Are Currencies Sensitive to Critical Minerals? Lessons from Exporters and Importers of Critical Minerals

Área de Macroeconomia Aplicada

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Os minerais críticos (CM) estão se tornando cada vez mais relevantes para a economia global à medida que os países intensificam seus compromissos com a produção e o consumo de energia limpa. Seguindo a literatura sobre choques de petróleo e de *commodities*, as taxas de câmbio domésticas são sensíveis a esses choques. O mesmo ocorre com choques de minerais críticos? Este artigo analisa como as moedas de quatro grandes exportadores (Austrália, Brasil, China e Indonésia) e quatro grandes importadores (Japão, Coreia do Sul, Zona do Euro e Estados Unidos) de minerais críticos reagem a esses choques. A identificação dos choques distingue suas fontes entre choques de oferta e de demanda por meio dos modelos SVAR e Projeções Locais, utilizando dados mensais para o período de 1994M1 a 2025M12. Os resultados mostram que choques positivos de oferta de minerais críticos estão associados à depreciação das moedas, enquanto choques positivos de demanda estão relacionados à apreciação das moedas dos principais exportadores e à depreciação das moedas dos principais importadores. O estudo fornece evidências de que a posição dos países nos mercados globais de minerais críticos é um fator relevante para compreender o impacto desses choques sobre as taxas de câmbio.
Palavras-chave: Minerais críticos; Taxas de câmbio; Exportadores; Importadores; Identificação de choques.

Critical minerals (CM) have become increasingly relevant to the global economy as countries commit to the production and consumption of cleaner energy. Following the literature on oil and commodity shocks, domestic exchange rates are sensitive to these shocks. Could the same happen with CM shocks? This paper analyzes how the currencies of four major exporters (Australia, Brazil, China, and Indonesia) and four major importers (Japan, Korea, the Eurozone, and the U.S.) of CM react to CM shocks. The shock identification distinguishes the sources of the shocks into supply and demand shocks using SVAR and Local Projection models over the period 1994M1–2025M12. The results show that CM supply shocks correspond to the depreciation of currencies, while CM demand shocks are associated with the appreciation of the currencies of major exporters and the depreciation of those of major importers. This study provides evidence that the global position of countries in critical mineral markets is relevant for understanding the impact of CM shocks on currencies.
Key words: Critical minerals; Currencies; Exporters; Importers; Shock identification.

Jel code: F41; Q41; Q43.

1. Introduction

The progress of the energy transition and the expansion of the production and consumption of renewable and nuclear energy have put critical minerals at the center of modern economies (Stern, 2025). Critical minerals are fundamental for the production of technologies and materials necessary for renewable energy production, such as wind turbines, solar panels, and batteries for electric vehicles (Stern, 2025). As critical mineral markets become increasingly important for economies, these markets may also generate broader economic consequences.

Considine et al. (2023) showed that critical mineral (CM) price shocks affect domestic inflation and oil prices, while Attílio (2025a) showed that CM price shocks generate changes in industrial production and financial markets. Thus, there is evidence that CM markets may affect economic variables. However, there are still limitations in the literature. One limitation concerns the absence of studies relating CM shocks to exchange rate changes according to the global position of countries in CM markets.

For example, major CM producers, such as China in rare earths and Australia in lithium, may experience different effects from higher CM prices than major CM importers, such as Japan and South Korea.

This intuition comes from the literature on oil and commodity shocks, in which major producers and exporters usually experience currency appreciations, while major importers tend to experience currency depreciations (Bodenstein et al., 2011; Habib et al., 2016; Volkov and Yuhn, 2016; Flaccadoro, 2024). This paper extends this discussion to CM markets.

The research goal is to analyze the impact of CM prices on the exchange rates of 8 economies, distinguished by their status as major producers and importers of CM. Four economies are characterized as major producers and exporters of CM: Australia, Brazil, China, and Indonesia; four economies are characterized as major importers of CM: Japan, South Korea, the Eurozone, and the United States.

The empirical strategy consists of identifying CM shocks through movements in renewable energy production (supply) and renewable energy consumption (demand), using SVAR and local projection. This shock identification is derived from the oil literature, where oil price changes originate from supply and demand movements. The period analyzed is 1994M1–2025M12.

The results show that changes in domestic exchange rates depend on the source of the CM shock. CM supply shocks are associated with the depreciation of most currencies (apparently without distinguishing economies according to their characteristics), while CM demand shocks correspond to the appreciation of the currencies of major CM producers and the depreciation of the currencies of major CM importers. Despite these results, there are gray areas, such as the appreciation of some currencies of major CM importers, possibly due to the exports of goods with higher technological content based on imported CM.

These results are tested through a battery of robustness checks (Appendices B–N): alternative proxies for CM and exchange rates, sub-periods, alternative transformations of the variables, different lag structures, extensions of the base model, and alternative econometric models. The main results remain robust.

The implication of this study is that CM shocks may affect countries' currencies differently depending on their global position in CM markets, including the phases of extraction, processing, and manufacturing. This study extends the literature on oil and commodity price shocks and exchange rate responses by providing evidence on CM shocks and exchange rate fluctuations.

This paper is structured as follows. Section 2 presents the data and methodology. Section 3 describes the results. Section 4 concludes the investigation.

2. Data and Methodology

2.1 Data

The proxy for critical mineral prices is based on the Energy Transition Metal Index from the International Monetary Fund (IMF), available in the Primary Commodity Prices section. The IMF index includes 16 metals that are indispensable for the energy transition. However, it is only available from 2012M6 onward.

To extend the sample period, only those metals with data available since 1990 were selected. This results in a set of 9 metals: aluminum, copper, lead, nickel, zinc, cobalt, silver, palladium, and platinum. A simple average of these metal prices—deflated by the U.S. CPI from the Organization for Economic Co-operation and Development (OECD) Data Explorer and normalized to 100 in 2015—generates the proxy for critical mineral prices[1] (CM).

Figure 1 shows the time series of CM. Two main observations emerge from the figure. First, critical mineral prices fluctuate over time, exhibiting persistent peaks. Second, CM prices appear to experience a structural break around 2004, when they reach a new high. Since then, CM prices have remained at higher levels compared to previous years.

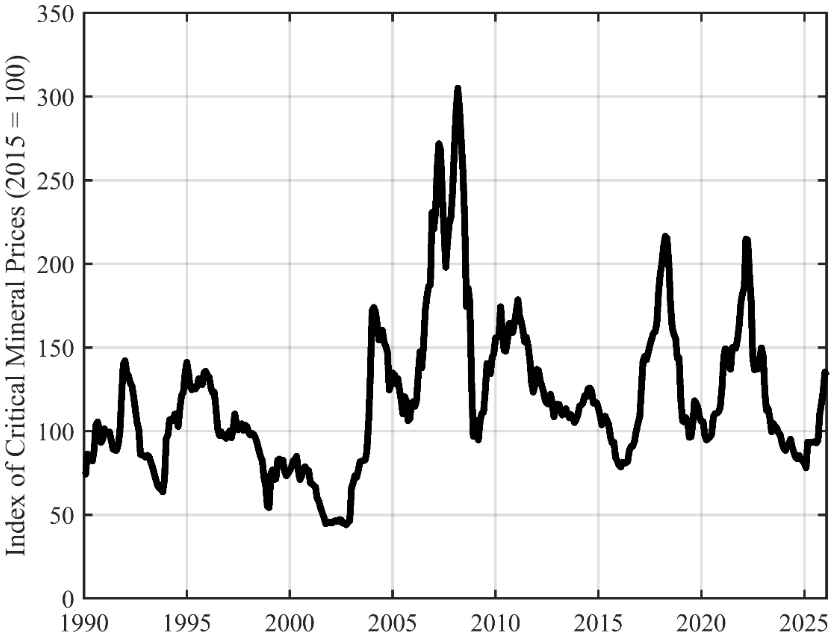

Figure 1: Time series of critical mineral prices

The exchange rates are represented by the effective exchange rates (e) from the Bank for International Settlements (BIS). These rates are constructed as weighted averages of bilateral exchange rates based on trade shares and are adjusted for relative

[1] Although this study uses this proxy as the main measure of CM, four alternative proxies are also tested. The first is the IMF Energy Transition Metal Index (see Appendix B); the second is a measure constructed using the same 16 metals included in the IMF index, but without weighting (see Appendix C); the third is the prices of rare earth elements (see Appendix D); the fourth is lithium prices (see Appendix E). The limitation of these alternative proxies is that they restrict the sample to start in 2012M6, implying a loss of observations and excluding the fluctuations in CM observed during the 1990s and 2000s (see Figure 1).

consumer prices. Increases in these rates denote an appreciation of the domestic currency, while decreases denote a depreciation. The advantage of using the effective exchange rate is that it captures trade dynamics between countries and provides a richer measure of the relative value of domestic currencies[2].

This study uses the currencies of 8 economies: Australia (AUS), Brazil (BRA), China (CHN), Indonesia (IND), Japan (JAP), Korea (KOR), the Eurozone (EUR), and the U.S. The first four countries are major producers and exporters of critical minerals. For example, Australia has major reserves of lithium, Brazil has relevant reserves of lithium, rare earths, and nickel, China has a dominant position in rare earth processing, and Indonesia is a major producer of nickel and cobalt (Stern, 2025; IEA, 2025).

Importantly, CM production involves at least three phases: extraction, processing, and manufacturing. These four countries are relevant across these stages, although with different roles. AUS, BRA, CHN, and IND are therefore treated as major producers and exporters of critical minerals.

The other four economies are closer to major importers of critical minerals: JAP, KOR, EUR, and the U.S. According to the WTO (2024), these economies are among the world's top seven importers of CM. By including both major exporters and importers, the sample allows the evaluation of the behavior of their currencies in response to global critical mineral prices. Thus, the choice of this sample opens the possibility of capturing heterogeneity in exchange rate responses to CM shocks, depending on the global position of these countries in CM markets.

The variables denoting the production (renewp) and consumption (renewc) of renewable energy are obtained from the U.S. Energy Information Administration (EIA), in the Monthly Energy Review section. These variables capture energy from renewable sources (wind, solar, geothermal, hydropower, and biomass), measured in quadrillion Btu. Both series are seasonally adjusted.

As described in the next section, the variables of production and consumption are used to identify supply and demand shocks. The variables are collected from the U.S. because the U.S., in 2024, was the second-largest producer and consumer of renewable and nuclear energy in the world, behind China (EIA, 2026).

Naturally, since China is the largest producer and consumer of renewable energy, it could also be considered as an option. However, the availability of these data in the EIA is annual for China. As described later, one adaptation for China is implemented using an alternative database.

Since the effective exchange rate has been available since January 1994, this is used as the initial period. As the variables of renewable energy production and consumption end in December 2025, this is the final period. Thus, the sample covers the period from 1994M1 to 2025M12, using monthly data.

In Appendix A, Table A1 presents the descriptive statistics of the variables.

2.2 Shock Identification

The shock identification follows the strategy implemented in studies on oil shocks (Kilian, 2009; Kumar and Mallick, 2024), where the source of the shock is separated into supply and demand components. In a SVAR through Cholesky decomposition, this implies the following specification:

$$SVAR = (renewp_t, renewc_t, cm_t, e_t) \quad (1)$$

[2] This study also tests an alternative proxy for the exchange rate: the traditional measure of the domestic currency relative to the U.S. dollar, deflated by domestic CPI (see Appendix N).

The rationale is that critical mineral prices move due to supply movements (changes in renewable energy production) and demand movements (changes in renewable energy consumption). Subsequently, exchange rates are affected by these fluctuations.

Due to the potential misspecifications of SVAR models highlighted by Jordà (2005), all estimates from Equation 1 are also constructed using local projections:

$$y_{t+h} = \alpha_h + \beta_h shock_t + \gamma_h X_t + \varepsilon_{t+h} \quad (2)$$

In Equation 2, y_{t+h} is the vector of variables at horizon h; α_h is the constant at horizon h; $\beta_h shock_t$ is the structural critical mineral shock recovered from the SVAR, where β_h represents the impulse response function associated with this shock at horizon h; $\gamma_h X_t$ is the vector of controls, consisting of the lagged variables; and ε_{t+h} is the error term.

The information criteria — Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ) — indicated between 2 and 4 lags. For parsimony, the baseline model adopts 2 lags. The estimates use 68% confidence intervals, and all variables are in logs.

Thus, in the empirical section, 8 models are estimated following Equations 1 and 2. In particular, all models include the variables renewp, renewc, and cm. The difference across the models concerns the last variable, the exchange rate.

Besides the baseline model, a battery of modifications is implemented to test the sensitivity of the results. Appendices B–E test four alternative proxies for critical minerals, Appendix F uses several sub-periods to accommodate global events and structural breaks, Appendix G tests the model using all variables in log differences, Appendix H changes the number of lags, and Appendix I extends the model to include commodity markets, uncertainty, and oil markets.

2.3 The Chinese Model

Given the acknowledgment of the importance of Chinese production and consumption of renewable energy for critical mineral markets, this section adapts the base model to Chinese variables. From Equation 1, the main change is:

$$SVAR = (electp_t, electc_t, cm_t, e_t) \quad (3)$$

In Equation 3, $electp_t$ denotes electricity generation from renewable and nuclear energy sources in China, measured in TWh; $electc_t$ denotes electricity demand in China, also measured in TWh. Both variables are collected from Ember Monthly Electricity Data.

Similar to the previous section, critical mineral prices may fluctuate due to changes in supply ($electp$) and demand ($electc$).

Naturally, there are two caveats to this configuration. First, compared to the U.S. variables of renewable energy production and consumption, the variables from Ember are related to electricity generation and demand. Second, the period of analysis starts in January 2015. However, it extends to February 2026. Thus, for the Chinese model, the sample period is 2015M1–2026M2.

As in the base model, the configurations of the model are similar. Appendix J implements robustness tests for the Chinese model by changing the lags and the transformations of the variables.

3. Results

3.1 Responses of Exchange Rates to CM Supply and Demand Shocks

Figure 2 presents a CM supply shock and the responses of the exchange rates of each country. As informed in the methodology, higher values of the exchange rate denote an appreciation, while lower values represent a depreciation. The red lines and bands are estimates from the SVAR model, while the blue lines and bands are related to the local projections. This pattern holds in the following figures, unless otherwise specified.

In Brazil, China, and the U.S., the CM supply shock corresponds to a depreciation of the currency for around 4 months. Korea and the Eurozone show a brief appreciation, which quickly becomes statistically nonsignificant. The solid lines, both red and blue, are very close, indicating that the SVAR estimates are likely robust to misspecification.

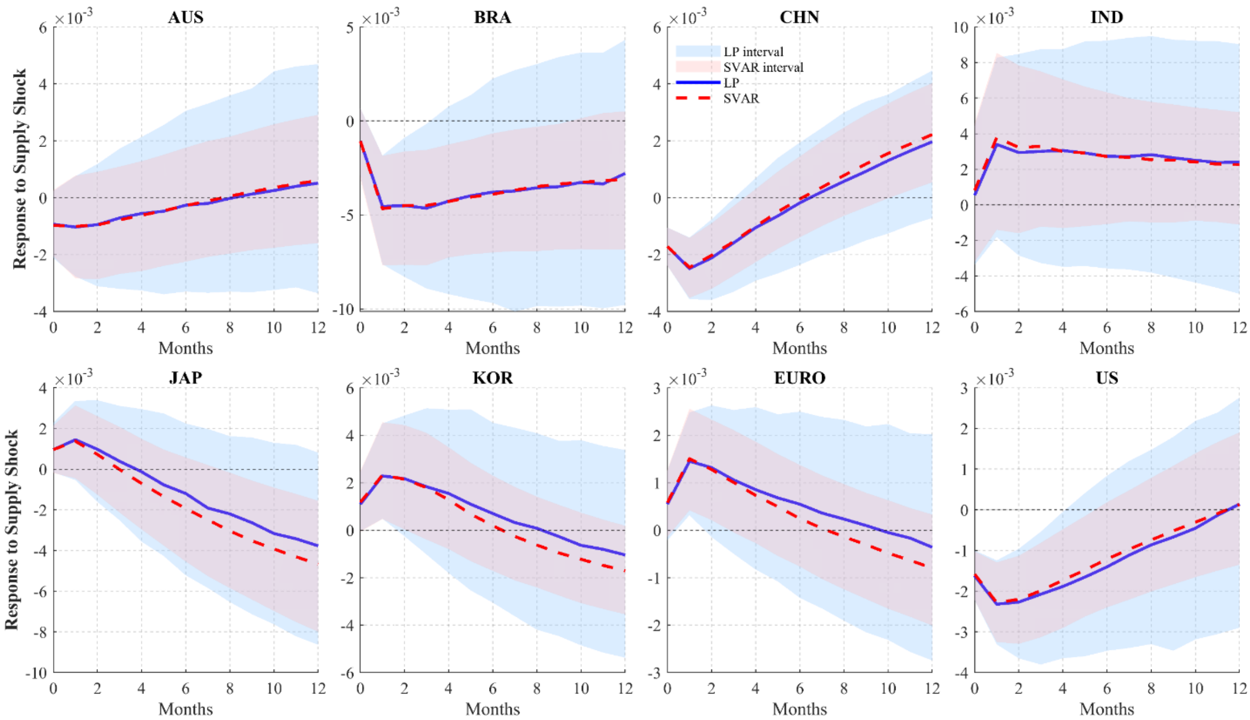

Figure 2: CM Supply Shocks and Responses of Exchange Rates

Notes: Each graph shows the responses of the exchange rate for each country (in acronyms). The blue solid line represents the estimates from the local projection, and the red dashed line represents the SVAR estimates. Confidence bands for the local projection are shown in light blue, and for the SVAR in light red. The horizontal axis shows the exchange rate responses over 12 months.

Figure 3 presents a CM demand shock and the responses of the exchange rates. As expected for countries that are larger producers and exporters of critical minerals, there are appreciations in the currencies of Australia, Brazil (although not statistically significant), China, and Indonesia. The differences lie in the timing of the effect, which is longer in Australia, lasting around 6 months. For countries that are more closely characterized as importers of critical minerals, a depreciation of the currencies is observed, except for Korea, which shows an appreciation that lasts for about 2 months before losing statistical significance.

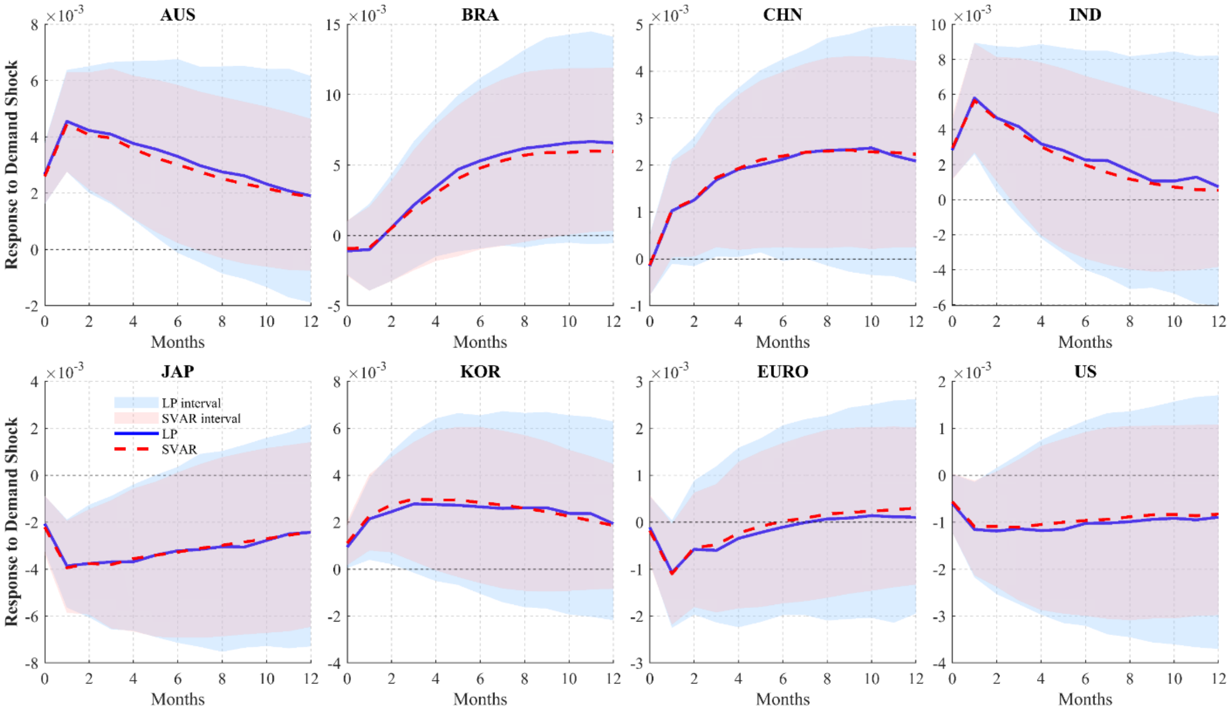

Figure 3: CM Demand Shocks and Responses of Exchange Rates

Notes: Each graph shows the responses of the exchange rate for each country (in acronyms). The blue solid line represents the estimates from the local projection, and the red dashed line represents the SVAR estimates. Confidence bands for the local projection are shown in light blue, and for the SVAR in light red. The horizontal axis shows the exchange rate responses over 12 months.

Table 1 presents the variance decomposition of the exchange rates. The table reports the values for each country in the first month and in the last month. The main results are shown in the column *cm*, denoting critical mineral prices. This column captures the influence of CM on exchange rate fluctuations.

A common pattern across all countries is that the impact of CM shocks on exchange rates increases over time. While in the first month the contribution of CM ranges from around 0.14% to 2.75%, it rises to between 0.8% and 7.8% in the last month. Besides reinforcing the influence of CM on currencies, these values indicate that the role of CM becomes more important over time.

Table 1: Variance Decomposition of the Exchange Rates

Country	Horizon	renewp	renewc	cm	e
AUS	1	0.3	1.81	2.75	94.47
		[0.03, 1.18]	[0.67, 3.74]	[1.36, 4.55]	[92.07, 96.56]
AUS	12	0.55	2.66	4.2	90.68
		[0.13, 1.64]	[0.80, 7.28]	[1.36, 9.97]	[83.87, 95.33]
BRA	1	0.2	0.23	0.31	98.88
		[0.02, 0.82]	[0.02, 0.84]	[0.02, 1.17]	[97.54, 99.56]
BRA	12	1.06	1.8	7.88	87.17
		[0.22, 3.07]	[0.42, 6.13]	[2.94, 15.52]	[78.86, 93.31]
CHN	1	1.8	0.13	0.14	97.56
		[0.68, 3.42]	[0.01, 0.54]	[0.01, 0.64]	[95.89, 98.84]
CHN	12	1.71	1.82	1.06	93.96
		[0.86, 3.19]	[0.29, 5.92]	[0.23, 3.64]	[89.18, 96.90]
IND	1	0.35	0.39	0.2	98.71
		[0.02, 1.48]	[0.07, 1.03]	[0.02, 0.76]	[97.18, 99.53]
IND	12	0.91	1.35	1.04	95.11
		[0.20, 3.41]	[0.44, 3.96]	[0.28, 3.23]	[90.90, 97.83]
JAP	1	0.25	0.89	0.54	97.72
		[0.02, 1.12]	[0.17, 2.15]	[0.08, 1.48]	[96.11, 98.86]
JAP	12	1.26	1.91	1.82	93.16
		[0.39, 3.56]	[0.55, 5.60]	[0.53, 5.69]	[87.52, 96.57]
KOR	1	0.28	0.2	0.38	98.74
		[0.03, 1.05]	[0.02, 0.75]	[0.04, 1.19]	[97.55, 99.46]
KOR	12	0.76	1.55	0.89	95.66
		[0.26, 1.80]	[0.31, 5.54]	[0.25, 2.98]	[90.67, 98.18]
EURO	1	0.27	0.15	0.21	98.96
		[0.03, 1.02]	[0.01, 0.64]	[0.02, 0.83]	[97.82, 99.61]
EURO	12	0.87	1.13	1.53	95.42
		[0.31, 1.98]	[0.26, 3.59]	[0.35, 5.14]	[90.63, 97.78]
US	1	2.17	0.33	2.12	94.87
		[0.86, 4.05]	[0.03, 1.24]	[0.87, 4.11]	[92.01, 97.00]
US	12	1.41	1.02	4.21	91.71
		[0.53, 3.25]	[0.22, 4.06]	[0.93, 10.14]	[85.35, 96.02]

Notes: The variance decomposition of the exchange rate is presented for all eight countries in the first column (Country). Estimates are reported for periods 1 and 12. All values are expressed in percent. Values in brackets denote confidence intervals.

These results confirm the links between energy shocks and fluctuations in exchange rates (Sokhanvar and Lee, 2022; Chatziantoniou et al., 2023; Mirza et al., 2023; Afonso et al., 2025). Regarding variables related to the energy transition, Attílio (2025a; 2025b) show that exchange rates depreciate in response to renewable energy supply shocks, while they appreciate following renewable energy demand shocks, without distinguishing countries by their role in critical mineral markets.

The results in this section are consistent with the literature showing that higher commodity or energy prices tend to appreciate the currencies of exporters, while leading to a depreciation in the currencies of importers (Bermpei et al., 2024). However, there are important nuances. This pattern is mainly observed for CM demand shocks, but not for supply shocks. CM supply shocks appear to generate market disruptions, leading to the depreciation of major CM producers, such as Brazil and China.

Another qualification concerns countries that import large amounts of CM, such as Korea. In this case, the currency shows an appreciation following CM shocks. Korea imports intermediate inputs and uses them in the production of more complex, higher value-added goods for exports, a pattern typical of global supply chains. This may help explain the behavior of its currency.

In Appendix B, Figures 2 and 3 and Table 1 are replicated using an alternative proxy for CM, the Energy Transition Metal Index from the IMF, in the Primary Commodity Prices section. This index combines 16 metal prices relevant for the energy transition (Aluminum, Chromium, Cobalt, Copper, Lead, Lithium, Manganese, Molybdenum, Nickel, Palladium, Platinum, Rare Earths, Silicon, Silver, Vanadium, and Zinc), weighted by their import shares.

However, there are two drawbacks to using this index. First, it is available only from 2012M6 onward, resulting in a substantial loss of observations. Second, it assigns very low weights to highly relevant critical minerals, such as rare earths (0.5%) and lithium (0.3%).

Figures B2–B5 and Table B1 show that the main results remain unchanged. The principal difference lies in the response of the U.S. exchange rate, which now appreciates following CM shocks, and the Eurozone exchange rate, which appreciates to CM supply shocks. Table B1 also indicates that the impact of CM under this alternative proxy is higher in some countries, particularly Australia and the U.S., reaching values of around 15%–16%.

Appendix C applies another proxy for CM. The proxy is based on the IMF index used in Appendix B, but excludes the weighting. Thus, this proxy combines 16 metals without weighting their global importance. Figures C2–C5 and Table C1 show that the results are very similar to those obtained using the IMF proxy.

Appendices D and E replicate the main model using single critical mineral prices as proxies for CM. Appendix D uses real rare earth prices, and Appendix E adopts real lithium prices. A limitation of these single-price proxies is that both series start only in 2012M6. Therefore, as in the previous appendices, the sample period is 2012M6–2025M12. Figures D2–D5, Figures E2–E5, and Tables D1 and E1 show that the main results remain.

Appendix F changes the sample periods. Figures F1 and F2 replicate Figures 2 and 3 using the period 2012M6–2025M12, allowing comparability with the IMF-based proxies. The estimates show that the main results remain, with the previously observed differences, the appreciation of the U.S. and Eurozone currencies in most shocks.

Major events are also considered in this appendix: the 2007–2008 financial crisis (Figures F3–F4, using the period 1994M1–2006M12), the COVID-19 pandemic (Figures F5–F6, period 1994M1–2019M12), the Russia–Ukraine war (Figures F7–F8, period 1994M1–2022M1), periods of declining CM prices (Figures F9–F10, period 1994M1–2002M7), and a potential structural break in CM prices (Figures F11–F12, period 2004M3–2025M12) – in Figure 1, it may be observed a possible structural break in CM prices around 2004. In all cases, despite some sensitivity due to different sample periods, the main results are preserved.

Appendix G replicates the base model and Appendix F using all variables in log-differences. Given that some variables have unit root (see Table A2 in Appendix A), the transformation in log differences mitigates this issue. Figures G1–G14 present the results. One qualitative improvement is that CM supply shocks now correspond to an appreciation of the currencies of major CM producers.

Appendix H uses alternative lag structures. Figures H1–H2 adopt 4 lags, while Figures H3–H4 adopt 12 lags (to account for possible serial correlation). The model with 4 lags shows an appreciation in the currencies of all major CM producers following CM demand shocks, suggesting that 4 lags capture dynamics not present in the baseline model with 2 lags.

Appendix I extends the base model by including: commodity markets (IMF commodity price index), financial uncertainty (VIX from the Federal Reserve Bank of St. Louis, FRED), geopolitical uncertainty (GPR from Caldara and Iacoviello, 2022), economic policy uncertainty (GEPU from Economic Policy Uncertainty), and oil markets (WTI from FRED). In all cases, these variables are included before exchange rates and after CM prices in the vector of variables. Figures I1–I10 present the results. The currencies of Australia and Indonesia consistently appreciate following CM demand shocks, while the Chinese currency remains statistically nonsignificant in all cases, suggesting that the extended models capture additional dynamics affecting China.

In short, the results from this section and Appendices B–I confirm that critical mineral shocks are a non-negligible driver of exchange rate dynamics, with effects that vary across countries depending on their position in global production and trade structures.

3.2 Chinese Shocks

This section replicates the baseline model, changing only the variables related to production and consumption, and the period of analysis due to the availability of the Chinese variables (2015M1-2026M2). While Section 3.1 used variables based on the U.S., this section adopts variables related to China. Figures 4 and 5 show the responses of exchange rates to CM shocks, distinguishing between supply and demand shocks.

Figure 4 mirrors Figure 2, showing that most currencies depreciate following CM supply shocks. The two exceptions are the Eurozone and the U.S., where the currencies appreciate.

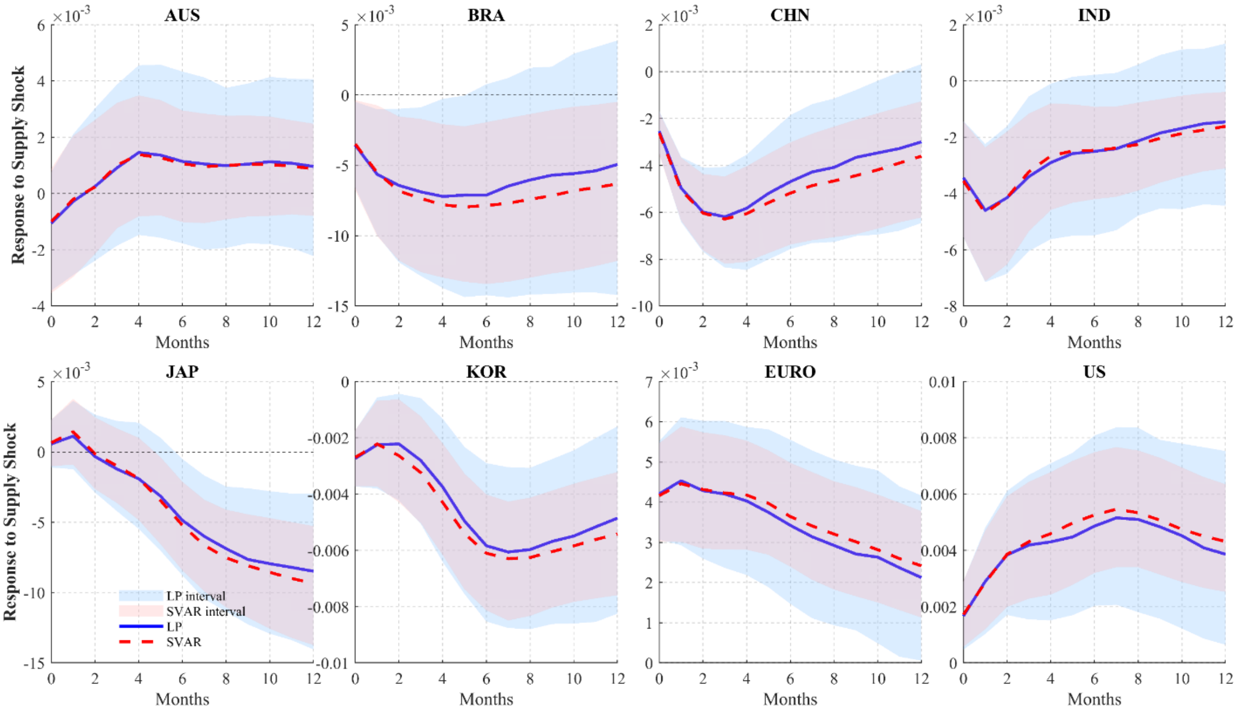

Figure 4: CM Supply Shocks and Responses of Exchange Rates (Chinese Model)

Notes: Each graph shows the responses of the exchange rate for each country (in acronyms). The blue solid line represents the estimates from the local projection, and the red dashed line represents the SVAR estimates. Confidence bands for the local projection are shown in light blue, and for the SVAR in light red. The horizontal axis shows the exchange rate responses over 12 months.

Figure 5 shows quick appreciations in Australia and China. Regarding CM importers, all countries exhibit depreciations of their currencies, except for the Eurozone, which shows statistically nonsignificant responses.

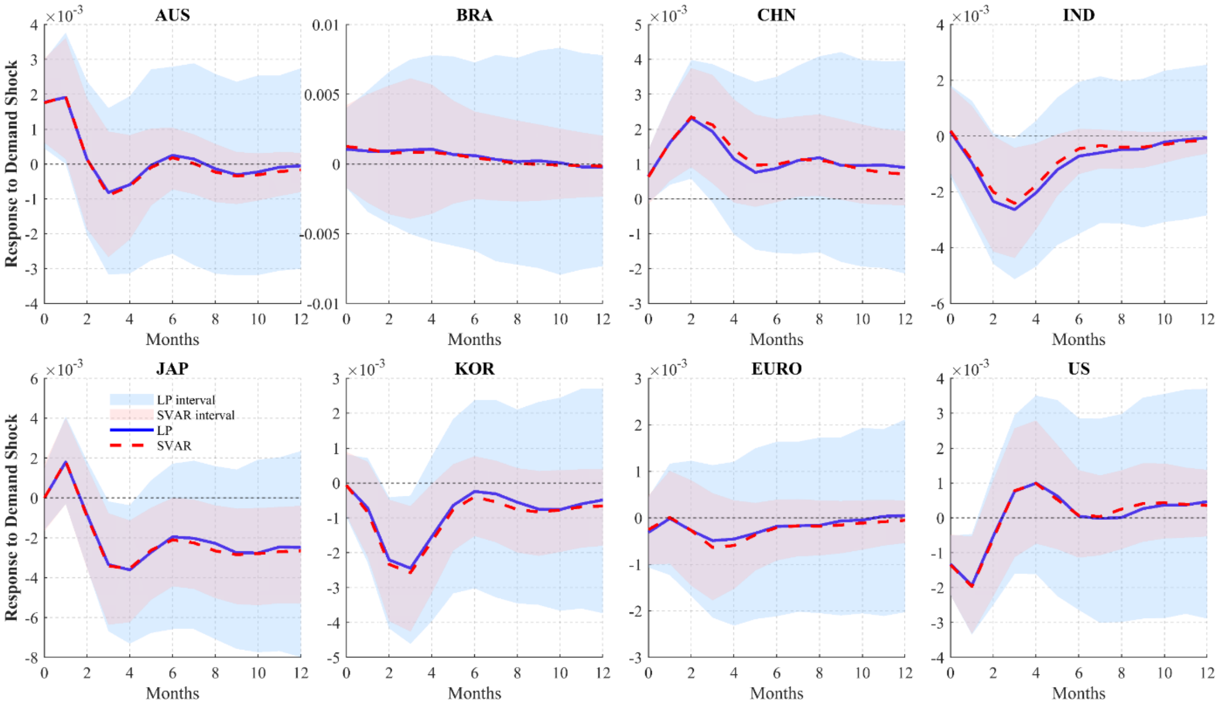

Figure 5: CM Demand Shocks and Responses of Exchange Rates (Chinese Model)

Notes: Each graph shows the responses of the exchange rate for each country (in acronyms). The blue solid line represents the estimates from the local projection, and the red dashed line represents the SVAR estimates. Confidence bands for the local projection are shown in light blue, and for the SVAR in light red. The horizontal axis shows the exchange rate responses over 12 months.

Table 2 replicates Table 1. The influence of critical mineral shocks on the variance decomposition of exchange rates is very similar to that of the base model, suggesting that identifying shocks by supply and demand using Chinese electricity generation from renewable and nuclear energy does not alter the main results.

Table 2: Variance Decomposition of the Exchange Rates (Chinese Model)

Country	Horizon	electp	electc	cm	e
AUS	1	1.03	1.49	4.56	90.9
		[0.10, 5.05]	[0.20, 3.85]	[1.59, 9.53]	[84.44, 95.63]
AUS	12	4.2	2.12	9.8	80.91
		[1.27, 10.64]	[0.90, 4.43]	[4.20, 19.36]	[70.05, 88.59]
BRA	1	1.61	0.49	0.41	96.21
		[0.15, 4.93]	[0.04, 2.31]	[0.03, 1.78]	[92.06, 98.68]
BRA	12	8.25	1.21	3.78	83.38
		[1.85, 20.83]	[0.33, 4.10]	[0.97, 10.52]	[68.31, 92.85]
CHN	1	6.89	0.59	0.47	90.65
		[3.28, 12.43]	[0.06, 2.15]	[0.05, 2.05]	[85.08, 95.19]
CHN	12	26.23	2.24	6.61	59.75
		[13.51, 41.08]	[0.57, 6.17]	[1.40, 19.78]	[44.63, 75.56]
IND	1	5.5	0.59	0.63	92.01
		[1.12, 12.24]	[0.05, 2.58]	[0.06, 2.35]	[84.64, 97.02]
IND	12	12.99	2.98	4.16	76.15
		[4.65, 25.08]	[0.89, 7.87]	[1.35, 10.73]	[63.73, 86.06]
JAP	1	0.53	0.42	0.62	97.34
		[0.06, 2.36]	[0.04, 1.84]	[0.05, 2.38]	[94.54, 99.09]
JAP	12	11.99	2.67	9.24	71.26
		[4.31, 23.53]	[0.91, 7.09]	[2.20, 21.33]	[59.29, 83.14]
KOR	1	5.61	0.28	1.29	91.83
		[2.33, 10.01]	[0.03, 1.25]	[0.14, 4.11]	[86.69, 95.84]
KOR	12	24.42	2.03	7.82	61.45
		[11.97, 38.53]	[0.66, 5.89]	[2.26, 19.67]	[46.59, 75.57]
EURO	1	18.6	0.31	1.36	78.14
		[10.64, 27.53]	[0.03, 1.31]	[0.13, 4.91]	[69.26, 86.84]
EURO	12	34.97	1.11	4.58	56.82
		[20.50, 50.20]	[0.37, 2.88]	[1.48, 11.24]	[43.13, 71.67]
US	1	2.77	1.7	4.97	88.63
		[0.43, 7.71]	[0.31, 4.52]	[1.78, 10.32]	[81.25, 94.14]
US	12	21.71	1.76	8.82	64.86
		[8.52, 37.02]	[0.74, 3.96]	[3.28, 19.02]	[48.38, 79.50]

Notes: The variance decomposition of the exchange rate is presented for all eight countries in the first column (Country). Estimates are reported for periods 1 and 12. All values are expressed in percent. Values in brackets denote confidence intervals.

Appendix J implements robustness checks for the Chinese model. Figures J1–J4 and Table J1 use 4 and 12 lags in the model, while Figures J5 and J6 transform all variables into log-differences. The main results are preserved, except in the model with 4 lags, where CM demand shocks generate a depreciation of the Chinese and Indonesian currencies. However, this unexpected result is not observed in the models with 12 lags and in log-differences.

Despite changing the proxies used to represent supply and demand shocks and the sample period, the results show that exporters of CM tend to experience currency appreciations following CM demand shocks. As before, CM supply shocks are associated with currency depreciations, regardless of countries' positions in global CM markets. This effect appears stronger in the Chinese model than in the base model.

3.3 Incorporating Domestic Factors in CM Shocks

The previous sections identified the CM shocks using supply and demand variables without incorporating domestic dynamics. This section tests an alternative shock identification, where domestic dynamics of each country contribute to the identification of the shock. This section adopts a Bayesian VAR (BVAR) with max-share shock identification.

The max-share approach consists of identifying a linear combination of reduced-form shocks that generates the highest share of the forecast error variance decomposition (FEVD) of the target variable. In this paper, the target variable is critical mineral prices. Thus, the BVAR uses all variables in the model to identify the vector that produces the structural shock that maximizes the FEVD of CM prices.

The new variables representing domestic dynamics are industrial production, *ip* (an index with 100 in 2015 from the OECD Data Explorer, under the section Production, sales, work started and orders), stock market, *q* (share prices, an index with 100 in 2015 from the OECD Data Explorer, under the section Financial market), short-term interest rates, *r* (3-month interbank rates from FRED Economic Data), and long-term interest rates, *l* (10-year government bond yields from FRED Economic Data). As before, each model also includes critical mineral prices and the effective exchange rate.

Thus, except for missing data, each model includes six variables (and, due to data availability, the sample periods may vary across models). The BVAR uses Minnesota priors, 2 lags, adopts the horizon from 0 to 4 to implement the max-share identification, uses 68% credible intervals, and all variables are in logs, except for short- and long-term interest rates.

While the SVAR and local projections offer identification of supply and demand shocks, the BVAR with max-share incorporates domestic dynamics to generate the structural shock, highlighting the main drivers of CM shocks. A useful comparison between the SVAR/local projection and BVAR identifications is that, if the results show relevant distinctions, this may indicate that domestic dynamics play an important role in understanding the impact of CM shocks on exchange rates.

Unlike the SVAR/local projection framework, the BVAR identifies a broader macro-financial shock associated with critical mineral markets. Therefore, the identified shock may capture expansionary domestic dynamics beyond pure supply and demand effects in CM markets.

Figure 6 presents the structural CM shock and the responses of exchange rates. There are currency appreciations in all countries, except in China (until the sixth month, after which the estimates become statistically nonsignificant) and in the U.S. throughout the entire period. These results suggest that domestic dynamics interacting with critical mineral prices may be relevant for understanding fluctuations in exchange rates.

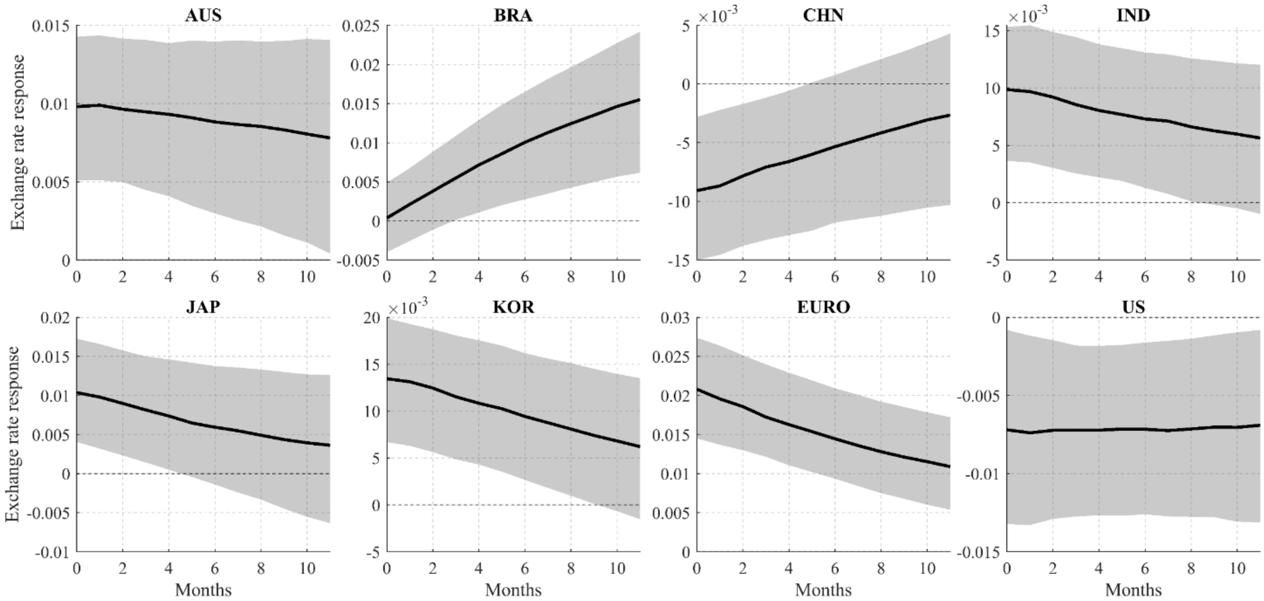

Figure 6: CM Shocks and Responses of the Exchange Rates (BVAR Model)

Notes: Each graph shows the responses of the exchange rate for each country (in acronyms). The black solid line represents the BVAR estimates, and the gray band denotes the credible interval. The horizontal axis shows the exchange rate responses over 12 months. The sample period for Australia is 1994M1–2026M2; for Brazil, 1996M10–2026M1; for China, 1999M1–2026M1; for Indonesia, 1998M1–2025M12; for Japan, 2002M4–2026M1; for Korea, 2000M10–2026M1; for the Eurozone, 1994M1–2026M1; and for the United States, 1994M1–2026M1.

Table 3 presents the variance decomposition with some changes compared to previous tables. First, the estimates capture the impact of the structural CM shock on the variables in percentage terms. Second, the horizons extend to 24 months, following other BVAR empirical studies that adopt longer horizons to capture long-term dynamics (Angeletos et al., 2020).

In Table 3, the main interest is in column *e*, which denotes the influence of the structural CM shock on exchange rates. Compared to the estimates from the SVAR/local projection, the influence of the shock is larger in all countries. At the 12-month horizon, the structural CM shock impacts exchange rates in the range of 1.5%–15.2% (compared to 0.8%-7.8% in Table 1); this range increases to 5.1%–27.9% at the 24-month horizon.

Table 3: Impact of the Structural CM Shock on Variables (BVAR Model)

Countries	Horizon	CM	ip	q	r	l	e
AUS	12	93.7		1.4	3.3	5.1	3.5
		[87.5, 97.5]		[0.5, 3.2]	[1.8, 5.5]	[2.7, 8.1]	[1.1, 7.0]
	24	25.9		6.0	7.6	6.6	6.8
		[7.8, 55.0]		[0.8, 21.1]	[1.8, 22.2]	[1.0, 21.7]	[1.4, 22.1]
BRA	12	97.4	2.2	3.8	0.8		1.5
		[94.4, 99.0]	[0.7, 4.6]	[1.7, 6.6]	[0.2, 2.0]		[0.5, 3.1]
	24	47.5	18.1	10.2	9.6		27.9
		[14.9, 77.6]	[5.0, 45.4]	[1.7, 37.0]	[1.7, 36.3]		[7.4, 54.3]
CHN	12	92.9	1.5	3.1	1.8		3.1
		[86.2, 97.0]	[0.6, 3.4]	[1.2, 5.9]	[0.6, 3.9]		[0.6, 7.1]
	24	38.2	18.9	11.5	18.6		9.9
		[13.7, 73.2]	[3.4, 48.4]	[1.7, 37.4]	[4.5, 42.1]		[1.5, 33.2]
IND	12	88.8	0.7	1.7	1.2		2.3
		[79.4, 94.6]	[0.2, 1.9]	[0.6, 3.3]	[0.4, 2.7]		[0.6, 5.7]
	24	44.7	9.9	12.6	8.3		10.4
		[19.0, 70.9]	[1.7, 34.8]	[1.2, 41.2]	[1.4, 26.3]		[1.8, 32.8]
JAP	12	76.2	4.4	4.3	1.0	1.1	3.2
		[62.0, 88.3]	[2.2, 7.5]	[1.7, 7.7]	[0.3, 2.7]	[0.3, 2.7]	[0.8, 7.6]
	24	17.1	7.3	5.2	5.1	4.6	5.1
		[5.4, 37.7]	[2.1, 19.3]	[1.3, 14.6]	[1.1, 14.1]	[1.0, 15.5]	[1.2, 15.0]
KOR	12	80.9	1.2	3.3	3.0	2.4	5.3
		[69.7, 90.4]	[0.4, 3.0]	[1.2, 6.7]	[1.0, 6.6]	[0.9, 4.9]	[1.5, 11.0]
	24	32.5	6.6	6.5	9.4	10.1	7.5
		[11.7, 59.9]	[0.8, 23.5]	[1.1, 23.0]	[2.1, 27.3]	[2.0, 29.6]	[1.8, 20.5]
EURO	12	63.2	2.2	1.9	1.7	1.3	15.2
		[48.6, 77.2]	[1.1, 4.2]	[0.5, 4.2]	[0.6, 3.9]	[0.4, 3.2]	[7.4, 26.3]
	24	25.6	13.8	15.4	15.6	15.3	17.3
		[10.6, 45.7]	[3.9, 30.6]	[3.2, 35.7]	[2.8, 37.5]	[2.3, 37.7]	[5.1, 35.6]
US	12	89.6	1.5	2.7	4.7	3.2	2.4
		[78.7, 96.0]	[0.4, 4.1]	[1.0, 5.3]	[2.5, 7.8]	[1.3, 5.5]	[0.5, 6.6]
	24	24.0	6.0	6.1	10.4	6.5	7.1
		[8.2, 51.8]	[1.2, 21.0]	[1.0, 22.3]	[2.1, 29.1]	[1.2, 22.6]	[1.6, 23.3]

Notes: The influence of the structural CM shock is presented for all eight countries in the first column (Country). Estimates are reported for periods 12 and 24. Each column corresponding to a variable shows the magnitude of the shock's impact on it. All values are expressed in percent. Values in brackets denote confidence intervals. The sample period for Australia is 1994M1–2026M2; for Brazil, 1996M10–2026M1; for China, 1999M1–2026M1; for Indonesia, 1998M1–2025M12; for Japan, 2002M4–2026M1; for Korea, 2000M10–2026M1; for the Eurozone, 1994M1–2026M1; and for the United States, 1994M1–2026M1.

Appendix K shows the responses of the other variables to the structural CM shock (Figures K1–K8). In most cases, industrial production, stock markets, and interest rates increase, with responses close to an economic expansion. If this is the case, the appreciations in most exchange rates become closer to the results from the SVAR/local projection for the major exporters of critical minerals (Australia, Brazil, and Indonesia) under CM demand shocks. However, the responses of other countries, particularly China, remain unexplained.

Given that cointegrating vectors may be present, Appendix L estimates a BVEC model with one cointegrating vector for all countries, except China, Indonesia, and the Eurozone, which adopt two vectors (according to cointegration tests). Figures L1–L9 and Table L1 present the results. The main findings remain, with appreciations in most currencies and a pattern consistent with economic expansion. However, a key difference is the depreciation of the Indonesian and Japanese currencies. In this case, long-term effects may be relevant for these economies. In the variance decomposition (Table L1), the impact of the structural CM shock is stronger than in the BVAR, reinforcing the possibility of long-term effects between critical mineral markets and domestic variables.

Appendix M replicates the BVAR model using 4 lags and adopting the horizon from 0 to 12 to implement the max-share identification. Figures M1–M9 and Table M1 show that the main results are not sensitive to these changes. The exception is the impact of the structural CM shock on exchange rates in Table M1, which is larger than in the BVAR with 2 lags and max-share over the 0–4 horizon. This likely indicates that maximizing the shock over a longer horizon captures dynamics relevant to exchange rate fluctuations.

Appendix N replicates all results presented in this paper, changing only the proxy for the exchange rate. Instead of using the effective exchange rate, this appendix uses the domestic currency per U.S. dollar, deflated by domestic CPI and U.S. CPI (all data from the OECD Data Explorer). For the U.S., the DXY index from investing.com is used. This new proxy allows the estimates to start in 1990M1 for all countries, except in China (1993M1) and in the Eurozone (1999M1). In the SVAR/local projection with U.S. variables (Figures N1–N2 and Table N1), exchange rate responses are generally short-lived and mostly indicate currency appreciations. In the Chinese model (Figures N3–N4 and Table N2), responses are mixed, varying between appreciations (mainly in CM demand shocks) and depreciations (primarily in CM supply shocks). In the BVAR (Figure N5 and Table N3), there are appreciations in all countries, except China and the U.S. These results suggest that this proxy is not capable of distinguishing exchange rate responses according to countries' positions in global critical mineral markets. However, for the BVAR, the proxy closely follows the main results, again reinforcing the importance of domestic dynamics.

In conclusion, this section presents an alternative shock identification that incorporates domestic dynamics. While this approach has the limitation of losing the distinction between supply and demand shocks, it provides evidence that domestic dynamics may be relevant for understanding critical mineral price shocks.

4. Conclusion

This study showed that CM price shocks generate exchange rate fluctuations. While CM supply shocks seem to indicate the depreciation of most economies, CM demand shocks follow the results from the literature on oil and commodity price shocks: major exporters tend to observe appreciation in their currencies, while major importers experience depreciation in their currencies.

If the future of the global economy is the transition toward the production and consumption of renewable and low-carbon energy, alongside the reduction in the importance of fossil fuel energy, then one probable scenario is one with increasing importance of CM prices in the functioning of economies.

Could critical minerals become as relevant to the global economy as oil has been since the last century? This question has no easy answer.

What the results suggest is that CM price fluctuations can affect exchange rate movements. Together with previous findings portraying the impacts of CM shocks on economic variables, there is evidence that critical minerals may become a source of economic volatility. The next years will help complete this picture.

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