Original Research Article
The Impact of Upstream Oil and Gas Investment On Petroleum Production in Indonesia

ABSTRACT

This study aims to analyze the impact of upstream oil and gas investment on petroleum production in Indonesia. The research data used are upstream oil and gas investment data in 2010-2020 and petroleum production data in 2010-2020 sourced from the Ministry of Energy and Mineral Resources (ESDM). The research method used in this study is a quantitative research method with a granger causality test analysis tool. The results showed that there is a one-way relationship between upstream oil and gas investment and petroleum production in Indonesia.

Keywords: Upstream Oil and Gas Investment, oil production and fical term

1. INTRODUCTION

Oil and gas (oil and gas) is a vital commodity that controls the lives of many people and has an important role in the national economy so that its management must be able to maximally provide prosperity and welfare of the people. The oil and gas industry is a capital-intensive, technology-intensive and risk-intensive industry. The oil and gas industry is divided into two, namely upstream activities and downstream activities, upstream activities are activities that are core or rely on Exploration and Exploitation business activities while downstream activities are business activities that are core or rely on processing, transportation, storage and commercial business activities

Investors who plan to invest in Indonesia must follow and agree to the legal rules contained in Law No. 22 of 2001 concerning oil and gas. In article 1 paragraph 23 it is stated that, Upstream business activities in the oil and gas sector in Indonesia are under the auspices of the Regulatory Agency, namely the Special Work Unit for Upstream Oil and Gas Business Activities (SKKMIGAS) (Law No. 22 of 2001). In Presidential Regulation No. 9 of 2013 it has been stipulated that the authority, duties and functions of oil and gas industry organizers and managers are carried out by SKK MIGAS. The task of SKK MIGAS as a supervisor and control of the implementation of the Cooperation Contract (PSC) and has the function of supervising so that the extraction of natural resources carried out by the oil and gas industry can provide benefits and profitable revenues for the state.

Investment activities in the oil and gas industry, especially upstream oil and gas businesses, are open to business entities (Indonesian Legal Entities) and / or Permanent Business Forms (Foreign Legal Entities). This business is carried out through a Cooperation Contract which can consist of a Production Sharing Contract (PSC), which is more beneficial to the State. Currently, the form of Cost and Fee Contract has been applied to contract with the Special Work Unit for Upstream Oil and Gas Activities (SKK MIGAS) representing the Government. According to the Ministry of Energy and Mineral Resources statistical report, in 2021 there are 60 oil and gas industries in Indonesia.

Table 1 Oil and Gas Industries with the Largest Oil Production in 2021

UNDER PEER REVIEW

No	Company	Oil Production (bph)
1	ExxonMobil Cepu Ltd	202.894
2	PT Pertamina Hulu Rokan	160.103
3	PT Pertamina EP	71.386
4	PHE ONWJ	27.136
5	PT PertaminaHuly Mahakam	24.922
6	PHE OSES	24.338
7	Petrochina Int Jabung Ltd	15.438
8	Medco E&P Natuna	13.715
9	PT Pertamina Hulu Sanga	12.241
10	PT Pertamina Hulu Kaltim	9.303

Source: Statistik Kementerian ESDM (2021)

According to data from the Ministry of Energy and Mineral Resources, throughout 2021 the average production of petroleum and condensate in Indonesia reached 658,540 barrels of oil per day (BOPD). In 2021 the oil company with the largest production capacity in Indonesia is ExxonMobil Cepu Ltd. The US-headquartered company was able to produce oil and condensate at an average of 202,894 BOPD, nearly one-third of the national production capacity in the previous year. ExxonMobil first became a Cooperation Contract Contractor in 1968 for the exploitation of natural gas fields in the Arun Field, Aceh Province. Exploration continued until ExxonMobil discovered 450 million barrels of oil reserves in the Banyu Urip oil field, Cepu Block, East Java, in 2001. The oil and gas company signed a Cooperation Contract (PSC) to cultivate the area in 2005. ExxonMobil holds 45 percent of the total participating shares in the Cepu Block and the PSC will continue until 2035.

SatuanKerjaKhususPelaksanaanKegiatan Usaha Hulu Minyak dan Gas Bumi (SKK Migas) recorded that the realization of upstream oil and gas (oil and gas) industry investment until the end of August 2023 reached IDR 124 trillion and the realization of this investment reflects the massive drilling and development of oil and gas wells in the country throughout 2023. According to SKK MIGAS, the trend of upstream oil and gas investment performance has exceeded the trend of upstream oil and gas performance globally by recording the end of 2023, the realization of upstream oil and gas investment reaching US $ 13.7 billion or around IDR 210 trillion.

2. METHODOLOGY

Based on the problems being analyzed by the author entitled "The impact of upstream oil and gas investment on petroleum production in Indonesia", this study examines the one-way relationship (causality) between upstream oil and gas investment and petroleum production in Indonesia using the Granger Causality test method. Therefore, in this study the author chose a quantitative research method using the granger causality approach. The analytical technique used in this study is the Granger Causality Test method. Causality tests are performed to measure the strength of the relationship between variables and show the direction of the causal relationship.

2.1 Granger Causality Test

The granger causality test basically assumes that the relevant information for predicting variables X and Y is if there are only two time series data from both variables. To empirically test this hypothesis uses granger causality analysis between two or more variables. Granger causality test is a method to find out where a dependent variable (non-free variable) can be influenced by another variable (independent variable) and the other side of the independent variable can occupy the position of the dependent variable. Such relationships are called causal or two-way relationships (Gujarati, 2013). To see the granger causality relationship between Upstream Oil and Gas Investment with Petroleum Production and Petroleum Production with Upstream Oil and Gas Investment, researchers conducted a Granger Causality test to see the relationship between the variables studied. Based on this, the estimation equation model used in this study is as follows:

2.1.1 Research test

2.1.1.1 Unit Root Test

UNDER PEER REVIEW

Stasionecity is one of the conditions that need to be done in this model with time series data. Stationary data is data that shows the mean, variance, autovariance (on lag variations) will remain the same at any time the data is formed or used. Therefore, with stationary data the time series model can be said to be more stable. If the data used in the model is not stationary, then the data is reconsidered for validity and stability, because regression results derived from non-stationary data will cause spurious regression.

One of the formal concepts used to determine data stationarity is through unit root tests. If a time series data is not stationary on order zero, I(0), then the stationarity of the data can be found through the next order so that the level of stationarity is obtained at the nth oerder first difference or I(1), or second difference or I(2) and so on.
The hypotheses for this test are:
H0 : δ = 0 (there is a root unit, not stationary)
Ha : δ < 0 (stationary time series)

2.1.1.2 Cointegration Test

The concept of cointegration is basically to determine the possibility of a long-term equilibrium relationship in research variables. In this concept, two or more non-stationary time sequence variables will be cointegrated if the combination is linear over time, although each variable may not be stationary at all. If the time sequence variables are cointegrated, there is a stable relationship in the long run (Gujarati, 2013).

The cointegration test is a test of whether there is a long-term relationship between the independent variable and the dependent variable. This test is a continuation of the stationary test. The main purpose of this cointegration test is to find out whether residual cointegration is stationary or not. If the variables are cointegrated, there is a stable relationship in the long run. Conversely, if there is no cointegration between variables, the implication is that there is no relationship in the long run.

2.1.1.3 Optimum Lag

The determination of optimum lag aims to determine the amount of lag used in Granger Causality Test estimation. The determination of the optimum lag is obtained from the minimum Akaike Information Crtiterion (AIC) value on all variables to be estimated. Determination of the optimal lag length can be done using the available information. The lag candidate selected is the lag length according to AIC and Schwartz Bayesian Criterion (SBC) criteria. The optimum lag will be found in the model specifications that provide the minimum AIC value (Gujarati, 2013).

2.1.1.4 Granger Causality Test

After testing the optimum lag, the next stage is to perform a granger causality test which is used to determine the relationship between variables. Granger's causality test looks at the influence of the past on present conditions. The granger causality test basically assumes that the information relevant for predicting the independent variable and the dependent variable is if there are only two time series data from both variables.

To empirically test this hypothesis uses granger causality analysis between two or more variables. Granger causality test is a method to find out where a dependent variable (non-free variable) can be influenced by another variable (independent variable) and the other side of the independent variable can occupy the position of the dependent variable. Such relationships are called causal or two-way relationships (Gujarati, 2013). While the equation used to perform Granger Causality testing, can be written as follows:

$$IHM_t = \sum_{i=1}^{n} \alpha_i IHM_{t-1} + \sum_{j=1}^{n} \beta_j PMB_{t-1} + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$PMB_t = \sum_{i=1}^{n} \lambda_i PMB_{t-1} + \sum_{j=1}^{n} \partial_j IHM_{t-1} + \mu_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

To see granger's causality can be seen by comparing the F-statistic with the critical value of the F-table at a confidence level of 5%, and can be seen from comparing its probability value with a confidence level of 5%. If all variables have an F-statistic value greater than the F-table value at a significant level, then both variables have bidirectional causality.

UNDER PEER REVIEW

3. RESULTS AND DISCUSSION

3.1 Research Results

3.1.1 Unit Root Test

Table2
Unit Root Test

Variabel	Uji Unit Root Test – ADF		
	Uji Akar Unit		
	Level		Informatian
	Level	2nd	
	ADF	Prob	
Investment	-4.316419	0.013	Stasioner
Production	-3.550150	0.030	Stasioner

The results of the stationary test using the Augmented Dicky-Fuller (ADF) test in Table 2 obtained the results that the upstream oil and gas investment variable was stationary at the level level and the stationary petroleum production variable at the second difference. The data used in the stationary test are upstream oil and gas investment data with units of US $ and petroleum production with units of Barells Oil Per Day (BOPD). The conclusion of the stationary test found a problem where the root test unit test of the dependent and independent variables is not stationary at the same level, because the variable of stationary oil and gas investment at the level level while the variable of stationary petroleum production at the level of second difference.

3.1.1 Cointegration Test

Table 3
Cointegration Test

Hypothesized	Trace Statistic	Prob
None*	25.24673	0.0094
At most 1*	9.443519	0.0443
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level		
*denotes rejection of the hypoyhesis at the 0.05 level		
**MacKinnon-Haug-Michells (1999) p-values		

Based on Johansen's cointegration test, there are both variables in the equation system, the number of possible relationships can be known. It can be seen in table 3 above that the trace test identifies 2 cointegration equations at level 5%. Thus, between the variables of oil and gas investment and oil production, there is a relationship between long-term equilibrium stability and long-term movement. While in the short term all variables adjust each other to achieve long-term balance.

3.1.3 Optimum Lag

The length of lag can be seen from the values of likelihood ratio (LR), final prediction error (FPE), Akaike information criterion (AIC) and Schwarz information (SC). The values can be seen from the table of test results The optimal lag length below.

Table 4
Optimum Lag

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-167.1884	NA*	7.85e+10	30.76152	30.83386	30.71592
1	-146.1674	30.59042	3.65e+09	27.66499	27.88202	27.52818
2	-137.3328	9.626920*	1.70e+09*	26.78778*	27.14950*	26.55976*

From table 4, the lag value is found in lag 2, where in this lag the lowest value for final prediction error (FPE) and Akaike information criterion (AIC) is collected. The lowest Schwarz information criterion (SC) value is in lag 2. The lowest Hannan-Quinn information criterion (HQ) point is at lag 2. Therefore, the optimum lag length is at lag 2.

UNDER PEER REVIEW

3.1.4 Granger Causality test

In this study, the granger causality test was carried out to see the relationship between upstream oil and gas investment and petroleum production and vice versa. The test level used in this granger causality test is at a confidence level of 0.05 (5%) and the lag length is up to lag 2. The following are shown the results of the granger causality test in table 5

Table5
Granger Causality Test

Null Hypothesis	F-Statistic	Prob.
Investment does not Granger Cause Production	6.31519	0.0334
Production does not Granger Cause Investment	1.31213	0.3367

Based on table 5, it can be explained that the variable that has a granger relationship is a variable with an F-statistic value greater than F-table 5.59144. So it can be explained that the significant investment variable affects the production variable (6.31519), this means that rejecting the null hypothesis and the production variable statistically does not significantly affect the investment variable (1.31213), so this means accepting the zero hypothesis.

Based on the causality test in table 5 above, it is found that there is a causality relationship between investment and production. In economics there is a relationship of investment with production which emphasizes that investment has a significant impact on production and economic growth. Investment, which includes spending on capital goods and production equipment, can spur productivity, increase potential output and contribute to long-term economic growth. Oil and gas investment is included in government and private investment, because oil and gas investment is a type of investment made by the government and the private sector which in the sense that the private party is foreign investment.There are factors that affect investment such as interest rates, depreciation, national income and government policies. Investment in the industry is undermined by existing government policies. Fiscal support from the government, such as tax policies and investment incentives, can affect investment realization in the upstream oil and gas sector. Regulations and investment climate created by the government can also affect the performance of oil and gas investment in Indonesia. The attractiveness of upstream oil and gas investment in Indonesia began to increase since 2020 after the government implemented a flexible fiscal system for investors such as investors given the freedom to choose cost recovery or gross split schemes.

There are various forms of agreements in the oil and gas industry such as concessions, joint ventures, profit sharing, production sharing, service sharing and risk contracts. Indonesia uses a form of production sharing agreement known as Production Sharing Contract Agreement (PSC) which is a method of agreement in business used in the oil and gas sector in Indonesia in order to increase state revenue from natural resources, and attract investors to invest in Indonesia. There are two types of PSC schemes, namely cost recovery and gross split where the cost recovery scheme that arises first from the gross split schemeThe gross split scheme was born referring to the definition of a profit-sharing contract or other forms of cooperation in Law Number 22 of 2001. The gross split scheme, which became the forerunner of the government, gave birth to a new format adapted to the development of the upstream oil and gas investment climate in Indonesia (Paramita, 2022).

Oil and gas investors consider the decision to invest based on prospectivity and fiscal attractiveness. Indonesia is one of the countries that has a prospectivity well above average (Woodmac, 2020). However, fiscal competitiveness in Indonesia must begin to be improved to be able to compete with other countries and can be an attractive attraction for investors. According to research conducted by BKF (2022), one of the obstacles that causes low investor interest in investing is bureaucracy in upstream oil and gas business activities which are considered less attractive to investors. To increase investment attractiveness in the upstream oil and gas sector and compete with other oil and gas producing countries, Indonesia is advised to improve the fiscal term revolutionarily rather than evolutionarily.The purpose of these improvements is to provide benefits equity between contractors and the state, prioritizing the optimization of oil and gas benefits that are greater than state fiscal revenues.

UNDER PEER REVIEW

4. CONCLUSION

Based on the results and discussion above, it can be concluded that there is a granger causality relationship between upstream oil and gas investment and oil production. As for oil production against upstream oil and gas investment, there is no granger causality. Upstream oil and gas investment in Indonesia has basically increased since 2020 until now. However, Indonesia is expected to develop the fiscal term in a revolutionary rather than evolutionary manner. The development of fiscal trams in the upstream oil and gas sector is expected to provide fairness and benefits between contractors and the state, by prioritizing the optimization of oil and gas benefits that are greater than state fiscal revenues.

UNDER PEER REVIEW

REFERENCES

Ariyon, M. (2012). Oil and Gas Policy Study in Indonesia. Journal of Earth, Energy, Engineering, 38-31. Indonesia

Hilly M, Adams ML, Nelson SC. A study of digit fusion in the mouse embryo. Clin Exp Allergy. 2002;32(4):489-98.

Paramita, R. (2022). Problems and Challenges of Increasing Investment in the Upstream Oil and Gas Industry.

Budget Journal, 7(2), 181-202. Indonesia

Gujarati, D. N. (2013). Fundamentals of Econometrics. Jakarta: Salemba Empat.

Sugiyono. (2012). Quantitative, Qualitative and R&D Research Methods. Bandung: Alphabeta.

JDIH CPC . (2022). Comparison of Cost Recovery Production Sharing Contract (PSC) with Gross Split PSC.

Available: jdih.bpk.go.id.

Ministry of Energy and Mineral Resources. (2017). Minister of Energy and Mineral Resources Regulation Number 08 of 2017 concerning Gross Split Production Sharing Contracts.

Available: https://migas.esdm.go.id/post/read/permen-esdm-nomor-08-tahun-2017-tangan-contract-bagi-hasil-gross-split

KPPU. (2019). Upstream Oil and Gas Sector Research.

Available: https://kppu.go.id/wp-content/uploads/2020/07/Abstrak-Hulu-Migas-2019.pdf

Indonesian Information Portal. (2024, January 18). Konclong Oil and Gas Investment Performance.

Available: https://www.indonesia.go.id/detik/editorial/7906/kinerja-investasi-migas-kinclong?lang=1

Prime, A. P. (2023, September 20). Large Investment Needed to Accelerate Oil and Gas Production.

Available: https://www.kompas.id/baca/ Ekonomi/2023/09/20/investasi-meningkat-tapi-sederet-tantangan-mengadang

UNDER PEER REVIEW