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Dynamic interactions of energy trade, logistics, and exchange rates in Indonesia

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Abstract

Purpose — This study examines how global price, logistics, and exchange-rate channels jointly determine Indonesia's coal export performance, and whether China's manufacturing demand adds independent explanatory power.

Method — Using monthly data (2015–2025), a two-stage framework is applied: a VECM to identify long-run equilibrium relationships, followed by a conditional error-correction model with Newey–West inference to assess short-run export dynamics and the role of China PMI proxies.

Findings — Two long-run equilibria link exports with prices and exchange rates, and logistics with exchange rates. In the short run, only logistics (BDI) and exchange-rate changes significantly drive exports, with logistics shocks dominating overall dynamics. China PMI proxies are insignificant, suggesting their effects are absorbed by structural channels.

Implications — Export performance is highly sensitive to logistics conditions, highlighting the importance of supply-chain efficiency and policy stability over reliance on commodity price movements.

Originality — The study provides a unified dynamic framework linking price, logistics, and currency channels while re-evaluating the role of China demand at monthly frequency.

Keywords: Coal exports; logistics; baltic dry index (BDI); exchange rate volatility; vector error correction model (VECM)

JEL Classification: C32; F14; Q37; Q41

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Introduction

Energy commodities remain central to international trade because they connect industrial production, electricity generation, and macroeconomic stability across exporting and importing economies. Coal continues to play a major role in Asia, and Indonesia is deeply embedded in this system as one of the world's largest thermal-coal exporters. Official Indonesian energy statistics report that coal exports reached 518 million tons in 2023, with China recorded as the largest export destination at 218 million tons.

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This scale makes coal exports economically important not only for trade earnings, but also for fiscal revenues and Indonesia's position in regional energy supply chains (Kementerian ESDM, 2024). The central issue is not simply that Indonesia exports coal, but that its export performance is shaped by a broader transmission process running from global market conditions, through major importing economies, and into domestic trade outcomes. China is particularly important in this system because changes in Chinese manufacturing conditions can alter world coal demand, freight-market pressure, and the incentives faced by commodity exporters. For Indonesia, external shocks are therefore transmitted through an interdependent set of price, logistics, and currency channels rather than through a single variable. Three channels are especially important. The first is the commodity-price channel, through which international prices coordinate supply, demand, and export incentives over time.

The second is the logistics channel, proxied here by the Baltic Dry Index (BDI), which captures shipping-market conditions relevant to bulk commodities such as coal. Recent work shows that the BDI contains meaningful information about commodity-transport conditions and does not simply mirror spot-price movements mechanically (Bandyopadhyay and Rajib, 2023). The third is the exchange-rate channel. Exchange-rate pass-through theory suggests that depreciation can improve export incentives by raising domestic-currency returns on foreign sales, while the Mundell–Fleming framework implies that exchange-rate dynamics in open economies are shaped not only by trade conditions, but also by monetary and capital-flow factors (Mundell, 1963).

Taken together, these channels suggest that Indonesia's coal exports should be analyzed as part of an interconnected external-adjustment system. Existing studies provide useful but incomplete insights into this problem. Recent Indonesian evidence shows that coal prices remain closely related to export performance, while country-specific trade-demand studies indicate that importer-side conditions matter for Indonesia's coal exports (Sya'diyah et al., 2024). At the same time, research on the BDI emphasizes that logistics conditions carry independent information about commodity-trade pressure, and recent work continues to treat the BDI as a real-time indicator of global trade intensity (Bandyopadhyay and Rajib, 2023; Kim et al., 2025).

However, these channels are often examined separately rather than as a single dynamic system. In addition, even when China's role is recognized conceptually, it is rarely tested within a monthly framework that asks whether Chinese manufacturing conditions add explanatory power once price, logistics, and exchange-rate channels are already modeled explicitly. This study addresses that gap by combining a long-run equilibrium model of coal exports, logistics, prices, and exchange rates with a conditional export-adjustment equation that tests whether China's monthly manufacturing demand contributes additional explanatory power beyond those structural channels.

The analysis therefore asks how international coal prices, global logistics conditions, and exchange-rate movements jointly shape Indonesia's coal export performance, and whether China's monthly manufacturing demand provides an additional transmission channel beyond those mechanisms. In doing so, the paper contributes to the empirical literature on Indonesian coal exports and to the broader question of how external shocks are transmitted to commodity-exporting economies through interacting price, logistics, and currency channels. The remainder of the paper is organized as follows. Section 2 describes the data, variables, and analytical framework. Section 3 presents the empirical results and discusses their theoretical and policy implications. Section 4 concludes.

Methodology

This study uses monthly time-series data from July 2015 to June 2025, yielding 120 observations. After accounting for the lag structure of the estimated models, the effective estimation sample runs from August 2015 to June 2025. The sample covers major episodes relevant to coal-trade dynamics, including the COVID-19 disruption, the temporary domestic coal export ban in January 2022, and the energy-market turbulence associated with the Russia–Ukraine conflict.The empirical design distinguishes between a core endogenous trade system and additional exogenous controls. The core system consists of coal exports, the Baltic Dry Index (BDI), the Rupiah–US Dollar exchange rate, and international coal prices.

Table 1. Operational Definition Variable

Variable	Symbol	Unit	Definition	Source
Coal Exports	l_Coal_Export	log kg	Monthly volume of Indonesian coal exports	BPS
Baltic Dry Index	l_BDI	log index	Monthly average of daily BDI values	Baltic Exchange via Investing.com
Exchange Rate	l_Exchange_Rate	log IDR/USD	Monthly average JISDOR reference rate	Bank Indonesia
International Coal Price	l_Coal_Price	log USD/ton	Newcastle benchmark spot coal price	FRED
China New Orders Index	Ch_NewOrdIndex	index points	Monthly manufacturing new-orders PMI sub-index	National Bureau of Statistics of China
China Manufacturing PMI	Ch_PMI	index points	Monthly headline manufacturing PMI	National Bureau of Statistics of China
China Production PMI	Ch_Prod_PMI	index points	Monthly manufacturing production PMI	National Bureau of Statistics of China
Inflation	Inflation	percent per month	Monthly inflation rate	BPS
VIX	l_VIX	log index	Monthly average of market-implied volatility index	FRED

Source: Processed by Author (2025)

These variables are transformed into natural logarithms to stabilize variance and to allow estimated coefficients to be interpreted as elasticities or semi-elasticities where appropriate (Wooldridge, 2025). Coal exports are measured as the monthly volume of Indonesian coal shipments and are drawn from Statistics Indonesia (BPS). The BDI is used as a proxy for global bulk shipping conditions and freight-market tightness. The Rupiah–US Dollar exchange rate is taken from Bank Indonesia's JISDOR series. International coal prices are proxied by the Newcastle benchmark series obtained from the Federal Reserve Economic Data (FRED) database. To capture the China-to-Indonesia transmission channel, the study includes a proxy for Chinese manufacturing demand.

The preferred proxy is the China New Orders Index, a sub-component of the official Chinese manufacturing Purchasing Managers' Index (PMI), because it isolates forward-looking demand conditions more directly than the headline PMI, which aggregates several dimensions of manufacturing activity (Koenig, 2002). Two alternative China PMI-family proxies, namely the headline manufacturing PMI and the production PMI, are retained for robustness analysis. Monthly inflation is included as a domestic macroeconomic control, while the VIX is introduced in robustness analysis as an external financial-risk proxy to assess whether global financial uncertainty adds explanatory power beyond the price, logistics, and exchange-rate channels already embedded in the core system (Whaley, 2000). All four core trade variables enter the VECM in natural logarithms. China PMI-family variables and inflation enter the conditional export equation in their natural units or first differences, depending on their integration properties and the robustness design.

The analysis is based on the premise that Indonesia's coal exports are shaped by both a long-run equilibrium structure and short-run adjustment dynamics. The long-run system captures the interaction among export volume, global shipping conditions, coal prices, and exchange-rate movements, while the short-run stage evaluates how export growth responds to contemporaneous changes in those channels together with China-demand proxies, domestic controls, and discrete shocks. Empirically, the study proceeds in two stages.

The first stage estimates a Vector Error Correction Model (VECM) for the four core endogenous variables. The VECM is appropriate when variables are non-stationary in levels but share one or more long-run cointegrating relationships (Engle and Granger, 1987; Johansen, 1988). The second stage estimates a conditional export adjustment equation using the error-correction terms extracted from the VECM together with additional exogenous controls. This design allows direct testing of China-demand proxies and short-run controls without placing them inside the Johansen system.

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta Y_{t-i} + \varepsilon_t \tag{1}$$

Where Yt is the vector of endogenous variables, β′Yt−1 contains the long-run cointegrating relations, α contains the adjustment coefficients that determine how each variable responds to disequilibrium, Γi captures short-run dynamics among differenced variables, and εt is the disturbance term. In this study, the endogenous vector is defined as:

$$Y_t = [\mathrm{l\_Coal\_Export}, \mathrm{l\_BDI}, \mathrm{l\_Exchange\_Rate}, \mathrm{l\_Coal\_Price}] \tag{2}$$

The extracted error-correction terms from the VECM are then entered into a conditional export equation of the form.

$$\Delta l\_Coal\_Export_t = \gamma_1 EC1_{t-1} + \gamma_2 EC2_{t-1} + \delta_1 \Delta l\_BDI_t + \delta_2 \Delta l\_Exchange\_Rate_t + \delta_3 \Delta l\_Coal\_Price_t + \theta'^{Z_t} + u_t \tag{3}$$

Where EC1t−1 and EC2t−1 are the lagged cointegrating residuals obtained from the VECM, and Zt contains additional exogenous controls such as the China-demand proxy, inflation, event dummies, and, in robustness analysis, the VIX. This conditional specification makes it possible to isolate export adjustment while preserving the long-run information generated by the multivariate cointegration system. The empirical analysis begins with several pre-estimation procedures. First, all variables are subjected to Augmented Dickey-Fuller (ADF) unit-root testing to determine whether they are stationary in levels or become stationary after first differencing (Dickey and Fuller, 1979). The ADF lag length is chosen to absorb residual autocorrelation in the univariate process and is not automatically imposed on the later multivariate system.

Second, the lag order for the core endogenous system is selected using the Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan–Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC). When these criteria disagree, preference is given to the more parsimonious lag order if the higher-order alternative would impose a substantial degree-of-freedom cost relative to sample size. Third, the Johansen procedure is applied to determine the number of cointegrating relations among the four core endogenous variables (Johansen, 1988). Both the trace statistic and the maximum-eigenvalue statistic are considered. A constant is included in the cointegrating space so that the long-run relations may contain intercept terms without imposing deterministic trends on the differenced equations. Finally, once the long-run rank is chosen, the VECM is estimated and the resulting cointegrating residuals are recovered for use in the conditional export equation.

After estimating the preferred VECM, the dynamic implications of the system are examined using orthogonalized impulse response functions (OIRFs) and forecast error variance decomposition (FEVD). OIRFs trace the response of coal exports to shocks in the BDI, exchange rate, and coal price over a twelve-month horizon, while FEVD quantifies how much of the forecast uncertainty in coal exports is attributable to each variable in the system over the same horizon (Brooks, 2008). The orthogonalization is based on a recursive Cholesky decomposition using the ordering (l_Coal_Export,l_BDI,l_Exchange_Rate,l_Coal_Price). This ordering is treated as an identifying convention for dynamic shock accounting rather than as a definitive structural ordering. Accordingly, the OIRFs and FEVD are interpreted descriptively and comparatively, with caution regarding their dependence on the recursive identification scheme. Three diagnostic tests are then applied to the VECM.

Residual autocorrelation is examined using a Lagrange Multiplier (LM) test, residual normality is evaluated using the Jarque–Bera decomposition into skewness and kurtosis components, and stability is assessed by verifying that the non-unit eigenvalues of the companion matrix lie inside the unit circle. These procedures are used to determine whether the estimated VECM is dynamically well behaved and suitable for interpretation. The second-stage export equation is estimated using Newey–West heteroskedasticity- and autocorrelation-consistent standard errors (Newey and West, 1987).

This choice is motivated by the monthly frequency of the data and by the possibility that export-growth disturbances may display both serial dependence and non-constant variance. A bandwidth of four lags is adopted to accommodate short-horizon monthly serial correlation without excessively inflating the covariance correction. The main conditional export model includes the lagged error-correction terms extracted from the preferred VECM, contemporaneous changes in the BDI, exchange rate, and coal price, the preferred China-demand proxy, monthly inflation in first differences, and the January 2022 coal export-ban dummy.

The conditional ECM is used to assess whether short-run export growth is driven primarily by logistics conditions, exchange-rate changes, coal-price movements, or by additional China-demand and macro-financial controls once the long-run equilibrium terms are already accounted for. The robustness strategy evaluates whether the main export-adjustment findings depend on a narrow set of proxy choices. It varies three dimensions: China-demand measurement, event identification, and global-risk control. First, alternative China PMI-family measures are considered. Because the headline PMI, the New Orders Index, and the Production PMI represent closely related dimensions of Chinese manufacturing activity, only one proxy is included at a time to avoid multicollinearity.

Robustness variants also consider whether the selected China proxy is entered in levels or first differences. Second, event identification is varied by replacing the single-month January 2022 export-ban indicator with broader bounded-window dummies representing the COVID-19 period and the early Ukraine-war period. Third, external financial uncertainty is tested by adding the VIX. The preferred treatment uses the first difference of log VIX, while the level log VIX is retained as a sensitivity check. In total, the design comprises the main conditional ECM plus nine robustness specifications. The robustness analysis evaluates whether the signs, relative magnitudes, and substantive inferences remain stable under alternative controls and event definitions.

Results and Discussion

Descriptive statistics for all variables over the full sample of 120 monthly observations. The core trade variables enter the estimation in natural logarithms, while the China PMI-family variables and inflation remain in their natural units. The data show substantial variation in the external and domestic conditions surrounding Indonesia's coal export performance.

Table 2. Descriptive Statistics

Variable	Unit	Obs	Mean	Std. Dev.	Min	Max
Coal_Export	kg	120	1.41e+09	7.66e+08	4.54e+08	3.64e+09
BDI	index	120	1462.698	759.516	306.9048	4,819.952
Coal_Price	USD/ton	120	136.543	98.376	51.383	467.784
Exchange_Rate	IDR/USD	120	14,490.170	930.191	13,018.210	16,752.500
VIX	index	120	18.549	6.745	10.126	57.737
Ch_PMI	index points	120	50.154	1.680	35.700	52.600
Ch_NewOrdIndex	index points	120	50.602	2.734	29.300	54.800
Ch_Prod_PMI	index points	120	51.743	2.872	27.800	56.700
Inflation	% per month	120	0.2432	0.348	-0.760	1.650

Source: Processed by Author (2025)

Coal prices and the BDI exhibit pronounced volatility, consistent with repeated episodes of commodity-market and shipping-market stress. By contrast, the China PMI-family indicators are relatively stable around the neutral 50 threshold, although they show clear downward breaks during the early COVID-19 period.

Inflation is also variable at monthly frequency, but it does not display the same persistence as the core trade variables. Overall, these patterns support a framework that distinguishes persistent long-run relationships from short-run adjustment and discrete shocks. The Augmented Dickey-Fuller (ADF) test was applied with four lags to all variables in order to determine their order of integration while absorbing univariate residual autocorrelation.

Table 3. ADF Unit Root Test Results

Variable	Level Z(t)	p-value	Stationary at Level	First-Difference Z(t)	p-value	Stationary at First Difference	Order
l_Coal_Export	-1.698	0.432	No	-5.234	0.000	Yes	I(1)
l_Coal_Price	-2.280	0.178	No	-3.453	0.009	Yes	I(1)
l_BDI	-2.850	0.051	No	-6.069	0.000	Yes	I(1)
l_Exchange_Rate	-0.253	0.932	No	-5.555	0.000	Yes	I(1)
Ch_PMI	-3.303	0.015	Yes	-8.208	0.000	Yes	I(0)
Ch_NewOrdIndex	-3.155	0.023	Yes	-8.211	0.000	Yes	I(0)
Ch_Prod_PMI	-3.804	0.003	Yes	-8.394	0.000	Yes	I(0)
Inflation	-4.278	0.000	Yes	-9.906	0.000	Yes	I(0)
l_VIX	-2.344	0.158	No	-6.544	0.000	Yes	I(1)

Source: Processed by Author (2025)

The criteria yield mixed recommendations: lag 1 is not uniquely selected by all criteria. Given the monthly sample size and the parameter cost implied by higher-order VEC specifications, the lag-1 specification is adopted as the parsimonious baseline for the long-run system. Cointegration testing was performed using the Johansen procedure with one lag and a constant in the cointegrating equations.

Table 4. Lag-Order Selection for the VEC System

Lag	LL	FPE	AIC	HQIC	SBIC
0	42.547	6.0e-06	-0.676	-0.637	-0.580
1	474.125	4.1e-09	-7.967	-7.772*	-7.487*
2	495.407	3.7e-09	-8.060	-7.709	-7.196
3	514.437	3.5e-09	-8.113	-7.606	-6.864
4	531.710	3.5e-09*	-8.135*	-7.473	-6.503
5	540.875	3.9e-09	-8.015	-7.197	-5.999
6	547.106	4.7e-09	-7.844	-6.870	-5.444

Source: Processed by Author (2025)

The criteria yield mixed recommendations: lag 1 is not uniquely selected by all criteria. Given the monthly sample size and the parameter cost implied by higher-order VEC specifications, the lag-1 specification is adopted as the parsimonious baseline for the long-run system. Cointegration testing was performed using the Johansen procedure with one lag and a constant in the cointegrating equations. The trace statistic supports rank 2, while the max-eigen test is borderline at the $r \leq 1$ threshold.

Table 5. Lag-Order Selection for the VEC System

Null Hypothesis	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value	Decision
r = 0	84.697	47.21	53.790	27.07	Reject
r ≤ 1	30.907	29.68	20.730	20.97	Trace rejects; max-eigen marginally does not
r ≤ 2	10.178	15.41	6.601	14.07	Fail to reject
r ≤ 3	3.577	3.76	3.577	3.76	Fail to reject

Source: Processed by Author (2025)

Rank 2 is adopted for the preferred VECM because it is consistent with the trace evidence and with the economically distinct long-run relations uncovered by the estimated system. Rank 2 is therefore retained for the preferred specification, although the supporting evidence is stronger for the trace statistic than for the max-eigen statistic.The estimated rank-2, lag-1 VECM is reported in Table 6.

Table 6. VECM Estimation Results (Rank 2, Lag 1)

Panel A. Equation-Level Fit

Equation	RMSE	R^2	Chi-square	p-value
D.l_Coal_Export	0.142	0.233	34.924	0.000
D.l_BDI	0.249	0.043	5.151	0.161
D.l_Exchange_Rate	0.019	0.035	4.166	0.244
D.l_Coal_Price	0.105	0.120	15.686	0.001

Panel B. Cointegrating Vectors (Beta Matrix)

Variable	CE1 Coefficient	p-value	CE2 Coefficient	p-value
l_Coal_Export	1.000 (normalized)	—	0.000 (excluded)	—
l_BDI	0.000 (excluded)	—	1.000 (normalized)	—
l_Exchange_Rate	-3.473	0.000	-5.539	0.001
l_Coal_Price	-0.663	0.000	-0.181	0.312
Constant	15.459	—	46.734	—

Panel C. Adjustment Coefficients (Alpha Matrix)

Equation	Alpha on CE1	p-value	Alpha on CE2	p-value
D.l_Coal_Export	-0.432	0.000***	0.115	0.000***
D.l_BDI	0.084	0.528	-0.114	0.025**
D.l_Exchange_Rate	0.016	0.119	0.001	0.863
D.l_Coal_Price	-0.035	0.541	0.082	0.000***

Note: *** $p < 0.01$, ** $p < 0.05$.
Source: Processed by Author (2025)

The estimated rank-2, lag-1 VECM identifies two economically interpretable long-run relations. The first cointegrating relation is export-centered and implies that higher coal exports are associated in the long run with a weaker Rupiah and higher international coal prices. The second relation is BDI-centered. In that equilibrium, the exchange rate remains significant, whereas the coal-price term is not statistically significant and should not be overinterpreted within CE2.

The adjustment coefficients indicate that coal exports respond significantly to both long-run disequilibria. The coefficient on CE1 is negative and sizable (−0.432, p<0.00), indicating substantial monthly correction toward the export-centered equilibrium, while the coefficient on CE2 is positive and significant (0.115, p<0.001), implying that deviations from the BDI-centered relation are also reflected in subsequent export growth.

The BDI and coal prices also adjust to CE2, whereas the exchange-rate equation does not significantly respond to either cointegrating relation. This pattern suggests that, within the estimated system, the exchange rate behaves more as an external driver than as an equilibrium-restoring variable.

The diagnostic results support the adequacy of the specification, although residual normality is not fully satisfied. The LM test finds no residual autocorrelation at lags 1–12, and the stability condition is satisfied because the non-unit roots lie inside the unit circle. Residual normality is rejected jointly and in some individual equations, particularly for coal exports and coal prices, which strengthens the case for using Newey-West inference in the conditional export adjustment stage. The impulse-response and variance-decomposition exercises are used descriptively to evaluate the relative importance and persistence of shocks.

Table 7. OIRF and FEVD of Coal Exports at Selected Horizons

Panel A. Orthogonalized Impulse Response of l_Coal_Export

Step	BDI shock	Exchange-rate shock	Coal-price shock
1	0.036	0.013	0.026
3	0.073	0.020	0.047
6	0.096	0.018	0.054
9	0.106	0.014	0.054
12	0.113	0.011	0.054

Panel B. Forecast Error Variance Decomposition of l_Coal_Export

Step	Own shock	BDI	Exchange rate	Coal price
1	1.000	0.000	0.000	0.000
3	0.824	0.110	0.012	0.053
6	0.556	0.304	0.020	0.120
9	0.420	0.419	0.019	0.142
12	0.349	0.487	0.016	0.148

Source: Data Processed (2025)

The point IRFs show that a BDI shock produces the largest and most persistent positive response in coal exports, a coal-price shock also yields a positive response but stabilizes more quickly, and an exchange-rate shock produces the smallest response. The FEVD confirms this ordering. By month 12, BDI shocks account for 48.7% of coal-export forecast variance, compared with about 14.8% for coal-price shocks and only 1.7% for exchange-rate shocks. This indicates that the logistics channel is dynamically more important than the exchange rate channel in the export system.

Table 8. Conditional Export Adjustment Model

Estimator: Newey-West; lag (4); N=119; F(8, 110) = 1275.78; p = 0.0000

Variable	Coefficient	Std. Err.	t-statistic	p-value
L.ce1_r2	-0.462	0.163	-2.84	0.005***
L.ce2_r2	0.147	0.036	4.13	0.000***
D.l_BDI	0.151	0.058	2.61	0.010**
D.l_Exchange_Rate	1.195	0.460	2.60	0.011**
D.l_Coal_Price	0.140	0.128	1.09	0.278
Ch_NewOrdIndex	-0.005	0.005	-0.91	0.364
D.Inflation	0.005	0.019	0.25	0.802
coalban2022	-0.922	0.053	-17.49	0.000***
Constant	0.246	0.268	0.92	0.360

Note: *** p < 0.01, ** p < 0.05.

Source: Processed by Author (2025)

To isolate short-run export adjustment while preserving long-run information from the VECM, the two cointegrating residuals are carried into a conditional export ECM estimated with Newey-West standard errors. The results show that both long-run disequilibrium terms remain significant, indicating that short-run export growth is still governed by the long-run structure extracted from the core VECM. Among the short-run controls, only BDI changes and exchange rate changes are significant and positive.

Short-run coal-price changes are not significant once the long-run terms and additional controls are included. The January 2022 coal-ban dummy is large, negative, and highly significant, implying an estimated single-month export reduction of about 60.2%. The main findings were subjected to a structured robustness exercise using alternative China PMI-family proxies, alternative event windows, and VIX-based global-risk controls.

Table 9. Consolidated Robustness Results

Specification	L.ce1_r2	L.ce2_r2	D.l_BDI	D.l_Exchange_Rate	D.l_Coal_Price	Control	Event
Main: Ch_NewOrdIndex + coalban2022	-0.462***	0.147***	0.151**	1.195**	0.140	-0.004	-0.922***
R1: Ch_PMI + coalban2022	-0.466***	0.149***	0.155**	1.220**	0.135	-0.009	-0.914***
R2: drop inflation	-0.461***	0.147***	0.152**	1.186**	0.140	-0.005	-0.921***
R3: D.Ch_NewOrdIndex + coalban2022	-0.443***	0.138***	0.135**	1.198**	0.156	-0.000	-0.924***
R3b: Ch_Prod_PMI + coalban2022	-0.466***	0.149***	0.159**	1.207**	0.120	-0.006	-0.913***
R3c: D.Ch_Prod_PMI + coalban2022	-0.442***	0.138***	0.135**	1.180**	0.156	0.000	-0.924***
R4: Ch_NewOrdIndex + covid	-0.490***	0.154***	0.236**	1.049**	-0.055	-0.005	-0.006
R5: Ch_NewOrdIndex + ukraine	-0.487***	0.151***	0.235**	0.999*	-0.066	-0.004	0.023
R6: Ch_NewOrdIndex + D.l_VIX + coalban2022	-0.460***	0.147***	0.150**	0.928*	0.133	D.l_VIX = 0.050	-0.925***
R7: Ch_NewOrdIndex + l_VIX + coalban2022	-0.459***	0.152***	0.149**	1.074**	0.133	l_VIX = 0.036	-0.934***

Note: *** p < 0.01, ** p < 0.05, * p < 0.10.
Source: Processed by Author (2025)

Across specifications, the main pattern remains stable. The two error-correction terms retain the same sign and significance, the short-run BDI effect remains consistently positive and significant, and the exchange-rate effect is generally positive and significant, although it weakens to marginal significance in the Ukraine-dummy and differenced-VIX variants.

Coal-price changes remain insignificant throughout. The China PMI-family controls are uniformly insignificant in both level and differenced specifications, and inflation is likewise insignificant. Finally, the January 2022 coal-ban effect remains robustly large and negative, whereas the broader COVID-19 and Ukraine-war windows do not retain independent significance once the core structural channels are controlled.

Indonesia's coal export performance is embedded in a stable long-run system linking export volume, global shipping conditions, international coal prices, and the exchange rate. This shifts the interpretation of Indonesia's coal trade away from a purely transactional view toward a structural one in which price incentives, logistics frictions, and currency conditions move together over time. The first long-run relation is best interpreted as an export supply equilibrium. In this relation, coal exports are positively associated with a weaker Rupiah and higher international coal prices. A depreciation raises the Rupiah value of US Dollar-denominated export receipts, thereby strengthening export incentives, while higher international coal prices increase the profitability of export activity.

This interpretation is consistent with Indonesian evidence showing that exchange-rate movements shape export competitiveness and that coal prices remain an important determinant of coal export performance (Nugroho and Setyo, 2021; Alif Sya'diyah et al., 2024). It is also consistent with the broader commodity-trade literature, which treats world prices as the main mechanism through which global demand and supply conditions are transmitted to exporting economies (Deaton and Laroque, 1992).

The second long-run relation is more appropriately interpreted as a logistics equilibrium than as a general commodity equilibrium. In that relation, the BDI is tied primarily to the exchange rate, while the coal-price term does not enter significantly. This indicates that the freight-market dimension of Indonesia's coal trade is not merely an extension of commodity pricing, but a partially separate structural channel shaped by bulk shipping demand, fleet capacity, and wider trade conditions. This interpretation is consistent with Bandyopadhyay and Rajib (2023), who show that the BDI contains meaningful information about commodity-market dynamics without moving mechanically with spot prices across all commodities and horizons.

The adjustment pattern across equations reinforces this interpretation. Coal exports respond significantly to both long-run disequilibria, implying that exports carry an important share of the adjustment burden after shocks. The BDI and coal prices also adjust, whereas the exchange-rate equation does not significantly respond to either disequilibrium term. Within the estimated system, the exchange rate therefore behaves more as an external driver than as an equilibrium-restoring variable. This is broadly consistent with the Mundell-Fleming view that exchange-rate movements in open economies are shaped primarily by monetary conditions and capital flows rather than by automatic correction to sector-specific trade imbalances (Mundell, 1963).

The short-run export adjustment is more selective than the long-run structure. Once the error-correction terms are included, the variables that continue to matter for monthly export growth are the BDI and the exchange rate. This indicates that short-run adjustment is driven mainly by variables most closely connected to immediate trading conditions. The dominance of the BDI points to the importance of the logistics channel. The BDI captures the condition of the international bulk shipping market and therefore proxies the cost and intensity of moving large-volume commodities such as coal.

For an exporter like Indonesia, changes in freight-market conditions affect export performance not only through shipping costs, but also through vessel availability, congestion pressures, and shipment timing. The dynamic evidence strengthens this interpretation: the BDI explains an increasing share of coal-export forecast variance over the one-year horizon and eventually becomes more important than own shocks.

This suggests that logistics shocks are not merely transitory disturbances but persistent features of the export system. The result is consistent with work that treats the BDI as a barometer of global trade conditions and commodity transport pressure (Bandyopadhyay and Rajib, 2023; Kim et al., 2025). The exchange-rate effect is also meaningful, although less dominant than the logistics effect. In most specifications, Rupiah depreciation is associated with stronger export growth in the same month. This is consistent with standard export-competitiveness logic: when the domestic currency weakens, exporters receive higher local-currency returns from foreign sales.

The fact that this effect weakens in a small number of robustness cases suggests that the exchange-rate channel is somewhat more sensitive to specification than the logistics channel. This is economically plausible because exchange-rate movements transmit both competitiveness effects and broader macro-financial shocks, making their trade effect less mechanically stable than that of shipping-market conditions. The results therefore support the view that exchange-rate changes matter for monthly coal export adjustment, but not as strongly or as consistently as logistics conditions. An important distinction in the study is the difference between the long-run role of coal prices and their short-run insignificance in the conditional export equation. This should not be reduced to the conclusion that coal prices do not matter. Rather, coal prices matter primarily through the long-run structure of the system rather than through immediate month-to-month export growth once other channels are controlled for.

This pattern is economically credible. International coal prices influence the long-run profitability of export activity, the allocation of supply between domestic and external markets, and the sustainability of export volumes over time. Monthly export realizations, however, are often constrained by operational rigidities such as shipping schedules, cargo nominations, vessel availability, contract commitments, and port handling capacity. Under such conditions, even large monthly price movements may not translate immediately into observed export-volume changes. This helps reconcile the present findings with studies that identify a meaningful role for coal prices in broader or lower-frequency export models (Sya'diyah et al., 2024; Pratama and Hidayat, 2022). The evidence therefore suggests that coal prices shape the equilibrium path of exports but do not act as an immediate short-run adjustment driver once the logistics and exchange-rate channels are already in place.

This interpretation is also consistent with the FEVD pattern. Coal-price shocks contribute to export variance, but their contribution remains clearly below that of the BDI. Coal prices therefore matter structurally, whereas logistics conditions matter more operationally. Across all tested variants, the China demand proxies remain statistically insignificant once the long-run disequilibrium terms, BDI, exchange-rate changes, coal prices, and event controls are included. This means that the selected monthly PMI-family indicators do not provide additional explanatory power for Indonesia's coal export growth beyond what is already captured by the structural variables in the model. This does not imply that China is irrelevant to Indonesia's coal exports.

That would be implausible, given China's role as a major coal-importing economy and prior Indonesian evidence linking importer demand to coal export performance (Sya'diyah et al., 2023). A more defensible interpretation is that, at monthly frequency, the relevant part of China's demand shock is already absorbed by the price and logistics channels. When Chinese manufacturing conditions strengthen or weaken, the first-order effects are rapidly transmitted into benchmark coal prices and bulk shipping conditions. Once those channels are explicitly controlled, the residual PMI signal no longer adds independent explanatory content to the short-run export equation. This inference nevertheless remains limited.

The insignificance of PMI-family controls does not prove mediation in a strict causal sense; it only shows that these proxies do not survive conditional estimation as separate monthly signals. A more direct test would require a consistent monthly series on China's coal imports or another coal-specific demand indicator over the full sample. The China result is therefore best interpreted as evidence that the direct monthly PMI signal is weak once the structural channels are controlled, rather than as definitive proof that China's entire effect is fully mediated by price and logistics.

The January 2022 coal-ban result is the clearest discrete finding in the paper. Its magnitude is much larger than that of the broader COVID-19 and Ukraine-war regime dummies, which become insignificant once the structural adjustment mechanisms are controlled for. This suggests that much of the effect of broad external crises is already captured indirectly through prices, logistics conditions, and exchange-rate movements. By contrast, the January 2022 export-ban episode represents a sharp domestic policy interruption that cannot be reduced to the usual structural channels. This asymmetry has direct policy relevance. It indicates that domestic regulatory interventions can generate export shocks of a magnitude that broad external crises do not necessarily produce independently once the core trade channels are accounted for.

Indonesia's coal export system is therefore exposed not only to global market conditions, but also to abrupt domestic policy discontinuities. The broader implications follow from the relative strength of the identified channels. First, the prominence of the BDI suggests that logistics efficiency is the most actionable medium-term policy margin. The BDI itself is a global index and not a direct policy instrument, but the system's sensitivity to logistics conditions means that domestic measures reducing port congestion, cargo dwell time, customs delays, and shipping inefficiencies are economically relevant. Second, the exchange-rate result supports the importance of macroeconomic stability, but the interpretation should remain tied to monthly exchange-rate changes rather than to an unestimated volatility process.

Third, the long-run role of coal prices underscores the importance of downstream transformation. As long as Indonesia remains tied to benchmark raw-coal prices, export performance will remain exposed to global commodity cycles. In this sense, downstreaming is better understood not as a short-run export booster, but as a strategy for altering the long-run equilibrium conditions under which Indonesia participates in global energy trade.

Conclusion

Indonesia's coal export performance is shaped by a stable long-run external-adjustment structure rather than by isolated short-run shocks. Two cointegrating relations characterize that structure: one links coal exports to coal prices and the exchange rate, while the other links logistics conditions, represented by the Baltic Dry Index (BDI), to the exchange rate. Coal exports adjust significantly to both disequilibria, indicating that export performance is closely tied to the restoration of equilibrium after external disturbances. In the short run, only changes in the BDI and the exchange rate consistently influence export growth, whereas short-run coal-price changes do not remain significant once the equilibrium-correction terms and other controls are included.

Dynamic analysis further shows that logistics shocks account for a much larger share of coal-export forecast variance than exchange-rate shocks over the one-year horizon. This indicates that Indonesia's coal export performance is shaped not only by commodity-market incentives, but also by the operational realities of global shipping conditions. China PMI-family proxies do not provide additional explanatory power once the structural price, logistics, and exchange-rate channels are controlled. The appropriate interpretation is therefore not that China is unimportant, but that its influence is more likely transmitted indirectly through those broader channels than through a separable monthly PMI signal.

The January 2022 domestic coal export ban also stands out as the strongest discrete shock in the sample, indicating that abrupt domestic policy interventions can disrupt export performance more sharply than broad external crisis windows once the structural channels are taken into account. Three implications follow from these findings. First, logistics efficiency is the most actionable medium-term policy margin because export performance is highly sensitive to freight-market conditions. Second, exchange rate stability remains important because monthly exchange rate changes influence export adjustment, even if that channel is less dominant than logistics in the dynamic system. Third, the long-run role of coal prices suggests that downstream transformation remains relevant if Indonesia seeks to reduce its exposure to raw-coal price cycles over time.

This study has several limitations. The estimated system is linear, whereas commodity trade may exhibit asymmetry and regime dependence. The analysis also does not include a direct monthly measure of China's coal imports because a consistent series was not available for the full sample period. Future research could therefore extend the analysis by incorporating more direct importer-side monthly indicators, longer samples, and nonlinear approaches such as threshold or regime-switching VECM models. Overall, Indonesia's coal export performance is best understood as the outcome of an interconnected external-adjustment system in which logistics conditions, exchange-rate movements, and long-run commodity-market forces interact persistently. Sustaining competitiveness in such a system requires not only responding to global shocks, but also reducing domestic logistical frictions and avoiding abrupt policy discontinuities that amplify them.

AI declaration

The authors declare that artificial intelligence (AI) tools were used solely to assist in language refinement, grammar checking, and improving the clarity of writing. The use of AI did not influence the research design, data collection, data analysis, interpretation of results, or the development of conclusions. All intellectual contributions, including conceptualization, methodology, analysis, and final content, remain the full responsibility of the authors.

Conflict Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. The research was conducted independently without any financial, commercial, or personal relationships that could be construed as a potential conflict of interest.

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Appendix 1. Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Date	120	22082.1	1058.774	20270	23893
mdate	120	725.5	34.78505	666	785
Coal_Export	120	1.41e+09	7.66e+08	4.54e+08	3.64e+09
BDI	120	1462.698	759.5158	306.9048	4819.952
Coal_Price	120	136.5427	98.37565	51.3825	467.7837
Exchange_R~e	120	14490.17	930.191	13018.21	16752.5
VIX	120	18.54899	6.745179	10.12545	57.73682
Ch_PMI	120	50.15417	1.67943	35.7	52.6
Ch_NewOrdI~x	120	50.60167	2.73376	29.3	54.8
Ch_Prod_PMI	120	51.74333	2.872347	27.8	56.7
Inflation	120	.2431667	.3474783	-.76	1.65

Appendix 2. ADF Testing

```
Augmented Dickey-Fuller test for unit root

Variable: l_Coal_Export                       Number of obs  = 115
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -1.698       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.4319.
```

```
Augmented Dickey-Fuller test for unit root

Variable: l_Coal_Price                        Number of obs  = 115
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -2.280       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.1783.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.l_Coal_Export                     Number of obs  = 114
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -5.234       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.l_Coal_Price                      Number of obs  = 114
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -3.453       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.0093.
```

```
Variable: l_BDI                               Number of obs  = 115
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -2.850       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.0514.
```

```
Augmented Dickey-Fuller test for unit root

Variable: l_Exchange_Rate                     Number of obs  = 115
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -0.253       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.9319.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.l_BDI                             Number of obs  = 114
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -6.069       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.l_Exchange_R~e                    Number of obs  = 114
                                              Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test        ———————— critical value ————————
              statistic           1%           5%          10%
Z(t)             -5.555       -3.505       -2.889       -2.579

MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: Ch_PMI                            Number of obs  = 115
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -3.303       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0147.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.Ch_PMI                          Number of obs  = 114
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -8.208       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: Ch_Prod_PMI                       Number of obs  = 115
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -3.804       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0029.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.Ch_Prod_PMI                     Number of obs  = 114
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -8.394       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: Ch_NewOrdIndex                    Number of obs  = 115
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -3.155       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0227.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.Ch_NewOrdIndex                  Number of obs  = 114
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -8.211       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: Inflation                         Number of obs  = 115
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -4.278       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0005.
```

```
Augmented Dickey-Fuller test for unit root

Variable: D.Inflation                       Number of obs  = 114
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -9.906       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000.
```

```
Augmented Dickey-Fuller test for unit root

Variable: l_VIX                             Number of obs  = 115
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -2.344       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1582.

. dfuller D.l_VIX, lags(4)

Augmented Dickey-Fuller test for unit root

Variable: D.l_VIX                           Number of obs  = 114
                                            Number of lags =   4

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test      ------- critical value -------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -6.544       -3.505       -2.889       -2.579
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000.
```

Appendix 3. Lag Order Selection

Lag-order selection criteria

Sample: 2016m1 thru 2025m6 Number of obs = 114

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	42.547				6.0e-06	-.676264	-.6373	-.580257
1	474.125	863.16	16	0.000	4.1e-09	-7.96711	-7.77229*	-7.48708*
2	495.407	42.564	16	0.000	3.7e-09	-8.05978	-7.7091	-7.19571
3	514.437	38.06	16	0.001	3.5e-09	-8.11293	-7.6064	-6.86484
4	531.71	34.546*	16	0.005	3.5e-09*	-8.13526*	-7.47288	-6.50314
5	540.875	18.331	16	0.305	3.9e-09	-8.01536	-7.19712	-5.99921
6	547.106	12.462	16	0.712	4.7e-09	-7.84397	-6.86988	-5.4438

* optimal lag
Endogenous: l_Coal_Export l_BDI l_Exchange_Rate l_Coal_Price
Exogenous: _cons

Appendix 4. Johansen Test

Johansen tests for cointegration
Trend: Constant — Number of obs = 119
Sample: 2015m8 thru 2025m6 — Number of lags = 1

Maximum rank	Params	LL	Eigenvalue	Trace statistic	Critical value 5%
0	4	450.5259	.	84.6965	47.21
1	11	477.42056	0.36365	30.9072	29.68
2	16	487.78522	0.15987	10.1778*	15.41
3	19	491.08592	0.05396	3.5765	3.76
4	20	492.87414	0.02961		

* selected rank

```
. * Maximum-eigenvalue test
. vecrank l_Coal_Export l_BDI l_Exchange_Rate l_Coal_Price, ///
>      lags(1) trend(constant) max
```

Johansen tests for cointegration
Trend: Constant — Number of obs = 119
Sample: 2015m8 thru 2025m6 — Number of lags = 1

Maximum rank	Params	LL	Eigenvalue	Trace statistic	Critical value 5%
0	4	450.5259	.	84.6965	47.21
1	11	477.42056	0.36365	30.9072	29.68
2	16	487.78522	0.15987	10.1778*	15.41
3	19	491.08592	0.05396	3.5765	3.76
4	20	492.87414	0.02961		

Maximum rank	Params	LL	Eigenvalue	Eigenvalue Maximum	Critical value 5%
0	4	450.5259	.	53.7893	27.07
1	11	477.42056	0.36365	20.7293	20.97
2	16	487.78522	0.15987	6.6014	14.07
3	19	491.08592	0.05396	3.5765	3.76
4	20	492.87414	0.02961		

* selected rank

Vector error-correction model

Sample: 2015m8 thru 2025m6 — Number of obs = 119; AIC = -7.929163
Log likelihood = 487.7852 — HQIC = -7.77743
Det(Sigma_ml) = 3.23e-09 — SBIC = -7.5555

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_l_Coal_Export	3	.142612	0.2329	34.92377	0.0000
D_l_BDI	3	.248574	0.0429	5.151111	0.1611
D_l_Exchange_R~e	3	.018969	0.0350	4.166186	0.2441
D_l_Coal_Price	3	.105288	0.1200	15.6861	0.0013

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
D_l_Coal_Export						
_ce1 L1.	-.4318193	.0765873	-5.64	0.000	-.5819276	-.281711
_ce2 L1.	.1148132	.0293088	3.92	0.000	.0573691	.1722574
_cons	.0004654	.0132006	0.04	0.972	-.0254073	.0263381
D_l_BDI						
_ce1 L1.	.0842364	.1334921	0.63	0.528	-.1774033	.345876
_ce2 L1.	-.1141353	.0510853	-2.23	0.025	-.2142607	-.0140099
_cons	.0040621	.0230087	0.18	0.860	-.0410341	.0491584
D_l_Exchange_Rate						
_ce1 L1.	.0158709	.0101867	1.56	0.119	-.0040947	.0358366
_ce2 L1.	.0006707	.0038983	0.17	0.863	-.0069699	.0083112
_cons	.001981	.0017558	1.13	0.259	-.0014602	.0054223
D_l_Coal_Price						
_ce1 L1.	-.03458	.056543	-0.61	0.541	-.1454023	.0762422
_ce2 L1.	.0818867	.0216381	3.78	0.000	.0394767	.1242966
_cons	.0049931	.0097458	0.51	0.608	-.0141082	.0240945

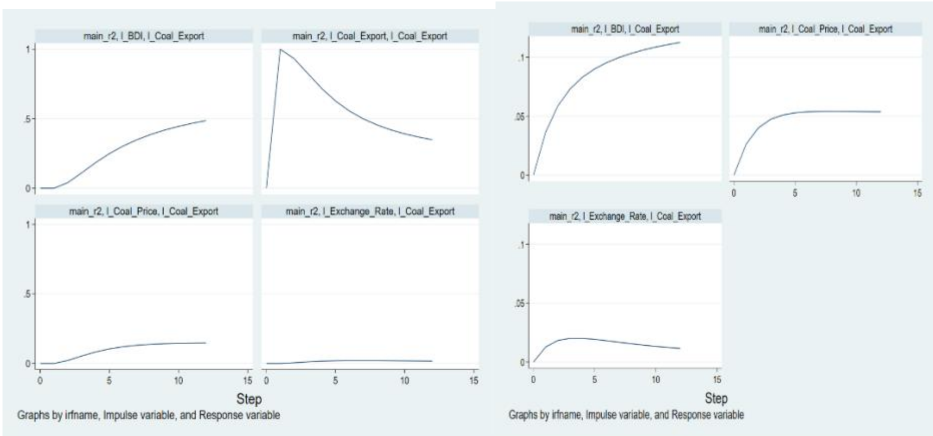
Johansen normalization restrictions imposed

beta	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
_ce1						
l_Coal_Export	1	.	.	.	.	.
l_BDI	0	(omitted)				
l_Exchange_Rate	-3.473252	.6712892	-5.17	0.000	-4.788955	-2.157549
l_Coal_Price	-.6633768	.0749565	-8.85	0.000	-.8102889	-.5164647
_cons	15.45877	.	.	.	.	.
_ce2						
l_Coal_Export	0	(omitted)				
l_BDI	1	.	.	.	.	.
l_Exchange_Rate	-5.539498	1.605702	-3.45	0.001	-8.686616	-2.39238
l_Coal_Price	-.1810969	.1792936	-1.01	0.312	-.5325059	.1703121
_cons	46.73475	.	.	.	.	.

Regression with Newey-West standard errors — Number of obs = 119
Maximum lag = 4 — F(8, 110) = 1275.78
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2 L1.	-.4623108	.1628371	-2.84	0.005	-.7850157	-.1396059
ce2_r2 L1.	.1469117	.0355381	4.13	0.000	.0764835	.2173398
l_BDI D1.	.1508458	.0576944	2.61	0.010	.0365091	.2651825
l_Exchange_Rate D1.	1.194513	.4600838	2.60	0.011	.2827347	2.106291
l_Coal_Price D1.	.1397099	.1280155	1.09	0.278	-.1139868	.3934066
Ch_NewOrdIndex	-.0047646	.0052242	-0.91	0.364	-.0151178	.0055886
Inflation D1.	.0046547	.0185578	0.25	0.802	-.0321225	.041432
coalban2022	-.9217523	.0527157	-17.49	0.000	-1.026222	-.8172821
_cons	.246138	.2675057	0.92	0.360	-.2839954	.7762714

Appendix 6. OIRF and FEVD



Appendix 7. Robustness Test

Regression with Newey-West standard errors — Number of obs = 119
Maximum lag = 4 — F(8, 110) = 1287.16
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2						
L1.	-.465359	.1599917	-2.91	0.004	-.7824249	-.1482931
ce2_r2						
L1.	.1493184	.0357915	4.17	0.000	.0783881	.2202487
l_BDI						
D1.	.1553713	.0573317	2.71	0.008	.0417534	.2689892
l_Exchange_Rate						
D1.	1.220031	.4841982	2.52	0.013	.2604641	2.179599
l_Coal_Price						
D1.	.1350534	.1289798	1.05	0.297	-.1205543	.3906611
Ch_PMI	-.0088375	.0074301	-1.19	0.237	-.0235623	.0058872
Inflation						
D1.	.0047445	.0186342	0.25	0.799	-.0321842	.0416731
coalban2022	-.9139123	.0505489	-18.08	0.000	-1.014088	-.8137363
_cons	.4481398	.3757119	1.19	0.236	-.2964331	1.192713

Regression with Newey-West standard errors — Number of obs = 119
Maximum lag = 4 — F(7, 111) = 1446.13
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2						
L1.	-.4612709	.1620846	-2.85	0.005	-.7824524	-.1400894
ce2_r2						
L1.	.1467895	.0355332	4.13	0.000	.0763781	.2172008
l_BDI						
D1.	.1520505	.0564467	2.69	0.008	.0401975	.2639034
l_Exchange_Rate						
D1.	1.186341	.4594269	2.58	0.011	.2759558	2.096726
l_Coal_Price						
D1.	.1399774	.1275575	1.10	0.275	-.1127864	.3927411
Ch_NewOrdIndex	-.0047341	.0051962	-0.91	0.364	-.0150306	.0055625
coalban2022	-.9213081	.0519408	-17.74	0.000	-1.024232	-.8183839
_cons	.244584	.2660328	0.92	0.360	-.2825776	.7717457

Regression with Newey-West standard errors — Number of obs = 119
Maximum lag = 4 — F(8, 110) = 1479.06
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2						
L1.	-.4432519	.1551146	-2.86	0.005	-.7506527	-.1358511
ce2_r2						
L1.	.1383424	.031933	4.33	0.000	.0750587	.2016261
l_BDI						
D1.	.134992	.0596918	2.26	0.026	.0166969	.2532871
l_Exchange_Rate						
D1.	1.197982	.4514705	2.65	0.009	.3032732	2.09269
l_Coal_Price						
D1.	.1557719	.1340834	1.16	0.248	-.1099498	.4214937
Ch_NewOrdIndex						
D1.	-.0000725	.002745	-0.03	0.979	-.0055125	.0053675
Inflation						
D1.	.0035992	.018225	0.20	0.844	-.0325186	.0397169
coalban2022	-.9239532	.0539663	-17.12	0.000	-1.030902	-.8170047
_cons	.005235	.010505	0.50	0.619	-.0155835	.0260535

Regression with Newey-West standard errors — Number of obs = 119
Maximum lag = 4 — F(8, 110) = 1279.64
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2						
L1.	-.466113	.1569207	-2.97	0.004	-.777093	-.1551331
ce2_r2						
L1.	.1486325	.0339631	4.38	0.000	.0813255	.2159395
l_BDI						
D1.	.1591374	.0572597	2.78	0.006	.045662	.2726127
l_Exchange_Rate						
D1.	1.207359	.4735005	2.55	0.012	.2689919	2.145725
l_Coal_Price						
D1.	.1196848	.1240668	0.96	0.337	-.1261864	.365556
Ch_Prod_PMI	-.0063672	.0048179	-1.32	0.189	-.0159152	.0031809
Inflation						
D1.	.0055303	.0188848	0.29	0.770	-.0318949	.0429555
coalban2022	-.9125992	.0504469	-18.09	0.000	-1.012573	-.8126254
_cons	.3343454	.2518592	1.33	0.187	-.1647804	.8334711

Regression with Newey-West standard errors
Maximum lag = 4

Number of obs = 119
F(8, 110) = 1480.82
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2 L1.	-.4428123	.1545848	-2.86	0.005	-.749163	-.1364615
ce2_r2 L1.	.1384665	.032051	4.32	0.000	.074949	.201984
l_BDI D1.	.1345139	.0597618	2.25	0.026	.0160801	.2529477
l_Exchange_Rate D1.	1.180012	.4543807	2.60	0.011	.2795362	2.080488
l_Coal_Price D1.	.156261	.133811	1.17	0.245	-.1089209	.421443
Ch_Prod_PMI D1.	.0002669	.0024904	0.11	0.915	-.0046684	.0052022
Inflation D1.	.0035931	.0182162	0.20	0.844	-.032507	.0396932
coalban2022	-.9243247	.0539728	-17.13	0.000	-1.031286	-.8173632
_cons	.005282	.0105021	0.50	0.616	-.0155307	.0260947

Regression with Newey-West standard errors
Maximum lag = 4

Number of obs = 119
F(8, 110) = 6.38
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2 L1.	-.4899234	.1874402	-2.61	0.010	-.8613859	-.1184608
ce2_r2 L1.	.1534547	.0421459	3.64	0.000	.0699315	.2369779
l_BDI D1.	.2361684	.1100048	2.15	0.034	.0181648	.4541721
l_Exchange_Rate D1.	1.049562	.4971565	2.11	0.037	.0643145	2.034809
l_Coal_Price D1.	-.0549667	.1628945	-0.34	0.736	-.3777854	.267852
Ch_NewOrdIndex	-.0054416	.0059822	-0.91	0.365	-.0172968	.0064137
Inflation D1.	.001286	.0211327	0.06	0.952	-.040594	.043166
covid	-.0061094	.0273099	-0.22	0.823	-.0602313	.0480125
_cons	.2746049	.3027662	0.91	0.366	-.3254066	.8746164

Regression with Newey-West standard errors
Maximum lag = 4

Number of obs = 119
F(8, 110) = 5.96
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval
ce1_r2 L1.	-.4868851	.1831509	-2.66	0.009	-.8498473	-.12392
ce2_r2 L1.	.1512668	.0397987	3.80	0.000	.0723951	.230138
l_BDI D1.	.2348529	.1080929	2.17	0.032	.0206381	.449067
l_Exchange_Rate D1.	.9988544	.5149491	1.94	0.055	-.0216539	2.01936
l_Coal_Price D1.	-.0654582	.1758973	-0.37	0.711	-.4140455	.28312
Ch_NewOrdIndex	-.0044541	.0049702	-0.90	0.372	-.0143039	.005395
Inflation D1.	.0001557	.0213487	0.01	0.994	-.0421525	.042463
ukraine	.0225573	.0630023	0.36	0.721	-.1022984	.14741
_cons	.2211332	.2510287	0.88	0.380	-.2763469	.718613

Regression with Newey-West standard errors
Maximum lag = 4

Number of obs = 119
F(9, 109) = 1160.50
Prob > F = 0.0000

D.l_Coal_Export	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
ce1_r2 L1.	-.4592748	.1591901	-2.89	0.005	-.7747844	-.1437652
ce2_r2 L1.	.1519798	.0372516	4.08	0.000	.0781483	.2258114
l_BDI D1.	.148754	.056835	2.62	0.010	.0361089	.2613991
l_Exchange_Rate D1.	1.073882	.416313	2.58	0.011	.2487635	1.899001
l_Coal_Price D1.	.13321	.1218291	1.09	0.277	-.1082513	.3746713
Ch_NewOrdIndex	-.00382	.0048187	-0.79	0.430	-.0133706	.0057305
Inflation D1.	.0054577	.0186088	0.29	0.770	-.0314243	.0423398
l_VIX	.0360306	.0320612	1.12	0.264	-.0275136	.0995748
coalban2022	-.9343534	.0541254	-17.26	0.000	-1.041628	-.8270786
_cons	.0954653	.2321174	0.41	0.682	-.3645838	.5555145