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Econometric analysis of the share premium evolution of Oil and Natural Gas Corporation Limited

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Oil and natural gas in India; Multinational company; Financial analysis; Extended CAPM model; Fama-French three factor model

Abstract: This paper aims to perform a statistical and econometric analysis of the premium evolution of Oil and Natural Gas Corporation Ltd (ONGC). The expected return of ONGC will be shown to be slightly below the market return of NIFTY 50, depicting how ONGC's performance is significantly correlated with and influenced by the overall market. A financial and descriptive analysis will be performed and the CAPM model will be applied, where residuals will be analysed (showing no serial correlation or heteroskedasticity problems), followed by an intervention analysis. Structural changes and exogenous variables (global oil prices and competitors) will be studied alongside the Fama-French Three-Factor model, reaching the final version of our CAPM model. The reader will be encouraged to consider investing in ONGC over other NIFTY 50 companies.

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PALABRAS CLAVE:

Petróleo y gas natural en India; Empresa multinacional; Análisis financiero; Modelo CAPM ampliado; Modelo de tres factores de Fama-French

Resumen: Este artículo pretende realizar un análisis estadístico y econométrico de la evolución de las primas de Oil and Natural Gas Corporation Ltd (ONGC). Se demostrará que la rentabilidad esperada de ONGC es ligeramente inferior a la rentabilidad de mercado del NIFTY 50, lo que muestra cómo el rendimiento de ONGC está significativamente correlacionado con el mercado general e influido por éste. Se realizará un análisis financiero y descriptivo y se aplicará el modelo CAPM, en el que se analizarán los residuos (que no mostrarán problemas de correlación serial ni de heteroscedasticidad), seguido de un análisis de intervención. Se estudiarán los cambios estructurales y las variables exógenas (precios mundiales del petróleo y competidores) junto con el modelo de tres factores de Fama-French, hasta llegar a la versión final de nuestro modelo CAPM. Se animará al lector a considerar la posibilidad de invertir en ONGC frente a otras empresas del NIFTY 50

I would like to express my deepest gratitude to the person responsible for awakening in me an interest in econometrics, Mercedes Gracia Díez, whom I ask to never change and to continue to enlighten with her passion for teaching.

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1. Introduction and project objectives

This paper aims to conduct a comprehensive statistical and econometric analysis of the premium evolution of Oil and Natural Gas Corporation Ltd (ONGC), the largest state-owned entity engaged in the exploration and production of oil and gas within India. The company was chosen based on its status as a listed company and the availability of historical data spanning over a twenty-two-year period, allowing for a substantial sample to be analysed. The primary objective is to apply economic theory, business economics, statistics, and econometrics to the stock data of ONGC and NIFTY 50, India's market index introduced by the National Stock Exchange.

In the contemporary landscape of corporate governance and financial analysis, an in-depth comprehension of a company's performance trajectory is paramount for stakeholders, investors, and researchers alike. This article endeavours to examine the hierarchical structure, historical evolution, and recent events of ONGC, also providing insights into the potential future of the most prominent entity within the country's energy sector.

Furthermore, a descriptive analysis of ONGC will be conducted. This analytical framework will serve as a foundation for the subsequent application of the Capital Asset Pricing Model (CAPM), enabling a systematic assessment of the company's risk-return profile. The Ordinary Least Squares estimation model will be applied, with a posterior analysis of its residuals.

An intervention analysis will be performed, and, subsequently potential relevant structural changes to our CAPM model will be investigated and tested. We also analysed other variables that may contribute to explaining the company's performance, such as the price of oil and competitors. The following section will introduce the three-factor Fama-French model to explain the functioning of our CAPM model further.

All in all, this study promises to deliver valuable insights into the Indian stock market and provide stakeholders with data-driven investment recommendations.

2. Oil and Natural Gas Corporation Limited (ONGC)

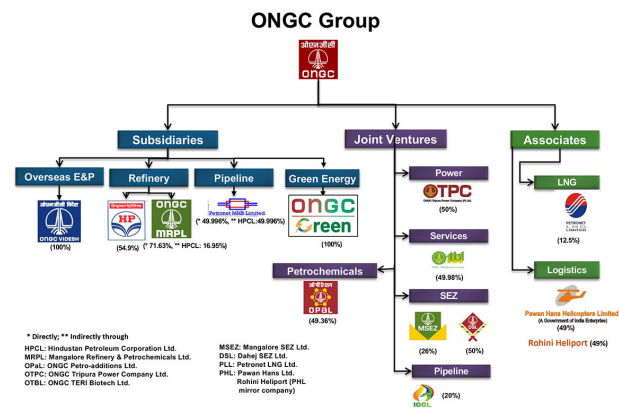
2.1. Company overview

Oil and Natural Gas Corporation Limited is a government-owned global energy holding company operating in both the crude oil and natural gas sectors. ONGC's main activities are the exploration, development and production of oil & gas and related oil-field services, with more than 27,000 committed industry professionals as part of their workforce, accounting for over 70% of India's production of crude oil (ONGC, 2024). Its methodical and comprehensive approach will undoubtedly be crucial in turning Maharatna into India's

energy backbone (*Financial Times*, 2024). Forbes' most recent Global 2000 list has ranked ONGC as the fifth-highest Indian company and 226th in the world (*Forbes*, 2023).

ONGC is the parent company of a group that is formed by four subsidiaries, amongst which we find ONGC Videsh, serving as India's second-largest petroleum corporation (ONGC, 2024). In refinery, we find Mangalore Refinery and Petrochemicals Limited (MRPL). This is a Central Public Sector Enterprise, also falling under the purview of the Ministry of Petroleum & Natural Gas. MRPL and ONGC own and operate ONGC Mangalore Petrochemicals Limited (OMPL), a petrochemical unit involved in Benzene production. In the pipeline industry, ONGC's subsidiary Hindustan Petroleum Corporation Limited (HPLC) dominates with an increasing 3370 km network, becoming the second largest share of product pipelines in India (ONGC, 2024).

Image 1: ONGC's organigram including Subsidiaries, Joint Ventures and Associates



Source: <https://ongcindia.com/es/web/eng/about-ongc/ongc-group-of-companies>

In 2023, ONGC conquered the International Asian Oil and Gas Award, for their excellent 'Offshore Initiative of the Year-India'. In order to alleviate bottlenecks in the FPSO system—a floating production storage and offloading unit—a cutting-edge strategy was used to enhance the surface facility of unmanned wellhead platforms to address the issues presented by growing output from offshore fields (*Asian Power*, 2024).

Furthermore, in the spirit of India Energy Week 2024, ONGC and Total Energies inked a cooperation agreement to use the latter's ground-breaking AUSEA technology to conduct campaigns for the detection and measurement of methane emissions¹ (ONGC, 2024).

¹ One-of-a-kind technology by TotalEnergies, the AUSEA (Airborne Ultralight Spectrometer for Environmental Applications) gas analyser is mounted on a drone, and was developed by TotalEnergies and its R&D partners. Consisting of a dual sensor capable of detecting methane and carbon dioxide emissions, AUSEA identifies their source at the same time. This technology marks a step change

in methane emissions detection and measurement compared to traditional techniques. By allowing access to hard-to-reach emission points, on all types of industrial facilities, both offshore and onshore, AUSEA is reputed as one of the most accurate technologies in the industry.

Image 2: AUSEA gas analyser mounted on a drone, developed by TotalEnergies and its R&D partners



Source: <https://www.futurenetzero.com/2021/03/22/total-disrupting-carbon-emissions-8/>

2.2. Future initiatives

ONGC is in the race for the extraction of gas from gas hydrate, the *rara avis* of fossil fuels. Hydrates naturally occur in permafrost and marine sediments, facilitated by ideal conditions of low temperature and low pressure.

With pioneer research and technology, gas hydrate could become India's national energy treasure. Mainly relying on this avant-garde alternative could result in the country's energetic autonomy. The secret lies in the exponentially promising energetic potential behind these deposits and the practical solution offered to the challenge of natural gas storage.

In the deep waters off the Andhra Pradesh coast, ONGC has found gas hydrate reserves. The Krishna-Godavari basin (where these reserves are located) attracted a lot of attention about 10 years ago. The newly discovered deposits are thought to contain over 134 trillion cubic feet, comparably

what is currently close to a third of the United States' gas reserves.

The burning question behind this energy form lies in the technology required for the extraction. Despite ONGC's discoveries, the true value is found in science. For this reason, a Gas Hydrate Research & Technology Centre (GHRTC) was founded in 2016. In the past two years, GHRTC has been carrying out projects involving the evaluation and assessment of geo-scientific data, mapping and prediction of gas hydrate formation, and most importantly, the remodelling of technology to achieve the goal of extraction ere long (Durcansky, 2020).

2.3. Financial analysis

In order to correctly analyse the evolution of ONGC's return, we will concentrate on the consolidated statements of the last two fiscal years available.

The financial statements used to analyse ONGC have been prepared considering all the Indian Accounting Standards promulgated under section 133 of the Companies Act, 2013, and officially communicated by the Ministry of Corporate Affairs (MCA) under the Companies (Indian Accounting Standards) Rules, 2015, as revised, until the approval of the financial statements. It is important to note that annual accounts are from the 31st of March of the previous year to the 31st of March of the current year.

We will begin this breakdown by inspecting the company's balance sheet.

As shown in Table 1, ONGC's assets are majorly non-current. The primary accounts include property, plant and equipment consisting of the machinery used to carry out their activities, the oil and gas extracted, and also their rights of use. Oil and gas facilities are also in progress (Capital work-in-progress) and exploratory wells (intangible assets under development).

Table 1: Simplified Balance Sheet Comparison of ONGC for years 2022 and 2023

Particulars	As at March 31, 2023 (₹ in Million)	As at March 31, 2022 (₹ in Million)	Change (%)
Non-current assets	5,003,781.95	4,794,006.20	4,38%
Current Assets	1,140,967.05	1,059,258.20	7,71%
Non-current liabilities	1,810,035.10	1,746,972.02	3,61%
Current liabilities	1,322,701.81	1,273,652.43	3,85%
Equity	3,012,550.35	2,833,278.43	6,33%

Source: Self-crafted based on ONGC's consolidated financial statements

Within their financial assets, we find a substantial increase in their 'Joint Ventures and Associates' investment (an increase close to 170,000 ₹ in Million). This variation is the cause behind the increase in non-current assets from 2022 to 2023. 'An associate is an entity over which the Group has significant influence' as defined in the Company's Statements. This refers to the capacity of influence over financial and operational policy decision-making.

ONGC's investment practice involves a firm commitment towards expansion. For instance, the most recent joint venture agreement (7th of February, 2024) has been with NTPC Green Energy Limited to foster offshore wind energy initiatives, both domestically in India and across international borders (*Offshore Wind*, 2024).

Over a third of their current assets are dedicated to inventories. This account is divided into Raw Materials and Stock in Process, Finished and semi-finished goods, and Store &

Spares. However, the positive percentage change in current assets should be attributed to financial assets, specifically the 'Other bank balances account' (showing an increase of about 250,000 ₹ in Million). ONGC made a substantial bank deposit for an original maturity of more than three months, up to twelve months. Moreover, half of non-current liabilities are composed of borrowings.

Solvency represents the firm's ability to pay its long-term debts and other financial obligations. This is achieved when Equity is above zero and, equally, when assets are more than liabilities. In 2023, ONGC's total assets were 6,145,287.26 (₹ in Million), compared to total liabilities of

3,132,736.91 (₹ in Million). Hence, ONGC is in long-term equilibrium.

Table 2 shows ONGC's ratios for years 2021 to 2022 and 2022 to 2023. The Debt-Equity and Debt coverage ratios ratify ONGC's solvency. The global industry average debt-to-equity ratio as of 2023 is approximately 0.5, indicating a moderate degree of financial leverage, whereas ONGC's ratio is at 0.03, showing much lower need for debt to finance its activities. Also, the increase in the debt coverage ratio is primarily because of an increase in earnings before interest and taxes brought on by higher operating revenue (Oak Business Consultant, 2023).

Table 1: Summary of ONGC's ratios for years 2021-2022 and 2022-2023

Particulars	2022-2023	2021-2022	Change (%)
Current ratio	1.29	0.98	31.63%
Debt-Equity ratio	0.03	0.03	-
Debt coverage ratio	194.88	142.18	37.07%
Return on Equity	0.16	0.18	(11.11)%
Inventory Turnover ratio	19.22	13.51	42.26%

Source: Self-crafted based on ONGC's consolidated financial statements

The current ratio showcases how ONGC is in a short-term equilibrium since current assets are superior to current liabilities. A substantial increase in ONGC's bank deposits explains the increase in this ratio, causing a positive variation due to its current assets (investment) account.

Return on equity shows that ONGC made 16% profit for each Indian Rupee of shareholder equity (2023 Consolidated Statement). Profit for the year 2023 of ONGC was 327,776.05 (₹ in Million), and of 492,940.57 (₹ in Million) in 2022. The average global industry ratio for Return on Equity was of 26% for that same year. This ratio dropped by 11.11%, from the 2022 to the 2023 accounts caused by a major decrease in profits, while equity remained relatively similar. The latest reported quarter, ending in December of 2023 has shown another 10% reduction in revenues with respect to last year's numbers (*The Economic Times*, 2024). The reason behind the fall has been a cut in the company's crude production (due to closing platforms in Panna-Mukta followed by the installation of new pipelines, and production discontinuance as a consequence of Cyclone Biparjoy in June 2023). Nevertheless, ONGC is planning to adjust and recover the losses (*Live mint*, 2024).

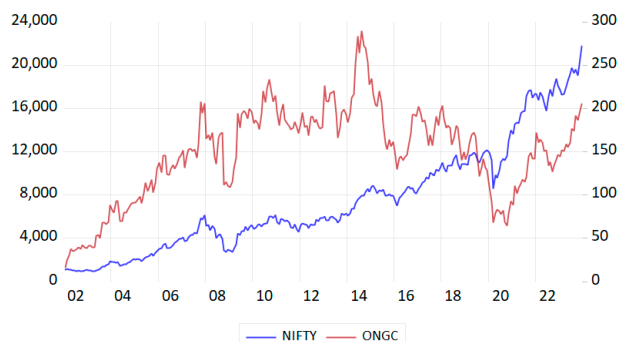
Finally, ONGC's inventory turnover ratio was of 19.22 from 2022 to 2023. This means the company's capacity to generate revenues is very high per unit of inventory. As represented in Table 2, there is a sharp increase in this ratio. This primarily stems from a rise in income generated from business activities and a reduction in the mean inventory over the fiscal year compared to the preceding one.

3. Descriptive analysis of data

With the aim to perform the analysis of ONGC's share price evolution, we have used India's market index introduced by the National Stock Exchange. We are referring to NIFTY 50. This benchmark displays the trading activity of the top fifty equities in the country. It includes a total of twelve industries including information technology, financial services, consumer goods, entertainment and media, financial services, metals, pharmaceuticals, telecommunications, cement and its products, automobiles, pesticides and fertilizers, energy, and other services (Groww, 2024).

Graph 1 shows the share price evolution of both ONGC and NIFTY 50 from January 2002 to December 2023, both months inclusive. ONGC's share price evolution is in a constant overall ascension from 2002 until February 2016. August of 2014 was ONGC's peak in number of points reached (290, as shown in Table 3 in the maximum value), making 2014 the company's largest boom, increasing to an outstanding growth of 55% during that year. This all-time high was 141 points above the mean points (149, as shown in Table 3 in the mean value) for the share price evolution of ONGC over the 22 years covered in this study. Market expectations of benefits from higher gas prices and higher net oil prices as a result of probable reductions in subsidies had propelled the recent rapid surge. Finally, the steep growth in the company's share price had been majorly due to the high expectations towards gas prices (*The Economic Times*, 2014).

Graph 1: Share price evolution of NIFTY 50 and ONGC from January 2002 to December 2023 (left-axis corresponding to NIFTY 50, and right-axis corresponding to ONGC)



Source: Self-crafted in EViews using financial data extracted from investing.com

Table 3: Descriptive statistics as indicator of performance of ONGC and NIFTY 50's share price from January 2002 to December 2023

	ONGC	NIFTY
Mean	149.1720	7466.034
Median	155.5000	5890.250
Maximum	290.0000	21731.40
Minimum	16.10000	934.0500
Std. Dev.	53.35043	5051.843
Skewness	-0.341895	0.836565
Kurtosis	2.842552	2.891141
Jarque-Bera	5.415949	30.92336
Probability	0.066672	0.000000
Sum	39381.41	1971033.
Sum Sq. Dev.	748568.5	6.71E+09
Observations	264	264

Source: Descriptive Statistics & Tests Tool in EViews

After 2014, share prices suffered the worst downfall the company had ever seen. This was a 161-point drop, from 290 points to 129 points in early 2016. The reason behind the slump was the global crude crash the industry was undergoing at the time. Crude created a great deal of concern over the earnings of oil and gas exploration corporations in the future (*The Economic Times*, 2014).

For the purpose of taking into account the global pandemic of COVID-19, we will take September 2020 as the minimum statistical value. The public sentiment, which had been subdued following the domestic oil and gas producing major's lackluster December quarter performance, had been further undermined by worries over the reduction in crude demand brought on by the coronavirus outbreak and the subsequent decline in oil prices (*Business Standard*, 2020).

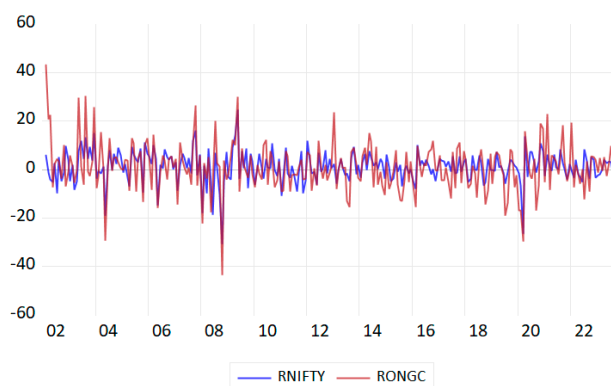
Despite an increase in revenue of 80%, the company experienced a hit which took its points down all the way to 65. Relative to the company's mean value of 149 (as shown in Table 3 in the mean value), we find an 84-point difference.

Regarding the progression of NIFTY 50, the first hindrance found surge was in 2008 (*The Economic Times*, 2009). This coincided with ONGC's pattern since we can also see a drop during that same year. Almost 30% of the index is made up of the financial sector. This explains why market disruptions frequently happen during recessions and economic booms. For instance, the Industrial Production Index (IIP), which measures the general level of industrial growth, fell by more than 10% as a result of the 2008 recession. As explained by a top ONGC official, their cost of production was above their actual price of realization, resulting in revenues loss in the 17.71 billion cubic metres of gas it sold. NIFTY 50 dropped to values of 2700 to 2800, becoming a substantial difference with the mean (7466, as shown in Table 3 in the mean value), amounting to a divergence of almost 4900 points, hence leading to a worrying scenario at the time.

The second obstacle to be tackled was COVID-19. We can once again see a similar pattern followed by ONGC. The Indian equities market was still under pressure on March 23, 2020, as a result of a large sell-off by investors who were concerned that the coronavirus outbreak may seriously harm the country's economy. In an effort to stop the deadly virus from spreading, the government took significant action. These actions included locking down 75 districts nationwide and stopping public transportation services including buses, metro trains, and trains. The Nifty 50 ended 12.7% short. This led to a decrease in NIFTY 50 to 8600 points. However, considering the arithmetic mean takes into account the 22 years analysed, it is expected that a downfall in the later stages of a sustained share price growth could remain above the mean, in this case around 1000 points above the mean (*7Prosper*, 2020).

Subsequently, having analysed the share price evolution of ONGC and NIFTY 50, to estimate the CAPM model, we first need to transform the price series into monthly logarithmic rates of change (returns) and then create the premium series with respect to the risk-free asset. The evolution of both returns is shown in Graph 2.

Graph 2: Logarithmic rate of return for NIFTY 50 and ONGC from January 2002 to December 2023



Source: Self-crafted in EViews using financial data extracted from investing.com

Regarding to volatility of both series, the standard deviation for RONGC is a third larger than RNIFTY's (9.99 and 6.36 respectively, as shown in Table 4). In other words, RONGC is much more volatile than RNIFTY, by the frequency and magnitude of the red-lined peaks. This is an indication that the rate of return in percentage terms of RONGC involves a higher risk than RNIFTY. This is because RONGC is more vulnerable to changes in the environment, for example, rapid changes in the price of oil.

Table 4: Descriptive statistics of ONGC's and NIFTY 50's logarithmic rates of change from January 2002 to December 2023

	RNIFTY	RONGC
Mean	1.142991	0.967466
Median	1.429311	0.988932
Maximum	24.73758	43.24275
Minimum	-30.66649	-43.54394
Std. Dev.	6.360688	9.999368
Skewness	-0.824757	0.125372
Kurtosis	6.915295	5.885300
Jarque-Bera	197.8026	91.91663
Probability	0.000000	0.000000
Sum	300.6066	254.4435
Sum Sq. Dev.	10600.09	26196.69
Observations	263	263

Source: Descriptive Statistics & Tests Tool in EViews

If we compare Graph 1 with Graph 2, we can determine that share price evolution and logarithmic rate of return for ONGC and NIFTY 50 reflect on one another. We must refer once again to the years 2008 and 2020. 2008 was a year to forget for all Indian companies, especially for ONGC, leading to the minimum value (-43.5, as shown by Table 4) during the 22-year period analysed.

Finally, if we examine 2023, as the most recent year we have available data for, we can find share prices for both ONGC and NIFTY 50 are increasing towards 2024. The root of ONGC's rise lies in the government's action towards cutting tax on domestically produced crude oil in line with weakening international oil prices. Lowering this windfall tax raises the company's realizations, which raises profitability. According to "The Times of India", ONGC's gain in trade is actually mainly due to their excellent management in production growth guidance.

In January 2024, ONGC officially started producing oil from its KG-DWN-98/2 Block in the deep waters of the Bay of Bengal (The Economic Times, 2024). Staying with this course of action would in turn result in an increase in overall oil and gas production, eyeing a strong improvement by 11% and 15% respectively. With the goal to successfully conclude the project, ONGC is currently (start of 2024) approaching the end of Phase 2. It has been vital to create a

revolutionary pipe in pipe technology in order to accomplish this. With this strategy, ONGC is demonstrating its support for the 'Make in India' campaign and the country's goal of energy sector self-reliance (The Times of India, 2023).

4. CAPM model

4.1. Explanation of the model

The Capital Asset Pricing Model, more commonly referred to as CAPM, is one of the most widely used tools for estimating the expected rate of return of a financial asset based on market returns. The mathematical formulation of the model is the following:

$$R_A = R_F + \beta(R_M - R_F)$$

where:

- R_A : expected rate of return on assets
- R_F : rate of return on a risk-free asset
- R_M : expected rate of return on the market

The corresponding econometric model is:

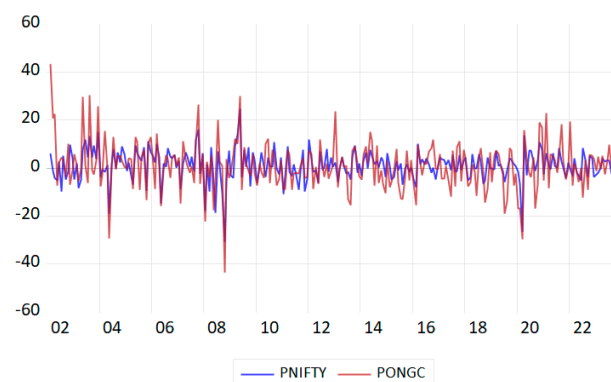
$$(R_A - R_F)_t = \alpha + \beta(R_M - R_F)_t + \varepsilon_t \quad t = 1, 2, \dots, n$$

where:

- $(R_A - R_F)_t$: expected asset premium with respect to the risk-free asset in period t.
- $(R_M - R_F)_t$: expected market premium with respect to the free risk asset in the same period t.
- β : variation of the asset's profitability in the face of movements in market profitability
- α : measures whether the asset's return is systematically higher ($\alpha > 0$) or lower ($\alpha < 0$) than the market return for exogenous reasons.

Graph 3 shows the premium of ONGC and NIFTY 50 from January 2002 to December 2023, both months inclusive:

Graph 3: Expected profitability evolution of ONGC compared to expected profitability evolution of NIFTY from January 2002 to December 2023



Source: Self-crafted in EViews using financial data extracted from investing.com

At first sight, without a comprehensive analysis, we can determine that the trends of PONGC and PNIFTY are noticeably similar from April 2004 to December 2023. The pattern is overall in the same direction, leaving aside some

divergences. For instance, in the early 2000s, we appreciate two substantially noticeable spikes in ONGC's values, which eventually decreased to lower levels. Another disparity is found in January 2013. This was a month when ONGC's expected return was much higher than NIFTY. PONGC is 24, compared to a value of 2 for PNIFTY, ascending to a 22-gap difference. However, in August 2013 PONGC dropped to -15, 10 points below PNIFTY. Another apparent dissimilarity occurred in July 2019, when PONGC was -19 and PNIFTY was -6, exhibiting a 13-point jump. The same happened in September 2020, this time PONGC positioned itself below PNIFTY by 16 points. These will be further analysed when we study the atypical values.

4.2. Ordinary least squares (OLS) CAPM estimation method

The estimated equation is the following:

$$pong_c = \alpha + \beta pnifty + \varepsilon_t \quad t = 1, 2, \dots, n$$

The dependent variable "PONGC" is ONGC's premium. The constant represented as "C" in EViews measures variables exogenous to the market, that affect ONGC's premium either positively or negatively. However, according to Table 5, alpha is not relevant considering its p-value of 0.6683, which is too large. Investors are always on the lookout for assets with a "seeking alpha" and it involves pursuing investment opportunities that can beat the market (Rackup, 2023). However, a positive alpha means that the CAPM model is not met because the market is not efficient for that asset.

Beta is relevant because its p-value is 0.000. Therefore, we can reject the null hypothesis that, this being that market returns have no effect on the asset's profitability (an asset without market risk). The change in the asset's yield is very similar to the change in the market yield, so the asset has the same risk as the market.

Table 5: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY

Dependent Variable: PONGC				
Method: Least Squares				
Date: 02/18/24 Time: 16:52				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.204069	0.475735	-0.428956	0.6683
PNIFTY	1.025178	0.073773	13.89632	0.0000
R-squared	0.425247	Mean dependent var		0.958156
Adjusted R-squared	0.423044	S.D. dependent var		9.998951
S.E. of regression	7.594962	Akaike info criterion		6.900423
Sum squared resid	15055.38	Schwarz criterion		6.927588
Log likelihood	-905.4056	Hannan-Quinn criter.		6.911340
F-statistic	193.1077	Durbin-Watson stat		1.796226
Prob(F-statistic)	0.000000			

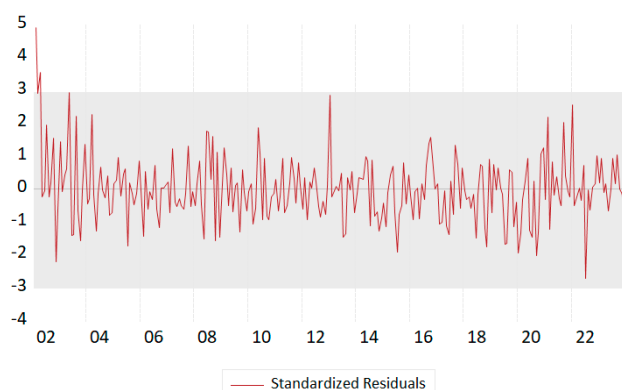
Source: Estimation Output Tool in EViews

In the model we have just estimated, for the hypothesis tests to be valid, the residuals must be white noise. This requires the fulfilment of a number of hypotheses that are examined in the section that follows.

4.3. OLS residuals analysis

Conducive to verify that the CAPM model estimation is reliable for performing hypothesis tests, the disturbances must be white noise $\varepsilon_t \rightarrow \text{i.i.d. } N(0, \sigma_\varepsilon^2)$. That is, residuals must follow a normal distribution and there must be no heteroskedasticity or serial correlation problem. The OLS residuals are shown in Graph 4.

Graph 4: Standardized Residual Graph for the CAPM model between January 2002 and December 2023



Source: Self-crafted in EViews using financial data extracted from investing.com

Table 6 provides an overview of the hypothesis tests conducted in this section by displaying the results of applying each of the three hypotheses and the conclusions that were drawn from applying each contrast.

Table 6: Residual Hypothesis Testing Summary Table

		Statistical Test	Statistic Value	P-value	Null Hypothesis	Interpretation
NORMAL DISTRIBUTION		Jarque-Bera	105.196	0.000	Residuals follow a Normal Distribution	Residuals do not follow a Normal Distribution
HETEROSKEDASTICITY		White	0.733090	0.6931	Residuals have the same variance	Residuals do not have a heteroskedasticity problem
SERIAL CORRELATION	AR(1)	Breusch-Godfrey	0.810805	0.3679	Residuals are independent	Residuals follow no serial correlations of lags 1, 2 or 12
	AR(2)		0.947233	0.6227		
	AR(12)		18.04556	0.1143		

Source: Self-crafted on Excel

In terms of normal distribution, the Histogram found a positive skewness alongside a leptokurtic curve (kurtosis above 3). The Jarque-Bera statistic suggests that the residuals are not normal, but we think this is due to the existence of outliers since we have a group of positive and negative residuals larger than the rest.

With respect to heteroskedasticity, White's statistic allows us to conclude all residuals have the same variance. Hence, we are not able to reject the null hypothesis of homoscedasticity with a significance level of 69.3%.

We also analyse possible serial correlations with lags of 1, 2 and 12. Applying the Breusch-Godfrey test we contrast if residuals are independent of one another. As Table 6 shows, there are no AR(1), AR(2) or AR(12) type correlations, since the associated p-values are 36.8%, 62.2% and 11.4% respectively.

Having investigated all possible problems that would invalidate the OLS CAPM estimation method, we come to the conclusion that, considering there is no heteroskedasticity

or serial correlation problem, the OLS estimates of the standard deviations are valid for hypothesis testing.

5. Intervention analysis

An intervention analysis is required considering the OLS residuals from our CAPM model are not normal. In order to correct the normality of our residuals, we must identify outliers that could be affecting our model. These outliers will be modeled through dummy variables and a new CAPM will be estimated to analyse a possible improvement in normality.

Graph 4 in section 4 shows the standardized residuals with a shaded background (3 to -3 on the y-axis) representing the margins to identify which would be the outliers that could be influencing the functioning of the original CAPM model. The forthcoming analysis will entail a meticulous examination of each anomalous data point, accompanied by a chronological elucidation of its occurrence whenever the temporal context of the data is ascertainable:

i. 2002: February (4.9), March (2.9), and April (3.5)

Despite exhaustive efforts to elucidate the underlying reasons behind these anomalous occurrences, the scarcity of available information pertaining to that period hindered a comprehensive analysis and the formulation of definitive explanations for the rapid swifts in ONGC's risk premium.

ii. 2003: May (2.9)

At the time, ONGC had demonstrated a notable progression, influenced by anticipations of a favourable trajectory for the energy sector throughout the ongoing fiscal year. The stock of ONGC had surged by 17% until May 9. The boost in the company's stock price was based on the expectations of surpassing more than 30 million tonnes produced during the fiscal year.

The primary cause for this anticipated increase in production is the addition of imports from the oilfield in Sudan that ONGC recently acquired. By paying \$670 million to acquire the project's shares from Talisman Energy Inc., a Canadian business, ONGC acquired a 25% interest in the Greater Nile Oil Project in Sudan. An estimated 3 million tonnes of oil are produced annually from the field which can be attributed to ONGC, making up 25% of the overall output. Furthermore, ONGC believes that domestic production levels would rise in the near future. Additionally, ONGC had disclosed its intention to initiate the retailing of automotive fuels through its own petrol stations by the conclusion of 2003.

On the other hand, certain market participants speculated that the rise in the value of ONGC's stock can be attributed to conjecture surrounding a substantial dividend payout and robust financial performance. ONGC had already announced an interim dividend of Rs 17 per share. It was anticipated by market players that the full dividend for the fiscal year 2002-2003 could range between Rs 23 to Rs 24 per share.

Moreover, significant oil deposits were discovered near the Vasai gas field off the coast of Bombay. It was anticipated that the Vasai West discovery has about 240 million barrels of oil-equivalent gas and oil in place. Preliminary estimates indicated that there may be about 100 million barrels of in-place oil in addition to oil-equivalent gas reserves in Laippling-gaon in the north-eastern state of Assam, according to ONGC's latest discovery. By this means, ONGC's recent exploration endeavours had resulted in six notable discoveries, including Vasai West (oil and gas) in the western offshore region, GS-49 (gas) and GS-KW (oil and gas) in the Krishna Godavari offshore area, Chinnewala Tibba (gas) in Rajasthan, and Laippling-gaon (oil and gas) and Banamali (oil) in Assam (*Rediff*, 2003).

iii. 2013: January (2.9)

Within the context of longitudinal data analysis, The Economic Times (India) juxtaposed the outlier value observed in January 2013 with February 2021 (standardized residual of 2.2). Through a comparative lens, we find a common external factor affecting our CAPM model: global oil prices. Given that the company accounts for two-thirds of the nation's crude oil production, its financial performance is intricately linked to global crude oil prices, as they directly impact the average revenue generated from each barrel of oil sold (*The Economic Times*, 2021).

Despite the positive outlook on global oil pricing, January was not the month for ONGC's Siberian oil production. ONGC planned to decrease oil production by 17.4% in Russia's Tomsk region to 512,900 tonnes in 2013. In 2012, production in Russia experienced a decline of 21.4% to 621,100 tonnes, falling short of the target by 2.3%. The overall reduction in oil production capabilities was attributed to the company's pursuit of optimal and economically viable technologies for extracting oil from tight reservoirs (*Interfax*, 2013).

Having identified and analysed the atypical values, we incorporate these dummy variables into the estimation of an adjusted CAPM and keep those that have significance in the model. Estimation results are shown in Table 7.

Table 7: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers

Dependent Variable: PONGC				
Method: Least Squares				
Date: 04/17/24 Time: 16:59				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.619259	0.430246	-1.439317	0.1513
PNIFTY	1.023891	0.066388	15.42280	0.0000
D2002M02	37.70539	6.837011	5.514893	0.0000
D2002M03	22.45991	6.831020	3.287929	0.0012
D2002M04	27.31066	6.838179	3.993849	0.0001
D2013M01	22.10276	6.829729	3.236258	0.0014
R-squared	0.544160	Mean dependent var		0.958156
Adjusted R-squared	0.535291	S.D. dependent var		9.998951
S.E. of regression	6.816239	Akaike info criterion		6.699042
Sum squared resid	11940.51	Schwarz criterion		6.780536
Log likelihood	-874.9240	Hannan-Quinn criter.		6.731793
F-statistic	61.35882	Durbin-Watson stat		2.092271
Prob(F-statistic)	0.000000			

Source: Estimation Output Tool in EViews

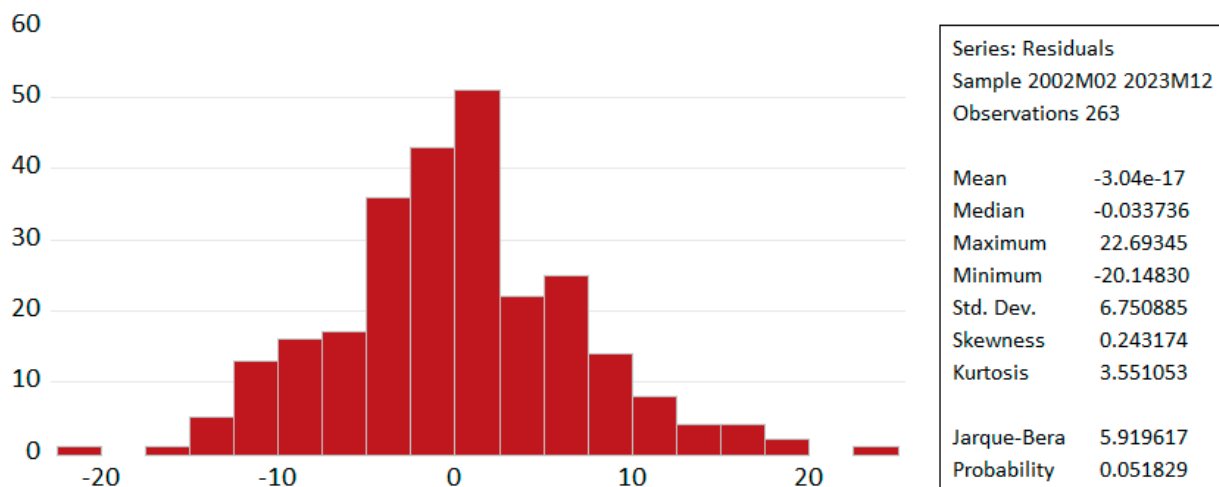
May 2003 was a month where the effect was negative, however, the p-value of 83,5% is too high for it to be relevant. Therefore, we remove May 2003 as a dummy variable from the model. This consolidates the CAPM model with four relevant atypical dummy variables.

The interpretation of the atypical values is carried out according to the coefficient, as shown in Table 7. All outliers show a positive effect on ONGC's risk premium. For instance, the steepest rise was in February 2002, with an

average of 37.7 percentual points. Since there is such a drastic change in the company, the atypical values from 2002 are dispensed with from now on. The other atypical values are found to increase on average between 22 to 27 percentual points.

If we perform the Jarque-Bera test in the model found in Table 7, we find the p-value increases to 0.0518 (as shown in Graph 5). This means we can reject the null hypothesis, following a normal distribution.

Graph 5: Histogram of the CAPM model adjusted for outliers



Source: Self-crafted in EViews using the Residual Diagnostics Option for Normality testing

6. Structural changes study

Ukraine-Russia Conflict (eve of the invasion of Ukraine in February 2022) & Government Tax on the Export of petrol, diesel, and jet fuel (July 2022)

The law of the use of force is one of the most contentious and difficult subjects in international law and in another sense is international law's weak point. With the Ukrainian conflict, it has proven once again to be an intractable problem.

Preceding the invasion, there had been an ongoing period of eight years marked by conflict in eastern Ukraine, characterized by hostilities between Ukrainian Government forces and separatist factions supported by Russia. In late February 2014, unidentified military personnel, subsequently identified as Russian forces, encircled the airports in Crimea, a predominantly Russian-populated peninsula within Ukraine. This action was followed by the seizure of the Crimean autonomous assembly by pro-Russian elements. Subsequently, Russia has retained control over Crimea and provided support to pro-Russian separatist factions, which also asserted control over segments of the Donetsk and Luhansk regions in eastern Ukraine, collectively known as the Donbas, in 2014.

The commencement of the present conflict in Ukraine occurred on 24 February 2022, with the entrance of Russian military forces into the nation through Belarus, Russia, and Crimea. President Putin officially acknowledged the independence of the self-proclaimed Donetsk People's Republic and the Luhansk People's Republic, subsequently dispatching troops to these territories under the guise of "peace-keeping duties" (*House of Commons Library*, 2023).

On the 1st of July 2022, the Indian stock markets experienced a consecutive third-day decline. Concurrently, shares of oil and gas companies witnessed a downturn, resulting in the complete erosion of gains amassed by energy sector entities within a singular trading day. Specifically, shares of Reliance exhibited an 8% decrease, while those of Oil India plummeted by a substantial 15%. ONGC, alongside these aforementioned stocks, also experienced a notable decline, with its shares depreciating by 13% over the course of a single trading session (*Equity Master*, 2022).

The detonator behind this crash was the Indian Government's disclosure of its intention to impose taxes on the exportation of petrol, diesel, and aviation turbine fuel (ATF) by Indian firms to overseas markets. This action was a consequence of the Ukrainian-Russian conflict. The Government was provoked by the scarcity of regions such as Gujarat, Rajasthan, and Madhya Pradesh. These areas had endured prolonged shortages as domestic refineries redirected their supplies to meet heightened demand in European and American markets. The announced tax rates amounted to Rs 6 per litre for petrol and ATF exports, and Rs 13 per litre for diesel exports within the country. Furthermore, the government introduced an additional wind-fall tax targeting oil-producing companies. This tax, characterized by its imposition on exceptional gains accrued by certain enterprises, was intended to address the significant gains realized by domestic crude oil suppliers who had been selling their products at international price levels, thereby benefiting from increased revenue streams (*Reuters*, 2023).

In order to find a significant structural change, we attempted two approaches. First, we experimented with the possibility of using the recent reactivation of the Ukraine-Russia Conflict (from the eve of the invasion, February 2022) until December 2023. We expected the war to be influencing our model heavily considering all the aforementioned occurrences related to the energy industry. Despite our beliefs, when including "SC_CONFLICT" and "SC_CONFLICT*PNIFTY", both p-values were once again too high (0.5217 and 0.1030, as shown in Table A1 in the Appendix) for the war to be considered a relevant structural factor.

In our second attempt, we aimed to isolate the Government's restrictive tax on exports of petrol, diesel, and ATF (as shown in in Table A2 in the Appendix).

At first sight, we are able to find a significant structural change if we consider the tax imposition from July 2022. The p-value (shown in Table A2 in the Appendix) is 0.0724 for "SC_TAX*PNIFTY" which suggests a possible change in the beta for the model. However, if we remove "SC_TAX" due to its p-value of 0.3078, the variable "SC_TAX*PNIFTY" also becomes non-significant since its p-value increases to 0.1301 (as shown in Table A3 in the Appendix). Therefore, we can conclude that there are no significant structural changes related to the Ukraine-Russian Conflict to be included in our model.

7. Other explanatory variables in the model

i. Global Oil Prices

We have chosen the evolution of monthly global oil prices adjusted to the same study period as the one used for ONGC and NIFTY 50 share prices (January 2002 to December 2023). The common unit used was "\$/bbl", meaning dollars per barrel representing the price of crude oil (*World Bank*, 2024).

The data set used by the World Bank originates from Australia, Colombia, South Africa, the Brent Index (United Kingdom), the West Texas Intermediate Index, Dubai, Saudi Arabia, the Natural Gas Index (Laspeyres) of Europe and the United States, and Japan. The sources used were Bloomberg, Coal Week International, Energy Intelligence Group, The Wall Street Journal and Thomson Reuters DataStream among others. The result of these reports is a monthly average of the price of crude oil starting January 1960, and finishing March 2024 (the most recent complete month at the time of conducting this econometric model) (*World Bank*, 2024).

The data was adjusted using the logarithmic rate of change ("RGLOBAL_OIL_PRICE") and introduced into the CAPM model as shown in Table 8.

Table 8: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the global price of oil as an exogenous variable

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/24/24 Time: 13:28				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.633983	0.424441	-1.493690	0.1365
PNIFTY	0.992304	0.066420	14.93994	0.0000
D2002M02	37.38677	6.745193	5.542728	0.0000
D2002M03	20.33742	6.779415	2.999879	0.0030
D2002M04	26.28442	6.755030	3.891089	0.0001
D2013M01	21.71361	6.738468	3.222337	0.0014
RGLOBAL_OIL_PRICE	0.124753	0.043788	2.849021	0.0047
R-squared	0.558169	Mean dependent var		0.958156
Adjusted R-squared	0.547813	S.D. dependent var		9.998951
S.E. of regression	6.723776	Akaike info criterion		6.675432
Sum squared resid	11573.55	Schwarz criterion		6.770509
Log likelihood	-870.8193	Hannan-Quinn criter.		6.713641
F-statistic	53.90114	Durbin-Watson stat		2.103809
Prob(F-statistic)	0.000000			

Source: Estimation Output Tool in EViews

The global price of oil is relevant considering its p-value of 0.0047. Therefore, we will include this variable in our most recent CAPM model. ONGC's premium has lower volatility than the global average oil price, and therefore lower risk.

ii. Competitors

Following meticulous screening, we identified two significant competitors, Hindustan Petroleum Corporation Ltd (a national competitor) and Chevron Corporation (an international, US, competitor), whose activity coincided with the entirety of our study period. We were able to adjust the CAPM model to a more explanatory version including the premium of both these competitors ("PCHEVRON" and "PHPCL", as shown in Table 9).

Table 9: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the global price of oil and competitors as exogenous variables

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/25/24 Time: 15:29				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.525767	0.402429	-1.306483	0.1926
PNIFTY	0.700146	0.082602	8.476123	0.0000
D2002M02	28.05409	6.630679	4.230954	0.0000
D2002M03	17.73513	6.440085	2.753866	0.0063
D2002M04	25.65907	6.403764	4.006873	0.0001
D2013M01	18.50271	6.409693	2.886677	0.0042
RGLOBAL_OIL_PRICE	0.168575	0.043874	3.842268	0.0002
PCHEVRON	0.145783	0.066435	2.194369	0.0291
PHPCL	0.217605	0.040364	5.391046	0.0000
R-squared	0.606820	Mean dependent var		0.958156
Adjusted R-squared	0.594436	S.D. dependent var		9.998951
S.E. of regression	6.367720	Akaike info criterion		6.573981
Sum squared resid	10299.16	Schwarz criterion		6.696222
Log likelihood	-855.4786	Hannan-Quinn criter.		6.623107
F-statistic	49.00179	Durbin-Watson stat		2.129849
Prob(F-statistic)	0.000000			

Source: Estimation Output Tool in EViews

ONGC has much less risk than its two competitors, for example, if CHEVRON's premium increases by 100 bp, ONGC's premium increases by only 14 bp.

8. Fama-French three-factor model

Applying this model, we take into account the higher risk involved in investing in a company with a lower share price (SMB), and how this means demanding a higher return from the investor. A positive SMB value within a specific month signifies the outperformance of small-capitalization stocks relative to large-capitalization stocks during that period. Conversely, a negative SMB value denotes the superior performance of large capitalization stocks over small capitalization stocks within the same timeframe (Womack & Zhang, 2003).

On the other hand, the HML factor has been formulated as a metric to gauge the "value premium" conferred upon investors for allocating their investments towards companies characterized by high book-to-market values. A positive HML value within a specific month signifies the superior performance of value stocks relative to growth stocks during that period. Conversely, a negative HML value in a given month indicates the outperformance of growth stocks over value stocks within the same temporal scope. Therefore, the model adopts the following expression:

$$R_a = R_f + \beta_1(Mkt - R_f) + \beta_2(SMB) + \beta_3(HML) + \alpha$$

Table A4 in the Appendix shows that only "HML" is relevant having a p-value of 0.0196. However, "SML" is not relevant (p-value of 0.7541) and will therefore be removed from the final CAPM model to be used in this study. With a coefficient of 0.360, the returns of ONGC's premium will be 36 basic points superior to those of a lower Book to Market Value.

Therefore, the model that will best explain the ONGC premium will be the CAPM that includes the NIFTY 50 premium, the outlier dummies (four in total), the global average oil price, the two competitors and the Fama and French HML factor. This model is shown below in Table 10.

Table 10: Ordinary Least Squares CAPM estimation method for ONGC and NIFTY adjusted for outliers, including the global price of oil and competitors as exogenous variables

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/25/24 Time: 15:35				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.662131	0.403221	-1.642104	0.1018
NIFTY	0.715282	0.082147	8.707378	0.0000
D2002M02	28.05463	6.573499	4.267838	0.0000
D2002M03	17.68688	6.384582	2.770248	0.0060
D2002M04	23.71040	6.403302	3.702840	0.0003
D2013M01	17.63031	6.365422	2.769700	0.0060
RGLOBAL_OIL_PRICE	0.172479	0.043528	3.962524	0.0001
PCHEVRON	0.157944	0.066068	2.390616	0.0176
PHPCL	0.205147	0.040371	5.081527	0.0000
HML	0.352639	0.151220	2.331960	0.0205
R-squared	0.615093	Mean dependent var		0.958156
Adjusted R-squared	0.601401	S.D. dependent var		9.998951
S.E. of regression	6.312809	Akaike info criterion		6.560320
Sum squared resid	10082.44	Schwarz criterion		6.696143
Log likelihood	-852.6820	Hannan-Quinn criter.		6.614904
F-statistic	44.92243	Durbin-Watson stat		2.121431
Prob(F-statistic)	0.000000			

Source: Estimation Output Tool in EViews

Having integrated all adjustments to the CAPM model, we will interpret Table 10. Beta is 0.715, meaning the expected return of ONGC will be slightly below the market return (NIFTY 50). That is, if the market premium increases or decreases by 100 b.p., it can be expected that the asset's premium will increase or decrease by 72 b.p., which means that the asset has less risk than the market. The effect of the inclusion of the explanatory variables justifies that the beta has dropped from 1.025 in table 5 to 0.715 in the final model.

The coefficient α is non-significant (p-value=0.1018). This suggests that the expected premium of the stock is not affected by exogenous factors according to market behaviour.

9. Conclusion

ONGC is the largest crude oil in the country. This set the ground for optimistic expectations in terms of returns and performance with respect to the market. However, as found in our final CAPM model the expected return of ONGC is slightly lower than the market return of NIFTY 50. Hence, we can ratiocinate that ONGC's performance is substantially connected and influenced by that of the market. For instance, the 2008 crash affected all Indian companies, especially ONGC. Another downfall was clear during the COVID-19 global pandemic, which once again affected both NIFTY 50 and ONGC in similar terms.

Conducive to verify that the CAPM model estimation was valid, we analysed the residuals. Although these did not follow a Normal distribution, they did not present a heteroskedasticity problem and they did not present an autocorrelation problem.

An intervention analysis was required considering the non-normality of residuals. Four relevant atypical values were included as dummy variables in an adjusted CAPM model. In the domain of longitudinal data analysis, a comparative examination conducted by The Economic Times (India) scrutinized the outlier value identified in January 2013 alongside that of February 2021, characterized by a standardized residual of 2.2. This investigation elucidates global oil prices as a shared external determinant influencing our CAPM model. In light of the corporation's substantial contribution, constituting two-thirds of the nation's crude oil production, its financial performance manifests a profound association with global crude oil prices. This correlation is underscored by the direct repercussion of such prices on the mean revenue derived from each barrel of oil sold (*The Economic Times*, 2021). Ergo, later in the model, the average global oil prices were introduced as a relevant exogenous variable in our CAPM.

The Ukraine-Russia Conflict and the imposition of taxes on exports were the structural changes studied in this paper, however, these were not included in the model when they showed to be non-relevant.

Utilizing investing.com we selectively filtered ONGC's global competitors achieving two main competitors: Hindustan Petroleum Corporation Ltd and Chevron Corporation. ONGC's premium showed to be less risky than that of its competitors.

Finally, the Fama-French model was used to find the relevance of the HML factor. With a coefficient of 0.352, the returns of ONGC's premium will be 35 basis points superior to those of a lower Book to Market Value.

In recommending potential investors to select ONGC over other NIFTY 50 companies, despite its apparent volatility, it is essential to underscore its alignment with the broader market trends and its notable gains in trade. Particularly, investors should take into account ONGC's commendable management in steering production growth, as evidenced by recent developments such as the initiation of oil production from its KG-DWN-98/2 Block in the deep waters of the Bay of Bengal in January 2024 (The Economic Times, 2024). This strategic trajectory is poised to yield a significant increase in overall oil and gas production, with projected improvements of 11% and 15% respectively. The ongoing progress toward the conclusion of Phase 2 of this endeavour is pivotal, leveraging innovative pipe-in-pipe technology, thereby demonstrating ONGC's commitment to the 'Make in India' initiative and the national objective of energy sector self-sufficiency (The Times of India, 2023).

In light of these factors, investing in ONGC represents not only a prudent financial decision but also a strategic alignment with India's energy sector objectives and technological advancements, encapsulated in the company's lemma:

"Image better, drill deeper, monetise faster."

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Appendix

Table A1: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the Ukraine-Russia Conflict

Dependent Variable: PONGC				
Method: Least Squares				
Date: 04/18/24 Time: 13:57				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.678296	0.449875	-1.507743	0.1329
PNIFTY	1.044263	0.067436	15.48534	0.0000
D2002M02	37.64214	6.828552	5.512464	0.0000
D2002M03	22.54159	6.822446	3.304033	0.0011
D2002M04	27.45286	6.829877	4.019525	0.0001
D2013M01	22.11756	6.821074	3.242533	0.0013
SC_CONFLICT	0.980879	1.528716	0.641636	0.5217
SC_CONFLICT*PNIFTY	-0.602244	0.368083	-1.636166	0.1030
R-squared	0.549022	Mean dependent var		0.958156
Adjusted R-squared	0.536642	S.D. dependent var		9.998951
S.E. of regression	6.806326	Akaike info criterion		6.703528
Sum squared resid	11813.15	Schwarz criterion		6.812187
Log likelihood	-873.5139	Hannan-Quinn criter.		6.747195
F-statistic	44.34823	Durbin-Watson stat		2.109791
Prob(F-statistic)	0.000000			

Table A2: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the Tax on petrol, diesel and ATF exports imposed by the Indian Government in July 2022 as a structural change

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/25/24 Time: 15:46				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.675093	0.444027	-1.520387	0.1297
PNIFTY	1.042199	0.067056	15.54229	0.0000
D2002M02	37.65133	6.820437	5.520369	0.0000
D2002M03	22.53609	6.814097	3.307275	0.0011
D2002M04	27.44123	6.821330	4.022857	0.0001
D2013M01	22.11884	6.812875	3.246623	0.0013
SC_TAX	1.861473	1.821554	1.021915	0.3078
SC_TAX*PNIFTY	-0.776471	0.430434	-1.803924	0.0724
R-squared	0.550071	Mean dependent var		0.958156
Adjusted R-squared	0.537720	S.D. dependent var		9.998951
S.E. of regression	6.798402	Akaike info criterion		6.701198
Sum squared resid	11785.66	Schwarz criterion		6.809857
Log likelihood	-873.2076	Hannan-Quinn criter.		6.744865
F-statistic	44.53664	Durbin-Watson stat		2.120832
Prob(F-statistic)	0.000000			

Table A3: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the Tax on petrol, diesel and ATF exports imposed by the Indian Government in July 2022 as a structural change (removing “SC_TAX”).

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/25/24 Time: 15:49				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.564484	0.430670	-1.310710	-0.564484
PNIFTY	1.039439	0.067007	15.51237	1.039439
D2002M02	37.55729	6.820407	5.506605	37.55729
D2002M03	22.42241	6.813778	3.290746	22.42241
D2002M04	27.31936	6.820877	4.005256	27.31936
D2013M01	22.01422	6.812695	3.231353	22.01422
SC_TAX*PNIFTY	-0.596295	0.392702	-1.518443	-0.596295
R-squared	0.548229	Mean dependent var		0.958156
Adjusted R-squared	0.537640	S.D. dependent var		9.998951
S.E. of regression	6.798990	Akaike info criterion		6.697681
Sum squared resid	11833.92	Schwarz criterion		6.792757
Log likelihood	-873.7450	Hannan-Quinn criter.		6.735889
F-statistic	51.77640	Durbin-Watson stat		2.102791
Prob(F-statistic)	0.000000			

Table A4: Ordinary Least Squares CAPM estimation method for PONGC and PNIFTY adjusted for outliers, including the global oil price, the premium of competitors and the Fama-French Three-Factor model.

Dependent Variable: PONGC				
Method: Least Squares				
Date: 07/25/24 Time: 15:51				
Sample (adjusted): 2002M02 2023M12				
Included observations: 263 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.651040	0.405488	-1.605571	0.1096
PNIFTY	0.713316	0.082532	8.642937	0.0000
D2002M02	28.03019	6.585706	4.256217	0.0000
D2002M03	17.67954	6.396033	2.764142	0.0061
D2002M04	23.77931	6.418507	3.704804	0.0003
D2013M01	17.56846	6.379846	2.753744	0.0063
RGLOBAL_OIL_PRICE	0.169182	0.044856	3.771666	0.0002
PCHEVRON	0.159341	0.066336	2.402022	0.0170
PHPCL	0.204750	0.040463	5.060163	0.0000
SMB	0.049921	0.159219	0.313535	0.7541
HML	0.360173	0.153384	2.348176	0.0196
R-squared	0.615243	Mean dependent var		0.958156
Adjusted R-squared	0.599975	S.D. dependent var		9.998951
S.E. of regression	6.324088	Akaike info criterion		6.567534
Sum squared resid	10078.51	Schwarz criterion		6.716940
Log likelihood	-852.6307	Hannan-Quinn criter.		6.627577
F-statistic	40.29592	Durbin-Watson stat		2.116232
Prob(F-statistic)	0.000000			