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A Projection Model for Resource-rich and Dollarized Economy

The Democratic Republic of the Congo

Victor Musa, Bertrand Gilles Umba, Lewis Mambo, Jonas Kibala, Christian Kandolo, Josephine Mushiya, Yannick Luvezo, Jules Nsunda, Grégoire Lumbala, Yves Siasi, Serge Mfumukanda, Lubaki Ange, Kabata Olivier, Luc Shindano, Dyna Heng, Diego Rodriguez-Guzman and Barna Szabo

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ABSTRACT: The paper introduces a semi-structural Quarterly Projection Model (QPM) tailored for the Democratic Republic of the Congo (DRC), highlighting its resource richness and high degree of dollarization. We provide an overview of the model's specifications to elucidate key features of the DRC economy and present its properties, evaluating its alignment with DRC data and assessing its goodness of fit. Additionally, the paper demonstrates the QPM's practical application through a counterfactual scenario, comparing policy recommendations with the actual policy responses of the Central Bank of the Republic of Congo to observed exchange rate and inflation pressures in 2023. Beyond the QPM, the paper showcases supplementary tools that enhance its utility for generating medium-term forecasts and developiong narratives in support of monetary policymaking. Specifically, we introduce the Nowcasting and Near-Term Forecast models, designed to assess the economy in real-time and predict short-term inflationary trends.

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[1] ICD technical assistance and customized training missions, which led to the development of this model, were provided to the Banque Central du Congo (BCC) within the project on Building Capacity in Monetary Policy Modeling in the DRC. This paper benefited from discussions with staff of the BCC and the IMF country team. We are grateful for comments from N. E. Babiker, N Epstein, R. Portillo, M. Singh, and L. Zanna. The views expressed in this paper are those of the authors and not necessarily those of the DRC authorities, the International Monetary Fund, or its Executive Board. We are also grateful to Ms. Elisa Manarinjara for her support along the publication procedures.

Contents

Glossary

ARMA	Auto-Regression Moving Average
ARMAX	Auto-Regression Moving Average with Exogenous Variables
BCC	Banque Central du Congo
CPI	Consumer Price Index
DFM	Dynamic Factor Model
GDP	Gross Domestic Product
FPAS	Forecasting and Policy Analysis System
MIDAS	Mixed Frequency Data Sampling
NTF	Near-term forecasting
OLS	Ordinary Least Squared
U-MIDAS	Unrestricted Mixed Frequency Data Sampling
VAR	Vector Auto-Regression
VARX	Vector Auto-Regression with Exogenous Variables
WEO	World Economic Outlook

Executive Summary

The paper introduces a semi-structural Quarterly Projection Model (QPM) tailored for the Democratic Republic of the Congo (DRC), highlighting its resource richness and high degree of dollarization. We provide an overview of the model's specifications to elucidate key features of the DRC economy and present its properties, evaluating its alignment with DRC data and assessing its goodness of fit. Additionally, the paper demonstrates the QPM's practical application through a counterfactual scenario, comparing policy recommendations with the actual policy responses of the Central Bank of the Republic of Congo to observed exchange rate and inflation pressures in 2023. Beyond the QPM, the paper showcases supplementary tools that enhance its utility for generating medium-term forecasts and providing monetary policy advice. Specifically, we introduce the Nowcasting and Near-Term Forecast models, designed to assess the economy in real-time and predict short-term inflationary trends.

An essential component of the FPAS is the establishment of a macroeconomic framework that facilitates the joint and systematic analysis of economic variables, as well as the development of policy scenarios that complement and support policy decisions within the institution. To fulfill this requirement, this document proposes a quarterly projection model for the DRC (DRCMOD), which incorporates the most relevant regularities of the DRC economy and includes an adequate representation of the monetary policy framework followed by the BCC.

The model presented can reflect significant characteristics of the Congolese economy, such as high dollarization, the strong impact of exchange rate on inflation, significant dependence on commodity exports, and dynamics of public debt. Additionally, it reflects the current Monetary Policy Framework (MPF) and exchange rate regime followed by the BCC, characterized by control over monetary aggregates and intervention in the foreign exchange market.

It is important to note that the proposed model not only incorporates the economic characteristics of the DRC but has also been calibrated with available data to plausibly reproduce the transmission mechanisms of monetary policy and relevant historical events for the DRC economy. Therefore, the DRCMOD can be used as a tool for analysis and forecasting within the BCC.

It is essential to understand that this tool is a structural model, not simply a forecasting generator. In this sense, the model should be understood as a tool that contextualizes and structures discussions around economic policy narratives both within and outside the institution, rather than merely predicting future events.

In line with the development of the FPAS within the institution, it is necessary for the use of the proposed DRCMOD to be accompanied by other fundamental elements to ensure a successful FPAS. These elements include the formation of teams within the institution to discuss and analyze recent economic developments according to the model. Additionally, the establishment of a systematic process for communicating staff analyses and macroeconomic projections to policymakers is required, ensuring a substantial influence on policy decisions.

I. Introduction

The Democratic Republic of the Congo (DRC) faces significant challenges across various aspects of its macroeconomic policies: a high level of dollarization, boom-bust cycle in the mining sector, and the considerable impact of exchange rate fluctuations and commodity prices on inflation. Moreover, a history of fiscal dominance and high level of informal sector further complicate and constraint monetary policy options.

To bolster the effectiveness of the DRC's macroeconomic policies, the Banque Central du Congo (BCC) has initiated a modernization process governed by Law No. 18/027, enacted on December 13, 2018. This law entrusts the BCC with exclusive responsibility for independently defining and implementing monetary policy. It grants the BCC full authority to determine intermediate monetary objectives, instruments, and execution methods autonomously.

The modernization process necessitates establishing elements that enable the BCC to conduct forward-looking monetary policy. These elements are (i) an analytical framework supporting policy decisions, (ii) a systematic process for communicating staff analyses and macroeconomic projections to policymakers, ensuring substantial influence on policy decisions, (iii) a coherent framework for policy implementation and operations, and (iv) effective external policy communications. These components and processes reinforce one another. In collaboration with the IMF, the BCC aims to develop these elements through a Forecasting and Policy Analysis System (FPAS) Technical Assistance project. This project aims to enhance staff capabilities in macroeconomic analysis, streamline decision-making processes within the institution, and establish effective channels for external policy communications.

At the heart of FPAS typically lies a macroeconomic model designed to capture the key characteristics and policy transmissions in economies. The Quarterly Projection Model (QPM) presented in this paper delineates fundamental features of the Congolese economy, such as high dollarization, high inflation passthrough, heavy reliance on commodity exports, and unstable public debt dynamics. The model also aims to mirror the Monetary Policy Framework (MPF) and the exchange rate arrangement established at the BCC. This alignment is crucial for maintaining the model as a robust tool for policy formulation and narrative and strategic decision-making amid the intricate dynamics of the country's economic landscape.

The MPF at the BCC employs several policy instruments to achieve its price stability objectives. First, it offers various interest rates on refinancing, providing banks with three distinct liquidity windows—short-term loans, standing facilities, and special loans. Second, the BCC implements variable mandatory reserve coefficients in response to structural shocks, based on deposit currency and maturity. Third, the issuance of BCC Bonds, comprising short-term debt securities ('Bon de la Banque Centrale du Congo'), helps stabilize bank liquidity under fluctuating financial conditions. Collectively, these measures contribute to the pursuit of price stability.

The official exchange rate arrangement is designated as floating, where the Congo Democratic Franc (CDF)'s exchange rate is dictated by supply and demand within the foreign exchange market. The BCC engages in interventions solely through auctions, representing the primary operational framework for its transactions within the market. However, the de facto exchange rate arrangement is categorized as crawl-like in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).

This paper aims to introduce the DRCMOD, a semi-structural quarterly projection model tailored for the DRC. It lays out the model structure capturing key economic characteristics and stylized facts of the DRC's economy, and then illustrates an application of the DRCMOD for policy analysis. To reflect the importance of commodity exports, we extended the aggregate demand block of the canonical model to include two sectors: mining and non-mining. Aligned with the MPF of the BCC, our modeling approach allows for incorporating monetary targets instead of a pure inflation targeting framework. We allow for exchange rate interventions and account for dollarization via the transmission channels of monetary policy and the high degree of pass-through of the exchange rate into prices. In the model, we do not explicitly reflect the informality present in the DRC. However, we incorporate its effects on the transmission of monetary policy through the calibration of the model. The DRCMOD serves as a practical analytical tool for assessing counter-factual policy scenarios, guiding monetary policy discussions and designs.

The paper also outlines additional tools that complement DRCMOD, including disaggregation methods for interpolating quarterly GDP data, a nowcasting models for real-time assessment of DRC's real GDP, and Near-Term Forecast (NTF) models for short-term inflation predictions. These tools enhance the effectiveness of DRCMOD in regular forecast rounds as part of the FPAS.

The rest of the paper is organized as follows: Section II describes the key characteristics of DRC economy and policy challenges. Section III presents approaches to interpolate quarterly GDP data for DRC, the nowcasting and NTF models. Section IV lay outs the key components of the DRCMOD and how it is calibrated to capture the key features of DRC. Section V presents a counterfactual scenario that compares the policy prescription that DRCMOD would have recommended with the policy response adopted by BCC authorities in response to the increase in inflation in 2023. Section VI concludes.

II. Key Characteristics and Monetary Policy Framework of the DRC

DRC's economy is largely based on the export of minerals and has a high level of dollarization. Exports and imports are largely composed of minerals and raw materials. This exposes the economy to global commodity price shocks and external demand.

Monetary policy options have been constrained by high level of dollarization and a history of fiscal dominance. Fluctuation in exchange rate and commodity prices tend to have strong impact on price stability. In addition, fiscal deficits financed by credit from the central bank, are often linked to exchange rate depreciation and thus an inflationary surge. Interventions in the foreign exchange market by the BCC constitute the main channel for mitigating the volatility of the exchange rate and inflation but is limited due to low level of foreign reserves.

A. Economic growth and the dominance of the mining sector

The Congolese economy is one of the world's most natural resource-rich countries: minerals and forest abound. The mining sector, dominated by copper and cobalt production, has been the key driver of the economy. DRC's production of cobalt, copper and industrial diamonds are among the top in the world. The mining sector accounts for about 35% of GDP in 2022. Figure 1 below shows the growth rates and key drivers. Figure 2 also shows the high correlation between economic growth and the prices of copper and cobalt. Prior to

1990s, the mining sector contributed over 70% of budget revenues. Today, it still remains a significant source of domestic revenues.

B. Dollarization, Fiscal Deficit, and Monetary Policy Framework in DRC

Dollarization in the DRC is intricately tied to hyperinflation resulting from the unrestrained monetary financing of fiscal deficits and periods of political uncertainty, a phenomenon observed in various other nations. The prevailing uncertainty regarding the central bank's capability to uphold currency value and control inflation fosters and solidifies dollarization, a trend witnessed in numerous fragile states and developing countries (refer to, for instance, García-Escribano and Sosa, 2011). Remarkably, more than 90 percent of the banking system's deposits and lending are denominated in US dollars. Figure 3, presented below, visually underscores the pronounced degree of dollarization in the DRC. This high level of dollarization poses constraints on monetary policy, thereby shifting a substantial burden of macroeconomic management onto fiscal policy.

However, lack of fiscal discipline and monetary financing of the deficit per se put pressures on and complicate monetary policy options. Tax revenues represent the majority of government income, mainly from the mining sector, exposing fiscal policy to fluctuations in the foreign economy. While it has forced itself to remain within the limits of its fiscal resources and external support in the execution of its expenditure, the government has been struggling to mobilize other resources through borrowing, especially domestic savings. Since 2020, the budget deficit has no longer been financed by advances from the BCC.

The BCC's primary objective is to ensure general price level stability while also emphasizing its support for the government's economic policy. To achieve this, the BCC operates within a monetary targeting system, wherein the money supply of domestic currency serves as an intermediate objective and the monetary base as the operational objective.

Monetary targeting is a common practice in low-income countries (LIC) as the DRC. In LICs money targets are often part of the de jure regime, but often serving more as guideposts of some sort than as a nominal anchor. These money targets are implemented flexibly in practice, with frequent misses that provide little information as to subsequent policy changes or economic outcomes. This flexibility helps avoid counterproductive responses to shocks, such as to shocks to supply or money demand; but it leaves the stance of policy undetermined. At the same time, and despite the BCC's official exchange rate regime is floating, the central bank conducts foreign exchange market interventions through auctions. In practice, these elements often combine in opaque ways making the MPF difficult to understand and communicate, and thus impairs the transmission of monetary policy signals and credibility[1].

This opacity in the MPF could partly explain why the economy of the DRC has experienced periods of high inflation (Figure 4). At the same time, high level of dollarization, shallow financial system, and lack of fiscal discipline constrains BCC's monetary policy options[2]. Inflation tends to have strong association with the increase of CDF money growth.

[1] Unsal et al., (2022) introduce the Independence and Accountability, Policy and Operational Strategy, and Communications (IAPOC) index, while Dincer et al., (2022) develop a transparency index for central banks. Regrettably, neither of these indices includes estimates for the DRC.

[2] Nevertheless, it is important to note that that monetary financing of fiscal deficit has been formally prohibited by Ordonnance – Law n°18/027 of December 13, 2018, on the organization and operation of the Central Bank of the Congo.

Before 2016, targeting monetary aggregates used to be the basis of the BCC's monetary policy. In the framework, BCC set the reserve requirement and auctions BCC bills to influence money supply, but with limited effect on the economy[3]. However, in 2016, to ensure greater stability and confidence of the central bank, and in view of the mixed results of targeting monetary aggregates especially in the context of high dollarization, the BCC adopted a medium-term inflation target of 7 percent.

The shallow interbank market also poses constraints to monetary policy operations. To help address this dysfunction, in 2015, BCC established a market operating framework based on bilateral auction of currencies. In this framework, BCC plays the role of central counterparty. As a market player which would intervene to mitigate price volatilities, BCC acts through currency auctions, either directly by transferring currencies to banks, or indirectly by making certain domestic expenditures in foreign currencies. For several years, this practice contributed to the stability of the local currency, particularly between 2010 and 2016 (Figure 5). However, after 2016, this foreign exchange market intervention by BCC to stabilize CDF is constrained by low level of foreign reserves and/or the commitment to build sufficient foreign exchange reserves[4]. With limited intervention, exchange rate tends to depreciation over time as shown in Figure 5.

BCC has also used several policy instruments for its price stability objectives. First, it offers various interest rates on refinancing, providing banks with three distinct liquidity windows—short-term loans, standing facilities, and special loans (Figure 6). Second, BCC implements variable mandatory reserve coefficients in response to structural shocks, based on deposit currency and maturity. Third, the issuance of BCC Bond, comprising short-term debt securities ("Bon de la Banque Centrale du Congo"), helps stabilize bank liquidity under fluctuating financial conditions, contributing collectively to the pursuit of price stability.

Figure 1: Key Drivers of Economic Growth

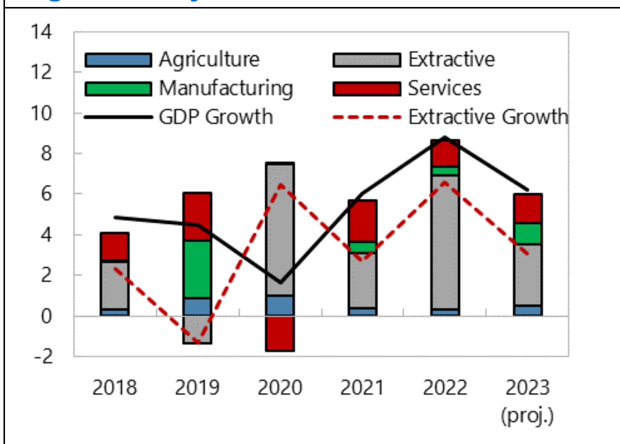
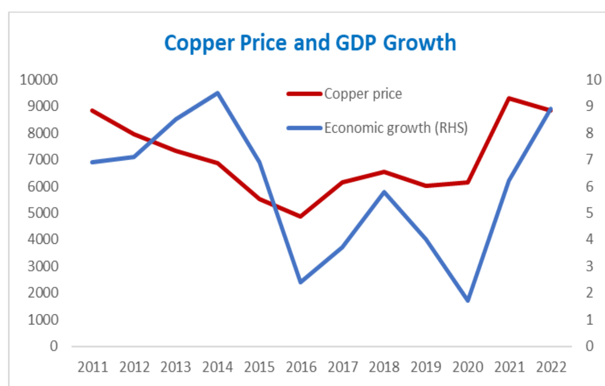


Figure 2: Growth and Commodity Prices



[3] The low absorption capacity of the Congolese economy has been a key characteristic of the DRC's economy since colonial times. Given the constraints on private investment and risks, excess liquidity and low credit growth to private sector have been observed in the banking system.

[4] Gross foreign reserves have been below 3 months of imports for several years - at around 6 weeks of imports on average between 2016-2022. As of December 2022, net international reserves stand at USD 4.72 billion, representing only 2.56 months of imports, less than the minimum target of 3 months.

Figure 3: Dollarization

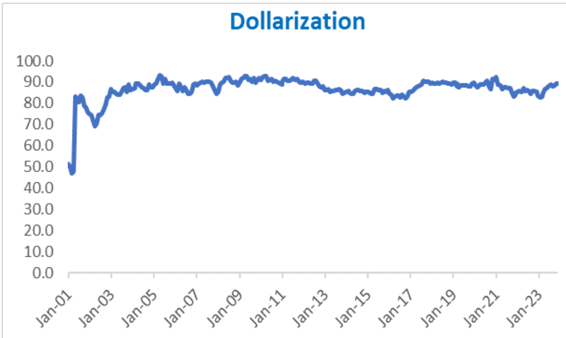


Figure 4: Money Growth Rates and Inflation

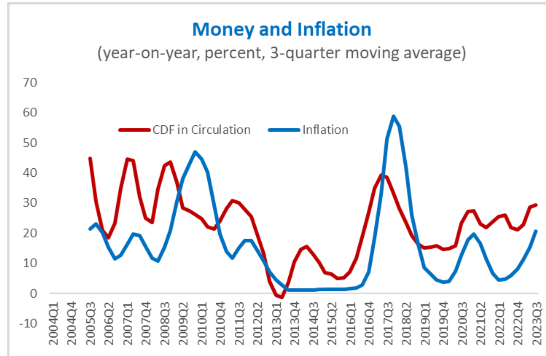


Figure 5: Congolese Franc per US Dollar

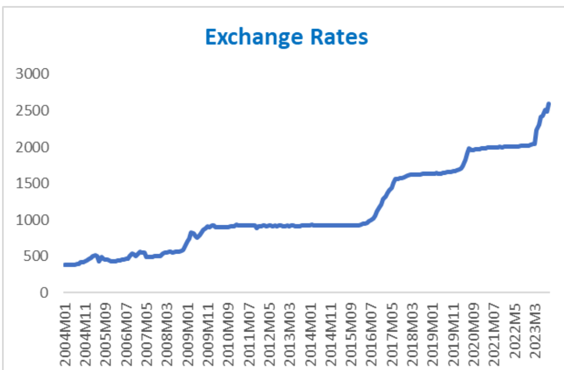
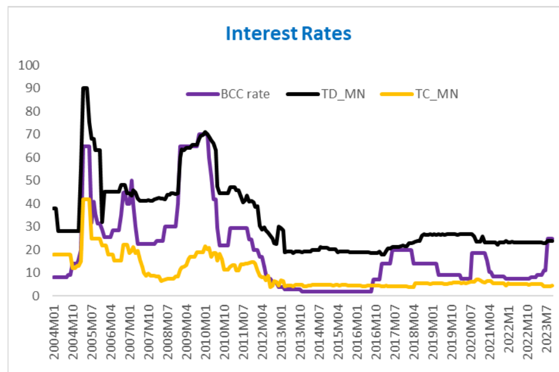


Figure 6: Interest Rates



III. Assessing the DRC's Economy in Real-time

Assessing the current state of the economy is an important step before forecasting the future. This exercise needs high-frequency data and quarterly GDP. This section will first discuss how to estimate historical quarterly GDP, and then describe the nowcasting model developed to assess the current state of the economy.

It should be noted that the availability of quarterly GDP data series, the assessment of current state of the economy (nowcasting) and in the near-term future (near-term forecasting, NTF), and satellite models for sectoral analysis are key components of FPAS. This section describes the development of additional tools as supplementary components of the FPAS, intended to contribute input for the medium-term forecast generated by the QPM.

A. Interpolating Quarterly GDP Data

The availability of quarterly GDP data is crucial for real-time economic assessment (nowcasting) and generating medium-term forecasts using a QPM. Unfortunately, the DRC's statistics office releases GDP figures only on an annual basis, with a lag exceeding one year. To overcome this data limitation, it is necessary to employ statistical methods that allow the estimation of quarterly GDP measures using other variables as indicators.

This section illustrates the application of interpolation methods, specifically Chow-Lin (1971), in estimating quarterly GDP (mining and non-mining) for the DRC. These econometric techniques estimate high-frequency data (i.e., quarterly GDP) from low-frequency data (i.e., annual GDP), using other high-frequency indicator variables in the estimation, such as industrial production, export prices, among others. The methodology assumes a linear relationship between the data series of interest and the indicator variables. In this approach, the selection of indicator series is crucial, as is the proper application of econometric models. Particularly, the chosen high-frequency indicators should accurately reflect the quarterly movements of economic activities in the DRC and be available for future periods (refer to Appendix 1 for further details).

During the selection of high-frequency indicators, several data series were evaluated in the pool of indicator candidates and compared in terms of their co-movement with annual GDP series of mining and non-mining sectors. The candidates include money supply (M2), foreign reserves, copper and cobalt production, and copper and cobalt prices, serving as quarterly indicator series (see Table 1). The selected high-frequency indicator series for quarterly GDP estimation need to exhibit a high correlation with GDP, and this correlation should remain stable over time. As an additional cross-check, the quarterly GDP growth and associated output gap needs to be aligned with expert judgment and previous estimates available at the BCC.

Table 1: High Frequency Indicator Candidates

	Frequency	Series Start Year	Source
Copper Production	Monthly	2004	BCC
Cobalt Production	Monthly	2004	BCC
Broad Money	Monthly	2004	BCC
Copper Price	Monthly	2004	IMF/WB
Cobalt Price	Monthly	2004	IMF/WB
Foreign Reserves	Monthly	2004	BCC

The ultimately selected indicator series included copper and cobalt production for mining GDP and broad money for non-mining GDP. Following their selection, these data series underwent deflation and seasonal adjustment as part of the estimation process. Considering the unavailability of quarterly deflator data, we employed monthly CPI data as an indicator variable to convert the annual GDP deflator into a quarterly series using the Chow-Lin conversion.

Figure 7 illustrates the level of quarterly real GDP based on the Chow-Lin procedure for both the mining and non-mining sectors. The results were cross-checked with the expertise at BCC to ensure that the estimated series captures key economic events and aligns with the common understanding of policymakers. A similar cross-checking procedure was performed for the growth rates, as depicted in Figure 8.

Figure 7: Estimates of Quarterly Real GDP using Chow-Lin

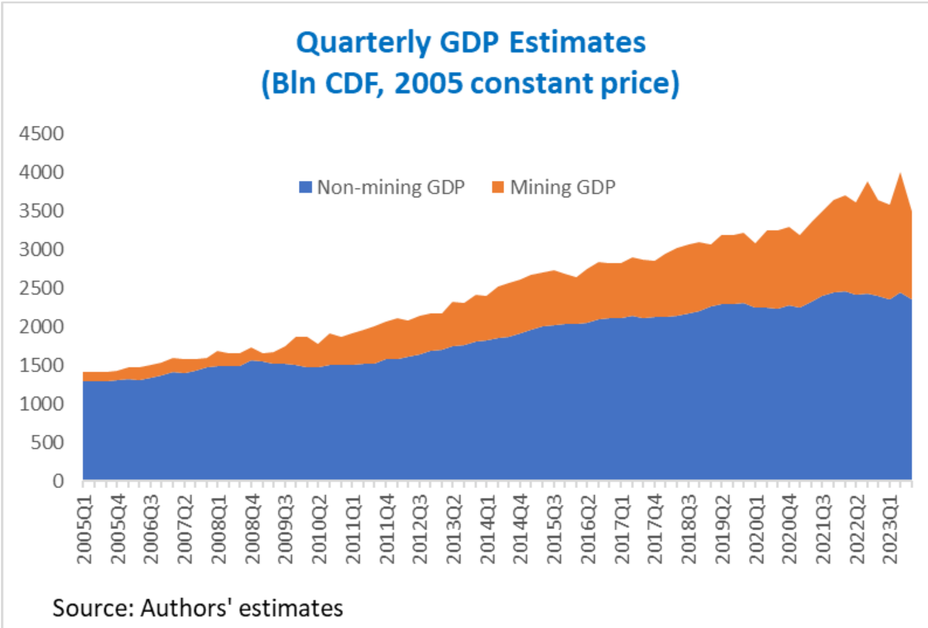
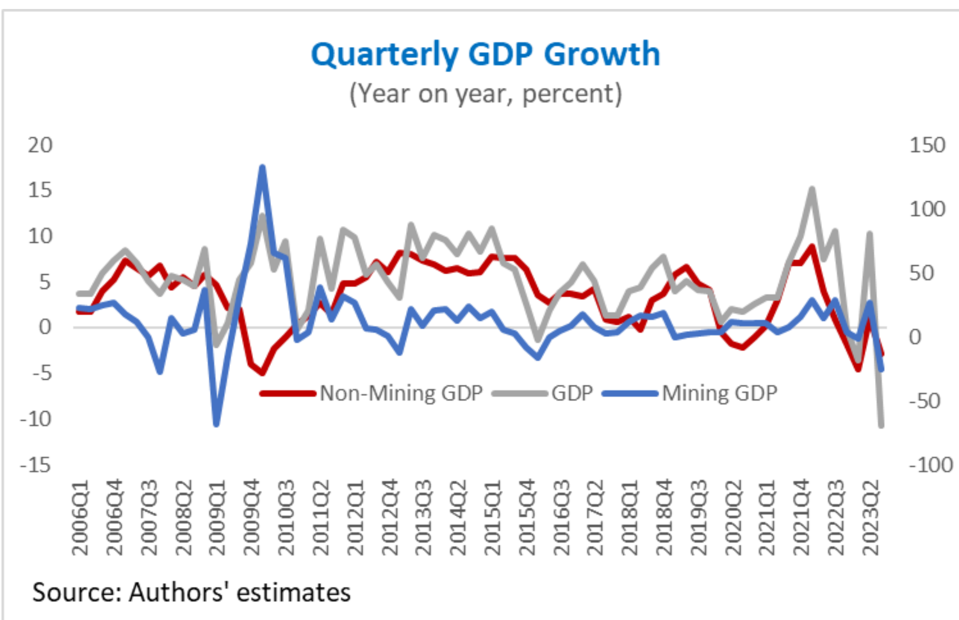


Figure 8: Quarterly GDP Growth



B. Nowcasting Quarterly GDP

Nowcasting is an exercise that use high-frequency data (up to date) to estimate the current quarterly GDP, which provide timely information for policy discussion and making. Nowcasting is used to provide an estimate of GDP for the current (and sometimes subsequent) quarter. It provides inputs to the QPM in the next section, which produces forecasts at up to 2 years horizon.

This section describes the models developed to assess the DRC's economy in real-time using monthly indicators and the quarterly GDP data estimated in the previous section. In other words, by examining the relationship among quarterly GDP and high-frequency data in the past, we can estimate current quarterly GDP using the current value of high-frequency data, i.e., production of cobalt and copper, and broad money.

Nowcasting involves model selection process based on in-sample forecast comparison. In this paper, we use the mean results of the Bridge Model, Mixed-frequency Data Sampling (MIDAS), and Unrestricted MIDAS (U-MIDAS). For all these approaches, one can put more key variables based on their insights but have to be confirmed by the econometric results. It should be emphasized that our purpose is to find a reduced-form model for nowcasting real GDP, i.e., the model does not have to be a very good-fit. Details of the methodology are listed in the Appendix 2. A quick summary of these approach is provided below.

Bridge Model

The Bridge model relies on linear (ordinary least squared) regressions that link ("bridge") high-frequency explanatory variables with the low-frequency quarterly GDP (target variable). To nowcast quarterly GDP, the monthly indicators such as copper production and broad money are transformed into quarterly frequency using the sum or average of the observations in the quarter (data transformation depends on the nature of the high frequency indicators). If the monthly indicators have publication lags, an auxiliary regression is used to forecast the monthly indicators so that each quarterly period has a complete set of monthly values. The selection of the right-side variables in the Bridge model is based more on a pre-assessment or prior rather than casual relations. These priors often contain timely updated information on the future direction of the real GDP (dependent variable). With simplicity and transparency, Bridge model has been used to guide policy decisions by numerous policy institutions such as European Central Bank (Baffigia, Golinellib, & Parigia, 2004) and Federal Reserve Bank of San Francisco (Ingenito & Trehan, 1996).

MIDAS and U-MIDAS Model

The Mixed Frequency Data Sampling (MIDAS) model is a tightly parameterized reduced form regression in which variables are sampled at a different frequency (Ghysels, Sinko, & Valkanov, 2007). The MIDAS approach is suitable if the frequency mismatch is large as the MIDAS model uses distributed lag polynomials that depend on a smaller number of parameters (to address parameter proliferation issues).

By contrast, the unrestricted MIDAS model (U-MIDAS) is often used when the frequency mismatch is not large. Unlike MIDAS, U-MIDAS does not use functional distributed lags. U-MIDAS generally performs better than MIDAS when mixing quarterly and monthly data (i.e., small frequency mismatch). We convert the higher frequency indicators to quarterly frequency using split-sampling.

Table 2 summarizes the key conclusions in the model estimate. It should be noted that global copper price plays important role in driving the copper production and export. Although China is a key export destination, there is a strong correlation between China GDP and global copper price. In this regards, one can tell a lot about DRC's economy by just observing the change in global copper price change.

It should be also emphasized that our purpose is to find a reduced-form model (parsimony) that are powerful to assess DRC's economy. We can also increase the fitness of the model, but it can make it more difficult to estimate as we would need to update/forecast the last period of the right-hand side variables. One period lag of the mining GDP is also included in the regression to capture the persistency in the sector. For non-mining sector, we use broad money (proxy for credit) as a key explanatory variable. The coefficient of the broad money is positive and statistically significant in the three regressions. Mining GDP is also included in the regression to capture the spillover from the mining to non-mining sector. The coefficients are positive, but not statistically significant. This suggests that there is limited spillover from the mining to non-mining sector.

Table 2: Nowcasting Model Estimates.

	Mining GDP			Non-Mining		
	BRIDGE	MIDAS	U-MIDAS	BRIDGE	MIDAS	U-MIDAS
One Period Lag	(-)***	(-)***	(-)***	(+)***	(+)***	(+)***
Change in Copper Production	(+)***	(+)*** (3 lags)	(+)*** (4 lags)	(+)	(+)	(+)
Crisis Dummy				(-)***	(-)***	(-)***
Broad Money				(+)***	(+)*** (6 lags)	(+)*** (4 lags)
Adjusted R Squared	0.59	0.63	0.62	0.56	0.48	0.48
Akaike Information Criteria	-1.69	-1.73	-1.73	-6.30	-6.10	-6.08
Durbin-Watson Statistics	1.66	-1.67	1.64	1.98	1.75	1.77

Source: Authors' estimates
* indicates 10 percent, ** 5 percet, and *** 1 percent, respectively.

After nowcasting mining and non-mining GDP, a total GDP is derived by the sum of mining and non-mining GDP. Figure 9-12 show the nowcasting results based on the models, expressed in year-on-year change. The results point out to the slowdown in the third quarter of 2023, especially the mining sector. These results help policymakers assess how is the economy performing and serves as inputs for the QPM, which are discussed in the next section.

Figure 9: Mining-GDP: 2023Q3 Growth Estimates (QoQ)

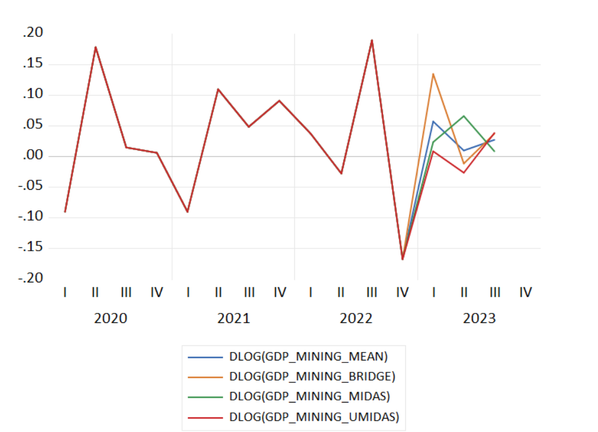


Figure 10: Mining GDP: 2023Q3 Growth Estimate (YoY)

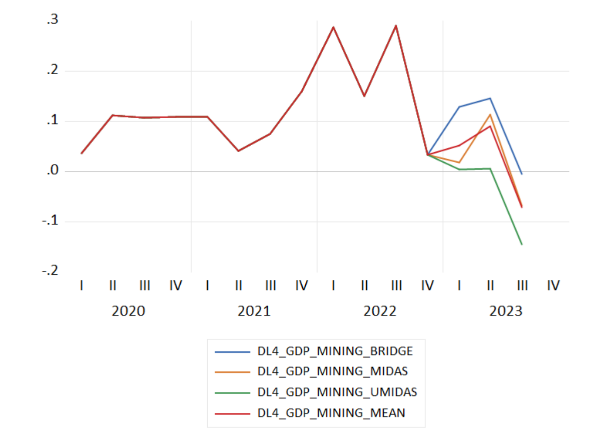


Figure 11: Non-Mining GDP: 2023Q3 Estimates (YoY)

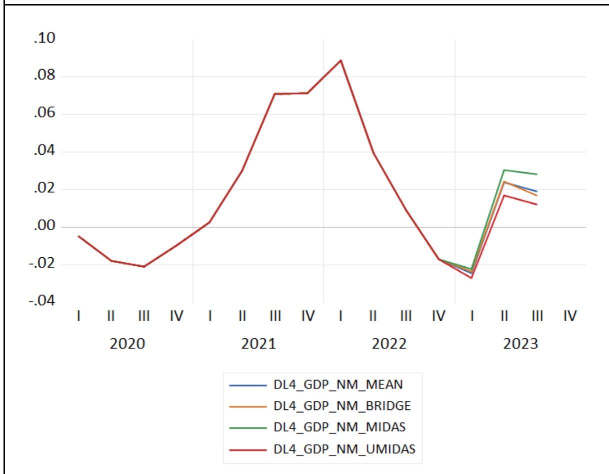
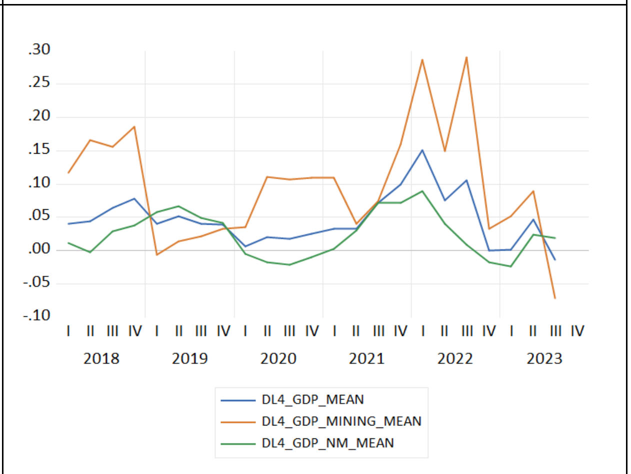


Figure 12: Aggregate GDP: 2023Q3 Estimates (YoY)



C. Inflation Near Term Forecast

In the QPM developed for the BCC, monetary policy is endogenous, and forward-looking expectations are integrated. These features render the model suitable for generating prospective policy recommendations and assessing associated risks. The structure of the QPM, rooted in economic theories and featuring a defined role for monetary policy, enables a systematic and coherent analysis of current and future economic conditions within a medium-term horizon.

However, Near-Term Forecast (NTF) models often exhibit greater precision in short-term forecasting than the QPM. Short-term events are typically influenced by past policy actions, shocks, and idiosyncratic occurrences — elements that, although identifiable, are not easily incorporated into the QPM. Consequently, short-term forecasts produced by sectoral experts using NTF models alongside their comprehensive understanding of sector-specific developments and data tend to consistently outperform any structural model within one or two quarters.

In response to these features of the analytical tools, expert judgments are employed in constructing forecast scenarios, integrating NTF outcomes as contributions to the QPM forecast. This practice harnesses the advantages and quality of short-term forecasts while maintaining a forward-looking perspective in the medium-term forecast.

At the BCC, NTF models have been crafted to derive projections for components of the CPI, such as core, food, and energy, one or two quarters ahead. This segmentation of the CPI involved selecting subclasses aligning with the categorization set forth by the BCC.

The set of BCC's NTF models encompasses econometric single equation autoregression and vector autoregression augmented with exogenous variables. In defining the econometric structure of these models, domestic variables (e.g., nominal exchange rates) and exogenous variables (e.g., primary goods prices, inflation in trade partners, among others) were meticulously chosen, considering their statistical significance, in-sample model fit, residual properties, and coefficient stability. Subsequently, their out-of-sample forecasting ability was assessed using standard statistical measures. Figure 13 shows historical inflation by components while Figure 14-16 illustrate the forecast of each inflation by different models. Annex 3 presents the forecast comparison across models.

Figure 13: Inflation by Components

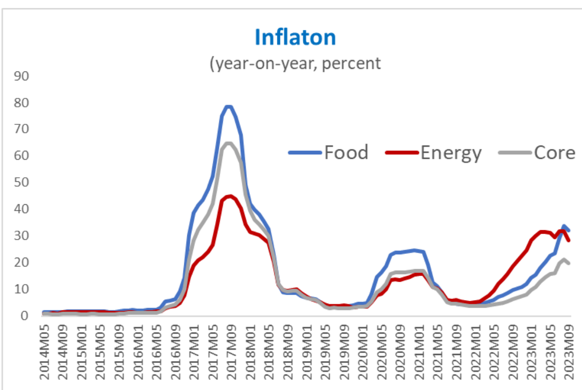


Figure 14: Core Inflation Forecast

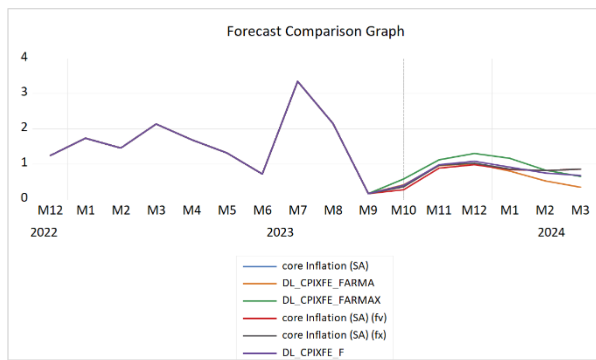


Figure 15: Energy Inflation Forecast

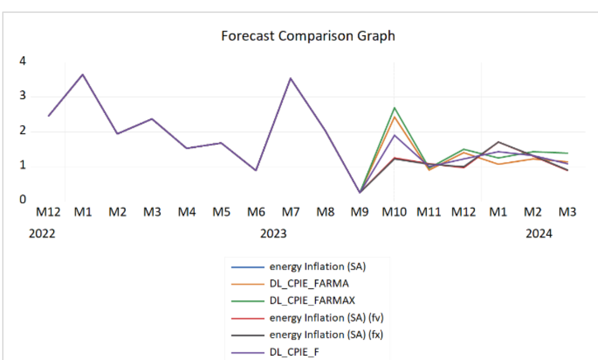
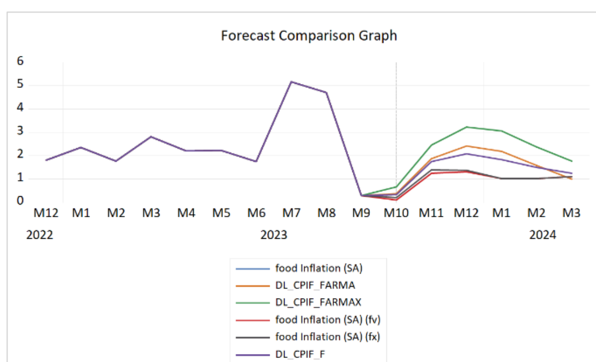


Figure 16: Food Inflation Forecast



IV. The DRC QPM Model

The quarterly projection model for the BCC is founded on the canonical version of the QPM (Berg et al., 2006). This canonical QPM comprises four key blocks: the aggregate demand/open economy IS curve, the aggregate supply curve/open economy forward-looking Phillips curve, the uncovered interest parity condition (UIP), and the monetary policy rule. Additionally, the canonical model accounts for the evolution of long-run equilibrium variables. This canonical model needs to be extended to integrate the specific features of the DRC economy discussed in the preceding sections.

We detail the key model equations below. All variables are in natural logarithm unless stated otherwise. Throughout, the gaps, denoted with 'hats,' are calculated as differences of the actual (x_t), observed variables from their estimated trends $(\bar{x}_t)$, denoted with 'bars' as

$$\hat{x}_t = x_t - \bar{x}_t.$$

All parameters have positive values and $\mathbb{E}_t$ denotes mathematical expectations at time t that can be interpreted as model-consistent ('rational') forward-looking expectations. The full set of model equations is listed in Appendix A.

A. Aggregate Demand: mining and non-mining output

The DRC is a commodity exporter economy; the principal exports are copper and cobalt. To incorporate this characteristic into the model, we extended the theoretical structure to include two sectors, mining, and non-mining. The former depends on the evolution of commodity prices and foreign variables. The mining sector feedbacks into the non-mining sector to reflect the spillovers from external variables in the domestic economy.

Thus, the aggregate demand block in the model is split into mining and non-mining output. Both the mining and non-mining outputs are decomposed into two unobserved components: gap and trend. The overall output gap and output growth rate are then determined as a linear combination of sectoral gaps and growth rates, respectively, as

$$\hat{y}_t = w_{NM}\,\hat{y}_t^{NM} + (1 - w_{NM})\,\hat{y}_t^{M}, \quad (1)$$

$$\Delta y_t = w_{NM}\Delta y_t^{NM} + (1 - w_{NM})\Delta y_t^{M} + \Delta y_t^{DISC}, \quad (2)$$

where $\hat{y}_t$ and Δy_t are the overall output gap and annualized quarter-on-quarter (QoQ) real GDP growth rate respectively, $\hat{y}_t^{NM}$ and Δy_t^{NM} are gap and QoQ growth rate for non-mining GDP, and $\hat{y}_t^{M}$ and Δy_t^{M} are gap and QoQ growth rate for mining GDP. The weight w_{NM} is the share of non-mining output in total GDP, and Δy_t^{DISC} is a discrepancy term that allows for changes in the weight of the two sectors.

The non-mining output in the short term is driven by demand factors. In addition to the foreign output gap and monetary conditions as in the canonical model, the non-mining output of the DRC is affected by spillovers from the mining sector as well as fiscal policy. The impact of fiscal policy is modeled using a variable called the fiscal impulse, which is a change in the cyclically adjusted deficit-to-GDP. The fiscal impulse will be discussed in more detail in the relevant subsection below. The non-mining output gap is thus modeled as

$$\hat{y}_t^{NM} = b_{11}\,\hat{y}_{t-1}^{NM} - b_{12} MCI_t + b_{13}\,\hat{y}_t^{rw} + b_{15}\,\hat{y}_t^{M} + b_{16} fimp_t \; + \epsilon_t^{y^{NM}} \qquad (3)$$

where MCI_t is a real monetary condition index, $\hat{y}_t^{rw}$ is the foreign output gap and $fimp_t$ is the fiscal impulse. $\epsilon_t^{y^{NM}}$ is a demand shock to the non-mining sector.

$$MCI_t = c_1\big(c_2\,\widehat{rr}_t + (1-c_2)\,\widehat{rr}_t^{FC}\big) + (1-c_1)(-\hat{z}_t). \qquad (3a)$$

We extended the model to incorporate the high level of dollarization of the DRC's economy. Dollarization is incorporated into the model through two channels. The first channel is the limited ability of the central bank to affect aggregate demand through changes in the monetary policy stance[5]. The second channel is through the valuation effects of the denomination of public debt on public finances.[6]

Therefore, the monetary condition index is composed of the weighted average of the real exchange rate $\hat{z}_t$ and the effective real interest rate, which is the linear combination of the local currency real interest rate gap $\widehat{rr}_t$ and the foreign currency interest rate gap $\widehat{rr}_t^{FC}$. As the BCC can only affect the domestic real interest rate gap, such a specification of the index reflects the limited ability of the central bank to affect aggregate demand through changes in the monetary policy stance.

The mining output gap of the DRC has an autoregressive component reflecting persistence in mining production. As it is a highly export-oriented sector driven by global factors, it is assumed to be affected by global demand conditions in general. Moreover, it also depends on the gaps in the production (i.e., extraction) of cobalt and copper, which are in turn affected by their respective world relative prices. The specification of the mining output gap is thus.

$$\hat{y}_t^{M} = b_{21}\,\hat{y}_{t-1}^{M} + b_{22}\,\hat{y}_t^{rw} + b_{23}\,\widehat{prod}_t^{cop} + b_{24}\,\widehat{prod}_t^{cob} + \epsilon_t^{y^M}, \qquad (4)$$

$$\widehat{prod}_t^{cop} \;=\; \rho^{cop}\,\widehat{prod}_{t-1}^{cop} + b_{231}\,\widehat{rp}_t^{cop} + \epsilon_t^{prod^{cop}}, \qquad (4a)$$

$$\widehat{prod}_t^{cob} \;=\; \rho^{cob}\,\widehat{prod}_{t-1}^{cob} + b_{241}\,\widehat{rp}_t^{cob} + \epsilon_t^{prod^{cob}}, \qquad (4b)$$

where $\widehat{prod}_t^{cop}$ and $\widehat{prod}_t^{cob}$ are the gaps in the production of copper and cobalt, respectively. And $\epsilon_t^{y^M}$ is a shock to mining production. To reflect that production is sensitive to global commodity prices, we include $\widehat{rp}_t^{cop}$ and $\widehat{rp}_t^{cob}$, the relative prices of copper and cobalt into the equations governing the gap in production,

[5] Enhancing monetary transmission and de-dollarization would require several important measures such as improving interbank market and establishing effective interest corridors (see, for example, IMF 2023 Article IV Consultation for Cambodia).

[6] Berg et al., (2024) extend the QPM to analyze internal and external equilibriums simultaneously. In their model, the presence of external assets, denominated in foreign currency, enables the incorporation of an additional channel for dollarization.

respectively. We define relative prices as the difference between the logs of the price of the commodity (p_t^{comm}) and the general effective foreign price level (p_t^{rw}):

$$rp_t^{comm} = p_t^{comm} - p_t^{rw}, \quad (5)$$

Where p_t^{comm} is the commodity price (copper or cobalt). The gap is obtained by decomposing the relative commodity price into a trend and a gap component as

$$rp_t^{comm} = \overline{rp}_t^{comm} + \widehat{rp}_t^{comm}. \quad (6)$$

B. Aggregate Supply – Relative prices and CPI decomposition

We extended the model to incorporate relative prices and the CPI decomposition between food, energy, and core components. This decomposition is consistent with the NTF models and allows to explore the drivers of inflation by components. This decomposition reflects the fact that core inflation is the inflation component that is affected by the central bank actions, meanwhile, food and energy prices are mostly determined by external, out of the reach of the central bank, components.

Consistent with this regularity, consumer price inflation is broken down into three subcomponents: core, food, and energy price inflation. Various price pressures affecting these subcomponents are modeled as differences in real marginal costs. The headline CPI is thus a weighted average of core, food, and energy CPIs:

$$p_t = w_{CPIE}\, p_t^E + w_{CPIF} \cdot p_t^F + (1 - w_{CPIE} - w_{CPIF}) \cdot p_t^C + \epsilon_t^{p^{DISC}}, \quad (7)$$

where p_t is headline CPI, p_t^E is the energy component of CPI, p_t^F is the food component of CPI, and p_t^C is core CPI, and w_{CPIE} and w_{CPIF} are the weights of energy and food components, respectively. Also, we assume that $0 < w_{CPIE}, w_{CPIF} < 1$. The stochastic process $\epsilon_t^{p^{DISC}}$ is a measurement error introduced to allow for potential discrepancies in the data in case (i) actual sub-components do not sum up to headline CPI and as (ii) weights are constant in the model, while they may be changing over the estimation sample.

Core inflation

The core inflation Phillips curve is similar to the aggregate supply relation in the canonical model. It relates core inflation to backward- and forward-looking expectations of core inflation, and the pass-through of production costs to prices as

$$\pi_t^C = a_{11}\pi_{t-1}^C + (1 - a_{11})\mathbb{E}_t\pi_{t+1}^C + a_{12}rmc_t^C + \epsilon_t^{\pi^C}, \quad (8)$$

where π_t^C is the QoQ annualized core inflation, rmc_t^C is the real marginal cost index to produce core goods and services, and $\epsilon_t^{\pi^C}$is the cost-push shock (supply shock) that is a Gaussian distributed process. The coefficient

a_{11} measures the persistence of core inflation. Real marginal costs for core inflation are defined as follows:

$$rmc_t^C = a_{13}\,\hat{y}_t^{NM} + (1 - a_{13})(\hat{z}_t - \widehat{rp}_t^C), \qquad (9)$$

where $\hat{y}_t^{NM}$ is the non-mining output gap, $\hat{z}_t$ is the real effective exchange rate gap, and $\widehat{rp}_t^C$ is the gap in relative prices of core goods and services (core CPI) to prices of the overall consumer basket (headline CPI). In the model, we define relative prices as the difference of their logs, in this case core and headline CPI:

$$rp_t^C = p_t^C - p_t. \qquad (10)$$

In turn, the gap in relative prices of core goods and services is given by decomposing the level to the unobserved components of trend and gap:

$$rp_t^C = \overline{rp}_t^C + \widehat{rp}_t^C. \qquad (11)$$

In the core Phillips curve, the real marginal costs index in equation (9) approximates both domestic and imported costs associated with producing goods and services in a small open economy, such as the DRC. Production costs linked to labor (wages) and capital (rental price of capital) are estimated using the non-mining output gap. Costs associated with imported factors of production are represented by the real exchange rate gap, which reflects the price of foreign goods expressed in domestic currency. To derive the real exchange rate gap defined in terms of the core CPI, we adjust it with the relative core price gap.

Food inflation

The food subcomponent in CPI is a price index for food. The Phillips curve for food inflation is given as

$$\pi_t^F = a_{21}\pi_{t-1}^F + (1 - a_{21})\mathbb{E}_t\pi_{t+1}^F + a_{22}rmc_t^F + \epsilon_t^{\pi^F}, \qquad (12)$$

where π_t^F is the QoQ annualized food inflation, rmc_t^F is the real marginal cost index for food prices, and $\epsilon_t^{\pi^F}$ is a food cost-push shock and we assume that $0 < a_{21} < 1$. As in the case of core inflation, we include backward- and forward-looking expectations of food inflation in the specification.

To capture the specific price pressures of the food subcomponent, the real marginal cost for food prices is defined as

$$rmc_t^F = a_{23}\,\hat{y}_t^{NM} + (1 - a_{23})(\hat{z}_t + \widehat{rp}_t^{wfood} - \widehat{rp}_t^F), \qquad (13)$$

where $\widehat{rp}_t^{wfood}$ is the world food prices gap, and $\widehat{rp}_t^F$ is the gap of the relative prices of food to the overall consumption basket. The parameter a_{23} measures the contribution of output gap on the real marginal cost for food prices and we assume that $0 < a_{23} < 1$. Relative prices and the respective gap for food prices are defined analogously to that for core in (10) and (11). The relative world food price is given as

$$rp_t^{wfood} = p_t^{wfood} - p_t^{rw}, \tag{14}$$

Where $p_t^{wfood}$is the global food price index and p_t^{rw} is the effective foreign price index. This term measures the global prices of food relative to the overall global price level of relevant trading partners of the DRC. The respective gap is obtained by decomposing the relative world food price into a trend and a gap component as

$$rp_t^{food} = \overline{rp}_t^{food} + \widehat{rp}_t^{food}. \tag{15}$$

The real marginal cost index for food prices, as defined in equation (13), employs the non-mining output gap to estimate price pressures arising from domestic demand conditions. It assumes that the costs of production associated with labor and capital move in tandem with the business cycle. Since the DRC is an open economy that relies significantly on imported food consumption, global food prices play a crucial role in domestic food inflation. The imported costs are encapsulated by the combination of the real exchange rate gap and world food prices, adjusted by the relative food price gap.

Energy inflation

The Phillips curve for energy prices is given as

$$\pi_t^E = a_{31}\pi_{t-1}^E + (1 - a_{31})\mathbb{E}_t\pi_{t+1}^E + a_{32}rmc_t^E + \epsilon_t^{\pi^E}, \tag{16}$$

where π_t^E is QoQ annualized energy inflation, rmc_t^E is the real marginal cost index for energy prices, and $\epsilon_t^{\pi^E}$ is an energy cost-push shock. The structure of expectation formation is the same as in the previous cases. The real marginal cost index of energy prices is given as

$$rmc_t^E = \hat{z}_t + \widehat{rp}_t^{oil} - \widehat{rp}_t^E, \tag{17}$$

where $\widehat{rp}_t^{oil}$ is the real-world oil prices gap, and $\widehat{rp}_t^E$is the gap of the relative prices of energy to the overall consumption basket. The relative world food oil is given as

$$rp_t^{oil} = p_t^{woil} - p_t^{rw} \tag{18}$$

where p_t^{woil} is the global oil price. This term measures the global prices of oil relative to the overall global price level of relevant trading partners of the DRC. The respective gap is obtained as in the case of world food prices above.

In the context of energy prices, we posit that domestic demand conditions are not influential, given the DRC's reliance on energy imports and exposure to global energy prices. Consequently, the real marginal cost index, formulated as the sum of the relative world energy price gap adjusted by the domestic relative price gap and the real exchange rate, guarantees that energy prices align with global market prices and adhere to the relative version of purchasing power parity.

It's worth noting that although the Phillips curves for the three subcomponents share a similar structure, the parameters are calibrated differently to effectively capture the distinct underlying economic mechanisms observed in the data.

C. The Uncovered Interest Rate Parity and Foreign Exchange Intervention

The exchange rate plays a central role in the Congolese policy mix; thus, appropriate equations are essential to capture its role. Moreover, the specifications must be consistent with the monetary policy regime. To incorporate foreign exchange intervention (FXI), we follow Beneš, Hurník, and Vávra (2008), who propose two alternatives. The first assumes that the central bank may have an implicit or explicit nominal exchange rate depreciation target where the market exchange rate may be partially determined by this target and the UIP condition, depending on the degree of adherence to the exchange rate target. In this case, the degree of central bank control over market interest rates would depend on the degree of commitment to the exchange rate target and the degree of capital account frictions/imperfect substitution between the domestic currency and foreign currency assets. The second alternative explicitly models the interventions associated with foreign exchange reserves by making the risk premium endogenous and dependent on the deviation of the stock of international reserves from the long-run level.

The first alternative is implemented as follows. We use a modified version of the Uncovered Interest Rate Parity (UIP) to characterize the behavior of the exchange rate of the DRC. As the central bank uses exchange rate depreciation as an instrument of monetary policy, we model the exchange rate as a weighted average of the implicit ‘policy target’ exchange rate, s^T, and the standard (slightly modified, see below) uncovered interest rate parity (UIP) implied exchange rate, depreciation, s^{UIP}:

$$s_t = k_2 \cdot s_t^T + (1 - k_2) \cdot s_t^{UIP} + \epsilon_t^s, \tag{19}$$

where k_2 is the weight of the exchange rate target set by the central bank, thus reflecting the tightness of the control over the exchange rate, and ϵ_t^s is an exchange rate (or UIP) shock. The implicit exchange rate target is set by the central bank, conditional on structural factors, as follows:

$$s^T = s_{t-1} + \frac{\Delta s_t^N}{4} - k_3 \cdot \hat{y}_t^{rw} - k_4 \cdot \widehat{rp}_t^{cob} - k_5 \cdot \widehat{rp}_t^{cop}, \tag{20}$$

$$\Delta s_t^N = \pi_t^{4T} - \bar{\pi}_{rw} + \Delta \bar{z}_t, \tag{21}$$

where the previous period’s exchange rate depreciates by the neutral depreciation rate Δs_t^N. The neutral rate of depreciation is given by country fundamentals, consistent with the equilibrium exchange rate depreciation rate

$\Delta\bar{z}_t$, and the differential between the domestic inflation target π_t^{4T} and global effective inflation target $\bar{\pi}_{rw}$. The exchange rate is also affected by cyclical factors, such as changes in global demand $\hat{y}_t^{rw}$ and cobalt and copper prices $\widehat{rp}_t^{cob}$ and $\widehat{rp}_t^{cop}$, reflecting the exposure of the Congolese franc to movements in commodity prices and demand.

The UIP-implied depreciation in (19) is determined by the modified UIP condition as in Musil et al., (2018), where the expected exchange rate is partly forward and partly backward-looking:

$$s_t^{UIP} = (1 - e_1) \cdot \mathbb{E}_t s_{t+1} + e_1 \cdot (s_{t-1} + 2/4 \cdot \Delta s_t^N) + (i_t^{US} - i_t + prem_t + prem_t^E)/4, \qquad (22)$$

Where $prem_t$ is the country risk premium, $prem_t^E$ is endogenous the risk premium related to FXI (see below), $i_t^{US} - i_t$ is the interest rate differential with respect to the US, and $\mathbb{E}_t s_{t+1}$ is the model-consistent nominal exchange rate expected at time t to take place at $t+1$. When forming expectations, backward-looking agents consider the last observation of the exchange rate and update it by the equilibrium rate of the nominal exchange rate depreciation Δs_t^N (detailed above). Forward-looking agents formulate expectations rationally, in a model-consistent way. The parameter e_1 regulates how backward-looking Congolese economic actors are.

We allow for a second alternative to allow for explicitly modeling the interventions associated with foreign exchange reserves by making the risk premium endogenous and dependent on the deviation of the stock of international reserves from the long-run level as

$$prem_t^E = \theta \cdot \left(RES2Y_t - \overline{RES2Y}_t\right), \qquad (23)$$

where Δs_t^N is the targeted exchange rate depreciation, and ϵ_t^{RES2Y} is a shock to foreign reserves.

D. Monetary Policy Reaction Function

Aligned with the MPF followed by BCC, the theoretical framework needs to be modified to incorporate money and monetary targets instead of an inflation targeting framework as in the canonical model. This extension followed the work of Berg, Portillo, and Unsal (2010) and Musil, Pranovich and Vlček (2018). The model extension included explicit equations that determine real money demand, monetary aggregate targeting, and the implicit interest rate associated with monetary targeting. This modeling approach allows analyzing monetary policy frameworks ranging from pure inflation targeting to monetary targeting with full or weak adherence (see Table 3 below).

Similarly, the specification of the monetary policy must be consistent with the above detailed exchange rate regime, as well as reflecting the characteristics of the policy of the BCC. The observed nominal interest rate i_t is modeled as a linear combination of an inflation targeting policy rate defined by an adjusted Taylor rule i_t^{IT} and a monetary aggregate targeting interest rate i_t^{MT} as

$$i_t = mpr \cdot i_t^{IT} + (1 - mpr) \cdot i_t^{MT} \qquad (24)$$

where the mpr parameter allows the partial adherence to the MT ($0 < mpr < 1$), and also to potentially cover policy regimes ranging from "pure" MT with full adherence ($mpr = 0$) to the target to full-fledged IT ($mpr = 1$).

Starting with the monetary aggregate targeting interest rate i_t^{MT}, we extend the canonical framework to incorporate money and monetary targets. The starting point is to add a money-interest rate relationship:

$$\Delta rm_t^T = \Delta y_t - c_1 \cdot (i_t - i_{t-1}) - c_2 \cdot \widehat{rm}_{t-1} - \Delta v_t + \epsilon_t^{\Delta rm}, \tag{25}$$

which is a dynamic specification relating real money growth target (Δrm_t^T) to real GDP growth (Δy_t); the rate of change in short-term interest rates ($i_t - i_{t-1}$); the real money gap ($\widehat{rm}_{t-1}$); the rate of change in money velocity (Δv_t); and a shock term. The real money gap is defined as the deviation of real money from what is explained by actual real GDP, nominal interest rates, and trend velocity as

$$\widehat{rm}_t = rm_t - (y_t - c_1 \cdot i_t - \bar{v}_t) \tag{26}$$

Note that when the economy is in long-term equilibrium (i.e., interest rate at its neutral level, and the real money demand gap at zero), this setup collapses to the identity from quantitative money theory.

$$\Delta\bar{m}_t - \pi_t^{4T} = \Delta\bar{y}_t - \Delta v_t$$

The nominal money growth target of the central bank is given as

$$\Delta m_t^T = \pi_t^{4T} + \Delta\bar{y}_t - c_1\big((\overline{rr}_t + \pi_t^{4T}) - (\overline{rr}_{t-1} + \pi_{t-1}^{4T})\big) - \Delta\bar{v}_t + \epsilon_t^{\Delta m^T}, \tag{27}$$

$$\Delta rm_t^T = \Delta m_t^T - \pi_t \tag{28}$$

where π_t^{4T} is the inflation target, $\Delta\bar{y}_t$ is the growth in potential GDP, $((\overline{rr}_t + \pi_t^{4T}) - (\overline{rr}_{t-1} + \pi_{t-1}^{4T}))$ is the change in the equilibrium nominal interest rate, $\Delta\bar{v}_t$ is the trend change in money velocity, and $\epsilon_t^{\Delta m^T}$ is a shock to the money target. The real money growth target Δrm_t^T is obtained by adjusting the money growth target with inflation. Strict adherence to the money target in equation (28) would, according to equation (26), imply the following, monetary target consistent, short-term interest rate:

$$i_t^{MT} = i_{t-1} + (1/c_1)(\pi_t + \Delta y_t - c_2\,\widehat{rm}_{t-1} - \Delta v_t - \Delta m_t^T) + \epsilon_t^{\Delta rm}. \tag{29}$$

As observed in Pranovich et al., (2021), this policy rule, depending on how actual growth, inflation, and shocks to the money interest rate relationship differ from their ex-ante projections, would result in volatile money market rates. The central bank may instead allow money growth to deviate from target in order to keep market interest rates more stable in the short term. To allow for no or only partial adherence to the money targets, market interest rates, i_t, are set as a weighted average of what they would have been under IT, i_t^{IT}, according to equation (25) and under i_t^{MT}.

To be consistent with the exchange rate regime detailed above, we need to modify the canonical Taylor rule. As the central bank uses the exchange rate as a short-term instrument, the inflation targeting rate i_t^{IT} is modeled as weighted average of a 'UIP interest rate' consistent with the targeted path of depreciation, i_t^{UIP}, and a canonical Taylor rule interest rate i_t^{Taylor} reacting to deviations of inflation from the target and the output gap:

$$i_t^{IT} = k_1 i_t^{UIP} + (1 - k_1) i_t^{Taylor} + \epsilon_t^i \quad (30)$$

where $k_1$allows for various degrees of control over the interest rate by the central bank, and ϵ_t^i is a monetary policy shock. In case $k_1 = 0$, then the central bank completely sterilizes its interventions on the foreign exchange market and retains complete control of the nominal interest rate (i.e., it applies the Taylor rule). On the other hand, if $k_1 = 1$, then the central bank loses control of the nominal interest rate (as in the case of an exchange rate peg).

The UIP interest rate is given as

$$i_t^{UIP} = 4 \cdot ((1 - e_1) s_{t+1} + e_1 (s_{t-1} + 2/4 \cdot \Delta s_t^N) - s_t, \quad (31)$$

where Δs_t^N is the 'targeted' exchange rate depreciation as defined in equation (21). The central bank intervenes to smooth fluctuations in the exchange rate, i.e., to obtain a 'targeted' rate of depreciation but does not actively use the exchange rate to achieve the inflation target. Recall that the 'targeted' depreciation must be consistent with the inflation differential and the equilibrium real exchange depreciation.

The Taylor rule part of the interest rate follows the canonical specification:

$$i_t^{Taylor} = g_1 i_{t-1}^{Taylor} + (1 - g_1)(i_t^N + g_2 \mathbb{E}_t(\pi_{t+4}^4 - \pi_{t+4}^{4T}) + g_3 \cdot \hat{y}_t) \quad (32)$$

Where $i_t^N = \overline{rr}_t + \mathbb{E}_t \pi_{t+1}^4$ is the neutral interest rate defined as the sum of the equilibrium interest rate and one-period-ahead expected inflation, $\mathbb{E}_t(\pi_{t+4}^4 - \pi_{t+4}^{4T})$ is the expected deviation of inflation from the target and $\hat{y}_t$ is the overall output gap. The parameter g_1 is an indicator of the degree of interest rate smoothing (or policy inertia); parameters g_2 and g_3 are the relative weights of deviations of expected inflation from target and of output from potential, respectively.

Thus, the entire framework for monetary and exchange rate policies, which dictates the policy interest rate and the exchange rate, is encapsulated by the preceding equations. Table 3 provides a list of calibration options along with the corresponding monetary and exchange rate regimes.

Table 3: Monetary Policy and Exchange Rate Regimes Based on Parameter Settings

	$k_1 = 0$	$0 < k_1 < 1$	$k_1 = 1$
$mpr = 0$	Money targeting and floating ER	Money targeting and managed ER	Money targeting and ER peg
$0 < mpr < 1$	Hybrid monetary policy regime and floating ER	Hybrid monetary policy regime and managed ER	Hybrid monetary policy regime and ER peg
$mpr = 1$	Inflation targeting and floating ER	Inflation targeting and managed ER	Inflation targeting and ER peg.

E. The Fiscal Block

The model is closed with a fiscal block, which has two objectives. First, the effects of fiscal policy on the Congolese business cycle are captured by the fiscal impulse. Second, the dynamics of government debt in local and foreign currency are incorporated, thus accounting for the impact of exchange rate movements on public finances and their implications on the type of financing. This extension also allows the BCC to include the effects of fiscal dominance observed in the DRC by adding public deficit financing through monetary issuance by the central bank.

Debt and deficit variables are expressed as proportions to nominal GDP. Debt is composed of local currency ($DEB2Y_t^{LC}$) and foreign currency debt ($DEB2Y_t^{FC}$). Debt dynamics is modeled as follows: we add current period's overall deficit ($DEF2Y_t$) to debt from previous period adjusted for growth in nominal GDP between current and previous period ($\Delta PY_t - \Delta PY_{ss}$), and foreign currency debt is also adjusted from previous period adjusted depreciation of the exchange rate ($\Delta s_t - \Delta s_{ss}$). The specification is thus.

$$DEB2Y_t^{LC} + DEB2Y_t^{FC} = DEF2Y_t + s_1 \cdot DEB2Y_{t-1}^{LC} - s_2 \cdot (\Delta PY_t - \Delta PY_{ss}) + s_3 \cdot DEB2Y_{t-1}^{FC} + s_4 \cdot (\Delta s_t - \Delta s_{ss}) - s_5 \cdot (\Delta PY_t - \Delta PY_{ss}) + \epsilon_t^{DEB2Y}, \quad (33)$$

where ϵ_t^{DEB2Y} is a shock to debt. Debt target anchors government behavior, which is modeled as

$$DEB2Y_t^T = \rho_{DEB2Y^T} \cdot DEB2Y_{t-1}^T + (1 - \rho_{DEB2Y^T}) \cdot DEB2Y^T{}_{ss} + \epsilon_t^{DEB2Y^T}, \quad (34)$$

where $DEB2Y_t^T$ is the target of the level of overall debt to GDP, $DEB2Y^T{}_{ss}$ is its steady state, and $\epsilon_t^{DEB2Y^T}$ is a shock to the government's debt target. The difference between actual debt and the target is debt deviation ($\widehat{DEB2Y}_t$), which is smoothed across periods as

$$\widehat{DEB2Y}_t = \rho_{\widehat{DEB2Y}} \cdot (DEB2Y_t - DEB2Y_t^T) + (1 - \rho_{DEB2Y}) \cdot \widehat{DEB2Y}_{t+1} \quad (35)$$

The overall deficit is decomposed into structural deficit ($SDEF2Y_t$) and a cyclical component as

$$DEF2Y_t = SDEF2Y_t - p_1 \cdot \hat{y}_t \quad (36)$$

where $\widehat{y}_t$ is the output gap. The structural deficit, in turn, is modeled by as a sum of the previous period's structural deficit adjusted with cyclical position of the economy ($\widehat{y}_t$) and the structural deficit target ($SDEF2Y_t^T$) adjusted with the debt deviation:

$$SDEF2Y_t = \rho_{SDEF2Y} \cdot \left(SDEF2Y_{t-1} - p_4 \cdot \widehat{y}_t\right) + (1 - \rho_{SDEF2Y}) \cdot \left(SDEF2Y_t^T - p_2 \cdot \widehat{DEB2}Y_t\right) + \epsilon_t^{SDEF2Y} \quad (37)$$

where ϵ_t^{SDEF2Y} is a shock to the structural deficit.

The fiscal impulse enters the aggregate non-mining demand equation (3). It is defined as a sum of shocks to the cyclically adjusted deficit (ϵ_t^{SDEf2Y}) and the debt target ($\epsilon_t^{DEB2Y^T}$):

$$fimp_t = \epsilon_t^{SDEF2Y} + p_3 \cdot \epsilon_t^{DEB2Y^T}. \quad (38)$$

The previously described model has the capacity to integrate policy recommendations outlined in the Integrated Policy Framework (IPF) (refer to Basu et al., 2020, 2023; Basu and Gopinath, 2024; Adrian et al., 2020, 2021), thereby enabling the amalgamation of policy tools, encompassing conventional monetary and fiscal policies, as well as FXIs, CFMs, and MPMs. However, it is crucial to emphasize that policy recommendations are contingent upon the interactions between external shocks and the frictions discussed in the IPF for each country. Additionally, the analysis should account for the presence of other frictions directly pertinent to the DRC, which can influence the utilization of monetary and other policies in ways that largely extend beyond the scope of the IPF.

V. Model Calibration and Database

A. Calibration

The database used in the QPM consists of domestic variables from BCC and foreign variables from the IMF's latest WEO database as well as the Fed database. The raw data are in annual, quarterly, and monthly frequency. To work with QPM, these data are converted to quarterly frequency based on the methods discussed previously. The main variables in the database are shown in Annex B.

The calibration of the long-term was based on historical averages and policy targets of the model variables. During the calibration, the growth rate of output components, interest rates, exchange rates, relative prices of CPI components, debt, and fiscal deficit ratios were adjusted. Likewise, the steady state value was calibrated for the external variables: foreign interest rate, foreign inflation, and international prices of oil, copper, cobalt, and food. The parameter values are presented in Annex C.

The calibration of the parameters that determine the dynamics of the model used the time series available together with filtering techniques and analysis of the model's forecasting capacity. The calibration was designed to reflect the transmission mechanisms of shocks in the DRC economy, to obtain an adequate forecast performance within the sample, and the identification of shocks is aligned with the vision of the BCC staff about the determinants of the Congolese economy.

The calibration embedded in the model reflects the impact that some of the characteristics of the DRC's economy have on the transmission mechanisms of monetary policy. Thus, it is to be expected that high levels of informality significantly decrease the effectiveness of monetary policy in the DRC. Primarily, this is because the informal sector largely operates in cash and outside the banking system, limiting the central bank's ability to influence economic activity through traditional monetary policy tools such as interest rates and bank reserve requirements. Dollarization also significantly undermines the effectiveness of monetary policy in the DRC. When a substantial portion of the economy operates in dollars, the Central Bank loses control over the money supply and interest rates. Finally, the high pass-through of the exchange rate significantly affects the transmission mechanism of monetary policy, complicating the central bank's efforts to maintain price stability and stimulate economic growth.

B. Test Driving the Model

In this section we validate the calibration against the generally accepted narrative based on three considerations: impulse response functions, estimation of unobserved variables, and recursive forecasts.

Impulse Responses

The current subsection provides a brief analysis of the impulse response functions implied by the calibrated QPM of the DRC. In the figures presented in this subsection, we illustrate the dynamic responses of key macroeconomic variables to several structural shocks of one unit size. Values are expressed as deviations from the corresponding equilibrium, for example representing inflation as the deviation from the target. In this theoretical exercise, we examine single, one-unit-size shock simulations initiated from the model's steady state equilibrium. It is worth noting that in practice, shocks may occur simultaneously and not necessarily when all sectors are in equilibrium. Nevertheless, maintaining a simple simulation setup proves beneficial for effectively exploring the model's propagation mechanisms and evaluating its theoretical consistency.

Figure 17 shows the responses to a positive shock in non-mining output. According to the impulse response functions, this type of shock leads to a short-term increase in overall inflation, fueled by a surge in core and non-food inflation. This outcome is attributed to heightened demand, causing a rise in the domestic component of real marginal costs. Conversely, the shock results in no change in energy prices, since we assume they are driven by foreign factors. The central bank responds to both an elevated output gap and inflation expectations exceeding the target by increasing the interest rate. Consequently, the tightening of monetary policy induces currency appreciation: as a consequence of the shock, the domestic currency strengthens both nominally and in real terms. Coupled with the positive real interest rate (RIR) gap, this contributes to tighter monetary conditions. These conditions play a role in gradually closing the positive output gap and restoring inflation to the target level. Notably, the model effectively incorporates transmission lags, extending the duration of demand-side inflation pressures beyond the initial quarter. This prolonged impact necessitates a sustained policy response to reestablish equilibrium in the system.

The effects of a positive copper production gap shock of one unit are presented on Figure 18. A shock to production increases the mining output gap, which has a spillover effect on the non-mining economy as well. The positive output gap exerts inflationary pressures on core and food prices. This is mitigated by an appreciation in the nominal exchange rate, induced by higher mining exports, slightly decreasing inflationary pressures through cheaper import prices. For this reason, energy inflation turns negative. The central bank reacts to the positive output gap and inflation expectations above target by increasing the policy rate, thus contributing to a positive real interest rate gap. Tighter monetary conditions close the output gap, thus returning inflation to the target.

Figure 19 depicts IRFs to a shock in core prices. To counteract the shock, the central bank raises the nominal interest rate in reaction to the increased expectations of headline inflation. Consequently, this action induces nominal appreciation and a negative real exchange rate (RER) gap, indicating an overvalued currency. The real interest rate (RIR) gap initially becomes negative due to heightened inflation expectations but later turns positive as inflation and expectations decline due to the implementation of tighter monetary policy and the overvalued real exchange rate. In the short term, non-mining output experiences a decline primarily because real appreciation dampens aggregate demand through the trade channel. Mining output is not affected by domestic demand conditions. Therefore, it is the monetary policy response that effectively guides core inflation, and consequently, headline inflation, back to the target. It is noteworthy that while cost-push shocks of this nature present a dilemma for policymakers, with higher inflation accompanied by a negative output gap, the QPM of the DRC suggests the central bank tighten policy. This is because the model assumes that the inflation objective holds relatively greater importance than maintaining stability in the output gap, as discussed further in the subsequent subsections.

Figure 17: Shock to non-mining output

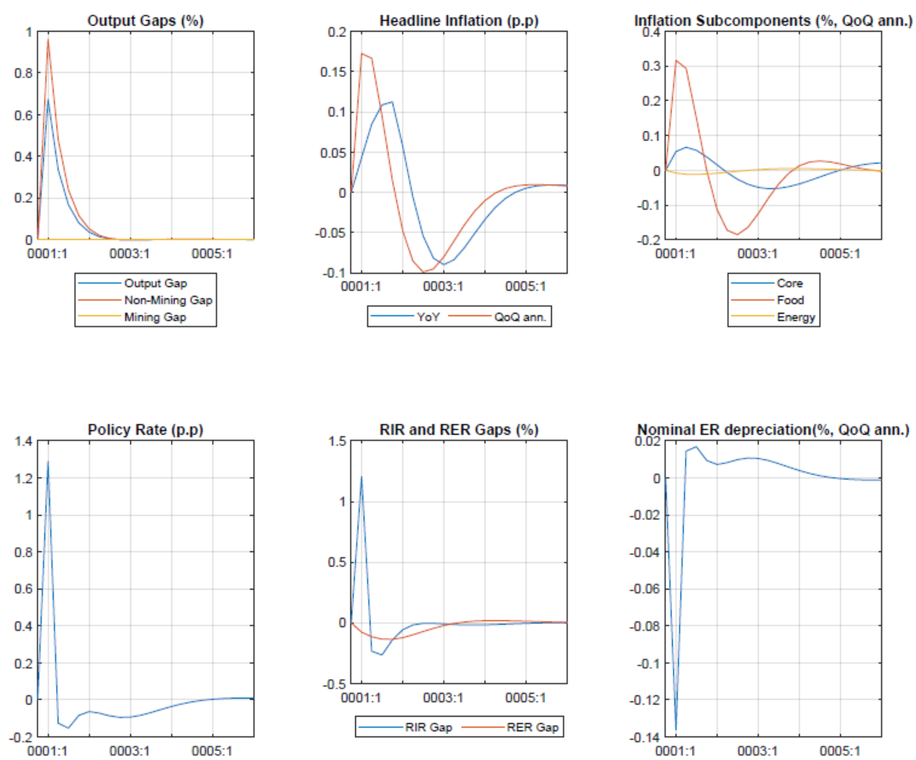


Figure 18: Shock to copper production gap

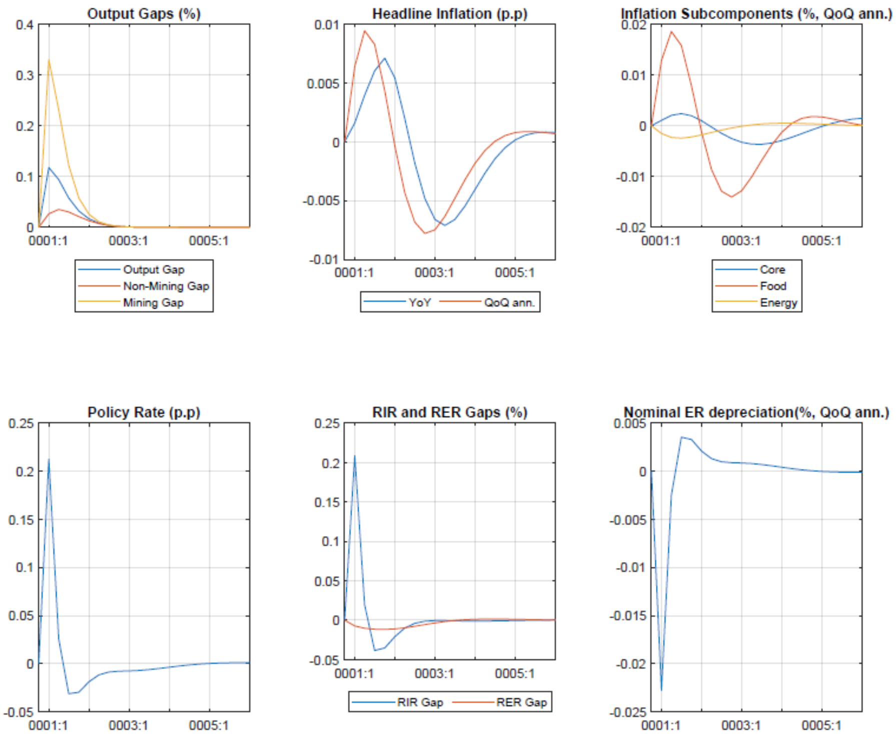


Figure 19: Shock to core inflation

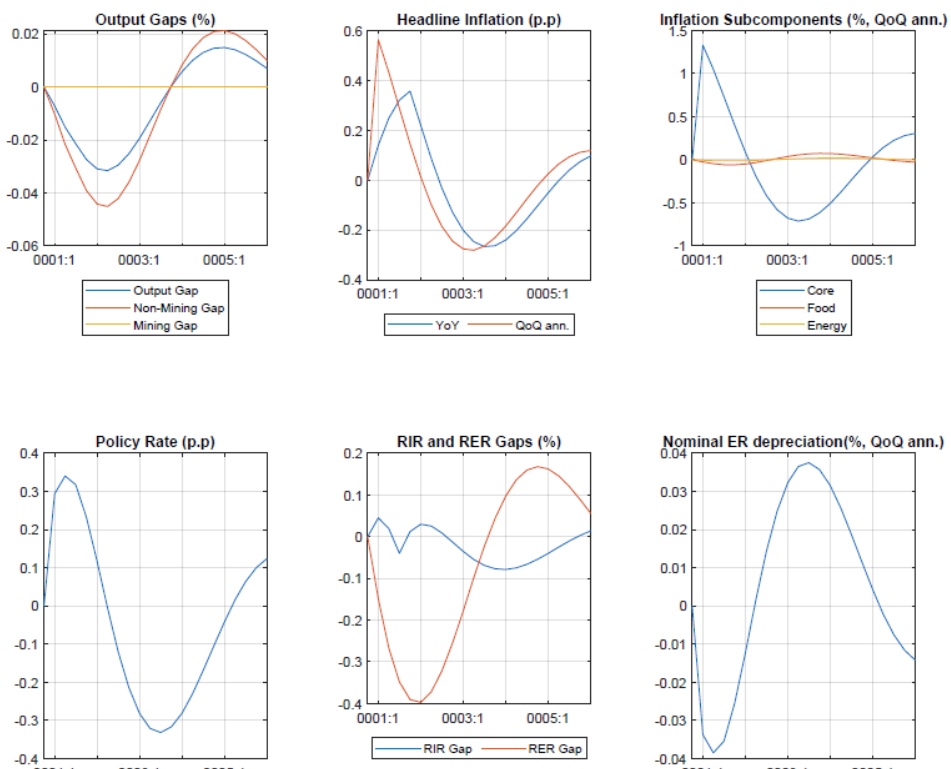


Figure 20 illustrates the reactions to a positive exchange rate shock under the Uncovered Interest Parity (UIP) condition, denoting a depreciation shock or a global risk-off episode potentially involving capital outflows. This shock results in both nominal and real exchange rate depreciation, subsequently contributing to headline inflation surpassing the target. The upswing in headline inflation is manifested through increases in both core and food, primarily attributed to the imported component of real marginal costs, driven by the positive (undervalued) real exchange rate gap.

In response to these inflationary pressures and the weakening domestic currency, the monetary authority reacts by elevating the short-term interest rate. In the short run, the real interest rate (RIR) gap turns slightly negative, initially influenced by higher inflation expectations. This, coupled with real exchange rate depreciation, results in more accommodative real monetary conditions, fostering a positive non-mining output gap in the initial post-shock periods. The gradual increments in both nominal and real interest rates play a role in strengthening the domestic currency. Consequently, this tightening of real monetary conditions contributes to steering output and inflation back toward their steady-state levels.

The reactions to a positive monetary policy shock of one unit align closely with economic theory, as depicted in Figure 21. The contractionary effects of this shock manifest in a hump-shaped negative trajectory of the non-mining (and thus the overall) output gap. This transmission occurs mostly through the real interest rate gap, influenced by short-run price rigidities embedded in the model, which tightens due to higher nominal rates and subsequently elevated real rates. Note however, that the effect of monetary policy on output is subdued, reflecting the high dollarization in the Congolese economy. The policy tightening induces nominal appreciation of the franc.

Consequently, both food and core inflation experience a maximum decline of 0.05 percent, respectively, in quarterly annualized terms. The response of headline inflation reflects a weighted average of the reactions of these two components with energy prices, which are affected by the nominal appreciation. The effects of nominal appreciation on the real exchange rate are mostly outweighed by the fall in inflation, thus the RER gap turns only slightly negative.

Figure 20: Exchange Rate (UIP) Shock

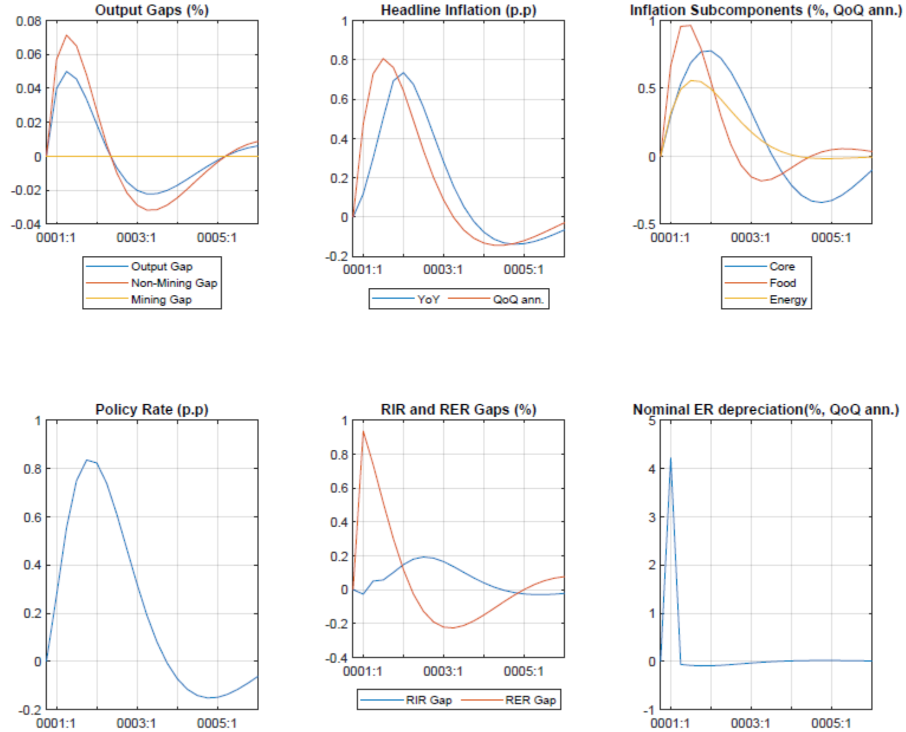
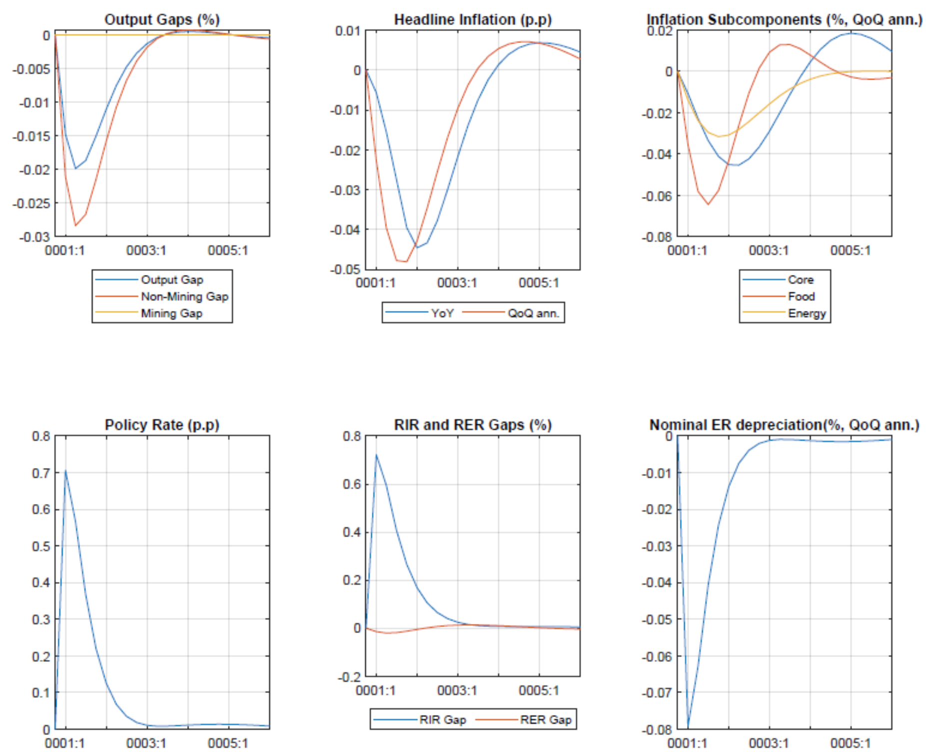


Figure 21: Monetary Policy Shock



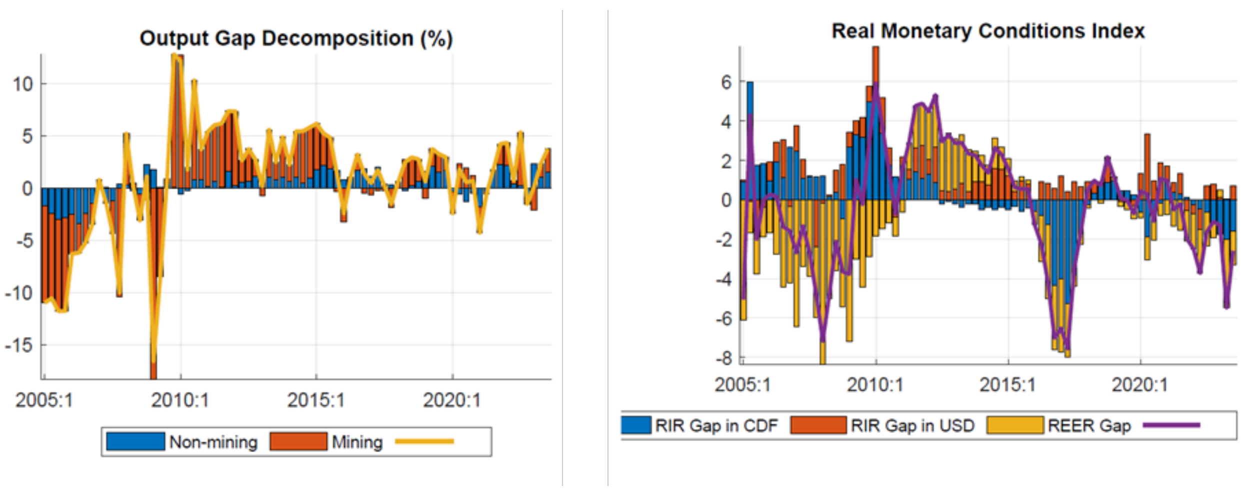
Multivariate Filter Results

Quantitative, (semi-)structural general equilibrium models such as the DRC QPM offer the advantage of providing a causal narrative analysis of past economic developments. Utilizing the Kalman filter (and smoother), these models estimate the time series of unobserved state vectors, such as gaps, trends, and shocks, which replicate the observed historical data. In this subsection, we delve into an exploration of how the calibrated model dissects observed data and other key variables, attributing their contributions to the corresponding underlying equations. In essence, the QPM delivers a compelling narrative regarding historical macroeconomic developments in the DRC, including the key drivers of inflation dynamics and identifying the fluctuations in the business cycle.

Figure 22 shows a decomposition of the output gap into a non-mining and mining part, along with the developments in real monetary conditions. Throughout the recovery from the civil war between 2005 and 2008, the Congolese GDP remained under its potential, exhibiting a negative output gap, driven by both components. Then, as commodity prices collapsed after the Great Financial Crisis in 2008-09, the mining sector's cyclical position turned severely negative. In the early 2010s, the economy enjoyed a period of robust growth, reflected in a positive output gap, until 2016. From then, the output gap fluctuated between slightly negative and positive values, driven by the mining sector.

Real monetary conditions index (RMCI) remained accommodative throughout 2005-08, driven by an undervalued real exchange rate. As the economy became overheated in the early 2010s, monetary conditions tightened. Then, in 2016-17 monetary conditions became highly accommodative, as inflation outpaced the interest rate, resulting in a highly negative real interest rate. Monetary conditions briefly turned restrictive in 2018, but they have been mostly accommodative in the past four years in terms of both RIR and RER gaps.

Figure 22: Output Gap and Real Monetary Conditions Index Decomposition



Figures 23 and 24 depict how RMCI affected the cyclical position of the economy. In the early 2010s, monetary conditions were cooling the economy, affecting negatively the non-mining output gap, which was driven mostly by spillovers from the mining sector. In 2016, RMCI became accommodative for six quarters. More recently, we observe again how easy monetary conditions support non-mining economic activity. On the other hand, as detailed above, mining output is not affected by domestic policy, but is driven by foreign demand and copper and cobalt production.

Figure 23: Non-mining Output Gap Decomposition

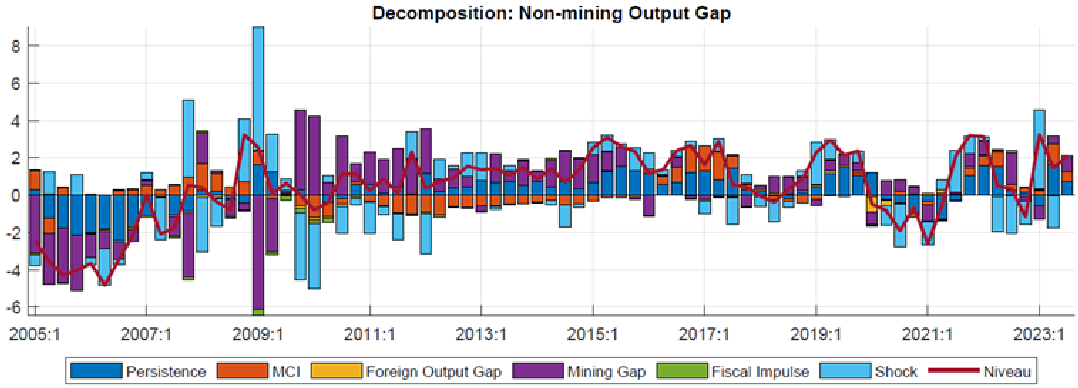


Figure 24: Mining Output Gap Decomposition

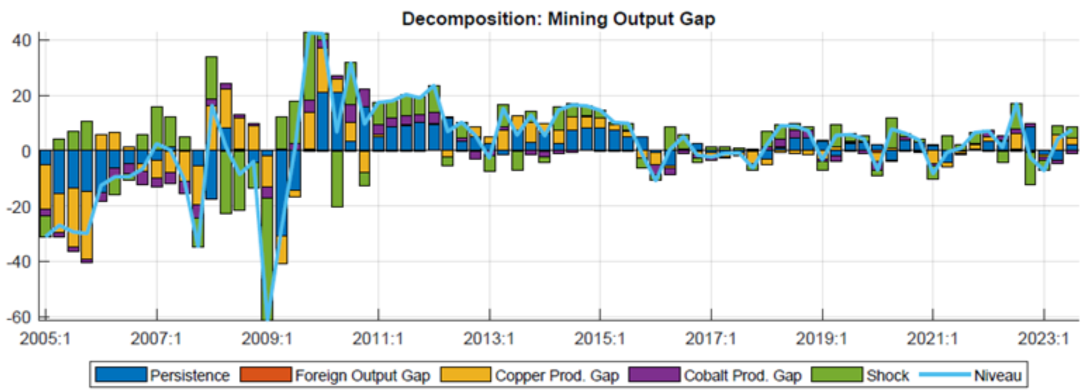
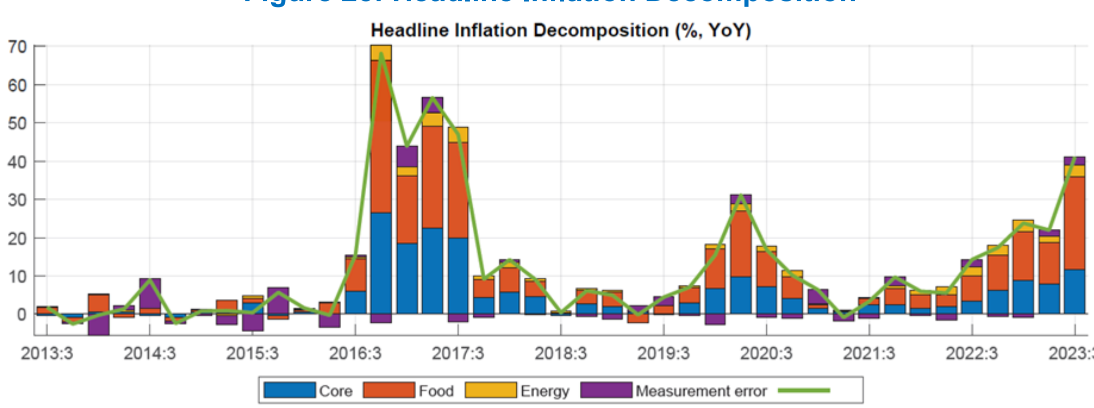


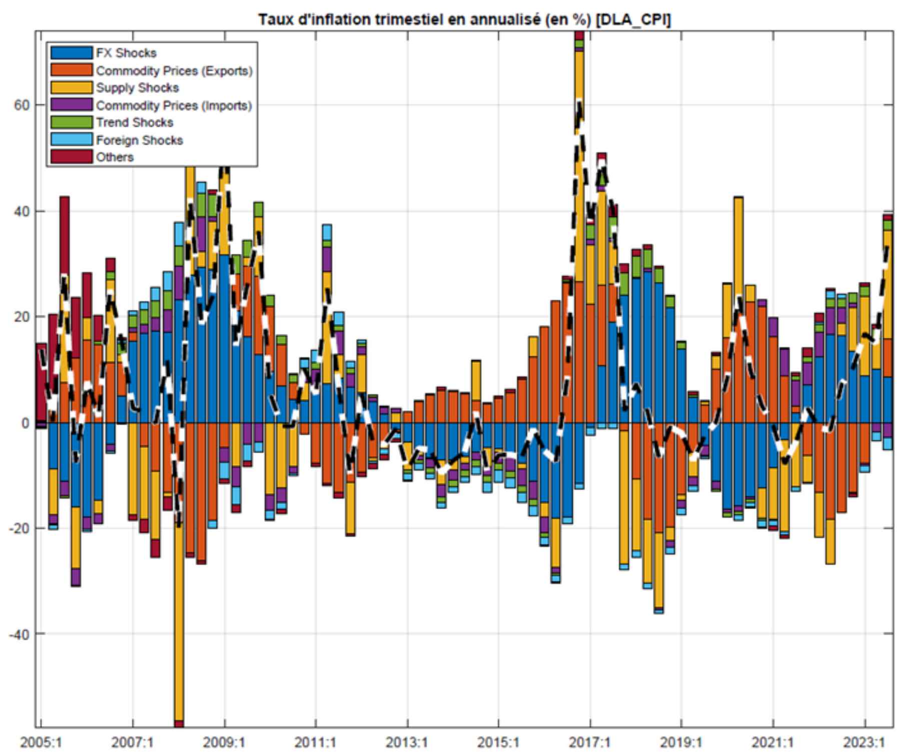
Figure 25 shows the decomposition of inflation to core, food, and energy parts between 2013Q1 and 2023Q3 (data for the subcomponents are not available before that). We observe three larger inflationary periods: between 2016 and 2017, in 2020 and the period since 2022Q3. In all three, the key driver is food inflation, along with a significant increase in core inflation. It is noteworthy that we observe an increasing trend in both core and food inflation since 2022.

Figure 25: Headline Inflation Decomposition



While even this simple, statistical decomposition can be useful to understand inflationary dynamics, the QPM allows for a more sophisticated, structural breakdown of the drivers of inflation. To assess the model calibration and properties, the decomposition should help to see that (i) the dynamics of a variable is not driven solely by its “own” shock (for example inflation should not be solely explained by the cost-push shocks) and (ii) a macroeconomic story based on the decomposition matches experts’ intuition and views on macroeconomic developments in the country during the analyzed period. Figure 26 shows the decomposition of headline inflation (QoQ) into structural shocks. For example, world copper and cobalt prices declined markedly both in the wake of the Great Financial Crisis in 2009-2010 and in the period of 2012-16, leading to the depreciation of the exchange rate, which given to the high degree of exchange rate pass-through, led to large increases in inflation.

Figure 26: Headline Inflation Decomposition

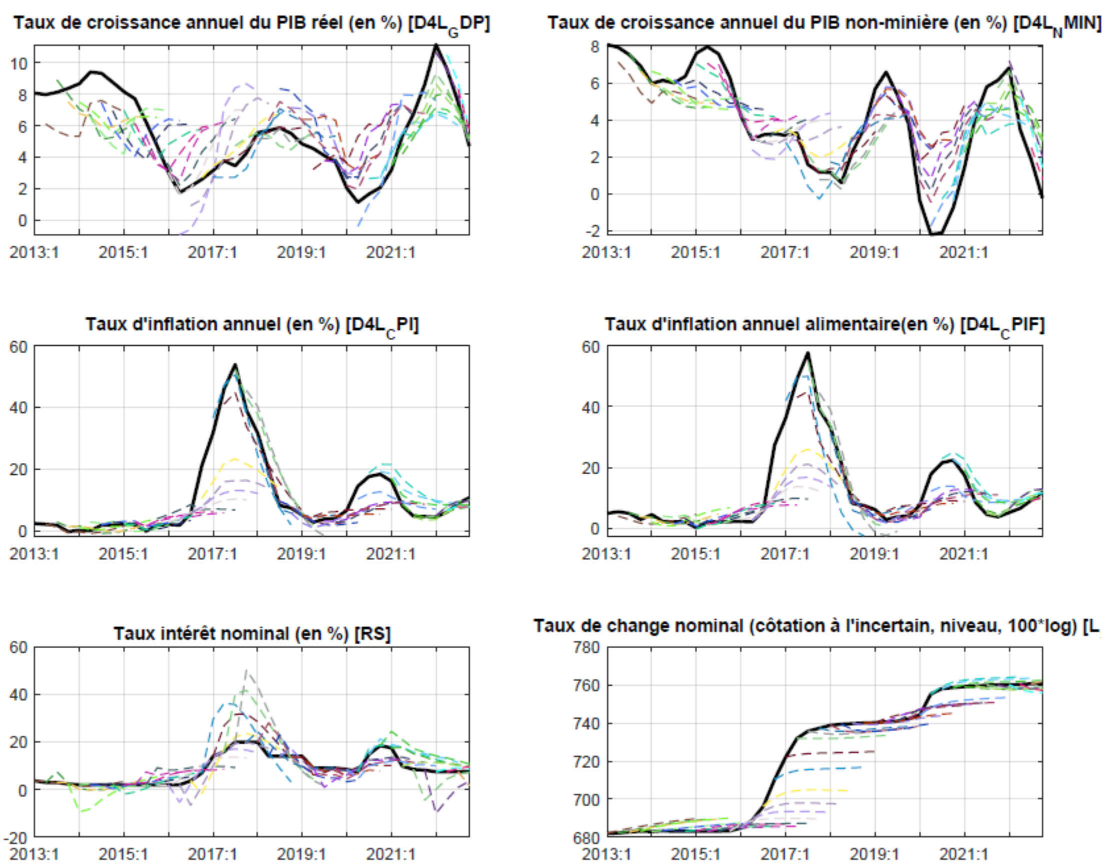


Recursive Forecasts

The BCC aims to use the QPM in real-time for both policy analysis and forecasting purposes. To ensure satisfactory forecast performance and to assess the calibration of the model, in this section we examine its in-sample forecasts. That is, we analyze in-sample projections on an 8-quarter horizon starting from 2013Q1. We assume that all external (foreign) variables are known over the forecasting horizon (as forecasting foreign variables is not the purpose of the QPM). All other observed variables are known only until the quarter preceding every forecast. No expert judgments are added in this exercise, despite it being the case in practice. Figure 27 presents in-sample forecasts where the colorful dotted lines are 8-quarters ahead model-based forecasts, and the solid black line is the actual data.

Model-based forecasts match the data reasonably well. The model could not forecast properly the great depreciation of the franc in 2016-17, and therefore underestimated the resulting inflation, too. At the same time, it would have predicted a tighter monetary policy response to the shock. In the post-depreciation period, however, the model performs well in forecasting both the exchange rate and inflation.

Figure 27: In-sample forecasts (colored) and actual data (black)



To formally assess the relative forecast performance of the DRC QPM model, Table 4 shows the one- to eight-quarter ahead root mean squared error (RMSE) statistics for the six variables of interest, relative to those of a naïve forecast from a random walk model, over the period 2013Q1 to 2023Q2. In this case, a ratio of less than one suggests that the QPM has a smaller RMSE than the naïve forecast for that specific variable and forecast horizon and is thus preferred. As a semi-structural framework, QPMs may not be optimal for short-term forecasting, especially given the limitations in the availability of quarterly data in the DRC. Consequently, in practical applications, the current and next quarter values for key macroeconomic variables are tuned using nowcasting and near-term forecasting methods, which emphasize statistical relationships and historical patterns as explained in section III. Thus, the key objects of interest are the RMSEs on horizons larger than two quarters.

The table reveals that, across all variables and forecast horizons above two quarters, the QPM exhibits significant outperformance compared to a random walk model. The substantial margin by which the QPM surpasses the random walk benchmark underscores its relevance and applicability to the DRC economy.

Table 4: QPM Root Mean Squared Errors relative to random walk.

Variable	The ratio of RMSEs for QPM over RW, for the forecast horizon quarters ahead							
	1Q	2Q	3Q	4Q	5Q	6Q	7Q	8Q
Real GDP growth (%, YoY)	1.13	0.83	0.69	0.65	0.61	0.61	0.59	0.56
Non-mining output growth (%, YoY)	0.50	0.40	0.36	0.38	0.48	0.56	0.64	0.72
Headline inflation rate (%, YoY)	0.44	0.43	0.46	0.52	0.54	0.56	0.59	0.64
Food inflation rate (%, YoY)	0.48	0.44	0.45	0.49	0.51	0.54	0.57	0.61
Policy interest rate (%, YoY)	3.44	1.81	1.12	0.77	0.52	0.42	0.49	0.60
Exchange rate CDF/USD	0.79	0.75	0.75	0.77	0.79	0.82	0.84	0.86

VI. A Policy-Relevant Exercise

In this section, we test the model on a counterfactual scenario to illustrate how the model can be used for preparing forecasts as well as policy analysis. We provide two pseudo-forecasts for the year 2023, using data only up to the last quarter of 2022. The goal is to test whether the model can capture the key economic trends in the Congolese economy. We hasten to say that the results do not represent official macroeconomic projections of the IMF or Congolese authorities and was designed primarily to showcase the scenario-making and reporting capabilities of the model: all judgmental assumptions are entirely our own.

A. Assumptions

The following analysis uses data until 2022Q4 to produce a pseudo-forecast for the key macroeconomic variables for the year 2023. The forecasts depend on two set of assumptions. First, regarding foreign variables, we condition the forecasts on the standard external assumptions: we take commodity price forecasts from the World Bank's Pink Sheet of 2022 December, and US, Eurozone and Chinese GDP, inflation are from the 2022 October IMF WEO projections. The Fed Funds rate projection is obtained from the Fed' dot plot from end-2022. Second, we assume that mining sector production will increase by 15.7 percent year-on-year in 2023, an expert judgement based on known new mining projects for the year that increase production capacity.

The economy was in a relatively favorable position by the end of 2022. The exchange rate has been stable at around 2000 CDF per USD since mid-2020. The BCC policy rate was 7.75 percent on average in the last quarter of 2022. Headline CPI inflation was 10.8 percent on average in 2022Q4, albeit on an increasing trend since the beginning of 2022. The external assumptions suggested subdued global growth, together with a fall in copper and cobalt prices in 2023.

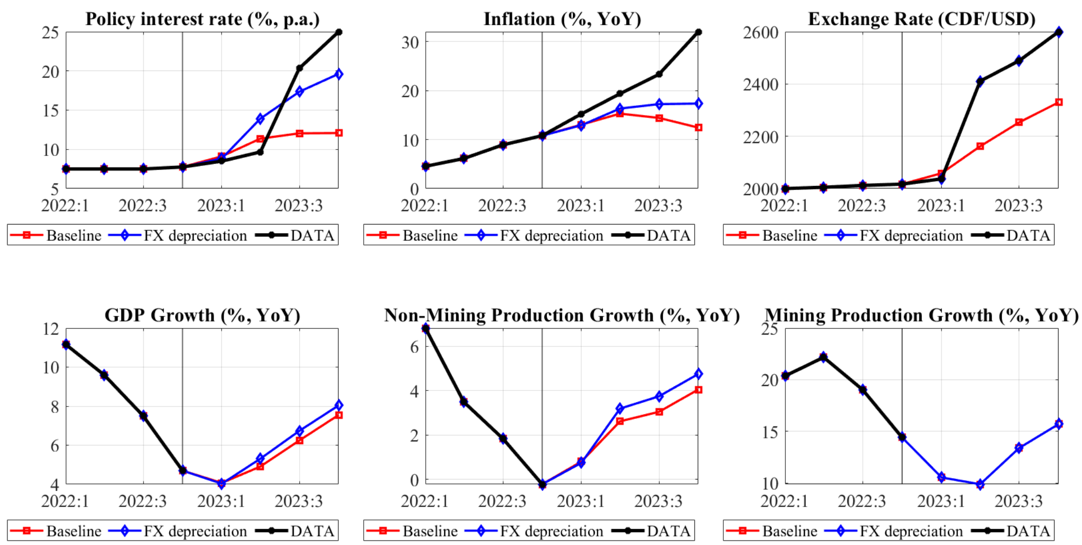
B. The Results

Simulation results are shown in Figure 28. First, we compare ex-post realized data (in black) with the baseline scenario (in red). In 2023, the Congolese economy was hit by a sharp depreciation on the back of falling commodity prices. By the end of the year, the franc reached 2600 per dollar on average, which is a 30 percent depreciation on a year-on-year. This has led to further acceleration in inflation, reaching 32 percent by the fourth quarter of the year. Note that for GDP growth, we do now have data for 2023 yet. To tackle inflationary pressures and stabilize the franc, the BCC tightened its policy significantly in the second half of the year, with the policy interest rate reaching 25 percent. As shown in Figure 28, the model was able to capture the key trends in the economy. It predicts a depreciation in the exchange rate on the back of falling commodity prices, predicting a 15 percent depreciation by the end of the year. Due to the high degree of pass-through to prices, inflation continues to accelerate to above 15 percent. As a result, the model captures the need to tighten policy to counterweigh inflationary pressures, suggesting an increase of the policy rate to 12.5 percent, and rising earlier than the actual policy of the BCC.

The exchange rate plays a key role in inflationary dynamics and thus in monetary policy in the DRC economy. However, arguably it has a high degree of exogeneity given its exposure to global commodity prices. As the realized exchange rate depreciation has been larger than what the model has predicted, we would like to perform another test to validate the DRCMOD. In an alternative scenario, we run the pseudo-forecast detailed above with the addition of fixing the later realized exchange rate depreciation path of 30 percent by end-2023 (in blue on Figure 28). As shown in the figure, with this alternative scenario the model forecasts higher inflation, reaching close to 20 percent by the fourth quarter of the year. At the same time, the model predicts a more pronounced tightening in the policy rate, closely following the realized path of the exchange rate (albeit starting the tightening earlier, already in the first quarter of 2023). GDP growth is higher in the alternative scenario than in the baseline, as the depreciation of the exchange rate makes imports more expensive than domestic products, as well as exports more competitive.

As the forecasting process in practice will be more elaborate and sophisticated than the above exercise, involving multiple weeks of consultations between the forecasting team, sectoral experts and decision makers, these results should be taken with a grain of salt. Notwithstanding, we think it provides a useful illustration of the capabilities and constraints of the DRCMOD.

Figure 28: Pseudo-forecasts for 2023: baseline scenario and alternative scenario with a more pronounced exchange rate depreciation



VII. Conclusion

The Banque Central du Congo (BCC) is undergoing a process of modernizing its monetary policy framework to contribute to its primary objective of achieving price stability and fostering sustained economic growth. As part of this initiative, the BCC is developing a Forecasting and Policy Analysis System (FPAS) within the institution. The FPAS encompasses the development of tools and processes designed to strengthen the formulation of data-driven monetary policies.

An essential component of the FPAS is the establishment of a macroeconomic framework that facilitates the joint and systematic analysis of economic variables, as well as the development of policy scenarios that complement and support policy decisions within the institution. To fulfill this requirement, this document proposes a quarterly projection model for the DRC (DRCMOD), which incorporates the most relevant regularities of the DRC economy and includes an adequate representation of the monetary policy framework followed by the BCC.

The model presented can reflect significant characteristics of the Congolese economy, such as high dollarization, the strong impact of exchange rate on inflation, significant dependence on commodity exports, and dynamics of public debt. Additionally, it reflects the current Monetary Policy Framework (MPF) and exchange rate regime followed by the BCC, characterized by control over monetary aggregates and intervention in the foreign exchange market.

It is important to note that the proposed model not only incorporates the economic characteristics of the DRC but has also been calibrated with available data to plausibly reproduce the transmission mechanisms of monetary policy and relevant historical events for the DRC economy. Therefore, the DRCMOD can be used as a tool for analysis and forecasting within the BCC.

It is essential to understand that this tool is a structural model, not simply a forecasting generator. In this sense, the model should be understood as a tool that contextualizes and structures discussions around economic policy narratives both within and outside the institution, rather than merely predicting future events.

In line with the development of the FPAS within the institution, it is necessary for the use of the proposed DRCMOD to be accompanied by other fundamental elements to ensure a successful FPAS. These elements include the formation of teams within the institution to discuss and analyze recent economic developments according to the model. Additionally, the establishment of a systematic process for communicating staff analyses and macroeconomic projections to policymakers is required, ensuring a substantial influence on policy decisions.

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Annex I. Interpolating Quarterly GDP

Only annual GDP data is available in many developing countries. To estimate quarterly GDP data, a number of disaggregation methods have been developed. Regression-based methods include Chow-Lin (1971), Fernandez (random walk) model (1981), and Litterman (1983). We applied Chow-Lin Approach here.

The Chow-Lin procedure makes use of a statistical relationship between low frequency data (i.e annual GDP) and higher frequency indicator variables (i.e., export of copper) through a regression equation. The approach assumes linear relationship between high frequency variables (not causation)

$$y_{hf} = X\beta + u$$

Then it imposes constraint relating high frequency data y (ex. quarterly GDP) to low frequency data Y (ex. annual GDP)

$$Y_{lf} = Cy_{hf} = C(X\beta + u) = CX\beta + Cu$$

Here is an example of C (sum), $n\ X\ 4n$ matrix converts 4n quarterly observations into n annual observations:

$$C_{sum} = \begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & & 0 & 0 & 0 & 0 \\ & & & & & & \ddots & & & & & & \\ 0 & 0 & 0 & 0 & & & \cdots & & & 1 & 1 & 1 & 1 \end{pmatrix}$$

Latest version of EViews has built-in Chow-Lin function (copy- paste special) which can be used to convert a low frequency series to a high frequency one using multiple indicator series.

First, we check the correlation to select potential indicators. Based on these correlations and a quick eyeballing on the charts, we can then use these indicators for Chow-Lin Procedure to estimates the quarterly GDP. For Mining GDP, we see high correlation with production of copper, cobalt and M2. For Non-mining GDP, the potential indicators are mining GD and M2. The interpolated quarterly GDP are then checked with insights from the BCC team.

Correlation Matrix

(percent change of Variables)

	GDP_MINING	GDP_NM	PROD_COPPER	RM2	WCOPPER
GDP_MINING	1.00	0.10	0.78	0.16	0.17
GDP_NM	0.10	1.00	0.10	0.72	-0.50
PROD_COPPER	0.78	0.10	1.00	0.21	0.17
RM2	0.16	0.72	0.21	1.00	-0.12
WCOPPER	0.17	-0.50	0.17	-0.12	1.00

Annex II. Nowcasting

Policymakers need to assess the current state of the economy in real-time, when only incomplete information is available. Here we provide technical details on the Bridge. MIDAS are tightly parameterized reduced form regressions with variables sampled at different frequencies. The response of the dependent variable (e.g., GDP) to the HF explanatory variable (e.g., interest rate, money supply etc.) is modelled using distributed lag polynomials with coefficients depending on a small number of parameters, to prevent parameter proliferation when frequency mismatch is large (e.g., daily/quarterly). For further details, see for example, Ghysels et al (2004).

The U-MIDAS model is estimated in LF (as MIDAS and Bridge), uses HF regressors (as MIDAS, not as Bridge), and can be re-estimated each month within the quarter (see Foroni, Marcellino and Schumacher (2015)).

The **bridge model** to be estimated is:

$$y_{t_q} = \alpha + \sum_{i=1}^{j} \beta_i(L) x_{it_q} + u_{t_q}$$

where y quarterly GDP growth of mining and non-mining sectors, and $\mathrm{x_i}$ is the high frequency (HF) indicators such as copper production, cobalt production, copper price, and broad Money. $\beta_i(L)$ are polynomials in the lag operator L. $\beta_i(L) = \beta_{0i} + \beta_{1i}L + \cdots + \beta_{p_i i}L^{p_i}$, one for each HF indicator, where p_i is the number of lags. u_{t_q} is an i.i.d. error term.

The results of the estimation for mining sector and non-mining sectors are shown below. For the non-mining, we also include copper production in the regression to capture spillover from mining to non-mining sector. The coefficients are positive but not statistically significant, suggesting the non-mining may not have benefited from mining sectors.

Model Estimates: Mining Sector

	BRIDGE			MIDAS	U-MIDAS
	1	2	3		
Constant	0.009	0.037**	0.009	0.005	0.00
	0.013	0.018	0.013	0.012	0.01
DLOG(GDP_MINING(-1)	(0.11)	(0.310)**	(0.12)	(0.12)	(0.12)
	0.079	0.114083	0.081	0.077	0.08
DLOG(PROD_COPPER)	0.462***		0.454***		
	0.048		0.049		
DLOG(WCOPPER)		0.160	0.078		
		0.132	0.092		
DLOG(WCOPPER(-1))		0.385***			
		0.133			
LAG1, DLOG(PROD_COPPER)				(0.448)**	(0.08)
				0.179	0.093
LAG2, DLOG(PROD_COPPER)				0.397***	0.187***
				0.149	0.072
LAG3, DLOG(PROD_COPPER)				-0.038	0.408***
				0.031	0.048
LAG4, DLOG(PROD_COPPER)					0.529***
					0.090
Adjusted R-Squared	0.59	0.16	0.60	0.63	0.62
Akaike Info Criterion	(1.69)	(0.97)	(1.67)	(1.73)	(1.73)
Durbin-Watson Stat	1.66	2.11	1.69	-1.67	1.64

* indicates 10 percent, ** 5 percet, and *** 1 percent, respectively. Negative numbers are in parenthesis

Model Estimates: Non_Mining Sector

	BRIDGE			MIDAS	U-MIDAS
	1	2	3		
Constant	0.00	0.004*	0.004*	0.002	0.001
	0.003	0.002	0.002	0.003	0.003
DLOG(GDP_NM(-1))	0.149	0.430***	0.446***	0.300***	0.322***
	0.101	0.101	0.103	0.11	0.111
DLOG(M2_F)	0.140***	0.173***	0.172***		
	0.026	0.023	0.023		
DLOG(M2_F(-1))		(0.132)***	(0.138)***		
		0.025	0.026		
OUTLIER	(0.014)***	(0.011)***	(0.011)***	(0.011)***	(0.0117)***
	0.004	0.003	0.003	0.003	0.004
DLOG(PROD_COPPER)			0.004		
			0.005		
LAG1, DLOG(M2(-1))				0.119	0.212***
				0.126	0.040
LAG2, DLOG(M2(-1))				0.144	0.167***
				0.125	0.063
LAG3, DLOG(M2(-1))				-0.052	0.100***
				0.026	0.046
Adjusted R-Squared	0.37	0.56	0.56	0.48	0.48
Akaike Info Criterion	(5.98)	(6.30)	(6.28)	-6.10	(6.08)
Durbin-Watson Stat	1.55	1.98	1.90	1.75	1.77

* indicates 10 percent, ** 5 percet, and *** 1 percent, respectively. Negative numbers are in parenthesis.

Annex III. Near Term Forecast

We checked several models for inflation forecasting: ARIMA, ARIMAX, VAR, VARX. With these models, we forecast core, energy, and food CPI. X here are exogenous variables which include energy price for energy inflation, and agriculture price for food and core inflation. Then, we conducted in sample forecast evaluation to select the best model. Future values of exogenous values are derived from the world bank commodity pink sheet.

Inflation Models: ARMA and ARMAX

	CPIE		CPIF		CPIXFE	
	1	2	1	2	1	2
Constant	0.691	0.690	0.987	1.01	0.797	0.812
	0.708	0.708	1.302	1.05	1.157	0.967
AR (1)	1.612***	1.612***	1.992***	1.892***	2.034***	1.986***
	0.198	0.145	0.158	0.14	0.136	0.098
AR (2)	(0.699)*	(0.733)**	(1.529)***	(1.357)***	(1.618)***	(1.580)***
	0.371	0.270	0.289	0.25	0.230	0.181
AR (3)	-0.289	-0.227	0.446**	0.378***	0.506***	0.515***
	0.299	0.232	0.159	0.13	0.132	0.099
AR (4)	0.278***	0.256***				
	0.133	0.098				
MA (1)	(0.748)***	(0.743)***	-1.322	-1.21	-1.316	-1.235
	0.203	0.140	61.145	237.98	122.765	125.429
MA (2)	(0.616)***	(0.623)***	0.301	0.08	0.335	0.222
	0.183	0.135	13.491	1.54	34.088	15.110
MA (3)	(0.882)***	0.877	0.405	0.53	0.390	0.459
	0.129	0.115	77.863	354.02	153.882	187.183
DL_ENERGY (-1)		0.012***		0.038***		0.025***
		0.01		0.01		0.011
Adjusted R-Squared	0.63	0.674	0.59	0.60	0.66	0.66
Akaike Info Criterion	2.38	2.356	3.49	3.43	2.89	2.84
Durbin-Watson Stat	1.55	1.995	2.02	2.03	2.01	2.04

* indicates 10 percent, ** 5 percet, and *** 1 percent, respectively. Negative numbers are in parenthesis.

VARX Model			
	DL_CPIE	DL_CPIF	DL_CPIXFE
LAG 1	0.95	0.83	0.89
	-0.10	-0.10	-0.10
	[9.71]	[8.00]	[8.66]
LAG2	-0.58	-0.34	-0.35
	-0.13	-0.13	-0.14
	[-4.41]	[-2.54]	[-2.54]
LAG 3	0.51	0.23	0.20
	-0.13	-0.13	-0.14
	[3.80]	[1.72]	[1.43]
LAG 4	-0.41	-0.02	0.02
	-0.13	-0.10	-0.10
	[-3.10]	[-0.20]	[0.19]
C	0.14	0.33	0.22
	-0.11	-0.18	-0.13
	[1.32]	[1.89]	[1.65]
DL_ENERGY_F	-0.01		
	-0.01		
	[-1.22]		
DL_AGRICULTURE_F(-2)		-0.06	-0.04
		-0.07	-0.05
		[-0.80]	[-0.82]
R-squared	0.60	0.50	0.58
Adj. R-squared	0.58	0.48	0.56
Sum sq. resids	60.15	194.15	107.57
S.E. equation	0.81	1.44	1.08
F-statistic	23.05	18.76	25.70
Log likelihood	-115.14	-173.81	-144.59
Akaike AIC	2.49	3.63	3.04
Schwarz SC	2.68	3.79	3.20
Mean dependent	0.78	1.09	0.90
S.D. dependent	1.25	1.99	1.62

Standard errors in ( ) & t-statistics in [ ]
Included observations: 98 after adjustments
Sample (adjusted): 2013M11 2021M12

Annex IV. Summary of the DRCMOD Model

Model Equations

Aggregate Demand

$$\hat{y}_t^{NM} = b_{11}\hat{y}_{t-1}^{NM} - b_{12}MCI_t + b_{13}\hat{y}_t^{rw} + b_{15}\hat{y}_t^{M} + b_{16}fimp_t + \epsilon_t^{y^{NM}} \quad (1)$$

$$y_t^{NM} = \overline{y}_t^{NM} + \hat{y}_t^{NM} \quad (2)$$

$$\hat{y}_t^{M} = b_{21}\cdot\hat{y}_{t-1}^{M} + b_{22}\cdot\hat{y}_t^{rw} + b_{23}\cdot\hat{y}_t^{cop} + b_{24}\cdot\hat{y}_t^{cob} + \epsilon_t^{y^{M}} \quad (3)$$

$$y_t^{NM} = \overline{y}_t^{NM} + \hat{y}_t^{M} \quad (4)$$

$$\hat{y}_t = \omega\cdot\hat{y}_t^{NM} + (1-\omega)\cdot\hat{y}_t^{M} \quad (5)$$

$$y_t = \overline{y}_t + \hat{y}_t \quad (6)$$

$$\Delta y_t = \omega\cdot\Delta y_t^{NM} + (1-\omega)\cdot\Delta y_t^{M} + \Delta y_t^{D} \quad (7)$$

$$y_t^{cob} = \overline{y}_t^{cob} + \hat{y}_t^{cob} \quad (8)$$

$$y_t^{cop} = \overline{y}_t^{cop} + \hat{y}_t^{cop} \quad (9)$$

$$\hat{y}_t^{cob} = \rho_{\hat{y}^{cob}}\cdot\hat{y}_{t-1}^{cob} + b_{241}\cdot\widehat{rp}_{t-1}^{cob} + \epsilon_t^{\hat{y}^{cob}} \quad (10)$$

$$\hat{y}_t^{cop} = \rho_{\hat{y}^{cop}}\cdot\hat{y}_{t-1}^{cop} + b_{231}\cdot\widehat{rp}_{t-3}^{cop} + \epsilon_t^{\hat{y}^{cop}} \quad (11)$$

$$\Delta\overline{y}_t^{cob} = 4\cdot\left(\overline{y}_t^{cob} - \overline{y}_{t-1}^{cob}\right) \quad (12)$$

$$\Delta\overline{y}_t^{cop} = 4\cdot\left(\overline{y}_t^{cop} - \overline{y}_{t-1}^{cop}\right) \quad (13)$$

$$\Delta\overline{y}_t^{cob} = \rho_{\Delta\overline{y}^{cob}}\cdot\Delta\overline{y}_{t-1}^{cob} + \left(1-\rho_{\Delta\overline{y}^{cob}}\right)\cdot ss_{\Delta\overline{y}^{cob}} + \epsilon_t^{\Delta\overline{y}^{cob}} \quad (14)$$

$$\Delta\overline{y}_t^{cop} = \rho_{\Delta\overline{y}^{cop}}\cdot\Delta\overline{y}_{t-1}^{cop} + \left(1-\rho_{\Delta\overline{y}^{cop}}\right)\cdot ss_{\Delta\overline{y}^{cop}} + \epsilon_t^{\Delta\overline{y}^{cop}} \quad (15)$$

$$y_t^{D} = y_{t-1}^{D} + \epsilon_t^{y^{D}} \quad (16)$$

$$\Delta y_t^D = 4 \cdot (y_t^D - y_{t-1}^D) \tag{17}$$

Philips Curve

$$p_t = \omega_E \cdot p_t^E + \omega_F \cdot p_t^F + (1 - \omega_E - \omega_F) \cdot p_t^C + \epsilon_t^{p^D} \tag{18}$$

$$\pi_t^C = a_{11} \cdot \pi_{t-1}^C + (1 - a_{11}) \cdot E\pi_t^C + a_{12} \cdot rmc_t^C + \epsilon_t^{\pi^C} \tag{19}$$

$$rmc_t^C = a_{13} \cdot \hat{y}_t^{NM} + (1 - a_{13}) \cdot (\hat{z}_t - \widehat{rp}_t^C) \tag{20}$$

$$rp_t^C = p_t^C - p_t \tag{21}$$

$$rp_t^C = \overline{rp}_t^C + \widehat{rp}_t^C \tag{22}$$

$$\Delta\overline{rp}_t^C = 4(\overline{rp}_t^C - \overline{rp}_{t-1}^C) \tag{23}$$

$$\Delta\overline{rp}_t^C = \rho_{\Delta\overline{rp}^C} \cdot \Delta\overline{rp}_{t-1}^C + \left(1 - \rho_{\Delta\overline{rp}^C}\right) \cdot ss_{\Delta\overline{rp}^C} + \epsilon_t^{\Delta\overline{rp}^C} \tag{24}$$

$$\pi_t^F = a_{21} \cdot \pi_{t-1}^F + (1 - a_{21}) \cdot E\pi_t^F + a_{22} \cdot rmc_t^F + \epsilon_t^{\pi^F} \tag{25}$$

$$rmc_t^F = a_{23} \cdot \hat{y}_t^{NM} + (1 - a_{23}) \cdot \left(\hat{z}_t - \widehat{rp}_t^F + \widehat{rp}_t^{food}\right) \tag{26}$$

$$rp_t^F = p_t^F - p_t \tag{27}$$

$$rp_t^F = \overline{rp}_t^F + \widehat{rp}_t^F \tag{28}$$

$$\Delta\overline{rp}_t^F = 4 \cdot (\overline{rp}_t^F - \overline{rp}_{t-1}^F) \tag{29}$$

$$\Delta\overline{rp}_t^F = \rho_{\Delta\overline{rp}^F} \cdot \Delta\overline{rp}_{t-1}^F + \left(1 - \rho_{\Delta\overline{rp}^F}\right) \cdot ss_{\Delta\overline{rp}^F} + \epsilon_t^{\Delta\overline{rp}^F} \tag{30}$$

$$\pi_t^E = a_{31} \cdot \pi_{t-1}^E + (1 - a_{31}) \cdot E\pi_t^E + a_{32} \cdot rmc_t^E + \epsilon_t^{\pi^E} \tag{31}$$

$$rmc_t^E = \hat{z}_t - \widehat{rp}_t^E + \widehat{rp}_t^{oil} \tag{32}$$

$$rp_t^E = p_t^E - p_t \tag{33}$$

$$rp_t^E = \overline{rp}_t^E + \widehat{rp}_t^E \tag{34}$$

$$\Delta\overline{rp}_t^E = 4\left(\overline{rp}_t^E - \overline{rp}_{t-1}^E\right) \quad (35)$$

$$0 = \omega_E \cdot \overline{rp}_t^E + \omega_F \cdot \overline{rp}_t^F + (1 - \omega_E - \omega_F) \cdot \overline{rp}_t^C + \epsilon_t^{p^D} \quad (36)$$

$$\pi_t = 4(p_t - p_{t-1}) \quad (37)$$

$$\pi_t^C = 4\left(p_t^C - p_{t-1}^C\right) \quad (38)$$

$$\pi_t^F = 4(p_t^F - p_{t-1}^F) \quad (39)$$

$$\pi_t^E = 4(p_t^E - p_{t-1}^E) \quad (40)$$

$$\pi_t^4 = p_t - p_{t-4} \quad (41)$$

$$E\pi_t = \pi_{t+1} \quad (42)$$

$$E\pi_t^E = \pi_{t+1}^E \quad (43)$$

$$E\pi_t^F = \pi_{t+1}^F \quad (44)$$

$$E\pi_t^C = \pi_{t+1}^C \quad (45)$$

$$\pi_t^{INS} = \pi_t + \Delta\pi_t^D \quad (46)$$

$$\pi_t^{INS} = 4 \cdot \left(p_t^{INS} - p_{t-1}^{INS}\right) \quad (47)$$

$$\pi_t^{4INS} = p_t^{INS} - p_{t-4}^{INS} \quad (48)$$

$$\Delta\pi_t^D = \rho_{\Delta\pi^D}\, \Delta\pi_{t-1}^D + \epsilon_t^{\Delta\pi^D} \quad (49)$$

Relative Prices

$$rp_t^{oil} = \overline{rp}_t^{oil} + \widehat{rp}_t^{oil} \quad (50)$$

$$\Delta\overline{rp}_t^{oil} = 4\left(\overline{rp}_t^{oil} - \overline{rp}_{t-1}^{oil}\right) \quad (51)$$

$$\Delta\overline{rp}_t^{oil} = \rho_{\Delta\overline{rp}^{oil}} \Delta\overline{rp}_{t-1}^{oil} + \left(1 - \rho_{\Delta\overline{rp}^{oil}}\right) ss_{\Delta\overline{rp}^{oil}} + \epsilon_t^{\Delta\overline{rp}^{oil}} \quad (52)$$

$$\widehat{rp}_t^{oil} = \rho_{\widehat{rp}^{oil}} \cdot \widehat{rp}_{t-1}^{oil} + \epsilon_t^{\Delta\widehat{rp}^{oil}} \quad (53)$$

$$rp_t^{oil} = p_t^{oil} - p_t^{rw} \quad (54)$$

$$rp_t^{cop} = \overline{rp}_t^{cop} + \widehat{rp}_t^{cop} \quad (55)$$

$$\Delta\overline{rp}_t^{cop} = 4\left(\overline{rp}_t^{cop} - \overline{rp}_{t-1}^{cop}\right) \quad (56)$$

$$\Delta\overline{rp}_t^{cop} = \rho_{\Delta\overline{rp}^{cop}}\ \Delta\overline{rp}_{t-1}^{cop} + \left(1 - \rho_{\Delta\overline{rp}^{cop}}\right) ss_{\Delta\overline{rp}^{cop}} + \epsilon_t^{\overline{rp}^{cop}} \quad (57)$$

$$\widehat{rp}_t^{cop} = \rho_{\widehat{rp}^{cop}} \cdot \widehat{rp}_{t-1}^{cop} + \epsilon_t^{\widehat{rp}^{cop}} \quad (58)$$

$$rp_t^{cop} = p_t^{cop} - p_t^{rw} \quad (59)$$

$$rp_t^{cob} = \overline{rp}_t^{cob} + \widehat{rp}_t^{cob} \quad (60)$$

$$\Delta\overline{rp}_t^{cob} = 4\left(\overline{rp}_t^{cob} - \overline{rp}_{t-1}^{cob}\right) \quad (61)$$

$$\Delta\overline{rp}_t^{cob} = \rho_{\Delta\overline{rp}^{cob}}\Delta\overline{rp}_{t-1}^{cob} + \left(1 - \rho_{\Delta\overline{rp}^{cob}}\right) ss_{\Delta\overline{rp}^{cob}} + \epsilon_t^{\overline{rp}^{cob}} \quad (62)$$

$$\widehat{rp}_t^{cob} = \rho_{\widehat{rp}^{cob}} \cdot \widehat{rp}_{t-1}^{cob} + \epsilon_t^{\widehat{rp}^{cob}} \quad (63)$$

$$rp_t^{cob} = p_t^{cob} - p_t^{rw} \quad (64)$$

$$rp_t^{food} = p_t^{food} - p_t^{rw} \quad (65)$$

$$rp_t^{food} = \overline{rp}_t^{food} + \widehat{rp}_t^{food} \quad (66)$$

$$\Delta\overline{rp}_t^{food} = 4\left(\overline{rp}_t^{food} - \overline{rp}_{t-1}^{food}\right) \quad (67)$$

$$\Delta\overline{rp}_t^{food} = \rho_{\Delta\overline{rp}^{food}}\Delta\overline{rp}_{t-1}^{food} + \left(1 - \rho_{\Delta\overline{rp}^{food}}\right) ss_{\Delta\overline{rp}^{food}} + \epsilon_t^{\Delta\overline{rp}^{food}} \quad (68)$$

$$\widehat{rp}_t^{food} = \rho_{\widehat{rp}^{food}}\widehat{rp}_{t-1}^{food} + \epsilon_t^{\Delta\widehat{rp}^{food}} \quad (69)$$

Uncovered Interest Parity

$$s_t = k_2\left(s_{t-1} + \frac{\Delta s_t^N}{4} - k_3\hat{y}_t^{rw} - k_4\widehat{rp}_t^{cob} - k_5\widehat{rp}_t^{cop}\right)$$
$$+(1-k_2)\begin{pmatrix}(1-e_1)s_{t+1} + e_1\left(s_{t-1} + \frac{2}{4}(\pi_t^{4T} - ss_{\Delta\pi^{rw}} + \Delta\bar{z}_t)\right) \\ +(i_t^{rw} - i_t + prem_t + prem_t^{RES2Y})/4\end{pmatrix} + \epsilon_t^s \quad (70)$$

$$\Delta s_t^N = \pi_t^{4T} - ss_{\Delta\pi^{rw}} + \Delta\bar{z}_t \quad (71)$$

Foreign Exchange Intervention

$$RES2Y_t = \overline{RES2Y}_t + \gamma \cdot (\Delta s_t^N - \Delta s_t) + \epsilon_t^{RES2Y} \quad (72)$$

$$\overline{RES2Y}_t = \rho_{\overline{RES2Y}} \cdot \overline{RES2Y}_{t-1} + \left(1 - \rho_{\overline{RES2Y}}\right) \cdot ss_{\overline{RES2Y}} + \epsilon_t^{\overline{RES2Y}} \quad (73)$$

$$prem_t^{RES2Y} = \theta\left(RES2Y_t - \overline{RES2Y}_t\right) \quad (74)$$

$$z_t = s_t + p_t^{rw} - p_t \quad (75)$$

$$\hat{z}_t = z_t - \bar{z}_t \quad (76)$$

$$\bar{z}_t = \bar{z}_{t-1} + \Delta\bar{z}_t/4 \quad (77)$$

$$\Delta s_t = 4(s_t - s_{t-1}) \quad (78)$$

$$\Delta s_t = s_t - s_{t-4} \quad (79)$$

Monetary Policy

$$i_t^{IT} = k_1\left(4\left((1-e_1)s_{t+1} + e_1\left(s_{t-1} + \frac{2}{4}(\pi_t^{4T} - ss_{\Delta\pi^{rw}} + \Delta\bar{z}_t)\right) - s_t\right) + (i_t^{rw} + prem_t)\right)$$
$$+(1-k_1)\left(g_1 i_{t-1}^{IT} + (1-g_1)(i_t^N + g_2(\pi_{t+4}^4 - \pi_{t+4}^{4T}) + g_3\hat{y}_t)\right) + \epsilon_t^i \quad (80)$$

$$i_t^N = \overline{rr}_t + \pi_{t+1}^4 \quad (81)$$

$$rr_t = i_t - \pi_{t+1}^4 \quad (82)$$

$$rr_t = \overline{rr}_t + \widehat{rr}_t \quad (83)$$

$$\Delta rm_t = \Delta y_t - c_1 \cdot (i_t - i_{t-1}) - c_2 \cdot \widehat{rm}_{t-1} - \Delta v_t + \epsilon_t^{\Delta rm} \tag{84}$$

$$\widehat{rm}_t = rm_t - (y_t - c_1 \cdot i_t - \overline{v}_t) \tag{85}$$

$$\Delta rm_t = 4 \cdot (rm_t - rm_{t-1}) \tag{86}$$

$$\Delta^4 rm_t = rm_t - rm_{t-4} \tag{87}$$

$$\Delta v_t = 4 \cdot (v_t - v_{t-1}) \tag{88}$$

$$\Delta m_t = \Delta rm_t + \pi_t \tag{89}$$

$$\Delta^4 m_t = 1/4(\Delta m_t + \Delta m_{t-1} + \Delta m_{t-2} + \Delta m_{t-3}) \tag{90}$$

$$\Delta^4 rm_t^T = 1/4 \cdot (\Delta rm_t^T + \Delta rm_{t-1}^T + \Delta rm_{t-2}^T + \Delta rm_{t-3}^T) \tag{91}$$

$$\Delta m_t^T = \pi_t^{4T} + \Delta \overline{y}_t - c_1 \cdot \left((\overline{rr}_t + \pi_t^{4T}) - (\overline{rr}_{t-1} + \pi_{t-1}^{4T}) \right) - \Delta \overline{v}_t + \epsilon_t^{\Delta m^T} \tag{92}$$

$$\Delta m_t^T = \Delta rm_t^T + \pi_t \tag{93}$$

$$\Delta rm_t^T = \Delta y_t - c_1(i_t^{MT} - i_{t-1}) - c_2 \widehat{rm}_{t-1} - \Delta v_t + \epsilon_t^{\Delta rm} \tag{94}$$

$$i_t = mpr\ i_t^{IT} + (1 - mpr) i_t^{MT} \tag{95}$$

$$v_t = \overline{v}_t + \hat{v}_t \tag{96}$$

$$\hat{v}_t = f_1 \cdot \hat{v}_{t-1} + \epsilon_t^{\hat{v}} \tag{97}$$

$$\Delta \overline{v}_t = 4 \cdot (\overline{v}_t - \overline{v}_{t-1}) \tag{98}$$

$$\Delta \overline{v}_t = d_1 \Delta \overline{v}_{t-1} + (1 - d_1)\ ss_{\Delta v} + \epsilon_t^{\Delta v} \tag{99}$$

Trend

$$\Delta \overline{y}_t^{NM} = \rho_{\Delta \overline{y}^{NM}} \cdot \Delta \overline{y}_{t-1}^{NM} + \left(1 - \rho_{\Delta \overline{y}^{NM}}\right) ss_{\Delta \overline{y}^{NM}} + \epsilon_t^{\Delta \overline{y}^{NM}} \tag{100}$$

$$\overline{y}_t^{NM} = \overline{y}_{t-1}^{NM} + \Delta \overline{y}_t^{NM}/4 \tag{101}$$

$$\Delta \overline{y}_t^{M} = \rho_{\Delta \overline{y}^{M}} \cdot \Delta \overline{y}_{t-1}^{M} + \left(1 - \rho_{\Delta \overline{y}^{M}}\right) \cdot ss_{\Delta \overline{y}^{M}} + \epsilon_t^{\Delta \overline{y}^{M}} \tag{102}$$

$$\overline{y}_t^{NM} = \overline{y}_{t-1}^{NM} + \Delta\overline{y}_t^{M}/4 \quad (103)$$

$$\overline{y}_t = \overline{y}_{t-1} + \Delta\overline{y}_t/4 \quad (104)$$

$$\Delta y_t = 4 \cdot (y_t - y_{t-1}) \quad (105)$$

$$\Delta y_t^{NM} = 4 \cdot (y_t^{NM} - y_{t-1}^{NM}) \quad (106)$$

$$\Delta y_t^{M} = 4 \cdot (y_t^{NM} - y_{t-1}^{NM}) \quad (107)$$

$$\pi_t^{4T} = \rho_{\pi^{4T}} \cdot \pi_{t-1}^{4T} + \left(1 - \rho_{\pi^{4T}}\right) \cdot ss_{\pi^{4T}} + \epsilon_t^{\pi^T} \quad (108)$$

$$\overline{rr}_t^{rw} = \rho_{\overline{rr}^r w} \cdot \overline{rr}_{t-1}^{rw} + \left(1 - \rho_{\overline{rr}^r w}\right) \cdot ss_{\overline{rr}^r w} + \epsilon_t^{\overline{rr}^r w} \quad (109)$$

$$\Delta\overline{z}_t = \rho_{\Delta\overline{z}} \cdot \Delta\overline{z}_{t-1} + (1 - \rho_{\Delta\overline{z}}) \cdot ss_{\Delta\overline{z}} - \tau 1_{\Delta\overline{z}} \cdot \Delta\overline{rp}_t^{cop} - \tau 2_{\Delta\overline{z}} \cdot \Delta\overline{rp}_t^{cob} + \epsilon_t^{\Delta\overline{z}} \quad (110)$$

$$\overline{rr}_t = \rho_{\overline{rr}} \cdot \overline{rr}_{t-1} + (1 - \rho_{\overline{rr}}) \cdot ss_{\overline{rr}} + \epsilon_t^{\overline{rr}} \quad (111)$$

$$prem_t = \overline{rr}_t - \overline{rr}_t^{rw} - \Delta\overline{z}_{t+1} \quad (112)$$

External Sector

$$\hat{y}_t^{rw} = \rho_{\hat{y}^{rw}} \cdot \hat{y}_{t-1}^{rw} + \epsilon_t^{\hat{y}^{rw}} \quad (113)$$

$$i_t^{rw} = \rho_{i^{rw}} \cdot i_{t-1}^{rw} + (1 - \rho_{i^{rw}}) \cdot \left(\overline{rr}_t^{rw} + \Delta\pi_t^{rw}\right) + \epsilon_t^{i^{rw}} \quad (114)$$

$$\Delta\pi_t^{rw} = \rho_{\Delta\pi^{rw}} \cdot \Delta\pi_{t-1}^{rw} + (1 - \rho_{\Delta\pi^{rw}}) \cdot ss_{\Delta\pi^{rw}} + \epsilon_t^{\Delta\pi^{rw}} \quad (115)$$

$$\Delta\pi_t^{rw} = 4 \cdot (p_t^{rw} - p_{t-1}^{rw}) \quad (116)$$

Fiscal Block

$$DEB2Y_t^T = \rho_{DEB2Y^T} \cdot DEB2Y_{t-1}^T + \left(1 - \rho_{DEB2Y^T}\right) \cdot ss_{DEB2Y^T} + \epsilon_t^{DEB2Y^T} \quad (117)$$

$$DEF2Y_t = SDEF2Y_t - p_1 \cdot \hat{y}_t \quad (118)$$

$$SDEF2Y_t = \rho_{SDEB2Y} \cdot (SDEF2Y_{t-1} - p_4 \cdot \hat{y}_t) + (1 - \rho_{SDEB2Y}) \cdot \left(SDEF2Y_t^T - p_2 \cdot \widehat{DEB2}Y_t\right) + \epsilon_t^{SDEB2Y} \quad (119)$$

$$\widehat{DEB2}Y_t = \rho_{\widehat{DEB2}Y} \cdot (DEB2Y_t - DEB2Y_t^T) + (1 - \rho_{\widehat{DEB2}Y}) \cdot \widehat{DEB2}Y_{t+1} \quad (120)$$

$$DEB2Y_t^{LC} + DEB2Y_t^{FC} = DEF2Y_t + s_1 \cdot DEB2Y_{t-1}^{LC} - s_2 \cdot \left(\Delta PY_t - ss_{\Delta\overline{PY}}\right) + s_3 \cdot DEB2Y_{t-1}^{FC} + s_4 \cdot \left(\Delta s_t - ss_{\Delta s^N}\right) - s_5 \cdot \left(\Delta PY_t - ss_{\Delta\overline{PY}}\right) + \epsilon_t^{DEB2Y} \quad (121)$$

$$DEB2Y_t = DEB2Y_t^{LC} + DEB2Y_t^{FC} \quad (122)$$

$$DEB2Y_t^{FC} = (1 - h_2) \cdot DEB2Y_t \quad (123)$$

$$DEB2Y_t^T = SDEF2Y_t^T + q_1 \cdot \left(\left(DEB2Y_t^T\right)\right) + q_2 \cdot \left(\left(\Delta s_t^N - ss_{\Delta s^N}\right)\right) - q_3 \cdot \left(\left(\Delta\overline{PY}_t - ss_{\Delta\overline{PY}}\right)\right) \quad (124)$$

$$\Delta PY_t = \Delta y_t + \pi_t \quad (125)$$

$$\Delta\overline{PY}_t = \Delta\overline{y}_t + \pi_t^{4T} \quad (126)$$

$$fimp_t = \epsilon_t^{SDEB2Y} + p_3 \cdot \epsilon_t^{DEB2Y^T} \quad (127)$$

Dollarization

$$MCI_t = h_1 \cdot (h_2 \cdot \widehat{rr}_t + (1 - h_2) \cdot \widehat{rr}_t^{FC}) + (1 - h_1) \cdot (-\hat{z}_t) \quad (128)$$

$$\widehat{rr}_t^{FC} = rr_t^{FC} - \overline{rr}_t^{FC} \quad (129)$$

$$i_t^{FC} = i_t^{rw} + \epsilon_t^{ifc} \quad (130)$$

$$rr_t^{FC} = i_t^{FC} - \Delta\pi_{t+1}^{rw} \quad (131)$$

$$\overline{rr}_t^{FC} = \overline{rr}_t^{rw} + \epsilon_t^{\overline{rr}^f c} \quad (132)$$

$$\Delta^4 y_t = y_t - y_{t-4} \quad (133)$$

$$\Delta^4 y_t^M = y_t^{NM} - y_{t-4}^{NM} \quad (134)$$

$$\Delta^4 y_t^{NM} = y_t^{NM} - y_{t-4}^{NM} \quad (135)$$

$$\pi_t^{4F} = p_t^F - p_{t-4}^F \quad (136)$$

$$\pi_t^{4E} = p_t^E - p_{t-4}^E \quad (137)$$

$$\pi_t^{4C} = p_t^C - p_{t-4}^C \quad (138)$$

A. Model Variables

Variable	Model name	Description
$\hat{y}$	L_GDP_GAP	Écart de production
$\hat{y}^{NM}$	L_NMIN_GAP	Écart de production non-minière
$\hat{y}^{M}$	L_MIN_GAP	Écart de production minière
MCI	MCI	Indice des Conditions Monétaires
$\hat{y}^{rw}$	L_GDP_RW_GAP	Écart de production pour le reste du monde
$\widehat{rr}$	RR_GAP	Écart de taux d'intérêt réel
$\hat{z}$	L_Z_GAP	Écart de taux de change réel
y	L_GDP	PIB domestique
y^{D}	L_GDP_DISC	Divergence statistique en PIB domestique
y^{NM}	L_NMIN	PIB non-minière
y^{NM}	L_MIN	PIB minière
$\overline{y}$	L_GDP_BAR	Production potentielle
$\overline{y}^{NM}$	L_NMIN_BAR	Production potentielle non-minière
$\overline{y}^{NM}$	L_MIN_BAR	Production potentielle minière
π	DLA_CPI	Taux d'inflation trimestriel annualisé (en %)
$E\pi$	E_DLA_CPI	Taux d'inflation trimestriel attendu, annualisé (en %)
p	L_CPI	Indice des prix domestiques (niveau, 100*log)
p^{C}	L_CPIXFE	Composante sous-jacente de l'Indice des Prix à la Consommation
π^{C}	DLA_CPIXFE	Taux d'inflation sous-jacent trimestriel annualisé (en %)
rmc^{C}	RMC_XFE	Coût marginal réel de la composante sous-jacente / IPC
$E\pi^{C}$	E_DLA_CPIXFE	Taux d'inflation sous-jacente trimestriel attendu, annualisé (en %)
p^{E}	L_CPIE	Indice des prix à la consommation en log
π^{E}	DLA_CPIE	Taux énergétique d'inflation trimestriel annualisé (en %)
rmc^{E}	RMC_E	Coût marginal réel de la composante énergétique/ IPC
$E\pi^{E}$	E_DLA_CPIE	Taux d'inflation énergétique trimestriel attendu, annualisé (en %)
p^{F}	L_CPIF	Composante alimentaire / IPC en log.
π^{F}	DLA_CPIF	Taux d'inflation trimestriel annualisé des aliments (en %)
rmc^{F}	RMC_F	Coût marginal réel de la composante alimentaire/ IPC
$E\pi^{F}$	E_DLA_CPIF	Taux d'inflation alimentaire trimestriel attendu, annualisé (en %)
rp^{C}	L_RPXFE	Prix relatif de l'IPC sous-jacente
$\overline{rp}^{C}$	L_RPXFE_BAR	Prix relatif de l'IPC sous-jacente - Tendance

$\widehat{rp}^C$	L_RPXFE_GAP	Prix relatif de l'IPC sous-jacente - Écart
$\Delta\overline{rp}^C$	DLA_RPXFE_BAR	Prix relatif de l'IPC sous-jacente en variation annualisée
p^{INS}	L_CPI_INS	Indice des prix domestiques (INS) (niveau, 100*log)
π^{INS}	DLA_CPI_INS	Taux d'inflation (INS) trimestriel en annualisé (en %)
π^{4INS}	D4L_CPI_INS	Taux d'inflation annuel (en %)
$\Delta\pi^D$	BCC_INS_DISC	Écart statistique entre l'inflation BCC et l'inflation INS
rp^E	L_RPE	Prix relatif de la composante énergie de l'IPC
$\overline{rp}^E$	L_RPE_BAR	Prix relatif de la composante énergie de l'IPC - Tendance
$\widehat{rp}^E$	L_RPE_GAP	Prix relatif de la composante énergie de l'IPC - Écart
$\Delta\overline{rp}^E$	DLA_RPE_BAR	Prix relatif de la composante énergie de l'IPC en variation annualisée
rp^F	L_RPF	Prix relatif de la composante alimentaire de l'IPC
$\overline{rp}^F$	L_RPF_BAR	Prix relatif de la composante alimentaire de l'IPC - Tendance
$\widehat{rp}^F$	L_RPF_GAP	Prix relatif de la composante alimentaire de l'IPC - Écart
$\Delta\overline{rp}^F$	DLA_RPF_BAR	Prix relatif de la composante alimentaire de l'IPC en variation annualisée
p^{oil}	L_WOIL	Prix mondial du pétrole brut
rp^{oil}	L_RWOIL	Prix relatif mondial du pétrole brut
$\overline{rp}^{oil}$	L_RWOIL_BAR	Prix relatif mondial du pétrole brut - Tendance
$\widehat{rp}^{oil}$	L_RWOIL_GAP	Prix relatif mondial du pétrole brut - Écart
$\Delta\overline{rp}^{oil}$	DLA_RWOIL_BAR	Prix relatif mondial du pétrole brut en variation annualisée
p^{cop}	L_WCOP	Cours mondial du cuivre
rp^{cop}	L_RWCOP	Prix relatif mondial du cuivre
$\overline{rp}^{cop}$	L_RWCOP_BAR	Prix relatif mondial du cuivre - Tendance
$\widehat{rp}^{cop}$	L_RWCOP_GAP	Prix relatif mondial du cuivre Écart
$\Delta\overline{rp}^{cop}$	DLA_RWCOP_BAR	Prix relatif mondial du cuivre en variation annualisée
p^{cob}	L_WCOB	Prix mondial du cobalt
rp^{cob}	L_RWCOB	Prix relatif mondial du cobalt
$\overline{rp}^{cob}$	L_RWCOB_BAR	Prix relatif mondial du cobalt - Tendance
$\widehat{rp}^{cob}$	L_RWCOB_GAP	Prix relatif mondial du cobalt - Écart
$\Delta\overline{rp}^{cob}$	DLA_RWCOB_BAR	Prix relatif mondial du cobalt
p^{food}	L_WFOOD	Indice mondial des produits alimentaires
rp^{food}	L_RWFOOD	Prix relatif mondial des produits alimentaires
$\overline{rp}^{food}$	L_RWFOOD_BAR	Prix relatif mondial des produits alimentaires - Tendance
$\widehat{rp}^{food}$	L_RWFOOD_GAP	Prix relatif mondial des produits alimentaires - Écart
$\Delta\overline{rp}^{food}$	DLA_RWFOOD_BAR	Prix relatif mondial des produits alimentaires en variation annualisée

i	RS	Taux d'intérêt nominal (en %)
i^N	RSNEUTRAL	Taux d'intérêt nominal neutre annuel (en %)
π^4	D4L_CPI	Taux d'inflation annuel (en %)
π^{4T}	D4L_CPI_TAR	Objectif de taux d'inflation annuel (en %)
$\overline{rr}$	RR_BAR	Taux d'intérêt réel annuel tendanciel (en %)
rr	RR	Taux d'intérêt réel annuel (en %)
s	L_S	Taux de change nominal (Niveau, 100*log)
Δs	DLA_S	Taux de variation du taux de change trimestriel, annualisé
Δs	D4L_S	Taux de variation du taux de change en glissement annuel
Δs^N	DLA_S_NEUTRAL	Taux de variation neutre du taux de change
$\Delta \bar{z}$	DLA_Z_BAR	Dépréciation tendancielle du taux de change réel trimestriel, en annualisé (en %)
i^{rw}	RS_RW	Taux d'intérêt nominal étranger
$prem$	PREM	Prime de risque
z	L_Z	Taux de change réel
$\bar{z}$	L_Z_BAR	Taux de change réel tendanciel (niveau, 100*log)
p^{rw}	L_CPI_RW	Indice des prix étranger (niveau, 100*log)
$\Delta \bar{y}$	DLA_GDP_BAR	Taux de croissance trimestrielle du PIB réel (en %)
$\Delta \bar{y}^{NM}$	DLA_NMIN_BAR	Taux de croissance trimestrielle du PIB non-minière (en %)
$\Delta \bar{y}^{M}$	DLA_MIN_BAR	Taux de croissance trimestrielle du PIB minière (en %)
$\overline{rr}^{rw}$	RR_RW_BAR	Taux d'intérêt réel étranger tendanciel (en %)
$\Delta \pi^{rw}$	DLA_CPI_RW	Taux d'inflation étranger (niveau, 100*log)
Δy	DLA_GDP	Taux de croissance trimestriel du PIB réel (en %)
Δy^D	DLA_GDP_DISC	Divergence statistique dans le taux de croissance trimestriel du PIB domestique
Δy^{NM}	DLA_NMIN	Taux de croissance trimestriel du PIB non-minière (en %)
Δy^M	DLA_MIN	Taux de croissance trimestriel du PIB minière (en %)
rm	L_RM	Demande d'encaisses réelles (en niveau, 100*log)
$\widehat{rm}$	L_RM_GAP	Demande d'encaisses réelles - Écart (en %)
Δrm	DLA_RM	Taux de croissance des encaisses réelles annualisée (en %)
$\Delta^4 rm$	D4L_RM	Taux de croissance des encaisses réelles annuel (en %)
Δm^T	DLA_M_TAR	Cible nominale de croissance monétaire (en %)
Δrm^T	DLA_RM_TAR	Cible de croissance des encaisses réelles (en %)
Δm	DLA_M	Taux de croissance des encaisses nominales annualisée (en %)
$\Delta^4 m$	D4L_M	Taux de croissance des encaisses nominales annuel (en %)
$\Delta^4 rm^T$	D4L_RM_TAR	Cible de croissance annuelle des encaisses réelles (en %)
v	L_V	Vitesse de circulation de la monnaie (en niveau, 100*log)

Δv	DLA_V	Croissance de la vitesse de circulation annualisée (en %)
$\overline{v}$	L_V_BAR	Vitesse de circulation d'équilibre (en niveau, 100*log)
$\hat{v}$	L_V_GAP	Vitesse de circulation de la monnaie - Écart (niveau, 100*log)
$\Delta\overline{v}$	DLA_V_BAR	Taux de croissance de la vitesse de circulation d'équilibre annualisé (en %)
i^{IT}	RS_IT	Taux d'intérêt : Règle de Taylor (en %)
i^{MT}	RS_MT	Taux d'intérêt : Ciblage monétaire (en %)
$DEB2Y^{T}$	DEB_RAT_TAR	Objectif du ratio dette/PIB
$DEB2Y$	DEB_RAT	Dette/PIB
$DEF2Y$	DEF_RAT	Déficit/PIB
$SDEF2Y$	DEF_S_RAT	Déficit Structurel/PIB
$SDEF2Y^{T}$	DEF_S_RAT_TAR	Objectif du Déficit/PIB
$\widehat{DEB2}Y$	DEB_DEV_RAT	Écart entre la dette et le PIB par rapport à l'objectif
ΔPY	DLA_NGDP	PIB Nominal
$\Delta\overline{PY}$	DLA_NGDP_BAR	PIB Nominal Potentiel
$fimp$	FIMP	Impulsion fiscale
$DEB2Y^{LC}$	DEB_LC_RAT	Dette/PIB devise locale
$DEB2Y^{FC}$	DEB_FC_RAT	Dette/PIB devises étrangères
$\widehat{rr}^{FC}$	RR_FC_GAP	Écart de taux d'intérêt réel sur les prêts en devises étrangères
rr^{FC}	RR_FC	Taux d'intérêt réel sur les prêts en devises étrangères
$\overline{rr}^{FC}$	RR_FC_BAR	Taux d'intérêt réel d'équilibre sur un prêt en devise étrangère
i^{FC}	RS_FC	Taux d'intérêt nominal d'équilibre sur un prêt en devise étrangère
$RES2Y$	RES	Réserves FX
$\overline{RES2Y}$	RES_BAR	Réserves FX - équilibre
$prem^{RES2Y}$	PREM_E	FX premium
$\Delta^4 y$	D4L_GDP	Taux de croissance annuel du PIB réel (en %)
$\Delta^4 y^{M}$	D4L_MIN	Taux de croissance annuel du PIB minière (en %)
$\Delta^4 y^{NM}$	D4L_NMIN	Taux de croissance annuel du PIB non-minière (en %)
π^{4F}	D4L_CPIF	Taux d'inflation annuel alimentaire (en %)
π^{4E}	D4L_CPIE	Taux d'inflation annuel énergétique (en %)
π^{4C}	D4L_CPIXFE	Taux d'inflation annuel sous-jacent (en %)
y^{cob}	L_prod_cobalt	Volume de production du cobalt (niveau, 100*log)
y^{cop}	L_Prod_copper	Volume de production du cuivre (niveau, 100*log)
$\hat{y}^{cop}$	L_Prod_copper_GAP	Volume de production du cuivre (niveau, 100*log)
$\hat{y}^{cob}$	L_prod_cobalt_GAP	Volume de production du cobalt (niveau, 100*log)
$\Delta\overline{y}^{cop}$	DLA_Prod_copper_BAR	Croissance de la production du cuivre (en %)

$\Delta\overline{y}^{cob}$	DLA_prod_cobalt_BAR	Croissance de la production du cobalt (en %)
$\overline{y}^{cop}$	L_Prod_copper_BAR	Volume de production du cuivre (niveau, 100*log)
$\overline{y}^{cob}$	L_prod_cobalt_BAR	Volume de production du cobalt (niveau, 100*log)

Model Parameters

Parameter	Model name	Description	Value
h_1	h1	Poids de TIR en l'ICM	0.70
h_2	h2	Poids de la non-dollarisation dans le TIR	0.20
b_{11}	b11	Persistance non-minière	0.50
b_{12}	b12	Indice de la Condition Monétaire	0.20
b_{13}	b13	Écart de production étranger	0.10
b_{15}	b15	Écart de production minière	0.10
b_{16}	b16	Impulsion fiscale	0.10
b_{21}	b21		0.50
b_{22}	b22		0.10
b_{23}	b23		0.28
b_{231}	b231		0.24
b_{24}	b24		0.10
b_{241}	b241		0.19
ω	w_NMIN		0.70
a_{31}	a31		0.50
a_{32}	a32		0.01
a_{11}	a11		0.50
a_{12}	a12		0.30
a_{13}	a13		0.50
a_{21}	a21		0.50
a_{22}	a22		0.30
a_{23}	a23		0.50
ω_E	w_CPIE		0.09
ω_F	w_CPIF		0.47
k_1	k1		0.10
k_2	k2		0.90
k_3	k3		0.09
k_4	k4		0.10
k_5	k5		0.12
γ	gamma		1.00

θ	theta	0.00
$\rho_{\overline{RES2Y}}$	rho_RES_BAR	0.80
$\rho_{\Delta\overline{rp}^C}$	rho_DLA_RPXFE_BAR	0.80
$\rho_{\Delta\overline{rp}^F}$	rho_DLA_RPF_BAR	0.80
$\rho_{\Delta\overline{rp}^{oil}}$	rho_DLA_RWOIL_BAR	0.80
$\rho_{\widehat{rp}^{oil}}$	rho_L_RWOIL_GAP	0.50
$\rho_{\Delta\overline{rp}^{food}}$	rho_DLA_RWFOOD_BAR	0.80
$\rho_{\widehat{rp}^{food}}$	rho_L_RWFOOD_GAP	0.50
$\rho_{\Delta\overline{rp}^{cop}}$	rho_DLA_RWCOP_BAR	0.80
$\rho_{\widehat{rp}^{cop}}$	rho_L_RWCOP_GAP	0.50
$\rho_{\Delta\overline{rp}^{cob}}$	rho_DLA_RWCOB_BAR	0.80
$\rho_{\widehat{rp}^{cob}}$	rho_L_RWCOB_GAP	0.50
ρ_{DEB2Y^T}	rho_DEB_RAT_TAR	0.99
ρ_{SDEB2Y}	rho_DEF_S_RAT	0.70
$\rho_{\widehat{DEB2Y}}$	rho_DEB_DEV_RAT	0.20
$\rho_{\Delta\overline{y}^{cob}}$	rho_DLA_prod_cobalt_BAR	0.80
$\rho_{\hat{y}^{cob}}$	rho_L_prod_cobalt_GAP	0.55
$\rho_{\Delta\overline{y}^{cop}}$	rho_DLA_Prod_copper_BAR	0.80
$\rho_{\hat{y}^{cop}}$	rho_L_Prod_copper_GAP	0.40
$\rho_{\Delta\pi^D}$	rho_BCC_INS_DISC	0.40
g_1	g1	0.70
g_2	g2	0.50
g_3	g3	0.50
e_1	e1	0.40
c_1	c1	0.60
c_2	c2	0.30
f_1	f1	0.50
d_1	d1	0.60
mpr	mpr	0.75
p_1	p1	0.05
p_2	p2	0.50
p_3	p3	0.10
p_4	p4	0.10
$\rho_{\Delta\overline{y}^{NM}}$	rho_DLA_NMIN_BAR	0.80
$\rho_{\Delta\overline{y}^{M}}$	rho_DLA_MIN_BAR	0.80

$\rho_{\pi^{4T}}$	rho_D4L_CPI_TAR	0.80
$\rho_{\overline{rr}^r{}_W}$	rho_RR_RW_BAR	0.80
$\rho_{\Delta\bar{z}}$	rho_DLA_Z_BAR	0.80
$\tau1_{\Delta\bar{z}}$	tau1_DLA_Z_BAR	0.10
$\tau2_{\Delta\bar{z}}$	tau2_DLA_Z_BAR	0.10
$\rho_{\overline{rr}}$	rho_RR_BAR	0.80
$\rho_{\hat{y}^{rw}}$	rho_L_GDP_RW_GAP	0.80
$\rho_{i^{rw}}$	rho_RS_RW	0.80
$\rho_{\Delta\pi^{rw}}$	rho_DLA_CPI_RW	0.80
$ss_{\Delta v}$	ss_DLA_V	0.00
$ss_{\Delta\overline{rp}^C}$	ss_DLA_RPXFE_BAR	−1.35
$ss_{\Delta\overline{rp}^F}$	ss_DLA_RPF_BAR	1.35
$ss_{\Delta\overline{rp}^{oil}}$	ss_DLA_RWOIL_BAR	3.00
$ss_{\Delta\overline{rp}^{food}}$	ss_DLA_RWFOOD_BAR	0.20
$ss_{\Delta\overline{rp}^{cop}}$	ss_DLA_RWCOP_BAR	4.70
$ss_{\Delta\overline{rp}^{cob}}$	ss_DLA_RWCOB_BAR	1.40
$ss_{\overline{RES2Y}}$	ss_RES_BAR	7.00
$ss_{\Delta\bar{y}^{cop}}$	ss_DLA_Prod_copper_BAR	8.47
$ss_{\Delta\bar{y}^{cob}}$	ss_DLA_prod_cobalt_BAR	3.82
$ss_{\Delta\pi^{rw}}$	ss_DLA_CPI_RW	3.00
$ss_{\Delta\bar{y}^{NM}}$	ss_DLA_NMIN_BAR	3.75
$ss_{\Delta\bar{y}^{M}}$	ss_DLA_MIN_BAR	9.58
$ss_{\pi^{4T}}$	ss_D4L_CPI_TAR	7.00
$ss_{\overline{rr}^r{}_W}$	ss_RR_RW_BAR	0.50
$ss_{\Delta s^N}$	ss_DLA_S	0.00
$ss_{\Delta\bar{z}}$	ss_DLA_Z_BAR	−0.95
$ss_{\overline{rr}}$	ss_RR_BAR	3.00
$ss_{\Delta\overline{PY}}$	ss_DLA_NGDP	12.50
ss_{DEF2Y}	ss_DEF_RAT	0.50
ss_{DEB2Y^T}	ss_DEB_RAT_TAR	4.50
$ss_{DEB2Y^{LC}}$	ss_DEB_LC_RAT	0.90
$ss_{DEB2Y^{FC}}$	ss_DEB_FC_RAT	3.60
s_1	s1	0.89
s_2	s2	0.01

s_3	s3	0.89
s_4	s4	0.03
s_5	s5	0.03
q_1	q1	0.89
q_2	q2	0.03
q_3	q3	0.04

Model Shocks

Shock	Model name	Description	StDev
$\epsilon^{y^{NM}}$	SHK_L_NMIN_GAP	Shock to non-mining sector gap	2.39
$\epsilon^{y^{M}}$	SHK_L_MIN_GAP	Shock to mining sector gap	14.34
ϵ^{i}	SHK_RS		14.34
ϵ^{s}	SHK_L_S		5.98
$\epsilon^{\Delta\bar{y}^{NM}}$	SHK_DLA_NMIN_BAR	Shock to non-mining sector potential	2.03
$\epsilon^{\Delta\bar{y}^{M}}$	SHK_DLA_MIN_BAR	Shock to mining sector potential	5.98
$\epsilon^{\pi^{T}}$	SHK_D4L_CPI_TAR		2.39
$\epsilon^{\overline{rr}^{r}w}$	SHK_RR_RW_BAR		2.39
$\epsilon^{\overline{rr}^{f}c}$	SHK_RR_FC_BAR		2.39
$\epsilon^{\Delta\bar{z}}$	SHK_DLA_Z_BAR		1.79
$\epsilon^{\hat{y}^{rw}}$	SHK_L_GDP_RW_GAP		1.00
$\epsilon^{i^{rw}}$	SHK_RS_RW		1.00
$\epsilon^{i^{fc}}$	SHK_RS_FC		4.78
$\epsilon^{\Delta\pi^{rw}}$	SHK_DLA_CPI_RW		2.00
$\epsilon^{\overline{rr}}$	SHK_RR_BAR		2.39
$\epsilon^{\Delta rm}$	SHK_DLA_RM		7.17
$\epsilon^{\hat{v}}$	SHK_L_V_GAP		3.59
$\epsilon^{\Delta m^{T}}$	SHK_DLA_M_TAR		0.24
$\epsilon^{\Delta v}$	SHK_DLA_V		2.39
$\epsilon^{p^{D}}$	SHK_L_CPI_DISC		1.20
$\epsilon^{\pi^{C}}$	SHK_DLA_CPIXFE		7.17
$\epsilon^{\pi^{F}}$	SHK_DLA_CPIF		11.95
$\epsilon^{\pi^{E}}$	SHK_DLA_CPIE		4.78
$\epsilon^{\Delta\overline{rp}^{C}}$	SHK_DLA_RPXFE_BAR		0.60

$\epsilon^{\Delta\overline{rp}^F}$	SHK_DLA_RPF_BAR		0.60
$\epsilon^{\Delta\overline{rp}^{oil}}$	SHK_DLA_RWOIL_BAR		3.59
$\epsilon^{\Delta\widehat{rp}^{oil}}$	SHK_L_RWOIL_GAP		21.51
$\epsilon^{\Delta\overline{rp}^{food}}$	SHK_DLA_RWFOOD_BAR		1.20
$\epsilon^{\Delta\widehat{rp}^{food}}$	SHK_L_RWFOOD_GAP		7.17
$\epsilon^{\overline{rp}^{cop}}$	SHK_DLA_RWCOP_BAR	Shock to the relative price of cooper trend	3.59
$\epsilon^{\widehat{rp}^{cop}}$	SHK_L_RWCOP_GAP	Shock to the relative price of cooper gap	15.54
$\epsilon^{\overline{rp}^{cob}}$	SHK_DLA_RWCOB_BAR	Shock to the relative price of cobalt trend	4.06
$\epsilon^{\widehat{rp}^{cob}}$	SHK_L_RWCOB_GAP	Shock to the relative price of cobalt gap	20.32
ϵ^{DEB2Y^T}	SHK_DEB_RAT_TAR	Shock to the debt to GDP target	5.98
ϵ^{SDEB2Y}	SHK_DEF_S_RAT	Shock to the structural deficit to GDP	2.39
ϵ^{DEB2Y}	SHK_DEB_RAT	Shock to the debt to GDP	8.96
ϵ^{RES2Y}	SHK_RES	Shock to reserves (level)	2.39
$\epsilon^{\overline{RES2Y}}$	SHK_RES_BAR	Shock to reserves (trend)	2.39
ϵ^{y^D}	SHK_L_GDP_DISC	Shock to statistical discrepancy in GDP	2.39
$\epsilon^{\Delta\pi^D}$	SHK_BCC_INS_DISC	Shock to statistical discrepancy in BCC and INS inflation	9.56
$\epsilon^{\hat{y}^{cob}}$	SHK_L_prod_cobalt_GAP	Shock to volume production of cobalt GAP	16.73
$\epsilon^{\hat{y}^{cop}}$	SHK_L_Prod_copper_GAP	Shock to volume production of copper GAP	19.12
$\epsilon^{\Delta\overline{y}^{cob}}$	SHK_DLA_prod_cobalt_BAR	Shock to volume production of cobalt trend	4.78
$\epsilon^{\Delta\overline{y}^{cop}}$	SHK_DLA_Prod_copper_BAR	Shock to volume production of copper trend	5.98

PUBLICATIONS

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