TECHNICAL ASSISTANCE REPORT

BOSNIA AND HERZEGOVINA

Technical Assistance to Develop a Macroeconomic Framework at the Central Bank of Bosnia and Herzegovina

December 2024

Prepared By

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This report reflects the situation as of December 2023 and does not necessarily include later changes and modifications.

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Acronyms and Abbreviations

AR	Autoregressive process
BiH	Bosnia and Herzegovina
BoP	Balance of Payments
CBBH	Central Bank of Bosnia and Herzegovina
CPI	Consumer Price Index
DDT	Public Debt Dynamics Tool
FDI	Foreign Direct Investment
FPAS	Forecasting and Policy Analysis Systems
FPP	Financial Programming and Policies
GDP	Gross Domestic Product
GFS	Government Finance Statistics
ICD	Institute of Capacity Development
IMF	International Monetary Fund
ITA	Indirect Taxation Authority
JVI	Joint Vienna Institute
OCE	Office of the Chief Economist
QMFF	Quarterly Macro Forecasting Framework
TA	Technical Assistance

Executive Summary

In September 2020, the Governor of the Central Bank of Bosnia and Herzegovina (CBBH), Mr. Senad Softić, requested technical assistance from the Institute for Capacity Development (ICD) to build a Financial Programming and Policies (FPP) framework. Subsequent discussions with the CBBH team resulted in a project proposal aiming at developing a macroeconomic framework for macroeconomic forecasting and analysis at the CBBH, bringing its toolkit in line with those employed by other central banks.

The Quarterly Macro Forecasting Framework (QMFF) developed during this project is a novel quarterly framework that quantifies its main behavioral equations in terms of deviations of real variables from their long-run trends. The model comprises a simultaneous system of calibrated equations covering all key FPP sectors, as well as key accounting restrictions within and across these sectors. The QMFF has the flexibility to be adjusted to accommodate the macroeconomic characteristics of various countries and different exchange rate regimes, as well as to incorporate backward- or forward-looking expectation formation. The QMFF is implemented and operated in Matlab, with the capacity to automatically export its output to FPP-style tables in Excel format.

The TA project was successful in meeting its key objective - the development of a medium-term macroeconomic framework to further strengthen the macroeconomic forecasting and analysis process at the CBBH. The QMFF with adaptive expectations developed during this project was custom-built for the CBBH and gradually brought to data for Bosnia and Herzegovina via a combination of empirical approaches. It is a pilot version of a new approach to financial programming that combines gap-based modeling approach and FPP. Thus, the tool uses the advantages of the two approaches. From gap models it takes the business cycle analysis and forecasting, as well as tractability and the fast production of automatized reports. At the same time, it has the granularity and full accounting consistency of a typical FPP framework.

The CBBH counterparts participated actively in the development of the tool. They were involved in all stages of building the framework. The Office of the Chief Economist (OCE) team gradually built up its ability to understand the main channels of the transmission mechanism implied by the tool. Despite the considerable progress the OCE team achieved in the operation of the QMFF, they will still need more time to exploit the framework to its full potential.

Both the authorities and the IMF country team were highly satisfied with the contribution of this project to CBBH's macroeconomic forecasting and analytical capabilities. The TA project helped equip the authorities with a vital tool for policy analysis. The tool could also help deepen discussions with the Fund in the context of Article IV missions and facilitate information sharing.

The mission team recommended further steps to the OCE that would facilitate the full utilization of the framework, gradually making it the core policy analysis and forecasting tool of the CBBH. Among other steps, the formalization of an internal forecast calendar would greatly facilitate forecasting rounds. OCE team members should be given the task and the opportunity to regularly work with the model, which would help them to gain full ownership of the macroframework and to operate it efficiently. The results generated by the tool should then be integrated into policymaking discussions with senior CBBH management and communicated to the public on a regular basis. The latter two are closely related, as

capacity building will facilitate the application of the tool for forecasting and policymaking, which will in turn further stimulate the strengthening of the analytical skills of the staff.

I. Background

Bosnia and Herzegovina (BiH) is a middle-income country in Southeastern Europe with a complex political and institutional setup.[1] The almost 4-year war following the breakup of Yugoslavia in the early 1990s ended with the Dayton Peace Agreement in late 1995. It put in place a complex and decentralized institutional structure of the country, with two largely autonomous entities, the Federation of Bosnia and Herzegovina (FBiH) and Republic of Srpska (RS), as well as the Brčko District. Within FBiH itself, significant autonomy is granted to its 10 federal units (cantons). The institutional and political setup is unique and rather complex; e.g., both entities have a prime minister and 16 ministries, including ministries of finance, tax administrations and banking supervisors. In terms of economic policy, state-level institutions include the central bank (CBBH), indirect taxation and customs, deposit insurance, with other functions delegated to the two entities and the Brčko District. The large number of institutions makes macroeconomic management complex, including the compilation of statistics (particularly fiscal) and hence macroeconomic projections.

Since 1997, there is a currency board which sets a fixed exchange rate with the Euro (initially the German mark). In December 2022, the European Council granted European Union candidacy status to BiH, further strengthening the need for institutional reforms, including comprehensive macroeconomic analysis and forecasting.

In March 2019, a one-week Financial Programming and Policies (FPP) course customized for Bosnia and Herzegovina (BiH) was delivered in the country at the request of the authorities. The course was aimed at addressing longstanding challenges of BiH to build a consistent, integrated macroeconomic framework. The course was attended by 35 participants. This included 10 participants from the Central Bank of Bosnia and Herzegovina, 10 from the Ministry of Finance and Treasury of BiH, 5 from the Department of Economic Planning of BiH and 12 from ministries of finance of the Federation of Bosnia and Herzegovina and Republika Srpska (6 participants each).

The customized training did not result in further inter-agency cooperation in this area. The macro framework developed for the participating institutions was only used by the CBBH staff that attended the training to produce one internal forecast in April 2019 and send it, per request of the CBBH governor, to the European Commission in Brussels. Because of the institutional complexity and high fragmentation of responsibilities within the country, the CBBH decided that further activities in this area made sense only if a country specific model would be built, and used in house, as the further enhancement to the forecasting toolkit of the CBBH. 4The IMF's European Department supported a TA project with the CBBH as the main recipient, with the hope that communication and cooperation with other institutions might be enhanced in the future.

In September 2020, the Governor of the CBBH, Mr. Senad Softić, requested ICD TA support in building a FPP framework that will take into account country specifics. Subsequent discussions with the CBBH team resulted in a project proposal aiming at developing a macroeconomic framework at

[1] For 2024, GDP per capita is estimated at $8,320 (and $20,730 in purchasing power parity terms) source: IMF: https://www.imf.org/external/datamapper/profile/BIH

quarterly frequency to be used by the CBBH for forecasting and analysis, bringing its toolkit in line with those employed by other central banks.[2]

The project was divided into two phases.[3] Phase I focused on data collection and processing as well as development of the QMFF prototype, including its technical and reporting infrastructure. Phase I of the project was organized across four TA missions over the period of April 2021 - April 2022. The first three missions were delivered remotely in 2021, while the last one took place in-person in April 2022. The virtual missions were recorded, thus facilitating the transfer of technical knowledge to the OCE team. In turn, the in-person mission allowed for more in-depth discussions with the OCE team and hands-on assistance. The key results of Phase I consisted of:

- Compilation of a database required for setting up the FPP framework.
- Development of an initial code infrastructure for data processing and reporting using a Matlab-based toolbox.
- Development of a prototype model covering key economic sectors: real, external, fiscal, and monetary.
- Calibration of behavioral relationships in the real economy.
- Building the initial infrastructure for baseline projections and scenario analysis.
- Transfer of the quarterly macroeconomic framework in Excel using the data and forecasts generated in Matlab.
- Supporting the CBBH team in acquiring hands-on experience with using Matlab and operating the framework.

Phase II of the project was aimed at achieving full accounting consistency of the QMFF framework and enabling the CBBH team to independently utilize and further develop the framework. Phase II encompassed four missions between November 2022 and December 2023. Each of these missions was conducted in person, thus utilizing direct engagement with the team and hands-on implementation. The key achievements of the Phase II consisted of:

- Ensuring internal consistency of the QMFF by explicit introduction and linking of trends in relative prices and quantities and adjusting the calibration of steady-state values.
- Ensuring full accounting consistency of the framework by introducing cross-restrictions within and across sectors.
- Review and extension of the fiscal block (at the state level) of the framework by introducing a link between discretionary fiscal policy and GDP.
- Review and finetuning of model calibration and verification of the dynamic model properties.
- Streamlining and finalizing model and reporting infrastructure.
- Populating the IMF's Debt Dynamics Tool (DDT) with QMFF projections, to allow the authorities to track public debt dynamics at the state level within the CBBH mandate.
- Continuing the transfer of knowledge to the OCE team to reinforce its command of the tool by conducting shadow forecast rounds.
- Working towards institutionalization of the framework, ensuring its integration and sustainable use within the organization's processes and systems.

[2] The main counterpart for this project was the Office of the Chief Economist (OCE). We use CBBH team and OCE team interchangeably in the text.
[3] See Appendix A for details. The project was initially planned to last for a year; the second phase was added later.

II. Outputs of the Project

A. KEY FEATURES OF THE QUARTERLY MACRO FORECASTING FRAMEWORK

The QMFF is a novel quarterly framework that quantifies its main behavioral equations in terms of deviations from their medium-term trends (so called "gap model"). The gaps are measured as percentage deviations of the level of macroeconomic variables from their trends.[4] The most prominent "gap" variable is the output gap – a deviation of output from its trend, which indicates the position of the economy in the cycle. In the QMFF, the gaps are calculated using the Hodrick-Prescott filter.[5] The model comprises a simultaneous system of calibrated equations covering all key FPP sectors, as well as key accounting restrictions within and across these sectors. The baseline version of the framework developed for the CBBH assumes adaptive expectations, but it can be adjusted to operate with forward-looking, model consistent expectations. Overall, the QMFF has the flexibility to be adjusted to accommodate the macroeconomic characteristics of various countries and different exchange rate regimes, as well as to incorporate backward- or forward-looking expectation formation. The framework's robust technical environment allows for a high level of automation (see further details below), as well as flexibility in terms of granularity of coverage of particular sectors or the specification of economic relationships.

The QMFF was custom-built with the CBBH. It is a combination of gap-based modeling approach and FPP, within a single framework and unified infrastructure (Matlab and Excel). Thus, the tool utilizes the advantages of the two approaches. From gap models it takes the business cycle analysis and forecasting, as well as tractability and the fast production of automatized reports. At the same time, it takes the granularity and full accounting consistency within and across sectors of a typical FPP framework. For instance, ensuring consistency between national accounts and balance of payments or national accounts and fiscal accounts.

The QMFF allows for the use of further useful tools. The QMFF infrastructure enables the integration with additional tools that can be used by the authorities in the policy analysis and forecasting process. First, it includes a program that populates a typical Excel-based FPP macroframework with the generated data and forecasts, which provides a compact overview of the results and can often be used as an output presentation format that the institutions are familiar with. Second, it involves updating ICD's Debt Dynamics Tool (DDT) template, which, in addition to macroeconomic forecasting, allows to track public debt dynamics and informs the discussion on potential risks and adjustment needs.

The main characteristics of the framework can be summarized as follows:

- It uses quarterly data. CBBH staff can produce analytic policy documents and forecasts at quarterly, semi-annual or annual frequency.
- An automatized database system, executing data transformations for all key FPP sectors (real, monetary, external, and fiscal) is used to enhance productivity and minimize data processing errors.

[4] Level model variables (except interest rates) are expressed in terms of natural logarithm and multiplied by 100. The multiplication by 100 makes reporting more user friendly: a 2 % growth rate, for instance, will be reported as 2 and not 0.02.

[5] The framework is set up in a manner that facilitates an easy adoption of Kalman filtering.

- The backbone of the framework relies on a semi-structural model consisting of a simultaneous system of behavioral equations (see Appendix B for the key economic relationships driving the QMFF).[6]
- The framework is implemented and operated using Matlab.
- Automatic reports on model diagnostics (e.g., impulse-response functions) and forecast output, covering all FPP sectors, are produced to support forecast rounds and analytical exercises and presentations.
- The results generated are exported to Excel in a standard FPP format.

Modelling real GDP expenditure components allows the framework to capture rich economic relationships at business cycle frequencies and adjust them to the case of Bosnia and Herzegovina. The link between aggregate demand and fiscal policy is established via quantification of the cyclically-adjusted primary balance that feeds into the household consumption and gross investment, that in turn feed into the import demand (Appendix D). Additional gap equations are introduced for variables that can be modeled via behavioral equations, such as FDI, private transfers, the real wage bill, loans and VAT revenues.[7] The model projections, already incorporating expert judgment, are then automatically exported to Excel, which includes data in a quarterly frequency (and can be easily extended to annual frequency).

Besides the behavioral gap equations described above, the framework also includes equations for nominal variables specified as ratios of GDP, mostly from fiscal, external, and monetary sectors. These variables are forecasted using autoregressive convergence of their ratios to nominal GDP towards HP-filtered trend ratios to nominal GDP. These equations are important for incorporation of any off-model information, including judgement or forecasts obtained from fiscal authorities or balance of payments experts. Finally, these equations are necessary to produce the full set of forecasts for standard FPP macroframework.

QMFF includes trends in relative prices and real quantities so that the projections produced by the macroframework are consistent with a balanced growth path. To achieve this, the model trends are derived and linked in a way that nominal expenditure shares relative to nominal GDP converge to stable shares in the steady state, real expenditure gaps close and real and nominal growth rates are constant in the steady state (Appendix C).

The QMFF was brought to data via a combination of empirical approaches. The main goal of the calibration process is to iteratively develop a model parameterization that results in plausible overall dynamic properties of the model, incorporating country specific features, as well as good in-sample forecasting performance. The emphasis, therefore, is not to obtain good econometric estimates of individual model equations, but to understand how overall model properties can be changed by finding a combination of parameter values that jointly result in the desired model properties. Specifically, the QMFF was calibrated to match the most important stylized facts characterizing the economy of Bosnia and Herzegovina. These include the replication of the growth rates of nominal and real variables observed in historic data, full consistency of the model with observed nominal expenditures in national accounts relative to nominal GDP, as well as a satisfactory explanation of key cyclical movements, especially in the

[6] All the main economic relationships underlying the QMFF for the CBBH (Appendix B, including Table 4 that lists the key equations, and parameters), as well as equations on the import demand and national accounts' deflators (Appendix D) are based on the December 2023 version of the model. The final version and calibration used by the CBBH team may differ.

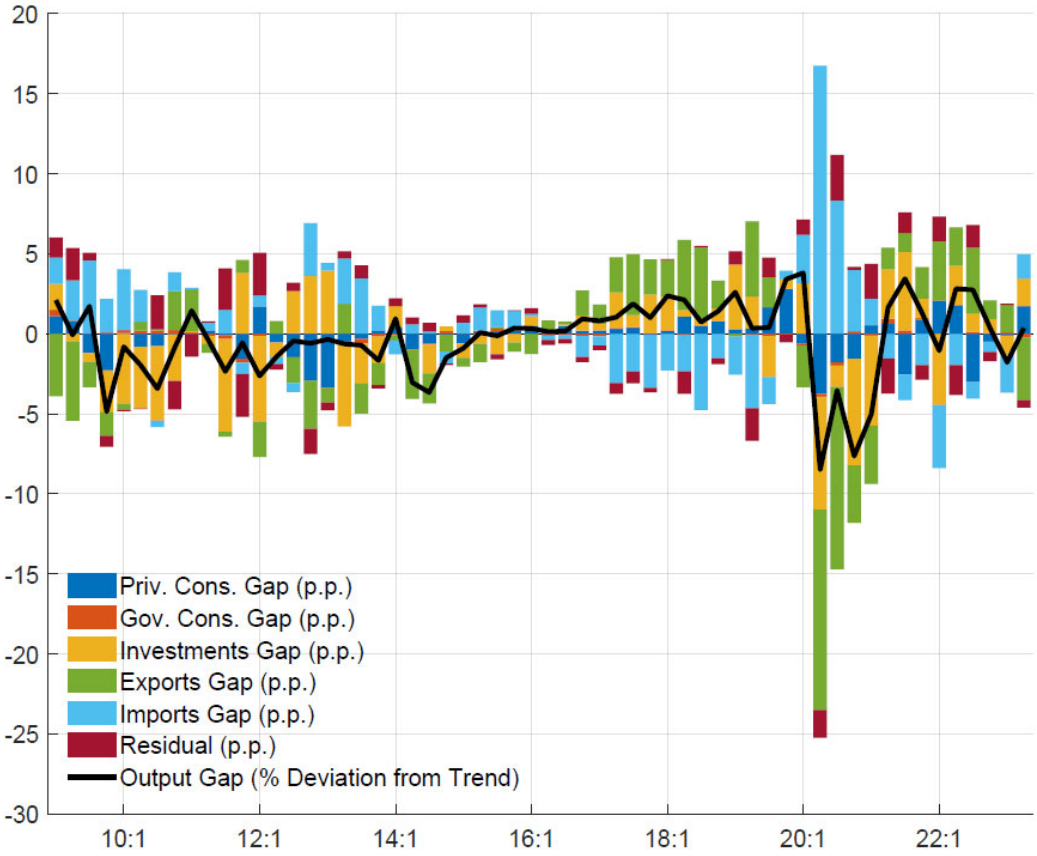
[7] The set of variables modeled via behavioral equations can be extended further.

recent past. This was done in the context of a currency board regime, and not fully consistent fiscal data at the state level. The following examples shed light on the calibration strategy in terms of the empirical verification of the model.

Calibrating nominal national expenditure shares

Most QMFF equations are log-linear, and the model relies on the gaps of the main real expenditure items of national accounts. The log-linearization of national accounts identities is important as it links the output gap with the real expenditure gaps. After using 2017-19 average shares during most of the project, they were recalibrated at their 2021-2022 average to capture the changes during and after the Covid-19 pandemic.[8] The resulting decomposition of the BiH output gap based on the log-linearization of the national accounts identity can be seen in Figure 1.

Figure 1: Log-Linearization of the National Accounts Identity[9]



Impulse response functions

[8] All steady-state shares were eventually calibrated to 2021-22 averages, which resulted in some improvement in model performance.

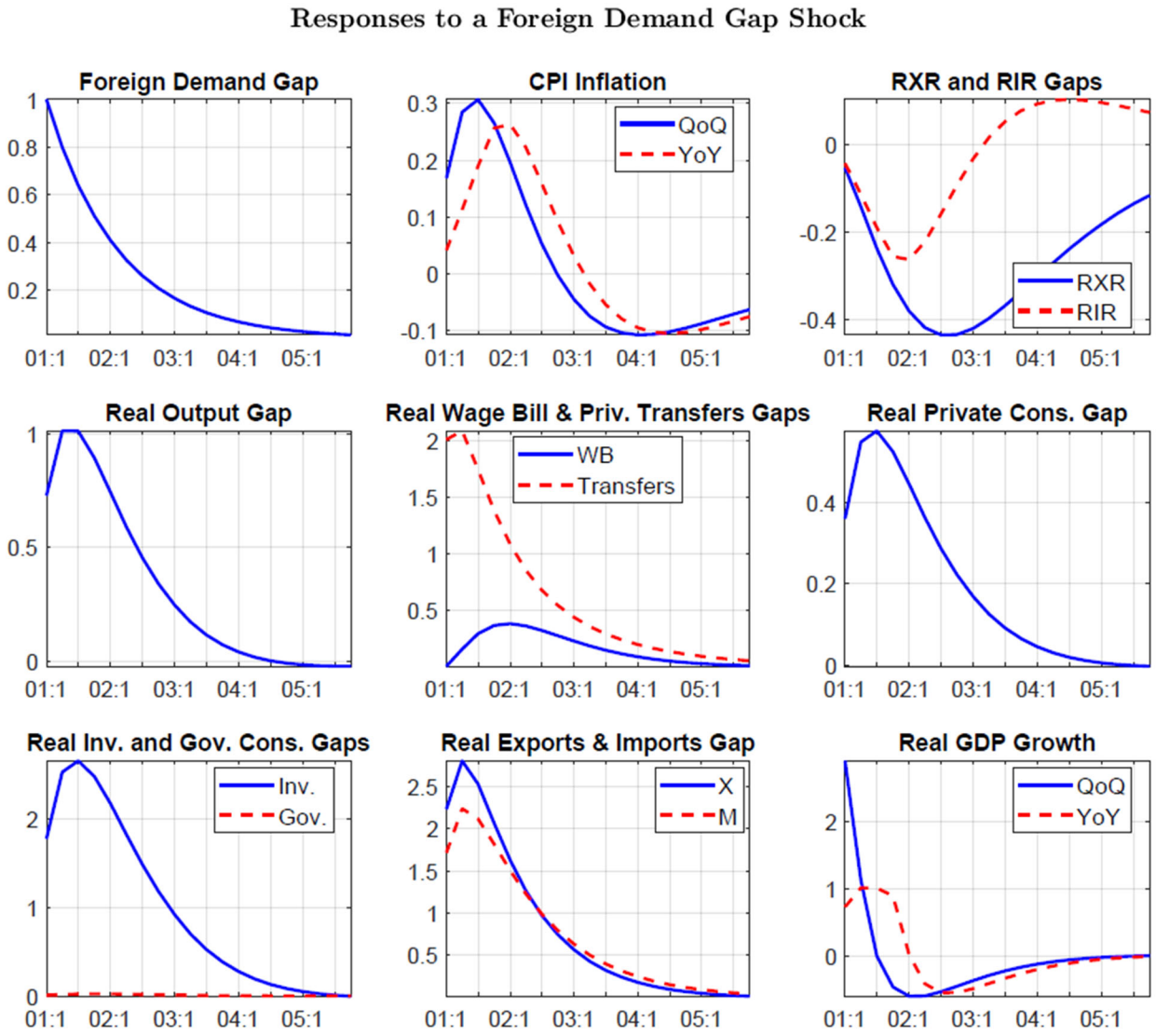
[9] Unless otherwise noted, all tables and graphs are based on calculations of the mission team; quarter-on-quarter changes are annualized; gaps show the percentage deviation of the log-level of the variable from the respective HP trend.

One of the advantages of setting up QMFF in the flexible computing environment (like Matlab) is the ability to efficiently solve the simultaneous system of equations and generate impulse response functions. Consequently, the users of the framework can examine the dynamic properties of the QMFF by analyzing the model's response to various shocks. Understanding impulse response functions is an important part of the model calibration process (before taking the model to data) and can also be used to compare it to other models for the Bosnian economy or other similar economies. The dynamic response of model variables to shocks, including their magnitude and speed of convergence to the steady-state, should be economically intuitive, in line with economic theory and reflecting the country-specific characteristics. Therefore, the mission team and the OCE team repeatedly analyzed the QMFF impulse response functions to understand the model's transmission mechanisms and verify its plausibility. Specifically, there are several characteristics that are expected in a small open economy, such as BiH, operating in a currency board regime. The role of the external business cycle in driving the domestic cycle is especially important (as illustrated below). That is given not only by the sensitivity of the export sector to foreign demand, but also by the strong reaction of private transfers (reflecting sizable diaspora from Bosnia and Herzegovina) and FDI to the external economic cycle. The role of domestic real interest rates in the transmission mechanism is minor, both in terms of the real economy and inflation. There are several reasons for that. In general, the domestic interest rates follow the corresponding rates in the euro area adjusted for the risk premium. The nominal anchor to the domestic economy is given by the exchange rate, therefore the interest rate channel in the monetary policy transmission mechanism is weaker. In addition, financial market development in countries with fixed exchange rates is often more gradual than in inflation targeting regimes, as hedging instruments are not as widely used as in economies operating in floating exchange rate regimes. Demand shocks, generated domestically or abroad, are expected to increase inflation, but the reaction is mostly contained due to the strong anchoring role of the fixed exchange rate in terms of price competitiveness and import substitution. The process of achieving plausible impulse response functions that are in line with these key characteristics of the economy resulted in gradual changes in the parametrization of the model, thus improving it considerably over time.

To illustrate the model's properties, a dynamic response of the model to a 1 p.p. shock to foreign demand is shown in Figure 2. The shock results in a growth of real GDP in the domestic economy (Panel 1), reflecting the positive effect of foreign demand on exports, investment and private consumption (via the increase in private transfers). In terms of the impact of the shock on inflation, on the one hand a positive output gap generates demand-led inflationary pressures, on the other hand the resulting real appreciation of the domestic currency pushes inflation down. On balance, the former effect outweighs the latter, leading to higher inflation. As nominal rates are unchanged and inflation increases, real interest rates become negative and initially contribute to economic growth. After improving due to the rise in exports at the beginning, the positive impact on the external position (captured by the current account in Panel 2) dies out soon afterwards, reflecting the high sensitivity of imports to domestic demand, the negative effect of the real appreciation on net exports and the higher long-run share of imports to GDP compared to exports. At the same time, this effect is partially countered by the strong positive impact of foreign demand expansion on private transfers and FDI. Consequently, the overall positive impact of the foreign demand shock on foreign reserves is longer lasting, highlighting the high dependence of a small open economy like BiH on external developments.

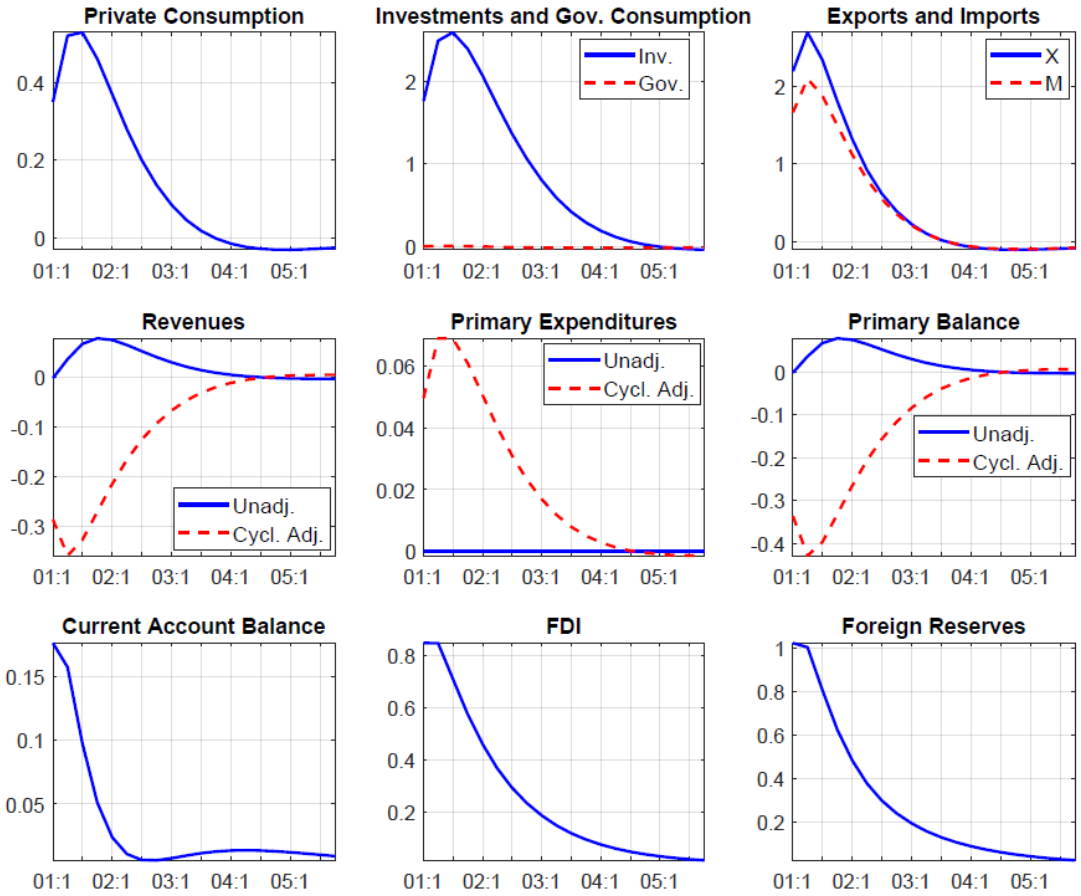
Figure 2: Impulse Responses of Selected Variables to a 1 %. Foreign Demand Gap Shock *(Y-axis: Percentage Points Deviations from the Steady State; X-axis: 5-year Horizon, Quarterly Frequency)*

Panel 1



Panel 2

Responses to a Foreign Demand Gap Shock as Deviations of Nom. Ratios to GDP from Trend Ratios

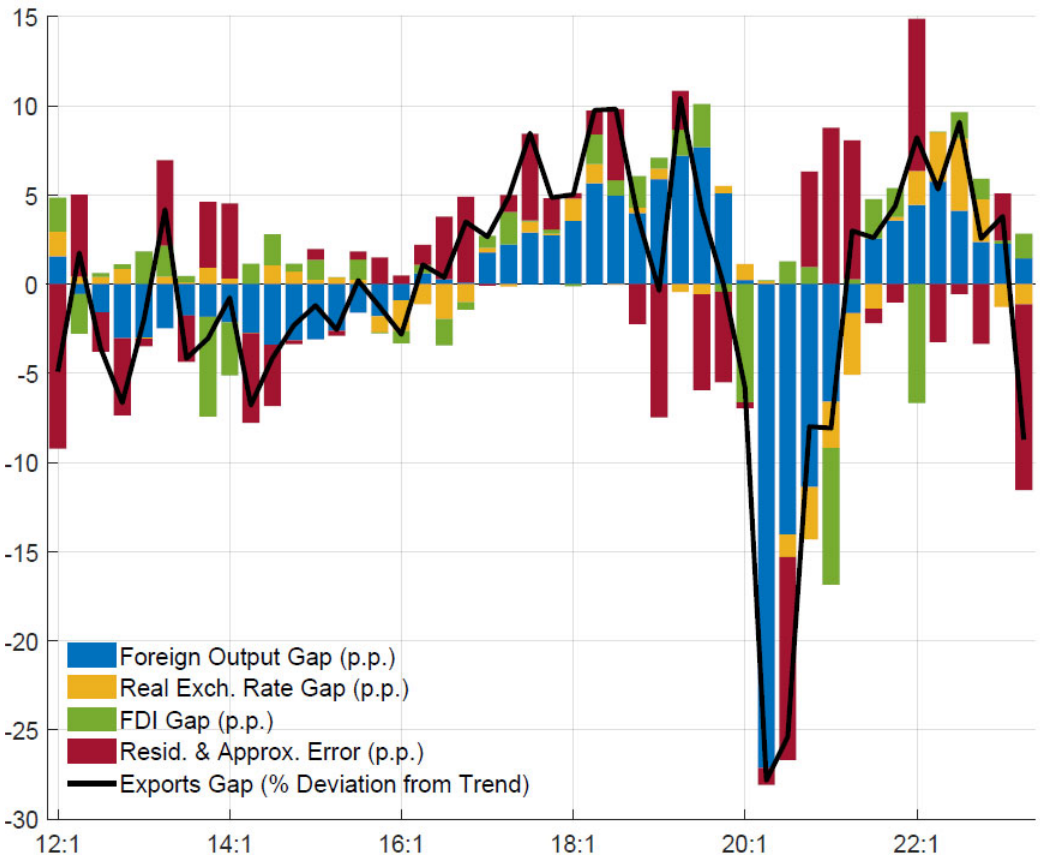


Decomposition graphs for behavioral equations

Besides their usefulness in checking identities (e.g., GDP and import equations), decomposition graphs are useful tools for empirical verification of behavioral equations, both in terms of theoretical priors and country specifics. In other words, they show how well a particular variable can be explained by economic factors, reflecting the model specification and calibration. In addition, decomposition graphs play an essential role during regular forecasting rounds, as they identify the business cycle drivers of the forecast.

While building the model, decomposition graphs were used extensively to check the specification of model equations in terms of selected variables, the lag structure and calibration of parameters. The volatility of some series notwithstanding, reasonable goodness of fit was achieved in most cases, with variables explaining a large share of the past movements, and residuals being moderate and resembling white noise. When analyzing the goodness of fit, higher weight was given to the recent years, thus mitigating the effect of historic structural changes on the current calibration of the model. Related to this, the lag of the dependent variable is substituted out, i.e., distributed across the variables and the residual. Alternatively, showing the lag as a separate variable would improve the goodness of fit but would make the economic interpretation more difficult. An example of these decomposition graphs for the gap in the real exports equation is shown in Figure 3. The equation demonstrates a reasonable fit, with foreign demand and FDI playing a dominant role in driving the dynamics of exports.

Figure 3: Decomposition of the Real Exports Gap Equation

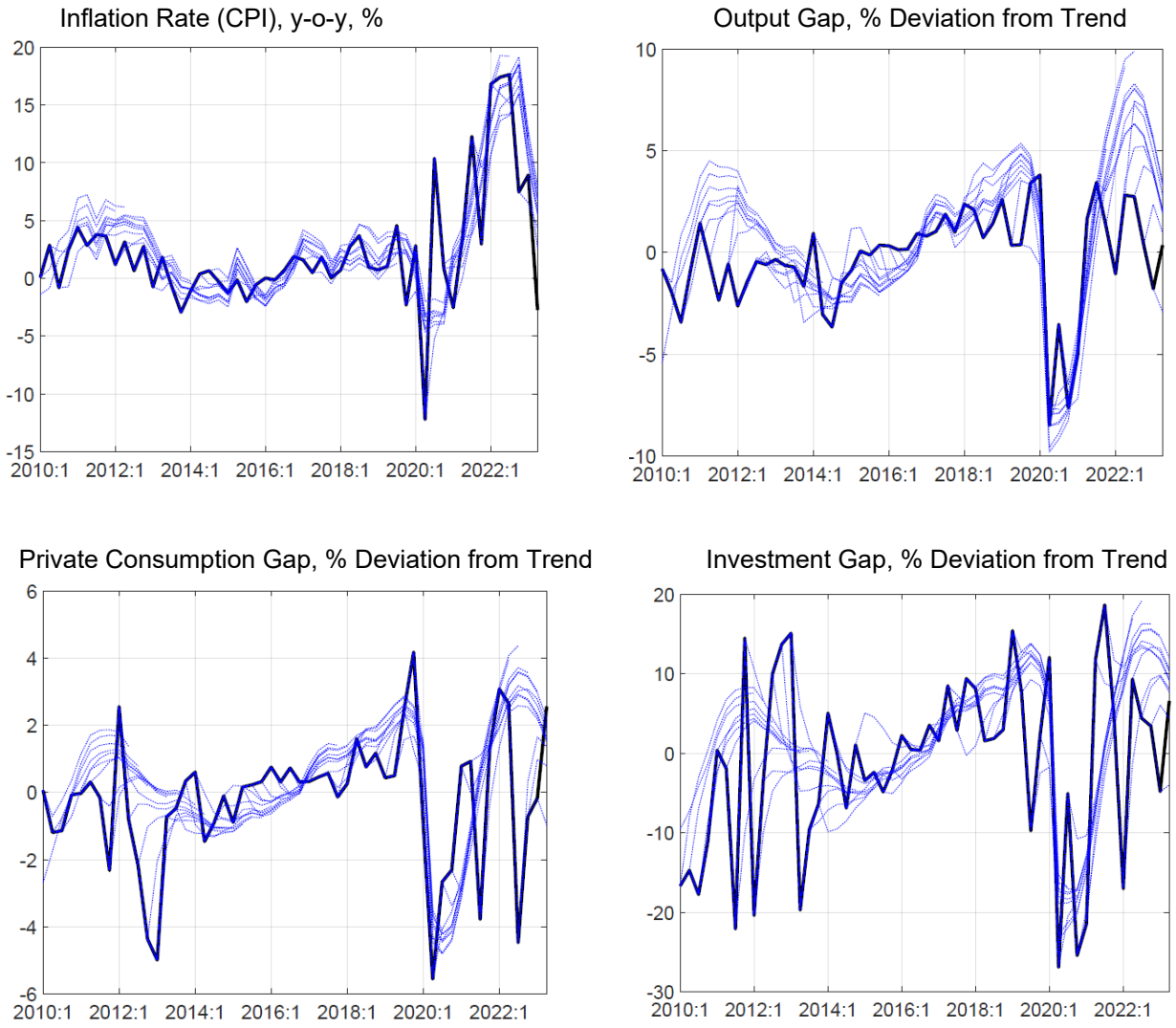


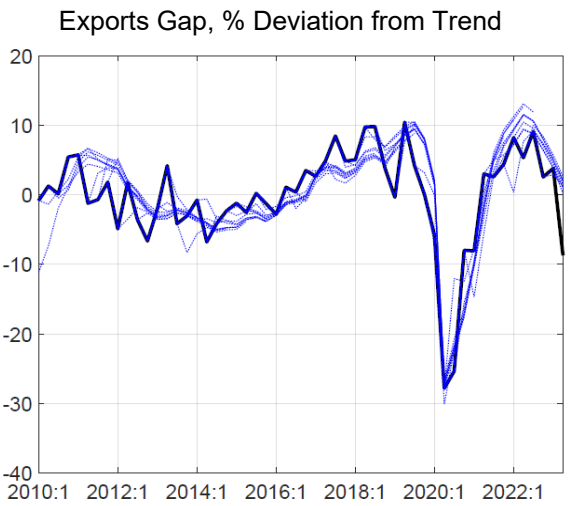
In-sample simulation results

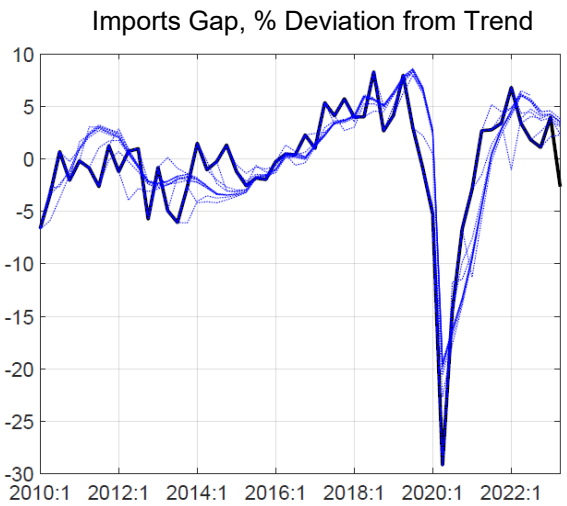
The in-sample simulation results included in Figure 4 are iterative, automatized "forecasts", produced starting in the first quarter of 2010 and continued successively in each period eight quarters ahead.[10] These simulations rely on the model structure and parameters, and the knowledge of exogenous variables. Overall, these results indicate a satisfactory performance of the model. The in-sample "forecasts" are close to observed variables for most of the behavioral equations: deviations from trends are not systematic and the model captures the turning points reasonably well. Although many of the variables included in Figure 4 are volatile and noisy, the dynamic simulations show a reasonable forecast for inflation. The forecasts of the output gap, but also real consumption, investment and exports are getting the turning points right most of the time, partially reflecting the information from external variables.

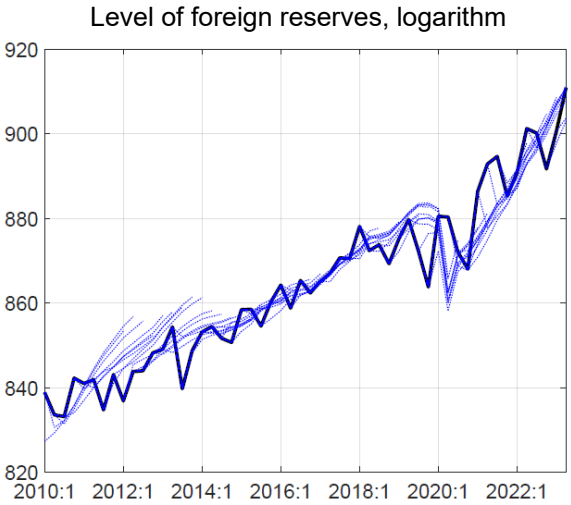
[10] The simulations are produced under the assumption that exogenous variables of the forecast (mostly external variables) and the future trends of all real variables are known. The model simulations are mechanical in the sense that no experts' judgements are incorporated: only the model solution, exogenous and trend variables are used to assess the dynamic properties of the QMFF.

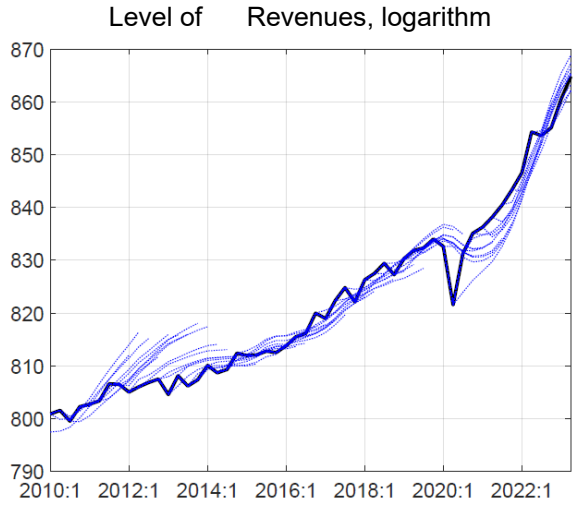
Figure 4: In-sample Simulations – Selected Variables











Forecasting

The forecasting process includes the update of the historical database and projected path of exogenous variables, solving the model, discussing initial conditions, incorporating nowcasts and judgement (if applicable) and producing a baseline medium-term forecast. The process is supported by a comprehensive reporting system, which is easily customizable, as well as transparent regarding nowcasts and judgement. Detailed automized reports were developed to capture historic data, initial conditions, baseline forecast, alternative scenarios and scenario comparisons. The forecast report, for instance, contains figures, decompositions, and tables, to be used by the forecasting team to analyze and explain the forecast. In particular, the decomposition graphs show both the projected gaps and their key driving factors. The tables depict key variables in annual or quarterly frequency and are currently set up to resemble a standard FPP representation across sectors. A sample of the forecast report is produced in Figure 5, Figure 6 and Table 1.

Figure 5: Baseline Forecast – Selected Variables

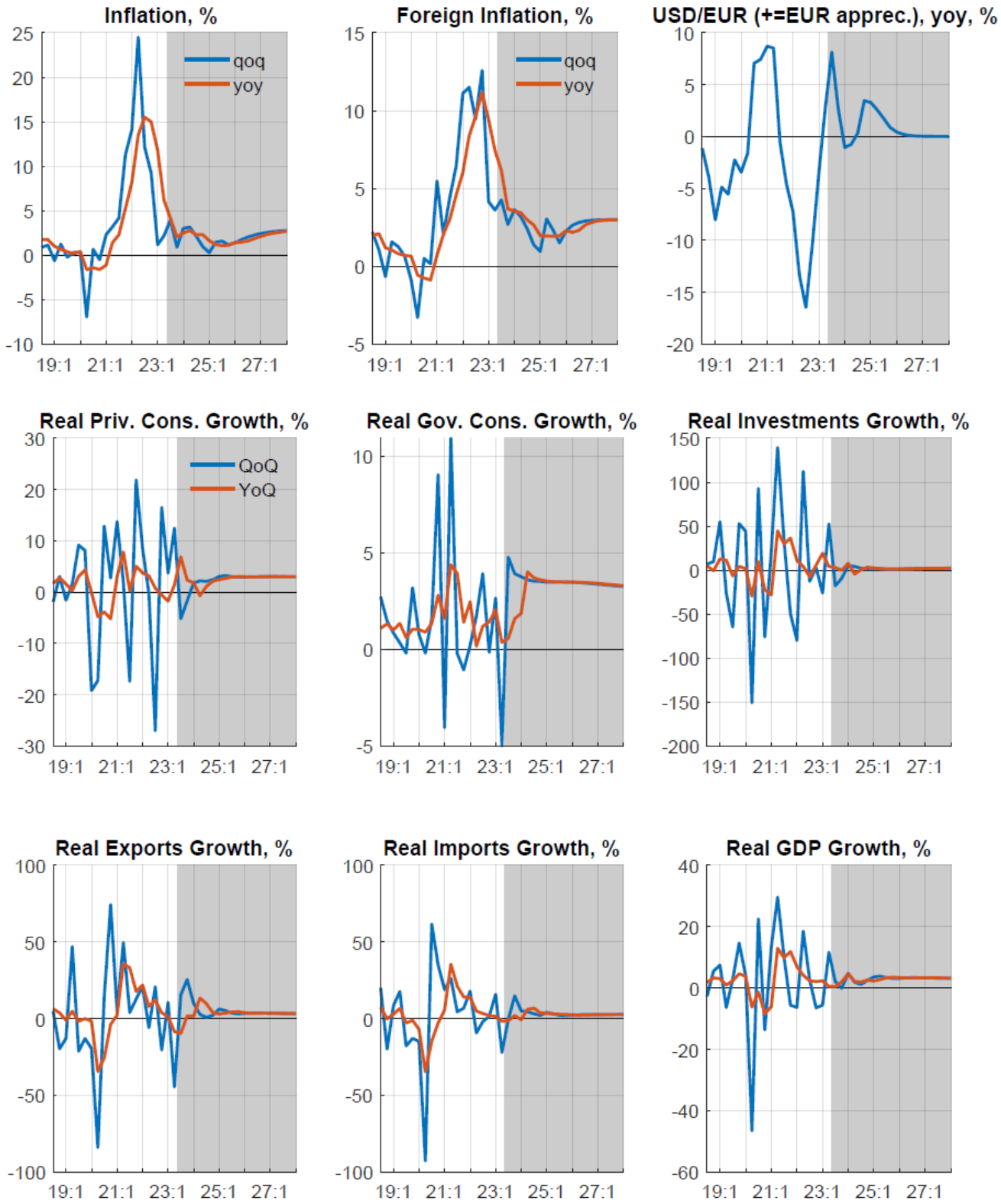


Figure 6: Baseline Forecast – Decomposition of Primary Expenditures to GDP Gap

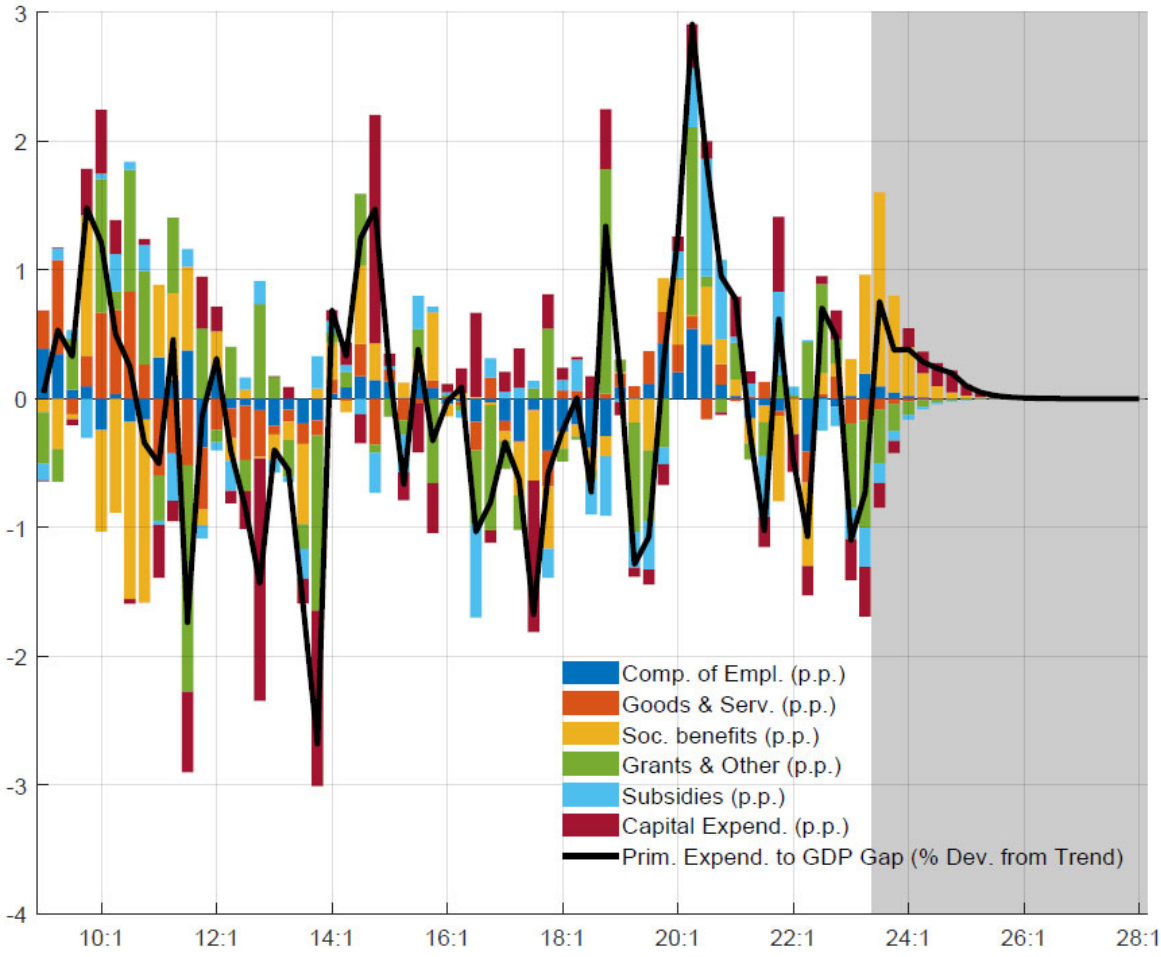


Table 1: Baseline Forecast – Selected Variables

Panel 1

Annual Projections - GDP

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2030	2040	2050
Real Variables, yoy, %														
GDP	**3.6**	**3.9**	**3.4**	**2.7**	**−3.0**	**7.1**	**3.8**	**1.3**	**2.8**	**2.9**	**3.3**	**3.0**	**3.0**	**3.0**
Priv. Consumption	2.2	1.4	2.2	2.3	−3.5	4.0	1.8	2.2	1.1	2.8	3.0	3.0	3.0	3.0
Gov. Consumption	−0.1	1.4	1.3	1.0	1.5	2.8	1.3	1.1	3.3	3.5	3.5	3.1	3.0	3.0
Investments	11.8	10.9	4.0	5.8	−9.3	20.8	2.7	6.0	1.7	1.7	1.4	2.7	3.0	3.0
Exports	9.0	11.2	7.1	0.5	−16.0	21.9	11.2	−3.7	7.0	3.8	3.5	3.0	3.0	3.0
Imports	7.0	7.4	3.9	1.4	−14.4	18.7	5.9	0.1	3.9	3.0	2.3	2.9	3.0	3.0
GDP	**3.6**	**3.9**	**3.4**	**2.7**	**−3.0**	**7.1**	**3.8**	**1.3**	**2.8**	**2.9**	**3.3**	**3.0**	**3.0**	**3.0**
Contributions, pp.														
Priv. Consumption	1.6	1.0	1.6	1.7	−2.5	2.9	1.3	1.4	0.8	1.9	2.0	2.0	2.0	2.0
Gov. Consumption	−0.0	0.3	0.3	0.2	0.3	0.5	0.3	0.2	0.6	0.7	0.7	0.6	0.6	0.6
Investments	2.6	2.6	1.0	1.4	−2.2	5.4	0.8	1.6	0.5	0.5	0.4	0.7	0.8	0.8
Exports	3.1	4.2	2.8	0.2	−5.7	8.2	4.7	−1.6	3.0	1.6	1.5	1.3	1.3	1.3
Imports	−3.7	−4.1	−2.2	−0.8	7.2	−9.9	−3.2	−0.2	−2.1	−1.7	−1.3	−1.6	−1.6	−1.6
Discr-before	−0.1	−0.1	−0.0	−0.1	−0.1	−0.3	0.2	−0.5	0.2	−0.1	−0.0	−0.0	−0.0	−0.0
Discr	0.0	0.0	−0.0	0.0	−0.0	0.0	0.0	−0.0	0.0	0.0	0.0	−0.0	−0.0	0.0
Dom. Demand	*4.2*	*3.9*	*2.8*	*3.3*	*−4.4*	*8.8*	*2.3*	*3.1*	*1.9*	*3.0*	*3.1*	*3.3*	*3.4*	*3.4*
Net Exports	*−0.5*	*0.1*	*0.6*	*−0.6*	*1.5*	*−1.7*	*1.5*	*−1.8*	*0.9*	*−0.1*	*0.2*	*−0.3*	*−0.4*	*−0.4*
Nominal Variables, yoy, %														
GDP	**4.2**	**4.8**	**5.2**	**4.4**	**−2.7**	**11.8**	**12.9**	**8.6**	**3.5**	**4.4**	**4.7**	**6.0**	**6.0**	**6.0**
Priv. Consumption	2.0	2.6	3.7	4.0	−3.5	6.5	14.2	9.1	3.3	4.0	4.6	5.9	6.0	6.0
Gov. Consumption	−0.4	1.3	3.9	3.7	3.9	5.3	11.4	8.0	3.6	4.9	4.9	6.0	6.0	6.0
Investments	9.2	13.1	5.3	6.7	−10.7	24.4	20.7	9.3	4.8	2.9	3.1	5.6	6.0	6.0
Exports	6.8	16.6	10.6	0.6	−17.6	32.7	27.6	−4.1	7.1	4.4	5.5	6.0	6.0	6.0
Imports	3.0	12.3	6.7	1.7	−15.8	23.8	29.1	−0.4	6.7	3.3	4.5	5.9	6.0	6.0
Foreign variables, yoy, %														
Foreign Eff. GDP Growth	2.5	2.7	2.5	2.3	−5.7	7.1	3.4	1.0	1.6	2.2	2.2	3.0	3.0	3.0

Panel 2

Monetary Survey - Annual, Amounts in Billions

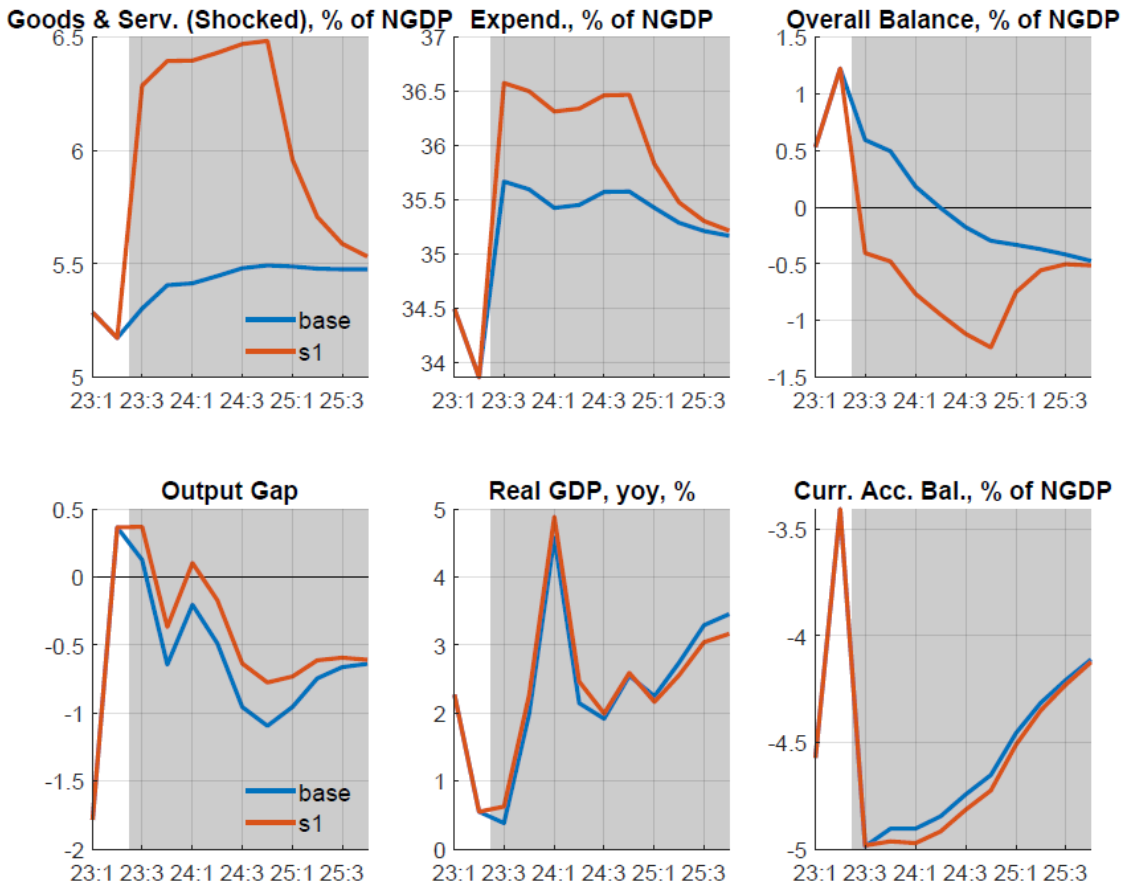
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2030	2040	2050
Net Foreign Assets	**9.6**	**10.7**	**12.3**	**13.8**	**15.8**	**18.9**	**19.0**	**20.2**	**22.0**	**23.5**	**25.3**	**35.7**	**78.7**	**157.5**
Foreign Assets	11.9	13.1	15.3	16.8	18.0	20.7	20.7	21.7	23.3	24.6	26.5	37.7	85.7	173.6
Foreign Liabilities	2.3	2.5	2.9	3.0	2.2	1.9	1.7	1.5	1.3	1.2	1.2	2.1	7.0	16.1
Net Domestic Assets	**10.5**	**11.3**	**11.7**	**12.3**	**12.2**	**12.4**	**14.0**	**15.1**	**15.8**	**17.1**	**18.2**	**21.7**	**32.7**	**52.4**
Domestic Credit	**17.0**	**17.9**	**18.6**	**19.6**	**19.6**	**19.8**	**21.2**	**23.0**	**24.0**	**25.8**	**27.7**	**37.8**	**76.6**	**147.3**
Claims on CG, net	**0.1**	**−0.2**	**−0.5**	**−0.7**	**−0.3**	**−0.8**	**−0.5**	**−0.0**	**−0.4**	**0.0**	**0.5**	**3.2**	**14.5**	**35.2**
Claims on GG	1.7	1.7	1.8	2.1	2.5	2.6	2.6	2.7	2.4	2.8	3.2	5.3	14.3	30.9
Liabilities on GG	1.6	1.9	2.3	2.8	2.8	3.4	3.2	2.7	2.8	2.7	2.6	2.1	−0.2	−4.3
Other Items Net	−6.5	−6.6	−6.9	−7.3	−7.4	−7.4	−7.2	−7.9	−8.2	−8.7	−9.6	−16.1	−43.9	−95.0
Broad Money (M2)	**20.1**	**22.0**	**24.0**	**26.1**	**28.0**	**31.3**	**33.0**	**35.3**	**37.8**	**40.6**	**43.5**	**57.4**	**111.4**	**209.9**
Currency Outside Banks	3.4	3.6	4.0	4.3	5.0	5.5	6.1	6.4	6.9	7.4	7.8	9.9	17.9	32.4
Deposits	16.7	18.3	20.1	21.8	23.0	25.7	26.9	28.9	30.9	33.2	35.7	47.5	93.5	177.4
Memorandum Items														
Ratios														
Velocity (GDP/e.o.p. M2), %	0.40	0.39	0.37	0.36	0.32	0.33	0.36	0.35	0.35	0.34	0.33	0.32	0.30	0.29
Currency/Broad Money, %	16.8	16.5	16.5	16.5	17.9	17.6	18.5	18.3	18.3	18.2	18.0	17.3	16.1	15.4
CB NFA/Mon. Base, %	115.0	113.2	112.8	114.2	113.3	113.5	107.8	106.9	106.8	103.9	103.1	108.4	122.2	128.5
Annual % change														
Broad Money	8.0	9.1	8.9	8.4	7.0	10.9	5.4	6.9	6.9	7.0	7.0	6.9	6.5	6.2
Claims on non-Government	3.3	7.1	5.4	6.5	−2.6	3.8	5.2	6.0	5.7	4.8	5.5	5.9	5.9	6.0
Loans to Households	3.6	6.4	6.9	7.5	−0.8	5.3	5.1	6.3	5.4	3.7	4.8	6.0	6.0	6.0
Loans to Priv. NFC	3.8	7.7	3.7	4.7	−5.0	2.2	4.3	5.4	3.1	3.6	4.7	6.0	6.0	6.0
% of GDP														
Broad Money	63.4	66.2	68.7	71.5	78.8	78.1	72.5	71.3	73.7	75.6	77.4	80.9	86.2	89.1
DMB Deposits	52.6	55.1	57.0	59.2	64.0	63.6	58.5	58.2	60.2	61.9	63.4	66.7	71.8	74.6
Claims on non-Government	51.8	53.0	53.1	54.2	54.3	50.1	46.4	45.2	46.2	46.4	46.8	47.1	46.7	46.4
ow Loans to Households	25.7	26.1	26.6	27.4	27.9	26.2	24.2	23.7	24.1	24.0	24.0	24.0	24.0	24.0
ow Loans to Priv. NFC	24.4	25.1	24.7	24.8	24.3	22.0	20.2	19.6	19.5	19.4	19.4	19.4	19.4	19.4

Incorporation of off-model information and scenario analysis

The framework is designed to easily adopt any judgement reflecting sectoral off-model information or alternative scenarios. These can be incorporated in the forecast via a transparent adjustment of residuals in respective equations, which are calculated based on the off-model or alternative evolution of the respective variables. To analyze the transmission of such shocks in the economy, extensive comparison graphs and tables were created (Figure 7); the same report is used when comparing forecast vintages (Table 2).

Figure 7: Alternative Scenario: Higher Spending on Goods and Services for 1 p.p. of GDP between 2023Q3 and 2024Q4 – Selected Variables

Panel 1



Panel 2

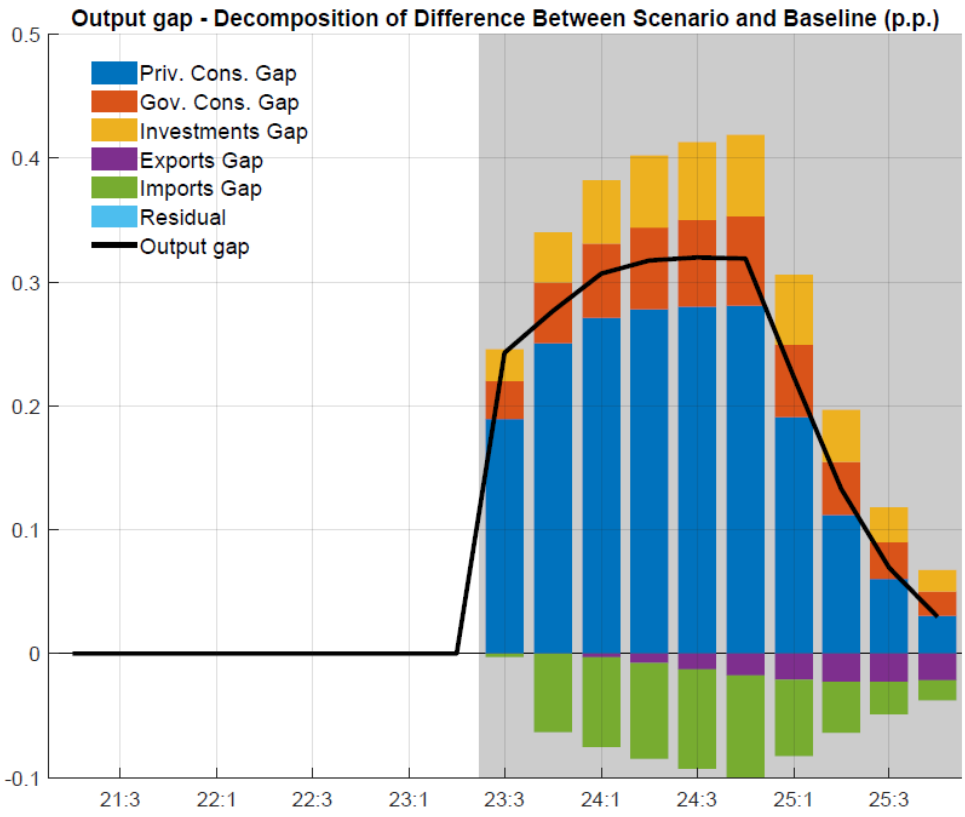

Output gap - Decomposition of Difference Between Scenario and Baseline (p.p.)
Priv. Cons. Gap
Gov. Cons. Gap
Investments Gap
Exports Gap
Imports Gap
Residual
Output gap
0.5
0.4
0.3
0.2
0.1
0
-0.1
21:3
22:1
22:3
23:1
23:3
24:1
24:3
25:1
25:3

Table 2: Comparison of Forecast Vintages – Example

Yearly Projections, % changes

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2030	2040
Real GDP													
apr	3.6	3.9	3.4	2.8	−3.3	6.9	3.7	4.3	0.5	2.6	3.3	3.0	3.0
oct	3.6	3.9	3.4	2.7	−3.0	7.1	3.8	1.3	2.8	2.9	3.3	3.0	3.0
Inflation													
apr	−1.6	0.8	1.4	0.6	−1.1	2.0	13.1	8.8	3.9	2.5	2.6	3.0	3.0
oct	−1.6	0.8	1.4	0.6	−1.1	2.0	13.1	5.9	2.5	1.3	1.6	3.0	3.0
GDP Deflator													
apr	0.5	0.8	1.8	1.7	0.3	4.7	7.7	3.7	4.3	2.4	2.5	3.0	3.0
oct	0.5	0.8	1.8	1.7	0.3	4.7	9.0	7.3	0.7	1.5	1.4	2.9	3.0
Real Priv. Consumption													
apr	2.2	1.4	2.2	2.3	−3.5	3.9	3.4	2.2	3.3	3.8	4.1	3.2	3.0
oct	2.2	1.4	2.2	2.3	−3.5	4.0	1.8	2.2	1.1	2.8	3.0	3.0	3.0
Real Gov. Consumption													
apr	−0.1	1.4	1.3	1.0	1.5	2.9	1.5	1.8	3.4	3.5	3.4	3.1	3.0
oct	−0.1	1.4	1.3	1.0	1.5	2.8	1.3	1.1	3.3	3.5	3.5	3.1	3.0
Real Investments													
apr	11.8	10.9	4.1	6.0	−9.0	20.5	15.6	6.1	−7.2	−4.2	−0.5	2.3	3.0
oct	11.8	10.9	4.0	5.8	−9.3	20.8	2.7	6.0	1.7	1.7	1.4	2.7	3.0
Real Exports													
apr	9.0	11.3	7.0	0.6	−17.3	22.0	21.3	−1.5	−0.9	0.9	1.9	2.7	3.0
oct	9.0	11.2	7.1	0.5	−16.0	21.9	11.2	−3.7	7.0	3.8	3.5	3.0	3.0
Real Imports													
apr	7.0	7.4	3.9	1.3	−14.4	18.5	21.9	−5.9	0.5	0.7	2.0	2.9	3.0
oct	7.0	7.4	3.9	1.4	−14.4	18.7	5.9	0.1	3.9	3.0	2.3	2.9	3.0

Exporting historic data and baseline forecasts to an Excel-based macroframework

The template is a classic FPP presentation of the history and projections for real, external, fiscal, and monetary sectors of the economy. It also includes a summary of the external assumptions used in the projections. As opposed to standard macroframeworks, however, Excel is only used to present results in the standard FPP table format. All other tasks and reporting are performed within Matlab: the introduction of changes and assumptions, within- and between-sectoral linkages, the solution of the system of equations, the production of forecasts and various reports. A built-in Excel macro uses the data/forecasts generated in the previous steps and copies them into a single data sheet; this data is then used to populate the rest of the Excel template (Table 3). The Excel template is currently set up to contain 12 quarters of historic data and 12 quarters of forecasts. The frequency of the projections/history (quarterly vs annual), the list of series displayed, and their historic and projection horizons can also be easily adjusted.

Table 3: Excel-based Framework – Example

General Government

(in mn KM, unless otherwise indicated)

							Projections									
	2022Q1	2022Q2	2022Q3	2022Q4	2023Q1	2023Q2	2023Q3	2023Q4	2024Q1	2024Q2	2024Q3	2024Q4	2025Q1	2025Q2	2025Q3	2025Q4
Revenue	**3,718.0**	**4,010.3**	**3,976.0**	**4,008.2**	**4,243.5**	**4,463.3**	**4,505.5**	**4,536.1**	**4,568.0**	**4,620.4**	**4,663.3**	**4,682.7**	**4,689.3**	**4,703.1**	**4,723.3**	**4,744.8**
Taxes	**1,968.0**	**2,158.1**	**2,109.5**	**2,032.0**	**2,228.8**	**2,327.5**	**2,426.5**	**2,428.4**	**2,434.2**	**2,450.4**	**2,464.1**	**2,469.3**	**2,469.3**	**2,474.9**	**2,484.1**	**2,494.0**
Direct taxes & other	82.7	125.4	123.4	56.8	225.1	253.1	214.9	201.4	193.9	189.7	185.6	180.4	174.7	169.2	164.1	159.2
Indirect taxes	1,885.3	2,032.7	1,986.2	1,975.2	2,003.7	2,074.3	2,211.6	2,227.0	2,240.3	2,260.7	2,278.5	2,288.8	2,294.6	2,305.6	2,320.0	2,334.9
VAT	1,204.7	1,300.6	1,310.2	1,307.7	1,335.4	1,381.3	1,449.4	1,477.0	1,491.4	1,503.9	1,513.6	1,519.4	1,522.6	1,530.0	1,539.6	1,549.4
Excise duties	385.1	412.1	406.5	377.0	379.0	370.8	451.5	427.4	417.6	417.0	418.8	419.7	420.2	421.7	424.0	426.6
Customs	94.6	104.2	114.1	118.7	118.7	123.9	134.0	129.6	128.2	128.7	129.4	129.5	129.3	129.2	129.3	129.4
Other	200.8	215.8	155.5	171.9	170.6	198.3	176.7	192.9	203.1	211.0	216.8	220.2	222.5	224.7	227.1	229.4
Social security contributions	**1,538.7**	**1,603.2**	**1,651.9**	**1,689.4**	**1,788.5**	**1,817.6**	**1,800.8**	**1,842.4**	**1,875.1**	**1,913.3**	**1,943.8**	**1,960.3**	**1,969.4**	**1,979.6**	**1,992.0**	**2,004.7**
Grants & other revenue	**211.3**	**249.0**	**214.6**	**286.8**	**226.3**	**318.3**	**278.1**	**265.3**	**258.8**	**256.7**	**255.4**	**253.1**	**250.6**	**248.6**	**247.2**	**246.1**
Expenditure	**3,547.7**	**3,806.7**	**3,995.0**	**4,111.7**	**4,179.1**	**4,307.7**	**4,419.6**	**4,453.8**	**4,517.7**	**4,597.4**	**4,667.4**	**4,707.2**	**4,721.5**	**4,743.9**	**4,774.0**	**4,805.9**
Expense	**3,449.6**	**3,696.4**	**3,866.1**	**3,963.7**	**4,069.5**	**4,200.7**	**4,300.8**	**4,323.5**	**4,363.9**	**4,434.5**	**4,495.4**	**4,527.8**	**4,545.0**	**4,566.0**	**4,592.5**	**4,619.7**
Compensation of employees	919.3	956.1	998.1	1,040.3	1,090.3	1,142.2	1,114.9	1,131.8	1,147.1	1,167.7	1,184.5	1,193.2	1,197.6	1,202.9	1,209.6	1,216.5
Use of goods and services	570.3	592.4	615.2	663.0	640.4	658.1	658.4	677.1	691.2	706.9	719.5	726.9	731.5	736.6	742.5	748.4
Social benefits	1,439.5	1,531.3	1,616.6	1,695.5	1,785.8	1,903.2	1,974.5	1,914.3	1,895.6	1,906.7	1,921.8	1,929.0	1,931.9	1,937.6	1,946.1	1,955.3
Interest	55.6	62.5	77.3	31.5	101.2	55.8	57.8	60.5	62.3	64.0	65.3	66.1	66.7	67.3	67.9	68.6
Subsidies	161.9	170.4	142.5	159.9	155.7	152.9	167.1	179.7	187.6	193.9	198.4	201.0	202.4	203.8	205.4	207.0
Grants & other expense	303.0	383.8	416.5	373.5	296.1	288.5	328.1	360.1	380.1	395.3	405.8	411.6	414.8	417.8	421.0	424.0
Net acquisition of nonfinancial assets	**98.2**	**110.2**	**128.9**	**148.0**	**109.5**	**107.0**	**118.8**	**130.3**	**153.9**	**162.9**	**172.0**	**179.4**	**176.4**	**177.9**	**181.6**	**186.2**
Gross / Net Operating Balance (revenue minus expense)	**268.4**	**313.9**	**109.9**	**44.5**	**174.0**	**262.6**	**204.6**	**212.5**	**204.2**	**185.9**	**167.9**	**154.9**	**144.3**	**137.1**	**130.9**	**125.1**
Net lending/borrowing (revenue minus expenditure)	**170.3**	**203.7**	**-18.9**	**-103.5**	**64.5**	**155.6**	**85.8**	**82.3**	**50.3**	**23.0**	**-4.1**	**-24.5**	**-32.2**	**-40.8**	**-50.7**	**-61.2**
Primary balance	**225.9**	**266.2**	**58.4**	**-72.0**	**165.7**	**211.4**	**143.6**	**142.8**	**112.6**	**87.0**	**61.2**	**41.6**	**34.5**	**26.5**	**17.2**	**7.4**
Cyclically adjusted primary balance	**293.7**	**126.8**	**-75.8**	**-104.1**	**300.8**	**222.3**	**73.9**	**102.2**	**66.9**	**81.2**	**98.1**	**99.7**	**94.3**	**77.8**	**64.6**	**53.6**

Linking projections with the ICD's DDT tool

The QMFF projections were further linked to the ICD's DDT tool, allowing the CBBH to track public debt dynamics, within their mandate.[11] The Excel-based DDT produces public debt projections as a share of GDP based on the macro-fiscal projections from the QMFF. In addition, it can help to identify a debt stabilizing primary balance and fiscal adjustment paths necessary to achieve a pre-defined public debt target. The template includes various alternative consolidation strategies to reach a debt-to-GDP target: constant primary balance, constant adjustment in primary balance, constant debt changes as well as a customized scenario (combination of the first two options). This enables the staff to do a comparison between the baseline projections of the primary balance and the primary balances required to stabilize debt or reach a specific debt target under various adjustment strategies. The results of this exercise can help signal risks to fiscal sustainability. Annual data and forecasts generated by the QMFF are exported as inputs into the DDT Excel file.

B. DOCUMENTATION OF THE MACROECONOMIC PROJECTIONS TOOL

The creation of internal documentation for the tool is key to maintaining continuity in knowledge transfer for new staff members. The core CBBH team has produced an internal user manual that provides step-by-step guidance on operating the model, understanding the model code structure and its outputs. Having a detailed technical documentation of the framework and its use will strengthen business continuity in using the model and facilitate knowledge transfer to new team members, allowing them to quickly learn how to use the tool to forecast, design and simulate policy scenarios. The internal user manual was presented by the CBBH staff to the ICD team during the final mission. The mission team gave its initial view on the documentation and agreed with the CBBH team on the main directions for its

[11] The analytical underpinnings and a user manual of the DDT can be found here: "A Guide and Tool for Projecting Public Debt and Fiscal Adjustment Paths with Local- and Foreign-Currency Debt"

future extension. Specifically, the CBBH team should work on improving the documentation of the model structure and its properties.

C. KNOWLEDGE TRANSFER

Knowledge transfer throughout the TA project was primarily achieved through a mix of virtual and in-person interactions with the core team. A combination of sessions, highlighting the theoretical underpinnings of the QMFF, combined with hands-on analytical and shadow forecasting rounds, were undertaken to enhance the capacity of the OCE team in policy-oriented analytic work.

Statistical integrity and consistency

The mission team, together with the OCE team, conducted an in-depth review of raw input databases and introduced comprehensive automatic checks embedded within the data processing codes.[12] These included examining the automatically generated reports that follow each data update. These automatized checks are vital for a seamless, reliable and efficient data management and data update process. The transfer of knowledge was further enhanced during shadow forecast rounds via proposing to the CBBH team good practice examples in terms of data update and incorporation of nowcasts and near-term forecasts into the baseline projection.

Specification and calibration of behavioral equations

The mission team was continuously engaged with the CBBH core team in the process of specification and (re)calibration of the model equations. The economists of the OCE worked further on model specification in-between missions, sharing their findings and suggestions on alternative specifications and parameterization of the behavioral equations with the mission team. The sensitivity to alternative parameterizations of the equations was also discussed. In addition, the overall forecasting properties of the macroframework using forecast decompositions, impulse response functions and in-sample simulations were discussed.

Construction of baseline forecast and alternative scenarios

The ICD team supported the CBBH during the shadow forecast rounds to construct a coherent and up-to-date baseline forecast. Discussions started with comparison of forecast vintages aimed at distinguishing the effect of changes in recent outcomes and external assumptions on forecast revisions. Furthermore, the ICD team guided the CBBH team to incorporate off-model assumptions, nowcasts and near-term forecasts into the baseline scenario. Shadow forecast rounds were accompanied with alternative policy scenarios to analyze the economic impact of possible exogenous shocks as well as changes in domestic policy (e.g., fiscal policy).

Tool operation and institutionalization

The mission team discussed the detailed steps in a typical forecasting round, including the role of the sectoral experts and staff using the model to produce forecasts. The mission team shared their experiences regarding the importance of a detailed, formal forecasting calendar pinning down the personal responsibilities of forecast team members and deadlines for delivering intermediate forecast inputs. The organization of the forecasting process reflecting these recommendations should facilitate a

[12] A specific example of such tool is a code enabling the comparison of the updated database with its previous vintage. The script identifies any changes in the naming of the variables or missing variables, as well as indicates the time series and specific time periods where data revisions exceed a pre-specified threshold.

smoother framework operation and more effective collaboration within the OCE team. The core team shared their experience and drew parallels with the good practice examples outlined by the mission team.

Synergies between TA and training

The mission team encouraged the OCE team to continue building their capacity by attending relevant training at the JVI and supported their applications throughout the project period. The OCE team members enhanced their capacity by attending courses such as FPP, Macroeconomic Diagnostics, Macroeconometric Forecasting and Analysis, Monetary Policy Analysis and Forecasting, and Vulnerability Diagnostics. The mission team recommends a similar approach for future members of the core forecasting team.

Use of technology

Virtual missions, as well as most of the face-to-face engagements, were recorded and the recordings shared with the CBBH core team. This greatly facilitated transfer of knowledge by allowing the OCE team members to refer to the recordings while drafting the user manual and working with the framework.

D. CHALLENGES IN THE TA DELIVERY

Sizable challenges arose from the novel approach to developing a macroeconomic framework. The unique integration of the gap-based methodology with the classic FPP in levels resulted in challenges in ensuring the consistency of trends in relative prices and quantities. Once this was accomplished, it was possible to impose cross-restrictions within and across the economic sectors and ensure both economic and accounting consistency. The TA project incorporated into the framework all sectors with a relatively high granularity almost simultaneously, as it is typically done in a standard FPP framework. In hindsight, however, it is possible that developing a small functional model first, and introducing granularity and extensions to other sectors afterwards, would have been more efficient.

Like in other similar TA projects, the size of the team presented some challenges regarding the absorption of the framework and its operation. The OCE team composed of seven staff is relatively small and stretched, with a high workload in many areas. During the early stages of the project, these circumstances affected the capacity of the team members to become proficient in using the model for policy analysis and forecasting. In addition, there was some staff turnover during the project and the new staff members had to familiarize themselves with the technical operation and use of the framework. The situation improved somewhat during the later missions, as the team started to acknowledge the productivity gains the QMFF can deliver and became more comfortable with various aspects of the framework.

Data quality and availability created challenges for identifying behavioral relationships and imposing accounting identities. Some of these issues are common in other transition countries (e.g., discrepancies between CPI inflation and the private consumption deflator or sizable revisions of data series on GDP expenditure items both in terms of volume and deflator (Panel 1 in Figure 8). Other issues are primarily related to fiscal data, as the macroeconomic framework utilizes quarterly central level fiscal statistics compiled by the CBBH, which are broadly in accordance with the definitions and concepts of the Government Finance Statistics (GFS) Manual 2014. For instance, CBBH GFS statistics provides data on total taxes only. To obtain the breakdown into direct and indirect taxes, the CBBH team relied on information from Indirect Taxation Authority for indirect taxes, whereas direct taxes are calculated as a

residual. This, however, may create inconsistencies and counter-intuitive values, with direct taxes sometimes becoming negative (Panel 2 in Figure 8).

Further issues arise when trying to impose cross-sectoral accounting restrictions, in particular:

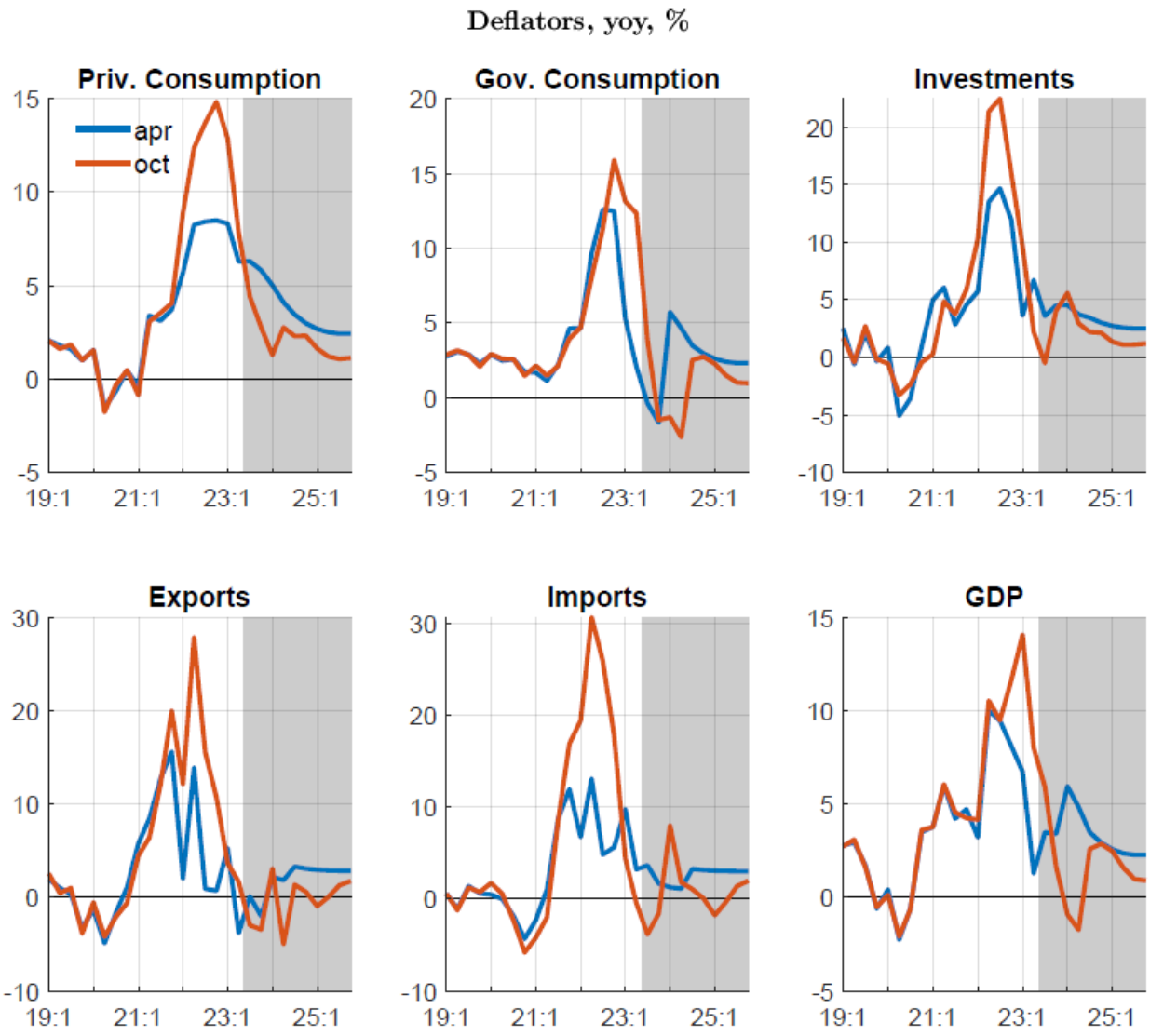
- Reconciling fiscal statistics with government consumption from the national accounts in BiH proved challenging given the persistently large gap between the time series. For instance, the difference between the sum of the compensation of employees and spending on goods and services, which represent the two key categories of government consumption, and government consumption from the national account statistics equals around 5% of GDP (Panel 3 in Figure 8); this discrepancy cannot be explained by the missing items in the calculation (such as depreciation). In addition to the typical discrepancies between government and national accounts statistics, driven primarily by the differences in cash vs. accrual accounting methodologies, challenges in fiscal data collection complicate the creation of a direct accounting link between the two. To reflect the relationship between fiscal policy and public consumption, we use the cyclically adjusted primary expenditures gap when projecting the public consumption gap (Appendix B).
- Similarly, the level of net acquisition of nonfinancial assets as a share of GDP data appears to be underestimated (around 1% of GDP). In addition, the investment in national accounts does not differentiate between public and private investment, making it difficult to establish an accounting link. In the framework, the total investment gap is linked to public investments to broadly capture the relationship between fiscal policy and total investments.

A more general approach for overcoming similar data issues and differences in accounting when introducing cross-sectoral linkages would be to model the discrepancy separately as a mean reverting process. If data discrepancies become smaller over time, the assumed steady state should be adjusted accordingly.

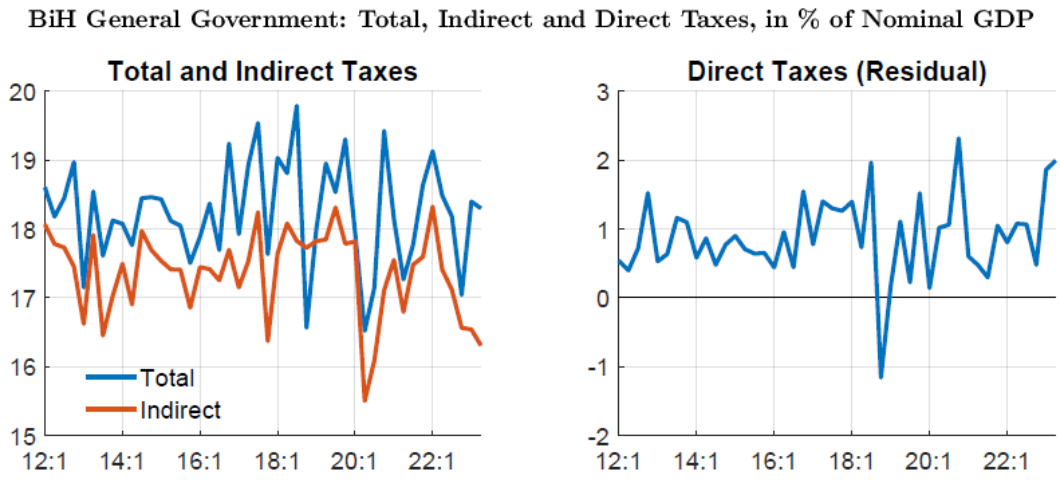
Finally, it was noted by the OCE team that many data series are published with considerable delays, and often do not follow a pre-defined publication schedule. For instance, in mid-December 2023, the last available BoP and fiscal data were for the second quarter of the year. Consequently, with such data availability, the generated forecast starts in the third quarter of 2023, which practically lags two quarters behind the current date. Shortening this lag by one quarter would require nowcasting almost all fiscal and external data, which would in turn affect the quality of the overall forecast.

Figure 8: Examples of Data Weaknesses

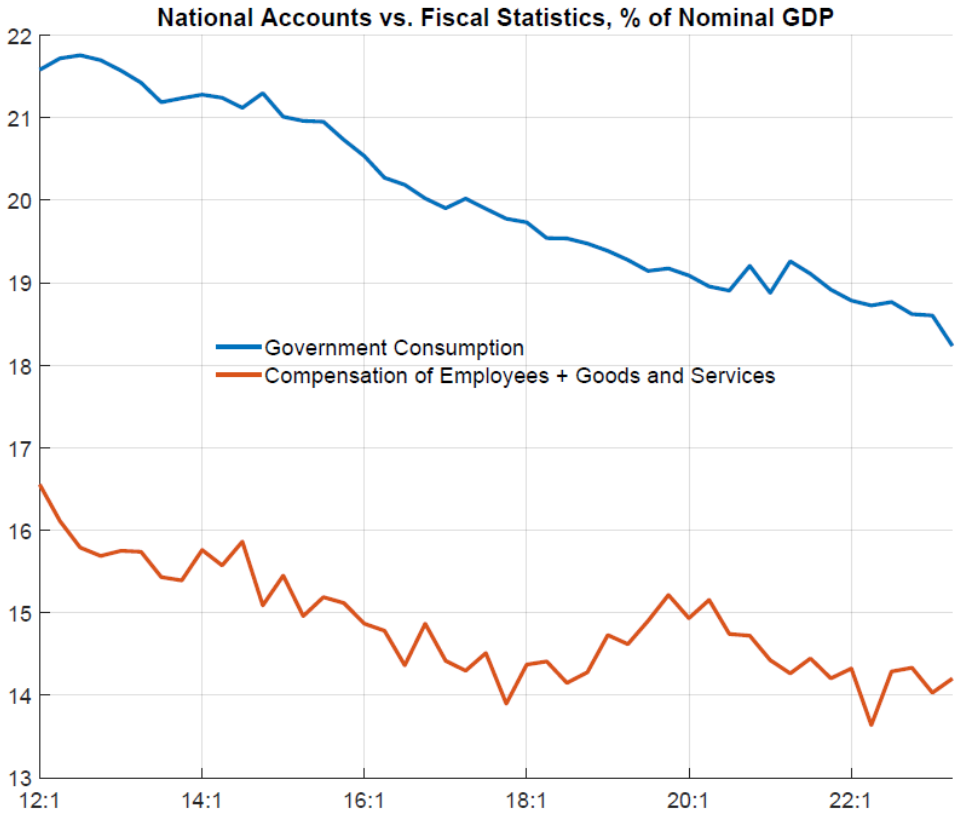
Panel 1



Panel 2



Panel 3



III. Achievements of the Project

A. ASSESSMENT OF TARGETED OUTCOMES

The TA project successfully met its key objective – the development of a medium-term macroeconomic framework to further strengthen the forecasting and analysis process at the CBBH.

Although CBBH counterparts actively participated in the development of the tool, there is still scope to fully integrate the tool into the forecast process. They were involved in populating the QMFF with data, calibrating behavioral equations, imposing cross-sector linkages and testing overall dynamic and in-sample forecasting properties. As the project progressed, the OCE team gradually built up its ability to understand the main transmission mechanisms implied by the tool, incorporate off-model information generated by sectoral specialists and produce alternative scenarios reflecting risks surrounding the baseline forecast. Despite the considerable progress the OCE team achieved in the applied use of QMFF, it will still need more time to be able to use the framework to its full potential.

B. DRIVERS OF THE RESULTS

The TA project benefited from numerous contributing factors. First, the authorities were committed to the development of the tool, actively engaging during the virtual and in-person missions; the excellent cooperation with the TA mission team was equally as important. Second, the core OCE team continued building its capacity throughout the duration of the project by attending relevant training courses at the JVI (see above). Third, the TA project benefitted from prior IMF in-country FPP course and especially online and in-person trainings at the JVI. Finally, the excellent communication and collaboration with the IMF country team and Resident Representative office greatly facilitated the delivery of the project.

C. EXPECTED MEDIUM-TERM BENEFITS AND RISKS

The medium-term benefits of the full-fledged use of QMFF include a rapid productivity increase of the OCE team in producing a model-consistent macroeconomic forecast. Specifically, the tool allows for:

- **Highly automatized data-processing and generation of sectoral reports.** The data processing infrastructure allows the OCE team to automatize all data transformations, e.g., frequency transformation, X13-ARIMA based seasonal adjustment, HP filtering, calculation of growth rates and

ratios.[13] It also generates sectoral reports and provides a detailed overview of the developments in the economy.

- **Efficient generation of projections.** The system of behavioral equations and accounting relationships is solved in Matlab upon data update and produces quarterly projections. Model properties can be assessed by examining automatically generated reports including impulse responses, decompositions and in-sample simulations. The relevant projections are transformed from HP-filtered gaps to levels/growth rates and exported into Excel in a standard FPP-style tables. The data and projections update in the Excel template is fully automatic and the details of the reported time series, their frequency and projection horizons are easily customizable. Thanks to this extensive automation, the system is immediately ready for generating forecasts, once raw input data is updated, including the outlook of exogenous variable. This level of automation highlights the advantages and efficiencies gained by adopting scriptable computing environments like Matlab, Python, or R.
- **Transparent use of expert judgment and off-model information.** The tool allows for a flexible use of expert judgement and a transparent incorporation of any off-model information via residual adjustment.
- **Seamless generation of alternative and stress-test scenarios.** Alternative and stress-test scenarios can be generated by the OCE team efficiently, making the system well-suited for quantifying uncertainty related to exogenous forecast assumptions. The framework also allows easy comparisons of different forecast vintages.
-

The main risks relate to the availability of adequate resources by the CBBH and to staff turnover. The core OCE team working on the QMFF development and use consists of seven people.[14] The constrained resources available for the project partially reflect the team's size combined with its high workload, covering many areas: macroeconomic analysis, report writing, ad-hoc operational tasks, strategic and communication documents of the CBBH. While OCE team members are enthusiastic to use the QMFF, without sufficient staffing and staff time to dedicate to the framework there is a risk that the framework will not be used at its full potential. Proper use of the tool requires mastering of all the entire framework's technical details, which is a time-consuming and continuous process.

Staff retention is a serious potential long-term bottleneck. The mission team members shared their views on this key challenge with the authorities. Staff using the QMFF and sectoral experts are trained professionals, with several years of specialized experience. These skills are in limited supply in most countries, which puts pressure on the central banks to offer competitive compensation and a recognition of their skills and analytical inputs. A failure to address these issues would raise the likelihood of high turnover in these positions, which could be costly for the central bank, as training new staff requires time and investment, and the remaining staff is overstretched with existing tasks.

[13] The U.S. Census Bureau's X-13 ARIMA-SEATS is a widely used software for seasonal adjustment. Calendar effects and outliers can also be accounted for using this seasonal adjustment method. Furthermore, other toolboxes can be used to remove seasonal effects from a time series to better identify trends and other underlying patterns.

[14] An additional member of the core team who was also the model operator left the CBBH in the final stages of the project.

D. RECOMMENDATIONS

The mission team proposes the following recommendations for the OCE:

- **Adopt the QMFF as the core forecasting and policy analysis tool.** The two members of the OCE team, who were assigned to directly operate the tool, supported by the expert judgments of other sectoral analysts, should work with QMFF regularly, by devoting most of their time to maintaining the model and understanding its functioning in detail. This will enable them to gain full ownership of the macroframework and operate it efficiently. In addition, it would increase the efficiency of the forecasting process if other OCE team members would become comfortable with the basic concepts and functionality of the QMFF, both to contribute to its use and to be able to rotate, should such a need arise.

- **Integrate forecasting and policy analysis results generated by the tool into policymaking discussions and communicate them to the public.** First, the OCE team should share this TA report and finalized tool with the CBBH senior management. Second, after conducting 2-3 shadow forecast rounds, the OCE team should discuss the results for baseline projections and alternative scenarios with policymakers to foster buy-in and tool institutionalization. Finally, like in most other central banks, the CBBH should evaluate to start publishing medium-term macroeconomic forecasts produced with the QMFF, in line with the CBBH mandate. Clearly, capacity building will facilitate the application of the tool for forecasting and policymaking, which will in turn further stimulate the strengthening of the analytical skills of the staff.

- **Formalize an internal forecast calendar to facilitate the use of the tool and its integration into the policymaking process.** Based on international experience, setting up a formal forecast calendar would greatly increase the efficiency of the forecasting process, by clearly defining timelines and roles within the team with respect to the final forecast publication date.[15] The OCE team made considerable progress in terms of operating the tool and documenting key roles and responsibilities. However, there is no formal calendar of the forecasting process that also includes setting exact deadlines for delivering intermediate inputs into the forecast. Flexibility should be embedded in the forecasting calendar to accommodate for delays in the publication of macroeconomic data inputs or other unforeseen circumstances.

- **Finalize the user manual of the QMFF model.** Having detailed technical documentation of the framework and its use in practice will strengthen business continuity in using the model and knowledge sharing within the team, should there be any staff fluctuations. The OCE team has started working on the documentation.

- **Address staff retention and capacity issues.** The mission team suggests the CBBH should consider the practice of other central banks in differentiating the compensation and the recognition of the staff working on complex analytical tasks and those that require less specialized skills. The mission team also recommends increasing the OCE team capacity in terms of the number of staff with relevant educational background and experience.

[15] For an example of how such a forecast calendar can be set up, as well more generally for good practice regarding forecasting and policy analysis systems, see IMF Departmental Paper No. 2021/026 ("Taking Stock of IMF Capacity Development on Monetary Policy Forecasting and Policy Analysis Systems")

E. THE TA PROJECT IN THE CONTEXT OF IMF MACROECONOMIC SURVEILLANCE – IMF COUNTRY TEAM ASSESSMENT OF THE PROJECT

The IMF country team welcomes the introduction of the QMFF at the CBBH. The tool will help enhance the IMF interactions with Bosnia and Herzegovina. The IMF has supported the efforts of the CBBH in establishing a macroframework that started with a tailored in-country FPP course in 2019 and was followed by a request to engage in a TA project aimed at building a comprehensive framework for macroeconomic projections and policy analysis. The thorough and cohesive overview of the economy and its various sectors provided by the tool can significantly enhance the depth of future discussions with the country team. Sharing ideas and discussing the complexities involved in developing consistent projections for BiH will boost communication between the country team and the CBBH and allow for better knowledge sharing.

The TA project has not only enhanced analytical capabilities but also equipped the authorities with a vital tool for policy analysis. In addition to the detailed baseline projections, the QMFF enables the authorities to conduct thorough scenario analysis allowing them to better explore the uncertainties and risks around the baseline projections and contribute to improved policymaking. This will also help enhance discussions during the Fund's surveillance activities by facilitating richer information sharing in the context of Article IV discussions. The IMF country team will encourage the CBBH management and OCE team to fully utilize the QMFF.

The authorities will likely need further assistance to support their ongoing efforts to fully integrate the tool into their regular projection rounds. Institutionalizing the tool will ensure its consistent application during the regular forecasting cycles. The CBBH team's initiative in developing a user manual that outlines guidelines for operating the tool represents a commendable step in this direction. This contributes to the project's long-term sustainability and facilitates the transfer of knowledge to future staff.

F. COUNTRY AUTHORITIES' ASSESSMENT OF THE PROJECT

The TA project on macroeconomic frameworks provided to the CBBH was successful. We are thankful to the IMF's Institute for Capacity Development for their support in building this framework, which has provided the CBBH with a modern tool for policy analysis and forecasting. In addition, despite all the challenges during the development of the tool, we are glad that the CBBH is the first institution where the QMFF has been implemented.

The project benefitted from a combination of virtual and in-person engagements with the mission team. During this process, we received hands-on training in coding in Matlab, thus improving our technical ability to operate and extend the framework. We actively took part in discussing and developing the main behavioral equations to analyze and forecast main macroeconomic variables, as well as the calibration of equation parameters and steady state values. At the same time, we considered and incorporated the specifics of the macroeconomic context in Bosnia and Herzegovina: currency board and a decentralized fiscal policy. We have also actively participated in the process of building baseline and alternative scenarios, including the incorporation of off-model information and nowcasts into the forecast.

The TA has delivered a tailor-made tool that will serve the CBBH for policy analysis and forecasting. Although our country lacks independent monetary policy, the comprehensive and granular nature of this macroeconomic framework will enable us to analyze the impacts of fiscal policy and various

shocks on the economy. We will also be able to produce consistent macroeconomic forecasts, thus enhancing the communication efforts and the credibility of the central bank, as well as strengthen communication with the IMF during regular surveillance.

Appendices

APPENDIX A. DELIVERY SCHEDULE

CBBH: Delivery Schedule for the Action Plan of the Technical Assistance Project on Macroeconomic Frameworks	
Key Objectives	**Dates**
Phase I	
Request from the CBBH Governor to support the development and implementation of a macroframework.	September 2020
Review the data needs for populating the macroframework; Present the automatized Matlab-based data processing codes infrastructure that will serve as the environment used for the QMFF; Develop the first versions of the core behavioral equations (delivered virtually).	April 12-20, 2021
Develop the core behavioral equations to form the backbone of the QMFF; Define the initial setup of the fiscal and monetary sectors; Extend the reporting infrastructure (delivered virtually).	August 16-18 and September 6-9, 2021
Review the data sources and ensure their consistency; Set up a consistent economic system, both in behavioral and accounting terms; Set up an Excel-based quarterly macroeconomic framework (delivered virtually).	November 8-16, 2021
Support the OCE team in mastering the overall use of the framework; Review the model equations and extend the reporting (delivered in-person).	April 11-21, 2022
Phase II	
Transform the previously non-linear model into a linear one; Improve the internal consistency of the QMFF by ensuring consistency between trends in relative prices and quantities (delivered in-person).	November 2-10, 2022
Ensure full internal consistency and performance of the model; Develop the fiscal block of the framework further (delivered in-person).	March 20-29, 2023
Enhance the capacity of the OCE team to effectively use and operate the QMFF; Conduct a shadow forecast round; Discuss project institutionalization. (delivered in-person).	November 20-24, 2023
Complete transfer of knowledge on QMFF utilization to the OCE team; Conduct a shadow forecast round; Discuss project institutionalization; Finalize project code and reporting infrastructure. (delivered in-person)	December 18-22, 2023

APPENDIX B. THE MAIN ECONOMIC RELATIONSHIPS UNDERLYING THE QMFF FOR THE CBBH

The key behavioral relationships driving the framework are included in Table 4, with calibrated parameters for Bosnia and Herzegovina also shown below. They are based on standard macroeconomic theory, including a well-defined balanced growth path and stable "great ratios" in the steady state. The model's main behavioral equations are specified in terms of gaps, which are defined as percentage deviations of any real variable from its trend. Specifically, for a variable X_t, the corresponding gap is denoted as $\hat{X}_t$. The baseline version of the framework assumes adaptive expectations, but it can easily be adjusted to operate with forward-looking, model consistent expectations.

The real economy block of the QMFF includes all key real expenditure variables of national accounts.[16] *Private consumption*, $\hat{c}_t$, is assumed to be a function of the real disposable income of households, approximated by output and private net transfers. Tighter real monetary conditions, represented in the model by the real households' lending rate, $\hat{r}_t^{LH}$, negatively affect private consumption as household's saving rate increases. The effect of fiscal policy on household demand is captured via the cyclically-adjusted primary balance, $\widehat{capb}$. Specifically, a higher cyclically adjusted primary balance due to restrictive fiscal policy results in lower consumption demand. The inertia observed in private consumption is captured via lagged private consumption.

Public consumption, $\hat{g}_t$, *is* linked to primary expenditures, $\widehat{pex}_t$, and lagged public consumption, $\hat{g}_{t-1}$, , with the latter reflecting observed inertia in historic data.

Over the business cycle, *total investment*, $\hat{\jmath}_t$, depends on demand generated both domestically and abroad, approximated by domestic output, $\hat{y}_t$, and foreign effective output, $\hat{y}_t^*$, respectively. FDI inflows, $\widehat{fdi}_t$, are assumed to be associated with higher investment demand too. Further, capital expenditures, $\widehat{ce}$, approximate the effect of public spending on investment. The cost of capital is captured via real lending rates faced by corporations, $\hat{r}_t^{LC}$**.** The higher real lending rates of corporations become, the less profitable it becomes to finance new investment projects, therefore investment demand, ceteris paribus, is expected to be negatively related to real lending rates. Finally, $\hat{\jmath}_{t-1}$ captures the inertia in total investment, reflecting staggered adjustment of investment plans in the face of likely investment adjustment costs.

Real exports, $\hat{x}_t$, are also strongly dependent on foreign demand $\hat{y}_t^*$. In line with theory, exports also depend on the real exchange rate, $\hat{q}_t$, capturing price competitiveness. Any increase in the domestic price level that is not accompanied by the corresponding increase in productivity of the exporting sector results in a fall in real exports. Finally, to reflect country specifics, FDI are also affecting exports, as foreign companies establish a presence in the country mainly aiming to export to other markets.

Real import demand, $\widehat{m}_t$, is proportionate to consumption-, government consumption-, investment- and export demands. Any depreciation of the real exchange rate, $\hat{q}_t$, results in an imports substitution effect: the more expensive foreign good prices are relative to domestic prices, economic agents will tend to substitute foreign goods for domestic counterparts. This will result in a fall in imports. (See Appendix D for the calibration of the import demand equation).

[16] In our description of key model equations, we will be discussing deviation of real variables from their corresponding trends, without emphasizing that we talk about gaps.

Domestic demand, $\hat{d}_t$, and the output gap equations are identities. The corresponding coefficients $\beta_1^d, \beta_2^d, \beta_3^d$ are normalized shares of ratios of nominal private consumption, government consumption and private investment to nominal potential GDP. Similarly, as in the case of domestic demand, the next equation, capturing the log-linearization of *national accounts identity* in terms of nominal potential GDP. $\beta_1^y - \beta_5^y$ are nominal expenditure shares relative to nominal potential GDP.

Two balance of payments items play an important role in BiH's economy. Private transfers, $\widehat{pt}_t$, contribute to the disposable income of households, reflecting the large diaspora with significant links to the country. They are positively related to foreign demand and negatively to domestic demand. In other words, in periods of external economic boom or domestic economic bust the inflow of private transfers increases. Lagged private transfers $\widehat{pt}_{t-1}$are included to capture inertia observed in the data. The second important BoP variable, which can influence investment activity, is real foreign direct investment (FDI). It is modeled as a function of lagged FDI, and the external sector's cyclical position captured by effective foreign demand.

Fiscal accounts included in QMFF are detailed. Although in the baseline specification most fiscal accounts are modelled via autoregressive processes of ratios to nominal GDP; behavioral equations can easily be incorporated into the model. Consequently, this summary focuses on the cyclically adjusted fiscal balance, which enters directly in some of the demand equations. In fact, this is an identity that equates the cyclically adjusted primary balance with the difference between the cyclically adjusted revenues, $\widehat{car}_t$, and expenditures, $\widehat{cape}_t$. Coefficients β_1^{ycapb} and β_2^{ycapb} are the steady state ratios of these variables to nominal potential GDP.

As far as financial markets are concerned, the model is consistent with the BiH currency board regime within a *de jure* open capital account. In this regime, there is no room for independent monetary policy; domestic policy rates, i_t ,are equal to policy rates in the eurozone, i_t^*. The nominal exchange rate of the Bosnian Mark, s_t, is fixed to the euro at a level 1.95 BAM per euro.[17]

The price block of the QMFF features a *Phillips curve* equation which assumes that inflation, π_t, measured as a quarterly annualized change in the consumption deflator, depends on lagged and expected inflation rates, with corresponding coefficients fulfilling the homogeneity condition.[18] As the BiH version of QMFF is backward looking, and the real exchange rate trend is stationary, expected inflation is approximated by the foreign effective inflation rate π_t^*. Inflation further depends on domestic demand pressures, approximated by the output gap, and imported inflation, captured by the real exchange rate, $\hat{q}_t$, and the other exogenous relative prices, denoted by $\widehat{rp}_t^e$. This specification of the aggregate supply curve ensures domestic and foreign price levels are identical in the steady state, as the real exchange rate gap, defined as a ratio of the import- and GDP deflators, is zero in the long run.

All *national accounts deflators*, denoted by p_t^{dN}, where N = C, G, J and X, are modeled as weighted averages of the GDP deflator, p_t^Y, approximating domestic production costs, and import deflator, p_t^M that approximates the prices of imported final- and intermediate goods used in production. β_1^{dN} is the domestic value-added share in X, 1-$\beta_1^{dN}$is the import share. Import prices reflect the structure of the most

[17] As mentioned earlier, the model variables are log transformed and multiplied by 100, for reporting purposes, therefore, $\beta_1^s = 67.3\ (= 100 * \log(1.95))$.

[18] The framework also includes CPI inflation, modeled as a function of the consumer deflator inflation and a residual.

important imported goods in BiH. Effective foreign CPI, p_t^{CPI*}, is a variable approximating the price if imported final goods, world food prices, p_t^{F*}, world metal prices, p_t^{Mt*}, and world oil prices, p_t^{O*}, account for the prices of imported commodities. For details on the calibration of parameters of imports demand- and national accounts deflator equations see Appendix D.

The economy's supply side is captured by potential output – a level of economic activity that, ceteris paribus, would not result in a change in inflation rate. In the baseline version it is approximated by the Hodrick-Prescott filter, but the framework can be easily adapted to use other methodologies such as the Kalman filter.

Table 4: Key equations of the QMFF

Variable	Key model equations
Private consumption	$\hat{c}_t = \beta_1^c \hat{c}_{t-1} + \beta_2^c \hat{y}_t + \beta_3^c \widehat{pt} - \beta_4^c \hat{r}_t^{LH} - \beta_5^c \widehat{capb} + \varepsilon_t^c$
Government consumption	$\hat{g}_t = \beta_1^g \hat{g}_{t-1} + \beta_2^g \widehat{pex}_t + \varepsilon_t^g$
Total investment	$\hat{\jmath}_t = \beta_1^j \hat{\jmath}_{t-1} + \beta_2^j \hat{y}_t + \beta_3^j \hat{y}_t^* + \beta_4^j \widehat{fdi}_t - \beta_5^j \hat{r}_t^{LC} + \beta_6^j \widehat{ce} + \varepsilon_t^j$
Exports	$\hat{x}_t = \beta_1^x \hat{x}_{t-1} + \beta_2^x \hat{q}_t + \beta_3^x \hat{y}_t^* + \beta_4^x \widehat{fdi}_t + \varepsilon_t^x$
Imports	$\hat{m}_t = \beta_1^m \hat{c}_t + \beta_2^m \hat{g}_t + \beta_3^m \hat{\jmath}_t + \beta_4^m \hat{x}_t - \beta_5^m \hat{q}_t + \varepsilon_t^m$
Domestic demand	$\hat{d}_t = \beta_1^d \hat{c}_t + \beta_2^d \hat{g}_t + \beta_3^d \hat{\jmath}_t + \varepsilon_t^d$
National accounts identity	$\hat{y}_t = \beta_1^y \hat{c}_t + \beta_2^y \hat{g}_t + \beta_3^y \hat{\jmath}_t + \beta_4^y \hat{x}_t - \beta_5^y \hat{m}_t + \varepsilon_t^y$
Private transfers	$\widehat{pt}_t = \beta_1^{pt} \widehat{pt}_{t-1} + \beta_2^{pt} \hat{y}_t^* - \beta_3^{pt} \hat{d}_t + \varepsilon_t^{pt}$
Foreign direct investment	$\widehat{fdi}_t = \beta_1^{fdi} \widehat{fdi}_{t-1} + \beta_2^{fdi} \hat{y}_t^* + \varepsilon_t^{fdi}$
Cyclically adjusted fiscal balance	$\widehat{capb} = \beta_1^{ycapb} \widehat{cap}_t - \beta_2^{ycapb} \widehat{cape}_t$
Domestic policy rate	$i_t = i_t^*$
Nominal exchange rate	$s_t = \beta_1^s$
Inflation	$\pi_t = \beta_1^\pi \pi_{t-1} + (1 - \beta_1^\pi)\pi_t^* + \beta_2^\pi \hat{y}_t + \beta_3^\pi \hat{q}_t + \beta_4^\pi \widehat{rp}_t^e + \varepsilon_t^\pi$
Expenditure deflators	$p_t^{dN} = \beta_1^{dN} p_t^Y + (1 - \beta_1^{dN}) p_t^M + \varepsilon_t^{dN}$
Import deflator	$p_t^{dM} = \beta_1^{dM} p_t^{CPI*} + \beta_2^{dM} p_t^{F*} + \beta_3^{dM} p_t^{Mt*} + (1 - \beta_1^{dM} - \beta_2^{dM} - \beta_3^{dM}) p_t^{O*} + \varepsilon_t^{dx}$
Potential output	*Hodrick-Prescott filter*
Budget balance	$\overline{gb}_t^{rat} = 100 \cdot \ln(b_{bal}) + \frac{b_{rev}}{b_{bal}}(grev_t^{rat} - 100 \cdot \ln(b_{grev})) - \frac{b_{gex}}{b_{bal}}(gex_t^{rat} - 100 \cdot \ln(b_{ex}))$
	$b_{pbal} \cdot l_{pbal2gdp_t} = b_{rev} \cdot l_{rev2gdp_t} - b_{p\,\exp end} \cdot l_{p\,\exp end2gdp_t}$

Parameters

$\beta_1^c = 0.35;\ \beta_2^c = 0.10;\ \beta_3^c = 0.10;\ \beta_4^c = 0.05;\ \beta_5^c = 0.25.$

$\beta_1^g = 0.60; \beta_2^g = 0.17.$

$\beta_1^j = 0.45;\ \beta_2^j = 0.40;\ \beta_3^j = 0.90;\ \beta_4^j = 0.02; \beta_5^j = 0.30;\ \beta_6^j = 0.10.$

$\beta_1^x = 0.20;\ \beta_2^x = 0.30;\ \beta_3^x = 3.00;\ \beta_4^x = 0.02.$

$\beta_1^m = 0.23; \beta_2^m = 0.02; \beta_3^m = 0.12;\ \beta_4^m = 0.63;\ \beta_5^m = 0.30.$

$\beta_1^d = 0.60;\ \beta_2^d = 0.17;\ \beta_3^d = 0.23.$

$\beta_1^y = 0.67;\ \beta_2^y = 0.19;\ \beta_3^y = 0.26;\ \beta_4^y = 0.45;\ \beta_5^y = 0.57.$

$\beta_1^{pt} = 0.30;\ \beta_2^{pt} = 2.20;\ \beta_3^{pt} = 0.30.$

$\beta_1^s = 67.3.$

$\beta_1^{fdi} = 0.20;\ \beta_2^{fdi} = 30.0.$

$\beta_1^{ycapb} = 0.44;\ \beta_2^{ycapb} = 0.34.$

$\beta_1^\pi = 0.40;\ \beta_2^\pi = 0.25;\ \beta_3^\pi = 0.25;\ \beta_4^\pi = 0.25.$

$\beta_1^{dC} = 0.20;\ \beta_1^{dG} = 0.05;\ \beta_1^{dJ} = 0.27;\ \beta_1^{dX} = 0.8.$

$\beta_1^{dM} = 0.55;\ \beta_2^{dM} = 0.35;\ \beta_3^{dM} = 0.05.$

APPENDIX C. MODELING TRENDS IN THE QMFF

This appendix includes the derivation of the trends of the real variables of the QMFF. Those are a function of potential GDP and the real exchange rate trend, so that they are consistent with constant nominal national accounts' expenditure ratios to nominal (potential) GDP in the long run.

Let's introduce the following notations:

- P^Y, P^C, P^M= GDP, households' consumption and import deflators
- Y, C = real GDP, real households' consumption
- $T^Y, T^C, T^{\frac{P^C}{P^Y}}$ = trends in real GDP and real households' consumption and trend in the relative price of $\frac{P^C}{P^Y}$

We will assume that the consumption goods are produced by using a constant share of domestic intermediate products and imported goods, therefore the consumption deflator will be a function of the domestic value-added price, approximated by the GDP deflator, and import prices, captured by the import deflator. Specifically, we assume:

$P^C = (P^Y)^{\alpha^C} \cdot (P^M)^{1-\alpha^C} \cdot \exp(\varepsilon^{P^C})$ where $1-\alpha^C$ is the import share of C and ε^{P^C} is a shock term.

The relative price of consumption deflator to GDP deflator, therefore, can be expressed as follows:

$$\frac{P^C}{P^Y} = \frac{(P^Y)^{\alpha^C} \cdot (P^M)^{1-\alpha^C} \cdot \exp(\varepsilon^{P^C})}{P^Y} = \frac{(P^Y)^{\alpha^C} \cdot (P^M)^{1-\alpha^C} \cdot \varepsilon^{P^C}}{(P^Y)^{\alpha^C} \cdot (P^Y)^{1-\alpha^C}} = \frac{(P^M)^{1-\alpha^C} \cdot \exp(\varepsilon^{P^C})}{(P^Y)^{1-\alpha^C}} = \left(\frac{P^M}{P^Y}\right)^{1-\alpha^C} \cdot \exp\left(\varepsilon^{P^C}\right)$$

Let's denote $\frac{P^M}{P^Y} = Q$ and the trend in Q as T^Q: $\frac{P^C}{P^Y} = Q^{1-\alpha^C} \rightarrow T^{\frac{P^C}{P^Y}} = (T^Q)^{1-\alpha^C}$

Let's first derive the trends that are consistent with constant nominal national accounts' expenditure ratios to nominal potential GDP in the long run for the ratio of nominal households' consumption, $P^C \cdot C$, to nominal potential GDP, $P^Y \cdot T^Y$:

$$\frac{P^C \cdot C}{P^Y \cdot T^Y} = \frac{P^C}{P^Y} \cdot \frac{C}{T^Y} = \frac{\frac{P^C}{P^Y}}{T^{\frac{P^C}{P^Y}}} \cdot T^{\frac{P^C}{P^Y}} \cdot \frac{C}{T^C} \cdot \frac{T^C}{T^Y} = \left(\left(\frac{Q}{T^Q}\right)^{1-\alpha^C} \cdot \frac{C}{T^C}\right) \cdot \frac{(T^Q)^{1-\alpha^C} \cdot T^C}{T^Y}$$

Since we assume long run stationarity of the nominal C to Y ratio around a constant share, sh^C, then $\frac{(T^Q)^{1-\alpha^C} \cdot T^C}{T^Y} = sh^C$, or in logarithmic form:

$$\log(sh^C) = (1-\alpha^C) \cdot \log(T^Q) + \log(T^C) - \log(T^Y) \rightarrow \log(T^C) = \log(T^Y) - (1-\alpha^C) \cdot \log(T^Q) + \log(sh^C)$$

Based on the derivation above, let's list the key trend equations derived above that are included into the model for any real variable Ω_t:

$$\log(T_t^{\Omega}) = \log(T_t^{Y}) - ss^{M\Omega} \cdot \log\left(T_t^{Q}\right) + \log(sh^{\Omega}) + \varepsilon_t^{T^{\Omega}}$$

$$\Omega_t^{gap} = \log(\Omega_t^{n}) - \log(T_t^{\Omega})$$

$$\Omega 2Y^{n}{}_t = \log(\Omega_t) + \log(T_t^{\Omega}) - (\log(P_t^{Y}) + \log(T_t^{Y}))$$

$$T_t^{\Omega 2Y^{n}} = ss^{M\Omega} \cdot \log(T_t^{Q}) + \log(T_t^{\Omega}) - \log(T_t^{Y}) + \varepsilon_t^{T^{\Omega 2Y^{n}}}$$

$$\Omega 2Y^{n}{}_t^{gap} = \Omega 2Y_t^{n} - T_t^{\Omega 2Y^{n}}$$

Finally, the derivations above make it possible to derive the national accounts identity in terms of gaps. Let's remember that $\frac{P^C \cdot C}{P^Y \cdot T^Y} = \left(\left(\frac{Q}{T^Q}\right)^{1-\alpha^C} \cdot \frac{C}{T^C}\right) \cdot \frac{(T^Q)^{1-\alpha^C} \cdot T^C}{T^Y}$. The log-linearization of $\frac{P^C \cdot C}{P^Y \cdot T^Y}$, therefore, yields: $sh^C \cdot ((1-\alpha^C) \cdot Q^{gap} + C^{gap})$, where sh^C is the steady-state share of nominal C on nominal Y.

The national accounts identity is as follows:
$P^Y \cdot Y = P^C \cdot C + P^G \cdot G + P^J \cdot J + P^X \cdot X - P^M \cdot M$

After dividing both sides by $P^Y \cdot T^Y$ and log-linearization of all expenditure items (identically as it was done for C above):

$$Y^{gap} = sh^C \cdot ((1-\alpha^C) \cdot Q^{gap} + C^{gap}) + sh^G \cdot ((1-\alpha^G) \cdot Q^{gap} + G^{gap}) + \cdots$$

$$sh^J \cdot ((1-\alpha^J) \cdot Q^{gap} + J^{gap}) + sh^X \cdot ((1-\alpha^X) \cdot Q^{gap} + X^{gap}) - \cdots$$

$$sh^M \cdot (Q^{gap} + M^{gap}) = sh^C \cdot C^{gap} + sh^G \cdot G^{gap} + sh^J \cdot J^{gap} + sh^X \cdot X^{gap} - sh^M M^{gap} + (sh^C \cdot (1-\alpha^C) + sh^G \cdot (1-\alpha^G) + sh^J \cdot (1-\alpha^J) + sh^X \cdot (1-\alpha^X) - sh^M) \cdot Q^{gap}$$

Since we assume constant import shares in consumption, government consumption, investment and exports, the total import share equals to the sum of import shares of all expenditure of C, G, J and X, we get:
$sh^M = sh^C \cdot (1-\alpha^C) + sh^G \cdot (1-\alpha^G) + sh^J \cdot (1-\alpha^J) + sh^X \cdot (1-\alpha^X)$, consequently:
$Y^{gap} = sh^C \cdot C^{gap} + sh^G \cdot G^{gap} + sh^J \cdot J^{gap} + sh^X \cdot X^{gap} - sh^M M^{gap}$

APPENDIX D. EQUATIONS ON THE IMPORT DEMAND AND NATIONAL ACCOUNTS' DEFLATORS

The process of calibrating the behavioral gap equations of QMFF implies imposing theoretical restrictions on model parameters and, at the same time, matching observed data as closely as possible. This approach can be illustrated in the estimation of coefficients of GDP expenditure component deflators and the demand for imports of goods and services function. First, we consider that deflators are functions of the import price and domestic value-added price. Consequently, we estimate via OLS a log-linear version of the following equation:

$$P^C = (P^Y)^{\alpha^C} * (P^M)^{1-\alpha^C} * \varepsilon^{P^C}$$

where P^C is the consumption deflator, P^Y is the GDP deflator and P^M is the import price deflator. α^C is the estimated share of domestic value added in the prices of consumption goods, so $1-\alpha^C$ is the share of imported goods in household consumption. Equations with similar specifications are estimated for government consumption, investment, and export deflators. Further theoretical restrictions were imposed so that the expenditure side import shares add up to the total import share and homogeneity conditions for deflators are fulfilled.[19]

By assuming constant import shares, $1-\alpha^C$, $1-\alpha^G$, $1-\alpha^J$ and $1-\alpha^X$ in the private consumption, government consumption, investments and exports, respectively, it is easy to see that the total import share in nominal GDP satisfies the following condition:

$$sh^M = sh^C * (1-\alpha^C) + sh^G * (1-\alpha^G) + sh^J * (1-\alpha^J) + sh^X * (1-\alpha^X)$$

where sh^C, sh^G, sh^J, sh^X are shares of household consumption, government consumption, gross investments, and exports, respectively, in nominal GDP. The decomposition of the import gap into expenditure components is shown in Figure 9.

Based on the analysis of imports, the import deflator itself is modelled as a function of current and lagged values of foreign CPI, and world food, metal, and oil prices. The fit of this equation is reasonably good most of the time. However, like most other transition countries, data on deflators are subject to revision in future GDP statistical releases. The fit of the equations for the import deflator and other deflators is shown in Figure 10.[20]

[19] This is a popular and rather intuitive technical tool, widely appreciated by TA recipients. The estimated equations are set up in an Excel spreadsheet and the coefficients are quantified via constrained optimization. The squared residuals of the equation(s) are minimized, at the same time, additional constraints can be specified (such as fulfilling homogeneity condition, imposing sign restrictions or theoretical constraints). Expert judgement, regarding the parameterization is frequently included.

[20] During the calibration/estimation, to avoid excessive volatility in actual data, smoothed data were often used instead, constructed as HP-filtered series of actual data with a low lambda equal to 1.

Figure 9: Decomposition of the Real Imports Gap Equation

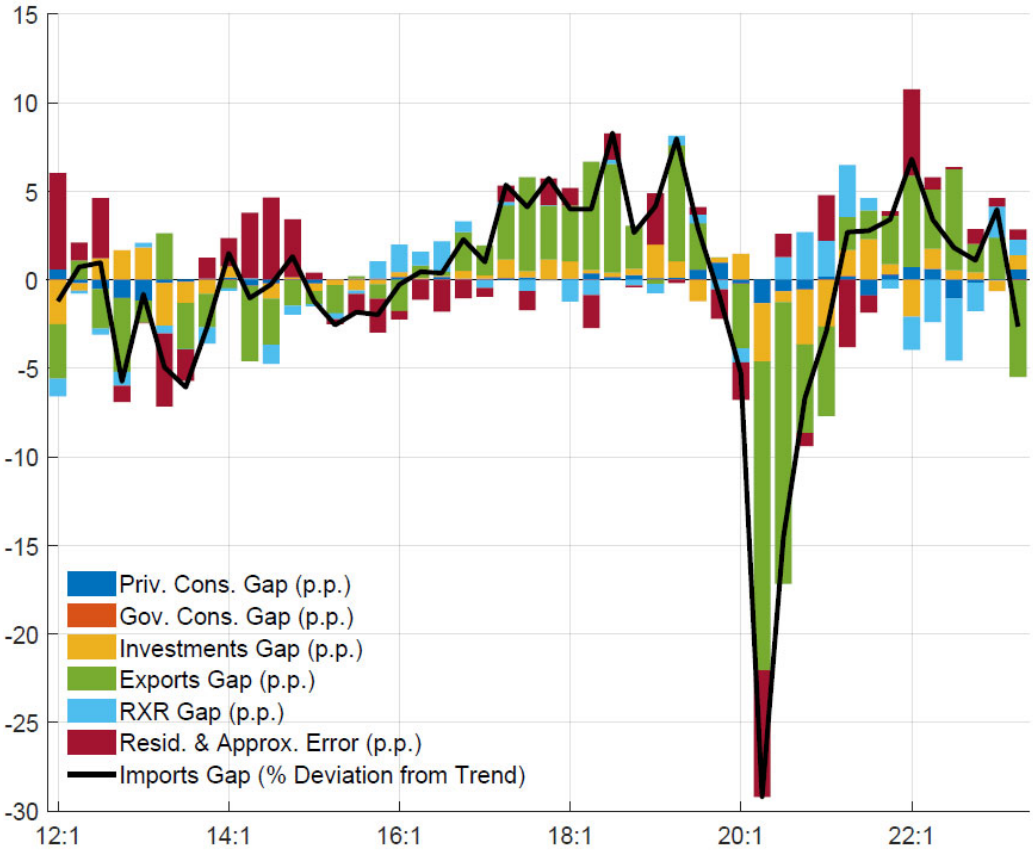


Figure 10: Fit of the National Accounts Deflators (annualized quarterly change, in %)