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Research Paper

Modeling and Analysis Data Production of Oil, and Oil and Gas in Indonesia by Using Threshold Vector Error Correction Model

Widiarti[1*], Mustofa Usman[1], Almira Rizka Putri[1], Edwin Russel[2]

[1]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Lampung, Bandar Lampung, 35141, Indonesia*
[2]*Department of Management, Faculty of Economic and Business, Bandar Lampung, 35141, Universitas Lampung, Indonesia*
***Corresponding author**: widiarti.1980@fmipa.unila.ac.id

Abstract
Data in the fields of finance, business, economics, agriculture, the environment and weather are commonly in the form of time series data. To analyze time series data that involves more than one variable (multivariate), vector autoregressive (VAR) models, vector autoregressive moving average (VARMA) models are generally used. If the variables discussed have cointegration, then the VAR model is modified into a vector error correction model (VECM). The relationship between short-term dynamics and deviation in the VECM model is assumed to be linear. If there is a nonlinear relationship between short-term dynamics and deviation, then a threshold vector error correction model (TVECM) can be used. The variables used in this research consist of oil production and Indonesian oil and gas production from January 2019 to March 2021. The research results show that the best model for data on oil production and oil and gas production is the TVECM 2 Regime model. Based on the TVECM 2 Regime model, further analysis, namely Granger causality and Impulse Response Function are discussed.

Keywords
Cointegration, Granger Causality, IRF, TVECM 2 Regime

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1. INTRODUCTION

A lot of time series data modelling in the field of economics involves two or more variables, or multivariate time series data. There are several reasons why it is important and interesting to analyse data series jointly. Peña et al. (2001) suggests that it is important to analyse multivariate time series data because of the following reasons: (a) to be able to understand the dynamic relationship between them; one variable may affect the other or there may be feedback relationships between them; and (b) to increase accuracy in forecasting data. Reinsel (1993) and Tsay (2013) extensively explain that a multivariate study of time series data discusses not only the nature of individual series but also the possibility of cross-relationships between them.

One of the methods that commonly used in multivariate time series data analysis is the VAR model which is an extension of univariate time series data analysis, namely the autoregressive (AR) model which is widely discussed by researchers (Reinsel, 1993; Lütkepohl, 2005; Tsay, 2005; Wei, 2006; Malik et al., 2017; Warsono et al., 2019). In many cases, in multivariate time series data economic, often the data is not stationary, but the linear function is stationary; this is called cointegration (Tsay, 2005; Wei, 2006). If the variables involved in the analysis are cointegrated, then the VAR model is modified into a VECM model (Tsay, 2005; Lütkepohl, 2005; Wei, 2018).

A detailed discussion of this case is discussed in Johansen (1991) and Johansen and Juselius (1990). If the model has a nonstationary problem and there is cointegration in economic variables, then the VECM model is used. In the VECM model we assume that the relationship between short-term dynamics and deviation is linear, but it is often found that the relationship between short-term dynamics and deviation is nonlinear. The model threshold vector error correction model (TVECM) can be used when the relationship pattern between short-term dynamics and deviation is nonlinear. In the TVECM model the threshold effect is highly dependent on the magnitude of the imbalance in the long-run system.

The VECM and TVECM have also been applied in many studies (Usman et al., 2022; Loves et al., 2021; Winarno et al., 2021; Warsono et al., 2020; Sharma et al., 2018; Usman et al., 2017; Sohibien, 2017; Hansen and Seo, 2002) to inflation, interest rate, energy and economics data. Loves et al. (2021) applied VECM to analysis PT Kalbe Farma Tbk and PT Kimia Farma Tbk stock data. Causal relationship between variables using Granger Causality showed that PT Kalbe Farma Tbk's stock data influenced PT Kimia Farma Tbk's stock data. Warsono et al. (2020) study the relationship of three share price of energy (from three ASEAN Countries) using VECM. Sohibien (2017) applied the TVECM in adjusting the working capital loan interest rate to the movement of the Bank Indonesia (BI) rate; Kanjilal and Ghosh (2017) applied the TVECM to the dynamics of crude oil and gold prices after the 2008 global financial crisis.

In this study, a causal relationship will be seen and adjustments were made to the nonlinear model toward the long-term balance between variables by estimating the TVECM 2 regime.

2. EXPERIMENTAL SECTION

2.1 Materials

The data used in this study were of Indonesian production of oil and gas during the period January 2019 to March 2021.

2.2 Methods

In time series data analysis, several assumptions must be checked. The assumption that the data meets the stationary can be checked by looking at the plot of the data and analyzing descriptively whether the data has a certain pattern that indicates it is not stationary. Note that if the data is stationary, it will generally fluctuate around a certain number. We also looked at the autocorrelation function (ACF) plot data. From the ACF plot the stationary assumption can be checked. Checking for stationary can also be done by using the augmented Dickey–Fuller test (ADF-test) with the null hypothesis that the data is not stationary (Brockwell and Davis, 2002; Tsay, 2005; Wei, 2006).

Many studies in the literature discuss cointegration tests using the vector autoregressive (VAR) model (Tsay, 2013). To test cointegration in the VAR(p) model, Johansen's method is generally used (Johansen, 1991). Suppose X_t is a vector variable with k-dimensional, then the VAR(p) model as shown in Equation (1):

$$X_t = \Phi_0 + \sum_{i=1}^{p} \Phi_i X_{t-i} + u_t \tag{1}$$

where Φ_0 is a vector constant, Φ_i is a $k \times k$ matrix parameters at the i-th lag, and u_t is a sequence of random vectors with mean zero and positive definite covariance matrix, Cov(u_t)=Σ_u.

2.3 Cointegration Test

The existence of cointegration can be tested using the trace test analysis, which is a test to measure the number of cointegration vectors in time series data using the cointegration rank test. The hypothesis used is as follows:

The null hypothesis is $H_0 : r = 0$; with the alternative hypothesis is $H_1 : r > 0$, where r is the rank of cointegration. The test statistics are as in Equation (2):

$$Tr(r) = -n \sum_{i=r+1}^{m} \ln(1 - \widehat{\lambda}_i) \tag{2}$$

where
$i = 1, 2, \cdots, p$
$\widehat{\lambda}$: the estimation of eigen value
n : total of observations
r : rank cointegration
m : number of endogenous variables

If the trace test value is greater than the critical value at the significant level = 5% or the p-value is less than 5%, then H_0 is rejected, which means that cointegration occurs (Kirchgässner et al., 2012).

2.4 Granger-Causality Test

The Granger causality is used to evaluate the causality relationship between variables in multivariate time series data (Siggiridou and Kugiumtzis, 2015). Granger causality was introduced by Granger (Wei, 2006). For the model where Y is Granger cause X, the model in Equation (3) can be used (Hamilton, 1994):

$$\begin{aligned} X_t = {} & c_1 + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \cdots + \alpha_p X_{t-p} + \beta_2 Y_{t-1} + \\ & \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} +_1 u_t \end{aligned} \tag{3}$$

2.5 Impulse Response Function (IRF)

The VAR model can be written as the Vector Moving Average as presented in Equation (4):

$$X_t = \mu + \mu_t + \Psi_1 \mu_{t-1} + \Psi_2 \mu_{t-2} + \cdots \tag{4}$$

where matrix Ψ_s is interpreted as follows:

$$\frac{\partial X_{t+s}}{\partial u_t} = \Psi_s \tag{5}$$

Row i and column j of the element Ψ_s in Equation (5) identify the consequences of a one-unit increase in the innovation of the j-th variable at date t (u_{jt}) for the i-th variable at time $t + s(X_{i,t+s})$, with the assumption that all the other innovations are fixed. If the first element u_t is changed by as big as δ_1, and at the same time, the second element is changed by as big as $\delta_2, \cdots$, and the n-th element is changed by as big as δ_n, then the joint effects of these changes on the value of vector (X_{t+s}) is written in Equation (6) as follows:

$$\Delta X_{t-s} = \frac{\partial X_{t+s}}{\partial u_{1t}} \delta_1 + \frac{\partial X_{t+s}}{\partial u_{2t}} \delta_2 + \cdots + \frac{\partial X_{t+s}}{\partial u_{nt}} \delta_n = \Psi_s \delta \tag{6}$$

The plot of the i-th row and j-th column of element Ψ_s is

$$\frac{\partial X_{i,t+s}}{\partial u j_t} \tag{7}$$

A function of s in Equation (7) is called the Impulse Response Function (IRF) (Warsono et al., 2019).

2.6 Vector Error Correction Model (VECM)

The general form of the VECM is as in Equation (8) (Rachev et al., 2007; Tsay, 2013):

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t \tag{8}$$

where
Δ : differencing operator, $\Delta X_t = X_t - X_{t-1}$,
X_{t-1} : first lag of the vector variable endogenous,
ε_t : vector residuals of $(k \times 1)$,
$\prod$: matrix coefficient of cointegration, $\prod = \alpha\beta^t; \alpha =$ vector adjustment, matrix of order $(k \times r)$ and β = vector cointegration (long-run parameter) matrix $(k \times r)$,
Γ_i : matrix coefficient of order $(k \times k)$ of the i-th variable endogenous coefficient variable (Lütkepohl, 2005).

2.7 Threshold Vector Error Correction Model

The threshold cointegration, TVECM), was introduced by Balke and Fomby (1997) in which the adjustment was not made immediately. Threshold cointegration is a feasible technique to combine cointegration and nonlinearity by allowing nonlinear adjustments in the long run (Wei, 2018). The TVECM equation is written in Equation (9) as follows:

$$\Delta X_t = \begin{cases} A_1^T X_{t-1}(\beta) + \varepsilon_t, \text{ if } W_{t-1}(\beta) \le \gamma \\ A_2^T X_{t-1}(\beta) + \varepsilon_t, \text{ if } W_{t-1}(\beta) > \gamma \end{cases} \tag{9}$$

where A_1 and A_2 are matrix coefficients in the two regimes, where $A_1 = A_2$ when there is no threshold, and γ is a threshold parameter.

3. RESULTS AND DISCUSSION

The data used in this study were of Indonesian production of oil and gas during the period January 2019 to March 2021. The following are the results of the checked for the assumption of stationary data using the ADF test.

Figures 1(a) and 1(b) are the plots of the ACF and IACF test results after differentiation with d = 1. After differentiation, the data fluctuate around certain numbers, and the data become stationary. The result of ADF-test can also be seen in Table 1. The results of the ADF test show that the p-value of the production of oil and gas data is <0.0001. Therefore, the null hypothesis is rejected and can be concluded that these data are stationary in the first differentiation.

3.1 Test for Lag Optimum

Next, to find the optimum lag for the model it was carried out by using the information criteria of Corrected Akaike Information Criterion (AICC), Akaike Information Criterion (AIC), Hannan-Quinn Information criterion (HQC), Schwartz Bayesian Criterion (SBC) and Final Prediction Error Criterion (FPEC) from each model. From Table 2, the five criteria used. The information that has a minimum value, which is marked with an asterisk (*), is in lag 4.

3.2 Test for Cointegration

Furthermore, the cointegration test was conducted out on the model with the following hypothesis: $H_0 : r = 0$ (there is no cointegration), with $H_1 : r > 0$ (there is cointegration). From Table 3, the p-value for rank = 1 is smaller than the significance limit used, namely, $\alpha = 0.05$, so there is not enough evidence to reject H_1 : rank > 0. Thus, it can be said that there is significant cointegration at $\alpha = 5\%$.

3.3 Test for Granger Causality

In Table 4, the magnitude of the p-value for the first null hypothesis is 0.0098 and the second is 0.0174. Both p-values are less than 0.05, so the decision for both hypotheses is to reject H_0. As production of oil affects production of oil and gas and vice versa, the causality relationship that occurs is a two-way causality relationship, which means that the two variables influence each other.

3.4 VECM

Next, we estimate the parameters of the VECM in Equation (8), which are presented in Table 5.

From Table 5, the VECM can be written in Equation (10) and Equation (11) as follows:

$$\begin{aligned} \text{PO} = &- 1.51247\text{ECT}_{t-1} + 0.44251PO_{t-1} \\ &- 0.00298\text{PMG}_{t-1} + 0.38676\text{PO}_{t-2} \\ &- 0.00154\text{POG}_{t-2} + 0.34477\text{PO}_{t-3} \\ &+ 0.00016\text{POG}_{t-3} \end{aligned} \tag{10}$$

$$\begin{aligned} \text{POG} = &4.37822\text{ECT}_{t-1} - 2.55374\text{PO}_{t-1} \\ &+ 1.27971\text{POG}_{t-1} - 1.74155\text{PO}_{t-2} \\ &+ 0.65352\text{POG}_{t-2} + 0.74553\text{PO}_{t-3} \\ &+ 0.15842\text{POG}_{t-3} \end{aligned} \tag{11}$$

where PO is the production of oil, and POG is the production of oil and gas.

3.5 IRF

From Figure 2, the production of oil (PO) variable gave a shock to the production of oil and gas (POG) variable and to itself.

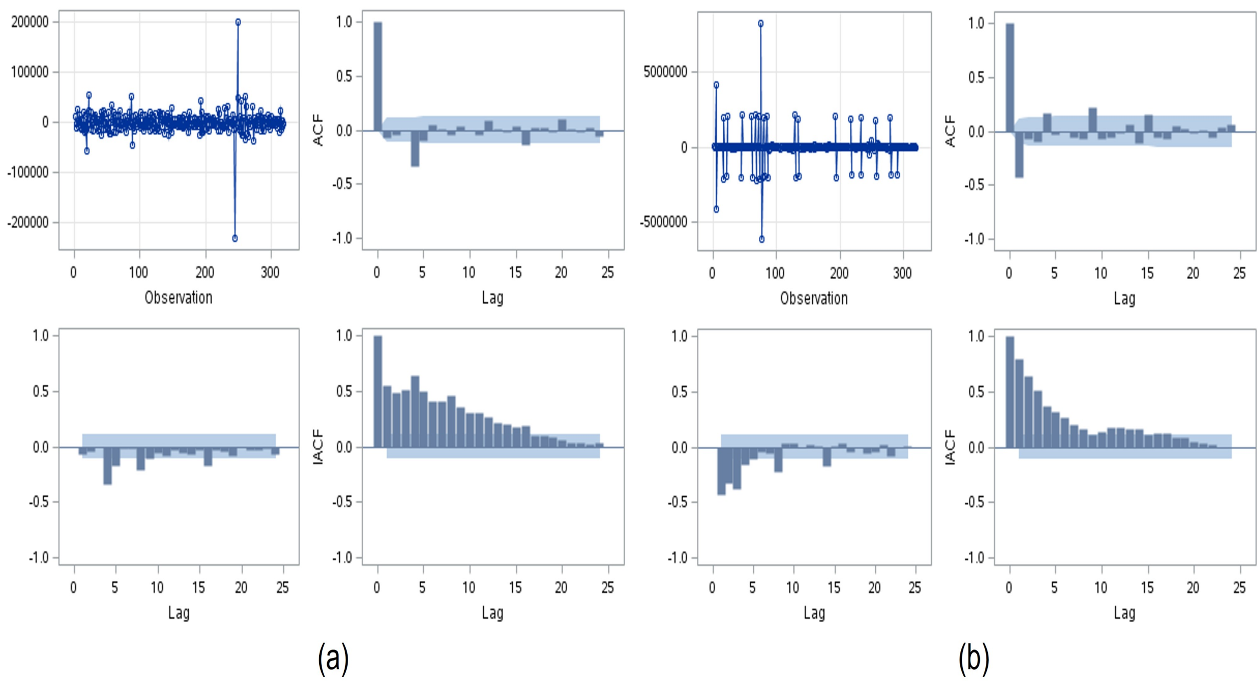

Figure 1. Residual Plot, ACF, PACF, and IACF After Differentiation with d = 1: (a) for Production of Oil (PO) and (b) for Production of Oil and Gas (POG)

Table 1. ADF Test or Unit Root Test for Production of Oil and Gas Data Before and After Differentiating (d = 1)

Variable	Type	Before Differentiation				After Differentiation			
		Rho	*p*-Value	Tau	*p*-Value	Rho	*p*-Value	Tau	*p*-Value
Production of Oil	Zero Mean	-0.2278	0.6307	-0.43	0.5254	-367.169	0.0001	-13.51	<0.0001
	Single Mean	-83.9593	0.0016	-6.40	<0.0001	-367.239	0.0001	-13.49	<0.0001
	Trend	-122.486	0.0001	-7.77	<0.0001	-367.302	0.0001	-13.47	<0.0001
Production of Oil and Gas	Zero Mean	-3.9000	0.1743	-1.47	0.1324	-881.995	0.0001	-20.93	<0.0001
	Single Mean	-88.7562	0.0016	-6.49	<0.0001	-882.370	0.0001	-20.90	<0.0001
	Trend	-136.692	0.0001	-8.17	<0.0001	-883.209	0.0001	-20.88	<0.0001

From the first lag to the fourth lag, the production of oil variable response gave a shock to itself with a continuous negative response, namely -0.0630 , -0.0609, -0.0252, and -0.3359 respectively for the first lag to the fourth lag. Furthermore, in the fifth to the eight lag, the response of the production of oil variable gives a shock with a positive response that moved closer to the zero-balance point, namely, 0.0409, 0.0487, 0.0107 and 0.1119 respectively for the fifth lag to the eight lag. Fron the ninth lag and on the response move to stable condition.

Meanwhile, production of oil gave a shock to production of oil and gas, with the first lag responding positively at 1.7654 and then responding negatively, dropping to -0.0200 in the second lag. In the third lag, the negative response occurred again at -1.6912 and then increase dramatically to a positive response of 2.5574 at the fourth lag. The increase occurred again in the fifth and sixth lag namely 0.4744 and 0.8886 respectively. In the seventh lag and on the response move the stable condition.

From Figure 2(b), the production of oil and gas (POG) variable gave a shock to the production of oil (PO) variable and itself. The presence of a shock of one standard deviation in production of oil and gas (POG) has no effect on changes in production of oil (Figure 2b) showing the response of production of oil (PO) plat. Meanwhile, production of oil and gas (POG) gave a shock to itself with the first lag, responding negatively at -0.8102 and then increasing, with a positive responses of 0.0414 and 0.0768 respectively for the second and third lag. Furthermore, in the fourth lag, a negative response occurred at -0.1081. The fifth lag and on the response tend to stable condition.

Table 2. Test for Lag Optimum

VAR Lag Order Selection Criteria					
Lag	AICC	HQC	AIC	SBC	FPEC
1	47.32303	47.35109	47.32267	47.39382	3.564E20
2	47.24322	47.28968	47.2422	47.36105	3.289E20
3	47.10589	47.17051	47.10387	47.27065	2.864E20
4	46.87101*	46.95351*	46.86763*	47.08256*	2.261E20*

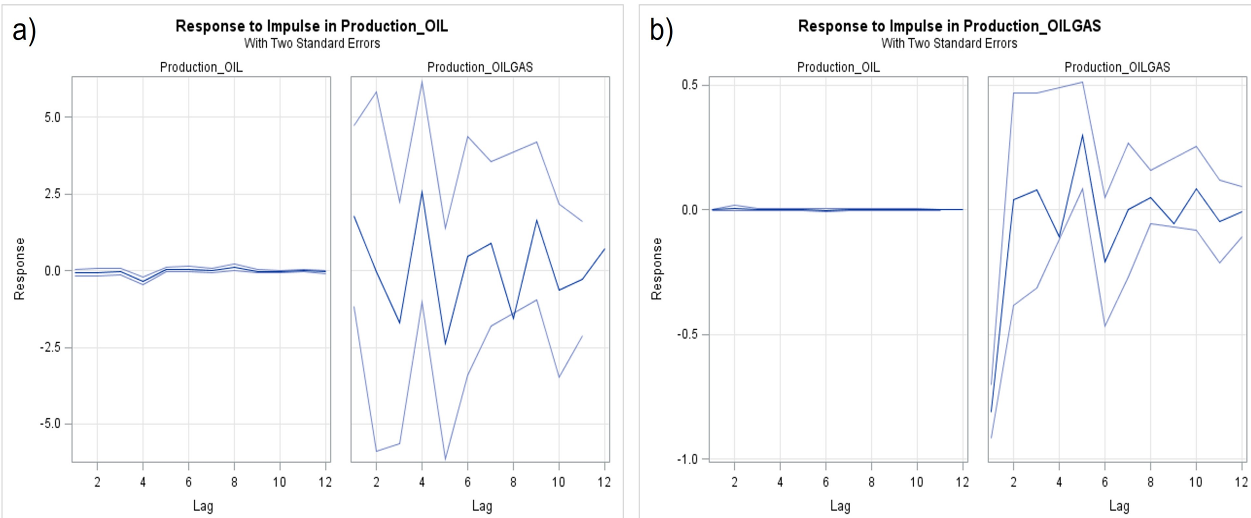

Figure 2. Response to Impulse in (a) Production of Oil (PO) and (b) Production of Oil and Gas (POG)

Table 3. Test for Cointegration

Cointegration Rank Test Using Trace				
H_0 : Rank = r	H_1 : Rank > r	Eigenvalue	Trace	Pr > Trace
0	0	0.5824	420.4684	<0.0001
1	1	0.3671	144.5489	<0.0001

Table 4. Granger Causality Test

Null Hypotheses	F-Statistic	p-Value
The Production of Oil and Gas has No Impact on Production of Oil	4.69799	0.0098
The Production of Oil has No Impact on Production of Oil and Gas	4.10592	0.0174

3.6 TVECM

The next step is to test the significance of the existence of a threshold. This test aims to see whether the TVECM is appropriate or not. The hypothesis used in this study is: H_0: the model is a linear VECM, with the alternative H_1: the model is a TVECM.

The significance of the presence of a threshold was tested using the SupLM method, where the p-value was obtained using the fixed regressor bootstrap method. The number of bootstrapping replications used was 1000 replications. Table 6 shows the results of testing the significance of the existence of a threshold:

The results of the test against the threshold obtained the SupLM value of 18.4399 with a p-value of 0.027. The results of this test indicate that the presence of a threshold in the modeling of Indonesia's production of oil and gas is correct, so that TVECM modeling is appropriate.

Figure 3 shows that the residuals for production of oil have a slight deviation from the normal distribution, this is shown by the QQ-plot (Figure 3(b)) which does not form a straight line, but from a normal probability plot with a histogram (Figure 3(a)) shows relatively small deviations from the normal distribution. Figure 4 shows that the residuals for Oil and Gas production have a slight deviation from the normal distribution, this is because some of the residuals are outliers. This is shown by the QQ-plot (Figure 4(b)) which does not form a

Table 5. Estimation of Parameters of the VECM

Equation	Parameter	Estimate	Standard error	t Value	p-Value	Variable
D_Production Oil	AR1_1_1	-1.51247	0.11412			Production Oil (t-1)
	AR1_1_2	0.00246	0.00569			Production Oil and Gas (t-1)
	AR2_1_1	0.44251	0.09725	4.55	0.0001	D_Production Oil (t-1)
	AR2_1_2	-0.00298	0.00458	-0.65	0.5158	D_Production Oil and Gas (t-1)
	AR3_1_1	0.38676	0.07739	5.00	0.0001	D_Production Oil (t-2)
	AR3_1_2	-0.00154	0.00316	-0.49	0.6267	D_Production Oil and Gas (t-2)
	AR4_1_1	0.34477	0.05300	6.51	0.0001	D_Production Oil (t-3)
	AR4_1_2	0.00016	0.00164	0.10	0.9205	D_Production Oil and Gas (t-3)
D_Production Oil and Gas	AR1_2_1	4.37822	3.68903			Production Oil (t-1)
	AR1_2_2	-3.03610	0.18394			Production Oil and Gas (t-1)
	AR2_2_1	-2.55374	3.14376	-0.81	0.4172	D_Production Oil (t-1)
	AR2_2_2	1.27971	0.14817	8.64	0.0001	D_Production Oil and Gas (t-1)
	AR3_2_1	-1.74155	2.50166	-0.70	0.4869	D_Production Oil (t-2)
	AR3_2_2	0.65352	0.10209	6.40	0.0001	D_Production Oil and Gas (t-2)
	AR4_2_1	0.74553	1.71331	0.44	0.6638	D_Production Oil (t-3)
	AR4_2_2	0.15842	0.05297	2.99	0.0030	D_Production Oil and Gas (t-3)

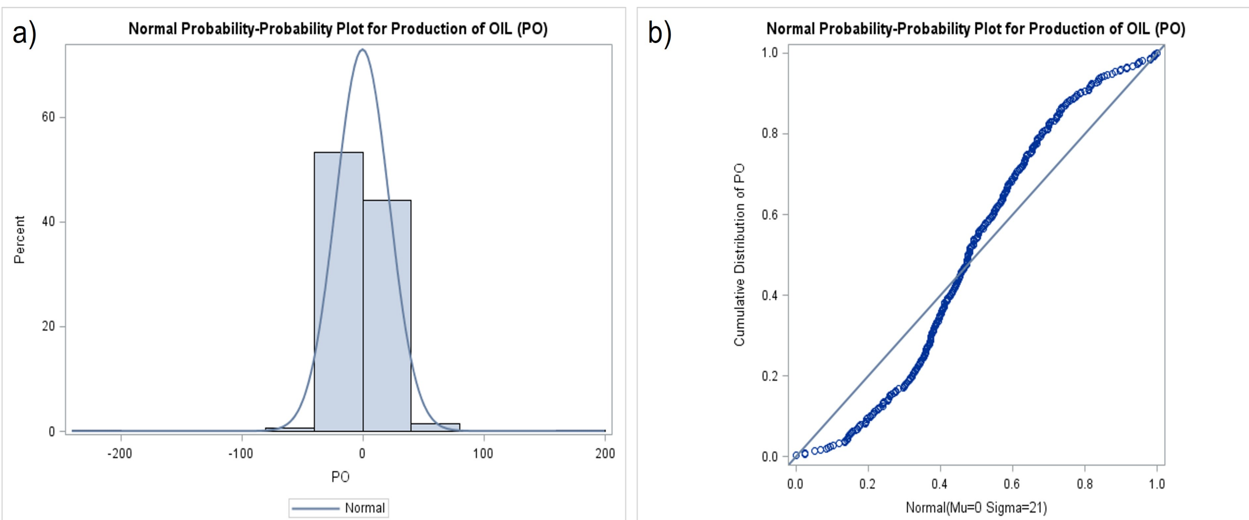

Figure 3. Normal Probability Plot Production of Oil (a) Histogram, (b) QQ Plot of Residuals

Table 6. Estimation of Parameters of the VECM

Level of Significance	Critical Value	Test Statistic	p-Value	Conclusion
1%	21.2496			Reject H_0
5%	16.9355	18.4399	0.027	Reject H_0
10%	15.1906			Reject H_0

straight line, but from a normal probability plot (Figure 4(a)) shows relatively small deviations from the normal distribution.

In Table 7, coefficient ECT_{t-1} shows the speed of adjustment of a variable when it deviates from the equilibrium value to return to balance. The value of coefficient ECT_{t-1} is significant only in the production of oil model in regime 2. This indicates that the behavior of production of oil will respond to the imbalance significantly when the magnitude of the deviation (ECT_{t-1}) has passed a certain threshold value. The threshold value is indicated by the threshold value of 42599. Production of oil will tend to decrease in response to the imbalance that occurs, where 39.78% of the imbalance that occurs will be corrected every day when the deviation value is below 42599. The TVECM 2 regime model is presented in Equations (12)-(15) as follows:

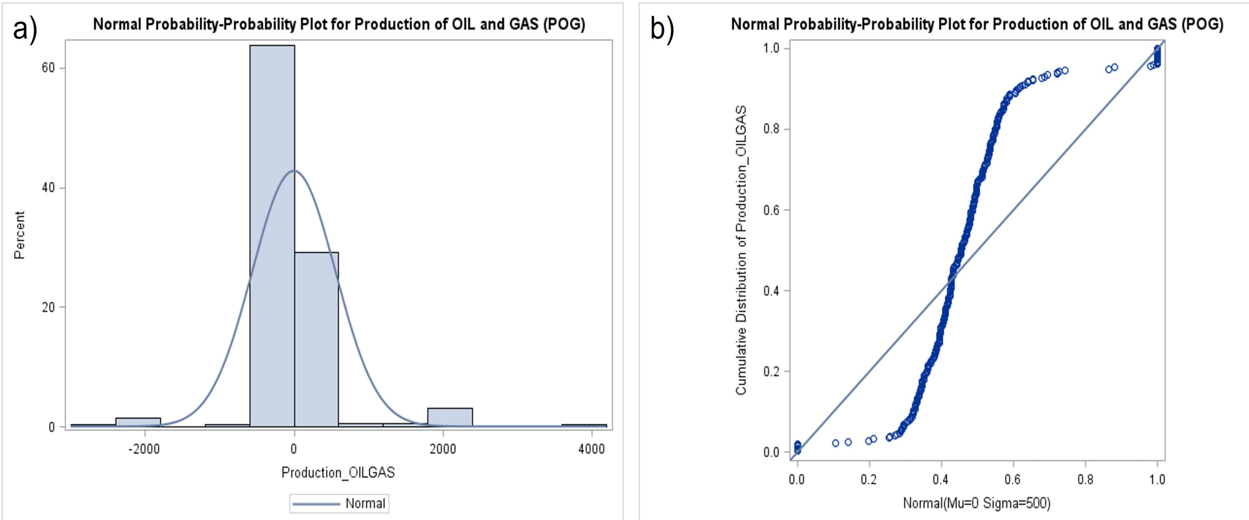

Figure 4. Normal Probability Plot for Production Oil and Gas (a) Histogram, (b) QQ Plot of Residuals

Table 7. Estimation of Coefficient of Parameters of the TVECM 2 Regime

Coefficient	First Regime (6.7%)		Second Regime (93.3%)	
	Production of Oil	Production of Oil and Gas	Production of Oil	Production of Oil and Gas
ECT_{t-1}	-0.3978	7.3710	-0.0033	-0.1247
	(0.0493)	(0.3223)	(0.7786)	(0.7433)
Intercept	8958.7700	-1017505.6089	-934.4779	50597.7211
	(0.3974)	(0.0037)**	(0.5025)	(0.2703)
Production Oil_{t-1}	0.2247	-9.1954	-0.0543	2.2919
	(0.2824)	(0.1815)	(0.4010)	(0.2814)
Production Oil and Gas_{t-1}	-0.0710	0.6623	-0.0038	-0.4695
	(0.0793)	(0.6179)	(0.2262)	(6.4e-06)***
Production Oil_{t-2}	0.3676	-8.9249	-0.0754	0.7492
	(0.0915)	(0.2126)	(0.2366)	(0.7206)
Production Oil and Gas_{t-2}	-0.0717	0.7005	0.0012	-0.4209
	(0.0809)	(0.6034)	(0.6709)	(7.2e-06)***
Production Oil_{t-3}	0.2382	-6.1016	-0.0314	1.7480
	(0.1228)	(0.2293)	(0.6220)	(0.4045)
Production Oil and Gas_{t-3}	-0.0023	0.1637	0.0013	-0.4155
	(0.7686)	(0.5285)	(0.6034)	(9.2e-07)***
Production Oil_{t-4}	-0.6053	-8.9262	-0.0697	-0.9681
	(0.0002)***	(0.0882)	(0.2773)	(0.6465)
Production Oil and Gas_{t-4}	0.0002	-0.1009	4.2e-05	-0.1677
	(0.9676)	(0.4175)	(0.9840)	(0.0156)*

3.7 First Regime

$$\begin{aligned} PO = {} & 8958.7700 - 0.3978ECT_{t-1} + 0.2247PO_{t-1} - \\ & 0.0710POG_{t-1} + 0.3676PO_{t-2} - \\ & 0.0717POG_{t-2} + 0.2382PO_{t-3} - \\ & 0.0023POG_{t-3} - 0.6053PO_{t-4} + \\ & 0.0002POG_{t-4} \end{aligned} \tag{12}$$

$$\begin{aligned} POG = {} & -1017505.6089 + 7.3710ECT_{t-1} - \\ & 9.1954PO_{t-1} + 0.6623PMG_{t-1} - \\ & 8.9249PO_{t-2} + 0.7005POG_{t-2} - \\ & 6.1016PO_{t-3} + 0.1637POG_{t-3} - \\ & 8.9262PO_{t-4} - 0.1009POG_{t-4} \end{aligned} \tag{13}$$

3.8 Second Regime

$$PO = -934.4779 - 0.0033ECT_{t-1} - 0.0543PO_{t-1} - 0.0038POG_{t-1} - 0.0754PO_{t-2} + 0.012POG_{t-2} - 0.0314PO_{t-3} + 0.0013POG_{t-3} - 0.0697PO_{t-4} + 0.000042POG_{t-4} \quad (14)$$

$$POG = 50597.7211 - 0.1247ECT_{t-1} - 2.2919PO_{t-1} - 0.4695POG_{t-1} + 0.7492PO_{t-2} - 0.4209POG_{t-2} + 1.7480PO_{t-3} - 0.4155POG_{t-3} - 0.9681PO_{t-4} - 0.1677POG_{t-4} \quad (15)$$

4. CONCLUSION

The best model for the relationship between the variables of production of oil and production of oil and gas Indonesia is TVECM 2 regime model (Equations (12), (13), (14), and (15)). Based on the results of the Granger-causality test, it can be concluded that the causal relationship between production of oil and Indonesian production of oil and gas is a two-way causality relationship. This means that the current production of oil is influenced by the production of oil and gas of the previous period and the current production of oil and gas is influenced by the production of oil of the previous period. From the cointegration test, there is a long-term balance relationship between production of oil and production of oil and gas in Indonesia. Based on model TVECM with 2 regimes, it can be concluded that adjustments will be made significantly only if the imbalance is less than 42599, where production of oil will decrease by around 39.78% of the imbalance that occurs. Based on the results of the IRF analysis, it can be concluded that if there is a shock in production oil or production of oil and gas in Indonesia, only give effect on production of oil and gas.

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