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IMPLICATIONS OF THE GLASGOW AGREEMENT (COP26) PHASING DOWN OF UNABATED COAL POWER ON INDONESIA'S TRADE BALANCE

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Abstract

At the 26th annual United Nations climate change conference (COP26) in Glasgow, Scotland, 197 countries succeeded in reaching an agreement to address the "Phase-down of Unabated Coal Power", i.e. the gradual reduction of coal-fired power generation and to ends fossil fuel subsidies that are not in efficient. Its going with the policy of Indonesia Government, in the General Draft of National Energy (RUEN), they will limit coal production up to 400 million tons per year and the exports will be reduced gradually from year to year and will be stopped on 2046. In another hand, China and India's dependence on coal energy for power generation and industry is still very high. Both countries demanding will affect Indonesia's trade balance considering the proportion of Indonesia's coal exports is 71% compared to domestic consumption. To determine this effect, this study uses the Autoregression Vector (VAR) model with annual data from 2000 to 2021. The test results show that Indonesia's coal exports have an effect on the trade balance by 13.17% in terms of the total export value. International coal price will have a positive impact on the Indonesia's trade balance by 17.91%. However, the price of coal is very influential on the volume of Indonesia's coal export. Momentum of Phase-down Coal is a golden opportunity to maximize economic benefits while preparing renewable energy as a substitute for coal.

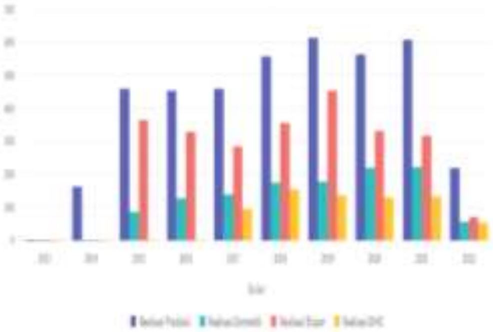
Keywords : Coal, export, Consumption, price, Balance of trade, VAR.

INTRODUCTION

At the 26th annual United Nations (UN) climate change conference (COP26) in Glasgow, Scotland, 197 countries reached an agreement on 13 November 2021 on reducing coal consumption. Participants committed to accelerating the "Phasedown of Unabated Coal Power", namely the gradual decline of coal-fired power plants and the termination of inefficient fossil fuel subsidies (Burki, 2022). This Glasgow Conference (COP26) highlighted the need for a rapid transition to a clean economy to meet the goals of the Paris Agreement. A crucial part of this transition is the energy transition from fossil fuels to renewable energy since electricity and heat production account for a quarter of global greenhouse gas emissions (Sharma et al., 2022). COP26 claims to "move away from coal and towards clean power about five times faster than at present" (Nerlinger & Utz, 2022).

Coal is a fossil fuel from organic compound deposits formed naturally from plant remains (Law No. 4 of 2009). According to, coal has more than 50 percent by weight (or 70 percent by volume) of carbon material produced by the compaction and hardening of plant residues called peat deposits. The varieties of coal differ due to differences in the type of plant material (coal type), degree of coalification (coal rank), and range of impurity (coal grade).

Table 1. Indonesian Coal Production and Sales, 2013 - 2022



Source: MODI, 2022

Based on information obtained from the Ministry of Energy and Mineral Resources (2021), Indonesia's coal resources as of 2021 amount to 143.7 billion tons and reserves of 38.84 billion tons. Kalimantan has 88.31 billion tons of resources and 25.84 billion tons of coal reserves. Sumatra has 55.08 billion tons of resources and 12.96 billion tons of coal reserves. With an average coal production of 600 million tonnes per year, Indonesia's coal reserves are still 65 years old, assuming no new founding. Until now, most of Indonesia's coal is still exported to various countries that rely on coal as a source of electrical energy, especially China and India. In 2020, it was recorded that 71.9% (238.2 million tons) of coal produced was used for export purposes (DEN, 2021).

The Glasgow COP26 agreement has the potential to impact Indonesian coal production, consumption, and exports. In this paper, the author tries to describe the impact of implementing the Phasedown of Unabated Coal Power Agreement on Indonesia's trade balance using the Vector Autoregressive (VAR) approach and Game Theory (Putra & Damanik, 2017).

METHOD RESEARCH

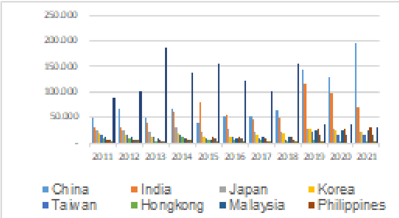
Based on the previous explanation, the purpose of this study was to determine the effect of production, consumption, price, and export of coal on the trade balance. (In this paper, the trade balance uses a proxy for Indonesia's total export value). So it can be said that this research belongs to associative research. According to Sugiyono (2015), associative research is research that aims to determine the effect or relationship between two or more variables. In many cases, the relationship between variables in a dynamic system cannot be explained using a single equation model but must use dynamic equations (Mahyus & Riyanto, 2005).

In this study, the authors used the VAR (Vector Autoregressive) model to analyze the relationship between variables using time series data. Implementation of the Government's COP26 and RUEN coal pashing-down regarding reducing coal consumption gradually until 2046 is transmitted in the form of a domestic coal consumption shock/innovation of one standard deviation or commonly referred to as the Impulse Response Function (Gujarati, 2003), (Mahyus & Riyanto, 2005).

At the end of the discussion, the author adds a shock simulation obtained from the Game Theory simulation payoff value. According to (McMillan, 2013), Game Theory is a mathematical technique for analyzing situations where the utility of each agent does not depend only on its own actions but also on the actions of others; all agents consider this interdependence when deciding their actions. Von Neumann and Morgenstern explain the difference between game theory problems and optimization problems that are usually solved more simply by using economic theory, such as the consumer maximization problem. Game theory has relatively little influence on international economic theory, but many policy issues in the international trade economy have game theory characteristics, for example, joint tariff reduction negotiations, FTAs , and others. Several game theory scenarios in economics can be in the form of static & dynamic games of complete information and static & dynamic game of incomplete information.

Figure 1: Framework

Source: Berbagai sumber, diolah (2022)



Source: HEESI 2022, diolah

RESULT AND DISCUSSION

European, American, and British coal embargoes from Russia have had a major impact on world coal prices. The scarcity of coal experienced by importers requires them to look for alternative sources of coal suppliers even though the price is higher. Power outages in India occur for eight hours a day due to coal scarcity, the need for cooking coal from Australia is also hampered by the high increase in coal prices in Australia, the United States, and Canada. Factories experienced a slowdown, schools were closed, demonstrations occurred, and so on. India is heavily dependent on coal, with as many as four million people directly and indirectly employed in India's coal industry, according to a recent report from the Brookings Institution. The majority of coal reserves are located in the east - the so-called Coal Belt - in the states of Jharkhand, Chhattisgarh, and Odisha. In this region, coal also drives the economy. It is the lifeline of the local communities, which are some of the poorest in India. Changing energy from coal to cleaner energy sources still takes a long time so that no parties and interests are left behind.

Based on research (Li et al., 2019), using two single forecasting models: Metabolic Gray Model (MGM) and Back-Pro-Pagation Network (BP) to make predictions from India's coal consumption data for 1995–2017. The forecast results show that coal consumption in India will continue to increase on an annual basis at an average of 2.5% over the period 2018–2030.

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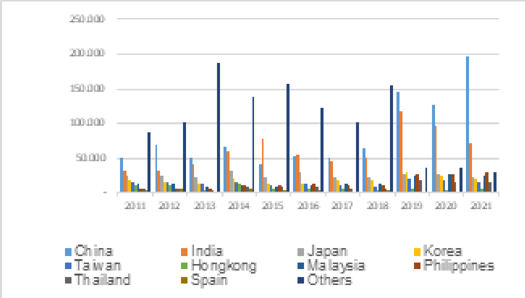
Figure 2: Indonesia's Coal Exports According to Destination Countries 2011-2021



Source: HEESI 2022, diolah

China is the largest coal importer of Indonesia, followed by India, Japan, Korea, the Philippines, and Taiwan. In 1980 China's coal consumption amounted to 714.7 million tons which were met by national production. Since 2005 China's coal production no longer meets national coal consumption. For example, in 2016 China's coal consumption was 4.3 billion tons, and only 86 percent of domestic production was met, the rest was obtained from imports, one of which was from Indonesia amounting to 53.9 million tons, and in 2021 Chinese coal imports from Indonesia amounted to 196.2 million tonnes (Ministry of Energy and Mineral Resources, 2022).

According to research (Lin et al., 2018), coal burning to power China's factories, generate electricity, and heat buildings have steadily increased since China's energy use statistics were first published in 1981. However, from 2013 to 2015, this trend reversed and coal use decreased from 2810 million metric tons of coal equivalent (Mtce) to 2752 Mtce, leading to a reduction in China's overall CO2 emissions. Some analysts have suggested that China's coal consumption may have peaked . However, preliminary data suggest that coal consumption increased in 2017. Lin finds that this projected increase will lead to near-term growth in China's coal use to levels of around 2,900 Mtce to 3,050 Mtce in 2020, with a corresponding increase in CO2 emissions associated with energy.

The Russian coal embargo caused a shortage of coal in India and China, which in turn led to significant price increases. On the other hand, this price increase benefits Indonesia. According to Kontan.co.id (2022), the price of Newcastle coal for the July 2022 trading contract is at $343.9 per ton, this price has jumped 177.79% compared to early 2022. According to Tradeindo.co-Founder, Wahyu (2022), the price of bricks will be around US $ 340-350 per ton until the end of 2022. On the other hand, the high price of coal has a positive effect on the Indonesian economy, especially Indonesia's trade balance. Indonesia's profits are obtained from two aspects, namely the volume aspect and the price aspect (Zhongming et al., 2021).

Table 3: Export-Import of Indonesian Coal Products 2011-2021

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Source: Handbook of Energy & Economic Statistics of Indonesia, 2022

Seeing that coal consumption tends to increase, national coal production will also continue to increase because coal is still a cheap type of fossil fuel and is very much needed to meet the needs of power plants and several industries such as cement, steel and other industries.

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Domestic coal consumption is dominated by the power generation sector (PLTU) with an average of 61% of national coal consumption (Directorate of Energy Mineral Resources and Mining BAPPENAS, 2016).

Table 4: Indonesian Coal Product User Industry 2011-2021

Source: Handbook of Energy & Economic Statistics of Indonesia, 2022

The basis for meeting domestic demand for coal is supported by regulations issued by the government, namely: 1. In 2006, the role of coal in the country became increasingly important since the issuance of Presidential Regulation Number 71 of 2006 regarding the assignment to PT. State Electricity Company (Persero) to accelerate the development of power plants that use coal to accelerate the energy diversification of power plants to non-oil fuels in order to meet the demand for electric power.

Based on the Central Bureau of Statistics (2015, 2020), the value of GDP from 2000 to 2018 shows an increasing trend. In addition, according to the Ministry of Energy and Mineral Resources (2016, 2018), domestic coal consumption and coal exports also experienced an increasing trend. The increasing trend of these three variables indicates a unidirectional relationship which will be tested using the vector autoregression (VAR) approach so that the impact of coal exports and domestic coal consumption on economic growth can be identified.

1. Multivariate Data Processing Using the VAR-VECM Model

The data used in this study are as follows:

Table 5: Research Data

	Produksi	Kons Dom	Harga	Ekspor BB	Kurs	Total Ekspor
Tahun	Ribu Ton	Ribu Ton	USD/MT	Ribu Ton	Rp-USD	Miliar USD
1	2	3	4	5	6	7
Year	P	K	H	Ev	Kr	Ex
2000	77,040	27,311	27.22	58,460	9,595	62,124
2001	92,540	31,265	27.95	65,281	10,400	57,365
2002	103,329	32,250	28.82	74,178	8,940	59,165
2003	114,278	36,012	28.4	85,681	8,465	64,109
2004	132,352	39,773	31.57	93,759	9,290	66,084
2005	152,722	45,581	36.8	110,790	9,830	81,682
2006	193,761	47,823	38.09	143,633	9,020	87,197
2007	216,947	51,439	38.41	163,000	9,419	111,303
2008	240,250	58,944	47.33	191,430	10,950	132,226
2009	256,181	72,611	71.91	198,366	10,363	113,266
2010	275,164	72,752	99.78	208,000	9,078	149,966
2011	353,271	79,558	121.67	272,671	9,069	191,109
2012	386,077	82,143	97.11	304,052	9,793	187,346
2013	474,371	72,070	85.18	356,357	12,173	182,089
2014	458,097	76,180	70.78	381,973	12,388	175,293
2015	461,248	86,814	59.16	365,849	13,788	149,124
2016	456,198	90,550	66.10	331,127	13,473	144,470
2017	461,248	97,030	96.85	286,936	13,555	168,883
2018	557,773	115,080	123.88	356,395	14,390	180,725
2019	616,160	138,418	77.80	454,500	13,866	168,455
2020	563,728	131,887	60.54	405,054	14,050	163,402
2021	613,990	133,043	137.09	435,216	14,263	232,835

From the data above, the following research model equation is made:

$$Ex_t = \beta_{11} + \sum_{=1}^{p} \beta_{12}\, Ex_{t-1} + \sum_{=1}^{p} \beta_{13}\, K_{t-p} + \sum_{=1}^{p} \beta_{14}\, H_{t-p} + \sum_{=1}^{p} \beta_{15}\, Ev_{t-p} + \varepsilon_{Ex_t} \quad (1)$$

$$K_t = \beta_{21} + \sum_{=1}^{p} \beta_{22}\, K_{t-1} + \sum_{=1}^{p} \beta_{23}\, Ex_{t-p} + \sum_{=1}^{p} \beta_{24}\, H_{t-p} + \sum_{=1}^{p} \beta_{25}\, Ev_{t-p} + \varepsilon_{K_t} \quad (2)$$

$$H_t = \beta_{31} + \sum_{=1}^{p} \beta_{32}\, H_{t-1} + \sum_{=1}^{p} \beta_{33}\, Ex_{t-p} + \sum_{=1}^{p} \beta_{34}\, K_{t-p} + \sum_{=1}^{p} \beta_{35}\, Ev_{t-p} + \varepsilon_{H_t} \quad (3)$$

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$$Ev_t = \beta_{41} + \sum_{=1}^{p} \beta_{42}\, Ev_{t-1} + \sum_{=1}^{p} \beta_{43}\, Ex_{t-p} + \sum_{=1}^{p} \beta_{44}\, K_{t-p} + \sum_{=1}^{p} \beta_{45}\, H_{t-p} + \varepsilon_{Ev_t} \quad (4)$$

The above equation can be made in the form of a matrix equation as follows:

$$\begin{bmatrix} Ex_t \\ K_t \\ H_t \\ Ev_t \end{bmatrix};\ A_0 = \begin{bmatrix} \beta_{11} \\ \beta_{21} \\ \beta_{31} \\ \beta_{41} \end{bmatrix};\ \ A = \begin{bmatrix} \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \end{bmatrix};\ \ \varepsilon = \begin{bmatrix} \epsilon_{Ex_t} \\ \epsilon_{K_t} \\ \epsilon_{H_t} \\ \epsilon_{Ev_t} \end{bmatrix}$$

So that the equation in this study can be simplified to:

Y_t = A_0 + 〚AY〛_(t-p) + ε_Yt (6)

Information:

Ex = Total Value of Indonesian Exports (billions of USD), as a proxy for the Trade Balance.
K = Indonesian Coal Consumption (Thousand tons)
H = Reference Coal Price (ICE NewCastle) (USD)
Ev = Total Coal Export Volume

The data collected in this study has a non-linear pattern, therefore the non-linear data is first transformed into a natural logarithmic form (Ln) (Matondang & Nasution, 2022). Transformations using natural logarithms are generally used when there is a non-linear relationship between the independent and dependent variables. The logarithmic transformation will make the relationship that was originally non-linear usable in a linear model. In addition, logarithmic transformation can change data that originally had a skewed distribution or was not normally distributed to become or at least close to a normal distribution (Benoit, 2011). Only the price variable is maintained by the author without being converted into natural logarithms, with the consideration that in this study prices will be more meaningful if they remain in the form of nominal figures. From the results of the model transformation, a stationarity test is then carried out to fulfill the VAR model requirements that the data must be stationary at the level level.

By using the STATA 17 application, the stationarity test using the Dickey-Fuller Test method obtained the following results:

Table 6: Unit Root Test Results

		Data in Level		
Variable	Test statistic	DF Critical Value 5%	Mac Kinnon *p-value*	Information
Total exports (Ln)	-0.797	-3.000	0.8200	Not stationary
Domestic Consumption	-1.227		0.6617	Not stationary
(Ln)	-1.304		0.6275	Not stationary
Coal price				Not stationary
Coal Export (Ln)	-1.937		0.3149	

From the results of the statistical test, the value of Z(t) for all variables is below the critical value of 5% (-3,000), or in another way the MacKinnon p-value for Z(t) is below the probability value of 5%, so that it can be said that the variable Ex (total exports), K (domestic consumption), H(price), and Ev (export BB) are found to be non-stationary at levels. Thus, the in-level model variables do not meet the requirements of the VAR model. The estimation results of the VAR model can be seen below:

Table 7: Regresi VAR

Source	SS	df	MS			
Model	4.16724093	3	1.38908031	Number of obs	=	22
Residual	.121206375	18	.006738132	F(3, 18)	=	206.15
Total	4.2885273	21	.204215586	Prob > F	=	0.0000
				R-squared	=	0.9717
				Adj R-squared	=	0.9670
				Root MSE	=	.08209

lnex	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnav	.6605529	.0958002	6.89	0.000	.459116	.8619899
lnk	-.2977691	.1382413	-2.15	0.045	-.5882034	-.0073348
h	.0050408	.0008395	6.00	0.000	.003277	.0068046
_cons	13.51541	.6477468	20.87	0.000	12.15454	14.87627

With a statistical description like this

. sum lnex lnk h lnav

Variable	Obs	Mean	Std. dev.	Min	Max
lnex	22	18.61818	.4519022	17.86	19.27
lnk	22	11.09636	.4907578	10.22	11.84
h	22	66.92909	34.40708	27.22	137.09
lnav	22	12.21636	.6684984	10.98	13.03

The next step is to do a 1st order differential, the following results are obtained:

Table 8: Unit Roots Test Results

	Data in 1^{st} *Differences*			
Variable	Test statistic	DF Critical Value 5%	Mac Kinnon *p-value*	Information
Total Exports (d.Ln)	-3.724	-3.000	0.0038	stationary
Domestic consumption (d.Ln)	-4.026		0.0013	stationary
Coal Price (d.H)	-2.931		0.0419	stationary
Coal Export (d.Ln)	-3.556		0.0067	stationary

Source: STATA17 processing results

From the table above it can be seen that at the order 1 differentiation level all variables are stationary, so that the model can be carried out a cointegration test to find out whether there is a cointegration relationship in the four variables. The results show that there is a cointegration relationship between these variables. Therefore, the model that will be used further in this study is the VECM model.

In the causality test, the following facts are obtained:

Table 9: Causality Test

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ALL	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ALL	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ALL	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ALL	[illegible]	[illegible]	[illegible]

Next, Optimal Lag Test is performed to determine the best model. Determination of this optimal lag is very important in the VECM model. According to (Alvyonita & Hidayat, 2013) as cited by (Wikayanti et al., 2020), the variable lag length is used in the VECM model, it is expected that it is neither too short nor too long. In this study to determine the optimal lag length of the VAR model using Akaike Information Criteria (AIC) as follows: 〚AIC〛_((p))=

p

ln det(∑▒〖(p))〗 + 〖2pK〗^2/T.

Table 10: Optimal Lag Test

Lag-order selection criteria

Sample: 2004 thru 2021 Number of obs = 18

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-63.7886				.02195	7.53207	7.55935	7.72993
1	-14.0258	99.526	16	0.000	.000547	3.78864	3.91705	4.76994
2	25.8933	79.838	16	0.000	.000054	1.12296	1.36851	3.90371
3	80.263	108.74	16	0.000	2.3e-06	-3.14034	-2.78567	-.568151
4	1099.32	2038.1*	16	0.000	1.6e-52*	-114.591*	-114.127*	-111.227*

* optimal lag
Endogenous: lntotalekspor lneksperbb lnkonsdom harga
Exogenous: _cons

Source: STATA17 processing results

(Wikayanti et al., 2020) The optimal lag is at the smallest (minimum) value obtained from the AIC calculation. The minimum value was chosen because the greater the lag used, the more parameters will be estimated so that it will reduce the degrees of freedom which will ultimately reduce the efficiency of the estimated parameters (Sianipar et al., 2016). By using the STATA 17 Application the optimal lag is obtained at lag 4.

In the next stage, a cointegration test is carried out using the Johannsen Cointegration test with the following hypotheses: Ho : Cointegration does not occur H1 : Cointegration occurs if the trace statistic > critical value, then Ho is rejected and H1 is accepted, which means cointegration occurs.

Table 11: Cointegration Test

[illegible]

Johansen tests for cointegration
Trend: Constant Number of obs = 18
Sample: 2003 thru 2021 Number of lags = 2

Maximum rank	Params	LL	Eigenvalue	Trace statistic	Critical value 5%
0	20	-17.951686	.	73.3508	47.21
1	27	-2.6150559	0.80055	42.7822	29.68
2	32	9.6257813	0.72434	18.2101	15.41
3	35	17.601349	0.57708	1.8680*	3.76
4	36	18.735236	0.09364		

* selected rank

Source: STATA17 processing results

From Table 11 it can be seen that the Cointegration Test results show that there are at least 2 cointegration equations (the * sign indicates cointegration limits). The test results show that hypothesis H0 (no cointegration) is rejected. This research can use the VECM model.

Next is testing the stability of the VA model). According to (Firdaus & Hafidah, 2020) as quoted by (Setiawan et al., 2020), if the VAR system is unstable, the results of IRF and FEVD processing are invalid, the VAR estimation is stable if all roots have a modulus smaller than one and located inside the unit circle.

Table 12: Model Stability Test

Residual Normality Test

Skewness and kurtosis tests for normality

Variable	Obs	Pr(skewness)	Pr(kurtosis)	Joint test: Adj chi2(2)	Joint test: Prob>chi2
resid	18	0.3997	0.2884	2.08	0.3526

From the table above it can be seen that the residual values are normally distributed, indicated by the p-value (Prob>chi2) which is greater than the degree of freedom of 5%. The normal distribution can be used to describe the average value and variance.

Autocollinearity Test

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Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	25.6226	16	0.05957
2	24.4986	16	0.07917

H0: no autocorrelation at lag order

Autocorrelation indicates a correlation between one member of the observation and another at different times. In relation to Ordinary Least Square (OLS), autocorrelation is the correlation between one residual and another. From the table above the Chi2 value is greater than the critical value, according to the Lagrange Multiplier test presented by Bruesch and Godfrey, then H0 = no autocorrelation is rejected, or it can be said that there is autocorrelation in the model. In time series data it is suspected that this autocorrelation often occurs (Melliana & Zain, 2013).

Model Stability Test

Eigenvalue stability condition

Eigenvalue	Modulus
-.214714 + 1.068256i	1.08962
-.214714 - 1.068256i	1.08962
1	1
1	1
1	1
-.6146203	.61462
.4345019	.434502
-.1375906	.137591

The VECM specification imposes 3 unit moduli.

According to (Firdaus, 2018: 182) as quoted by (Setiawan et al., 2020), if the VAR system is unstable, the results obtained from IRF and FEVD will be invalid. From the stability test of the Eigenvalue model above, it is known that the 3 unit-roots modulus is below 1, so it can be said that the model is stable.

After testing the stability of the model, then the selection of the best decision-making model is carried out. The best VAR model is obtained from the optimum lag. From Table 10 it is known that the optimum lag is found in lag 4. From this optimum lag, a regression of the VECM model is then carried out.

Table 13 Regression of the VECM Model with Optimum Lag

maximum lag reduced to 4 because of collinearity

Vector error-correction model

Sample: 2000 thru 2011 — Number of obs = 17

AIC = -34.59469

Log likelihood = 411.8548 — HQIC = -38.30724

Det(Sigma_ml) = -1.07e-23 — SBIC = -31.70205

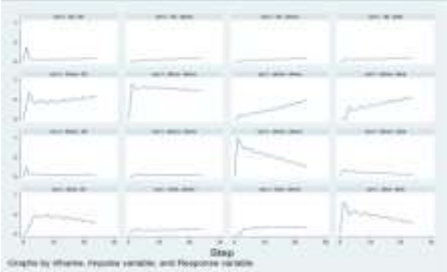
Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_dlnex	14	.044592	0.9514	347.7752	0.0000
D_dlnm	14	.107841	0.6436	16.10588	0.3021
D_ch	14	5.24612	0.9956	673.414	0.0000
D_dlnev	14	.112006	0.8834	22.71812	0.0456

Source: STATA17 processing results

After obtaining the best VECM model, the next step is to provide shock/innovation to the model using the Impulse Response Function (IRF) and Faorecast Errors Variance Decomposition (FEVD) techniques. In addition to forecasting IRF and FEVD, it can be used to see the impact of changes in one variable in the system on other variables dynamically. VAR and VECM analysis is not focused on reading the model coefficients by looking at the optimum lag, causality test, model stability test and others, because the VAR and VECM models are quite difficult to interpret. The advantages of the VAR and VECM models lie precisely in the analysis of the output Impulse Response Function (IRF) and Variance Decomposition (FEVD) (Saskara & Batubara, 2015).

According to (Saskara & Batubara, 2015), IRF analysis describes the estimated impact of a variable shock on the variable itself and other variables so that the duration of the shock or innovation effect of a variable can be known, and which variable gives the greatest response to the shock. Meanwhile, the FEVD analysis describes an estimate of how much a variable contributes to changes in the variable itself and other variables in several future periods, whose value is measured in percentage form.

Figure 7 Graph of Impulse Response Function (IRF)



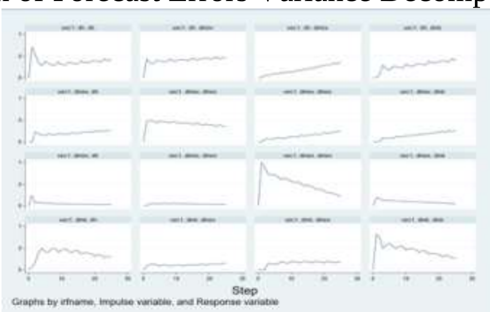
Source: STATA17 processing results

Based on the IRF simulation above, it can be explained that the previous total export variable greatly influenced the total exports in the trade balance. It is estimated that there will be a surge in Indonesian exports in 2023 and then it will gradually decline. The world market shock as a result of the renewed demand for Indonesian goods post-covid-19 is expected to have a momentary effect and at the same time form a pattern with a new intercept that is higher than before. In contrast, the total export variable does not have much influence on the coal price, coal consumption, and coal export volume variables. Likewise, the effect of total exports does not have much effect on coal consumption and coal prices.

The coal export volume variable is strongly influenced by previous export volume data. It is estimated that in 2022-2023 there will be a surge in coal exports, but after that, there will be stagnation. This surge is thought to have occurred as a result of the Russian-Ukrainian war (Nerlinger & Utz, 2022). The volume of coal exports will have a constant positive effect on total exports even though the effect is sloping. This indicates that the portion of coal exports to Indonesia's trade balance is still quite significant. A similar effect is experienced by domestic coal consumption. On the other hand, total national exports do not have much influence on Indonesia's coal demand.

The coal price variable relatively does not have too many shocks to consumption and exports, except for a momentary shock. The effect of coal prices was responded to positively by total exports although with relatively small changes. Likewise, the effect of coal prices on coal consumption and exports. Meanwhile, the variable domestic consumption of coal is greatly influenced by past consumption, but that only happens for a moment, after that it will gradually decrease continuously. Coal consumption does not significantly affect the volume of coal exports and total national exports. However, coal consumption has a significant impact on coal prices, especially in the near future.

Figure 8 Graph of Forecast Errors Variance Decomposition (FEVD)



In general, the variable shocks of coal consumption, coal prices, and coal export volume are not large enough to affect the trade balance. Based on the FEVD simulation above, in general, the growth of total exports, domestic coal consumption, coal exports, and coal prices are influenced by past performance. The interesting thing in this research is that all variables experience significant shocks at the beginning of the forecasting. This is in line with the

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positive sentiment in 2022-2023 regarding the rise of the post-covid-19 commodity market and the effects of economic sanctions on Russia.

In accordance with the objectives of this study, the implementation of reducing coal-based energy industries is reflected in the consumption, price, and volume of coal exports, which has a positive impact with a gentle growth in Indonesia's trade balance, which is represented by total exports. From the FEVD simulation, the following results are obtained:

Table 16: Relationship Matrix between Variables

Response

Impulse	Total Ekspor Nasional	Konsumsi Domestik BB	Harga BB	Vol Ekspor BB
Total Ekspor Nas	49.76%	9.17%	5.17%	4.29%
Konsumsi Dom BB	15.31%	44.26%	36.13%	11.17%
Harga BB	17.91%	27.85%	35.77%	39.95%
Vol Ekspor BB	13.17%	14.88%	19.08%	40.74%

From Table 16 it can be seen that the Trade Balance (proxy of Total Exports) is most influenced by past data of the Total Exports variable itself (49.76%), while the variables of Domestic Coal Consumption, Coal Prices, and Coal Export Volume contribute to the Trade Balance respectively by 15.31%; 17.91%; and 13.17%. Thus it can be said that the impact of the Glasgow COP26 agreement for gradually reducing coal consumption will affect Indonesia's trade balance through three transmissions namely coal prices, coal consumption, and coal exports. To implement the Glasgow COP26 Agreement and the RUEN Policy, reducing domestic coal consumption by gradually replacing environmentally friendly energy until 2046 will harm the trade balance by 15.31%.

Another finding in this study that is interesting to convey is that the impulse in the form of changes in world coal prices will be responded to quite highly by Indonesian coal exports with an influence of 39.95% (Suganda, 2018). This means that the volume of Indonesian coal exports is strongly influenced by community coal prices. On the other hand, the response of domestic coal consumption was not much affected by the impulse of coal exports (14.88%), most likely this occurred due to the Domestic Market Obligation (DMO) policy implemented by the Government, meaning that no matter how much the volume of coal exports does not significantly affect the demand for coal national. Domestic consumption of coal responds higher to impulse world coal prices (27.85%) (Pujoalwanto, 2014).

CONCLUSION

Based on the results of the VAR-VECM analysis regarding the effect of domestic consumption, prices, and volume of coal exports on Indonesia's trade balance, it can be concluded that the Trade Balance (Proxy of Total Exports) is most influenced by past data on Total Exports (49.76%), while Domestic Consumption, Prices, and Coal Export Volume contribute to the Trade Balance each by 15.31%; 17.91%; and 13.17%, implement the Glasgow COP26 Agreement and the RUEN Policy, reducing domestic coal consumption by gradually replacing environmentally friendly energy until 2046 will harm the trade balance by 15.31%, and omestic coal consumption was not much affected by the fluctuation in coal exports (14.88%), most likely this occurred due to the Domestic Market Obligation (DMO) policy implemented by the Government, meaning that no matter how much the volume of coal exports does not significantly affect the national coal demand. Domestic consumption of coal is more influenced by world coal prices (27.85%).

REFERENCES

Benoit, K. (2011). Linear Regression Models With Logarithmic Transformations. *London School Of Economics, London*, *22*(1), 23–36.

Burki, T. K. (2022). "Phasedown" Of Coal Use After COP26 Negotiations. *The Lancet Respiratory Medicine*, *10*(1), 10.

Fikriah, D., Cahyandari, R., & Awalludin, A. S. (2017). Pendekatan Metode VAR-GARCH Pada Pemodelan Keterkaitan Indeks Harga Saham Gabungan (IHSG), Kurs Dollar Amerika Dan Harga Emas Dunia. *LOGIK@*, *7*(2), 137–145.

Firdaus, S., & Hafidah, S. (2020). Mnemonik: Solusi Kreatif Untuk Meningkatkan Kemampuan Menghafal Kosa Kata Bahasa Arab Siswi Madrasah Aliyah Nurul Jadid. *Palapa*, *8*(1), 81–96.

Matondang, Z., & Nasution, H. F. (2022). *Praktik Analisis Data: Pengolahan Ekonometrika Dengan Eviews Dan SPSS*. Merdeka Kreasi Group.

Melliana, A., & Zain, I. (2013). Analisis Statistika Faktor Yang Mempengaruhi Indeks Pembangunan Manusia Di Kabupaten/Kota Provinsi Jawa Timur Dengan Menggunakan Regresi Panel. *Jurnal Sains Dan Seni ITS*, *2*(2), D237–D242.

Nerlinger, M., & Utz, S. (2022). The Impact Of The Russia-Ukraine Conflict On The Green Energy Transition–A Capital Market Perspective. *Swiss Finance Institute Research Paper*, *22–49*.

Pujoalwanto, B. (2014). *Perekonomian Indonesia: Tinjauan Historis, Teoritis, Dan Empiris*. Graha Ilmu.

Putra, M. U. M., & Damanik, S. (2017). Pengaruh Ekspor Migas Dan Non Migas Terhadap Posisi Cadangan Devisa Di Indonesia. *Jurnal Wira Ekonomi Mikroskil*, *7*(2), 245–254.

Saskara, I. A. N., & Batubara, D. M. H. (2015). Analisis Hubungan Ekspor, Impor, PDB Dan Utang Luar Negeri Indonesia Periode 1970-2013. *Jurnal Ekonomi Kuantitatif Terapan*, *8*(1), 44312.

Setiawan, A., Wibowo, A. P., & Rosyid, F. A. (2020). Analisis Pengaruh Ekspor Dan Konsumsi Batubara Terhadap Pertumbuhan Ekonomi Indonesia. *Jurnal Teknologi Mineral Dan Batubara*, *16*(2), 109–124.

Sharma, M., Lingford, J. P., Petricevic, M., Snow, A. J. D., Zhang, Y., Järvå, M. A., Mui, J. W.-Y., Scott, N. E., Saunders, E. C., & Mao, R. (2022). Oxidative Desulfurization Pathway For Complete Catabolism Of Sulfoquinovose By Bacteria. *Proceedings Of The National Academy Of Sciences*, *119*(4), E2116022119.

Sianipar, M., Suciptawati, N. P., & Dharmawan, K. (2016). Analisis Hubungan Pendapatan Wisatawan Dan Harga Pariwisata Terhadap Permintaan Pariwisata Dengan VECM. *Jurnal Matematika*, *5*(2), 44–51.

Suganda, T. R. (2018). *Teori Dan Pembahasan Reaksi Pasar Modal Indonesia*. Puntadewa.

Wikayanti, N. L. P. D., Aini, Q., & Fitriyani, N. (2020). Pengaruh Kurs Dolar Amerika Serikat, Inflasi, Dan Tingkat Suku Bunga Terhadap Indeks Harga Saham Gabungan Dengan Vector Error Correction. *Eigen Mathematics Journal*, *3*(1), 64–72.

Zhongming, Z., Linong, L., Xiaona, Y., Wangqiang, Z., & Wei, L. (2021). *Down And Out In Paris And Glasgow*.

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