by Flannery and Rangan (2006), I further examine the robustness of my findings by using the book leverage ratio as an alternative measure. This analysis indicated that using book leverage ratios substantially increased the SOA from 36.91%, when calculated with market leverage ratios, to 61.49%. Additionally, I find no evidence to imply that the oil price plunge impacts the overall SOA of the sample when using book leverage ratios.

Further research should examine the impact of oil shocks on the asymmetries observed in firms' responses as they move towards their target leverage.

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