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An Extended Quarterly Projection Model for the Central Bank of Jordan

Adel Al-Sharkas, Nedal Al-Azzam, Sarah AlTalafha, Rasha Abu Shawish, Ahmad Shalein, Auday Rawwaqah, Amany Al-Rawashdeh, Daniel Baksa, Philippe Karam and Jan Vlcek

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ABSTRACT: The Central Bank of Jordan (CBJ) has developed a Forecasting and Policy Analysis System (FPAS) to serve as a reliable analytical framework for macroeconomic analysis, forecasting and decision-making under a pegged exchange rate regime. At the heart of the FPAS is the CBJ's extended Jordan Analysis Model (JAM2.0). The model captures the monetary transmission mechanism and provides a consistent monetary policy framework that uses the exchange rate as an effective nominal anchor. This paper outlines the structure and properties of JAM2.0 and emphasizes the enhanced interplay and tradeoffs among monetary, fiscal, and foreign exchange management policies. Simulation and forecasting exercises demonstrate JAM2.0's ability to match key stylized facts of the Jordanian economy, produce accurate forecasts of important macroeconomic variables, and explain the critical relationships among policies.

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[1] Acknowledgement: The authors comprise Central Bank of Jordan (CBJ) staff and the IMF team (Institute for Capacity Development (ICD)) that have jointly participated in the Technical Assistance (TA) project on modernizing CBJ's Forecasting and Policy Analysis System (FPAS). As part of this TA project the CBJ and ICD teams jointly contributed to the development of CBJ's in-house core Quarterly Projection Model (QPM), the Jordan Analysis Model (JAM). The CBJ TA project started in June 2021 and was completed in September 2022, financed in part by the COVID-19 Crisis CD Initiative Funding Program. The authors greatly appreciate the strong support for the FPAS TA project provided by CBJ Governor Adel Al-Sharkas and the Executive Director of the Research Department, Nedal Al-Azzam. The authors are also grateful to Paul Cashin for providing edits and comments, Andy Berg, Adam Remo, and Diego Rodriguez for feedback through the development work on FINEX, and to the IMF Middle East and Central Asia Department's Jordan Mission Chief Ali Abbas and team for their continuous support of the TA project. The authors also thank Rahel Kidane of ICD for her excellent work on formatting and editing the paper. The views expressed in this paper are those of the authors and do not necessarily represent the views of the Central Bank of Jordan, IMF, its Executive Board, or IMF management.

Contents

I. Introduction

The modernized version of the structural Jordan Analysis Model, known as JAM2.0, plays a central role in the Central Bank of Jordan's (CBJ) Forecasting and Policy Analysis System (FPAS). As CBJ's core medium-term forecasting model, JAM2.0 has proven to be a reliable tool for conducting macroeconomic analyses and projections to support policy recommendations. JAM2.0 captures Jordan's monetary-exchange rate regime, which is based on an exchange rate anchor and follows a conventional fixed exchange rate regime. By providing an operational framework for policy analysis and forecasting, JAM2.0 has been customized to align with Jordanian data and characteristics. It effectively describes the dynamics of key macro variables, identifies trends and structural breaks, and analyzes policy responses to supply, demand, and financial shocks.[1]

The Jordan Analysis Model (JAM) falls within the category of policy-oriented central bank Quarterly Projection Models (QPMs) that operate under a fixed (pegged) exchange rate regime. The success of Jordan's exchange rate regime can be attributed to the CBJ's clear articulation of internally-consistent policy goals and the institutional arrangements that grant the Bank the necessary legal, decision-making, and operational autonomy to pursue these goals. The JAM2.0 model's structure highlights several key features and stylized facts of the Jordanian economy and the CBJ's policy framework. These include: (i) the pegged exchange rate regime, supported by a committed exchange rate nominal anchor, which has effectively ensured macroeconomic stability through the application of an operational, reserve adequacy-based rule; (ii) the status of Jordan as a small open economy, which exposes it to developments in trading partners; (iii) detailed determinants of domestic and external demand and their distinct implications for inflation; (iv) an analysis of inflation dynamics, including trends in relative prices; (v) the role of fiscal policy; (vi) favorable access to international financial markets; and (vii) the use of the overnight interbank market rate, as the counterparty to the CBJ main policy rate, to signal the stance of monetary policy.

The modern JAM incorporates additional features that enhance its ability to analyze data dynamics and forecast economic developments in the face of uncertainty. First, the inclusion of a fiscal block allows for the tracking of the transmission channels and effects of the (cyclically-adjusted primary) fiscal balance on the real sector. This feature enables the assessment of the economic impact of government stimulus, analysis of public debt projections, evaluation of fiscal adjustment amid COVID-19, differentiation between foreign and domestic currency-denominated debt, and exploration of crucial fiscal-monetary policy interactions and tradeoffs. Second, conducting an expenditure-side GDP decomposition, by distinguishing between domestic and foreign demand, enhances the understanding of drivers of growth and policy effects. Third, the enriched open economy analysis explicitly examines the role of interest rate and foreign exchange intervention (FXI) policies. This feature highlights the tradeoffs in achieving internal and external balances, endogenizes the interaction between market-based capital flows and risk premia and models the dynamics of the buying and selling of foreign exchange reserves. Overall, JAM has proven to be an invaluable quantitative tool for analyzing the effects on the Jordanian economy of domestic and global supply shocks, global food and fuel price shocks, and global financial shocks (changes in investor risk appetites and in global/U.S. interest rates). It has also assisted the CBJ decision-making body in navigating complex policy tradeoffs in the presence of heightened economic uncertainty.

[1] JAM2.0's extensions align with the novel properties introduced in a new ICD semi-structural model, the *Forecasting Model of Internal and External Balance (FINEX).* See Berg, Hul, Karam, Remo and Rodriguez (forthcoming, 2023).

The model structure and calibration of JAM2.0 are tested using a set of simulations to examine key empirical findings and model properties. The impulse responses of the model confirm that JAM2.0 aligns with economic intuition, and the ex-post in-sample model-based forecasts demonstrate its success in capturing important data dynamics.

In conclusion, JAM2.0 serves as a country application of the FINEX framework under a pegged exchange rate regime and is a key extension in central banks' suite of QPM policy models. JAM2.0 effectively addresses the key challenges within Jordan's monetary policy framework, while incorporating essential frictions and tradeoffs highlighted by the IMF's Integrated Policy Framework (IPF),[2] particularly in its emphasis on the interaction between fiscal and monetary policies. For the CBJ, highlighting this policy interaction has been crucial in developing a manageable policy framework to address the complex shocks faced by the Jordanian economy.

The remaining sections of the paper are organized as follows. Section II describes the stylized facts of the Jordanian economy, motivating the structure of JAM2.0 as set out in Section III. Section IV presents a comprehensive array of model results, including impulse response functions, transmission mechanisms, historical simulations, and out-of-sample forecasting performance. Section V provides concluding remarks.

Publication of this version of the JAM follows on from the completion of the IMF Technical Assistance (TA) on the modernization of CBJ's semi-structural model and FPAS in September 2022.[3] This version represents the state of thinking at the time of completion, but the model is expected to evolve as new empirical evidence emerges and new economic theories are developed. Tracking the model's performance and addressing feedback from Jordanian policymakers are essential for ensuring it remains a reliable analytical tool for policymaking in the future.

II. Jordanian Economy and Macroeconomic Policy: Stylized Facts and Model Motivation

To ensure its applicability in macroeconomic policy analysis and monetary policy making, the JAM2.0 incorporates the key stylized facts of the Jordanian economy and closely aligns with CBJ's policy framework. Recognizing the policy relevance of integrating country-specific features into the analytical framework, this section presents the stylized facts of Jordan that have motivated specific deviations from a standard QPM. These departures enhance the model's structure and properties and are detailed in Sections III and IV of the paper.

II.1 GDP and Production

QPMs typically have a limitation of being highly aggregated, primarily focusing on total GDP. In response to this limitation, JAM2.0 has introduced an operational level of decomposition, allowing for a more detailed analysis of specific variables. This decomposition can be complemented by other models to provide insights into the behavior of variables at a more disaggregated level. Experts responsible for analyzing specific sectors are best positioned to develop further disaggregated tools and models as needed, in support of CBJ's Economic Modeling Division (EMD) as the core group for monetary policy analysis and projections.

[2] See Adrian et al. (2021) and Basu et al. (2020).
[3] See Mæhle et al. (2021) for a detailed account of the practical aspects of FPAS implementation in the context of the IMF's Technical Assistance (TA) provided to central banks. It highlights the role of canonical QPMs as the cornerstone of a modern forward-looking forecasting and policy analysis framework.

The Jordanian economy experienced growth of 2.2 percent in 2021,[4] driven by a robust recovery in the manufacturing sector and the finance, insurance, and business services sectors. The estimated output gap for 2021 stood at -1.7 percent, expected to close in the second half of 2022. This positive development is attributed to the strong performance of all economic sectors, supported by the recovery of the external sector, including travel receipts, exports, and remittances. These factors were further boosted by the acceleration of the national vaccination campaign against COVID-19, leading to the full reopening of the economy by September 2021. In 2022, real GDP growth was projected to reach 2.7 percent,[5] despite the impact of Omicron-related restrictions in the first quarter of 2022. The nascent recovery is underpinned by accommodative monetary conditions, the rise in export commodity prices (particularly phosphate prices), and the revival of tourism. However, the economy has faced challenges beyond 2022 due to a surge in energy and food prices, as well as global tightening of macroeconomic policies, expected to exert downward pressure on real growth.

II.2 Core, Non-Core Prices, and Trends in Relative Prices

Under JAM2.0, the inflation subcomponents are decomposed to establish a connection with the determinants of real marginal costs,[6] which aim to capture significant cost pressures. In this framework, the headline Consumer Price Index (CPI) is specified as a weighted average of the two main components: core CPI and non-core CPI. Core CPI represents 55 percent of the total weight, and non-core CPI the remaining 45 percent:

- *Core CPI* is split into *core services* (82 percent) and *core goods* (18 percent). Typically, core subcomponents are largely determined by output gap, inflation expectations, real wage pressures, real exchange rate gap, and imported inflation. The core inflation measure used by the CBJ is published by the Department of Statistics (DOS) and is compiled using items with low variability in price changes – this includes mainly housing, health, communication, and transportation.

- *Non-core inflation components* include highly volatile items, mainly energy and food items. *CPI* food inflation has a relatively large weight of 26.5 percent in the overall CPI basket, and fuel prices account for 4.7 percent of CPI.

Figure II.1: **Inflation**, yoy in %

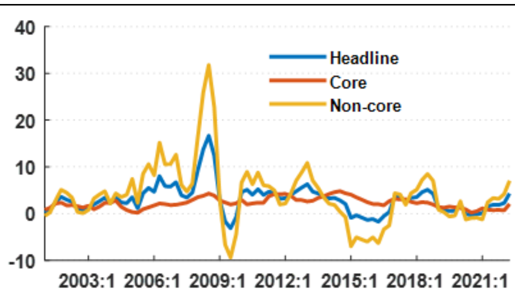
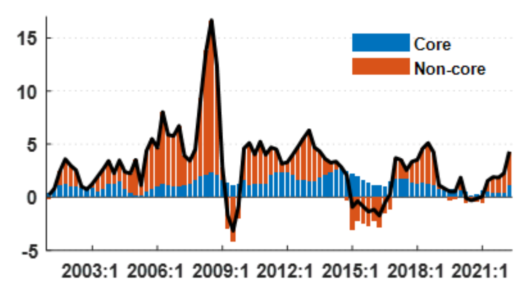


Figure II.2: **Headline inflation and contributions of subcomponents**, yoy in % and contributions in pp

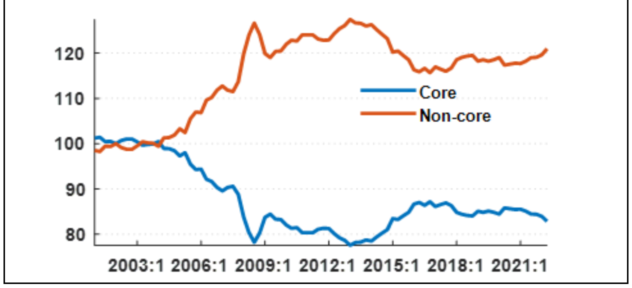


[4] The model uses seasonally-adjusted data. As a result, there may be differences comparing model outputs and the published data.

[5] Projections as of December 2022.

[6] Real marginal costs are essentially the increase in production costs (in real terms) that are related to a marginal increase in output at the firm level. This decomposition allows for a comprehensive analysis of inflation by considering both core components (which tend to exhibit greater persistence), and non-core components (which may be more volatile).

Figure II.3: **Relative price of core and non-core to headline**, 2002Q1=100



During the period from 2005 to 2013, *trends in relative prices* indicated a decline in core item prices compared to headline CPI. Consequently, core inflation was noticeably lower during this period and beyond. In contrast, non-core inflation experienced faster growth than core inflation, leading to non-stationary relative prices. Although relative prices have stabilized since 2015, it is important to note that periods of relative price changes can be relatively prolonged, as shown in Figure II.3. Ignoring such trends in relative prices would introduce biases in predicting the dynamics of inflation subcomponents. By incorporating relative prices into the model, it becomes possible to capture the interaction and pass-through of price increases among subcomponents. These dynamics typically operate through labor market and wage dynamics in Dynamic Stochastic General Equilibrium (DSGE) models.

Following its containment in 2021, headline inflation experienced a moderate rise up until March 2022, after which it sharply increased, reaching 5.4 percent (year-on-year) in August 2022. Several factors have played a role in this upward trend. Firstly, surging food prices, partially driven by input supply bottlenecks, have been compounded by the ongoing Russia-Ukraine war.[7] Secondly, there have been upward adjustments in domestic petroleum prices, resulting in second-round effects that included higher-than-expected wage and transport fare increases. Despite efforts to mitigate the pass-through effect through long-term stable-price import contracts for natural gas used in electricity generation and the phased-out blanket fuel subsidies, these factors have still had an impact on inflation. Additionally, there has been an increase in non-commodity import prices. Although these inflationary factors have only been partly offset by the disinflationary effect resulting from low domestic demand (reflected in a negative output gap) and the phased-out fiscal measures, challenges to price stability have emerged. This is evident in the abrupt pick-up in headline inflation and the increase in core inflation to 5.4 percent and 4.3 percent (year-on-year) respectively in August 2022. Managing these challenges has become a priority to maintain price stability in the economy.

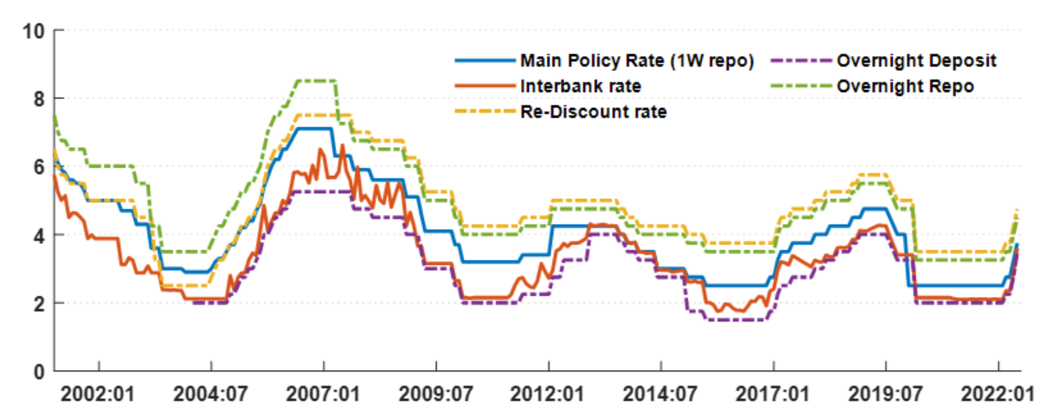
II.3 Monetary Policy: Policy and Market Rates, Monetary Conditions, Banking and Credit

The CBJ is committed to maintaining monetary and financial stability, with a primary objective of ensuring price and monetary stability. This is achieved by protecting the stability of the pegged exchange rate (the fixed Jordanian dinar to the U.S. dollar) and facilitating full capital mobility[8]. In line with its mandate, the CBJ maintains short-term interest rates that are consistent with the pegged exchange rate. Operationally, the CBJ relies on overnight interbank rates and a corridor system. The corridor consists of two key rates: the overnight deposit interest rate (window rate), which serves as the floor, and the overnight repurchase agreement interest rate (repo rate), which acts as the ceiling. To manage liquidity, the CBJ sets its "CBJ main rate" at 25 basis points (bps) above the window rate. Currently, due to the excess liquidity in banks primarily being deposited in the CBJ's overnight deposit facility, interbank short rates have remained close to the overnight deposit rate (as

[7] While Jordan's strategic wheat reserves (with stocks equivalent to 12 months of national consumption) have shielded the Jordanian authorities from having to import wheat at elevated global prices, such insurance against abrupt price surges may be eroded under a prolonged crisis scenario.
[8] The Jordanian dinar has been the national currency of Jordan since 1950, and the dinar is pegged to the U.S. dollar at a rate of 0.709 per dollar since 1995.

shown in Figure II.4). Consequently, the overnight deposit rate is considered the effective CBJ policy rate, guiding the interbank rate. This effective interbank rate is utilized as the reference rate in JAM 2.0 for modeling purposes.

Figure II.4: Main Rates under CBJ Interest Rates Corridor System (in percent)



The assessment of the stance of "real monetary conditions" in Jordan is based on the dynamics of two key indicators: the real interest rate (RIR) and the real exchange rate (RER). The RIR, which represents the difference between the nominal interest rate and the inflation rate, has generally remained around 1 percent and has mostly been in positive territory (as shown in Figure II.5). Although nominal interest rates have been rising since early 2022, however, in 2022, the RIR turned negative, indicating an accommodative monetary policy stance. This shift can be attributed to the surge in inflation during that period. The RER, on the other hand, has experienced a depreciation trend since 2019 (as depicted in Figure II.6). This depreciation has been driven by imported inflation resulting from relatively higher increases in foreign prices. The depreciation of the RER has contributed to an expansionary monetary policy stance, particularly in the first half of 2022. Taken together, the negative RIR and the RER depreciation have indicated an expansionary monetary policy stance in Jordan. These developments have been influenced by factors such as the surge in inflation and the impact of imported inflation on the exchange rate.

Figure II.5: Real interest rate, % p.a.
Note: Interbank rate and core inflation are used

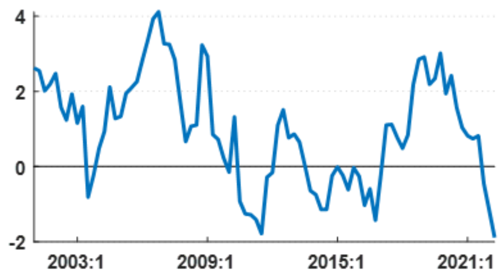
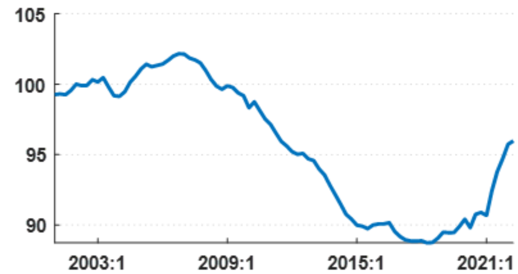


Figure II.6: Real exchange rate (bilateral with respect to the U.S.), index 2002Q1=100

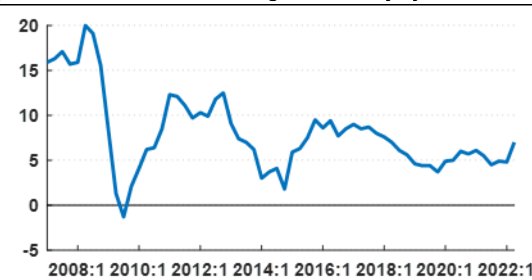


The exchange rate is defined as units of domestic currency per one unit of foreign currency (U.S. dollar). Hence an increase in real exchange rate is defined as real depreciation of domestic currency.

The banking sector in Jordan demonstrates strong fundamentals and a high level of resilience to shocks, supported by adequate capital and liquidity levels. The capital adequacy ratio, which measures the banks' capital in relation to its risk-weighted assets, has consistently ranged between 17 and 21 percent from 2007 to 2020. This level is well above the minimum requirements set by the CBJ and the Basel Committee.

During the COVID-19 period, measures were taken to support the economy, including postponing the distribution of dividends to bolster the banks' capital base. Dividend distribution was resumed in 2020, following established regulations governing capital and liquidity ratios. Additionally, the CBJ implemented proactive measures to increase liquidity ratios, such as reducing the required reserve ratio and conducting repurchase agreements. These actions aimed to ease financing constraints in key sectors and support businesses affected by the pandemic. Credit facilities also increased in 2020, with postponed loan installments for affected clients and supportive lending schemes for impacted SMEs and key sectors.

Figure II.7: Nominal credit growth, % yoy



The total credit to GDP ratio stood at 92.6 percent of GDP at the end of 2020 and increased slightly to 93.7 percent of GDP in 2021. This indicates a healthy level of credit provision in the economy (Figure II.7). Moreover, the financial stability index, which measures the stability of the financial system, showed improvement, reaching 0.44 in 2020 and 0.47 in 2021. These figures indicate that the financial system in Jordan remains sufficiently stable and has shown resilience despite the unprecedented challenges posed by the pandemic and subsequent crises. Overall, Jordan's banking sector is characterized by soundness, stability, and high resilience. It demonstrates strong capitalization, adequate liquidity, and effective measures implemented by the CBJ to support the economy during challenging times.

II.4 Fiscal Balances and Public Debt

Since 2008, Jordan's public debt-to-GDP ratio has been on the rise and surpassed 100 percent by 2020. This elevated level of public debt has persisted into 2022, including the debt held by the Social Security Investment Fund. Approximately half of the public debt is denominated in foreign currency, and this composition of foreign versus local currency debt has implications for debt dynamics. The model takes into account these implications when analyzing Jordan's fiscal situation.

In response to the COVID-19 pandemic, fiscal policy in Jordan adopted a countercyclical stance to mitigate the sharp decline in economic activity, albeit leading to a significant increase in debt. The fiscal deficit, also known as the general government overall deficit, is currently around 5 percent of GDP, including grants. It is worth noting that interest payments on debt have been growing at a relatively faster pace compared to primary deficits. This trend is reflected in the model and underscores the importance of debt sustainability considerations. Given the elevated level of public debt, the authorities are carefully examining the details of a fiscal consolidation strategy to preserve debt sustainability. This strategy aims to address the fiscal imbalances and ensure the long-term sustainability of public finances. By implementing prudent fiscal measures, Jordan aims to reduce the fiscal deficit, manage interest payments, and gradually bring down the public debt-to-GDP ratio over time.

Figure II.8: Debt-to-GDP ratio (in percent) (government and guaranteed debt).

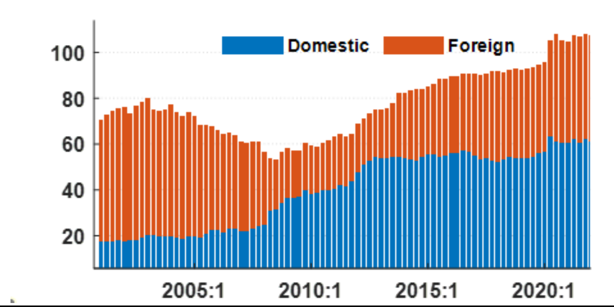


Figure II.9: Government debt including Social Security Investment Fund, % of nominal GDP

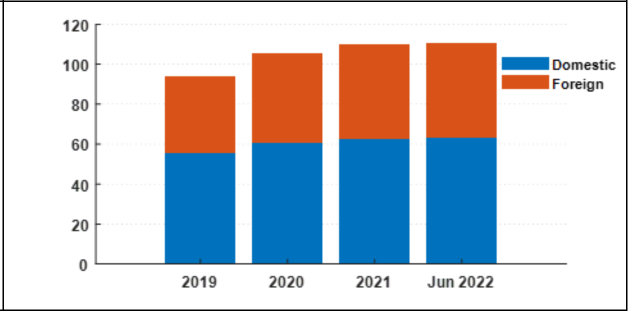


Figure II.10: Government debt excluding Social Security Investment Fund, % of nominal GDP

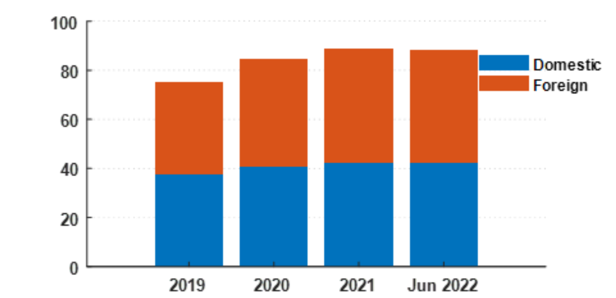


Figure II.11: Overall fiscal deficit-to-GDP ratio, decomposed into primary deficits and (domestic and foreign) interest payments (in percent)

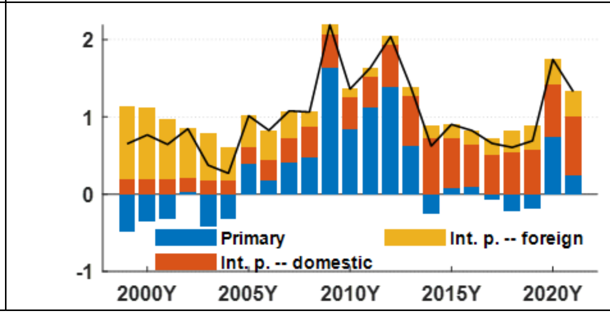


Figure II.12: Budget deficits, % of nominal GDP

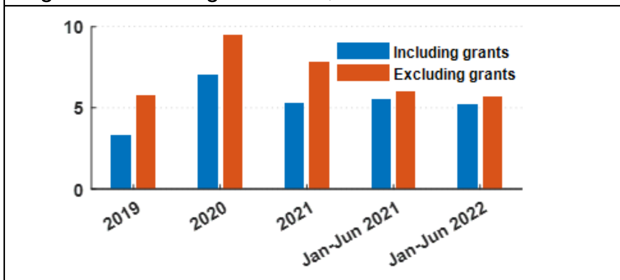
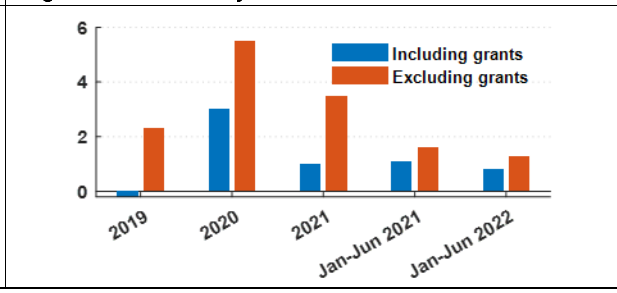


Figure II.13: Primary deficits, % of nominal GDP



In response to the surge in world fuel and food prices, fiscal policy in Jordan has been proactive in limiting the pass-through of these global price increases to domestic prices. As an oil importer, Jordan has been particularly affected by the rise in prices of oil derivatives, which have increased by an average of 16.3 percent since the beginning of the Russia-Ukraine war up to September 2022. To mitigate the impact of these price increases on domestic consumers, the authorities initially re-introduced blanket fuel subsidies in February 2022. However, recognizing the fiscal implications of such subsidies, they were subsequently phased out and replaced by direct payment schemes targeting specific individuals and sectors. These targeted fuel subsidy programs were implemented from July to the end of 2022.

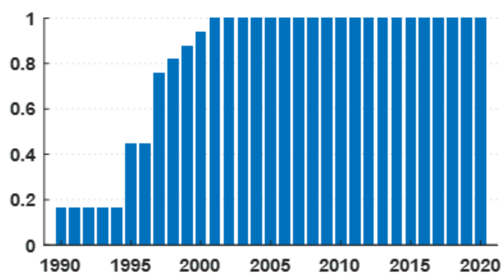
The analysis conducted by the DOS indicates that there is a pass-through of world oil prices to energy-related items in the consumer basket, typically with one month lag. This means that changes in global oil prices can influence the prices of energy-related goods and services in Jordan. However, the government's efforts to implement subsidy schemes and limit the pass-through have played a role in mitigating the impact of these global price increases on domestic prices. By actively managing fuel subsidies and implementing targeted payment schemes, the fiscal policy in Jordan has aimed at protecting consumers from excessive price increases and ensuring the stability of domestic prices, particularly in energy-related sectors. These measures contribute to maintaining macroeconomic stability and mitigating the inflationary pressures associated with global price shocks.

II.5 Pegged Exchange Rate Regime and FX Reserve Management

The exchange rate regime in Jordan is classified as a de-facto peg arrangement since October 1995. To maintain the peg to the U.S. dollar, the CBJ intervenes on the FX market as needed. The capital and financial accounts are open as indicated by a Chinn-Ito index close to one (Figure II.14).

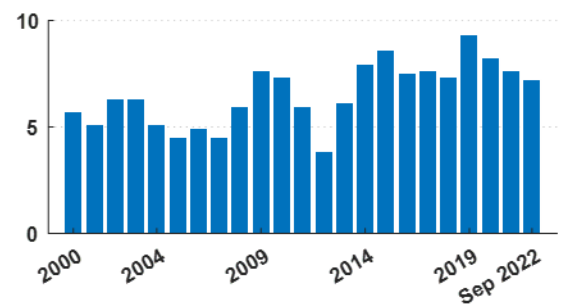
Gross foreign reserves (excluding banks deposits in FX at CBJ) stood at US$18 billion (39.9 percent of GDP) at end-2021, and US$16.7 billion (37.0 percent of GDP) in September 2022, above the end-2020 level (US$ 15.9 billion). Reserves are assessed to be adequate based on their coverage of about 7.2 months of imports of goods and services, at end-2021, and around 7.1 months as of September 2022 (Figure II.15) and based on international reserves exceeding 100 percent of the IMF's reserve adequacy metric during 2021 (IMF Country Report (2022), Annex II: External Sector Assessment – FX Intervention and Reserves Level).

Figure II.14: Chinn-Ito index of capital controls (0=full control, 1=no constraints)



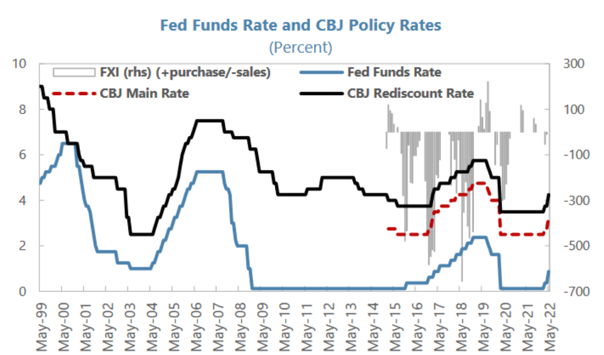
Chinn-Ito index measures a country's degree of capital account openness. It is based on the binary dummy variables that codify tabulation of restrictions on cross-border financial transactions.

Figure II.15: FX reserves in months of imports



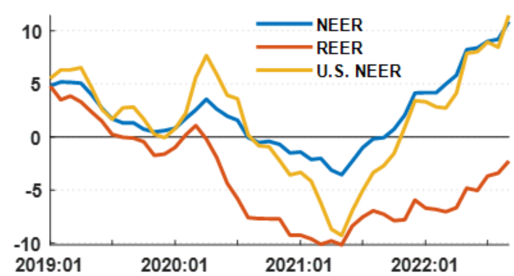
Under a pegged exchange rate regime and a fully open capital account, the CBJ policy rate has typically moved closely with the Federal Reserve Fund rate (Fed rate), adjusted by the country risk premium (Figure II.16).[10]

Figure II.16: Fed Funds rate and the CBJ rate



Source : IMF Article IV, https://www.imf.org/-/media/Files/Publications/CR/2022/English/1JOREA2022003.ashx

Figure II.17: Effective exchange rates, % yoy 3-month moving average



[10] The CBJ raised its policy rates, maintaining a margin of 200 basis points (bps) above the Fed rate, with due consideration to maintaining the attractiveness of Jordanian dinar (JD) deposits. In smoothing the increase in lending rates under a nascent recovery, the CBJ maintained a small and medium-sized enterprise (SME) lending scheme (a COVID-19 measure) through December 2022 at low interest rates (2 percent) in support of productive sectors – a policy that the CBJ terminated in April 2023. Moreover, the CBJ kept the other subsidized lending scheme which has aimed to support ten vital economic sectors, with a ceiling of JD 1.4 billion.

The real effective exchange rate (REER) is fairly valued in the long run.[11] In the short run, it appreciated by 15 percent from 2012-2019 reflecting a global strength of the dollar (to which the Jordanian dinar is pegged) but depreciated significantly since the beginning of the pandemic as driven by weak inflation in Jordan relative to trading partners and the weaker dollar (Figure II.17). Foreign variables enter JAM 2.0 in effective terms with trade weights used in constructing the effective measures, which apply to the real exchange rate, foreign demand, and inflation.

II.6 External Sector

Jordan's economy relies significantly on international trade and tourism, which play a crucial role in driving economic growth. The share of exports to nominal GDP is close to 40 percent, indicating the importance of export-oriented industries in the country. Similarly, the share of imports to nominal GDP is around 60 percent, highlighting the reliance on imported goods and services. Jordan's main trading partners include the United States, countries in the Euro Area, emerging and developing Asian countries (such as India and China), and Middle Eastern countries, particularly those in the Gulf Cooperation Council (GCC) and Iraq (Figure II.21).

In terms of exports, Jordan's main commodity exports include clothes (light industries, apparel, and textile industry), phosphate products, potash, fertilizers, and medical products. The apparel and textile industry has particularly benefited from the free trade agreement with the United States since 2010. On the import side, the main items include machinery and transport equipment, fuel, food, and manufactured goods. These imports are essential for various sectors of the economy, including manufacturing, transportation, and agriculture (Figures II.18 - II.19). Understanding the composition of trade and the main trading partners is important for assessing the vulnerabilities and opportunities in Jordan's economy. It allows policymakers to identify areas for potential growth, monitor trade balances, and make informed decisions regarding trade policies and economic strategies.

Figure II.18: Export structure, % of total exports

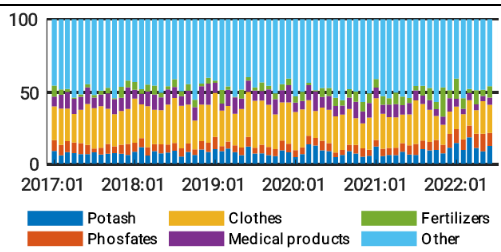
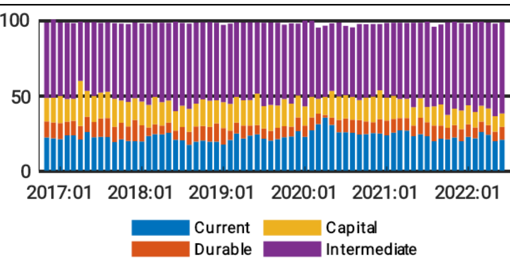


Figure II.19: Import structure, % of total imports



[11] In reference to the IMF External Sector Report (2022), Annex II External Sector Assessment, both the EBA-lite Current Account model and the External Sustainability model suggest no gaps in the REER.

Figure II.20: Jordan current account, % of GDP

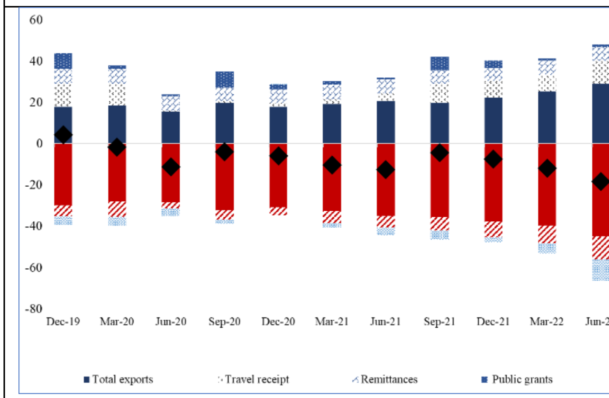


Figure II.21: Exports to selected countries, % of total

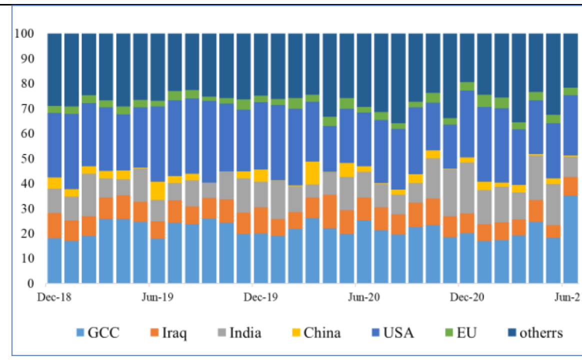
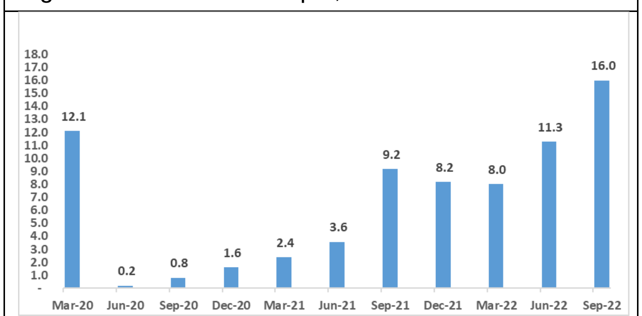


Figure II.22: Tourist receipts, % of GDP



Travel receipts and remittances play significant roles in Jordan's income flows. Travel receipts accounted for an average of 7.4 percent of GDP during the period of 2019-2021. The recovery of tourist arrivals began in the second half of 2021 and has been progressing towards pre-pandemic levels (Figure II.22). The pace of recovery has been faster than expected, with travel receipts in 2022 growing by 110.5 percent compared to 2021. This represents 100.4 percent of the level recorded in 2019, indicating a rebound in the tourism sector. The increase in the number of tourists, including non-resident Jordanians and tourists from Arab countries, has contributed to this growth. On the other hand, workers' remittances have shown relatively weaker growth. In 2021, workers' remittances grew by 1.0 percent, and in 2022, increased by 1.5 percent. The reasons for this relatively weaker growth in remittances vary, including factors such as economic conditions in the countries where Jordanian workers are employed and the impact of the pandemic on employment and income levels abroad. Monitoring and understanding the trends in travel receipts and remittances is crucial for assessing the resilience of the tourism sector and the financial well-being of households relying on remittances.

The *current account* deficit was expected to reach 8.5 percent of GDP in 2022, as the pickup in imports with higher economic activity and higher energy and food prices are likely to be stronger than in exports, remittances, and tourism receipts. Regarding the *financial account*, foreign direct investment (FDI), on a net basis, fell by over 17 percent in 2021 to 1.3 percent of GDP, down from 1.7 percent of GDP in 2020. The portfolio recorded an out-flow in 2021, compared to an inflow in 2020, as Eurobonds of USD 1.25 billion matured and USD 1.75 billion were issued in 2020. Furthermore, tightening global financial conditions and rising borrowing costs have brought new concerns. As a result, the reliance on government flows to support external stability has increased, in particular, government net official loans have risen by nearly 26 percent (from USD 0.967 billion in 2020 to USD 1.22 billion in 2021). This was further supported by IMF-EFF disbursements of around of about USD 542 million and SDR augmentation of USD 469 million during 2021. In addition, there was a considerable reduction in banks' net foreign assets, driven by an increase in non-resident deposits of roughly USD 1.2 billion during 2021. These increased flows helped cover the current account deficit (CAD) in 2021 and attenuate pressures on foreign reserves. These flows helped the authorities meet the EFF program's net international reserves (NIR) targets by comfortable margins.

External Assumptions. In JAM 2.0, the diversification of export destinations and import origins is captured by considering foreign variables in effective terms. These effective measures are constructed as weighted averages of indicators from various countries, including the United States, the eurozone, China, Japan, Brazil, India, Russia, the United Kingdom, and South Africa. These countries represent the bulk of international trade in goods and services for Jordan, accounting for more than 60 percent of trade in recent years. JAM 2.0 approximates the behavior of external variables using simple autoregressive (AR) processes. This means that there is no interaction among the external variables themselves within the model. Instead, the emphasis is placed on the transmission of external variables to the domestic variables, which is crucial for conducting forecasting exercises and analyzing the impact of external factors on the Jordanian economy.

The transmission of foreign demand to domestic variables is captured through the channel of exports of goods and services. Changes in foreign interest rates, on the other hand, are transmitted to domestic variables through an uncovered interest parity (UIP) condition, which relates interest rate differentials to exchange rate movements. The external outlook for foreign variables, including estimations of gaps and trends, is derived from projections developed by a third-party provider. This external input helps incorporate the effects of global economic conditions and trends into the model's analysis and forecasting exercises.

II.7 Data limitations

In the JAM2.0 model, while only nominal and real GDP data are available for the Jordanian economy, export and import data are also available in nominal terms from the balance of payments (BoP). However, corresponding deflators for these trade flows are not directly available. To overcome this limitation, the model approximates the deflators based on the commodity structure of imports and exports (see Section III). In contrast, other BoP components, and fiscal statistics are available at a sufficient level of detail for the purpose of model development.

II.8 Trends and Gaps — An Overview

JAM 2.0 is classified as a "gap model". It decomposes all real variables into a trend component and a gap component, representing the deviation of the variable from its long-run trend. The model assumes that these gaps eventually converge to zero as the effects of business cycle shocks dissipate. This convergence process typically takes place over a period of 3-6 years. In addition to the convergence of gaps to their respective trend paths, the model also considers the convergence of time-varying trends to a "balanced-growth" steady state value. This steady state value represents the long-term equilibrium level of the variable in the absence of any permanent shocks. The convergence of trends to the steady state occurs over a longer time horizon, typically within 10-15 years. The interaction between gaps, trends, and the steady state is crucial in JAM 2.0, as it allows the model to both empirically fit the data and maintain theoretical consistency. By accounting for these dynamics, the model captures the cyclical fluctuations in the economy while considering the long-term growth patterns and equilibrium values of the variables.[12]

For an overview of economic developments during the recent period, including the COVID-19 pandemic, see Jordan IMF Article IV Staff Reports (2021 and 2022). Overall, key economic considerations and transmission mechanisms described above are incorporated in the model structure below, making the model a relevant tool for real-time policy analysis and forecasting.

[12] For more details, see Box 1, Berg et al. (2023).

III. Jordan Analysis Model — Structure

The CBJ has aligned its operational framework with the forward-looking model-based analysis provided by JAM 2.0. The FPAS framework is designed to incorporate desirable features that reflect technical advancements and the preferences of policymakers. The development of the FPAS framework and models will continue to evolve over time, incorporating new empirical findings that govern the dynamics and fundamental properties of the Jordanian economy. This includes expanding the portfolio of short- to medium-term forecasting techniques and models such as nowcasting, near-term forecasting (NTF),[13] and core medium-term forecasting. These techniques aim to provide more accurate and timely forecasts of key economic variables. In addition, efforts will be made to enhance the transmission mechanism from the policy rate to the overnight interbank rate and banks' rates. This improvement will help in better capturing and communicating the stance of monetary policy, strengthening the coherency and reliability of the CBJ's forecasts. Overall, the CBJ is committed to continuously improving its forecasting and policy analysis framework to ensure it remains effective, up-to-date, and aligned with the evolving dynamics of the Jordanian economy.

In the semi-structural framework of the QPM, each behavioral equation has an economic interpretation, although the coefficients are reduced form rather than deep parameters as in DSGE models. The QPM incorporates the New Keynesian (NK) modeling approach, which includes features such as monopolistic competition, nominal and real rigidities, and a non-neutral role for monetary policy in the short run. This makes the QPM a suitable analytical toolkit for central banks (Ireland (2004)). In the JAM2.0 extended QPM, the focus is on "gaps" or "cyclical fluctuations" rather than "trends". Trends are typically modeled as non-structural equations using simple AR processes. Steady-state variables enter the model as fixed parameter values, representing the long-run properties of the economy. When temporary shocks or underlying economic fundamentals push current or expected variables away from their equilibrium levels or target values (or from an implicit target in the case of the inflation variable), policies are triggered to return variables to their equilibrium (or steer inflation back around its implicit target).[14] More rigorously, "gaps" drive policymaking decisions.

In designing JAM 2.0, the focus is on addressing a broader range of macroeconomic policy issues that are typically relevant in Jordan and other emerging market and developing economies (EMDEs). The model emphasizes the interaction of three key elements:

- *Internal balance.* In JAM 2.0, internal balance is captured through a set of equations that focus on the main components of aggregate demand and the Phillips curves. These equations determine the levels of output and inflation by considering the interaction between demand and supply factors. The disaggregated investment-savings (IS) curve is used to model the relationship between aggregate demand and its components. It explicitly incorporates domestic demand components such as consumption, investment, and government absorption, as well as net exports (exports minus imports). This allows for a comprehensive analysis of the factors driving aggregate demand and their impact on output. Moreover, the Phillips curves in JAM 2.0 are a key element in understanding inflation dynamics. The model includes a set

[13] The NTF models comprise a set of technical tools and analyses which are related to the medium-term forecasting model. Many of these NTF tools are well documented in the form of previous CBJ working papers or presentations. These tools include a Factor Augmented VAR (FAVAR) model used to forecast real GDP growth, an ARIMAX model used to calculate sectoral GDP deflators, and Autoregressive Moving Average (ARMA) models to forecast exports and imports.

[14] In reacting to shocks, the CBJ has discretion regarding the appropriate time and speed at which variables return to equilibrium. In its policy implementation under a forward-looking framework, the CBJ considers the impact on output, interest rate, exchange rate, as well as financial stability in setting the pace of adjustment. This entails anticipating events that are likely to happen, which may threaten price stability over the forecast horizon.

of Phillips curves that decompose inflation into core and non-core components. These Phillips curves capture the relationship between inflation and the output gap, real marginal costs, and other relevant variables specific to the inflation equations. By incorporating these factors, the model can analyze how changes in output and other determinants affect price dynamics. By considering the breakdown of aggregate demand and incorporating decomposed Phillips curves, JAM 2.0 provides a framework to examine the internal balance of the economy. It allows policymakers to assess the interactions between different components of aggregate demand and their effects on output and inflation. This enables a more detailed analysis of the factors influencing internal stability.[15]

- *External balance.* In JAM 2.0, external balance is addressed by considering private (portfolio) financial flows and their interaction with exchange rate-adjusted interest-rate differentials. These financial flows play a crucial role in closing the BoP identity. The model explicitly incorporates the BoP framework, allowing for consistent forecasts of its underlying components, such as exports, imports, and various financial flows. By explicitly modeling the BoP, JAM2.0 enables policymakers to analyze the dynamics of external balances and their implications for the economy. The model takes into account the role of cross-border capital mobility, which is important for understanding the behavior of financial flows and their impact on the BoP. Moreover, JAM2.0 allows for the modeling of policies that directly affect the BoP. For example, it can analyze the effects of FXI and potential Capital Flow Management measures (CFMs) on the BoP and overall external balance. This provides policymakers with insights into the potential effectiveness and consequences of different policy actions aimed at managing external imbalances.[16]

- *Policies*, where *monetary* (interest rates, FXI, possible CFMs either used to help macroeconomic management or achieve financial stability goals)[17] and *fiscal* (government absorption – consumption and investment, taxes) policies respond to inflation, output gap, the exchange rate, debt levels and other objectives. *Macroprudential* (see Karam et al. 2021,) and *labor market* (see Botha et al., 2017) policies among others are either left for future extensions of the semi-structural model or deemed more suitable to be addressed under a broader DSGE structure.

The schematic representation of the model (Figure III.1) incorporates these elements. At the core of the diagram is the mechanism through which monetary policy transmits to the real economy, and ultimately inflation. The model decomposes the GDP into domestic demand and net exports where domestic demand is affected by the real interest rate, and net exports are a function of foreign demand and competitiveness. Inflation is built from domestic demand pressures and imported inflation. Considering that the CBJ operates under a pegged exchange rate regime with open financial account, the domestic interest rate follows the (U.S.) foreign interest rate, and the CBJ manages the country risk premium to maintain the peg while also intervening in the FX market as needed. Fiscal policy stabilizes the macroeconomy and anchors public debt around the medium-term debt target. An important novelty of JAM2.0 is the BoP block that describes the country's net foreign assets position and implications for the country risk premium. For the sake of exposition, descriptions of

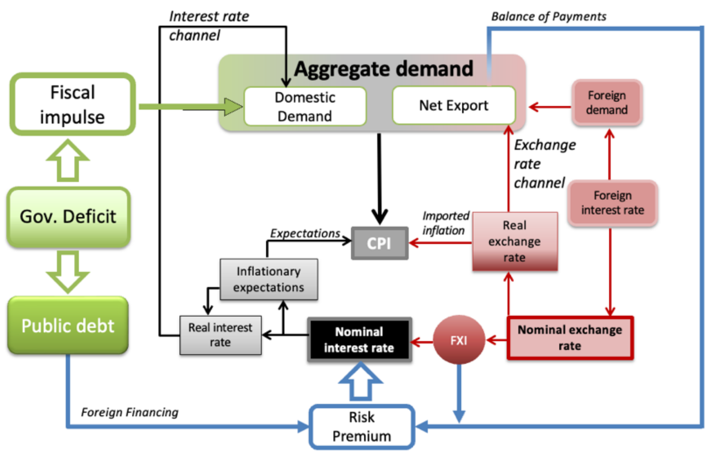
[15] Wages have also featured under expanded "prices and wages" sections of QPMs when discussing Phillips curves.

[16] To put things in context, faster and larger than expected Fed rate hikes could weaken global growth and tighten global financial conditions, with knock-on effect on Jordan's risk premia and capital inflows. JAM2.0 has the capabilities to provide a quantitative assessment of these premia and how they evolve endogenously in the face of foreign risk appetite, changes in global risk aversion, or changes in advanced economy monetary policy, placing it at the frontier of central bank analysis. JAM2.0 may also incorporate domestic policies that can potentially affect the country risk premium through fiscal as well as FX reserve management (as discussed later).

[17] Measures that are both capital flow measures (CFMs) and macroprudential measures (MPMs) can be designed to limit capital flows to reduce systemic financial risks that might emanate from such flows.

more detailed channels in JAM2.0 have been omitted (e.g., the changes in CPI decomposition in core and non-core inflation, and the link between nominal interest rate and the fiscal block (interest payments, overall balance and public debt)).

Figure III.1: A Schematic Diagram of JAM2.0—Key Relationships and Channels



Essentially, there are five gaps that matter for policy analysis and forecasting in the QPM: (1) the output gap; (2) the real exchange rate (RER) gap, in relation to an underlying equilibrium; (3) the deviation of the real interest rate (RIR) from its neutral level; (4) a fiscal impulse; and (5) net private financial flows. These gaps (or disequilibria) are illustrated in Figures III.2-7 and described in more detail as follows:

- The *output gap* reflects the deviation of the level of real GDP from its potential level. A gap that equals zero means that the current level of GDP is at potential or its underlying equilibrium level—there is no excess or insufficient demand pressures for inflation to increase or decrease. At an aggregated level, the key factors in a typical QPM that influence the output gap are the lagged value for the output gap, the real monetary conditions index (expressed as the weighted average of the real interest rate (RIR) gap and the real exchange rate (RER) gap), foreign demand (expressed as the output gap in the rest of the world), commodity terms of trade (TOT)[18], and fiscal stimulus, among other determinants.

- The *RIR gap* reflects the deviation of the real (short-term) interest rate from its natural level (equilibrium). Based on observed data, the model identifies the gap (based on filtration techniques), with the natural rate of the interest then computed as the difference between the RIR level and gap. Monetary policy is assessed to be expansionary (contractionary) when the short term RIR lies below (above) its equilibrium (natural) rate.

- The *RER gap* reflects the deviation of the RER from its equilibrium level. A closed gap (i.e., a RER that is in line with its equilibrium level) is consistent with output at potential, and inflation at its target. Based on the adopted RER definition in JAM2.0 as the price of U.S. consumption basket in terms of the JD (an increase (decrease) denotes a depreciation (appreciation)), a positive RER gap reflects a domestic

[18] As a proxy for the terms of trade (TOT), defined as the price of phosphate minus the price of oil, in logs.

currency that has depreciated beyond its equilibrium level, in real terms. Monetary policy is assessed to be expansionary (contractionary) when the RER lies above (below) its equilibrium.

- The *fiscal impulse* is computed as the difference between the structural primary deficit and its target. The deficit target is derived from the debt target which can be interpreted as the sustainable level of public finance. A positive impulse generates fiscal stimulus, while fiscal consolidation affects domestic demand negatively.

- The *private sector foreign financing need* highlights the financial account, excluding the public financing need and central bank intervention / reserve policy. Private financial flows play a role in determining the endogenous country risk premium and directly affect the medium-term monetary conditions discussed in more detail in Section III.3.1.

What follows is an example of estimates of unobserved variables based on data to September 2022.

A negative output gap identified during the COVID-19 period is closing as real GDP has recovered from the pandemic shock. Improving terms of trade has boosted net exports, partly offset by a drag in domestic demand. As a result, the output gap in 2022Q3 is around -1 percent.

Figure III.2: Output gap, %

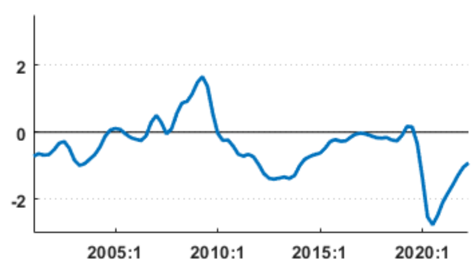
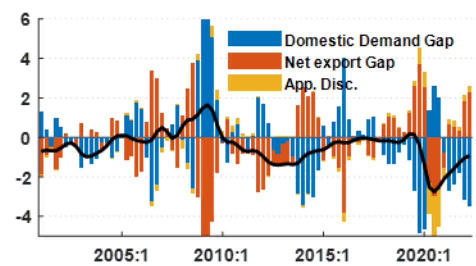


Figure III.3: Output gap decomposition, p.p.



Domestic demand's negative contribution and disinflationary effects are primarily due to the fiscal stimulus withdrawal. During the COVID-19 shock period, a countercyclical fiscal policy provided support for the real economy. Despite the global tightening cycle, monetary policy has remained expansionary because of a continued negative real interest rate.

Figure III.4: Output gap and fiscal impulse, %

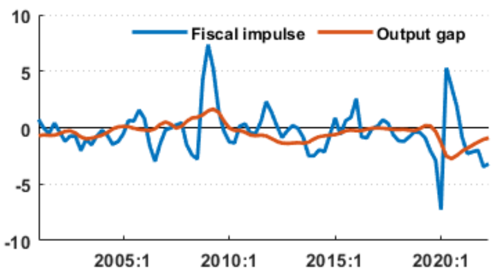
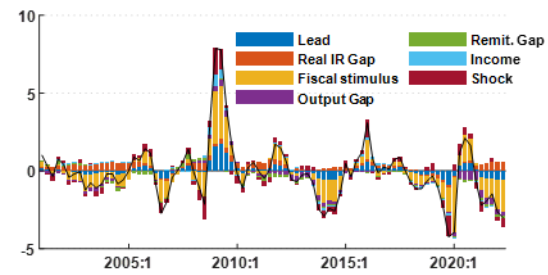


Figure III.5: Domestic demand gap decomposition, p.p.



Easy monetary conditions are driven by a negative RIR gap and a positive RER gap. Easing in terms of the RIR is accelerating in light of widening negative RIR gaps under rising expected inflation. Competitiveness, captured through the RER is improving, coinciding with rising foreign prices relative to domestic prices.

Figure III.6: Real interest rate gap, %

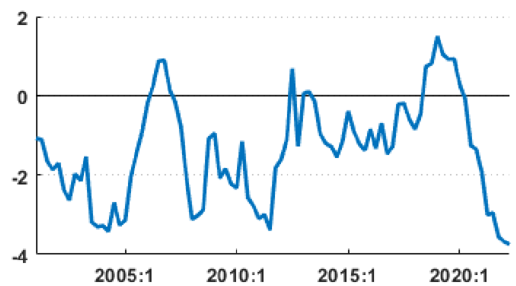
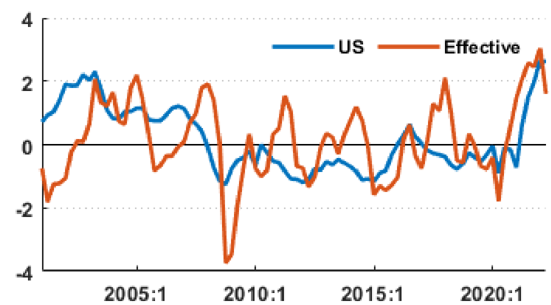


Figure III.7: Real exchange rate gaps, %



Notation. Before discussing the key equations of the model, we describe the notation adopted in the model. Any variable in *small letter*, x_t , denotes the natural logarithm of the variable, multiplied by 100 (log × 100). *Capital letters* refer to levels of the variables. A *hat* above the variable, $\hat{x}_t$, indicates that the variable is a gap, or deviation from equilibrium and a *line/bar* that appears above the variable, $\bar{x}_t$, is in reference to the variable's trend or equilibrium value. Foreign variables are denoted with an *asterisk*, x_t*. The *gap component* describes the business cycle dynamics of a variable and the *trend component* its secular dynamics. We interchangeably refer to the business cycle dynamics as "cyclical" (or "short-term"), and to the secular dynamics as "trend" (a "medium-term equilibrium" or a slowly-evolving medium-term concept that generally fluctuates around the steady state over time). The medium-term can be thought of as 3-6 years. It is hence important to distinguish between a variable's "equilibrium" level concept and that of a "steady state", where steady states are a set of fixed values that represent the fundamental long-run properties of an economy. To indicate the *steady state* of a variable, a superscript ss is used and the time subscript t is not shown (since steady states remain constant over time), that is x^{ss}. We denote a variable that represents a ratio of nominal variable X_t to nominal GDP (in percent, x 100) by adding "rat" in the superscript (X_t^{rat}), and the $\bar{X}_t^{rat}$ assigns the trend of a nominal variable to trend of nominal GDP. The *annualized quarter-on-quarter change* in a variable is denoted by Δx, and $\Delta^4 x$ denotes *year-on-year growth rates*. Finally, *stochastic shocks* are represented by ε^i, where i represents the left-hand-side variable in structural equations. For a complete list of the variables and their definitions, see Appendix 1.

We move next to describing the key dynamic equations in the model. The full set of model equations can be found in Appendix 2.

III.1 Internal Balance

The decomposition of aggregate demand in JAM2.0 allows for a more detailed analysis of the drivers of economic growth and the impact of various shocks on the economy. It allows for richer analysis of fiscal policies – for example, the magnitude of fiscal multipliers can be implicitly linked to the type of government expenditures. In principle, each component of the real GDP has an associated price level deflator and corresponding pricing mechanism which we approximate.

We now turn to describing the structure of the GDP components and prices. In JAM2.0, this structure is designed based on a combination of economic theory, specific characteristics of the Jordanian economy, and the availability of relevant data.

III.1.1 Real Aggregate Demand (Real Economy)

A domestic market clearing condition (1) states that gross domestic product (Y) equals domestic demand, DD, plus exports, X, minus imports, M.[19]

$$P_t^Y Y_t = P_t^{DD} DD_t + P_t^X X_t - P_t^M M_t \tag{1}$$

where P^Y, P^{DD}, P^X and P^M are corresponding deflators we approximate below. In gap terms, the aggregate real output gap, $\hat{y}$, is the weighted sum of the corresponding gaps in each expenditure component (denoted by $\widehat{dd}$, $\hat{x}$, $\hat{m}$) where the weights are determined by the long-run aggregate demand components as shares of nominal GDP (denoted by $\overline{dd}_t^{rat}$, $\bar{x}_t^{rat}$, $\bar{m}_t^{rat}$– see (11)). Similarly, potential real GDP growth (denoted by $\Delta\bar{y}_t$ – see (9)) is the weighted sum of growth rates in trends of the GDP (expenditure) components.

In what follows, we describe the determinants of each component, noting that the equations are reduced-form representations of equations from standard open-economy New Keynesian models.
Domestic demand gap can be interpreted as an optimizing agents' Euler equation in (open economy) DGSE models,[20] linking domestic demand to its determinants. Usually, demand is said to be captured through the IS curve:

$$\widehat{dd}_t = a_1\widehat{dd}_{t-1} + a_2 E_t\widehat{dd}_{t+1} - a_3\hat{r}_t + a_4\widehat{fis}_t + a_5\hat{y}_t + a_6\widehat{remit}_t^{rat} + a_7(\widehat{rpc}_t^{phos} - \widehat{rpc}_t^{oil}) + \varepsilon_t^{\widehat{dd}} \tag{2}$$

Specifically, the development of the dynamic domestic demand gap, $\widehat{dd}$, over the business cycle depends on its past (a backward-looking component to allow for some degree of habit persistence of private consumption) and one-period ahead expected future value (a forward-looking rational expectations component). It is affected by monetary policy whereby tighter real monetary/credit conditions in the economy, represented over the business cycle by a positive real interest rate gap $(\hat{r})$,[21] would tend to reduce the private demand gap in the

[19] To be precise, aggregate demand is decomposed into domestic demand and export demand. Output (in the identity) is then defined as the difference between aggregate demand and imports.

[20] Gali and Monacelli (2005), among others have provided detailed structural deviation of similar microfounded demand equations / IS curves.

[21] The interbank rate is the effective rate used to steer macroeconomic conditions. It can be linked to the policy rate via a premium, to capture any persistent deviations of the interbank rate from the CBJ main policy rate.

short run. This term captures the intertemporal substitution effects between today and future consumption, whereby an increase of the real interest rate raises the price of today relative to future consumption which reduces current consumption and raises savings and future consumption. Domestic demand is also driven by income from: (i) domestic sources, approximated by the output gap ($\hat{y}$);[22] (ii) external sources, namely cyclical remittance inflows ($\widehat{remit}$) and terms-of-trade effect ($\widehat{rpc}_t^{phos}$and $\widehat{rpc}_t^{oil}$)[23]; and (iii) fiscal expenditures (and/or taxes in models with more detail fiscal instruments, e.g., FINEX) where direct government transfers (above their trend value) affect household disposable income. This is approximated by a fiscal impulse $\widehat{(fis)}$ where a positive value represents an expansionary fiscal policy, under the fiscal authority's control (Section III.2).[24] Finally, the structural nature of the model allows interpreting $\varepsilon_t^{\widehat{dd}}$ as the domestic demand shock in (2).

Real export gap follows a standard demand function for real exports,[25] to complete the open economy part of the IS curve:

$$\hat{x}_t = a_8 \hat{x}_{t-1} + a_9 \widehat{reer}_t + a_{10} \hat{y}_t^w + \varepsilon_t^{\hat{x}} \quad (3)$$

The first term influencing the real export gap, $\hat{x}$, is its own lagged value, meant to capture persistency in the business cycle and potential real rigidities. The next two terms, characterizing the open economy nature of Jordan, show that the gap of foreign demand for Jordanian goods and services depend on foreign output gap, $\hat{y}^w$, and the real effective exchange rate gap, $\widehat{reer}$, defined as the relative price of domestic and foreign goods (comprised of a nominal effective exchange rate multiplied by a foreign to domestic price ratio, expressed in logarithms).[26] A real depreciation usually means that that the real effective exchange rate is undervalued which can stimulate demand for exports.[27]

Real import gap**,** $\hat{m}$, is driven by the domestic business cycle position (allowing for lag), with real expenditure gaps (domestic demand and exports) and relative price of imported goods and services as key determinants:

$$\hat{m}_t = a_{11} \hat{m}_{t-1} + (1 - a_{11}) \left(a_{12} \left(\widehat{dd}_t - a_{13} \widehat{reer}_t \right) + (1 - a_{12})(\hat{x}_t - a_{14} \widehat{reer}_t) \right) + \varepsilon_t^{\hat{m}} \quad (4)$$

Two terms capture the domestic demand and income effects. First, domestic demand and real export gaps affect the real import gap positively. The two gaps are both adjusted by $\widehat{reer}$ to account for their relative prices compared to the domestic price level. Real effective real exchange rate depreciation $(\widehat{reer} > 0)$ makes imports more costly compared to domestic production and hence reduce the demand for real imports. More specifically,

[22] The output gap captures income effects, particularly those derived from wages. Ideally, a real wage gap term could be added to capture pressures on demand originating from high consumption of current income, but this depends on the availability of labor market data, including other income (capital or transfers from government). In the absence of this data, GDP is the best proxy for wage and other income.

[23] The relative price of phosphate exports explains the link between the profitability of Jordanian exporters and households' income position, while the oil price expresses the potential negative demand effect of global energy price shocks.

[24] A breakdown of consumption between private and public consumption is not available.

[25] In principle, the model can separate natural resource (NR) from non-natural resource (NNR) exports with similar formulations in terms of dynamics, where the total exports gap is $x_t = x_t^{NR} + x_t^{NNR}$. However, calibration of the different exports from I/O tables adds a layer of complexity.

[26] A trade weighted average comprising both exports and imports is used here. An export-weighted $reer$ that is adjusted by the corresponding relative price gap – as in the form of $(reer_t^X - rp_t^{export})$ has been used in other country QPMs.

[27] Additionally, trading partners' output may affect remittances (see (2)), such that remittances depend on the business cycle abroad and influence domestic demand.

regarding the relative price of imports, if import price increases relative to the price of consumption or investment, the demand for imports falls.[28] [29]

Gaps and equilibriums (trends and steady state)

As discussed in Section I.H, each variable is decomposed into a gap and a trend. The trend of a variable in the model is non-structural and is assumed to follow a smooth (but time-varying) growth of each component.

The level of real economic variables (the domestic demand, exports and imports) follows the decomposition identity:
$j_t = \bar{j}_t + \hat{j}_t$ for $j = \{dd, x, m, y\}$
where we define the trends ($\bar{j}_t$) in growth terms[30] and gaps ($\hat{j}_t$) in level terms.

The potential GDP growth ($\Delta\bar{y}$) follows an AR process:

$$\Delta\bar{y}_t = \rho^{\Delta\bar{y}}\Delta\bar{y}_{t-1} + (1 - \rho^{\Delta\bar{y}})\Delta y^{SS} + \varepsilon_t^{\Delta\bar{y}}, \qquad (5)$$

where, Δy^{SS} is a parameter (assumed to be 3 percent) defining steady-state growth of potential GDP.

The domestic demand trend growth, $\Delta\overline{dd}$, is assumed to follow:

$$\Delta\overline{dd}_t = \rho^{\Delta\overline{dd}}\Delta\overline{dd}_{t-1} + \left(1 - \rho^{\Delta\overline{dd}}\right)\Delta\bar{y}_t - \delta^{\Delta\overline{dd}}(\overline{dd}_t^{rat} - dd^{rat,SS}) + \varepsilon_t^{\Delta\overline{dd}}, \qquad (6)$$

where we assume that the domestic demand trend converges to the potential GDP growth, and the third error-correction term ensures that following a shock the domestic demand trend growth return to a path in the long-run that is consistent with the long-term GDP ratio ($dd^{rat,SS}$).

Similarly, the growth of real export trend is defined as:

$$\Delta\bar{x}_t = \rho^{\Delta\bar{x}}\Delta\bar{x}_{t-1} + (1 - \rho^{\Delta\bar{x}})(\Delta\bar{y}_t - \Delta\overline{rp}_t^{x}) - \delta^{\Delta\bar{x}}(\bar{x}_t^{rat} - x^{rat,SS}) + \varepsilon_t^{\Delta\bar{x}}, \qquad (7)$$

with a notable difference that the export growth trend, growing by potential GDP is adjusted by the trend in (the bilateral, U.S.) real exchange rate depreciation, $\Delta\overline{re}_t$ in this case.[31]

With a defined AR process for the potential growth rate, the real import trend growth ($\Delta\bar{m}_t$) is computed from the following familiar identity defined in trend growth rates:

$$\Delta\bar{y}_t = \frac{\overline{dd}_{t-1}^{rat}}{100}\,\Delta\overline{dd}_t + \frac{\bar{x}_{t-1}^{rat}}{100}\,\Delta\bar{x}_t - \frac{\bar{m}_{t-1}^{rat}}{100}\,\Delta\bar{m}_t, \qquad (8)$$

where ratios to nominal GDP are time-variant weights of the growth components.

Nominal GDP identity (1) can be rewritten as

[28] The model can separate oil from non-oil imports with similar formulations in terms of dynamics, where the total imports gap is $n_t = m_t^{oil} + m_t^{Noil}$.

[29] Fiscal policy decisions in the form of import duties can play a role with an increase (decrease) in duties in the near-term impacting the contemporaneous demand for imports, temporarily rising (declining) as economic agents frontload their planned import expenditures in anticipation of more expensive (cheaper) future imports.

[30] Real economic trends are non-stationary variables without well-defined steady-state levels. In order to define robust structural equations, we calculate the growth rates by formulating such equations using stationary values.

[31] The compact nature of equations (6) and (7) is to keep the model tractable. The potential GDP growth $\bar{y}_t$ term can be adjusted by a trend growth term in relative prices (of GDP to consumption). In (7), the ret term reflects fundamental improvements in productivity and competitiveness of exports proxied by some trend relative price dynamics which in turn depends on the growth trend (equilibrium) real effective exchange rate (re_t).

$$Y_t = \frac{P_t^{DD}}{P_t^{Y}} DD_t + \frac{P_t^{X}}{P_t^{Y}} X_t - \frac{P_t^{M}}{P_t^{Y}} M_t \qquad (1')$$

Lacking national account data on the expenditure side, we assume that the domestic demand and GDP deflators are equal, and that export and import deflators reflect the structure of trade:[32]

$$p_t^X = \omega^{X,US}(e_t + cpi_t^{US}) + \omega^{X,phos}(e_t + pc_t^{phos}) + (1 - \omega^{X,US} - \omega^{X,phos})(e_t + pc_t^{food}) \qquad (9)$$

and

$$p_t^M = \omega^{M,US}(e_t + cpi_t^{US}) + \omega^{M,oil}(e_t + pc_t^{oil}) + (1 - \omega^{M,US} - \omega^{M,oil})(e_t + pc_t^{food}) \qquad (10)$$

where e denotes the nominal exchange rate, cpi^{us} is the U.S. CPI, pc^{phos}, pc^{oil} and pc^{food} are the phosphate, oil and food prices expressed in U.S. price levels respectively (see also (14)).

Equation (1) can be written

$$100 = dd_t^{rat} + x_t^{rat} - m_t^{rat} \qquad (11)$$

where each ratio can be decomposed into gap and trend. Hence, the identity in trends is as follows:

$$100 = \overline{dd}_t^{rat} + \bar{x}_t^{rat} - \bar{m}_t^{rat} \qquad (11')$$

Then based on the GDP-identity, the real output gap is defined as a weighted average of GDP components gaps, with weights trends in nominal shares used.[33]

$$exp\left(\frac{\hat{y}_t}{100}\right) = \frac{\overline{dd}_t^{rat}}{100} exp\left(\frac{\widehat{dd}_t}{100}\right) + \frac{\bar{x}_t^{rat}}{100} exp\left(\frac{\hat{x}_t}{100}\right) - \frac{\bar{m}_t^{rat}}{100} exp\left(\frac{\hat{m}_t}{100}\right) \qquad (11'')$$

III.1.2 Aggregate Supply – Phillips Curves Inflation

Consistent with Section III.1.1, each demand component should ideally have its own price deflator to be modeled in JAM2.0. Considering data limitations and for tractability reasons, this paper focuses on core and non-core price inflations and ensures that the underlying dynamics in the headline inflation consumer price index (CPI) are adequately captured with sufficient detail. In subsection III.1.2.E, a nominal GDP deflator is approximated using CPI.[34]

III.1.2.A Headline CPI / inflation

Headline CPI is specified as a weighted average of subcomponents of core and non-core indices (in logs)

$$cpi_t = w^{cpi} cpi_t^{core} + (1 - w^{cpi}) cpi_t^{ncore} + \varepsilon_t^{cpi} \qquad (12')$$

which in change term (headline inflation rate) is written as follows:

$$\Delta cpi_t = w^{cpi} \Delta cpi_t^{core} + (1 - w^{cpi}) \Delta cpi_t^{ncore} + \varepsilon_t^{\Delta cpi} \qquad (12)$$

[32] Equations ((9) and (10) capture the direct effect of external assumptions on the import and export deflators, however, there are also second-round effects on domestic demand via the current account and external financing of the economy.

[33] Equation (11'') is non-linear. A linearized version is actually used in the model to represent model outcomes. As a result, there is an approximation error, which may be sizeable under large changes of GDP components, i.e., in the wake of COVID-19 (which we report in the decomposition analysis, see Figure IV.15).

[34] In countries with sufficient and reliable statistics, the CPI can be further split into its services and goods subcomponents, and the non-core CPI can comprise separate equations for the CPI indices of food, electricity, and fuel. A detailed food-transportation-administered price split has also been a feature in certain other QPMs.

The term $\varepsilon^{\Delta cpi}$ is a measurement error introduced in principle to capture discrepancies that appear because the actual subcomponents do not sum up to headline CPI and because the weights are treated as constant in the model where they may be time-varying over the estimation sample.[35]

The corresponding quarter-on-quarter (annualized) inflation rates are

$$\Delta cpi_t^i = (cpi_t^i - cpi_{t-1}^i) \text{ x } 4 \qquad (12'')$$

where the superscript *i* represents core and non-core inflation subcomponents.

In this paper, the two core and non-core Phillips curves determine the evolution of prices as function of relevant determinants, including real marginal costs aimed at capturing relevant cost pressures (*III.1.2.C and III.1.2.D).* Before we discuss the Phillips curves, we highlight next the importance of relative prices and trend movements (*III.1.2.B*).

III.1.2.B Relative prices and their trends

When the price of a specific good changes relative to the price of others, such relative price movements often alter consumption patterns, as consumers would substitute a less expensive good for the good that has become more expensive. These relative price movements are important drivers of overall inflation dynamics, since, in theory, a reduced demand for the good that has become relatively more expensive should ultimately constrain the price change that caused the initial relative price movement. In the model, the relative prices of CPI components are expressed relative to headline CPI:

$$rp_t^i = cpi_t^i - cpi_t \qquad (13)$$

While theory would predict that substitution effects ultimately correct relative price changes, this does not hold in the Jordanian data because of inelastic demand for certain goods or for other structural reasons. On average, non-core inflation rates were higher than core inflation in Jordan (Figure (II.1)). As such, existing permanent differences in relative prices must be accounted for (see Kenya (2021), Malawi (2022), and South Africa (2017) for experiences in modeling relative prices in QPMs).[36] Furthermore, considering the persistent changes in relative prices, core and non-core CPI components exhibit different long-term trends. This has required an explicit modeling of the temporarily deviation from the long-term trend (gap) in relative prices and their impact on the inflation process ((17) and (22) below).

In computing the real price of each commodity, using the U.S. CPI:

$$rpc_t^{comm} = pc_t^{comm} - cpi_t^{US} \qquad (14)$$

where superscript "*comm"* represents phosphate, oil and food commodities (representing the highest share in Jordanian foreign trade), and pc_t^{comm} represents the world commodity *comm* price expressed in U.S. dollar per unit of commodity.

[35] Changes in CPI composition and the weights of items over time are a source of discrepancy from the model as they tend to be present in the actual data as published by the DOS of Jordan. The shock ε_t^{cpi}, however, is not used as non-core inflation is calculated from headline and core inflation.

[36] Trends in relative prices, in non-core (food and fuel) items for example, have presented significant challenges to monetary policy in many countries, particularly in EMDEs. Modeling them has required substantial additional notation and complexity, albeit necessary to ensure accurate analyses and forecasts. Trend growth of the relative prices $\overline{rp}_t$ which follows an AR process is discussed below (see (20)).

Each real price of commodity is then decomposed into a trend and a gap. The trend is assumed to be non-stationary with a smooth growth. In order to ensure that the model solves, the real price converges to trend for gaps to be closed.
Specifically,

$$\widehat{rpc}_t^{comm} = rpc_t^{comm} - \overline{rpc}_t^{comm} \tag{15}$$

III.1.2.C Core price inflation

An aggregate supply curve, open-economy forward-looking core Phillips curve simply incorporates the mechanism for formation of inflation expectations and the pass-through of production costs to prices. $\varepsilon^{\Delta cpi^{core}}$ is a cost-push shock (supply shock).

$$\Delta cpi_t^{core} = b_1 \Delta cpi_{t-1}^{core} + (1-b_1) E_t \Delta cpi_{t+1}^{core} + rmc_t^{core} + \varepsilon_t^{\Delta cpi^{core}} \tag{16}$$

In (16), agents' inflation expectations are a weighted average of past inflation and of inflation expected in next period (quarter), $E_t \Delta cpi_{t+1}^{core}$ representing rational expectations formed in period t. The real marginal costs (rmc^{core}) are approximated by the output gap (in the case of domestic producers) and by the real exchange rate gap (for imports); more specifically, they are defined as follows:

$$rmc_t^{core} = b_2 \hat{y}_t + b_3 \widehat{reer}_t + b_4\left(\widehat{rpc}_t^{oil} + \widehat{re}_t\right) + b_5\left(\widehat{rpc}_t^{food} + \widehat{re}_t\right) - b_6\left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t \tag{17}$$

where $\hat{y}$ is the output gap, $\widehat{reer}$ is the real effective exchange rate gap, $\widehat{rpc}_t^{oil}$ is the real oil price gap, and $\widehat{rpc}_t^{food}$ is the real world food price gap, where real world oil and food prices are computed (deflated) using U.S. CPI (14). Prices in U.S. dollars are transformed to domestic currency using (bilateral) real exchange rate gap with respect to the U.S. as denoted by $\widehat{re}$. Last, $\widehat{rp}$ is the relative price gap.

Writing (13) for the core component:

$$rp_t = cpi_t^{core} - cpi_t \tag{18}$$

and the relative price gap $\widehat{rp}$ is derived from (19):

$$rp_t = \overline{rp}_t + \widehat{rp}_t \tag{19}$$

$\overline{rp}$ is the relative price trend, with relative price trend growth assumed to follow an AR process:

$$\Delta\overline{rp}_t = \rho^{\Delta\overline{rp}} \Delta\overline{rp}_{t-1} + (1-\rho^{\Delta\overline{rp}}) \Delta rp^{ss} + \varepsilon_t^{\Delta\overline{rp}} \tag{20}$$

where Δrp^{ss} is the steady state parameter and $\varepsilon_t^{\Delta\overline{rp}}$ is a shock to relative price trend.

The real marginal costs index (17) approximates domestic and imported costs of producing goods and services in a small open economy like Jordan. The output gap, $\hat{y}$, approximates costs of production related to labor (wages) and capital (rental price of capital). The $\widehat{reer}_t$ (defined as the price of foreign goods expressed in domestic currency relative to domestic prices) captures the cost of imported factors of production and ensures that the prices in Jordan and foreign economies are in line with the relative version of the purchasing power parity. When adjusting the relative oil and food price gap ($\widehat{rpc}_t^{oil}$) and ($\widehat{rpc}_t^{food}$) by $\widehat{re}$, we get the real exchange rate gap defined in terms of the core CPI, justifying the last term in rmc^{core}. Finally, world oil and food prices (in relative price gap terms), capture the effects of the world commodity prices on core inflation. Core inflation is defined in the form of less volatile items which may also include some food items, hence the role of the world food price. Rising non-core inflation prices naturally create inflationary pressures also in core via production costs, including wages. This is captured in (50) via the relative price gap term ($\widehat{rp}$).

III.1.2.D Non-core price inflation

The structure of the non-core, Δcpi^{ncore} inflation equation (21) is similar to the core function, with a distinct difference where expectations are replaced by the non-core inflation implicit target term, $cpi^{ncore,TAR}$, used because non-core prices are mainly energy and food prices which are smoothed by the government:

$$\Delta cpi_t^{ncore} = d_1 \Delta cpi_{t-1}^{ncore} + (1-d_1)\Delta cpi_t^{ncore,TAR} + (1-d_1) rmc_t^{ncore} + \varepsilon_t^{\Delta cpi^{ncore}} \quad (21)$$

rmc^{ncore} denotes the real marginal costs of production of non-core goods (defined in 22) and $\varepsilon^{\Delta cpi^{ncore}}$ denotes a cost-push (supply) shock.

$$rmc_t^{ncore} = d_2\left(\widehat{rpc}_t^{oil} + \widehat{re}_t + \left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t\right) + d_3\left(\widehat{rpc}_t^{food} + \widehat{re}_t + \left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t\right) - d_4\left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t \quad (22)$$

rmc^{ncore} does not feature an output gap or a domestic demand term as we assume in the model that the demand does not affect non-core prices, in line with what is mentioned earlier that these prices are smoothed by the government. As such, the real-world oil and food prices adjusted by $\widehat{re}$ and $\widehat{rp}$ together make up the real marginal costs that price-setters in the non-core sector face.[37] The last term in the marginal cost reflects the weak spillover effect from the core to non-core inflation, as the domestic demand-side inflationary pressure exerts limited effect on non-core inflation through this pass-through channel.[38]

III.1.2.E GDP deflator

In relation to the market-clearing condition (1), each component of real GDP has in principle an associated price deflator ($defl_t^{DD}$, $defl_t^{X}$ and $defl_t^{M}$) and corresponding pricing mechanisms that endogenously determine the GDP deflator ($defl_t^{GDP}$) (in 23), yielding nominal GDP gdp_t^{nom} . This has enabled us to define many variables in JAM 2.0 in shares of nominal GDP terms denoted by rat:

$$gdp_t^{nom} = y_t + defl_t^{GDP} \quad (23)$$

where small letters denote variables in natural logarithm. Given the complexity involved and data related issues in arriving at the GDP component deflators, $defl_t^{GDP}$is approximated using CPI as follows:

$$\Delta defl_t^{GDP} = \rho^{\Delta defl^{GDP}} \Delta defl_{t-1}^{GDP} + \left(1-\rho^{\Delta defl^{GDP}}\right)\Delta cpi_t + \varepsilon_t^{\Delta defl^{GDP}} \quad (24)$$

III.2 External Balance

Broadly following the canonical FINEX's model structure, a similar novelty is introduced in JAM2.0 by modeling the BoP constraint explicitly. This has allowed for consistent forecasts of the BoP's underlying components (exports, imports, and various financial flows) under a given exchange rate regime, all of which are of direct interest to policymakers. Furthermore, the simulated effects of different external shocks (risk appetite, aid flows, etc.) allow us to capture the degrees of cross-border capital mobility,[39] and importantly model policies that act directly on the BoP (e.g., FX intervention and possible CFMs).

[37] This adjustment is consistent with the difference of the nominal commodity price in Jordanian dinars and the non-core price level.

[38] The effective and bilateral real exchange rates are defined as the ratio of foreign (U.S.) core price over the domestic core price. We assume that the imported non-core inflationary pressure affects costs through the commodity prices and not the imported core inflationary pressure.

[39] The degree of capital account frictions / imperfect substitution between domestic currency and foreign currency assets and development (depth/thinness) of the FX markets can affect the degree of the central bank control over (market) interest rates. For example, under a hard peg exchange rate regime and full capital mobility, interest rates are determined by the UIP condition.

Notationally, variables in the external balance (BoP) block of JAM2.0 enter as shares of nominal GDP. They are decomposed into a trend related to country fundamentals (or long-term developments, loosely referred to as trends or equilibriums) and a gap as driven by cyclical fluctuations (or the business cycle).
The BoP constraint is represented by the key BoP identity (25) which states that net cross border flows of goods and services (the current account) matches the net flows of financial claims (the financial account) as follows:

$$0 = ca_t^{rat} + fa_t^{rat} \quad (25)$$

Namely, ca^{rat} is the current account as a ratio of nominal GDP, and fa^{rat} the financial account ratio.
The identity also holds in terms of trends:

$$0 = \overline{ca}_t^{rat} + \overline{fa}_t^{rat} \quad (25')$$

The current account itself consists of the balance of trade – total exports of goods and services net of imports are net exports (nx); remittances $(remit)$; interest payments related to domestic government borrowing abroad $(intcost^*)$ (see fiscal policy below); and other income category (oth) which capture dividends, profits on foreign direct investment, and/or foreign aid among other primary and secondary income.

$$ca_t^{rat} = nx_t^{rat} + remit_t^{rat} - intcost_t^{*rat} + oth_t^{rat} \quad (26)$$

The same equation also holds in trends:

$$\overline{ca}_t^{rat} = \overline{nx}_t^{rat} + \overline{remit}_t^{rat} - \overline{intcost}_t^{*,rat} + \overline{oth}_t^{rat} \quad (26')$$

and the current account gap is:

$$\widehat{ca}_t^{rat} = ca_t^{rat} - \overline{ca}_t^{rat} \quad (27)$$

Net exports, defined as exports net of imports are:

$$nx_t^{rat} = x_t^{rat} - m_t^{rat} \quad (28)$$

They are decomposed into a trend and a gap, with trend of net exports defined using export and import trends (in shares of GDP) as defined above ((7) and (8) implicitly), linking BoP and real GDP blocks.

$$\overline{nx}_t^{rat} = \bar{x}_t^{rat} - \bar{m}_t^{rat} \quad (29)$$

Net exports gap is the difference between the level and the trend of next exports:

$$\widehat{nx}_t^{rat} = nx_t^{rat} - \overline{nx}_t^{rat} \quad (30)$$

Remittances are decomposed into trend and gap components:

$$remit_t^{rat} = \overline{remit}_t^{rat} + \widehat{remit}_t^{rat} \quad (31)$$

The remittance ratio trend is assumed to be smooth, written as follows:

$$\overline{remit}_t^{rat} = \rho^{\overline{remit}^{rat}} \overline{remit}_{t-1}^{rat} + \left(1 - \rho^{\overline{remit}^{rat}}\right) remit^{rat,ss} + \varepsilon_t^{\overline{remit}^{rat}} \quad (32)$$

and the remittance gap or remittance flow is a function of foreign effective output gap, $\hat{y}^w$:

$$\widehat{remit}_t^{rat} = \rho^{\widehat{remit}^{rat}} \widehat{remit}_{t-1}^{rat} + \left(1 - \rho^{\widehat{remit}^{rat}}\right) g_1 \hat{y}_t^w + \varepsilon_t^{\widehat{remit}^{rat}} \quad (33)$$

Other current account flows, oth^{rat}, are divided into a trend and a gap following simple AR processes:

$$\overline{oth}_t^{rat} = \rho^{\overline{oth}^{rat}} \overline{oth}_{t-1}^{rat} + \left(1 - \rho^{\overline{oth}^{rat}}\right) oth^{rat,ss} + \varepsilon_t^{\overline{oth}^{rat}} \quad (34)$$

$$\widehat{oth}_t^{rat} = \rho^{\widehat{oth}^{rat}} \widehat{oth}_{t-1}^{rat} + \varepsilon_t^{\widehat{oth}^{rat}} \quad (35)$$

Based on the BoP identity (25), once a current account is determined we can derive the financial account. Similarly for the trend form of the financial account.

Financial account flows, fa^{rat}, consists of foreign assets (portfolio among other types of) inflows and outflows; two channels related to FX reserve management (FX interventions and FX reserve accumulation); and a term capturing government net foreign borrowing:

$$fa_t^{rat} = nfp_t^{rat} - fxi_t^{rat} - fxa_t^{rat} + debt1Y_t^{f,rat} - debt1Y_{t-4}^{f.rat} * \frac{expexp\left(\frac{\Delta^4 e_t}{100}\right)}{expexp\left(\frac{\Delta^4 gdp_t^{nom}}{100}\right)} \quad (36)$$

Specifically, nfp^{rat} is net foreign private inflows; fxi^{rat} are FX interventions (a positive (negative) value refers to purchase (sale) of reserves); fxa_t^{rat} is planned reserves accumulation, and $debt1Y^{f,rat}$ is 1- year government debt, where in computing net government foreign borrowing, the maturing debt is adjusted by potential nominal exchange rate changes and nominal GDP growth.[40]

To note, (36) allows nfp^{rat} to be endogenously determined under a determined fa_t^{rat} from (25). fxi_t^{rat} and fxa_t^{rat} are discussed in Section III.3.1 (monetary policy and the rules therein).

Equation (36') defines trend net financial account inflows:

$$\overline{fa}_t^{rat} = \overline{nfp}_t^{rat} - \overline{fxa}_t^{rat} + debt1Y_t^{f,rat,TAR} - debt1Y_{t-4}^{f,rat,TAR} * \frac{exp\left(\frac{\Delta^4 e_t}{100}\right)}{exp\left(\frac{\Delta^4 \overline{gdp}_t^{nom}}{100}\right)} \quad (36')$$

To note that trend FX interventions are by assumption planned and thus captured by trend planned reserve accumulation $\overline{fxa}^{rat}$, hence can assume $\overline{fxi}^{rat} = 0$. We also assume that the net government debt ratio is on the target path, so that new external borrowing/lending by the government takes place only as needed to cover the equilibrium foreign debt ratio ($debt1Y_t^{f,rat,TAR}$) revaluation, which results from equilibrium nominal exchange rate changes and potential GDP growth.

III.3 Macroeconomic Policies

In the context of JAM2.0, *monetary policy* plays a crucial role in achieving internal and external balance in the Jordanian economy. The CBJ assesses the interaction of various policy instruments, such as the interest rate, FXI, and potentially CFMs, within the framework of the pegged exchange rate regime. The formulation of monetary policy in JAM2.0 takes into account not only the policy instruments but also the initial conditions of the economy and various features specific to the Jordanian context. These factors can include the level of inflation, fiscal policy stance, financial market conditions, and the country's economic structure.[41] [42] Regarding *fiscal policy*, short- and medium-term implications of different combinations of fiscal measures can be assessed in this model, interaction within instruments as well as interaction with other policies analyzed – for e.g., assessing the implications of government financing on interest rate, FXI, and fiscal policies. While other policies, including *macroprudential policies* can be useful in helping to achieve financial stability, they are left for future extensions of JAM2.0.

The COVID-19 pandemic and the subsequent external shocks have posed significant challenges for policymakers in Jordan. To mitigate the impact of the pandemic, the government implemented a range of policy measures aimed at supporting vulnerable households and businesses. Monetary measures played a crucial role in supporting the economy during this period. The central bank maintained a loose monetary policy stance,

[40] The adjustment reflects revaluation, whereby in (36) the matured 1-year government bond was expressed in terms of previous year's nominal GDP.

[41] A high weight on past inflation in the Phillips curve might reflect backward indexation in price formation but also less anchored inflation expectations.

[42] This is akin to Basu et al. (2020) and the IPF more broadly in that it maps the combination of shocks and country characteristics to the desirable policy mix.

ensuring sufficient liquidity in the financial system and facilitating lending to small and medium-sized enterprises (SMEs). Additionally, measures were taken to allow borrowers to postpone principal repayments to banks, providing temporary relief to businesses and individuals facing financial difficulties. On the fiscal front, the government implemented targeted fiscal measures to provide support to affected sectors and households. However, these measures, along with the decline in tax revenues and increased spending, led to a significant fiscal deficit and a rise in public debt. As the economy started to recover from the pandemic, Jordan faced a more challenging and uncertain global environment. Several external shocks, such as higher inflation in major economies like the U.S. and Europe, a slowdown in China due to COVID-19 outbreaks and lockdowns, and negative spillovers from the war in Ukraine, added to the complexities. In this context, policymakers have been faced with the task of balancing the need for monetary tightening to address inflationary pressures and maintain financial stability, while also ensuring that the pace of fiscal consolidation is carefully managed to avoid excessive harm to economic growth. The challenge lies in finding the right mix of monetary tools and fiscal measures to navigate the uncertain external environment and promote sustainable economic growth. Policymakers need to strike a balance between implementing necessary tightening measures to address inflationary pressures and ensuring that fiscal consolidation measures are paced appropriately to avoid undermining the recovery. In this context, the JAM2.0 model provides a framework to analyze the potential effects of different policy choices and assess the trade-offs between monetary and fiscal measures in achieving internal and external balance. It allows policymakers to consider the interactions between policy instruments, macroeconomic variables, and external shocks, aiding in the formulation of effective and well-calibrated policies to support economic growth and stability in Jordan.[43]

III.3.1 Monetary Policy

Monetary policy in Jordan is primarily focused on maintaining the pegged exchange rate to the U.S. dollar. The exchange rate serves as an operational target for the CBJ, which intervenes in FX markets to ensure the stability of the peg. This peg has proven to be effective in providing monetary and financial stability in the face of various external shocks. To support the peg, the CBJ maintains an adequate level of international reserves. These reserves act as a buffer to absorb fluctuations in FX demand and help maintain confidence in the currency. By combining stylized economic considerations with the practical aspects of the Jordanian economy, JAM2.0 provides policymakers with a relevant and effective framework for conducting policy analysis and making informed decisions in real-time.

The CBJ has generally responded one-to-one to the Fed rate hikes (for example during 2004-06 and 2015-19), with only small and temporary deviations along the path. Consistent with that, the CBJ matched the two Fed’s 75 basis point increases in June and July 2022 and interest rates on all CBJ monetary policy instruments were raised, except some subsidized lending schemes which have aimed to provide support to SMEs. Overall, necessary monetary policy adjustments in response to Fed actions has helped in credibly protecting the peg, which operationally has implied maintaining adequate reserve buffers (defined by the CBJ as above 100 percent of the Fund’s Assessing Reserve Adequacy (ARA) metric.)[44]

[43] In its support, the IMF is committed to help address higher financing needs under an increasingly volatile external environment, while recognizing the critical donor support role to enable Jordan to cope with current global headwinds and address other longer term regional challenges since 2012.

[44] As discussed earlier, Gross International foreign reserves (GIR excluding banks deposits in FX at CBJ) stood at US$18 billion (39.9 percent of GDP) at end-2021, and US$16.7 billion (37.0 percent of GDP) in September 2022, above the end-2020 level (US$ 15.9 billion). Reserves are assessed to be adequate based on coverage of about 7.2 months of imports of goods and services, or about 100 percent of the IMF’s reserve adequacy metric as of end-2021.

The capital account is described as mostly open with no constraints on capital flows and investment based on the Chinn-Ito index (Figure II.14).

The exchange rate and interest rate specifications for some degree of managed / fixity in the exchange rate regimes have in most cases followed the approach in Benes et al (2008), with the hard peg as a special case and with different degrees of capital (financial) account frictions captured. With full adherence to the exchange rate target and full capital mobility, domestic market interest rates would be determined by the uncovered interest parity (UIP) condition (37) – that is domestic interest rates (i) equal foreign interest rates (i^{US}, the Fed rate) adjusted by the country risk premium $(prem)$ to reflect investors' risk appetite, and by an expected nominal exchange rate depreciation term (assumed zero under a conventional peg). e denoted the natural logarithm of nominal exchange rate. No shock enters the equation because under the peg any variation in the domestic interest rate is assumed to be reflected in the country risk premium:

$$i_t = i_t^{US} + prem_t + 4(E_t e_{t+1} - e_t) \quad (37)$$

The country risk premium is broken down into a trend and a gap:

$$prem_t = \overline{prem}_t + \widehat{prem}_t \quad (38)$$

The trend of the country risk premium is derived from the trend in net foreign private inflows:[45]

$$\overline{nfp}_t^{rat} = nfp^{SS} + h_2\left(\overline{prem}_t - prem^{SS} - \varepsilon_t^{\overline{prem}} - h_{22}(debt_t^{rat} - debt^{rat,ss})\right) \quad (39)$$

Equation (39) links the deviation of trend in net foreign private financing ($\overline{nfp}_t^{rat}$) from its steady state value (nfp^{SS}) to the deviation in the trend country risk premium from its steady state required excess return $(prem^{SS})$ adjusted by a shock, $\varepsilon^{\overline{prem}}$, and to the government debt ratio deviation from some steady-state (sustainable) level (last term in (39)). To note that a stock of foreign reserves term, needed in the case of a managed or peg regime can enter as another endogenous determinant of the excess return required by foreign investors. This is reflected in the policy reaction function below (41) – the sterilized intervention type to buy / sell reserves in response to economic conditions.

The parameter h_2 reflects secular cross-border capital mobility, which may be different (often higher) over longer horizons than over the cycle as captured by h_1 in (40). The parameter h_3, is the risk associated with public debt which grows exponentially with the public debt ratio – it can capture nonlinearity in JAM2.0 (as in FINEX) i.e., the way small changes in debt and reserves can have explosive effects on capital flows when risks are already high. This, in the literature has been associated with "sudden stops". Finally, a trend risk appetite shock, $\varepsilon^{\overline{prem}}$, captures trend risk-off shocks – it typically has a persistent component that capture longer term risk appetite cycles in global capital markets.

The premium gap, $\widehat{prem}_t$, is linked to the gap in net foreign private financing:

$$\widehat{nfp}_t^{rat} = h_1\left(\widehat{prem}_t - \varepsilon_t^{\widehat{prem}}\right) \quad (40)$$

Equation (40) says that whenever there are business cycle pressures on external (say portfolio) financial flows to deviate from their trend level, a risk premium gap $(\widehat{prem}_t)$ must open. The gap is relative to the risk appetite shock, $\varepsilon^{\widehat{prem}}$: a positive value of $\varepsilon^{\widehat{prem}}$ implies a decline in investor appetite for the country's assets and dictates that a given financial inflow requires a larger risk premium. The extent to which the risk premium needs to rise to attract a given quantity of financial inflow is driven by the h_1 parameter which captures the degree of cross-border capital mobility over the business cycle. The value of h_1 would typically reflect structural

[45] In this paper, we do not categorize portfolio and other flow types as endogenous or strictly exogenous components of financial flows.

characteristics such as the depth of domestic financial markets as well as the strength of CFM (e.g., an administrative restriction on banks' open FX positions which is different from a market-based capital inflow tax as used in the IMF's Integrated Policy Framework (IPF) papers).

An advantage of JAM2.0 lies in its ability to account for the need to accumulate and maintain FX reserves as a pre-condition for FX intervention. The size of the FX reserves needed is balanced against sterilization costs involved in the accumulation of sizeable reserves under constrained borrowing of FX at the risk-free rate. The CBJ has in practice sought to build an adequate level of FX reserves (at above 100 percent of the Fund's ARA metric) to successfully maintain the viability of the peg and to engage successfully in FX sales during outflow pressures as needed, increasing in reality the credibility of its intervention.[46]
The CBJ is assumed to use interventions as a policy instrument. FX intervention as a ratio to GDP (fxi^{rat} in (41)) follows a rule which is a function of the current account deficit, foreign reserves, and interest rate differential adjusted for $prem^{ss}$ to ensure that a proper steady-state is reached:

$$fxi_t^{rat} = g_6 fxi_{t-1}^{rat} + (1-g_6)\left(g_7 \widehat{ca}_t^{rat} - g_8 \widehat{fxres}_t^{ratimp}\right) - g_9\left(i_t - i_t^{US} - prem^{ss}\right) + \varepsilon_t^{fxi^{rat}} \quad (41)$$

where $\widehat{fxres}^{ratimp}$ is the gap in the ratio of FX reserves on imports. The gap of reserves in terms of imports is a weighted average of current and future expected gaps in reserves on imports:[47]

$$\widehat{fxres}_t^{ratimp} = g_{12}\left(fxres_t^{ratimp} - \overline{fxres}_t^{ratimp}\right) + (1-g_{12})\widehat{fxres}_{t+1}^{ratimp} \quad (42)$$

Reserve accumulation depends on last period's level of FX reserves adjusted by the U.S. interest rate, approximating the yield on FX reserves, interventions against possible valuation losses/gains of assets, and the planned reserve accumulation strategy.

$$fxres_t^{rat} = fxi_t^{rat} + \overline{fxa}_t^{rat} + \left(1 + \frac{i_{t-1}^{us}}{400}\right) fxres_{t-1}^{rat} \left(1 + \frac{\Delta e_t}{400}\right) / \left(1 + \frac{\Delta gdp_t^{nom}}{400}\right) \quad (43)$$

III.3.2 Fiscal Policy

The JAM 2.0 contains a parsimonious fiscal block that anchors public debt accumulation based on a fiscal rule for the structural deficit (a cyclically-adjusted primary deficit). This block provides a consistent stock-flow analysis for the debt trajectories and the government total and primary deficits. It embeds an underlying empirically realistic account of government spending and revenues without modeling them explicitly.[48]
Importantly though, when we analyze the impact of fiscal policy and government intervention, we can in theory distinguish between government revenues and expenditures and calibrate the shock simulations in JAM2.0 to reflect the expected behavioral mechanisms from different types of fiscal instruments.

As such, the fiscal block allows us to analyze (i) the macroeconomic effects of fiscal measures (stimulus or otherwise, that are usually associated with revenue- or expenditure-based measures) and realistic fiscal multipliers; (ii) public debt projections and fiscal adjustment required to achieve sustainability; (iii) the macroeconomic implications of different financing choices, such as between official (concessional) and private,

[46] An extensive literature points to the stock of FX reserves as signal of resilience, as central banks then would have more ammunition to use FX (sales) to counter pressures, reducing the probability of success of a speculative attack (see Morris and Shin, (1998)). More recently, Cubedu et al (2021) have confirmed this finding, showing that FX reserves play a role in reducing vulnerability from external indebtedness.

[47] By way of comparison, reporting gross usable reserves in months of 'next year' imports of GNFS, differs from our objective to model the forward-looking term, next-period reserve as a ratio of next-period imports, which is estimated in a model-consistent way.

[48] To be clear, the model does not feature explicit revenue and expenditure equations as the model focuses on balance measures, i.e., a description of primary deficit (which reflects expenditures net of interest payments / debt service minus revenues). The framework works well with back-of-the envelope calculations, detailed spreadsheet-based models for government balances, or other inputs from satellite models.

and foreign and domestic, debt; (iv) fiscal-monetary interactions;[49] and (v) long-term implications of fiscal consolidation plans for prices, growth, and debt levels and risk premium (39 and 40).[50]

In what follows, we first discuss the fiscal instruments before describing specific fiscal policy targets and fiscal reaction functions.[51]

III.3.2.A Government revenues

In a typical stylized model, three main types of taxes have been discussed: consumption, labor income and capital gain or profit taxes, with tax revenues computed using relevant tax bases (consumption, gross labor income and capital income). These taxes are distortionary as they affect economic agents' inter- and intra-temporal labor supply, consumption demand and investment decisions with the level of distortion being different for different tax rates. The literature finds that changes in consumption taxes affect the short-run (cyclical) consumption decision of agents, with an increase of consumption taxes encouraging more savings and capital investment that strengthen the medium-term economic growth. Higher capital or labor income taxation are also likely to discourage capital investment and negatively affect the labor supply, undermining the long-term growth prospects of economies. An appealing feature of JAM2.0, is its ability to reflect these theoretical advances in a reduced form (i.e., bypassing the need to include the detailed and explicit structural equations), and to replicate the channels above through a combination of fiscal shocks and shocks to domestic demand and potential growth.

III.3.2.B Government expenditures

Stylistically, total government expenditures are the sum of government absorption (current and capital expenditures), debt service, other government expenditures and direct government transfers to the economic sectors. The government absorption is part of domestic demand, consistently compiled in the national accounts. The role of current and capital expenditures and their economic impact differ. Capital expenditures may contribute to the long-term potential growth, and current expenditures affect short-term domestic demand, and a potential decrease of current expenditures will not deteriorate long-term economic fundamentals. Therefore, in a typical structural model, current expenditures are used as the main instrument to maintain fiscal rule and stabilize the public debt.

Debt service or interest payments are explicitly described in JAM 2.0 based on both domestic (LCY) and foreign (FCY) currency denominated debt. As a simplification, we assume 1-year maturity for both debts. Interest payments related to LCY debt ($intcost_t^{d,rat}$) as a ratio to nominal GDP are presented as follows:

[49] On the effectiveness of fiscal-monetary interactions in severe recessions, see Chen et al. (2022).

[50] The ability to focus on public investment vis-à-vis public consumption or other revenue measures would enrich the model, particularly if able to link explicitly productive public investment to long-run growth.

[51] A *fiscal target* is an objective for a fiscal variable (e.g., debt-to-GDP ratio). A *fiscal reaction function* adjusts fiscal policy to achieve the target through adjusting expenditures / revenues, say for example as part of a fiscal consolidation plan where debt-to-GDP ratio projections are deemed to be high. Policy must react to stabilize the model economy, that is to ensure convergence of debt (considering the policymaker preferences) to sustainable levels, akin to a Taylor reaction function aimed at returning inflation to target.

$$intcost_t^{d,rat} = \frac{\left(exp\left(\frac{i4_{t-1}^d}{400}\right)-1\right)debt1Y_{t-1}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-2}^d}{400}\right)-1\right)debt1Y_{t-2}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-3}^d}{400}\right)-1\right)debt1Y_{t-3}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-4}^d}{400}\right)-1\right)debt1Y_{t-4}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}+\frac{\Delta gdp_{t-3}^{nom}}{400}\right)} \quad (44)$$

where $i4^d$ denotes the domestic 1-year interest rate, and $debt1Y_{t-1}^{d,rat}$ the 1-year LCY debt in terms of nominal GDP. Every quarter, the government issues LCY and FCY debt and interest payments contain all outstanding/non-matured previous issuances. The domestic 1-year interest rate is based on the term structure of interest rates:

$$i4_t^d = (1-w^c)\left(\frac{i_t+i_{t+1}+i_{t+2}+i_{t+3}}{4} + tprem_t^d\right) + w^c(\bar{\iota}_t + tprem^{d,ss}) \quad (45)$$

where $tprem^d$ is the domestic term premium with steady-state denoted by $tprem^{d,ss}$, and $\bar{\iota}$ is the neutral level of interest rate computed as a sum of the natural rate of interest and the inflation target. The w_c assigns the share of concessional debt, and we implicitly assume that the interest rate of the concessional debt is fixed at the natural interest rate plus steady-state term premium. The term $tprem^d$ is set by the financial markets which considers the level of domestic debt compared to its steady-state:

$$tprem_t^d = \rho^{tprem^d} tprem_{t-1}^d + \left(1-\rho^{tprem^d}\right)tprem^{d,ss} + g_2\left(debt_t^{d,rat} - debt^{d,rat,ss}\right) + \varepsilon_t^{tprem^{dom}} \quad (46)$$

Likewise, foreign interest rate costs are computed in a similar way. Foreign policy interest rate is used along with the expected country risk premium and the foreign term premium in determining the 1-year foreign interest rate. We also assume concessional foreign financing for which the interest rate cost equals to foreign risk-free interest rate adjusted by the steady state term premium. The term $tprem_t^*$ is defined in a similar way to the equation above defining $tprem_t^d$.

$$i4_t^* = (1-w^c)\left(\frac{i_t^{us}+i_{t+1}^{us}+i_{t+2}^{us}+i_{t+3}^{us}}{4} + \frac{prem_t+prem_{t+1}+prem_{t+2}+prem_{t+3}}{4} + tprem_t^*\right) + w^c(\bar{\iota}_t^{US} + \overline{prem}_t + tprem^{*,ss}) \quad (47)$$

The equations just described are based on using quarterly data. However, commonly-discussed annual measures are also a part of the model for reporting purposes.

III.3.2.C Debt accumulation

Total debt as a share of nominal GDP, $debt^{rat}$, is a sum of debt in domestic currency, $debt^{d,rat}$, and debt in foreign currency, $debt^{f,rat}$:

$$debt_t^{rat} = debt_t^{d,rat} + debt_t^{f,rat} \quad (48)$$

Both domestic and foreign debts are accumulation of debts from current and previously issued bonds. Therefore, the domestic debt is a sum of all previously issued debts until their maturity. As the model works with shares, previously issued debt need to be adjusted by changes in nominal GDP:

$$debt_t^{d,rat} = debt1Y_t^{d,rat} + \frac{debt1Y_{t-1}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}+\Delta gdp_{t-1}^{nom}}{400}\right)} + \frac{debt1Y_{t-3}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}+\Delta gdp_{t-1}^{nom}+\Delta gdp_{t-2}^{nom}}{400}\right)} \quad (49)$$

Where $debt1Y^{d,rat}$ is the part of the debt issued in a particular quarter and Δgdp^{nom} is nominal gdp growth (annualized quarter-on-quarter change).

Similarly, the foreign issued debt is accumulation of foreign debts across duration of 1 year.

$$debt_t^{f,rat} = debt1Y_t^{f,rat} + \frac{debt1Y_{t-1}^{f,rat} exp\left(\frac{\Delta e_t}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{f,rat} exp\left(\frac{\Delta e_t+\Delta e_{t-1}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom}+\Delta gdp_{t-1}^{nom}}{400}\right)} + \frac{debt1Y_{t-3}^{f,rat} exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom}+\Delta gdp_{t-1}^{nom}+\Delta gdp_{t-2}^{nom}}{400}\right)} \quad (50)$$

The new LCY and FCY debt issuance is the constant function of the total deficit, and we also assume that the government automatically renews the matured government debt:

$$debt1Y_t^{d,rat} = \theta_t \cdot def_t^{rat} + \frac{debt1Y_{t-4}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom} + \Delta gdp_{t-2}^{nom} + \Delta gdp_{t-3}^{nom}}{400}\right)} + \varepsilon_t^{debt1Y_t^{d,rat}}$$

$$debt1Y_t^{f,rat} = (1-\theta_t) \cdot def_t^{rat} + \frac{debt1Y_{t-4}^{f,rat} exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}+\Delta e_{t-3}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom}+\Delta gdp_{t-1}^{nom}+\Delta gdp_{t-2}^{nom}+\Delta gdp_{t-3}^{nom}}{400}\right)} + \varepsilon_t^{debt1Y_t^{f,rat}} \quad (51)$$

where def_t^{rat} denotes total deficit, θ is the financing plan and shows the share of total deficit that is financed from domestic currency issuance, and $\varepsilon_t^{debt1Y_t^{d,rat}}$ and $\varepsilon_t^{debt1Y_t^{f,rat}}$ are measurement errors for LCY and FCY debts respectively which are meant to absorb the statistical discrepancy between the deficit and public debt data.

III.3.2.D Fiscal anchor, deficits and reaction functions

The government deficit, def^{rat} is divided into primary deficit, $primdef^{rat}$ and interest cost to service the debt, $intcost^{rat}$:

$$def_t^{rat} = primdef_t^{rat} + intcost_t^{rat} + \varepsilon_t^{def^{rat}} \quad (52)$$

The shock in the equation enters as maturity of bonds might differ from the assumed 1 year.

The primary deficit has two parts: structural ($defstruct^{rat}$) and cyclical ($defcycle^{rat}$):

$$primdef_t^{rat} = defstruct_t^{rat} + defcycle_t^{rat} \quad (53)$$

The cyclical deficit is linked to the business cycle, or the output gap:

$$defcycle_t^{rat} = -f_1\hat{y}_t + \varepsilon_t^{defcycle^{rat}} \quad (54)$$

Fiscal policy adjusts structural deficits to achieve a desired level of debt. As such, the equation for structural deficit (40) constitutes a fiscal rule. It captures two competing objectives. As a primary objective, the fiscal policy anchors the public debt level whereby a perceived excessive public indebtedness necessitates that the government follows a consolidation plan to reduce the structural deficit and achieve the targeted debt level. As a secondary objective, the fiscal policy seeks to smooth cyclical fluctuations and design an intervention that seeks to stabilize the macroeconomy, keeping economic activity close to potential level.

$$defstruct_t^{rat} = \rho^f(defstruct_{t-1}^{rat} - f_2\hat{y}_{t-1}) + (1-\rho^f)\left(defstruct_t^{rat,TAR} - f_3 edebtdev_t^{rat}\right) + \varepsilon_t^{defstruct^{rat}} \quad (55)$$

Equation (55) assumes persistency through the structural deficit lag and the response to output gap ($\hat{y}_{t-1}$). The first term captures the cyclical smoothing by the fiscal policy. The structural deficit is countercyclical, responding negatively to the output gap (a positive output gap means an overheating economy and structural deficit goes down). Changing the sign in front of the output gap, one can get procyclical fiscal policy. In the last debt stabilization term, structural deficits respond to expected deviations of debt from target level, $edebtdev^{rat}$. The deviation is defined as a weighted average of current and all future expected deviations:

$$edebtdev_t^{rat} = f_4\left(debt_t^{rat} - debt_t^{rat,TAR}\right) + (1-f_4)E_t edevdebt_{t+1}^{rat} \quad (56)$$

Finally, in the steady-state the structural deficit is consistent with its target. The target for structural deficit is consistent with a debt target.
The debt-to-GDP target follows a simple AR process with a defined steady-state:

$$debt_t^{rat,TAR} = \rho^{debt^{rat,TAR}} debt_{t-1}^{rat,TAR} + \left(1 - \rho^{debt^{rat,TAR}}\right) debt^{rat,SS} + \varepsilon_t^{debt^{rat,TAR}} \quad (57)$$

From (57) and based on the debt denomination and financing structure of the government, we can derive targets for domestic and foreign debt and the implicit total and primary deficit targets.
A fiscal impulse provides a link from the fiscal to real economy. Fiscal impulse, $fiscimp$, is linked to deficit deviation from the deficit target:

$$fiscimp_t = f_5\left(defstruct_t^{rat} - defstruct_t^{rat,TAR}\right) + f_6 \varepsilon_t^{debt^{rat,TAR}} \quad (58)$$

A positive fiscal impulse is assumed if the deficit rises above its implicit target (which is consistent with the target for debt). Naturally, if the target for debt is shifted up, there is a positive fiscal stimulus and vice-versa.

IV. Jordan Analysis Model – Properties

The Jordan Analysis Model's dynamic responses to key structural shocks are illustrated in subsection IV.1 and further calibration checks and tests carried out in subsections IV.2 and IV.3.

IV.1 Impulse Response Analysis

In JAM2.0, impulse responses are used to analyze the transmission mechanisms of various shocks and the policy responses to stabilize the economy and achieve price stability. These impulse responses track the dynamic changes in key macroeconomic variables in response to unanticipated structural shocks. The model considers a set of shocks, including a foreign inflation surge, a commodity price increase, a drop in domestic demand, a domestic cost push shock, and fiscal stimulus. Over a period of 20 quarters, the impulse responses track the adjustments and movements of the macroeconomic variables in response to these shocks. The policy responses aim to ensure that the variables return to their equilibrium levels over time, thereby stabilizing the economy. Additionally, the model allows for the introduction of multiple shocks to replicate realistic scenarios. This enables policymakers to assess the combined effects of different shocks and evaluate the effectiveness of various policy responses in mitigating their impact on the economy.

It is important to note that while impulse response analysis provides valuable insights into the dynamics of a semi-structural model like JAM2.0, there are some limitations compared to a fully structural DSGE model. To mention, semi-structural models, by their nature, incorporate some ad hoc relationships and may not fully capture all the structural relationships in the economy. This can introduce some theoretical inconsistencies and limitations in interpreting the impulse response functions (IRFs). In contrast, DSGE models are based on more explicit and fully specified structural relationships, providing a stronger theoretical foundation for analyzing IRFs.

Foreign Inflation Surge

In this scenario foreign inflation accelerates and the Fed reacts by tightening monetary policy.
Figure IV.1: Shock to foreign inflation

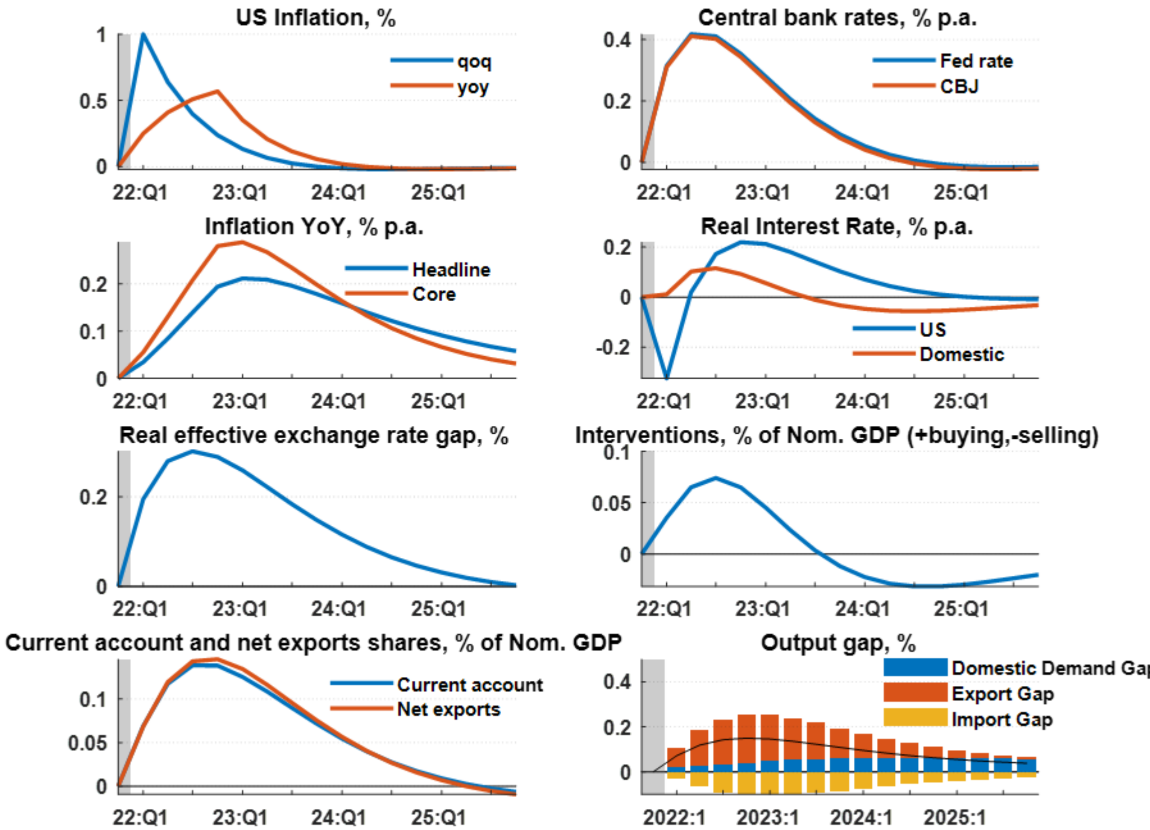
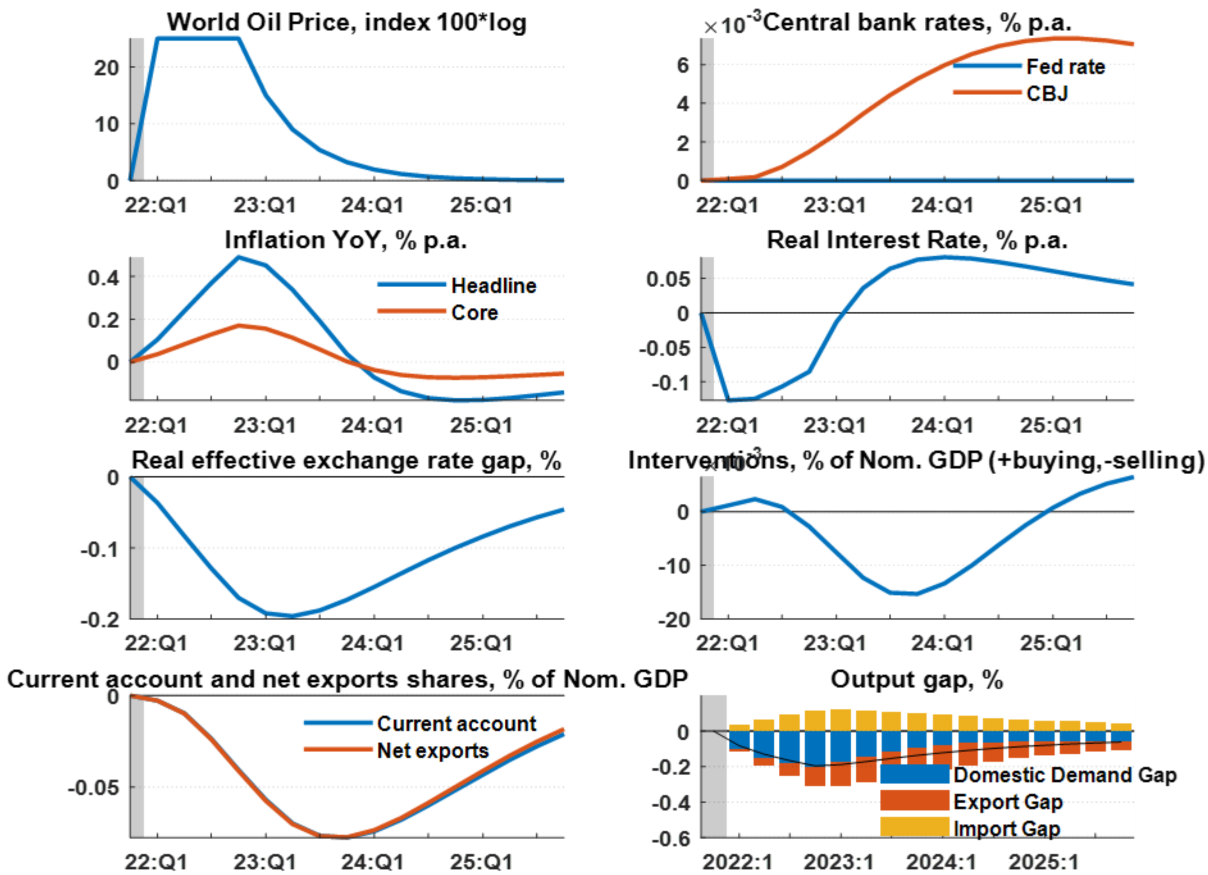


Figure IV.1 plots the IRFs for a one percent shock to foreign (U.S.) inflation, in the first quarter of the simulation. Considering persistent dynamics, year-on-year (yoy) U.S. inflation peaks within a one-year horizon reaching about 0.5 percent. The Fed responds to rising inflation by raising the nominal interest rate. A higher increase in the (nominal) Fed rate at one-year horizon than inflation expectations in the same period, means a positive real interest rate gap opens up which implies a tightening of policy and leads to a decline in the U.S. output gap. This in turn brings disinflationary pressures.

To maintain the peg, the central bank follows the increase in the Fed rate by the same amount. Given the openness of the Jordanian economy, domestic inflation also starts to rise. However, the domestic inflation increase is lower compared to the U.S.'s increase and as a result the real exchange rate depreciates. The latter creates favorable conditions for exports and as a result, there is a positive trade balance and improvement of current account. This improvement creates inflows of capital and initially, the central bank accumulates reserves. At the same time, the tightening in monetary policy dampens domestic demand.

Oil Price Increase

Figure IV.2: Oil price shock



In Figure IV.2, world oil price increases by 25 percent over a one-year period. This raises prices in the Jordanian economy as oil is an imported determinant of inflation. However, the passthrough of world oil prices is assumed to be gradual (supported empirically) partly due to government's stabilized contract prices.[52] In comparison, the passthrough of world food prices is relatively strong and complete.[53] Despite the gradual pass-through the effects of the oil price increase results in higher inflation due to non-core inflation.[54]

Spillover effects from non-core to core take place. This deteriorates net exports and the current account balance. The worsened net exports and current account force the central bank to intervene in the FX market. The negative net exports also imply a decline in domestic economic activity and a negative output gap opens. It is worthwhile to keep in mind that the domestic interest rate follows the Fed's rate in support of the peg.

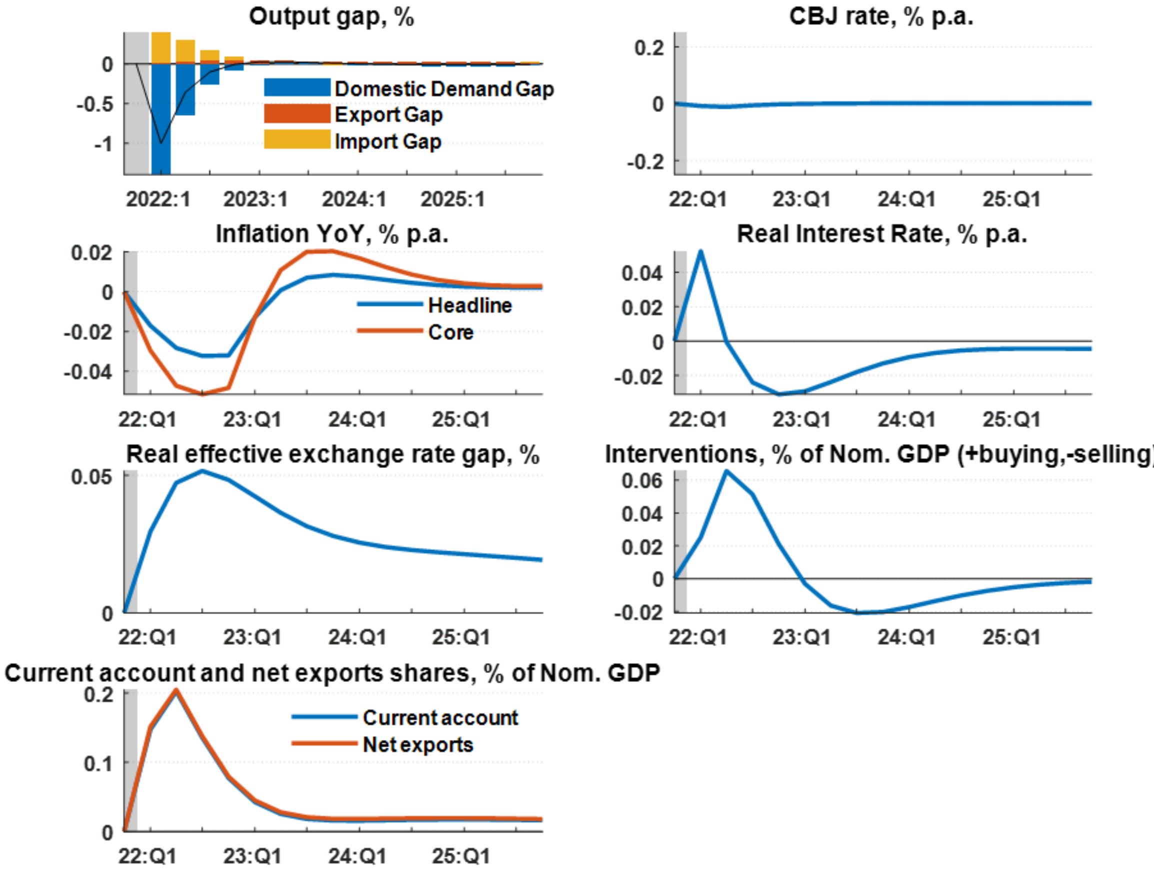
[52] A worsening of government deficits due to declining tariffs is not assumed in this scenario.

[53] The wheat reserve strategy also had some mitigating effects on food prices following the Russia-Ukraine war.

[54] This can be deduced from the headline inflation response exceeding core inflation and implying a noncore inflation rate exceeding both headline and core inflation rates.

Drop in Domestic Demand

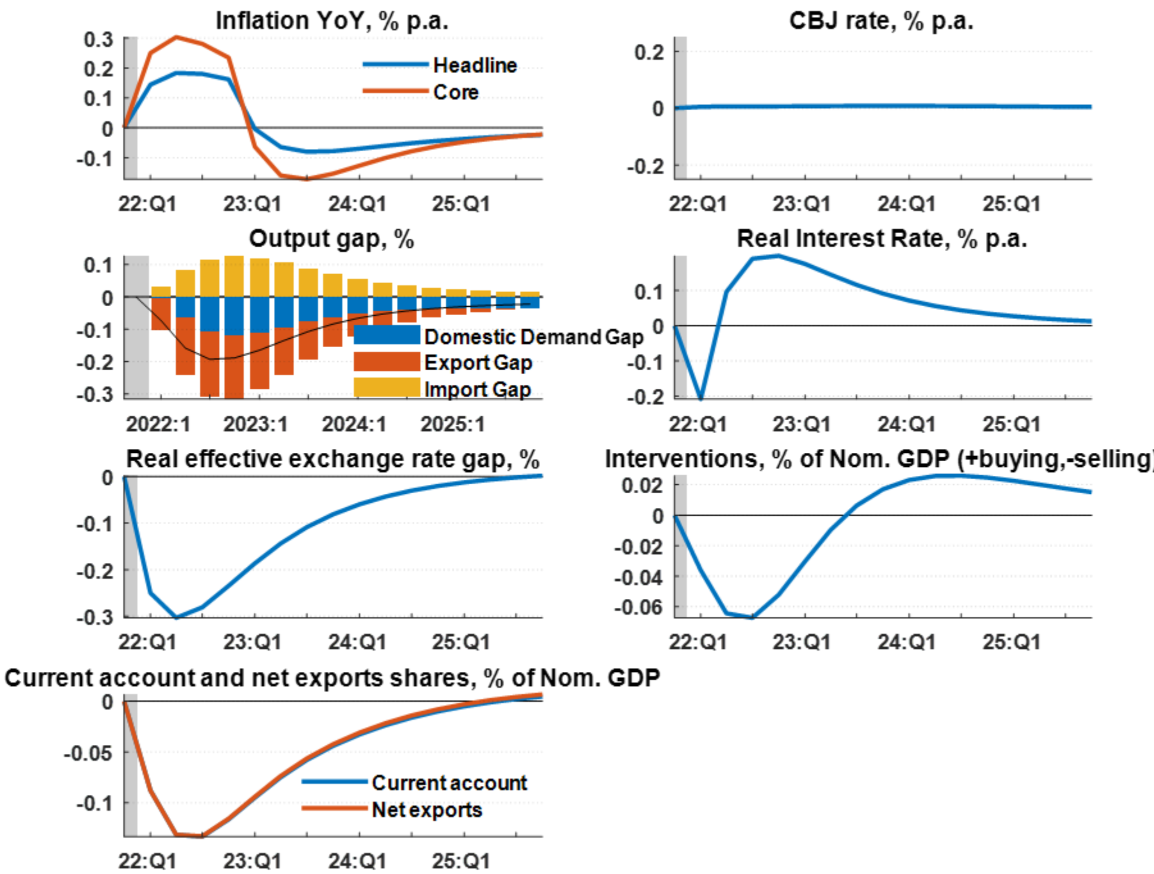
Figure IV.3: Shock to domestic demand



A negative demand shock is implemented via a negative domestic demand shock. The size of the shock is set so that the output gap is reduced by 1 percent (Figure IV.3). The negative shock can be interpreted as a drop in wages and other disposable incomes (including transfers). As a result of the decline in domestic demand, a negative output gap exerts a dampening effect on prices. Under a pegged exchange rate regime, the CBJ has limited control over its domestic interest rate (to pursue domestic stabilization) and chooses not to change its policy rate in response to inflation, in keeping with a particular interest rate differential with the Fed rate. Declining domestic prices, that is negative inflation, improves the net exports and current account. Better exports help close the negative output gap, moderating the initial effect of reduced domestic demand on inflation.

Domestic Cost Push Shock

Figure IV.4: Cost push shock



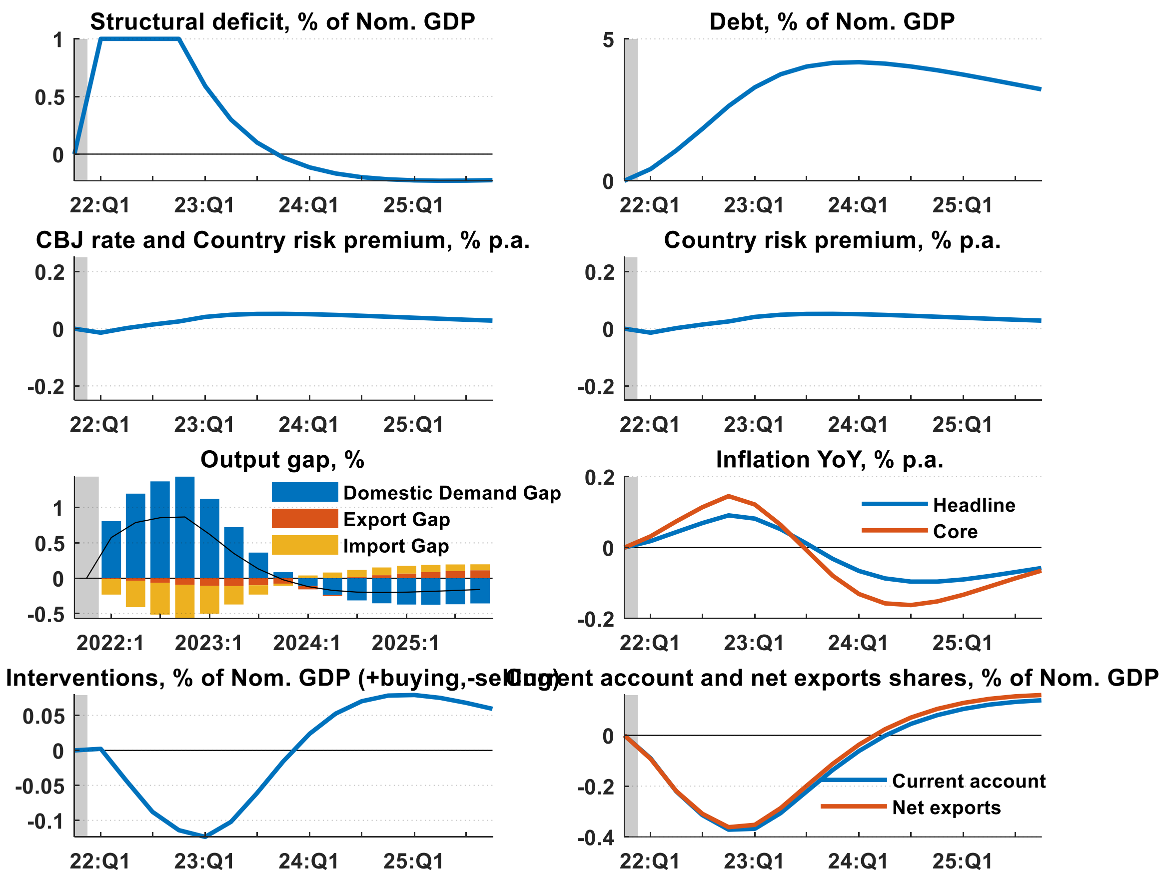
The cost push shock is implemented via a (positive) shock on core inflation, Figure IV.4. A cost push shock in noncore inflation would lead to similar results.

An increase in domestic prices results in worsening of export competitiveness, net exports and current account. Under unchanged net financial inflows, the central bank intervenes (sell FX reserves) to maintain the peg. The worsening of exports also pushes down the output gap despite easy (negative) policy real interest rates. The latter results from higher inflation and inflation expectations under unchanged nominal interest rate (which follows the Fed's under the peg).

The negative output gap creates disinflationary pressures and inflation starts to decelerate with domestic prices gradually returning to their (pre-shock) level.

Domestic Fiscal Stimulus

Figure IV.5: Fiscal stimulus



We analyze the effects of an expansionary fiscal policy shock and illustrate the fiscal-monetary policy interaction in the model. Figure IV.5 present the IRFs to an increase in government spending by 1 percent of nominal GDP over 1 year which translates into a higher structural deficit over the same period. Moreover, the fiscal multiplier is relatively large because under the peg regime the monetary policy cannot fully offset the negative real interest rate. Higher deficits are financed by debt and the debt-to-GDP ratio increases. The debt-to-GDP ratio peaks at about 1 year after the shock. Despite a relatively moderate increase in debt, the country risk premium rises, and the central bank raises the policy rate in response.

The fiscal stimulus to the real economy raises the output gap, creating inflationary pressures. Higher (domestic/foreign) relative prices undermine the competitiveness of exporters and lead to a net trade and current account deficit. Higher domestic demand consistent with a positive output gap leads to higher demand for imports further worsening external trade.

Overall, the different impulse responses of the Jordan Analytical Model confirm that model characteristics are in line with economic intuition.

IV.2 Calibration

The model is calibrated to match the policy transmission mechanism and stylized facts of the Jordanian economy.[55] In calibrating JAM2.0's parameters, we split them into four groups. Each group has different implications for model properties, and model parameters are inferred in a specific way. The grouping of parameters is based on their implications for model properties or based on their structural nature.

The first set of model parameters determines the steady state of the model. Calibration of the steady state parameters is usually informed by in-sample averages of respective variables, and judgments about changes or breaks in such averages over the historical period. Steady-state parameters determine the level where any model-based forecast would converge over the long-term horizon. Therefore, the values of these parameters do not change the dynamics of impulse responses and the business cycle.

The second set of parameters consists of coefficients in structural equations. These equations can be considered as the core of the model determining the business cycle and transmission channels. Micro-foundations of the model and recommendations in the literature provides guidance calibrating these parameters. This set of parameters also relies on recommendations and guidance arising from FINEX (Berg et al 2023). Assessment of these parameters is based on in-sample forecasting performance of the model. Other published models, historical data and evaluating properties of the model by means of impulse response analysis help calibrating coefficients in the QPM equations.

The third set of parameters are those in non-structural equations. Usually, non-structural equations are autoregressive processes. Calibration of coefficients in the reduced form equations is also guided by matching the observed data and ensuring reasonably smooth long-term trends (see Appendix 3 – Model parameters).

Finally, the fourth set of parameters consists of the standard deviations of shocks. Standard deviations of shocks determine only the stochastic properties of the model, leaving dynamic properties unaffected. Standard deviations of shocks are calibrated accounting for the observed variance in the data, ensuring that unobserved and estimated trends in the model in general are less volatile than gaps.

IV.3 Model Simulations to Assess Model Forecasting and Historical Data Interpretation[56]

We apply the model in several simulation exercises: first, in-sample simulations are used to check the ex-post forecasting ability of the model, and second filtration of the historical data and decomposition of observed variables into structural shocks are held to assess historical macroeconomic developments.

IV.3.1 In-Sample Simulations and Forecasting Accuracy

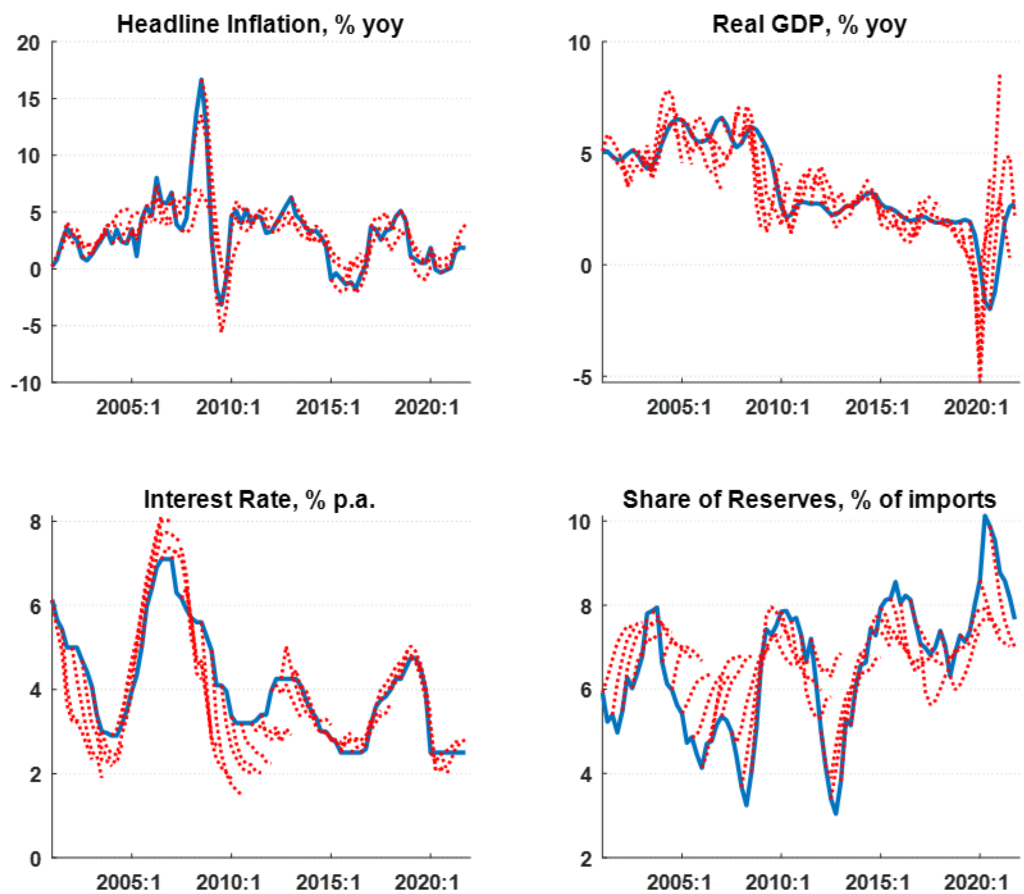
In assessing that a model is reasonably calibrated initially, we check that forecasts do not deviate systematically from the data and that do not contradict macroeconomic intuition. This appears to be broadly the

[55] The FINEX paper provided guidance on calibration, including suggested values of parameters for specific types of economies and monetary policy regimes.

[56] In a number of QPMs, the exercises aimed at assessing how the model fit the data are referred to as "Historical Decomposition" or "Equation Decomposition".

case for JAM2.0.[57] In-sample projections starts from 2001:Q1 and it is assumed that all external (foreign) variables are known over the forecast horizon. All other observed variables are known only until the quarter preceding every forecast realization over the next 6 quarters. No expert judgments are added in this exercise, although in practice this is often the case. Figure IV.6 presents in-sample simulations where dotted red lines are model-based forecasts 6-quarters ahead and solid blue lines are actual data. The model forecasting capabilities are illustrated during the COVID-19 episode (a non-business cycle shock).

Figure IV.6.: In-sample model simulations



Four key variables of interest are analyzed: Inflation (considering the price stability primary objective of the central bank), real GDP growth (to capture the real economy development), policy rate, and reserves as a ratio of imports to reflect the stance of monetary policy and CBJ policy of maintaining adequate reserves in defense of the peg.

Headline inflation has hovered around 3 percent on average and model in-sample forecasts replicate its dynamics well. In particular, the model forecasts are able to predict a sharp drop of inflation in the wake of the

[57] Note that not all deviations of model-based in-sample forecasts from the actual data should be interpreted as shortcomings of the model or of its calibration.

global financial crisis (GFC). Similarly, the period of very low inflation or even the decline of price level after 2015 are also well predicted by the model.

Real GDP growth declined to a level below 3 percent after the GFC. The model-based forecasts of GDP are slightly more volatile compared to the actual data. This occurs mainly before the GFC. The higher volatility of forecasts comes from the fact that model-based forecasts for GDP are compiled from forecasts of individual components.

As a result, forecast errors in GDP components might multiply themselves once GDP is put together. Finally, the calibration of the model is heavily affected by the COVID-19 shock. Hence, model calibration should be finetuned once the effects of the COVID shock fade away.

Model-based forecasts perform well for the main policy variables. First, the nominal interest rate forecasts capture well the actual data. This might be considered as a natural outcome observing the foreign interest rate and the country risk premium is endogenously determined in the model. Second, the trend of the share of reserves on imports is also well predicted by the model.

In summary, the model forecasts are unbiased, in that the model forecasts do not deviate in a systematic and persistent way from the actual data, and mean errors as reported in Table IV.1. (over the one to six quarters horizon) are relatively small and, in some cases, change sign over the forecast horizon.

Additionally, we compare the root mean square forecast errors (RMSEs) for JAM2.0 and those for the random walk (RW) benchmark to further evaluate the forecasting ability of JAM2.0 over the one to six quarters horizon (Table IV.1). A reported ratio less than 1, indicates that the JAM2.0 model forecast outperforms the RW for the respective variable and forecasting horizon. Overall, the RMSEs are better than those of the RW benchmark or at least comparable to those of the RW. For the interest rate and reserves ratio they are not discernably different in the short run, but the RMSE is better over the medium-term horizon. Inflation forecasts based on the JAM2.0 model are more accurate than those of the RW over all horizons. As for the forecasts of real GDP growth based on the model, they are relatively volatile compared to the data and the RMSEs do not fare well exhibiting a ratio above 1 over the entire horizon. This feature of the model can be improved with better quality / disaggregated GDP data availability. For example, missing deflators and consequently real GDP subcomponents has impeded the model's forecasting ability.

Although assessments of model-based forecasts is critical, forecast precision should be carefully interpreted.[58]

Table IV.1. In-sample forecasts statistic properties

Table: Mean errors

Mean error	Horizon					
	1q	2q	3q	4q	5q	6q
Inflation YoY	-0.01	-0.03	-0.03	-0.05	-0.09	-0.13
GDP growth YoY	-0.07	-0.09	-0.10	-0.10	-0.02	0.07
Interest rate	-0.11	-0.19	-0.26	-0.31	-0.36	-0.39
Share of reserves	-0.01	0.04	0.12	0.19	0.24	0.29

Table: RMSE relative to random walk

	Horizon					
	1q	2q	3q	4q	5q	6q
Inflation YoY	0.53	0.51	0.50	0.50	0.51	0.56
GDP growth YoY	2.53	1.55	1.06	0.87	1.19	1.34
Interest rate	1.22	1.05	0.91	0.78	0.71	0.64
Share of reserves	1.18	1.05	0.94	0.85	0.79	0.74

[58] The "forecasting performance" of JAM2.0 has focused on the knowledge obtained during the forecasting process and the ex-post forecast evaluation following regular forecast rounds. Specifically, one should assess if the forecast has correctly signaled the need for a policy adjustment and helped communicate the reasons for changing the policy stance to the decision makers and the public. This is a more useful assessment for policymaking purposes than those of purely statistical-based assessments.

IV.3.1.A Historical filtration of the data and its interpretation

In further evaluating the calibration of the model and its ability to interpret the data, filtration of the historical data and decomposition of observed variables into structural shocks are conducted.

We begin by presenting results from the historical data filtration exercise, using the JAM2.0 model, with the purpose to demonstrate the capability of the model to interpret the data and provide a reasonable and comprehensive story of developments of the Jordanian economy. The filtration of the data provides a cross-check of model calibration.

Two outcomes of model filtration of the data are key. First, provide an estimate of unobserved variables, such as gaps and trends (equilibriums). Estimated gaps and trends help to compile an economic story of past developments and consequently identify underlying disinflationary / inflationary pressures. Second, identify underlying shocks in structural equations. These shocks should ideally be unbiased in their means and autocorrelations. The identified historical shocks also help to understand which major shocks hitting the economy cause economic fluctuations, based on the premise that shocks cause business cycle fluctuations, and cause economic variables to move away from their equilibriums (gaps opening).

We next describe past developments of the Jordanian economy based on the filtration outcomes. Besides gaps and trends, two model-based decompositions are conducted. First, decompositions based on model equations track the driving forces / explanatory variables of a decomposed variable. This links each variable to the other variables in the model. Second, each variable is decomposed into all the underlying economic shocks in the model.[59] Both types of decompositions seek to underpin the economic narrative. The first decompositions provide the driving forces in terms of model variables, whereas the second decompositions focus on the origin – the shocks – of these driving forces. For example, the domestic demand gap might be driven by foreign demand in the equation-based decomposition but the underlying shock causing the shift of foreign demand might be demand, supply, or monetary policy shocks which can be read from the decomposition to shocks.

The two decompositions are complementary, however, and together provide a model-consistent interpretation of historical drivers of say inflation and real economic activity (and components). The economic story based on filtration outcomes below is discussed by blocks, with the focus set primarily on unobserved variables.

Inflation

Headline inflation has remained in single digit levels most of the time (Figure IV.7), with one exception prior to the global financial crises (GFC). Decomposing headline inflation into core and non-core, core inflation is relatively smooth by design and accordingly due to its contribution. The main contributor to the volatility of yoy headline inflation is non-core inflation, mainly energy items.

Under the exchange rate peg, inflation should primarily follow the price dynamics of the country's trading partners. This should be obvious from the decomposition of real marginal costs for core and non-core inflation. When real marginal costs go up, inflation should follow. Figure IV.8 presents core inflation and model-based estimate of its real marginal costs – when the latter are positive, inflationary pressures and core inflation tends to increase and vice-versa. The shape of the real marginal costs reveals that there were strong inflationary

[59] To make this decomposition readable, shocks are grouped based on economic meaning and implications to key macroeconomic variables. As such, four main groups of shocks are of focus: demand (domestic), supply (domestic), foreign shocks and world commodity prices, and fiscal shocks. Remaining shocks are grouped in one "others" category. There is no group of monetary policy shocks as the exchange rate regime is a peg, and contributions of monetary policy shocks to macroeconomic variables have not been significant in the past.

pressures prior to the GFC, while the COVID-19 shocks brought disinflationary pressures which rapidly turned inflationary early 2022 (not shown).

Figure IV.7: **Headline inflation and its breakdown**, inflation % yoy and contributions in p.p.

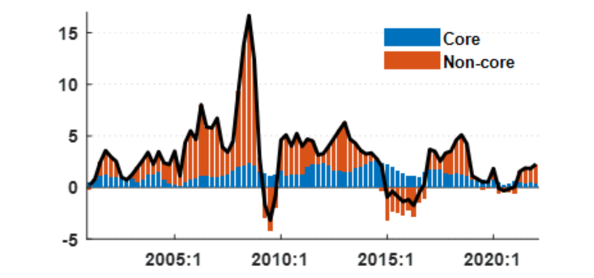
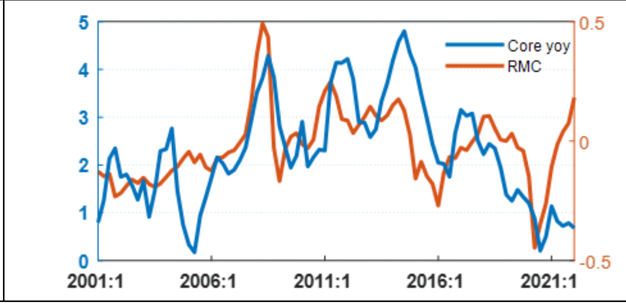


Figure IV.8: **Core inflation** (yoy %, left axis) **and real marginal costs** (% right axis)



The decomposition of real marginal costs for core inflation (Figure IV.9), shows the contribution of four factors to core inflation dynamics: domestic demand, approximated by the output gap; the effects of foreign prices, captured by the real exchange rate gap; commodity prices, as world oil and food prices affect core price inflation; [60] and a relative price gap, capturing the pass-through of non-core prices to core. Foreign prices along with commodity prices have mostly driven the variability of real marginal costs.

Figure IV.9: **Decomposition of real marginal costs for core inflation**, %

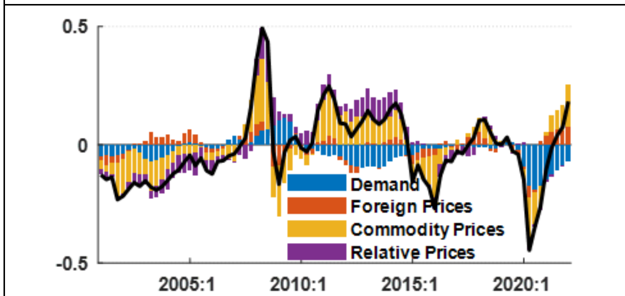
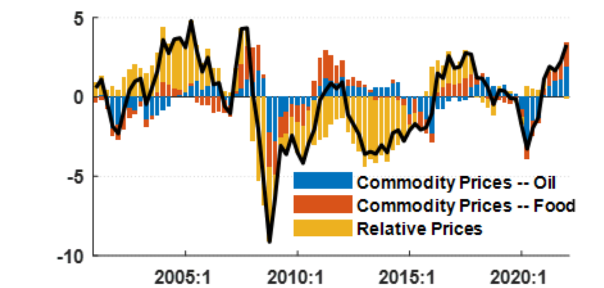


Figure IV.10: **Decomposition of real marginal costs for non-core inflation**, %



Non-core real marginal costs rose prior to the GFC and in early 2022, creating pressures on non-core prices (Figure IV.10). Non-core inflation pressures have been dominated by world commodity prices, and also by a relatively strong contribution from relative prices. Although the effects of relative prices should capture the pass-through of core to non-core prices, their large contribution is probably related to government smoothing of non-core prices by imposing tariffs and other measures.

Decomposition of shocks shows that headline inflation is mainly driven by supply (cost push) shocks and foreign and commodity price shocks. Headline inflation deviation from an implicit target[61] is shown in Figure IV.11. The contribution of foreign and commodity prices exerting inflationary pressures is particularly strong in 2022, with domestic supply shocks also affecting inflation dynamics significantly. The high contribution

[60] Core inflation is defined based on less volatile items. The decomposition does not reflect the type of goods and as a result, core inflation encompasses some items affected by oil prices and some food items.
[61] The target implied by the peg and underlying real convergence trends.

of supply shocks should be tied to non-core inflation supported by dynamics from the core inflation decomposition (Figure IV.12), where supply shocks albeit important, do not dominate. Core inflation is driven mainly by foreign and commodity price shocks. Back to Figure IV.11, the contributions of demand and fiscal shocks, while present, are relatively moderate.

Figure IV.11: **Decomposition to shocks – Headline inflation deviation from an implicit target**, pp

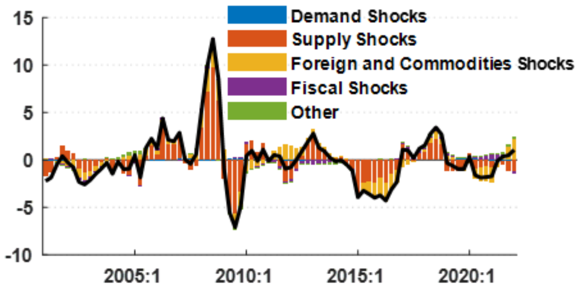
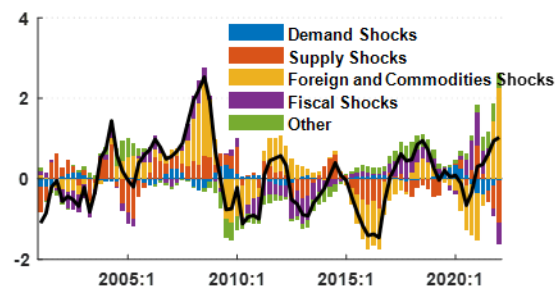


Figure IV.12: **Decomposition to shocks – Core inflation deviation from an implicit target**, pp



Real economic activity

The output gap (as identified using the model) is a proxy for inflationary pressures coming from the demand side of the economy (Figure IV.13). The output gap was positive prior to the GFC, creating inflationary pressures, which then started to decline in the wake of the GFC and become disinflationary for a brief period in 2013. A positive output gap is also identified prior to COVID-19, albeit very small compared to the earlier period, followed by a significant drop in economic activity as a result of COVID-19, represented by a large negative output gap.

Consistent with the identified output gap, real economic growth began to decline from a high of about 6 percent to 2 percent, following the GFC. Along with the observed dynamics of GDP growth, the trend growth (a slow and smoothly evolving process) has also trended downward (Figure IV.14).

Figure IV.13: **Output gap, %**

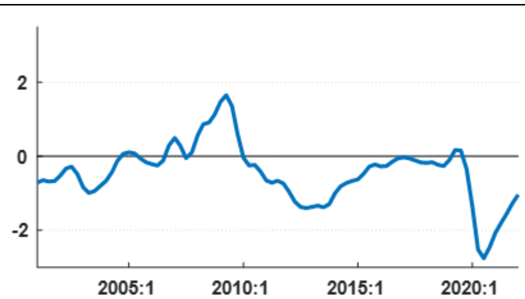
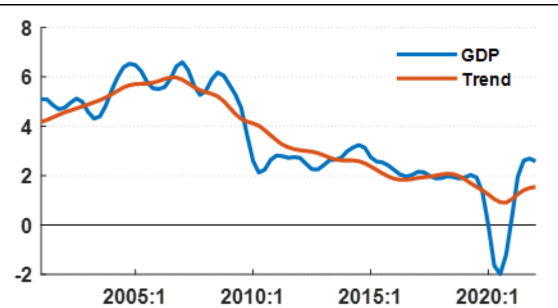


Figure IV.14: **Real GDP growth and trend, yoy in %**



The output gap in the model is disaggregated into domestic demand gap and export and import gaps (Figure IV.15). The decomposition shows that domestic demand is mostly offset by net exports. Prior to the COVID-19 shock the positive output gap was mainly driven by net exports – mostly tourism and favorable commodity prices. However, with the onset of COVID-19, its contribution turned sharply negative because of lockdowns and a drop in tourism, with domestic demand partly compensating.

In terms of shocks, the output gap is affected mainly by demand, fiscal policy, and by foreign shocks (Figure IV.16). The significant contribution of shocks originating in the fiscal block of the model underlines its importance in explaining the data. It was also clear that fiscal policy was countercyclical during the COVID-19 episode.

Figure IV.15: **Output gap breakdown**, pp

Note: Contributions of gaps are non-linear and linear approximation is presented here. As a result, there is approximation discrepancy.

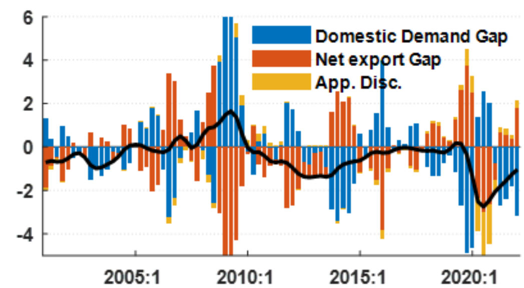
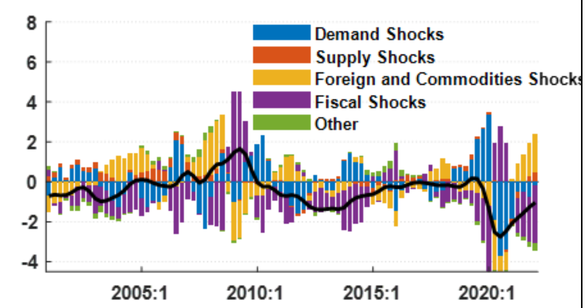


Figure IV.16: **Output gap decomposition to shocks**, in pp



The domestic demand gap exhibited a sharp decline in the wake of the COVID-19 shock (Figure IV.17). During 2007-2012, the domestic demand gap was positive, driving up the overall the output gap. Starting in 2013 until the onset of COVID-19, the domestic demand gap was close to neutral. Following the equation-based decomposition of the domestic demand gap (Figure IV.18), the gap was driven mainly by income factors (including the effects of fiscal policy), the output gap as a proxy for labor income, the remittance gap, and purchasing power effects (denoted as Income), with intertemporal substitution as captured by the real interest rate gap also playing an important role. The effects of domestic demand shocks are relatively modest, which implies that the model equation can explain domestic demand dynamics well.

Figure IV.17: **Domestic demand gap**, %

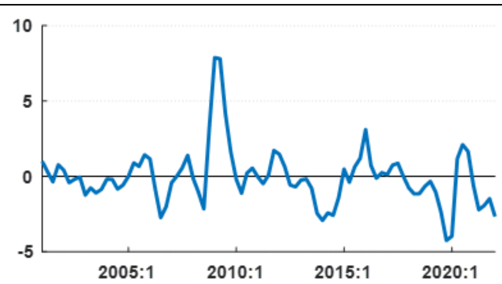
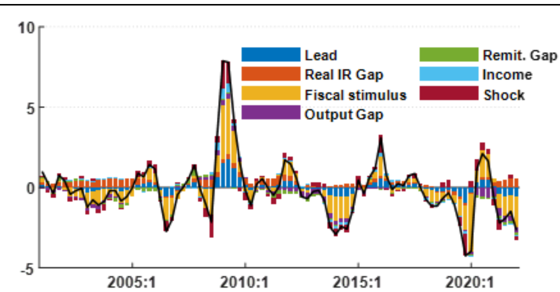


Figure IV.18: **Domestic demand gap decomposition**, pp



The decomposition of domestic demand gap to shocks (Figure IV.19) supports the story highlighted above. The gap is driven mainly by fiscal shocks and by foreign shocks, with some contribution from supply shocks, while demand shocks appear to be modest.

The export and import gaps are more volatile than domestic demand (Figure IV.20). The export gap was positive prior to the GFC and COVID-19, with the positive contribution suppressed significantly with the advent of COVID-19. The decomposition of the export gap (following the model equation) is driven predominantly by competitiveness (relative prices) and foreign demand (see Figure IV.21). This is consistent with the decomposition of the export gap's contribution of shocks (Figure IV.22). The demand shocks, including the export gap shocks, along with foreign prices, are the main drivers of the export gap.

Figure IV.19: **Domestic demand gap decomposition to shocks**, pp

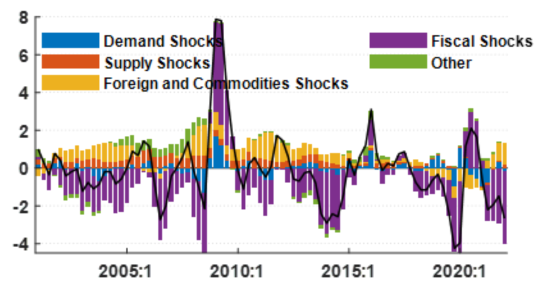


Figure IV.20: **Export and import gaps**, %

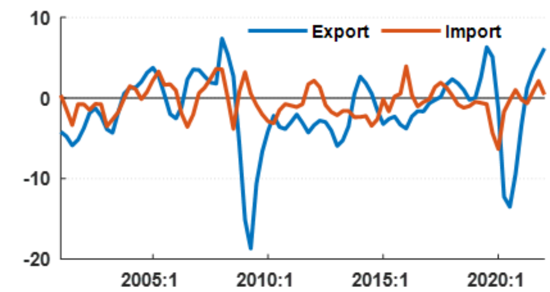


Figure IV.21: **Export gap decomposition**, pp

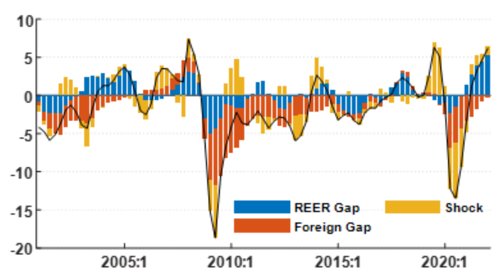
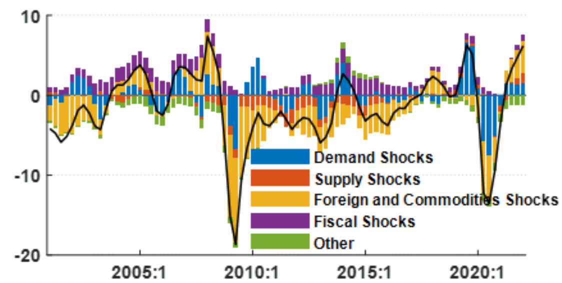


Figure IV.22: **Export gap decomposition to shocks**, pp



There is a clear co-movement of export and import gaps, as imports are used to produce exports. Imports are also affected by domestic demand. Contributions of domestic demand and export gaps are visible from equation-based decomposition (Figure IV.23). The shock in the equation plays an important role. In line with the above, the import gap is driven mainly by demand and fiscal shocks (Figure IV.24). Fiscal shocks drive imports through effects on domestic demand.

Figure IV.23: **Import gap decomposition**, pp

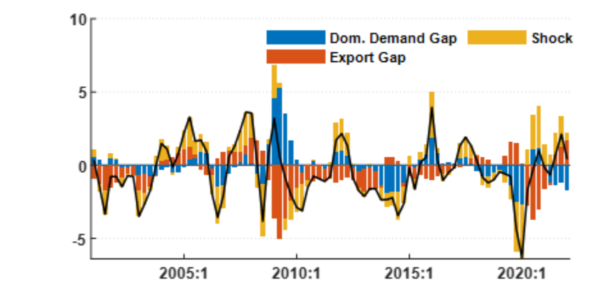
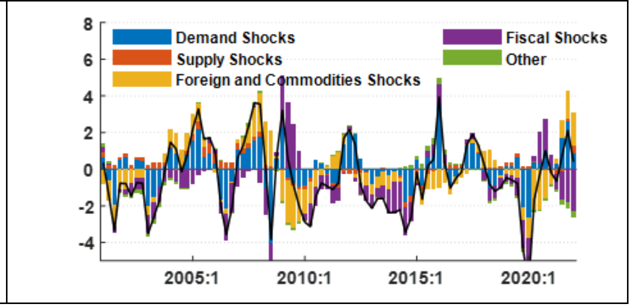


Figure IV.24: **Import gap decomposition to shocks**, pp



Monetary conditions

Monetary conditions capture the effects of monetary policy on the real economy. These conditions consist of two components: the real interest rate gap (which captures effects of the real rate on intertemporal substitution); and the real exchange rate gap (describing intra-temporal substitution between domestic and foreign goods).

The negative real interest rate gaps observed since the beginning of 2020 suggests an accommodative monetary policy (Figure IV.25). The easing of monetary policy is given by the low level of the real interest rate, which means that the nominal interest rate was relatively low when compared to inflation. Under the pegged exchange rate regime, easing monetary policy is not driven by the Jordanian monetary policy but implied from abroad.

Figure IV.25: **Real interest rate gap**, %

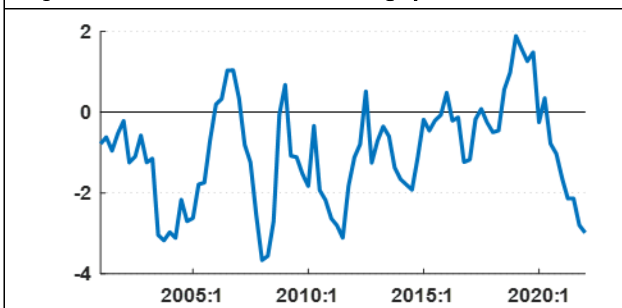
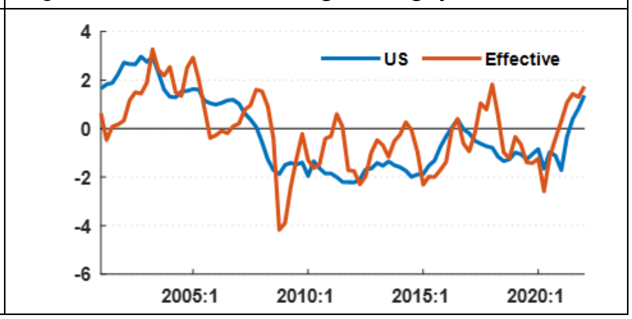
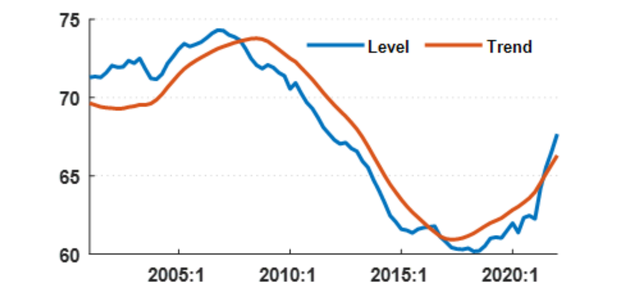


Figure IV.26: **Real exchange rate gaps**, %



The RER depreciation is observed since 2019 in the data, as measured by the RER gap (Figure IV.26). However, a part of this depreciation is interpreted by the model as a trend. This means that the RER appreciation trend observed in 2008-2015 switched to depreciation, consistent with the real GDP growth slowdown experienced after the GFC.

Figure IV.27: **Real exchange rate with respect to the US**, 100*log



Fiscal policy

Fiscal policy plays an important role in shaping the dynamics of the real economy in Jordan. Fiscal data are available on an annual frequency, and are interpolated to quarterly frequency based on model structure and observations.

The government debt-to-GDP ratio increased gradually. Following a decline during 2001-2010, the debt-to-GDP ratio has risen continuously to reach and surpass 100 percent (Figure IV.28). A sharp increase was evident coinciding with the start of COVID-19, which triggered the sizeable government support measures. Based on model estimates, consistent with the increasing debt-to-GDP ratio, the implicit target (in line with the debt sustainability analysis (DSA)) for debt also rose. This assessment is consistent with gradually rising premiums for government borrowing (Figure IV.29), inferred from the data by the model filtration.

Figure IV.28: **Government Debt-to-GDP**, %

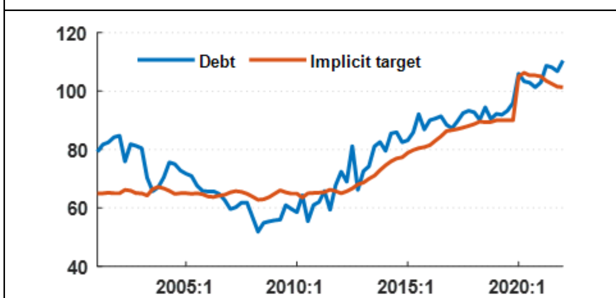
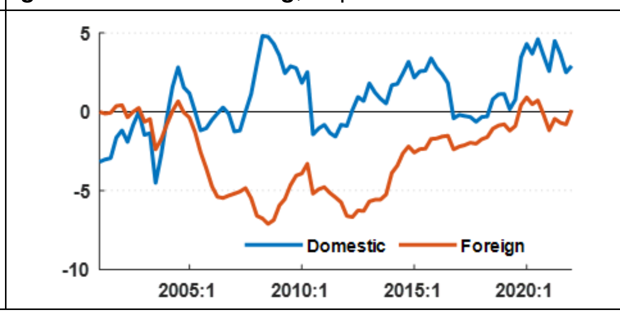
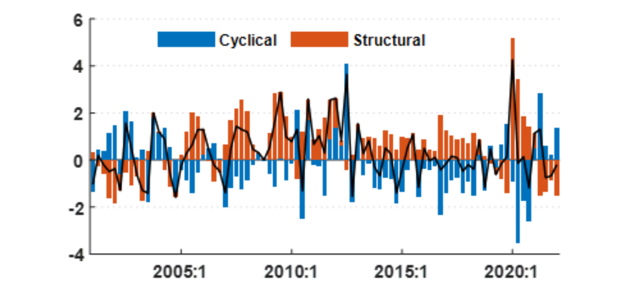


Figure IV.29: **Implied term premium for government borrowing**, % p.a.



Primary deficits increased in the wake of the GFC and the COVID-19 pandemic. Rising deficits in response to adverse economic shocks suggest a countercyclical fiscal policy. The model-based breakdown of primary deficits into cyclical and structural parts provides a similar story – structural deficits increased in 2008-2010 and in 2020.

Figure IV.30: **Decomposition of primary deficit on GDP**, %



Monetary policy

Monetary policy operates under a pegged exchange rate regime with free capital flows. Policy and short-term market interest rates closely follow the Fed funds rate (Figure IV.31). The spread between the Jordanian rate and the Fed funds rate rose in the wake of the GFC, given the flight to quality experienced at that time. Since 2015, the interest rate differential was roughly constant, capturing the country risk premium in JAM 2.0.

The CBJ has been gradually accumulating FX reserves, which reached 8 months of imports at end-2021 (Figure IV.32). Historically, this reserves ratio has fluctuated between 3 and 10 months in the past. As a share of nominal GDP, FX reserves have gradually increased, driven mainly by valuation effects and accumulation of reserves (Figure IV.33). The volatility in the stock of reserves/ratio is driven by FX interventions.

Figure IV.31: **Nominal interest rates and spread**, %

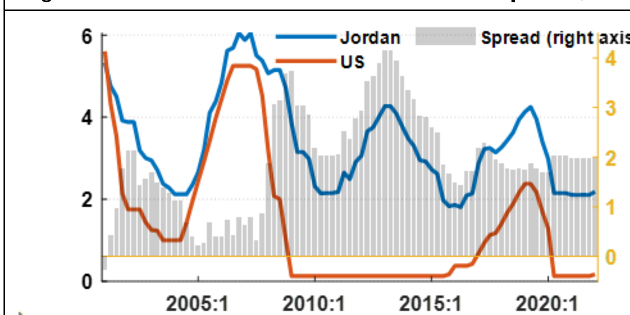
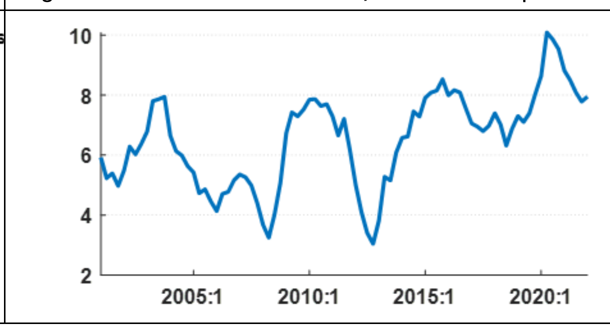


Figure IV.32: **FX reserve ratio,** months of imports



The CBJ intervenes in the FX market in order to maintain the exchange rate peg. Besides capital flows induced by interest differentials and current account related flows (Figure IV.34), the CBJ responds to one-off shocks and capital swings (labeled as “shocks”) in the Figure. Furthermore, CBJ activity in the FX market reflects the current stock of FX reserves, and the reserve coverage of imports.

Figure IV.33: **FX reserve ratio,** % of nom. GDP

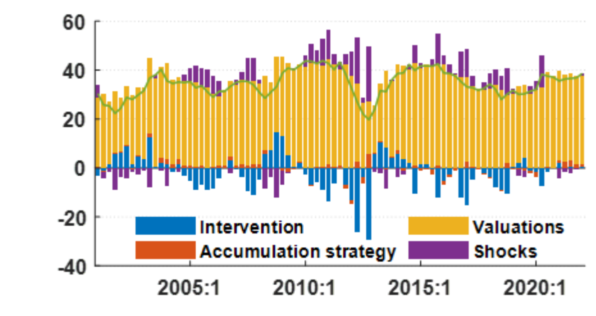
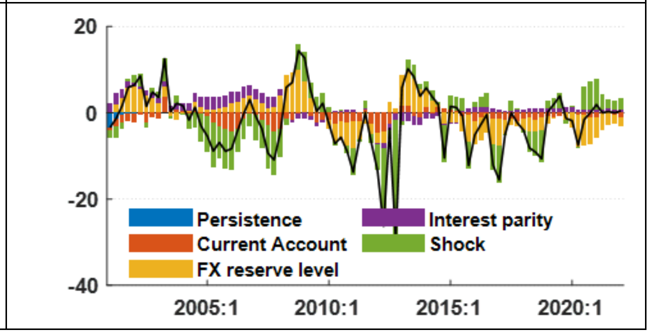


Figure IV.34: **FX interventions,** % of nom. GDP



V. Conclusion

This paper presents a revised semi-structural model of the Jordanian economy, the JAM2.0. The model is based on the framework of a QPM and can be described as an open economy New Keynesian general equilibrium model, which incorporates recent developments and structural changes in the Jordanian economy. The aim is to create a robust model that fits the Jordanian empirical evidence while maintaining theoretical consistency and takes into account Jordan's fixed exchange rate regime.

In extensions made to the standard QPM as used by central banks, the CBJ-IMF co-developers of the JAM2.0 introduced disaggregated demand components and multiple Phillips curves to capture factors influencing output and inflation dynamics in Jordan.[62] The fiscal block has explicitly considered the currency structure of public debt, allowing for a more accurate representation of fiscal policy-monetary policy interactions. The external sector was also expanded to incorporate FX interventions for reserve accumulation, taking into account the UIP condition. While the model as presented in this paper already captures important aspects of the Jordanian economy, future extensions could incorporate additional features. This could include the inclusion of real-financial sector linkages, labor market and wage variables, and a more detailed analysis of fiscal policy dynamics. The flexible nature of the JAM2.0 allows for these and other extensions to be considered and integrated as further data becomes available and as understanding of the economy evolve.

The JAM2.0 has become the central component of the modeling and forecasting framework at the CBJ. It has emphasized its forward-looking nature, stressing that monetary policy actions have an impact on expectations, which in turn influence the behavior of consumers and firms. In forecasting, the JAM2.0 has provided medium-term baseline projections for key macroeconomic variables, offering a coherent and comprehensive narrative of the Jordanian economic outlook. These projections have been generated by integrating inputs from various short-term forecasting tools, satellite models, and expert judgment. In addition to the baseline projections, the model has also been used to generate alternative forecast scenarios and conduct counterfactual analyses, allowing policymakers to assess the potential risks and uncertainties that the economy may face, and help in designing appropriate policy responses.

In fitting to the characteristics of the Jordanian economy, the calibrated model, subject to future re-parameterization as needed, has demonstrated its ability to capture the transmission channels of relevant structural shocks in a theoretically-consistent manner. This is reflected in the reasonable IRFs generated by the

[62] To address the limited availability of certain data, such as the expenditure-side of GDP at a quarterly frequency, efforts are being made by the DOS to obtain disaggregated quarterly GDP data (using an expenditure approach) by 2024.

model. Through simulation and forecasting exercises, JAM2.0 has shown its capability to produce reliable forecasts of key macroeconomic variables, such as inflation and output growth. These forecasts have outperformed a benchmark random walk model, indicating the model's ability to explain important relationships and transmission mechanisms within the Jordanian economy. While the model has formed the foundation of the analysis, expert judgment has also played a significant role in the modeling process. This has allowed for the incorporation of developments that may fall outside the model's specific structure, ensuring that the model's data fit remains robust and reflective of economic realities.

From the perspective of policymakers, JAM2.0 should continue to prove to be a valuable tool that quantifies the potential impacts of their policy actions on the economy. It provides a clear understanding of the trade-offs that policymakers face in their decision-making process. One of the key strengths of JAM2.0 is its ability to transparently communicate the expected trajectory of key operating targets over the forecast horizon. This enables policymakers to assess the necessary actions that need to be taken to achieve the policy objectives of maintaining price stability and preserving the viability of the pegged exchange rate regime.

Furthermore, a key contribution of JAM2.0 to the existing literature and the IMF's suite of quantitative policy models is three-fold. First, JAM2.0 has extended the FINEX framework into a pegged exchange rate regime. Second, the model has emphasized the importance of understanding and analyzing the channels and trade-offs between interest rate, FXI, and fiscal policies in achieving price, macroeconomic and financial stability, in line with the IMF's Integrated Policy Framework channels and mechanisms. This contribution has expanded the existing literature and provided valuable insights for policymakers in designing effective policy strategies. And third, JAM2.0 has enhanced the CBJ's ability to make informed decisions and formulate effective policies, by providing a comprehensive and dynamic framework for macroeconomic analysis and forecasting. Going forward, the JAM2.0 should serve as a powerful tool for policymakers, enabling them to quantify the effects of their policy actions, understand the associated trade-offs, and ensure that their decisions align with the long-term objectives of the CBJ.

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Appendix 1: List of JAM2.0 model variables

Real Aggregate Demand		
Code	**Name**	**Unit**
	GDP	
Y	GDP: Real volume	level
y	GDP: Real volume	100*log
$\hat{y}$	GDP: Gap	% dev. from its trend
$\bar{y}$	GDP: Trend	100*log
Δy	GDP: Real volume	%, QoQ changes, annualized
$\Delta^4 y$	GDP: Real volume	%, YoY changes
$\Delta\bar{y}$	GDP: Trend	%, QoQ changes, annualized
$\Delta^4\bar{y}$	GDP: Trend	%, YoY changes
	Domestic demand	
DD	Domestic demand: Real volume	level
dd	Domestic demand: Real volume	100*log
$\widehat{dd}$	Domestic demand: Gap	% dev. from its trend
$\overline{dd}$	Domestic demand: Trend	100*log
Δdd	Domestic demand: Real volume	%, QoQ changes, annualized
$\Delta^4 dd$	Domestic demand: Real volume	%, YoY changes
$\Delta\overline{dd}$	Domestic demand: Trend	%, QoQ changes, annualized
$\Delta^4\overline{dd}$	Domestic demand: Trend	%, YoY changes
dd^{rat}	Domestic demand: Nominal ratio	% of nominal GDP
$\overline{dd}^{rat}$	Domestic demand: Nominal ratio trend	% of nominal GDP trend
	Export	
X	Export: Real volume	level
x	Export: Real volume	100*log
$\hat{x}$	Export: Gap	% dev. from its trend
$\bar{x}$	Export: Trend	100*log
Δx	Export: Real volume	%, QoQ changes, annualized
$\Delta^4 x$	Export: Real volume	%, YoY changes
$\Delta\bar{x}$	Export: Trend	%, QoQ changes, annualized
$\Delta^4\bar{x}$	Export: Trend	%, YoY changes
x^{rat}	Export: Nominal ratio	% of nominal GDP
$\bar{x}^{rat}$	Export: Nominal ratio trend	% of nominal GDP trend
	Import	
M	Import: Real volume	level
m	Import: Real volume	100*log
$\hat{m}$	Import: Gap	% dev. from its trend
$\bar{m}$	Import: Trend	100*log
Δm	Import: Real volume	%, QoQ changes, annualized
$\Delta^4 m$	Import: Real volume	%, YoY changes
$\Delta\bar{m}$	Import: Trend	%, QoQ changes, annualized
$\Delta^4\bar{m}$	Import: Trend	%, YoY changes
m^{rat}	Import: Nominal ratio	% of nominal GDP
$\bar{m}^{rat}$	Import: Nominal ratio trend	% of nominal GDP trend

Aggregate Supply		
Code	**Name**	**Unit**
CPI: Headline, Core, Non-Core and GDP deflator		
cpi	CPI: Headline index	100*log
Δcpi	CPI: Headline	%, QoQ changes, annualized
$\Delta^4 cpi$	CPI: Headline	%, YoY changes
cpi^{core}	CPI: Core index	100*log
Δcpi^{core}	CPI: Core	%, QoQ changes, annualized
$\Delta^4 cpi^{core}$	CPI: Core	%, YoY changes
rmc^{core}	Real marginal cost: Core	%
cpi^{ncore}	CPI: Non-Core index	100*log
Δcpi^{ncore}	CPI: Non-Core	%, QoQ changes, annualized
$\Delta^4 cpi^{ncore}$	CPI: Non-Core	%, YoY changes
rmc^{ncore}	Real marginal cost: Non-Core	%
$defl^{GDP}$	GDP deflator index	100*log
$\Delta defl^{GDP}$	GDP deflator	%, QoQ changes, annualized
$\Delta^4 defl^{GDP}$	GDP deflator	%, YoY changes
Relative prices		
rp	Relative price of core: Index	100*log
$\widehat{rp}$	Relative price of core: Gap	% dev. from its trend
$\overline{rp}$	Relative price of core: Trend	100*log
$\Delta\overline{rp}$	Relative price of core: Trend	%, QoQ changes, annualized
rp^X	Relative price of export: Index	100*log
$\overline{rp}^X$	Relative price of export: Trend	100*log
rp^M	Relative price of import: Index	100*log
$\overline{rp}^M$	Relative price of import: Trend	100*log

Monetary policy		
Code	**Name**	**Unit**
Monetary policy		
re	Real exchange rate: Index (USD/JOD)	100*log
$\widehat{re}$	Real exchange rate: Gap	% dev. from its trend
$\overline{re}$	Real exchange rate: Trend	100*log
$\Delta\overline{re}$	Real exchange rate: Trend	%, QoQ changes, annualized
Δcpi^{TAR}	Implicit Headline CPI target	%, QoQ changes, annualized
$\Delta cpi^{core,TAR}$	Implicit Core CPI target	%, QoQ changes, annualized
$\Delta cpi^{ncore,TAR}$	Implicit Non-Core CPI target	%, QoQ changes, annualized
i	CBJ Interest rate	%
r	Real Interest Rate	%
$\hat{r}$	Real Interest Rate: Gap	%
$\bar{r}$	Real Interest Rate: Trend	%
e	Nominal exchange rate: Index (USD/JOD)	100*log
Δe	Nominal exchange rate	%, QoQ changes, annualized
$\Delta^4 e$	Nominal exchange rate	%, YoY changes
$prem$	Country Risk Premium	%
$\widehat{prem}$	Country Risk Premium: Gap	%
$\overline{prem}$	Country Risk Premium: Trend	%
fxi^{rat}	FX-Interventions	% of nominal GDP
$\overline{fxa}^{rat}$	FX-reserve accumulation: Trend	% of nominal GDP trend
$fxres^{rat}$	FX-reserve: Total	% of nominal GDP
$\overline{fxres}^{rat}$	FX-reserve: Trend	% of nominal GDP trend
$fxres^{ratimp}$	FX-reserve: Total	in months of import
$\overline{fxres}^{ratimp}$	FX-reserve: Trend	in months of import
$\widehat{fxres}^{ratimp}$	FX-reserve: Gap	in months of import

Balance of payment

Code	Name	Unit
ca^{rat}	Current Account: Nominal ratio total	% of nominal GDP
$\overline{ca}^{rat}$	Current Account: Nominal ratio trend	% of nominal GDP trend
$\widehat{ca}^{rat}$	Current Account: Nominal ratio gap	% of nominal GDP
nx^{rat}	Net Export: Nominal ratio total	% of nominal GDP
$\overline{nx}^{rat}$	Net Export: Nominal ratio trend	% of nominal GDP trend
$\widehat{nx}^{rat}$	Net Export: Nominal ratio gap	% of nominal GDP
$remit^{rat}$	Remittances: Nominal ratio total	% of nominal GDP
$\overline{remit}^{rat}$	Remittances: Nominal ratio trend	% of nominal GDP trend
$\widehat{remit}^{rat}$	Remittances: Nominal ratio gap	% of nominal GDP
oth^{rat}	Other foreign income: Nominal ratio total	% of nominal GDP
$\overline{oth}^{rat}$	Other foreign income: Nominal ratio trend	% of nominal GDP trend
$\widehat{oth}^{rat}$	Other foreign income: Nominal ratio gap	% of nominal GDP
fa^{rat}	Financial Account: Nominal ratio total	% of nominal GDP
$\overline{fa}^{rat}$	Financial Account: Nominal ratio trend	% of nominal GDP trend
$\widehat{fa}^{rat}$	Financial Account: Nominal ratio gap	% of nominal GDP
nfp^{rat}	Private sector foreign financing: Nominal ratio total	% of nominal GDP
$\overline{nfp}^{rat}$	Private sector foreign financing: Nominal ratio trend	% of nominal GDP trend
$\widehat{nfp}^{rat}$	Private sector foreign financing: Nominal ratio gap	% of nominal GDP

Fiscal variables		
Code	**Name**	**Unit**
$intcost^{rat}$	Debt service: Total	% of nominal GDP
$intcost^{rat,TAR}$	Debt service: Total	% of nominal GDP trend
$intcost^{d,rat}$	Debt service: LCY	% of nominal GDP
$intcost^{d,rat,TAR}$	Debt service: LCY	% of nominal GDP trend
$intcost^{f,rat}$	Debt service: FCY	% of nominal GDP
$intcost^{f,rat,TAR}$	Debt service: FCY	% of nominal GDP trend
$i4^{d}$	1Y LCY Interest rate	%
$\overline{i4}^{d}$	1Y LCY Interest rate: Trend	%
$tprem^{d}$	1Y LCY Term premium	%
$i4^{*}$	1Y FCY Interest rate	%
$\overline{i4}^{*}$	1Y FCY Interest rate: Trend	%
$tprem^{f}$	1Y FCY Term premium	%
$debt^{rat}$	Public Debt: Total	% of nominal GDP
$debt^{rat,TAR}$	Public Debt: Total Target	% of nominal GDP trend
$debt^{d,rat}$	Public Debt: LCY	% of nominal GDP
$debt^{d,rat,TAR}$	Public Debt: LCY Target	% of nominal GDP trend
$debt^{f,rat}$	Public Debt: FCY	% of nominal GDP
$debt^{f,rat,TAR}$	Public Debt: FCY Target	% of nominal GDP trend
$debt1Y^{d,rat}$	Public Debt: LCY	% of nominal GDP
$debt1Y^{f,rat,TAR}$	Public Debt: LCY Target	% of nominal GDP trend
$debt1Y^{f,rat}$	Public Debt: FCY	% of nominal GDP
$debt1Y^{f,rat,TAR}$	Public Debt: FCY Target	% of nominal GDP trend
def^{rat}	Government Balance: Total	% of nominal GDP
$def^{rat,TAR}$	Government Balance: Target	% of nominal GDP trend
$primdef^{rat}$	Primary Deficit: Total	% of nominal GDP
$defstruct^{rat}$	Primary Deficit: Cyclically Adjusted	% of nominal GDP
$defcycle^{rat}$	Primary Deficit: Cyclically Part	% of nominal GDP
$edebtdev^{rat}$	Debt deviation term	% of nominal GDP
$fiscimp^{rat}$	Fiscal Impulse	% of nominal GDP
θ	LCY Financing share	%/100
$defstruct^{rat,TAR}$	Primary Deficit: Target	% of nominal GDP trend

Foreign variables		
Code	**Name**	**Unit**
Relative prices: Commodities		
pc^{oil}	Oil price: Index, USD	100*log
rpc^{oil}	Relative price of oil: Index	100*log
$\widehat{rpc}^{oil}$	Relative price of oil: Gap	% dev. from its trend
$\overline{rpc}^{oil}$	Relative price of oil: Trend	100*log
$\Delta\overline{rpc}^{oil}$	Relative price of oil: Trend	%, QoQ changes, annualized
pc^{food}	Food price: Index, USD	100*log
rpc^{food}	Relative price of food: Index	100*log
$\widehat{rpc}^{food}$	Relative price of food: Gap	% dev. from its trend
$\overline{rpc}^{food}$	Relative price of food: Trend	100*log
$\Delta\overline{rpc}^{food}$	Relative price of food: Trend	%, QoQ changes, annualized
pc^{phos}	Phosphate price: Index, USD	100*log
rpc^{phos}	Relative price of phosphate: Index	100*log
$\widehat{rpc}^{phos}$	Relative price of phosphate: Gap	% dev. from its trend
$\overline{rpc}^{phos}$	Relative price of phosphate: Trend	100*log
$\Delta\overline{rpc}^{phos}$	Relative price of phosphate: Trend	%, QoQ changes, annualized
US and other trading partners		
cpi^{US}	US CPI: Headline index	100*log
Δcpi^{US}	US CPI: Headline	%, QoQ changes, annualized
$\Delta^4 cpi^{US}$	US CPI: Headline	%, YoY changes
i^{US}	US FED Interest rate	%
r^{US}	US Real Interest Rate	%
$\hat{r}^{US}$	US Real Interest Rate: Gap	%
$\bar{r}^{US}$	US Real Interest Rate: Trend	%
$\hat{y}^{US}$	US Output Gap	% of potential GDP
$\hat{y}^{w}$	Foreign Demand	%
$\widehat{reer}$	Real Effective Exchange Rate	%

Shocks in the model		
Code	**Name**	**Unit**
$\varepsilon^{\widehat{dd}}$	Shock to Domestic Demand Gap	%
$\varepsilon^{\hat{x}}$	Shock to Export Gap	%
$\varepsilon^{\hat{m}}$	Shock to Export Gap	%
$\varepsilon^{\Delta\bar{y}}$	Shock to Potential Growth Rate	%
$\varepsilon^{\Delta\overline{dd}}$	Shock to Domestic Demand Trend	%
$\varepsilon^{\Delta\bar{x}}$	Shock to Export Trend	%
$\varepsilon^{\Delta cpi}$	Shock to Headline CPI weights	%
$\varepsilon^{\Delta cpi^{core}}$	Shock to Core CPI	%
$\varepsilon^{\Delta cpi^{ncore}}$	Shock to Non-Core CPI	%
$\varepsilon^{\Delta\overline{rp}}$	Shock to Relative Price Trend	%
$\varepsilon^{\Delta defl^{GDP}}$	Shock to GDP deflator	%
$\varepsilon^{\Delta\overline{re}}$	Shock to Real Exchange Rate	%
$\varepsilon^{\overline{remit}^{rat}}$	Shock to Remittances Trend	% of nominal GDP trend
$\varepsilon^{\widehat{remit}^{rat}}$	Shock to Remittances Gap	% of nominal GDP
$\varepsilon^{\overline{oth}^{rat}}$	Shock to Other Income Trend	% of nominal GDP trend
$\varepsilon^{\widehat{oth}^{rat}}$	Shock to Other Income Gap	% of nominal GDP
ε^{e}	Shock to Nominal Exchange Rate	%
$\varepsilon^{\widehat{prem}}$	Shock to Risk Premium Gap	%
$\varepsilon^{\overline{prem}}$	Shock to Risk Premium Trend	%
$\varepsilon^{fxi^{rat}}$	Shock to FX-intervention	% of nominal GDP
$\varepsilon^{\overline{fxres}^{ratimp}}$	Shock to FX-reserve Trend	%

Shocks in the model		
Code	**Name**	**Unit**
$\varepsilon^{tprem^{dom}}$	Shock to LCY Term Premium	%
$\varepsilon^{tprem^{*}}$	Shock to FCY Term Premium	%
$\varepsilon^{debt1Y^{d,rat}}$	Shock to 1Y LCY New Debt issuance	% of nominal GDP
$\varepsilon^{debt1Y^{f,rat}}$	Shock to 1Y FCY New Debt issuance	% of nominal GDP
$\varepsilon^{def^{rat}}$	Shock to Total Deficit	% of nominal GDP
$\varepsilon^{defstruct^{rat}}$	Shock to Cyclically Adjusted Primary Deficit	% of nominal GDP
$\varepsilon^{debt^{rat,TAR}}$	Shock to Public Debt Target	% of nominal GDP
ε^{θ}	Shock to LCY Debt issuance share	%/100
$\varepsilon^{\Delta\overline{rpc}^{oil}}$	Shock to Oil Price Trend	%
$\varepsilon^{\widehat{rpc}^{oil}}$	Shock to Oil Price Gap	%
$\varepsilon^{\Delta\overline{rpc}^{food}}$	Shock to Food Price Trend	%
$\varepsilon^{\widehat{rpc}^{food}}$	Shock to Food Price Gap	%
$\varepsilon^{\Delta\overline{rpc}^{phos}}$	Shock to Phosphate Price Trend	%
$\varepsilon^{\widehat{rpc}^{phos}}$	Shock to Phosphate Price Gap	%
$\varepsilon^{\Delta cpi^{US}}$	Shock to US CPI	%
$\varepsilon^{i^{US}}$	Shock to US FED Interest Rate	%
$\varepsilon^{\hat{y}^{US}}$	Shock to US Output Gap	%
$\varepsilon^{\bar{r}^{US}}$	Shock to US Real Interest Rate Trend	%
$\varepsilon^{\hat{y}^{j}}$	Shock to Trading partners Output Gap	%
$\varepsilon^{\widehat{re}^{j}}$	Shock to Trading partners RER	%

Appendix 2: JAM2.0 model equations

A.2.1 Real Aggregate Demand

Domestic demand gap equation:

$$\widehat{dd}_t = a_1\widehat{dd}_{t-1} + a_2 E_t\widehat{dd}_{t+1} - a_3\hat{r}_t + a_4\widehat{fis}_t + a_5\hat{y}_t + a_6\widehat{remit}_t^{rat} + a_7(\widehat{rpc}_t^{phos} - \widehat{rpc}_t^{oil}) + \varepsilon_t^{\widehat{dd}}$$

Export gap equation:

$$\hat{x}_t = a_8\hat{x}_{t-1} + a_9\widehat{reer}_t + a_{10}\hat{y}_t^w + \varepsilon_t^{\hat{x}}$$

Import gap equation:

$$\widehat{m}_t = a_{11}\widehat{m}_{t-1} + (1 - a_{11})\left(a_{12}\left(\widehat{dd}_t - a_{13}\widehat{reer}_t\right) + (1 - a_{12})(\hat{x}_t - a_{14}\widehat{reer}_t)\right) + \varepsilon_t^{\widehat{m}}$$

Potential GDP growth:

$$\Delta\bar{y}_t = \rho^{\Delta\bar{y}}\Delta\bar{y}_{t-1} + (1 - \rho^{\Delta\bar{y}})\Delta y^{SS} + \varepsilon_t^{\Delta\bar{y}}$$

Domestic demand trend growth:

$$\Delta\overline{dd}_t = \rho^{\Delta\overline{dd}}\Delta\overline{dd}_{t-1} + \left(1 - \rho^{\Delta\overline{dd}}\right)\Delta\bar{y}_t - \delta^{\Delta\overline{dd}}(\overline{dd}_t^{rat} - dd^{rat,SS}) + \varepsilon_t^{\Delta\overline{dd}}$$

Export trend growth:

$$\Delta\bar{x}_t = \rho^{\Delta\bar{x}}\Delta\bar{x}_{t-1} + (1 - \rho^{\Delta\bar{x}})(\Delta\bar{y}_t - \Delta\overline{rp}_t^x) - \delta^{\Delta\bar{x}}(\bar{x}_t^{rat} - x^{rat,SS}) + \varepsilon_t^{\Delta\bar{x}}$$

Import trend growth:

$$\Delta\bar{y}_t = \frac{\overline{dd}_{t-1}^{rat}}{100}\,\Delta\overline{dd}_t + \frac{\bar{x}_{t-1}^{rat}}{100}\,\Delta\bar{x}_t - \frac{\overline{m}_{t-1}^{rat}}{100}\,\Delta\overline{m}_t$$

Gap and trend identities:

$$dd_t = \overline{dd}_t + \widehat{dd}_t$$
$$x_t = \bar{x}_t + \hat{x}_t$$
$$m_t = \overline{m}_t + \widehat{m}_t$$
$$y_t = \bar{y}_t + \hat{y}_t$$

Annualized q-o-q growth rates:

$\Delta y_t = (y_t - y_t)$ x 4
$\Delta dd_t = (dd_t - dd_t)$ x 4
$\Delta x_t = (x_t - x_{t-1})$ x 4
$\Delta m_t = (m_t - m_{t-1})$ x 4
$\Delta\bar{y}_t = (\bar{y}_t - \bar{y}_{t-1})$ x 4
$\Delta\overline{dd}_t = (\overline{dd}_t - \overline{dd}_{t-1})$ x 4
$\Delta\bar{x}_t = (\bar{x}_t - \bar{x}_{t-1})$ x 4
$\Delta\overline{m}_t = (\overline{m}_t - \overline{m}_{t-1})$ x 4

Y-o-Y growth rate:

$\Delta^4 y_t = (y_t - y_{t-4})$
$\Delta^4 dd_t = (dd_t - dd_{t-4})$
$\Delta^4 x_t = (x_t - x_{t-4})$
$\Delta^4 m_t = (m_t - m_{t-4})$
$\Delta^4 \bar{y}_t = (\bar{y}_t - \bar{y}_{t-4})$
$\Delta^4 \overline{dd}_t = (\overline{dd}_t - \overline{dd}_{t-4})$
$\Delta^4 \bar{x}_t = (\bar{x}_t - \bar{x}_{t-4})$
$\Delta^4 \bar{m}_t = (\bar{m}_t - \bar{m}_{t-4})$

Great ratios (in nominal GDP):
$100 = dd_t^{rat} + x_t^{rat} - m_t^{rat}$
$dd_t^{rat} = \frac{DD_t}{Y_t}$ x 100
$x_t^{rat} = RP_t^X \frac{X_t}{Y_t}$ x 100

Great rations in for trends (in nominal trend GDP):
$100 = \overline{dd}_t^{rat} + \bar{x}_t^{rat} - \bar{m}_t^{rat}$
$\overline{dd}_t^{rat} = \frac{\overline{DD}_t}{\bar{Y}_t}$ x 100
$\bar{x}_t^{rat} = \overline{RP}_t^X \frac{\bar{X}_t}{\bar{Y}_t}$ x 100

Output gap:
$$exp\left(\frac{\hat{y}_t}{100}\right) = \frac{\overline{dd}_t^{rat}}{100} exp\left(\frac{\widehat{dd}_t}{100}\right) + \frac{\bar{x}_t^{rat}}{100} exp\left(\frac{\hat{x}_t}{100}\right) - \frac{\bar{m}_t^{rat}}{100} exp\left(\frac{\hat{m}_t}{100}\right)$$

Nominal GDP:
$gdp_t^{nom} = y_t + defl_t^{GDP}$
$\Delta gdp_t^{nom} = (gdp_t^{nom} - gdp_{t-1}^{nom})$ x 4
$\Delta^4 gdp_t^{nom} = (gdp_t^{nom} - gdp_{t-4}^{nom})$

Nominal GDP trend:
$\Delta \overline{gdp}_t^{nom} = \Delta \bar{y}_t + \Delta cpi_t^{TAR}$
$\Delta \overline{gdp}_t^{nom} = (\overline{gdp}_t^{nom} - \overline{gdp}_{t-1}^{nom})$ x 4
$\Delta^4 \overline{gdp}_t^{nom} = (\overline{gdp}_t^{nom} - \overline{gdp}_{t-4}^{nom})$

A.2.2 Aggregate Supply

Headline CPI:
$\Delta cpi_t = w^{cpi} \Delta cpi_t^{core} + (1 - w^{cpi}) \Delta cpi_t^{ncore} + \varepsilon_t^{\Delta cpi}$

Core inflation Phillips-curve:
$\Delta cpi_t^{core} = b_1 \Delta cpi_{t-1}^{core} + (1 - b_1) E_t \Delta cpi_{t+1}^{core} + rmc_t^{core} + \varepsilon_t^{\Delta cpi^{core}}$

Real marginal cost of core inflation:

$$rmc_t^{core} = b_2\hat{y}_t + b_3\widehat{reer}_t + b_4\left(\widehat{rpc}_t^{oil} + \widehat{re}_t\right) + b_5\left(\widehat{rpc}_t^{food} + \widehat{re}_t\right) - b_6\left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t$$

Non-core inflation Phillips-curve:

$$\Delta cpi_t^{ncore} = d_1\Delta cpi_{t-1}^{ncore} + (1-d_1)\Delta cpi_t^{ncore,TAR} + (1-d_1)rmc_t^{ncore} + \varepsilon_t^{\Delta cpi^{ncore}}$$

Real marginal cost of Non-core inflation:

$$rmc_t^{ncore} = d_2\left(\widehat{rpc}_t^{oil} + \widehat{re}_t + \left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t\right) + d_3\left(\widehat{rpc}_t^{food} + \widehat{re}_t + \left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t\right) - d_4\left(\frac{1}{1-w^{cpi}}\right)\widehat{rp}_t$$

Relative price of core CPI:

$$rp_t = cpi_t^{core} - cpi_t$$

Trend and gap decomposition of relative price of core CPI:

$$rp_t = \overline{rp}_t + \widehat{rp}_t$$

Relative price trend:

$$\Delta\overline{rp}_t = \rho^{\Delta\overline{rp}}\Delta\overline{rp}_{t-1} + (1-\rho^{\Delta\overline{rp}})\Delta rp^{ss} + \varepsilon_t^{\Delta\overline{rp}}$$

Implicit inflation target for headline CPI:

$$\Delta cpi_t^{core,TAR} = \Delta cpi_t^{TAR} + \Delta\overline{rp}_t$$

Implicit inflation target for non-core CPI:

$$\Delta cpi_t^{TAR} = w^{cpi}\Delta cpi_t^{core,TAR} + (1-w^{cpi})\Delta cpi_t^{ncore,TAR}$$

Q-o-Q changes of CPIs and relative price:

$$\Delta cpi_t = (cpi_t - cpi_{t-1}) \text{ x } 4$$
$$\Delta cpi_t^{core} = (cpi_t^{core} - cpi_{t-1}^{core}) \text{ x } 4$$
$$\Delta cpi_t^{ncore} = (cpi_t^{ncore} - cpi_{t-1}^{ncore}) \text{ x } 4$$
$$\Delta\overline{rp}_t = (\overline{rp}_t - \overline{rp}_{t-1}) \text{ x } 4$$
$$\Delta\overline{rp}_t^X = (\overline{rp}_t^X - \overline{rp}_{t-1}^X) \text{ x } 4$$
$$\Delta\overline{rp}_t^M = (\overline{rp}_t^M - \overline{rp}_{t-1}^M) \text{ x } 4$$

Y-o-Y changes of CPI:

$$\Delta^4 cpi_t = (cpi_t - cpi_{t-4})$$
$$\Delta^4 cpi_t^{core} = (cpi_t^{core} - cpi_{t-4}^{core})$$
$$\Delta^4 cpi_t^{ncore} = (cpi_t^{ncore} - cpi_{t-4}^{ncore})$$

GDP deflator:

$$\Delta defl_t^{GDP} = \rho^{\Delta defl^{GDP}}\Delta defl_{t-1}^{GDP} + \left(1-\rho^{\Delta defl^{GDP}}\right)\Delta cpi_t + \varepsilon_t^{\Delta defl^{GDP}}$$
$$\Delta defl_t^{GDP} = (defl_t^{GDP} - defl_{t-1}^{GDP}) \text{ x } 4$$
$$\Delta^4 defl_t^{GDP} = (defl_t^{GDP} - defl_{t-4}^{GDP})$$

Implicit export deflator (level and trend):

$$rp_t^X = \rho^{rp^X}rp_{t-1}^X + (1-\rho^{rp^X})\left(\omega^{X,US}re_t + \omega^{X,phos}(rpc_t^{phos} + re_t) + (1-\omega^{X,US} - \omega^{X,phos})(rpc_t^{food} + re_t)\right)$$

$$\overline{rp}_t^X = \rho^{rp^x}\overline{rp}_{t-1}^X + (1-\rho^{rp^x})\left(\omega^{X,US}\Delta\overline{re}_t + \omega^{X,phos}(\overline{rpc}_t^{phos} + \overline{re}_t) + (1-\omega^{X,US}-\omega^{X,phos})(\overline{rpc}_t^{food} + \overline{re}_t)\right)$$

Implicit import deflator (level and trend):

$$rp_t^M = \rho^{rp^M} rp_{t-1}^M + (1-\rho^{rp^M})\left(\omega^{M,US}re_t + \omega^{M,oil}(rpc_t^{oil} + re_t) + (1-\omega^{M,US}-\omega^{M,oil})(rpc_t^{food} + re_t)\right)$$

$$\overline{rp}_t^M = \rho^{rp^M}\overline{rp}_{t-1}^M + (1-\rho^{rp^M})\left(\omega^{M,US}\overline{re}_t + \omega^{M,oil}(\overline{rpc}_t^{oil} + \overline{re}_t) + (1-\omega^{M,US}-\omega^{M,oil})(\overline{rpc}_t^{food} + \overline{re}_t)\right)$$

A.2.3 Real Interest Rate and Exchange Rate

Real interest rate identity:

$$r_t = i_t - E_t\Delta cpi_{t+1}^{core}$$

Real exchange rate (PPP) identity:

$$re_t = e_t + cpi_t^{US} - cpi_t^{core}$$

Real exchange rate trend:

$$\Delta\overline{re}_t = \rho^{\Delta\overline{re}}\Delta\overline{re}_{t-1} + (1-\rho^{\Delta\overline{re}})\Delta re^{ss} + \varepsilon_t^{\Delta\overline{re}}$$

Real exchange rate gap:

$$\widehat{re}_t = re_t - \overline{re}_t$$

Q-o-Q change of Real exchange rate trend

$$\Delta\overline{re}_t = (\overline{re}_t - \overline{re}_{t-1}) \text{ x } 4$$

Real uncovered interest rate parity condition:

$$\bar{r}_t = \bar{r}_t^{US} + \overline{prem}_t + E_t\Delta\overline{re}_{t+1}$$

Real interest rate gap:

$$\hat{r}_t = r_t - \bar{r}_t$$

Implicit target for core CPI (PPP condition with trends):

$$\Delta\overline{re}_t = \Delta cpi^{US,ss} + \Delta e_t - \Delta cpi_t^{core,TAR}$$

A.2.4 Balance of Payments

Balance of payment identity:

$$0 = ca_t^{rat} + fa_t^{rat}$$

Balance of payment identity (trend):

$$0 = \overline{ca}_t^{rat} + \overline{fa}_t^{rat}$$

Current account:

$$ca_t^{rat} = nx_t^{rat} + remit_t^{rat} - intcost_t^{*rat} + oth_t^{rat}$$

Current account trend:
$\overline{ca}_t^{rat} = \overline{nx}_t^{rat} + \overline{remit}_t^{rat} - \overline{intcost}_t^{*,rat} + \overline{oth}_t^{rat}$

Current account gap:
$\widehat{ca}_t^{rat} = ca_t^{rat} - \overline{ca}_t^{rat}$

Net-export:
$nx_t^{rat} = x_t^{rat} - m_t^{rat}$

Net-export trend:
$\overline{nx}_t^{rat} = \bar{x}_t^{rat} - \bar{m}_t^{rat}$

Net-export gap:
$\widehat{nx}_t^{rat} = nx_t^{rat} - \overline{nx}_t^{rat}$

Total remittances:
$remit_t^{rat} = \overline{remit}_t^{rat} + \widehat{remit}_t^{rat}$

Remittances trend:
$\overline{remit}_t^{rat} = \rho^{\overline{remit}^{rat}}\overline{remit}_{t-1}^{rat} + \left(1 - \rho^{\overline{remit}^{rat}}\right)remit^{rat,ss} + \varepsilon_t^{\overline{remit}^{rat}}$

Remittances gap:
$\widehat{remit}_t^{rat} = \rho^{\widehat{remit}^{rat}}\widehat{remit}_{t-1}^{rat} + \left(1 - \rho^{\widehat{remit}^{rat}}\right)g_1\hat{y}_t^{w} + \varepsilon_t^{\widehat{remit}^{rat}}$

Other foreign net income:
$oth_t^{rat} = \overline{oth}_t^{rat} + \widehat{oth}_t^{rat}$

Other foreign net income trend:
$\overline{oth}_t^{rat} = \rho^{\overline{oth}^{rat}}\overline{oth}_{t-1}^{rat} + \left(1 - \rho^{\overline{oth}^{rat}}\right)oth^{rat,ss} + \varepsilon_t^{\overline{oth}^{rat}}$

Other foreign net income gap:
$\widehat{oth}_t^{rat} = \rho^{\widehat{oth}^{rat}}\widehat{oth}_{t-1}^{rat} + \varepsilon_t^{\widehat{oth}^{rat}}$

Financial account gap:
$\widehat{fa}_t^{rat} = fa_t^{rat} - \overline{fa}_t^{rat}$

Private sector net foreign financing position:

$$fa_t^{rat} = nfp_t^{rat} - fxi_t^{rat} + debt1Y_t^{f,rat} - debt1Y_{t-4}^{f,rat} * \frac{exp\left(\frac{\Delta^4 e_t}{100}\right)}{exp\left(\frac{\Delta^4 gdp_t^{nom}}{100}\right)}$$

Private sector net foreign financing position trend:

$$\overline{fa}_t^{rat} = \overline{nfp}_t^{rat} - \overline{fxa}_t^{rat} + debt1Y_t^{f,rat,TAR} - debt1Y_{t-4}^{f,rat,TAR} * \frac{exp\left(\frac{\Delta^4 e_t}{100}\right)}{exp\left(\frac{\Delta^4 \overline{gdp}_t^{nom}}{100}\right)}$$

A.2.5 Monetary Policy

CBJ fixed exchange rate rule:
$e_t = e_{t-1}$

CBJ monetary policy rate (UIP condition):
$i_t = i_t^{US} + prem_t + 4(E_t e_{t+1} - e_t) + \varepsilon_t^e$

Country risk premium:
$prem_t = \overline{prem}_t + \widehat{prem}_t$

Country risk premium trend:
$\overline{nfp}_t^{rat} = nfp^{SS} + h_2\left(\overline{prem}_t - prem^{SS} - \varepsilon_t^{\overline{prem}} - h_{22}(debt_t^{rat} - debt^{rat,ss})\right)$

Country risk premium gap:
$\widehat{nfp}_t^{rat} = h_1\left(\widehat{prem}_t - \varepsilon_t^{\widehat{prem}}\right)$

FXI-rule:
$fxi_t^{rat} = g_6 fxi_{t-1}^{rat} + (1 - g_6)\left(g_7 \widehat{ca}_t^{rat} - g_8 \widehat{fxres}_t^{ratimp}\right) - g_9(i_t - i_t^{US} - prem^{ss}) + \varepsilon_t^{fxi^{rat}}$

FX-reserve target:
$\overline{fxres}_t^{ratimp} = \rho^{\overline{fxres}^{ratimp}} \overline{fxres}_{t-1}^{ratimp} + \left(1 - \rho^{\overline{fxres}^{ratimp}}\right) fxres^{ratimp,ss} + \varepsilon_t^{\overline{fxres}^{ratimp}}$

FX-reserve accumulation:
$fxres_t^{rat} = fxi_t^{rat} + \overline{fxa}_t^{rat} + \left(1 + \frac{i_{t-1}^{us}}{400}\right) fxres_{t-1}^{rat} \left(1 + \frac{\Delta e_t}{400}\right) / \left(1 + \frac{\Delta gdp_t^{nom}}{400}\right)$

FX-reserve gap:
$\widehat{fxres}_t^{ratimp} = g_{12}\left(fxres_t^{ratimp} - \overline{fxres}_t^{ratimp}\right) + (1 - g_{12})\widehat{fxres}_{t+1}^{ratimp}$

FX-reserve consistent accumulation trend:
$\overline{fxres}_t^{rat} = \overline{fxa}_t^{rat} + \left(1 + \frac{\overline{i}_{t-1}^{US}}{400}\right) \overline{fxres}_{t-1}^{rat} \left(1 + \frac{\Delta e_t}{400}\right) / \left(1 + \frac{\Delta \overline{gdp}_{t-1}^{nom}}{400}\right)$

Q-o-Q changes of nominal exchange rate:
$\Delta e_t = (e_t - e_{t-1})$ x 4

Y-o-Y changes of nominal exchange rate:
$\Delta^4 e_t = (e_t - e_{t-4})$

FX-reserve in months (Adequacy ratio):

$$fxres_t^{ratimp} = 12\frac{fxres_t^{rat}}{m_t^{rat}}$$

FX-reserve trend in months (Adequacy ratio trend):

$$\overline{fxres}_t^{ratimp} = 12\frac{\overline{fxres}_t^{rat}}{\bar{m}_t^{rat}}$$

A.2.6 Fiscal Policy

A.2.6.1 Government expenditures

Total debt service:

$$intcost_t^{rat} = intcost_t^{d,rat} + intcost_t^{f,rat}$$

LCY debt service:

$$intcost_t^{d,rat} = \frac{\left(exp\left(\frac{i4_{t-1}^d}{400}\right)-1\right)debt1Y_{t-1}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-2}^d}{400}\right)-1\right)debt1Y_{t-2}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-3}^d}{400}\right)-1\right)debt1Y_{t-3}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}\right)} +$$
$$\frac{\left(exp\left(\frac{i4_{t-4}^d}{400}\right)-1\right)debt1Y_{t-4}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}+\frac{\Delta gdp_{t-3}^{nom}}{400}\right)}$$

1Y LCY interest rate:

$$i4_t^d = (1-w^c)\left(\frac{i_t + i_{t+1} + i_{t+2} + i_{t+3}}{4} + tprem_t^d\right) + w^c(\bar{\iota}_t + tprem^{d,ss})$$

1Y LCY term premium:

$$tprem_t^d = \rho^{tprem^d} tprem_{t-1}^d + \left(1-\rho^{tprem^d}\right)tprem^{d,ss} + g_2\left(debt_t^{d,rat} - debt^{d,rat,ss}\right) + \varepsilon_t^{tprem^{dom}}$$

1Y FCY debt service:

$$intcost_t^{f,rat} = \frac{\left(exp\left(\frac{i4_{t-1}^*}{400}\right)-1\right)exp\left(\frac{\Delta e_t}{400}\right) debt1Y_{t-1}^{f,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} +$$
$$\ldots \frac{\left(exp\left(\frac{i4_{t-2}^*}{400}\right)-1\right)exp\left(\frac{\Delta e_t+\Delta e_{t-1}}{400}\right) debt1Y_{t-2}^{f,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{i4_{t-3}^*}{400}\right)-1\right)exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}}{400}\right) debt1Y_{t-3}^{f,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}\right)} +$$
$$\ldots \frac{\left(exp\left(\frac{i4_{t-4}^*}{400}\right)-1\right)exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}+\Delta e_{t-3}}{400}\right) debt1Y_{t-4}^{f,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}+\frac{\Delta gdp_{t-1}^{nom}}{400}+\frac{\Delta gdp_{t-2}^{nom}}{400}+\frac{\Delta gdp_{t-3}^{nom}}{400}\right)}$$

1Y FCY interest rate:

$$i4_t^* = (1 - w^c)\left(\frac{i_t^{us} + i_{t+1}^{us} + i_{t+2}^{us} + i_{t+3}^{us}}{4} + \frac{prem_t + prem_{t+1} + prem_{t+2} + prem_{t+3}}{4} + tprem_t^*\right) + w^c(\bar{\imath}_t^{US} + \overline{prem}_t + tprem^{*,ss})$$

1Y FCY term premium:

$$tprem_t^* = \rho^{tprem^*} tprem_{t-1}^* + \left(1 - \rho^{tprem^*}\right) tprem^{*,ss} + g_3\left(debt_t^{f,rat} - debt^{f,rat,ss}\right) + \varepsilon_t^{tprem^*}$$

A.2.6.2 Debt accumulation

Total public debt:

$$debt_t^{rat} = debt_t^{d,rat} + debt_t^{f,rat}$$

Total 1Y LCY debt:

$$debt_t^{d,rat} = debt1Y_t^{d,rat} + \frac{debt1Y_{t-1}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom}}{400}\right)} + \cdots$$

$$\cdots \frac{debt1Y_{t-3}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom} + \Delta gdp_{t-2}^{nom}}{400}\right)}$$

Total 1Y FCY debt:

$$debt_t^{f,rat} = debt1Y_t^{f,rat} + \frac{debt1Y_{t-1}^{f,rat} exp\left(\frac{\Delta e_t}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{f,rat} exp\left(\frac{\Delta e_t + \Delta e_{t-1}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom}}{400}\right)} + \cdots$$

$$\cdots \frac{debt1Y_{t-3}^{f,rat} exp\left(\frac{\Delta e_t + \Delta e_{t-1} + \Delta e_{t-2}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom} + \Delta gdp_{t-2}^{nom}}{400}\right)}$$

1Y LCY new debt issuance:

$$debt1Y_t^{d,rat} = \theta_t \cdot def_t^{rat} + \frac{debt1Y_{t-4}^{d,rat}}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom} + \Delta gdp_{t-2}^{nom} + \Delta gdp_{t-3}^{nom}}{400}\right)} + \varepsilon_t^{debt1Y_t^{d,rat}}$$

1Y FCY new debt issuance:

$$debt1Y_t^{f,rat} = (1 - \theta_t) \cdot def_t^{rat} + \frac{debt1Y_{t-4}^{f,rat} exp\left(\frac{\Delta e_t + \Delta e_{t-1} + \Delta e_{t-2} + \Delta e_{t-3}}{400}\right)}{exp\left(\frac{\Delta gdp_t^{nom} + \Delta gdp_{t-1}^{nom} + \Delta gdp_{t-2}^{nom} + \Delta gdp_{t-3}^{nom}}{400}\right)} + \varepsilon_t^{debt1Y_t^{f,rat}}$$

A.2.6.3 Fiscal anchor, deficits and reaction functions

Government deficit:

$$def_t^{rat} = primdef_t^{rat} + intcost_t^{rat} + \varepsilon_t^{def^{rat}}$$

Primary deficit:

$$primdef_t^{rat} = defstruct_t^{rat} + defcycle_t^{rat}$$

Primary deficit (cyclical):

$$defcycle_t^{rat} = -f_1\hat{y}_t + \varepsilon_t^{defcycle^{rat}}$$

Cyclically adjusted primary deficit:

$$defstruct_t^{rat} = \rho_{fp}(defstruct_{t-1}^{rat} - f_2\hat{y}_{t-1}) + (1-\rho_{fp})(defstruct_t^{rat,TAR} - f_3 edebtdev_t^{rat}) + \varepsilon_t^{defstruct^{rat}}$$

Debt deviation:

$$edebtdev_t^{rat} = f_4(debt_t^{rat} - debt_t^{rat,TAR}) + (1-f_4)E_t edevdebt_{t+1}^{rat}$$

Fiscal impulse:

$$fiscimp_t = f_5(defstruct_t^{rat} - defstruct_t^{rat,TAR}) + f_6\varepsilon_t^{debt^{rat,TAR}}$$

Share of LCY financing:

$$\theta_t = \rho^{\theta}\theta_{t-1} + (1-\rho^{\theta})\theta^{ss} + \varepsilon_t^{\theta}$$

A.2.6.4. Fiscal targets

Public debt target:

$$debt_t^{rat,TAR} = \rho^{debt^{rat,TAR}} debt_{t-1}^{rat,TAR} + (1-\rho^{debt^{rat,TAR}})debt^{rat,SS} + \varepsilon_t^{debt^{rat,TAR}}$$

Total public debt target:

$$debt_t^{rat,TAR} = debt_t^{d,rat,TAR} + debt_t^{f,rat,TAR}$$

LCY public debt target:

$$debt_t^{d,rat,TAR} = debt1Y_t^{d,rat,TAR} + \frac{debt1Y_{t-1}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom}}{400}\right)} + \cdots$$

$$\dots \frac{debt1Y_{t-3}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom} + \Delta\overline{gdp}_{t-2}^{nom}}{400}\right)}$$

FCY public debt target:

$$debt_t^{f,rat,TAR} = debt1Y_t^{f,rat,TAR} + \frac{debt1Y_{t-1}^{f,rat,TAR} exp\left(\frac{\Delta e_t}{400}\right)}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}}{400}\right)} + \frac{debt1Y_{t-2}^{f,rat,TAR} exp\left(\frac{\Delta e_t + \Delta e_{t-1}}{400}\right)}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom}}{400}\right)} + \cdots$$

$$\dots \frac{debt1Y_{t-3}^{f,rat,TAR} exp\left(\frac{\Delta e_t + \Delta e_{t-1} + \Delta e_{t-2}}{400}\right)}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom} + \Delta\overline{gdp}_{t-2}^{nom}}{400}\right)}$$

LCY targeted new issuance:

$$debt1Y_t^{d,rat,TAR} = \theta_t \cdot def_t^{rat,TAR} + \frac{debt1Y_{t-4}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom} + \Delta\overline{gdp}_{t-2}^{nom} + \Delta\overline{gdp}_{t-3}^{nom}}{400}\right)}$$

FCY targeted new issuance:

$$debt1Y_t^{f,rat,TAR} = (1-\theta_t) \cdot def_t^{rat,TAR} + \frac{debt1Y_{t-4}^{f,rat,TAR} exp\left(\frac{\Delta e_t + \Delta e_{t-1} + \Delta e_{t-2} + \Delta e_{t-3}}{400}\right)}{exp\left(\frac{\Delta\overline{gdp}_t^{nom} + \Delta\overline{gdp}_{t-1}^{nom} + \Delta\overline{gdp}_{t-2}^{nom} + \Delta\overline{gdp}_{t-3}^{nom}}{400}\right)}$$

Targeted total debt service:

$$intcost_t^{rat,TAR} = intcost_t^{d,rat,TAR} + intcost_t^{f,rat,TAR}$$

LCY targeted debt service:

$$intcost_t^{d,rat,TAR} = \frac{\left(exp\left(\frac{\overline{i4}_t^d}{400}\right)-1\right) debt1Y_{t-1}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{\overline{i4}_t^d}{400}\right)-1\right) debt1Y_{t-2}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{\overline{i4}_t^d}{400}\right)-1\right) debt1Y_{t-3}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}+\Delta\overline{gdp}_{t-2}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{\overline{i4}_t^d}{400}\right)-1\right) debt1Y_{t-4}^{d,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}+\Delta\overline{gdp}_{t-2}^{nom}+\Delta\overline{gdp}_{t-3}^{nom}}{400}\right)}$$

LCY long term interest rate:

$$\overline{i4}_t^d = \bar{i}_t + tprem^{d,ss}$$

FCY targeted debt service:

$$intcost_t^{f,rat,TAR} = \frac{\left(exp\left(\frac{\overline{i4}_t^*}{400}\right)-1\right) exp\left(\frac{\Delta e_t}{400}\right) debt1Y_{t-1}^{f,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}}{400}\right)} + \dots \frac{\left(exp\left(\frac{\overline{i4}_t^*}{400}\right)-1\right) exp\left(\frac{\Delta e_t+\Delta e_{t-1}}{400}\right) debt1Y_{t-2}^{f,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}}{400}\right)} + \frac{\left(exp\left(\frac{\overline{i4}_t^*}{400}\right)-1\right) exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}}{400}\right) debt1Y_{t-3}^{f,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}+\Delta\overline{gdp}_{t-2}^{nom}}{400}\right)} + \dots \frac{\left(exp\left(\frac{\overline{i4}_t^*}{400}\right)-1\right) exp\left(\frac{\Delta e_t+\Delta e_{t-1}+\Delta e_{t-2}+\Delta e_{t-3}}{400}\right) debt1Y_{t-4}^{f,rat,TAR}}{exp\left(\frac{\Delta\overline{gdp}_t^{nom}+\Delta\overline{gdp}_{t-1}^{nom}+\Delta\overline{gdp}_{t-2}^{nom}+\Delta\overline{gdp}_{t-3}^{nom}}{400}\right)}$$

FCY long term interest rate:

$$\overline{i4}_t^* = \bar{i}_t^{US} + prem^{ss} + tprem^{*,ss}$$

Primary deficit target:

$$def_t^{rat,TAR} = defstruct_t^{rat,TAR} + intcost_t^{rat,TAR}$$

A.2.7 Foreign variables

Relative price of oil:

$$rpc_t^{oil} = pc_t^{oil} - cpi_t^{US}$$

$rpc_t^{oil} = \widehat{rpc}_t^{oil} + \overline{rpc}_t^{oil}$

$\Delta\overline{rpc}_t^{oil} = \rho^{\Delta\overline{rpc}^{oil}}\Delta\overline{rpc}_{t-1}^{oil} + \left(1 - \rho^{\Delta\overline{rpc}^{oil}}\right)\Delta rpc^{oil,ss} + \varepsilon_t^{\Delta\overline{rpc}^{oil}}$

$\Delta\overline{rpc}_t^{oil} = (\overline{rpc}_t^{oil} - \overline{rpc}_{t-1}^{oil})$ x 4

$\widehat{rpc}_t^{oil} = \rho^{\widehat{rpc}^{oil}}\widehat{rpc}_{t-1}^{oil} + \varepsilon_t^{\widehat{rpc}^{oil}}$

Relative price of food:

$rpc_t^{food} = pc_t^{food} - cpi_t^{US}$

$rpc_t^{food} = \widehat{rpc}_t^{food} + \overline{rpc}_t^{food}$

$\Delta\overline{rpc}_t^{food} = \rho^{\Delta\overline{rpc}^{food}}\Delta\overline{rpc}_{t-1}^{food} + \left(1 - \rho^{\Delta\overline{rpc}^{food}}\right)\Delta rpc^{food,ss} + \varepsilon_t^{\Delta\overline{rpc}^{food}}$

$\Delta\overline{rpc}_t^{food} = (\overline{rpc}_t^{food} - \overline{rpc}_{t-1}^{food})$ x 4

$\widehat{rpc}_t^{food} = \rho^{\widehat{rpc}^{food}}\widehat{rpc}_{t-1}^{food} + \varepsilon_t^{\widehat{rpc}^{food}}$

Relative price of phosphate:

$rpc_t^{phos} = pc_t^{phos} - cpi_t^{US}$

$rpc_t^{phos} = \widehat{rpc}_t^{phos} + \overline{rpc}_t^{phos}$

$\Delta\overline{rpc}_t^{phos} = \rho^{\Delta\overline{rpc}^{phos}}\Delta\overline{rpc}_{t-1}^{phos} + \left(1 - \rho^{\Delta\overline{rpc}^{phos}}\right)\Delta rpc^{phos,ss} + \varepsilon_t^{\Delta\overline{rpc}^{phos}}$

$\Delta\overline{rpc}_t^{phos} = (\overline{rpc}_t^{phos} - \overline{rpc}_{t-1}^{phos})$ x 4

$\widehat{rpc}_t^{phos} = \rho^{\widehat{rpc}^{phos}}\widehat{rpc}_{t-1}^{phos} + \varepsilon_t^{\widehat{rpc}^{phos}}$

US CPI Phillips curve:

$\Delta cpi_t^{US} = k_1\Delta cpi_{t-1}^{US} + (1 - k_1)E_t\Delta cpi_{t+1}^{US} + k_2\hat{y}_t^{US} + \varepsilon_t^{\Delta cpi^{US}}$

Q-o-Q US CPI:

$\Delta cpi_t^{US} = (cpi_t^{US} - cpi_{t-1}^{US})$ x 4

Y-o-Y US CPI:

$\Delta^4 cpi_t^{US} = (cpi_t^{US} - cpi_{t-4}^{US})$

US FED policy rate:

$i_t^{US} = k_3 i_{t-1}^{US} + (1 - k_3)(\bar{\imath}_t^{US} + k_4(E_t\Delta^4 cpi_{t+3}^{US} - \Delta cpi^{US,TAR}) + k_5\hat{y}_t^{US}) + \varepsilon_t^{i^{US}}$

US real interest rate:

$r_t^{US} = i_t^{US} - E_t\Delta cpi_{t+1}^{US}$

US GDP gap:

$\hat{y}_t^{US} = k_6\hat{y}_{t-1}^{US} + k_7E_t\hat{y}_{t+1}^{US} - k_8\hat{r}_t^{US} + \varepsilon_t^{\hat{y}^{US}}$

US real interest rate gap:

$r_t^{US} = \hat{r}_t^{US} + \bar{r}_t^{US}$

US real interest rate trend:

$$\bar{r}_t^{US} = \rho^{\bar{r}^{US}}\bar{r}_t^{US} + \left(1 - \rho^{\bar{r}^{US}}\right)r^{US,ss} + \varepsilon_t^{\bar{r}^{US}}$$

Other trading partners output gap and real exchange rate gap $j = \{EZ, CN, JP, BR, IN, RU, GB, ZA, RC\}$

$$\hat{y}_t^j = \rho^{\hat{y}^j}\hat{y}_{t-1}^j + \varepsilon_t^{\hat{y}^j}$$

$$\widehat{re}_t^j = \rho^{\widehat{re}^j}\widehat{re}_{t-1}^j + \varepsilon_t^{\widehat{re}^j}$$

Effective foreign demand gap:

$$\hat{y}_t^w = \sum_{US,EZ,CN,JP,BR,IN,RU,GB,ZA,RC} w^{\hat{y}^j}\hat{y}_t^j$$

Real effective exchange rate gap

$$\widehat{reer}_t = w^{\widehat{re}^{US}}\widehat{re}_t + \sum_{EZ,CN,JP,BR,IN,RU,GB,ZA,RC} w^{\widehat{re}^j}(\widehat{re}_t - \widehat{re}_t^j)$$

Appendix 3: JAM2.0 model parameters

Real Aggregate Demand			
Code	**Value**	**Parameter role**	**Calibration choice and justification**
Cyclical variables			
a_1	0.4	Domestic demand gap lag term	Iterative adjustment
a_2	0.2	Domestic demand gap forward looking term	Iterative adjustment
a_3	0.1	Elasticity of the domestic demand gap wrt monetary conditions	Iterative adjustment
a_4	0.4	Elasticity of the domestic demand gap wrt the fiscal impulse	Staff judgement
a_5	0.15	Elasticity of the domestic demand gap wrt income	Iterative adjustment
a_6	0.2	Elasticity of the domestic demand gap wrt remittances	Iterative adjustment
a_7	0.0025	Elasticity of the domestic demand gap wrt terms-of-trade	Iterative adjustment
a_8	0.5	Export gap lag term	Iterative adjustment
a_9	1	Elasticity of the export gap wrt real effective ex. rate	Iterative adjustment
a_{10}	1.1	Elasticity of the export gap wrt foreign demand	Iterative adjustment
a_{11}	0.25	Import gap lag term	Iterative adjustment
a_{12}	0.7	Weight of domestic demand in import	I/O tables
a_{13}	0.05	Price elasticity of the import gap wrt domestic demand components	Iterative adjustment
a_{14}	0.025	Price elasticity of the import gap wrt export components	Iterative adjustment
Trend variables			
$\rho^{\Delta\bar{y}}$	0.9	Potential growth persistence	Iterative adjustment
$\rho^{\Delta\overline{dd}}$	0.8	Domestic demand trend persistence	Iterative adjustment
$\delta^{\Delta\overline{dd}}$	0.01	Domestic demand trend error-correction term	Iterative adjustment
$\rho^{\Delta\bar{x}}$	0.9	Export trend persistence	Iterative adjustment
$\delta^{\Delta\bar{x}}$	0.01	Export trend error-correction term	Iterative adjustment
Steady-state ratios			
Δy^{ss}	3	Steady-state potential GDP growth	Historical average
$dd^{rat,ss}$	124	Domestic demand in terms of GDP	Historical average
$x^{rat,ss}$	41	Export in terms of GDP	Historical average

Aggregate Supply			
Code	**Value**	**Parameter role**	**Calibration choice and justification**
CPI: Core and Non-core Phillips-curves			
w^{cpi}	0.55	Weight of core items in CPI basket	CPI database
b_1	0.3	Core CPI lag term	Iterative adjustment
b_2	0.07	Elasticity of the core inflation wrt output gap	Iterative adjustment
b_3	0.025	Elasticity of the core inflation wrt real effective exchange rate	Iterative adjustment
b_4	0.0025	Elasticity of the core inflation wrt oil price	Iterative adjustment
b_5	0.005	Elasticity of the core inflation wrt food price	Iterative adjustment
b_6	0.01	Elasticity of the core inflation wrt non-core prices	Iterative adjustment
d_1	0.35	Non-core CPI lag term	Iterative adjustment
d_2	0.05	Elasticity of the non-core inflation wrt oil price	Iterative adjustment
d_3	0.1	Elasticity of the non-core inflation wrt food price	Iterative adjustment
d_4	0.4	Elasticity of the non-core inflation wrt core prices	Iterative adjustment
$\rho^{\Delta\overline{rp}}$	0.9	Relative price trend lag	Iterative adjustment
Deflators			
$\rho^{\Delta defl^{gdp}}$	0.25	GDP deflator lag	Iterative adjustment
ρ^{rp^X}	0.5	Implicit export deflator lag	Iterative adjustment
$\omega^{X,US}$	0.6	Weight of US prices in implicit export deflator	BoP database
$\omega^{X,phos}$	0.25	Weight of phosphate prices in implicit export deflator	BoP database
ρ^{rp^M}	0.5	Implicit import deflator lag	Iterative adjustment
$\omega^{M,US}$	0.5	Weight of US prices in implicit import deflator	BoP database
$\omega^{X,oil}$	0.3	Weight of phosphate prices in implicit import deflator	BoP database
Steady-state			
$\Delta\overline{rp}^{ss}$	0	Steady-state relative price growth	Historical average

Balance of Payments and Monetary policy			
Code	**Value**	**Parameter role**	**Calibration choice and justification**
Balance of Payments			
$\rho^{\Delta\overline{re}}$	0.95	Real exchange rate trend lag	Iterative adjustment
$\rho^{\overline{remit}^{rat}}$	0.9999	Remittances trend lag	Iterative adjustment
$\rho^{\widehat{remit}^{rat}}$	0.5	Remittances gap lag	Iterative adjustment
g_1	0.1	Elasticity of the remittances gap wrt foreign effective demand gap	Iterative adjustment
$\rho^{\overline{oth}^{rat}}$	0.9	Other income trend lag	Iterative adjustment
$\rho^{\widehat{oth}^{rat}}$	0.7	Other income trend gap	Iterative adjustment
h_1	10	Elasticity of the premium gap wrt private sector capital flow	Iterative adjustment
h_2	10	Elasticity of the premium trend wrt private sector capital flow	Iterative adjustment
h_3	0.01	Elasticity of the premium trend wrt public sector capital flow	Iterative adjustment
Monetary policy			
h_4	0.4	FXI-rule lag term	Iterative adjustment
h_5	0.8	Elasticity of the FX-intervention wrt current account	Iterative adjustment
h_6	2	Elasticity of the FX-intervention wrt adequacy ratio	Iterative adjustment
h_7	0.8	Elasticity of the FX-intervention wrt interest rate differential	Iterative adjustment
h_8	0.7	Weight of actual adequacy in FX-reserve accumulation rule	Iterative adjustment
$\rho^{\overline{fxres}^{ratimp}}$	0.8	FX-reserve target lag term	Iterative adjustment
Steady-state			
$\Delta\overline{re}^{ss}$	-1	Steady-state relative real app.	Historical average
$\overline{remit}^{rat,ss}$	8	Steady-state remittances	Historical average
$\overline{oth}^{rat,ss}$	8	Steady-state other income	Historical average
$prem^{ss}$	2.5	Steady-state risk premium	Historical average
$\overline{fxres}^{ratimp,ss}$	7	Steady-state FX-reserve	Historical average

Fiscal policy			
Code	**Value**	**Parameter role**	**Calibration choice and justification**
Debt service			
w^c	0.5	Share of concessional financing	Iterative adjustment
ρ^{tprem^d}	0.75	LCY term-premium lag	Iterative adjustment
ρ^{tprem^*}	0.75	FCY term-premium lag	Iterative adjustment
g_2	0.05	Elasticity of the LCY term-premium wrt LCY indebtedness	Iterative adjustment
g_3	0.05	Elasticity of the FCY term-premium wrt FCY indebtedness	Iterative adjustment
Fiscal rule			
f_1	0.2	Elasticity of the primary deficit wrt output gap	Iterative adjustment
f_2	0.1	Elasticity of the fiscal reaction function wrt output gap	Iterative adjustment
f_3	0.1	Elasticity of the fiscal reaction function wrt debt deviation	Iterative adjustment
f_4	0.2	Weight of actual debt deviation in fiscal reaction function	Iterative adjustment
f_5	1	Elasticity of the fiscal impulse wrt structural deficit deviation from	Iterative adjustment
f_6	0.25	Elasticity of the fiscal impulse wrt debt target shock	Iterative adjustment
ρ^f	0.75	Smoothing of fiscal reaction function	Iterative adjustment
ρ^θ	0.9	Share of LCY financing lag term	Iterative adjustment
Steady-state			
$debt^{rat,ss}$	80	Steady-state public debt target	Historical average
$tprem^{d,ss}$	0	Steady-state LCY term-premium	Historical average
$tprem^{*,ss}$	0	Steady-state FCY term-premium	Historical average
θ^{ss}	0.6875	Steady-state LCY financing	Historical average

Foreign variables			
Code	**Value**	**Parameter role**	**Calibration choice and justification**
Commodity prices			
$\rho^{\Delta\overline{rpc}^{oil}}$	0.9	Real price of oil trend lag term	Iterative adjustment
$\rho^{\widehat{rpc}^{oil}}$	0.6	Real price of oil gap lag term	Iterative adjustment
$\rho^{\Delta\overline{rpc}^{food}}$	0.8	Real price of food trend lag term	Iterative adjustment
$\rho^{\widehat{rpc}^{food}}$	0.4	Real price of food gap lag term	Iterative adjustment
$\rho^{\Delta\overline{rpc}^{phos}}$	0	Real price of phosphate trend lag term	Iterative adjustment
$\rho^{\widehat{rpc}^{phos}}$	0.6	Real price of phosphate trend lag term	Iterative adjustment
US block			
k_1	0.4	US CPI lag term	Iterative adjustment
k_2	0.035	Elasticity of the US CPI wrt US output gap	Iterative adjustment
k_3	0.71	US FED policy rate smoothing	Iterative adjustment
k_4	1.9	US FED policy reaction to inflation	Iterative adjustment
k_5	0.21	US FED policy reaction to output gap	Iterative adjustment
k_6	0.6	US output gap lag term	Iterative adjustment
k_7	0.3	US output gap forward-looking term	Iterative adjustment
k_8	0.05	Elasticity of the US output gap wrt monetary conditions	Iterative adjustment
$\rho^{\bar{r}^{US}}$	0.9	US neutral rate lag term	Iterative adjustment
Steady-state			
$r^{US,ss}$	1.88	Steady-state US real interest rate	Historical average
$\Delta cpi^{US,TAR}$	2	Steady-state US CPI target	Historical average
$\Delta\overline{rpc}^{oil,ss}$	2.18	Steady-state growth of real price of oil	Historical average
$\Delta\overline{rpc}^{food,ss}$	2	Steady-state growth of real price of food	Historical average
$\Delta\overline{rpc}^{phos,ss}$	2.18	Steady-state growth of real price of phosphate	Historical average

Other trading partners demand and bilateral real ex. rate			
Code	**Value**	**Country**	**Weight ($w^{\hat{y}^j}$ or $w^{\widehat{re}^j}$)**
Other foreign demand components lag term (Calibrated to GPMN forecast)			
$\rho^{\hat{y}^{EZ}}$	0.94	Eurozone	0.03
$\rho^{\hat{y}^{CN}}$	0.80	China	0.03
$\rho^{\hat{y}^{JP}}$	0.85	Japan	0.00
$\rho^{\hat{y}^{BR}}$	0.94	Brazil	0.00
$\rho^{\hat{y}^{IN}}$	0.80	India	0.11
$\rho^{\hat{y}^{RU}}$	0.88	Russia	0.00004
$\rho^{\hat{y}^{UK}}$	0.93	United Kingdom	0.00
$\rho^{\hat{y}^{ZA}}$	0.90	South Africa	0.00
$\rho^{\hat{y}^{AR}}$	0.90	Arabic countries	0.44
$\rho^{\hat{y}^{RC}}$	0.84	Rest of the world	0.08
Other bilateral real exchange rate components lag term (Calibrated to GPMN forecast)			
$\rho^{\widehat{re}^{EZ}}$	0.76	Eurozone	0.12
$\rho^{\widehat{re}^{CN}}$	0.92	China	0.11
$\rho^{\widehat{re}^{JP}}$	0.62	Japan	0.01
$\rho^{\widehat{re}^{BR}}$	0.83	Brazil	0.01
$\rho^{\widehat{re}^{IN}}$	0.91	India	0.09
$\rho^{\widehat{re}^{RU}}$	0.70	Russia	0.00005
$\rho^{\widehat{re}^{UK}}$	0.83	United Kingdom	0.01
$\rho^{\widehat{re}^{ZA}}$	0.80	South Africa	0.00
$\rho^{\widehat{re}^{RC}}$	0.68	Rest of the world	0.11

PUBLICATIONS

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