

INTERNATIONAL MONETARY FUND

# The Ararat Fiscal Strategy Model: A Structural Framework for Fiscal Policy Analysis in Armenia

Victoria Babajanyan, Daniel Baksa, Martin Fukač, Eduard Hakobyan, Arshaluys Harutyunyan, Narek Karapetyan, Babken Pashinyan, Garik Petrosyan and Luis-Felipe Zanna

**WP/22/118**

*IMF Working Papers* describe research in progress by the author(s) and are published to elicit comments and to encourage debate.

The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

**2022  
JUN**



**WORKING PAPER**

**IMF Working Paper**

Institute for Capacity Development

**The Ararat Fiscal Strategy Model:  
A Structural Framework for Fiscal Policy Analysis in Armenia****Prepared by Victoria Babajanyan, Daniel Baksa, Martin Fukač, Eduard Hakobyan,  
Arshaluys Harutyunyan, Narek Karapetyan, Babken Pashinyan,  
Garik Petrosyan and Luis-Felipe Zanna\***

Authorized for distribution by Paul Cashin

April 2022

**IMF Working Papers describe research in progress by the author(s) and are published to elicit comments and to encourage debate.** The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

**ABSTRACT:** This paper presents an overview of the Ararat Fiscal Strategy Model (AFSM), which is a structural, New-Keynesian, DSGE, small open economy model with a rich fiscal block that includes several expenditure and revenue instruments, and types of debt. The AFSM is now a formal part of the Ministry of Finance analytical toolkit to do macroeconomic fiscal policy scenario analysis, which feeds into policy discussions, budget planning, and the Medium-Term Expenditure Framework. The model was applied to assess the macroeconomic impact of the “first wave” of the Covid-19 pandemic on the Armenian economy, including the mitigating effects of policy responses. AFSM simulations revealed a potential severe impact in 2020, with declines in GDP and consumption of 12.9 and 11.7 percent, respectively, and a cumulative loss of GDP of 38 percent for the period 2020-2023. They also highlighted a significant fiscal outlook deterioration that would increase public debt-to-GDP ratios by 18.8 percentage points over 2020-23. The package of counter-cyclical fiscal measures of 3.6 percent of GDP, however, was estimated to cushion the 2020 GDP decline by almost 2 percentage points, as well as protect jobs. A second AFSM application related to the 2018 public investment under-execution showed the importance of improving the efficiency of public investment to have positive macroeconomic and fiscal effects.

JEL Classification Numbers:	E37, E47, E62, F34, O11.
Keywords:	Structural model; DSGE model; fiscal rules; scenario analysis; financial programming; Armenia; Covid-19.
Author’s E-Mail Address:	<a href="mailto:victoriasbabajanyan@gmail.com">victoriasbabajanyan@gmail.com</a> ; <a href="mailto:dbaksa2@imf.org">dbaksa2@imf.org</a> ; <a href="mailto:mfukac@gmail.com">mfukac@gmail.com</a> ; <a href="mailto:eduard.hakobyan@minfin.am">eduard.hakobyan@minfin.am</a> ; <a href="mailto:arshaluys.harutyunyan@minfin.am">arshaluys.harutyunyan@minfin.am</a> ; <a href="mailto:narek_karapetyan@minfin.am">narek_karapetyan@minfin.am</a> ; <a href="mailto:babken.pashinyan@minfin.am">babken.pashinyan@minfin.am</a> ; <a href="mailto:garik.petrosyan@minfin.am">garik.petrosyan@minfin.am</a> ; <a href="mailto:fzanna@imf.org">fzanna@imf.org</a> .

\* Hakobyan, Babajanyan, Harutyunyan, Karapetyan, Pashinyan, and Petrosyan: Ministry of Finance of Armenia; Fukač: The Caucasus, Central Asia, and Mongolia Regional Capacity Development Center, IMF; Baksa and Zanna: Institute for Capacity Development, IMF.

## WORKING PAPERS

# The Ararat Fiscal Strategy Model: A Structural Framework for Fiscal Policy Analysis in Armenia

Prepared by Victoria Babajanyan, Daniel Baksa, Martin Fukač, Eduard Hakobyan, Arshaluys Harutyunyan, Narek Karapetyan, Babken Pashinyan, Garik Petrosyan and Luis-Felipe Zanna<sup>1</sup>

---

<sup>1</sup> We thank Klakow Akepanidaworn, Maria Atamanchuk, Matthieu Bellon, Anh Nguyen, Raphael Espinoza, and participants in the CCAMTAC Webinar for their useful comments. This work is part of the technical assistance project on “Strengthening Macroeconomic Management in Armenia and Georgia,” which was funded by the Netherlands Constituency Partnerships Program.

# Contents

1. Introduction .....	6
2. Key Characteristics of the Armenian Economy .....	10
2.1. Macroeconomic Characteristics .....	10
2.2. Policy Characteristics .....	13
3. The Model Structure .....	17
3.1. Household Sector .....	18
3.2. Production Sector .....	21
3.3. Government Sector .....	26
3.4. External Sector .....	28
3.5. Aggregate Resource Constraints and Definition of Equilibrium .....	29
4. Model Parametrization .....	30
5. Capturing the Fiscal Rules Taxonomy of Armenia .....	37
6. Policy Scenario Applications .....	40
6.1. An Assessment of the First Wave of the Covid-19 Pandemic .....	40
6.2. Comparing Alternative Policies Under Public Investment Under-Execution .....	51
7. Final Remarks .....	59
References .....	61

## TABLES

1. Calibration .....	32
2. The Great Ratios and Selected Fiscal Statistics (percent of GDP) .....	35
3. Fiscal Policy Multipliers .....	36
4. The Net Impact of the Fiscal Package on GDP and Components .....	49

## FIGURES

1. Contributions of Sectors to GDP Growth .....	11
2. Expenditures of the Gross Domestic Product .....	12
3. Inflation and Exchange Rate Developments .....	14
4. Fiscal Developments .....	15
5. Government Debt Developments and Structure .....	15
6. The Structure of the AFSM .....	17
7. The Fiscal Speed Limit Monitor .....	38
8. Gains in Real GDP due to Fiscal Policy .....	42
9. Real GDP Shock Decomposition .....	42
10. Public Debt Shock Decomposition .....	43
11. The Impact of the Covid-19 Pandemic on the Macroeconomy .....	44
12. The Impact of the Covid-19 Pandemic on Fiscal Stance and Public Debt .....	46
13. Baseline Scenario: Macroeconomic Outcomes .....	50
14. Baseline Scenario: Prices, Interest and Exchange Rates .....	52
15. Debt Repayment (Alternative): Macroeconomic Outcomes .....	54
16. Debt Repayment (Alternative): Fiscal Outcomes .....	54
17. Increasing Social Benefits (Alternative): A Social Transfer Increase .....	55
18. Increasing Social Benefits (Alternative): Macroeconomic Outcomes .....	56
19. Increasing Social Benefits (Alternative): Fiscal Outcomes .....	57
20. Increasing Public Investment Efficiency (Alternative): GDP and Fiscal Outlook .....	58

## 1 Introduction

Over the past decades, the Ministry of Finance (MOF) of Armenia has developed a system for macroeconomic forecasting and analysis to support the design and implementation of fiscal policy. The system has gone through several development stages and been supported with simple tools—e.g., elasticity-based calculations, linear trend models, and univariate regressions—and more sophisticated econometric frameworks—e.g., multivariate regressions, error correction models, and structural vector autoregression models (SVARs). In the last 10 years, the introduction of a financial programming framework has helped organize the forecasting and analysis process in a more structured and interconnected way. The framework consists of real, external, fiscal, and monetary sectors with satellite models, setting the foundations of a short- and medium-term forecasting system. In addition, the system is complemented with models for the analysis of business cycles, fiscal risks, and debt sustainability.

Although the system and related frameworks have served the MOF well, the need of a consistent dynamic model-based macro framework to help address questions on structural fiscal policies has become more evident over time. The existing system has helped organize forecasts, while facilitating communication. However, the underlying frameworks are not structural and, as such, lack the theoretical underpinnings—i.e., crucial frictions and externalities in the transmission mechanism of fiscal policy—to address key fiscal policy questions. Consider, for instance, the question about the macroeconomic effects of public investment programs financed with changes of distortionary taxes. This question, which is structural by nature, requires a model that captures the positive externalities on production of public investment, as well as the tax distortions affecting households and firms' decisions.

The use by MOF staff of the IMF's Global Integrated Monetary and Fiscal model (GIMF) was an intermediate step to incorporate a structural Dynamic Stochastic General Equilibrium (DSGE) model into the institution's forecasting and policy analysis the system.<sup>1</sup> At the same time, it created the institutional need of a smaller core macro fiscal DSGE model, which could be validated using Armenian data, owned by the MOF staff, and made operational for MOF policy processes. Moreover, the model needed to capture several specificities of the Armenian economy, including the new fiscal rules framework adopted by the country.

To fulfill the MOF needs, staff of this institution, in collaboration with staff of the International Monetary Fund (IMF), developed the Ararat Fiscal Strategy Model (AFSM). This was part of a three-year Technical Assistance (TA) project, whose objective was to provide in-house training to MOF staff on developing and using model-based frameworks for fiscal policy analysis. The project included a key institutional capacity development component, as captured by the MOF staff's commitment of owning the AFSM and using it in policy discussions, decisions, and

---

<sup>1</sup> For a description of GIMF, see Kumhof et al. (2010).

processes in their institution. In this sense, the AFSM was developed to become a founding cornerstone for quantitative modeling and evidence-based policy advising at the MOF.

The structure of AFSM is based on the canonical DSGE model of the Financial Programming (FP) 2.0 initiative of the IMF Institute for Capacity Development (ICD). This initiative, which contains several frameworks, aims at modernizing FP to help policy makers with macroeconomic forecasting and policy scenario analysis, as a basis for sound decision making. As part of integrating models in macro frameworks, a canonical structural DSGE model—named the Structural Analysis of Macroeconomic Policies (STAMP) model—was developed, extended, adapted, and used in TA projects for Colombia, Georgia, and Israel, besides Armenia.<sup>2</sup>

The AFSM is a New-Keynesian, DSGE model which captures several characteristics of the Armenian economy, the MOF fiscal framework, and the MOF views about the macroeconomic effects of fiscal policy. It is a small open economy model with nominal price and wage rigidities, two sectors (traded and non-traded), two types of households (savers and non-savers), and limited integration to international capital markets. It also embeds the fiscal rules framework of the country and is calibrated to match key Armenian macroeconomic ratios and fiscal multipliers from SVAR estimations.<sup>3</sup>

The AFSM features household heterogeneity by incorporating two types of finite-life horizon consumers: (i) savers that smooth consumption over time using assets and debt; and (ii) liquidity-constrained consumers (poor households) that are forced to consume their net income in every period. Finite life horizon agents, some of which face liquidity constraints, help break the Ricardian equivalence. This, together with price rigidities, captures the MOF views about the non-neutrality of fiscal policy, including the significant effects of both government spending and revenue measures on output. Moreover, because of household heterogeneity, the AFSM can help assess the different impact of fiscal measures on households, including on the significant Armenian share of vulnerable liquidity-constrained consumers.

The AFSM also introduces some productive sector heterogeneity: there are traded and non-traded good sectors. This helps capture the Government's view that the traded sector is an engine of growth as well as the interaction between the two sectors, including labor flows and the real exchange rate adjustment. Production in each sector uses labor, private capital, public infrastructure, and imported inputs to reflect the high import dependence of Armenia. Capital is sector specific, while labor is mobile across sectors. Public capital is a public good and increases

---

<sup>2</sup> For a description of STAMP, see Remo et al. (2022). The model builds on more-than-a-decade efforts in academia and policymaking institutions to develop DSGE models for research and policy analysis and shares features of these models, including those in Christiano et al. (2005), Buffie et al. (2012), Erceg et al. (2005), Gali and Monacelli (2005), Kumhof et al. (2010), Melina et al. (2016), Shen et al. (2018), Smets and Wouters (2003, 2007), Woodford (2003). For a recent critical discussion on DSGE models, see Christiano et al. (2018). STAMP is a simpler model, in comparison to other IMF structural quantitative models, which are used in multi-country or G-7 analysis—e.g., GIMF and FSGM, and, more recently, the models in Adrian, et al. (2021), Adrian et al. (2020), Basu et al. (2020), and International Monetary Fund (2021). This facilitates its calibration and use by country officials for policy analysis, both in terms of running it and interpreting the model's output.

<sup>3</sup> See Fukač et al. (2021).

the productivity of other factors; it is accumulated via public investment but is subject to inefficiencies—one Dram of investment does not necessarily translate into one Dram of public capital.

The rich fiscal block of the AFSM includes several instruments on the spending and revenue side, as well as different types of debt. On the spending side, the model features consumption spending, transfers to households, and public investment. On the revenue side, it considers (distortionary) taxes on labor income, capital income, and consumption. Moreover, the government can issue 3 types of debt: domestic, external commercial, and concessional debt. The government pays different interest rates for each type of debt, and external commercial debt is subject to a country risk premium, which depends on the level of government indebtedness relative to GDP.

The AFSM incorporates fiscal rules that ensure macroeconomic stability and debt sustainability government. The government is assumed to follow a counter-cyclical primary deficit rule that responds to deviations of public debt from a target. The long-term targets of this rule, for both the primary deficit and debt, work as anchors for fiscal policy, aiming at ensuring fiscal and debt sustainability.

To capture the intricacies of the fiscal rule framework in Armenia, the AFSM introduces a *fiscal speed limit monitor*. The rules in the framework are challenging to model because of non-linearities: there are several debt thresholds that serve as a fiscal anchor and that, once they bind, activate different expenditure measures. To overcome this, the AFSM uses a satellite monitor that comprises several *non-linear* fiscal rules in line with the Armenian law. The monitor helps check the adherence to the *de jure* rules for any fiscal experiment simulated in the AFSM. It works as a traffic light that monitors the evolution of current and capital expenditures as viewed by the *de jure* rules. If capital or current expenditures violate the constraints in the law, then the monitor highlights the development in red. The AFSM user then needs to design the necessary fiscal intervention to bring the debt level back to desired levels and rerun the monitor and the AFSM.

Monetary policy is modeled as a Taylor rule, while macroeconomic variables of the rest of the world are assumed to follow exogenous processes. The interest rate rule captures the Armenian central bank's mandate of price level stability. The exchange rate regime, on the other hand, is assumed to be fully flexible. Since Armenia is a small open economy, it cannot affect the decisions and associated variables of the rest of the world. As such, and for simplicity, all foreign variables are assumed to be exogenous and follow autoregressive processes that can be subject to shocks.

The AFSM is mainly a tool for quantitative policy scenario analysis. That is, it is a simulation model designed to quantifying the macroeconomic effects as well as the trade-offs of policy alternatives. In the simulation process, the model provides economic insights and stories, consistent with its Armenian tailored structure, which may help organize and inform policy discussions and decisions. Although the AFSM is not a forecasting tool, it is expected that

AFSM-based analysis will complement the macroeconomic outlook and forecasts based on other tools and serve as input for budget planning and medium-term fiscal frameworks.

To illustrate the use of the AFSM, this paper presents the results of two model applications that were undertaken under the TA project. First, the model was applied to assess the quantitative macroeconomic and fiscal effects of the “first wave” of the Covid-19 pandemic on the Armenian economy, as well as the mitigating effects of some of the related policy responses. And second, the model was used to do a comparative analysis of the fiscal policy alternatives associated with the public investment under-execution of 2018, including debt repayment.

The AFSM-based assessment of the pandemic revealed that its “first wave” would have a profound negative macroeconomic impact. Real GDP and consumption were estimated to decline by 12.9 and 11 percent, respectively, in 2020, and slowly converge to their pre-crisis levels with above-trend growth rates. The loss in GDP would amount to 13 percent in 2020 and 38 percent over 2020-2023, relative to the pre-crisis level. Moreover, the deterioration of the government financial position would dramatically increase the debt burden and deplete the fiscal space—AFSM simulations suggested that debt-to-GDP ratios would increase by 18.8 percentage points in less than 5 years and stay at a higher level in the medium term. In the shock decomposition analysis, external shocks, as reflected by a contraction in foreign demand, remittances, and tourism as well as an increase in the country risk premium, accounted for the biggest part of these macroeconomic effects and fiscal losses, relative to the domestic shocks—i.e., a decline in the marginal propensity to consume and investment appetite.

According to AFSM simulations, the initial fiscal package of 3.6 percent of GDP was expected to be effective from the macro-fiscal cost-benefit perspective. Real GDP and consumption would decline by almost 2 percentage points less, relative to the case of no fiscal action. In addition, in 2020, the envisaged temporary tax and expenditure measures would have long-term effects helping to mitigate the negative effects of the shocks not only in 2020, but also in the following years. The fiscal policy measures would cushion real GDP by 4.6 percent in cumulative terms, over 2020-2023 as well as protect 35460 jobs.

The AFSM was also used to compare alternative policies associated with the 2018 public investment under-execution. A baseline scenario replicated the main policy dimensions of the official Fiscal framework for 2020-2022, which was used to assess the following three alternative policies, assuming that capital expenditures would continue to be under-executed: (i) reallocating the saved budget funds to debt repayments, (ii) increasing social spending, and (iii) increasing the efficiency of public investment.

The AFSM-based comparison of alternative policies underscored the importance of improving the efficiency of public investment. The scenarios of debt repayment and increasing social spending delivered worse economic outcomes in terms of GDP, relative to the case of increasing efficiency. To maintain the same GDP of the baseline scenario, it would be necessary to increase efficiency by 16.6 percentage points from a baseline value of 60 percent—one Dram of public investment was assumed to translate into 0.6 cents of public capital—, which could take

significant time and effort.<sup>4</sup> In terms of fiscal costs, while the alternatives of debt repayment and increasing public investment efficiency could ensure a declining medium-term debt burden, increasing social transfers could raise instead debt sustainability problems. In sum, the quantitative analysis revealed that improvements in efficiency improvements could dominate the other two policy alternatives in terms of positive macroeconomic effects and debt developments.

The rest of the paper is structured as follows. The next section presents some key stylized facts about the Armenian economy, including the fiscal rules legal framework. Section 3 describes the structure of the AFSM, explaining the economic behavior of each agent, and providing details on the fiscal block. Section 4 presents the calibration of the model as well as its validation by comparing the model-implied fiscal multipliers with some empirical estimates for Armenia. Section 5 describes how the taxonomy of the fiscal rules in Armenia is captured in the AFSM and explains the fiscal speed limits monitor. Section 6 illustrates the use of the model for scenario analysis addressing actual policy questions. Last, Section 7 provides some concluding remarks.

## **2 Key Characteristics of the Armenian Economy**

This section summarizes the key empirical facts about the Armenian economy that were used to inform the design of the AFSM. We compile here the key measures of aggregate supply and demand, market characteristics, and the characteristics of the monetary and fiscal policy landscape. Most of the following discussion focuses on pre-Covid 19 facts.

### **2.1 Macroeconomic Characteristics**

Armenia is a small, low-income, open economy located in the Caucasus region in Eurasia. It has about 3 million people and US\$4,500 per capita annual income (US\$10,000 in PPP terms). The country is highly import dependent and inflows of remittances help finance large trade deficits. However, international trade is still challenging, given that Armenia is a landlock country and there are significant constraints for transportation. For geopolitical reasons, borders with neighboring Azerbaijan and Turkey are closed, and Georgia and Iran are the main ground trade routes connecting the country with the sea and the rest of the world. Moreover, the infrastructure of roads and railways is past its lifecycle, which further hinders the transportation of people, goods, and services within the country and with its trading partners.

#### ***Production Structure***

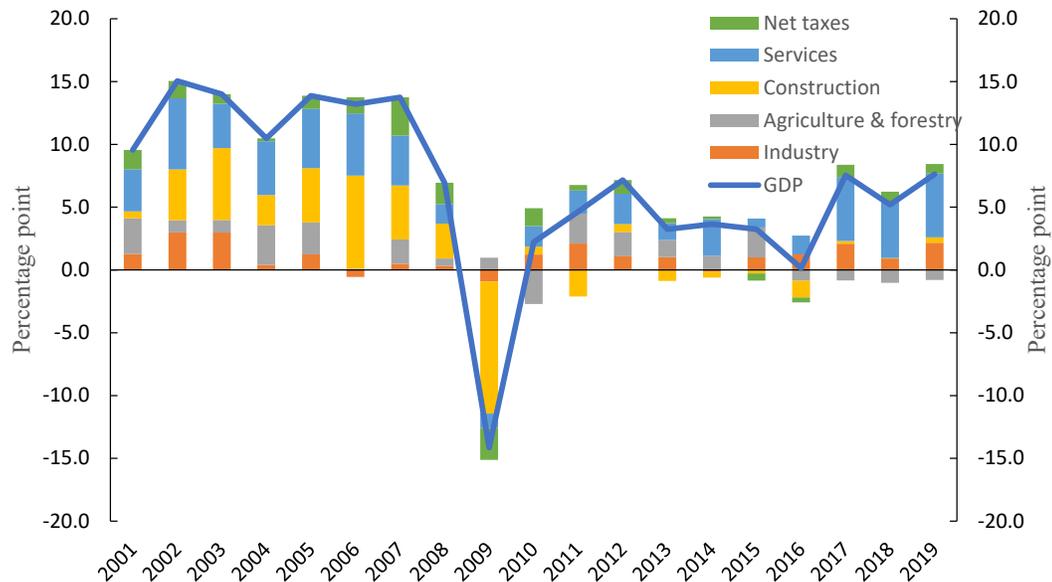
The government that took office in 2018 initiated a set of major reforms with the aim of building high, sustainable, and inclusive long-term growth. The goal was to move Armenia into an export-led economy model in which the sectors producing traded goods would play a key role.

---

<sup>4</sup> The increase here refers to an increase of the efficiency associated with the new public investment programs while maintaining constant the historical efficiency of old projects. For a discussion on some misconceptions about public investment efficiency and growth, see Berg (2018).

Given this, it is then important to understand (and model) the non-tradable and tradable productive sectors of the economy.

**Figure 1. Contributions of Sectors to GDP Growth**



**Source:** Statistical Committee of Republic of Armenia, authors' calculations.

Real Gross Domestic Product (GDP) is created by firms in the traded and non-traded sectors. Estimates show that the traded sector corresponds to about 53 percent of GDP, using data for the period 2010-2019.<sup>5</sup> The export part of tradable production consists mainly of mining (61 percent of exports), prepared food (20 percent), and agricultural and other (19 percent). The traded sector employs 54 percent of the labor force and attracts 52 percent of total investment. On the other hand, the non-traded sector is relatively smaller, representing about 47 percent of GDP.<sup>6</sup> High earnings opportunities attract investment, which corresponds to 48 percent of total investment. The non-traded sector employs 46 percent of the labor force. Both sectors feature high market concentration with certain degree of market power, with 69 percent of the market being supplied by large firms.<sup>7</sup>

During the period 2010-2019, the Armenian economy exhibited an average growth of 4.5 percent, mostly driven by increases in total factor productivity. Growth was mainly driven by services and industry sectors, with average contributions of 2.7 and 1.3 percent, respectively (Figure 1). There were, however, some exceptions. A boom in construction and investment in residential housing, financed by foreign remittances, induced double-digit growth rates in the

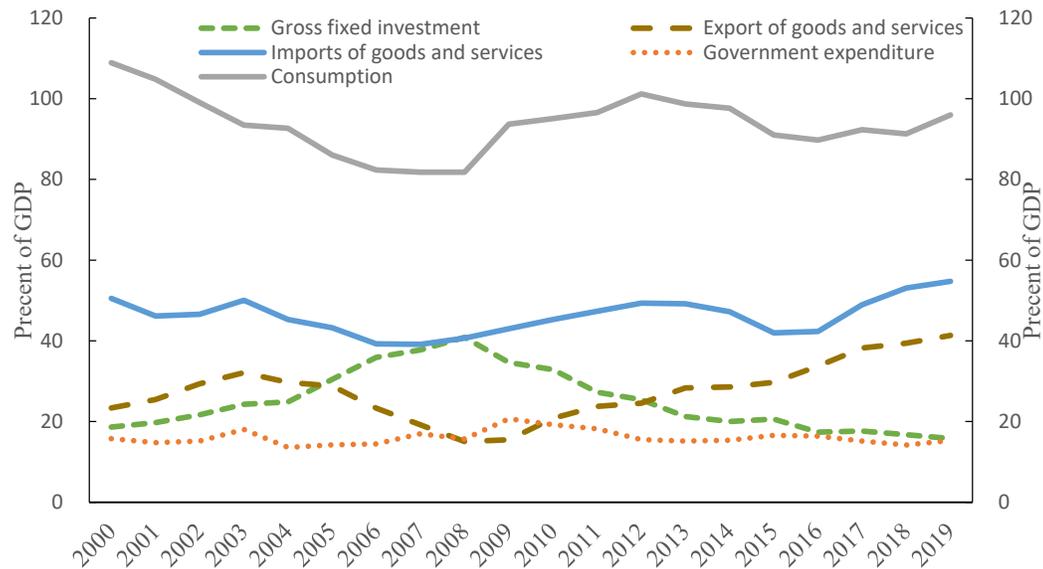
<sup>5</sup> MOF staff estimate obtained by summing up the sectors with exports and export potential, based on GDP by NACE breakdown.

<sup>6</sup> MOF staff estimate obtained by summing up the GDP shares of construction and the subsectors of industry and services which do not export.

<sup>7</sup> MOF staff estimate. Firms in each sector are classified as large, medium, and small, based on the number of employees.

2000s, increasing its GDP contribution to 25 percent; but, after the Global Financial Crisis, this construction sector shrank by about 2.3 percent annually and reduced its GDP contribution to 6 percent.<sup>8</sup>

**Figure 2. Expenditures of the Gross Domestic Product**



**Source:** Statistical Committee of Republic of Armenia, authors' calculations.

It is difficult to identify resource use intensity by sectors from available data, but some scant evidence suggests equal intensities in terms of labor and capital. Both traded and non-traded sectors use domestic as well as foreign factors of production. During 2010-2019, the average labor share of gross value added was about 40 percent, although the labor force was declining, because of migration.<sup>9</sup> Moreover, imports of industrial supplies and capital goods were about 14 and 7 percent of GDP, respectively.

From the perspective of expenditures, private consumption is the main use of GDP (Figure 2). On average, during 2010-2019, 82.7 percent of GDP went to private consumption and 18.9 percent to private investment, while the Government consumed and invested 16.3 percent. Moreover, exports corresponded to 30.6 percent, whereas imports represented about 47.7 percent of GDP. Despite some cyclicity in these shares—also known as great ratios—their long-term averages were stable with no clear trend.

<sup>8</sup> In the near future, the housing sector is not expected to become a major driver of growth and, therefore, the specificities of this sector were not explicitly considered in the first generation of the AFSM.

<sup>9</sup> During 2010-2017, the labor force featured a declining trend, which was reversed after the revolution of 2018, as labor force started to increase.

### ***Households***

In Armenia, food products are the main component of household consumption, and wages, public benefits, and remittances are the main source of household income. During 2010-2019, food product consumption accounted, on average, for 46 percent of total consumption. Services and non-food products, including durables, represented 32 and 19 percent, respectively, while housing and utility consumption amounted to 13 percent. Moreover, the share of wages in total income was 50 percent, and the share of public benefits and remittances was 26 percent. Over, the last decade the level of household liabilities increased more than wages and remittances.

There is heterogeneity across the household savings patterns, in Armenia. The average saving rate was 17 percent, during 2010-2019. But at least 40 percent of households are not able to save, which is captured by the AFSM.<sup>10</sup> The model associates the non-saving households with lower- to middle-income households that may be liquidity constrained.

### ***International Trade***

Armenia ran large trade deficits, almost 20 percent of GDP, over 2010-2019. Remittances played an important role in funding these trade deficits, reaching 12 percent of GDP, on average. Primary and secondary income inflows accounted for about 10 percent of GDP, leaving the average current account deficits near 7 percent of GDP. However, after the implosion of the construction sector and international sanctions of Russia, during 2015-2019, the trade and current account deficits shrunk to averages of 13 and 3 percent of GDP, respectively. This trend, however, is not expected to be permanent, which suggests higher current account deficits to calibrate the AFSM.

## **2.2 Policy Characteristics**

### ***Monetary and Exchange Rate Policy***

In 2016, the Central Bank of Armenia (CBA) adopted an inflation targeting regime. It committed to stabilize the 12-month consumer price inflation at 4 percent, with 1.5 percentage points of tolerance. A 12-quarter inflation forecast was selected as the intermediate target and the refinancing rate as the key policy instrument. In the AFSM, this policy is encompassed by an interest rate rule that targets inflation. Moreover, the CBA follows *de jure*, and to a great extent *de facto*, a flexible exchange rate system, with occasional interventions to smooth excessive market volatility.<sup>11</sup> The capital account is liberalized without major restrictions on capital flows.

During 2010-2019, the CPI inflation hovered around its target, while nominal and real effective exchange rates appreciated (Figure 3). Average CPI inflation was 3.5 percent, oscillating between -2.1 and 11.5 percent. Both nominal and real effective exchange rates appreciated by 40

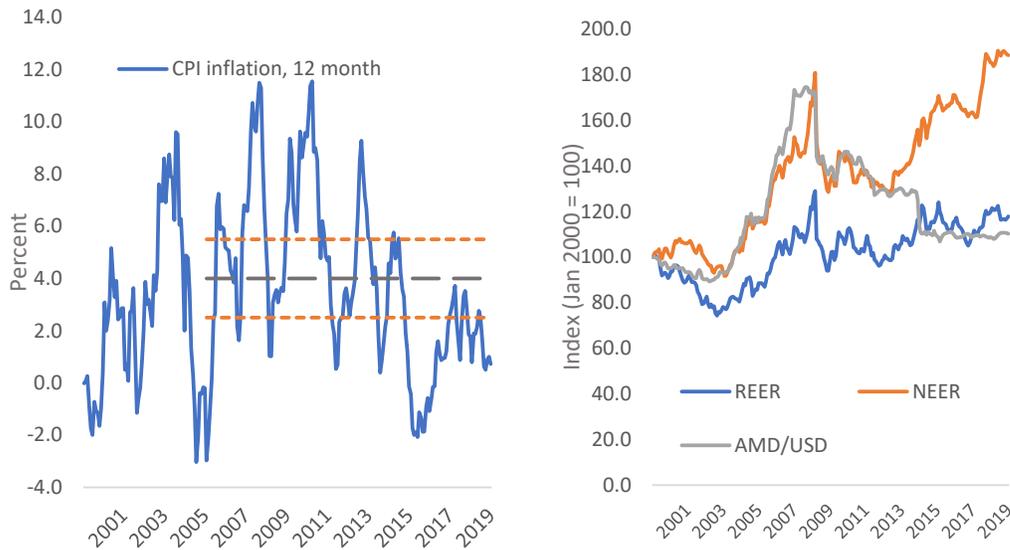
---

<sup>10</sup> MOF staff estimate. Figures are estimated based on the difference between household expenditure and consumption available for each income decile.

<sup>11</sup> See the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions 2018. Available at <https://www.elibrary-areaer.imf.org/Pages/countryreport.html>.

and 15 percent respectively, while the AMD/USD nominal exchange rate depreciated by 21 percent.

**Figure 3. Inflation and Exchange Rate Developments**



**Source:** Central bank of Armenia and authors' calculations

### ***Fiscal Outlook, Policy, and Multipliers***

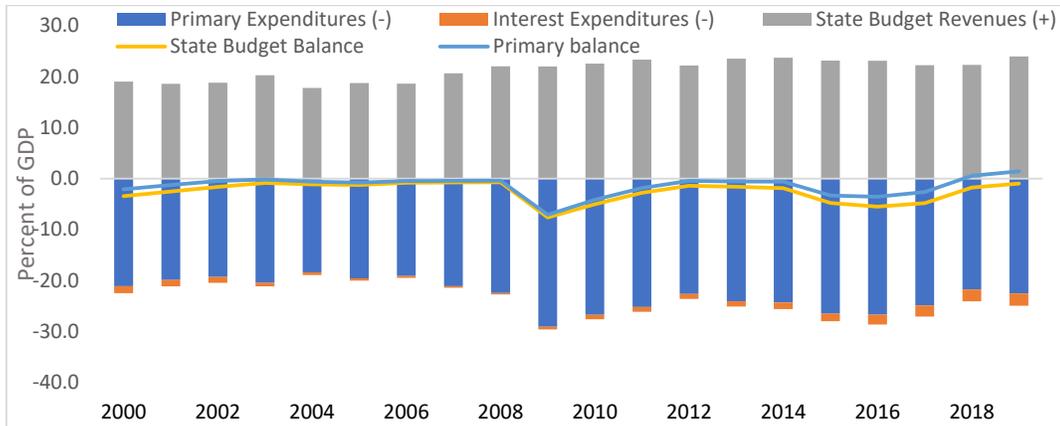
During 2010-2019, the average overall fiscal deficit was 3.0 percent of GDP, and the primary deficit was 1.5 percent of GDP (Figure 4). Revenues amounted to 21.7 percent of GDP and were associated with personal income taxes (5.9 percent of GDP), corporate income taxes (3.2 percent of GDP), and consumption taxes (10.6 percent of GDP).<sup>12</sup> Primary expenditures, on the other hand, corresponded on average to 24.5 percent of GDP. Out of these expenditures, current spending (excluding debt service) were about 12.8 percent, capital spending was 3.6 percent, and social and other transfers were 7.0 percent. Interest payments related to debt service were about 1.5 percent of GDP.

In the aftermath of the Global Financial Crisis, central government debt increased from 13.9 percent to 54 percent of GDP in 2017. However, given the recent fiscal consolidation efforts by the Government, debt declined to 50 percent of GDP in 2019 (Figure 5). In terms of debt composition, about 80 percent is external, and most of it is concessional, while the rest is domestic. Since 2013, the Government has had access to international capital markets, with the

<sup>12</sup> All types of taxes and duties of the consolidated budget are aggregated into the following four categories (i) personal income taxes, which include income tax and mandatory social contributions, (ii) corporate income taxes, covering profit tax, 40 percent of turnover tax, and part of state duties, (iii) consumption taxes, including value added tax, excise tax and customs, (iv) other taxes, representing the non-distortionary types of taxes and duties and calculated as residuals.

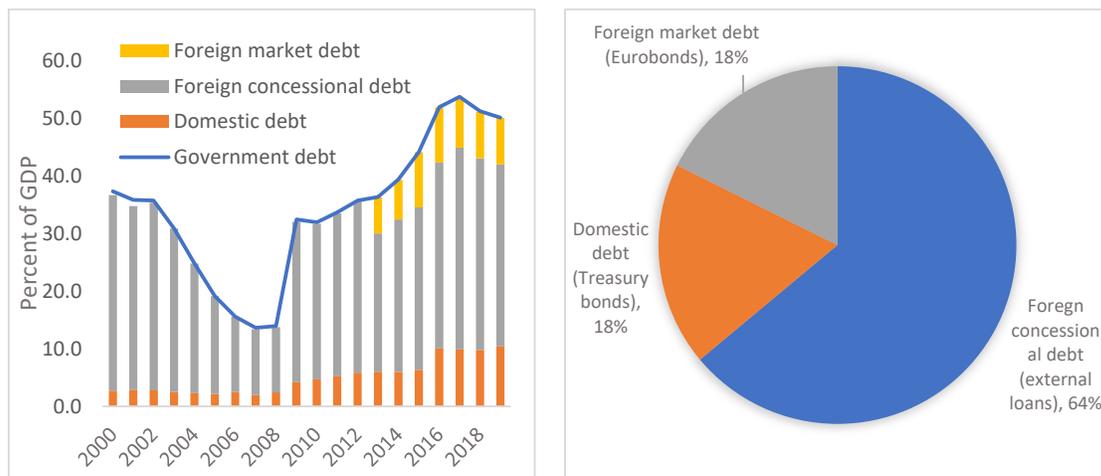
last issuance of Eurobonds taking place in 2019. The high share of external debt raises concerns about currency risks (Figure 5).

**Figure 4. Fiscal Developments**



Source: MOF.

**Figure 5. Government Debt Developments and Structure**



Source: MOF.

The objectives of the Government fiscal policy are economic growth, macroeconomic stability and fiscal sustainability, which are prerequisites for sustainable development. This motivated the development, adoption, and application of several fiscal rules. The first set of rules from 2008 embedded strict limits for the fiscal deficit and were fundamentally debt rules. They had a debt ceiling, a debt brake, and a deficit ceiling. But they did not address long-term fiscal challenges. Neither did they provide proper guidance for economic stabilization, including sufficient flexibility to deal with economic shocks. Under these rules, countercyclical increases in current expenditures were mainly implemented and financed by more borrowing, which violated the

“golden rule” of fiscal policy.<sup>13</sup> This also created an inadequate reallocation of resources from future generations to the current one, as well as long-term pressures on fiscal policy to repay the accumulated debt.

In 2018, the MOF enacted a new system of general fiscal rules to establish clear guidance for public finance management and strengthen fiscal sustainability. This new and current fiscal framework is based on operational expenditure rules, with debt thresholds that serve as specific fiscal anchors. The rules embed a more systematic approach to conduct fiscal policy, while allowing for important medium-term fiscal strategy considerations. By addressing the problems of inadequate reaction along the business cycle and budget allocations across generations, the new fiscal rules can help boost long-term economic growth, stabilize the business cycle, and enhance accountability.

The Government’s long-term objective is to reduce its debt level below 40 percent of GDP, which is perceived as the “safe level.” However, since Central Government (CG) debt can be, at some point, above 50 or even 60 percent of GDP, the CG needs to specify debt reduction strategies guided by debt thresholds, as medium-term fiscal anchors. The new set of rules are specified in the Laws on the Budget System and Public Debt. These Laws consider three thresholds for CG debt, namely: 40, 50, and 60 percent of GDP. When actual debt breaches these thresholds, the Laws require the Government to take corrective actions. In this requirement, the Laws only prescribe explicit speed limits for current expenditures, while giving the Government the flexibility and responsibility of engineering consolidation strategies. Specifically, the Laws require the following:

- If CG debt exceeds 40 percent of GDP: the overall deficit should not be greater than capital expenditures.
- If CG debt is between 50 and 60 percent of GDP: (i) the previous rule applies; (ii) the growth rate of primary current expenditures is capped by the average nominal GDP growth of the previous 7 years; (iii) the Government must introduce a debt reduction program, as part of its Medium-Term Expenditures Framework, which is a public document.
- If CG exceeds 60 percent of GDP: (i) the previous two rules apply but the growth rate of primary current expenditures is capped by the average nominal GDP growth of the previous 7 years minus 0.5 percentage points; (ii) current expenditures are capped by the anticipated volume of tax revenues; and (iii) the Government must submit a debt reduction program to the Parliament.

As discussed in Hakobyan and Karapetyan (2019), the numerical parameters of the expenditure rules are calibrated to capture the characteristics of the Armenian economy and help stabilize the business cycle. The design and calibration of these rules also respect the “golden rule” of public

---

<sup>13</sup> The government borrowed more, mainly from non-residents, than it invested in public capital. Moreover, it spent on current needs more than it collected in tax revenues.

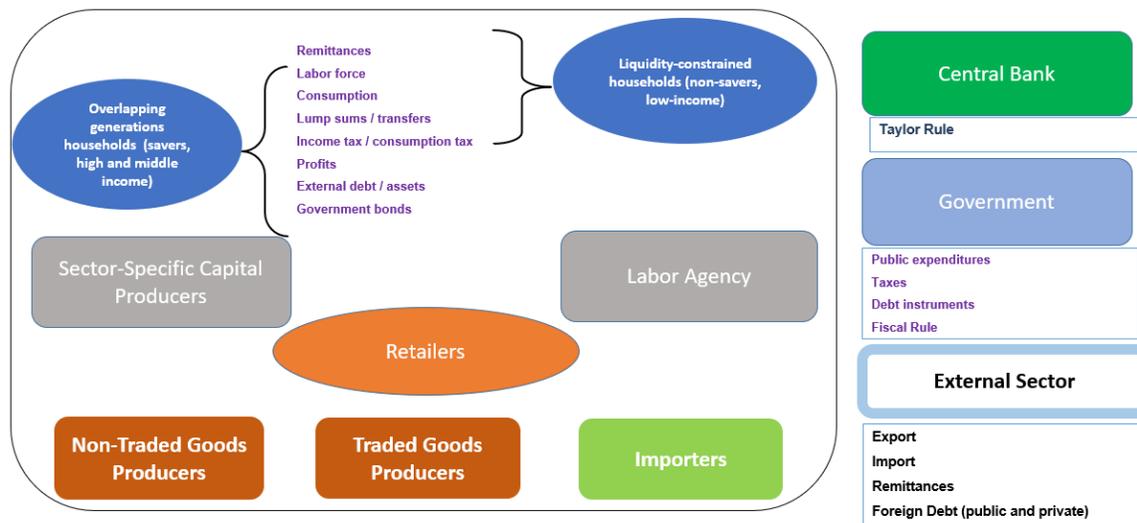
finance, while allowing for flexibility between the Government debt burden and medium- and long-term debt stability.<sup>14</sup> The rules are subject to escape clauses, including large-scale natural disasters, wars, or economic shocks, such as the Covid-19 pandemic.<sup>15</sup>

The MOF subscribes to the view that fiscal policy can have significant effects on GDP. This is supported by estimates of fiscal multipliers provided in Fukač et al. (2021) using SVARs, for different types of taxes and expenditures. A summary of these estimates is provided below in Table 3, where we use them to validate the AFSM calibration—we present a comparison of the fiscal multipliers from the SVARs and the AFSM.

### 3 The Model Structure

This section details the microeconomic foundations of the AFSM. The model consists of four high-level blocks: (i) the household sector, (ii) the production sector, (iii) the government sector, and (iv) the rest of the world. In each sector, there are different agents (Figure 6).

**Figure 6. The Structure of the AFSM**



**Source:** Authors.

The modeling strategy includes the following key assumptions: (i) all economic private agents (households and firms) are forward-looking, have rational expectations and complete

<sup>14</sup> As defined by HM Treasury, to follow the “golden rule” of public finances over the economic cycle, the Government must only borrow to invest and not to fund current expenditure. Source: <https://www.internationalbudget.org/wp-content/uploads/UnitedKingdom-CodeOfFiscalStability1998-English.pdf>.

<sup>15</sup> The escape clause regulations are set in The Law on the Budget System of the Republic of Armenia (Article 21, Paragraph 8.3). The Government Decree of August 23, 2018 (N942-Ն) sets the procedure of defining the exceptional situation that triggers the escape clause. For a detailed description and analysis of these fiscal rules, see IMF (2017).

information, and solve well-specified intertemporal maximization problems subject to constraints; (ii) monetary and fiscal authorities follow policy rules, aiming at targets for some key macro variables (e.g., inflation and debt); (iii) some markets have monopolistic structures (e.g. non-traded goods market), which leads to (Pareto) sub-optimal resource allocations, and thus may justify Government's intervention policies, (iv) agents interact in markets that always clear; and (v) fluctuations in the economy are driven by fundamental shocks. Technology grows exogenously at a rate  $g_t$ , but for simplicity in the description of the AFSM, we will assume that  $g_t = 0$ .

### 3.1 Household Sector

There is an infinite number of households who live on a unit circle and are divided into the following 2 groups: (i) a  $(1-f)$  share of liquidity *constrained* households, also called non-savers, who consume fully their current income in every period; and (ii) an  $f$  share of liquidity *unconstrained* households, or savers, who have access to financial assets and firms' dividends and, therefore, can smooth consumption over time. Very broadly, the latter can be viewed as middle/higher income households, while the former can be viewed as lower-income households. This household split allows to study basic aspects of income re-distribution policies.

Since the share of liquidity constrained households in Armenia is significant, their presence and expenditure pattern in the AFSM have important implications. First, these households allow to capture significant fiscal policy Keynesian effects on output—they influence the size of fiscal multipliers. Second, they help capture more volatile economic booms and busts, and thus motivate a bigger role for fiscal policy in macroeconomic stabilization. And third, they help break the Ricardian equivalence.

All households consume goods and services and supply labor to firms. A representative household  $i$  of both savers and non-savers—household  $i$  is either liquidity constrained,  $i=l$ , or unconstrained,  $i=o$ —consumes a CES basket of goods, which consists of domestically (non-traded and traded) produced goods and imported goods. The demand functions for these goods depend on their relative prices and aggregate consumption  $C_t^i$ :

$$C_{d,t}^i = \omega \left( \frac{P_{d,t}}{P_t} \right)^{-\theta_c} C_t^i, \quad C_{h,t}^i = \kappa \left( \frac{P_{h,t}}{P_t} \right)^{-\theta_c} C_t^i, \quad \text{and} \quad C_{f,t}^i = (1 - \omega - \kappa) \left( \frac{P_{f,t}}{P_t} \right)^{-\theta_c} C_t^i,$$

where  $C_{d,t}^i$ ,  $C_{h,t}^i$ ,  $C_{f,t}^i$  are the respective consumptions for domestically produced non-traded goods, domestically produced traded goods, and foreign produced traded goods, with corresponding shares  $\kappa$ ,  $\omega$ , and  $1 - \kappa - \omega$ , satisfying  $\kappa + \omega < 1$ , and elasticity of substitution  $\theta_c$ . The nominal prices of domestic non-traded, domestic traded, and foreign traded goods are denoted by  $P_{d,t}$ ,  $P_{h,t}$ , and  $P_{f,t}$ , respectively, and the aggregate consumer price index,  $P_t$ , corresponds to

$$P_t = \left[ \omega P_{d,t}^{1-\theta_c} + \kappa P_{h,t}^{1-\theta_c} + (1 - \omega - \kappa) P_{f,t}^{1-\theta_c} \right]^{\frac{1}{1-\theta_c}}.$$

### ***Liquidity Unconstrained Households (Savers)***

These households have access to financial assets and firms' dividends, which allows them to save. Following Blanchard (1985) and Yaari (1965), they face a probability  $(1-\xi)$  of dying in every period, which is calibrated to match the average length of productive life in Armenia. Therefore, savers have a finite planning horizon, which weakens the Ricardian equivalence and strengthens the potency of fiscal policy in macroeconomic stabilization. Savers who die are replaced immediately by new savers that are born, keeping their population size constant.

Savers maximize their life-time welfare, by making optimal decisions about consumption, labor supply, and an optimal portfolio of domestic and foreign bonds. More formally, they solve the following problem:

$$\max_{\{C_{a,t}^o, N_{a,t}^o, B_{a,t}^o, B_{a,t}^{o,f}\}} E_0 \sum_{t=0}^{\infty} (\beta\xi)^t \left[ \frac{1}{1-\sigma} \left[ \left( \frac{C_{a,t}^o}{(C_{t-1}^o)^\chi} \right)^\gamma (1 - N_{a,t}^o)^{1-\gamma} \right]^{1-\sigma} \right],$$

subject to the budget constraint:

$$(1 + \tau_{c,t})P_t C_{a,t}^o + B_{a,t}^o + S_t B_{a,t}^{o,f} \\ \leq (1 - \tau_{N,t})V_t N_{a,t}^o + \frac{1}{\xi} [(1 + i_{t-1})B_{a,t-1}^o + (1 + i_{t-1}^f)S_t B_{a,t-1}^{o,f}] + D_{a,t} + P_t T_{a,t}^o.$$

In this maximization problem,  $E_0$  is the conditional rational expectations operator;  $C_{a,t}^o$  is the real consumption of savers  $o$  of cohort  $a$  at time  $t$ ;  $N_{a,t}^o$  is the total hours worked;  $B_{a,t}^o$  and  $B_{a,t}^{o,f}$  are the nominal values of domestic and foreign bonds, respectively;  $\beta$  is the long-term discount factor and  $\xi$  is the probability of surviving;  $\sigma$  is the relative risk aversion coefficient;  $\chi$  is the external consumption habit parameter; and  $\gamma$  is the relative contribution of consumption to utility. In the budget constraint,  $\tau_{c,t}$  is the consumption tax rate;  $\tau_{N,t}$  is the labor income tax rate;  $S_t$  is the nominal exchange rate;  $V_t$  is the nominal (reservation) wage rate paid to the households by an employment agency;  $i_t$  is the domestic nominal interest rate on risk-free assets;  $i_t^f$  is the world nominal interest rate on foreign risk-free assets;  $D_{a,t}$  is the sum of dividends firms ownership; and  $T_{a,t}^o$  are the total real net transfers from the government.

The optimal solution to the maximization problem involves several key equilibrium conditions. After manipulating the first-order conditions and aggregating across cohorts, savers' consumption can be represented as a linear function of wealth,  $\mathcal{U}_t^o$ , which includes their assets and life-time income from working. That is,

$$P_t C_t^o = MPC_t^o \mathcal{U}_t^o,$$

where  $MPC_t^o$  is the marginal propensity to consume, which can be subject to shocks. This consumption function is just a manifestation of the permanent income hypothesis, since savers smooth consumption over time. Moreover, the solution (and cohort aggregation) also yields the optimal intra-temporal condition:

$$\frac{C_t^o}{\Psi - N_t^o} = \frac{\gamma}{1-\gamma} \frac{(1-\tau_{N,t})V_t}{(1+\tau_{c,t})P_t},$$

which equalizes the marginal rate of substitution between consumption and labor to real wages—this is an implicit representation of the savers labor supply. In this condition,  $\Psi$  is the aggregate weighted time-endowment of savers, and taxes create a distortion.

The optimal conditions also include the following UIP condition:

$$(1 + i_t) = (1 + i_t^f) E_t \left[ \frac{S_{t+1}}{S_t} \right],$$

which equalizes the net returns of domestic and foreign bonds, adjusting by the expected nominal exchange rate depreciation.

### ***Liquidity-Constrained Households (Non-Savers)***

The main characteristic of the liquidity-constrained households is that they do not save. All their disposable income is immediately spent. They maximize their lifetime utility from consumption and leisure, according to:

$$\max_{\{C_{a,t}^l, N_{a,t}^l\}} E_0 \sum_{t=0}^{\infty} (\beta\xi)^t \left[ \frac{1}{1-\sigma} \left[ \left( \frac{C_{a,t}^l}{(C_{a,t-1}^l)^\chi} \right)^\gamma (1 - N_{a,t}^l)^{1-\gamma} \right]^{1-\sigma} \right],$$

where  $C_{a,t}^l$  is consumption of non-savers  $l$  from cohort  $a$  at time  $t$ ;  $N_{a,t}^l$  is the labor supply. The discount factor  $\beta$ , the probability of surviving  $\xi$ , the relative contribution of consumption to the utility  $\gamma$ , and the relative risk aversion coefficient  $\sigma$  are the same as those parameters in the savers' problem.

Non-savers consumption expenditures,  $P_t C_t^l$ , need to be less or equal than their real disposable income, according to the following budget constraint:

$$(1 + \tau_{ct})P_t C_{a,t}^l \leq (1 - \tau_{Nt})V_t N_{a,t}^l + P_t T_{a,t}^l + S_t Rem_{a,t}^*,$$

where the disposable income consists of labor income,  $V_t N_{a,t}^l$ , government net transfers,  $P_t T_{a,t}^l$ , and foreign remittances,  $S_t Rem_{a,t}^*$ . Note that the effective income tax and wage rates are the same for both the liquidity-constrained and unconstrained households.

The solution to the non-savers' problem yields the following optimal labor supply (after aggregating across cohorts):

$$N_t^l = 1 - \Psi - \frac{1-\gamma}{\gamma} \frac{1+\tau_{c,t}}{1-\tau_{N,t}} \left( \frac{V_t}{P_t} \right)^{-1} C_t^l,$$

where the household's willingness to work is negatively related to consumption, and positively related to the real wage. Given the labor supply and disposable income, the budget constraint then determines non-savers consumption.

Aggregate remittances (in foreign currency) are an exogenous flow of income, which is assumed to follow an autoregressive process:

$$Rem_t^* = (1 - \rho_{rem})Rem^* + \rho_{rem}Rem_{t-1}^* + \varepsilon_t^{Rem},$$

where  $Rem^*$  is the steady-state level of remittances,  $\rho_{rem}$  is the autoregressive parameter, and  $\varepsilon_t^{Rem}$  is a normally distributed shock, with zero mean and finite variance  $\sigma_{Rem}^2$ .<sup>16</sup>

### **Aggregation**

It is useful to define aggregate variables  $X_t$  as the sum of the savers' variable  $X_t^o$  and the non-savers' variable  $X_t^l$ . That is,  $X_t = X_t^o + X_t^l$ . For instance, for aggregate consumption, we have  $C_t = C_t^o + C_t^l$ .

## **3.2 Production Sector**

The real sector consists of the employment agency, domestic traded and non-traded goods producers, capital goods producers, importers, and retailers. This subsection details the structure and decision problems of all these agents.

### **Non-Traded Goods Producers**

The representative producer “ $i$ ” of domestic non-traded goods uses the following constant-return-to-scale technology of production, combining labor ( $N_{d,t}^i$ ), capital ( $K_{d,t-1}^i$ ), imported inputs ( $M_{d,t}^i$ ), and public capital ( $G_{t-1}^{d,i}$ ):

$$Y_{d,t}^i = [A_{d,t}(N_{d,t}^i - \bar{N}_d)]^{\alpha_{Nd}} (K_{d,t-1}^i)^{\alpha_{Kd}} (M_{d,t}^i)^{(1-\alpha_{Nd}-\alpha_{Kd})} (G_{t-1}^{d,i})^\psi,$$

where  $A_{d,t}$  is the labor-augmenting technology level,  $\bar{N}_d$  is the overhead labor ( $\bar{N}_d > 0$ ),  $\alpha_{Nd}$  is the labor income share,  $\alpha_{Kd}$  is the capital income share, and  $\psi$  is the elasticity of output with respect to public capital. Public capital complements private inputs, making them more productive.<sup>17</sup> The labor-augmenting technology follows an exogenous autoregressive process  $A_{d,t} = (1 - \rho_{Ad})\bar{A}_d + \rho_{Ad}A_{d,t-1} + \varepsilon_t^{Ad}$ , with  $\bar{A}_d > 0$  and  $\varepsilon_t^{Ad} \sim N(0, \sigma_{Ad}^2)$ .

The representative firm in the non-traded sector works in a monopolistically competitive environment. As such, it faces a demand for their output  $Y_{d,t}^i$  of the Dixit-Stiglitz type:

$$Y_{d,t}^i = \left( \frac{P_{d,t}^i}{P_{d,t}} \right)^{-\theta_p} Y_{d,t},$$

<sup>16</sup> One could also link remittances to foreign macroeconomic conditions, such as foreign output (growth).

<sup>17</sup> The share of public capital satisfies  $0 \leq \psi < \alpha_N$ , to guarantee stationary. See Barro and Sala-i-Martin (2004).

where  $Y_{d,t}$  is the aggregate demand for non-traded goods,  $P_{d,t}^i$  is the price the firm sets,  $P_{d,t}$  is the aggregate price, and  $\theta_p$  is the price-demand elasticity. Moreover, the firm faces price rigidities a la Rotemberg (1982) by incurring in the costs  $ACP_{d,t}^i = \frac{\zeta_{d,p}}{2} \left( \frac{P_{d,t}^i}{P_{d,t-1}^i (\pi_{t-1}^d)^{\zeta_d}} - 1 \right)^2 P_{d,t} Y_{d,t}$ , where  $\pi_t^d$  is the gross inflation rate of non-traded goods prices,  $\zeta_d$  is a past inflation indexation parameter, and  $\zeta_{d,p}$  is the adjustment costs parameter.

The firm's objective is to maximize the net present value of its expected current and future stream of profits. In equilibrium, there is a non-zero profit, which is redistributed to equity owners (savers). Formally, the representative firm optimally chooses the demand for labor,  $N_{d,t}^i$ , physical capital,  $K_{d,t}^i$ , imported inputs  $M_{d,t}^i$ , and the price,  $P_{d,t}^i$  to solve the following problem:

$$\max_{\{P_{d,t}^i, N_{d,t}^i, K_{d,t-1}^i, M_{d,t}^i\}} E_0 \sum_{j=0}^{\infty} \frac{\xi^j}{\prod_{k=0}^j (1+i_{t+k})} \{P_{d,t+j}^i Y_{d,t+j}^i - W_{t+j} N_{d,t+j}^i - R_{t+j}^{K,d} K_{d,t+j-1}^i - S_{t+j} P_{t+j}^{M,*} M_{d,t+j}^i - ACP_{d,t+j}^i - ACN_{d,t+j}^i - ACM_{d,t+j}^i\}$$

subject to the production technology and demand constraints described above, where  $W_t$  is nominal wages,  $R_t^{K,d}$  is the nominal rental price of capital, and  $P_t^{M,*}$  is the foreign price of imported inputs.

The production costs of a representative firm in the optimization problem include those associated with labor, capital, and imported inputs. They also comprise adjustment costs for prices  $ACP_{d,t}^i$  (defined above), and the following adjustment costs for labor and imported inputs  $ACN_{d,t}^i = \frac{\zeta_{N,d}}{2} \left( \frac{N_{d,t}^i}{N_{d,t-1}^i} - 1 \right)^2 W_t N_{d,t}^i$  and  $ACM_{d,t}^i = \frac{\zeta_{M,d}}{2} \left( \frac{M_{d,t}^i}{M_{d,t-1}^i} - 1 \right)^2 S_t P_t^{M,*} M_{d,t}^i$ , where  $\zeta_{N,d}$  and  $\zeta_{M,d}$  are the respective adjustment costs parameters. These adjustment costs ensure that firms cannot easily change or substitute labor and imported inputs.

The solution to the non-traded goods firm's problem is a set of demand functions for labor, capital, and imported goods. It also includes, after some manipulation and imposing a symmetric equilibrium, the following new-Keynesian Phillips curve for non-traded inflation:

$$\frac{\theta_p}{\zeta_{d,p}} \left( \frac{mc_{d,t}}{p_{d,t}} - \frac{\theta_p - 1}{\theta_p} \right) + \frac{\xi \pi_{t+1}}{1+i_t} \left( \frac{\pi_{t+1}^d}{(\pi_t^d)^{\zeta_d}} - 1 \right) \frac{\pi_{t+1}^d}{(\pi_t^d)^{\zeta_d}} \frac{p_{d,t+1}}{p_{d,t}} \frac{Y_{d,t+1}}{Y_{d,t}} = \left( \frac{\pi_t^d}{(\pi_{t-1}^d)^{\zeta_d}} - 1 \right) \frac{\pi_t^d}{(\pi_{t-1}^d)^{\zeta_d}}$$

where we define  $p_{d,t} = \frac{P_{d,t}}{P_t}$  and  $mc_{d,t} = \frac{MC_{d,t}}{P_t}$  as the relative price and real marginal costs for non-traded goods, respectively.

### **Traded Goods Producers**

Like non-traded goods producers, the traded goods producers maximize the present value of their expected profits with respect to capital ( $K_{h,t-1}^i$ ), labor ( $N_{h,t}^i$ ), and imported inputs ( $M_{h,t}^i$ ). They have market power and set their own optimal nominal prices  $P_{h,t}^i$  satisfying a demand for

their output ( $Y_{h,t}^i$ ). They use capital, labor, imported inputs, and sector-specific public capital ( $G_{h,t-1}$ ) for their production, and face price-adjustment costs  $ACP_{h,t}^i$  a la Rotemberg (1982), which introduce price stickiness. More specifically,  $ACP_{h,t}^i = \frac{\zeta_{h,p}}{2} \left( \frac{P_{h,t}^i}{P_{h,t-1}^i (\pi_{t-1}^h)^{\zeta_h}} - 1 \right)^2 P_{h,t} Y_{h,t}$ , with parameters  $\zeta_{h,p}$  and  $\zeta_h$ , and where  $\pi_t^h$  is the gross inflation rate of the price of traded goods. There are also real rigidities for labor and imported inputs, which are captured by the adjustment costs  $ACN_{h,t}^i = \frac{\zeta_{N,h}}{2} \left( \frac{N_{h,t}^i}{N_{h,t-1}^i} - 1 \right)^2 W_t N_{h,t}^i$  and  $ACM_{h,t}^i = \frac{\zeta_{M,h}}{2} \left( \frac{M_{h,t}^i}{M_{h,t-1}^i} - 1 \right)^2 S_{t+j} P_t^{M,*} M_{h,t}^i$  with parameters  $\zeta_{N,h}$  and  $\zeta_{M,h}$ .

Formally, the profit maximization problem of the representative firm  $i$  is the following:

$$\max_{\{P_{h,t}^i, N_{h,t}^i, K_{h,t-1}^i, M_{h,t}^i\}} E_0 \sum_{j=0}^{\infty} \frac{\xi^j}{\prod_{k=0}^j (1 + i_{t+k})} \{ P_{h,t+j}^i Y_{h,t+j}^i - W_{t+j} N_{h,t+j}^i - R_{t+j}^{K,d} K_{h,t+j-1}^i - S_{t+j} P_{t+j}^{M,*} M_{h,t+j}^i - ACP_{h,t+j}^i - ACN_{h,t+j}^i - ACM_{h,t+j}^i \}$$

subject to the production and demand functions:

$$Y_{h,t}^i = [A_{h,t} (N_{h,t}^i - \bar{N}_h)]^{\alpha_{N,h}} (K_{h,t-1}^i)^{\alpha_{K,h}} (M_{h,t}^i)^{(1-\alpha_{N,h}-\alpha_{K,h})} G_{h,t-1}^{\psi,d}$$

and

$$Y_{h,t}^i = \left( \frac{P_{h,t}^i}{P_t^i} \right)^{\theta_p} Y_{h,t},$$

where  $A_{h,t}$  is the traded-sector-specific labor augmenting technology, and  $\alpha_{N,h}$  and  $\alpha_{K,h}$  are the sector-specific labor and capital income shares, respectively. The labor-augmenting technology level follows an autoregressive process  $A_{h,t} = (1 - \rho_{Ah}) \bar{A}_h + \rho_{Ah} A_{h,t-1} + \varepsilon_t^{Ah}$ , with  $\varepsilon_t^{Ah} \sim N(0, \sigma_{Ah}^2)$ .

The solution to the traded goods producer's problem is a set of demand functions for labor, capital, and imported inputs. It also includes an optimal price condition, which can be used to derive the following new-Keynesian Phillips curve:

$$\frac{\theta_p}{\zeta_{h,p}} \left( \frac{mc_{h,t}}{p_{h,t}} - \frac{\theta_p - 1}{\theta_p} \right) + \frac{\xi \pi_{t+1}}{1 + i_t} \left( \frac{\pi_{t+1}^h}{(\pi_t^h)^{\zeta_h}} - 1 \right) \frac{\pi_{t+1}^h}{(\pi_t^h)^{\zeta_h}} \frac{p_{h,t+1}}{p_{h,t}} \frac{Y_{h,t+1}}{Y_{h,t}} = \left( \frac{\pi_t^h}{(\pi_{t-1}^h)^{\zeta_h}} - 1 \right) \frac{\pi_t^h}{(\pi_{t-1}^h)^{\zeta_h}}$$

where we define  $p_{h,t} = \frac{P_{h,t}}{P_t}$  and  $mc_{h,t} = \frac{MC_{h,t}}{P_t}$  as the relative price and real marginal costs for traded goods, respectively.

### Capital Producers

The traded and non-traded producers own branches that are responsible for capital accumulation. The capital good producers decide how much domestic ( $I_{i,t}^i$ ) and imported investment ( $I_{f,t}^i$ ) are needed. The capital producers supply capital ( $K_{i,t}$ ) to the firms, and in return receive a rental fee.

The profit maximization problem for a representative capital producer is the following:

$$\max_{\{k_t^i, I_t^i, I_{f,t}^i\}} E_0 \sum_{j=0}^{\infty} \frac{\xi^j}{\prod_{k=0}^j (1 + i_{t+k})} \{ [(1 - \tau_{k,t+j}^i) R_{t+j}^{k,i} K_{i,t+j-1} + \tau_{k,t+j}^i \delta Q_{t+j}^i K_{i,t+j-1}] - P_{i,t+j} I_{i,t+j}^i - S_{t+j} P_{t+j}^M I_{f,t+j}^i \}$$

for the sub-index  $i = \{h, d\}$ , subject to the capital accumulation and investment allocation equations:

$$K_{i,t} = (1 - \delta) K_{i,t-1} + I_t^i \left[ 1 - \frac{\zeta_I}{2} \left( \frac{I_t^i}{I_{t-1}^i} - 1 \right)^2 \right]$$

and

$$I_t^i = \left[ \mu_i \frac{1}{\theta_I} I_{tt}^i \frac{\theta_I - 1}{\theta_I} + (1 - \mu_i) \frac{1}{\theta_I} I_{ft}^i \frac{\theta_I - 1}{\theta_I} \right]^{\frac{\theta_I}{\theta_I - 1}},$$

where  $\tau_{k,t}^i$  is the capital gain tax—capital producers do not have to pay taxes after the replacement of depreciated capital, receiving  $\tau_{k,t}^i \delta Q_t^i K_{i,t-1}$  in return—,  $P_{i,t}$  is the price of domestic investment,  $Q_t^i$  denotes the shadow price of the available capital portfolio,  $\delta$  is the depreciation rate of capital,  $\mu_i$  is the weight of domestic investment in total investment, and  $\theta_I$  is an elasticity of substitution. Note that investment is subject to adjustment costs in the capital accumulation equation, where  $\zeta_I$  is the coefficient for these adjustment costs.

The solution to the capital producers' problem yields the allocation functions for domestic and foreign investment, as well as an investment decision equation that depends negatively on the real Tobin's Q,  $q_t^i = \frac{Q_t^i}{P_t}$ , which can be subject to shocks. Moreover, it gives the following non-arbitrage condition:

$$\xi \frac{(1 - \tau_{k,t+1}^i) r_{t+1}^{k,i} + \tau_{k,t+1}^i \delta q_{t+1}^i + q_{t+1}^i (1 - \delta)}{q_t^i} = \frac{1 + i_t}{\pi_{t+1}}$$

where  $r_t^{k,i} = \frac{R_t^{k,i}}{P_t}$ .

### **Employment Agency**

Households supply their labor force to labor unions, which work as an employment agency. These labor unions hire households, paying them the reservation wage  $V_t$ , and supply labor to firms. They have monopolistic power—there is a labor demand constraint for the labor variety  $N_t^i$ —and therefore set the profit-maximizing nominal wages, which are also sticky. That is, there are wage adjustment costs  $ACW_t^i = \frac{\phi_w}{2} \left( \frac{W_t^i}{W_{t-1}^i \pi_{t-1}^W} - 1 \right)^2 W_t N_t^i$ , where  $\pi_t^W$  is the gross inflation of nominal wages and  $\phi_w$  is a wage-stickiness parameter.

More formally, the decision problem of the representative agency is the following:

$$\max_{W_t^j} E_0 \sum_{j=0}^{\infty} \frac{\xi^j}{\prod_{k=0}^j (1 + i_{t+k})} [(W_{t+j}^i - V_{t+j}) N_{t+j}^i - ACW_{t+j}^i]$$

subject to the demand constraint  $N_t^i = \left(\frac{W_t^i}{W_t}\right)^{-\theta_w} N_t$ , where  $\theta_w$  is the elasticity of substitution across labor varieties, and  $W_t$  is the aggregate nominal wage paid by firms. The solution to this problem gives the following new-Keynesian Phillips curve for wage inflation:

$$\frac{\theta_w}{\phi_w} \left( \frac{V_t}{W_t} - \frac{\theta_w - 1}{\theta_w} \right) + \frac{\xi \pi_{t+1}}{1 + i_t} \left( \frac{\pi_{t+1}^W}{\pi_t^W} - 1 \right) \frac{\pi_{t+1}^W}{\pi_t^W} \frac{w_{t+1} N_{t+1}}{w_t N_t} = \left( \frac{\pi_t^W}{\pi_{t-1}^W} - 1 \right) \frac{\pi_t^W}{\pi_{t-1}^W}.$$

### **Importers**

Import markets for final and intermediate inputs are perfectly competitive and importers charge a full-cost-recovery price. For simplicity, we assume that importers face no fixed or variable costs associated with running their business. The only costs they have is the costs of purchasing of foreign goods abroad, which are fully passed on to the domestic consumers. The total imports ( $M_t$ ) correspond to the sum of consumption spending on foreign goods ( $C_{f,t}$ ), investment spending on foreign goods for each sector by capital producers ( $I_{d,t}^f$  and  $I_{h,t}^f$ ), and imported inputs for production in each sector ( $M_{d,t}$  and  $M_{h,t}$ ). Hence

$$M_t = C_{f,t} + M_{d,t} + M_{h,t} + I_{d,t}^f + I_{h,t}^f.$$

### **Retailers**

Retailers combine the final traded and non-traded consumption goods and the imported consumption goods, according to the CES technology:

$$C_t = \left[ \omega \frac{1}{\theta_C} C_{d,t} \frac{\theta_C - 1}{\theta_C} + \kappa \frac{1}{\theta_C} C_{h,t} \frac{\theta_C - 1}{\theta_C} + (1 - \omega - \kappa) \frac{1}{\theta_C} C_{f,t} \frac{\theta_C - 1}{\theta_C} \right]^{\frac{\theta_C}{\theta_C - 1}},$$

where  $\omega$  and  $\kappa$  are the relative shares of the non-traded and traded goods in the consumption basket, respectively, and  $\theta_C$  is the elasticity of substitution.

Retailers work in a perfectly competitive environment, and solve the following problem:

$$\min_{\{C_{d,t}, C_{h,t}, C_{f,t}\}} P_{d,t} C_{d,t} + P_{h,t} C_{h,t} + S_t P_t^{M*} C_{f,t},$$

subject to the CES technology described above. The solution to this problem is a set of demand functions for traded, non-traded, and foreign goods, and the price index, which were presented at the beginning of the Household subsection.

### 3.3 Government Sector

The government sector consists of the Central Bank (CB) that conducts monetary policy, and the Fiscal Authority (FA) that is responsible for the revenue, expenditure, and debt policies of the country.

#### *Monetary Authority*

The CB has a dual mandate. The main objective of monetary policy is price level stability, but it also supports economic growth. The main policy instrument is the short-term risk-free interest rate, which is set following the Taylor-type rule:

$$i_t = \rho_i i_{t-1} + (1 - \rho_i) [\bar{i} + \phi_\pi (\pi_t - \bar{\pi}) + \phi_y \hat{y}_t] + \varepsilon_t^i,$$

where  $\bar{i}$  is the natural interest rate;  $\bar{\pi}_t$  is the CPI inflation target;  $\hat{y}_t$  is the output gap; and  $\varepsilon_t^i$  is a monetary policy shock that satisfies  $\varepsilon_t^i \sim N(0, \sigma_i^2)$ .  $\rho_i$  is the interest smoothing coefficient;  $\phi_\pi > 1$  is the response coefficient to inflation stabilization; and  $\phi_y \geq 0$  is the weight on the output gap stabilization.

#### *Fiscal Authority*

The FA is responsible for the revenue, expenditure, and debt policies of the country. All policies are conducted in a framework that supports debt sustainability. It has different expenditure instruments, such as current expenditures ( $C_t^g$ ), transfers ( $T$ ), and public investment ( $I_t^{g,i}$  for  $i = \{h, d\}$ ). It also has different tax instruments, including taxes on consumption, labor income, and capital income from both sectors, with corresponding tax rates  $\tau_{C,t}$ ,  $\tau_{N,t}$ ,  $\tau_{k,t}^d$  and  $\tau_{k,t}^h$ . Regarding borrowing, it has access to domestic debt ( $B_t^g$ ), foreign commercial debt ( $B_t^{gf}$ ) and foreign concessional debt ( $B_t^{gcf}$ ), with associated nominal interest rates  $i_t$ ,  $i_t^f$ , and  $i_t^c$ , respectively.

The authority faces the following budget constraint:

$$\begin{aligned} & \overbrace{\tau_{k,t}^h R_t^{k,h} K_{h,t-1} + \tau_{k,t}^d R_t^{k,d} K_{d,t-1} + \tau_{N,t} V_t N_t + \tau_{C,t} P_t C_t}^{\text{Tax revenues}} + \overbrace{\Delta B_t^g + S_t (\Delta B_t^{gf} + \Delta B_t^{gcf})}^{\text{Total borrowing}} \\ & = \underbrace{i_{t-1} B_{t-1}^g + S_t (i_{t-1}^f B_{t-1}^{gf} + i_{t-1}^c B_{t-1}^{gcf})}_{\text{Debt repayments}} + \underbrace{P_{d,t} C_t^g + P_{h,t} I_t^{g,h} + P_{d,t} I_t^{g,d} + P_t T_t}_{\text{Expenditures}} \\ & + \underbrace{\tau_{k,t}^h \delta Q_t^h K_{h,t-1} + \tau_{k,t}^d \delta Q_t^d K_{d,t-1}}_{\text{Corporate tax deductibles}} \end{aligned}$$

where  $\Delta B_t^j = B_t^j - B_{t-1}^j$  for  $j = \{g, gf, gcf\}$  and  $T_t = T_t^o + T_t^l$ .

The total stock of nominal debt in domestic currency,  $B_t$ , is given by:

$$B_t = B_t^g + S_t B_t^{gf} + S_t B_t^{gcf},$$

and the primary deficit is defined as:

$$D_t = [P_{d,t}C_t^g + P_{h,t}I_t^{g,h} + P_{d,t}I_t^{g,d} + P_tT_t + \tau_{k,t}^h\delta Q_t^h K_{h,t-1} + \tau_{k,t}^d\delta Q_t^d K_{d,t-1}] \\ - (\tau_{k,t}^h R_t^{k,h} K_{h,t-1} + \tau_{k,t}^d R_t^{k,d} K_{d,t-1} + \tau_{N,t}V_t N_t + \tau_{C,t}P_t C_t)$$

The net financial transfers to each household  $i = \{l, o\}$  and the tax rates follow exogenous autoregressive processes:

$$T_t^i = \rho_T^i T_{t-1}^i + (1 - \rho_T^i)\bar{T}^i + \varepsilon_t^{Ti}, \\ \tau_{C,t} = (1 - \rho_{\tau C})\bar{\tau}_C + \rho_{\tau C}\tau_{C,t-1} + \varepsilon_t^{\tau C}, \\ \tau_{N,t} = (1 - \rho_{\tau N})\bar{\tau}_N + \rho_{\tau N}\tau_{N,t-1} + \varepsilon_t^{\tau N}, \\ \tau_{k,t}^d = (1 - \rho_{\tau kd})\bar{\tau}_k^d + \rho_{\tau kd}\tau_{k,t-1}^d + \varepsilon_t^{\tau kd},$$

and

$$\tau_{k,t}^h = (1 - \rho_{\tau kh})\bar{\tau}_k^h + \rho_{\tau kh}\tau_{k,t-1}^h + \varepsilon_t^{\tau kh},$$

where  $\bar{T}^i$ ,  $\bar{\tau}_C$ ,  $\bar{\tau}_N$ ,  $\bar{\tau}_k^d$ , and  $\bar{\tau}_k^h$  are the steady-state levels of transfers and the tax rates;  $\rho_T^i$ ,  $\rho_{\tau C}$ ,  $\rho_{\tau N}$ ,  $\rho_{\tau kd}$ , and  $\rho_{\tau kh}$  are the autoregressive parameters; and  $\varepsilon_t^{Ti}$ ,  $\varepsilon_t^{\tau C}$ ,  $\varepsilon_t^{\tau N}$ ,  $\varepsilon_t^{\tau kd}$  and  $\varepsilon_t^{\tau kh}$  are the normally distributed shocks, with zero mean and finite variances,  $\sigma_{T^i}^2$ ,  $\sigma_{\tau C}^2$ ,  $\sigma_{\tau N}^2$ ,  $\sigma_{\tau kd}^2$ , and  $\sigma_{\tau kh}^2$ , respectively.

Public capital ( $G_t^i$ ), which may be sector-specific, is accumulated via public investment according to<sup>18</sup>

$$G_t^i = (1 - \delta_g)G_{t-1}^i + \epsilon_g I_t^{g,i},$$

for  $i = \{d, h\}$ . Note that public investment may be subject to inefficiencies and, therefore, may add less than one-to-one real value to public capital, as in Buffie et al. (2012). This inefficiency is captured by the parameter  $\epsilon_g$ , which can be shocked, to capture the insights of Berg et al. (2018)—what matters for growth is not the level of efficiency but changes in efficiency.

The sector-specific public investment ( $i = \{d, h\}$ ), is also modeled as an exogenous autoregressive stochastic rule:

$$I_t^{g,i} = \rho_{I_g^i}^i I_{t-1}^{g,i} + (1 - \rho_{I_g^i}^i)\bar{I}^{g,i} + \varepsilon_t^{Igi},$$

where  $\bar{I}^{g,i}$  for  $i = \{d, h\}$  are steady-state levels of public investment in each sector,  $\varepsilon_t^{Igi}$  is a random shock—satisfying  $\varepsilon_t^{Igi} \sim N(0, \sigma_{Igi}^2)$ —and  $\rho_{I_g^i}^i$  is the autoregressive parameter.

In the AFSM, the government budget policy is conducted following a counter-cyclical and debt-stabilizing primary deficit rule<sup>19</sup>

<sup>18</sup> There is an extension of the AFSM that also introduces a time-to-build process a la Kydland and Prescott (1982) for public capital accumulation. Details can be provided upon request.

$$pd_t = (1 - \rho_{pd})\overline{pd} + \rho_{pd}pd_{t-1} - \rho_y\hat{y}_t - \rho_b(b_t - \bar{b}) + \varepsilon_t^{pd},$$

where  $pd_t$  and  $b_t$  are the primary deficit-to-GDP and total debt-to-GDP ratios, and  $\overline{pd}$  and  $\bar{b}$  are the targets for these ratios. These targets are the long-term anchors for fiscal policy that put an envelope on fiscal and debt sustainability. The two targets are set by the government and are mutually consistent.  $\varepsilon_t^{pd}$  is the random shock to deficits, following  $\varepsilon_t^{pd} \sim N(0, \sigma_{pd}^2)$ . In terms of parameters,  $\rho_y \geq 0$  captures the weight that the government puts on the importance of countercyclical policy, and  $\rho_b > 0$  is the weight on the speed of fiscal consolidation.

The currency structure of debt is given exogenously. Given exogenous concessional borrowing, a constant share of the primary deficit and the total debt servicing costs are financed by domestic debt issuance. There is a financing rule, in which the parameter  $\phi_d$  determines that share of domestic debt, while the share of foreign market debt is then a residual.

Given this fiscal structure, and in line with the historical patterns of fiscal policy in Armenia, the government uses consumption spending,  $C_t^g$ , as the main instrument to align its fiscal strategy with the budget rule. That is,  $C_t^g$  is determined endogenously by the interactions of the fiscal rule, the budget constraint, and the previously described processes for the other fiscal variables. However, the AFSM is sufficiently flexible to accommodate different specifications for fiscal policy, where taxes and public investment can also act as the main instrument.

### 3.4 External Sector

Armenia is a small open economy that cannot affect global markets. Given this, the world economy variables are mainly modeled as exogenous processes. We can limit the definition of global to the Armenia trading partners and use the following definitions: effective foreign demand,  $Y_t^*$ , effective foreign consumer price inflation,  $\pi_t^*$ , effective foreign nominal risk-free interest rates,  $i_t^*$ , effective foreign concessional nominal interest rate,  $i_t^c$ , real import prices,  $p_t^{m*}$ , real export prices,  $p_t^{x*}$ , and the terms of trade,  $tot_t \equiv p_t^{x*}/p_t^{m*}$ . Both  $p_t^{m*}$  and  $p_t^{x*}$  are denominated in the effective foreign currency. We are agnostic about the regularities among the foreign variables and capture them by independent autoregressive processes:

$$\pi_t^* = (1 - \rho_{\pi w})\pi^* + \rho_{\pi w}\pi_{t-1}^* + \varepsilon_t^{\pi^*},$$

$$i_t^* = (1 - \rho_{i^*})i^* + \rho_{i^*}i_{t-1}^* + \varepsilon_t^{i^*},$$

$$i_t^c = (1 - \rho_{ic})i^c + \rho_{ic}i_{t-1}^c + \varepsilon_t^{ic},$$

$$\log(Y_t^*) = (1 - \rho_{yw})\log(Y^*) + \rho_{yw}\log(Y_{t-1}^*) + \varepsilon_t^{y^*},$$

$$\log(p_t^{x*}) = \rho_{px}\log(p_{t-1}^{x*}) + \varepsilon_t^{px^*},$$

---

<sup>19</sup> This fiscal rule represents a generalized form that we use in most of policy simulations. We later expand the set of rules to include the fiscal rules that are legally enacted in Armenia. They are outside of the baseline calibration, because they are only occasionally binding, and their use is subject to exclusions. Section 5 provides more details.

$$\log(\text{tot}_t) = \rho_{\text{tot}} \log(\text{tot}_{t-1}) + \varepsilon_t^{\text{tot}}.$$

where  $\pi^*$ ,  $i^*$ ,  $i^c$  and  $Y^*$  are the steady states of the effective foreign inflation rate, foreign risk-free interest rate, interest rate on foreign concessional loans, and the level of foreign output, respectively.  $\rho_{\pi^*}$ ,  $\rho_{i^*}$ ,  $\rho_{i^c}$ ,  $\rho_{y^*}$ ,  $\rho_{p^x}$  and  $\rho_{\text{tot}}$  are the autoregressive parameters and  $\varepsilon_t^{\pi^*}$ ,  $\varepsilon_t^{i^*}$ ,  $\varepsilon_t^{i^c}$ ,  $\varepsilon_t^{y^*}$ ,  $\varepsilon_t^{p^x}$ , and  $\varepsilon_t^{\text{tot}}$  are random shocks, which are uncorrelated and normally distributed with zero mean and finite variance  $\sigma_{\pi^*}^2$ ,  $\sigma_{i^*}^2$ ,  $\sigma_{i^c}^2$ ,  $\sigma_{y^*}^2$ ,  $\sigma_{p^x}^2$ , and  $\sigma_{\text{tot}}^2$ , respectively.<sup>20</sup>

We assume that total exports,  $X_t$ , depend on the effective foreign demand,  $Y_t^*$ , the relative price of exports  $p_t^{X^*}$ , and the real exchange rate  $z_t$ , according to

$$X_t = \left( \frac{p_{h,t}}{p_t^{X^*} z_t} \right)^{-\theta_X} Y_t^*,$$

where  $\theta_X$  is the price elasticity of demand for exported goods.<sup>21</sup>

Moreover, foreigners charge a premium over the risk-free interest rate, which is increasing on the total net external debt-to-GDP ratio of the country—sum of public and private foreign debt divided by GDP—as reflected by the following equations:

$$1 + i_t^f = (1 + i_t^*) \text{prem}_t$$

and

$$\text{prem}_t = \varsigma \left[ \frac{z_{t-1} (B_{t-1}^{gf} + B_{t-1}^{gcf} - B_{t-1}^{of})}{GDP_{t-1}} - \overline{NFD} \right],$$

where  $\overline{NFD}$  is a target for the total net external debt-to-GDP ratio consistent with the public debt targets defined above. The parameter  $\varsigma$  measures the sensitivity of the premium to debt, capturing the degree of openness of the capital account. The premium can be subject to shocks.

### 3.5 Aggregate Resource Constraints and Definition of Equilibrium

In equilibrium, all markets clear—e.g., for the labor market:  $N_{a,t} + N_{d,t} = N_t^o + N_t^l$ . And these market equilibrium conditions imply some resource constraints.

<sup>20</sup> This assumption simplifies the model, but it may introduce biases in measuring the impacts of foreign variables on the Armenian economy. In the baseline model, these variables are orthogonal to each other. In reality, the development of some of the variables may be interlinked. For example, low global interest rates may be associated with weak global economic activity and low inflation.

<sup>21</sup> This specification implies that foreign output shocks have a one-to-one effect on exports, making them a dominant driver. To dampen this effect, it is possible to introduce a pass-through coefficient to the domestic economy or incorporate judgement in the calibration by adjusting the shock.

### ***Domestic Resource Constraints***

There are two domestic resource constraints. They require that the supply of domestic non-traded and traded goods is equal to the demand for these goods. Specifically, the market clearing conditions for the non-traded goods correspond to

$$Y_{d,t} = C_{d,t} + C_t^g + I_t^{g,d} + I_{d,t}^d + ACP_{d,t} + ACN_{d,t} + ACM_{d,t} + ACW_t$$

and for the traded goods is

$$Y_{h,t} = C_{h,t} + I_t^{g,h} + I_{h,t}^h + X_t + ACP_{h,t} + ACN_{h,t} + ACM_{h,t} + ACW_t$$

Later in the text, we report some variables in terms of the nominal GDP, which corresponds to

$$NGDP_t = P_t C_t + P_{d,t} C_t^g + P_{h,t} I_t^{g,h} + P_{d,t} I_t^{g,d} + P_{h,t}^l I_t^h + P_{d,t}^l I_t^d + P_{h,t} X_t - S_t P_t^M M_t.$$

### ***External Resource Constraint***

The external resource constraint requires that the real and financial cross-border exchanges between residents and non-residents are in balance. The constraint can be expressed in terms of the law of motion for the net foreign assets position. Specifically,

$$S_t(B_t^{o,f} - B_t^{gf} - B_t^{gcf}) = S_t[(1 + i_{t-1}^f)(B_{t-1}^{o,f} - B_{t-1}^{gf}) - (1 + i_{t-1}^c)B_{t-1}^{gcf}] + \underbrace{P_{h,t} X_t - S_t P_t^{M,*} M_t}_{Trade\ balance} + S_t Rem_t^*.$$

### ***Definition of Equilibrium***

The model dynamic equilibrium is given by prices and quantities that satisfy the optimal conditions of all the agents' problems, the monetary and policy rules, the budget constraint of the government, and all the market clearing conditions. A technical appendix, available upon request, provides a summary of all the equations that characterize the dynamic equilibrium. We will refer to that set of equations as to the model or the AFSM. A technical appendix, available upon request, further details the model steady state.

## **4 Model Parametrization**

The AFSM has several structural parameters. We group them into four sets: (i) the steady-state parameters; (ii) the transitory parameters that affect only the equilibrium dynamics off the steady state; (iii) fiscal and monetary policy parameters; and (iv) structural shocks variances. The steady-state parameters are calibrated to match selected stylized facts for the Armenian economy between 2015 and 2019. The transitory and policy parameters are set using information from other studies and expert judgement.

Table 1 summarizes the model parametrization, which is quarterly. We proceed to discuss the values of a selected key (deep) structural parameters. Note that we assume an exogenous annual growth rate of 4 percent for the Armenian economy.

### *Steady-State Parameters*

- *Discount factor* ( $\beta$ ). It is linked to the real yield of the domestic risk-free assets, which is about 2 percent per year. In quarterly terms  $\beta = 0.9951$ .
- *Probability of survival* ( $\zeta$ ). We assume households spend about 37 years in the productive labor force. Then in quarterly terms,  $\zeta = (1 - 1/37)^{1/4} = 0.9932$ . We also experimented with higher probabilities, as in Kumhof *et al.* (2010) who consider a 10-year planning horizon.
- *Relative risk aversion parameter* ( $\sigma$ ). All households are risk neutral,  $\sigma = 1$ , which helps match quantitatively fiscal multipliers.
- *Share of consumption in households' utility* ( $\gamma$ ). We set  $\gamma = 0.7$  to match the labor supply elasticity of 0.5, common in the business cycle literature.
- *Depreciation rates of physical capital in tradable and non-tradable sectors* ( $\delta_h, \delta_d$ ). The depreciation rates are calibrated to approximate the investment-to-GDP ratio of 16.1 percent, which corresponds to a quarterly depreciation of about 1 percent.
- *Income shares of labor, capital, and imported inputs in production* ( $\alpha_{Nh}, \alpha_{Nd}, \alpha_{Kh}, \alpha_{Kd}$ ) and *the elasticity of output to public capital* ( $\psi$ ). The labor income shares in traded and non-traded production are set at 0.55 and 0.45, respectively, reflecting the actual shares for the 2015-2019 period. They fall within the estimates for low-income countries by Buffie *et al.* (2012).  $\alpha_{Kh}\alpha_{Kd}$ .  $\psi = 0.3$  which matches returns on public capital of about 15 percent.
- *Share of liquidity constrained households* ( $f$ ). This share is calibrated at 40 percent, based on household income and expenses from the Household survey of the Statistical Committee of the Republic of Armenia for the years 2010-19.
- *Price elasticity parameters* ( $\theta_p, \theta_w, \theta_x$ ). The consumption and labor demand elasticities are both calibrated to 6 to match 20 percent profit mark-ups of retailers and the employment agency. The profit mark-ups are close to the average profitability in Armenia. The elasticity of export demand  $\theta_x$  is calibrated to 1.5.
- *Intra-temporal elasticities of substitution* ( $\theta_c, \theta_l$ ). We use the estimates by Igityan (2018) and set  $\theta_c$  and  $\theta_l$  to 0.75.
- *Shares of non-traded and traded goods in consumption and investment* ( $\omega, \kappa, \mu_d, \mu_h$ ). The shares are set exogenously and fall within the estimates in Igityan (2018).
- *Private foreign debt* ( $\bar{b}\bar{b}^f$ ). The steady-state value is calibrated to match the 2015-2019 debt-to-GDP ratio. From the balance of payments data, we estimate the net foreign liabilities of private sector at 45 percent of GDP.
- *Non-traded and traded sectors technology parameters* ( $\bar{A}_d, \bar{A}_h$ ). The steady-state values are calibrated to 1.5 and 1, respectively, to approximate the sectors' relative contribution to their aggregate added value. In expert judgement, these contributions are roughly 40 and 60 percent for the non-traded and traded sector, respectively.
- *Risk premium elasticity with respect to foreign liabilities* ( $\zeta$ ). This elasticity is exogenously set at 0.05, which captures a moderately open capital account.

Table 1. Calibration

Parameter	Value	Definition
<i>Steady-state parameters</i>		
$\beta$	0.9951	Discount factor
$\zeta$	0.9932	Probability of survival
$\sigma$	1	Relative risk aversion
$\gamma$	0.7	Share of consumption in households' utility
$\delta_h$	0.01	Depreciation of physical capital in tradable sector
$\delta_d$	0.01	Depreciation of physical capital in non-tradable sector
$\underline{g}$	0.0125	Steady state growth rate, quarterly
$\bar{i}$	9.4	Steady-state domestic nominal risk-free interest rate
$\bar{i}^*$	9.4	Steady-state foreign nominal risk-free interest rate
$\alpha_{Nh}$	0.55	Share of labor in tradable sector
$\alpha_{Kh}$	0.33	Share of physical capital in tradable sector
$\alpha_{Nd}$	0.45	Share of labor in non-tradable sector
$\alpha_{Kd}$	0.35	Share of physical capital in non-tradable sector
$\psi$	0.1	Share of public capital in non-tradable and tradable sectors
$\theta_p$	6	Price elasticity of demand for final consumption goods
$\theta_w$	6	Price elasticity of labor demand
$\theta_c$	0.75	Intra-temporal elasticity of substitution of consumption goods
$\theta_I$	0.75	Intra-temporal elasticity of substitution of investment goods
$\theta_X$	1.5	Price elasticity of foreign demand for Armenian exports
$\omega$	0.35	Share of domestic goods in consumption
$\kappa$	0.3	Share of domestic traded goods in consumption
$\mu_d$	0.7	Share of non-traded investment goods in non-traded sector investment
$\mu_h$	0.7	Share of non-traded investment goods in traded sector investment
$f$	0.4	Share of liquidity constrained households
$\varsigma$	0.05	Risk premium elasticity with respect to foreign liabilities
$\bar{b}^f$	4*0.45	Private net foreign liabilities
$\bar{\pi}^*$	2	Annual target for foreign average headline inflation
$Rem^*$	0.119	Remittances (share of GDP)
$\bar{A}_d$	1.5	Technology level in non-tradable sector
$\bar{A}_h$	1	Technology level in tradable sector
<i>Transitory parameters</i>		
$\chi$	0.65	Habit persistence in liquidity constrained households' consumption
$\zeta_w$	180	Wage adjustment costs
$\zeta_{pd}, \zeta_{ph}$	96	Price adjustment costs for both traded and non-traded sectors
$\varsigma_d, \varsigma_h$	0	Price inflation indexation in traded and non-traded sectors
$\zeta_I$	1	Private investment adjustment costs
$\zeta_{Nd}, \zeta_{Nh}$	1	(Non-)tradable-sector-specific labour adjustment costs
$\zeta_{Md}, \zeta_{Mh}$	1	(Non-)tradable-sector-specific imported inputs adjustment costs
$\rho_{yw}$	0.8	Persistence of foreign demand for Armenian exports
$\rho_{rem}$	0.5	Persistence of remittances inflows
$\rho_{tot}$	0.5	Persistence of terms-of-trade
$\rho_{i^*}$	0.7	Persistence of foreign nominal interest rate
$\rho_{\pi^*}$	0.4	Persistence of foreign headline inflation
$\rho_{pf}$	0.4	Persistence of foreign inflation
$\rho_{Ad}, \rho_{Ah}$	0.95	Persistence of labor-augmenting technology in (non-)traded sector
$\rho_{px}$	0.5	Persistence of real export prices

Source: Authors' expert judgement and empirical estimates.

**Table 1 (continued). Calibration**

Parameter	Value	Definition
<b>Fiscal policy parameters</b>		
$\delta_g$	0.02	Depreciation of public capital
$\epsilon_g$	0.6	Government investment efficiency
$\bar{b}_g$	0.103	Domestic public debt target (share of GDP)
$\bar{b}_g^f$	0.078	Foreign public debt target (share of GDP)
$\bar{b}_{gc}^f$	0.321	Foreign public concessional debt target (share of GDP)
$\bar{i}^c$	1.2	Annual nominal interest rate on concessional loans
$\rho_y$	0.06	Weight on business cycle stabilization in fiscal rule
$\rho_b$	0.06	Weight on debt stabilization in fiscal rule
$\phi_d$	0.1789	Share of fiscal deficits financed domestically
$\bar{\tau}_c$	0.13	Long-run level of consumption effective tax
$\bar{\tau}_N$	0.15	Long-run level of labor income effective tax
$\bar{\tau}_k^h$	0.12	Long-run level of effective profit tax rate in tradable sector
$\bar{\tau}_k^d$	0.19	Long-run level of effective profit tax rate in non-tradable sector
$\bar{I}^{g,d}, \bar{I}^{g,h}$	0.02	Long-run level of (non)tradable-sector-specific public capital investment
$\bar{T}^l$	0.13	Long-run level of net transfers to liquidity constrained households
$\bar{T}^o$	-0.06	Long-run level of net transfers to liquidity unconstrained households
$\rho_{pb}$	0.84	Fiscal deficit persistence in fiscal policy rule
$\rho_{\tau kd}, \rho_{\tau kh}$	0.8	Persistence of (non-)traded-sector-specific profit tax
$\rho_{\tau n}$	0.9	Persistence of labor income tax
$\rho_{\tau c}$	0.8	Persistence of consumption tax
$\rho_{Igh}, \rho_{Igd}$	0.8	Persistence of public capital investment in (non)tradable sectors
$\rho_T^o, \rho_T^l$	0.5	Persistence of net-transfers to liquidity (un)constrained households
$\rho_{ic}$	0	Persistence of concessional interest rates
<b>Monetary policy parameters</b>		
$\bar{\pi}$	4	Domestic headline annual inflation target
$\rho_i$	0.75	Persistence of monetary policy rate
$\phi_\pi$	1.6	Weight on inflation stabilization in monetary policy rule
$\phi_y$	0.8	Weight on business cycle stabilization in monetary policy rule
$\rho_{mpc}$	0.6	Persistence of monetary policy shocks

Source: Authors' expert judgement and empirical estimates.

### Transitory Parameters

- *Habit persistence* ( $\chi$ ). Following Stepanyan *et al.* (2009), we use the empirical estimate of 0.65.
- *Tradable and non-tradable price inflation indexation* ( $\zeta_d, \zeta_h$ ). No price inflation indexation is assumed in the baseline.
- *Adjustment costs* ( $\zeta_{p,d}, \zeta_{p,h}, \zeta_w, \zeta_I, \zeta_{N,d}, \zeta_{N,h}, \zeta_{M,d}, \zeta_{M,h}$ ). All parameters control the quadratic adjustment costs a la Rotemberg (1982). We set  $\zeta_{p,d}, \zeta_{p,h} = 96$ , which corresponds to 18 months of nominal price stickiness, and falls near Igityan's (2018) estimates of the stickiness of home-produced-goods prices. The same source estimates  $\zeta_w$  values near 80, but we use judgment to set  $\zeta_w = 180$ , implying that nominal wages are stickier than prices. The

remaining parameters for private investment, labor, and imported inputs adjustment costs ( $\zeta_I$ ,  $\zeta_{N,d}$ ,  $\zeta_{N,h}$ ,  $\zeta_{M,d}$ ,  $\zeta_{M,h}$ ) are set to 1 in the baseline.

### ***Fiscal Policy Parameters***

- *Public investment efficiency* ( $\epsilon_g$ ). Dabla-Norris *et al.* (2011) estimates the public investment management index for Armenia at 2.39, between 2007 and 2010. A normalized value of this index implies an efficiency of  $\epsilon_g = 0.6$ .
- *Depreciation rate of public capital* ( $\delta_g$ ). We set it equal to 8 percent annually. Together with the steady-state public investment efficiency, this depreciation rate implies a public capital-to-output share of 64 percent, which is within the estimates for low- income countries in Gupta *et al.* (2014).
- *Public debt targets and debt financing* ( $\bar{b}^g, \bar{b}^{g,f}, \bar{b}^{g,cf}, \phi_d$ ). Public debt targets are set with an eye on stabilizing debt levels near 2015-2019 average levels and government's preferences. The individual public debt targets are calibrated to match the total government debt target of 50.2 percent of GDP. The domestic debt target is 10.3 percent of GDP; the foreign debt target is 7.8 percent; the concessional debt steady state is 32.1 percent. The share of domestic debt financing  $\phi_d$  is calibrated at 0.179, to match the balanced-growth path of the domestic public debt level, given the permanent annual growth rate of 4 percent.
- *Baseline fiscal rule parameters* ( $\rho_b, \rho_y, \rho_{pd}$ ). We set  $\rho_b = 0.06$  to ensure a very gradual but sufficient debt return to its target. It implies about 2.8-year half-life of a percentage point deviation from the debt target. The baseline fiscal rule is counter-cyclical with  $\rho_y = 0.06$ , which implies that 1 percent of output gap will decrease the annual primary balance by 0.25 percentage points of GDP.  $\rho_{pd} = 0.84$ , which implies a relatively short half-life of primary deficits of about 1 year.
- *Long-run effective tax rates* ( $\bar{\tau}_C, \bar{\tau}_N, \bar{\tau}_k^d, \bar{\tau}_k^h$ ). They are calibrated to match the value-added, labor income tax, and profit tax ratios to GDP (see Table 2).
- *Public capital investment and net transfers* ( $\bar{I}^{g,d}, \bar{I}^{g,h}, \bar{T}^o, \bar{T}^l$ ). The total public investment is 3.8 percent of GDP and we split it equally between the non-traded and traded sector-specific investment. From the government fiscal statistics, the total net transfers are about 10 percent of GDP (Table 2). Combining that information with the judgment that the non-savers form about one third of the total labor force yields that transfers correspond to  $\bar{T}^l/GDP = 0.13$ , and  $\bar{T}^o/GDP = -0.06$ .

### ***Monetary Policy Parameters***

- *Headline inflation target* ( $\bar{\pi}$ ). The target of the CBA is 4 percent.
- *Parameters of monetary policy rule* ( $\phi_\pi, \phi_y, \rho_i$ ). According to the estimates by Barseghyan (2013), the weight on expected inflation  $\phi_\pi = 1.6$ ; the weight on output gap  $\phi_y = 0.8$ ; and the monetary policy rate smoothing  $\rho_i = 0.7$ .

**Table 2. The Great Ratios and Selected Fiscal Statistics (percent of GDP)**

Variable	Data averages			Model (steady state)
	2000-2019	2010-2019	2015-2019	
<b>Expenditures on gross domestic product</b>				
Private consumption expenditures	82.2	82.7	80.3	80.3
... <i>domestic goods</i>	65.5	65.0	62.3	57.0
... <i>imported goods</i>	16.7	17.8	18.1	23.5
Gross private fixed investment	21.4	18.9	16.3	16.1
Government expenditures	16.1	16.3	16.1	16.0
... <i>government consumption</i>	11.7	12.6	13.0	12.9
... <i>government investment</i>	4.4	3.7	3.2	3.1
Exports of goods and services	27.4	30.6	35.3	35.3
Imports of goods and services	46.0	47.7	48.1	48.1
... <i>final consumption goods*</i>	16.7	17.8	18.1	18.1
... <i>intermediate goods**</i>	29.3	29.9	30.0	30.0
<b>Fiscal policy</b>				
Total revenues (incl. grants and non-tax revenues)	19.9	21.7	21.8	-
... <i>grants</i>	0.8	0.5	0.4	-
Total tax revenue (excl. other taxes)	17.9	19.7	19.7	19.7
... <i>income tax</i>	4.9	5.9	6.2	6.2
... <i>profit tax</i>	2.8	3.2	3.2	3.2
... <i>consumption tax</i>	10.2	10.6	10.3	10.3
... <i>other</i>	1.0	1.7	2.0	-
Total expenditures	24.5	26.7	27.1	-
Total expenditures excl. transfers	17.2	17.9	18.1	18.1
... <i>current (incl. debt-servicing costs)</i>	13.6	14.3	14.8	14.9
... <i>capital</i>	3.7	3.6	3.2	3.2
... <i>net transfers</i>	5.4	7.0	6.9	5.1
Total central government debt	35.4	43.3	50.2	50.2
... <i>domestic</i>	5.5	8.1	10.3	10.3
... <i>external</i>	29.9	35.1	39.9	39.9
... <i>market</i>	2.6	5.2	7.8	7.8
... <i>concessional</i>	27.2	29.9	32.1	32.1
Overall deficit	2.5	3.0	3.5	3.5
... <i>primary deficit</i>	1.4	1.5	1.4	1.4
... <i>interest costs</i>	1.1	1.5	2.1	2.1

**Source:** Authors' calculations using data from the Statistical Committee and the Ministry of Finance of the Republic of Armenia.

**Note:** (†) Approximated from construction share on the production-based GDP; (\*) Imported final consumption goods include food and beverages, consumption goods, and transportation (3 ppt); (\*\*) intermediate goods include industrial supplies, transportation equipment and parts (1ppt), fuels and lubricants, and capital goods.

The standard deviations of structural shocks are the last group of parameters. Since we are not using the model to match actual data volatilities, we set all shock variances at a default unitary value. The appropriate scaling of volatilities comes through judgment on the structural shocks when we design specific simulation scenarios below.

In summary, the calibration was done to match the basic dimensions of the Armenian economy and of the government fiscal policy. Table 2 compares the model key characteristics with the actual uses of gross domestic product and fiscal accounts.

To validate the AFSM and its calibration, we use the model to calculate fiscal multipliers and compare them with empirical estimates. The latter are obtained using SVARs, following the identification methodology initially proposed by Blanchard and Perotti (2002). All the details of the estimation are provided in Fukač et al. (2021). The estimation uses Armenian quarterly fiscal and macroeconomic data from 2000 through 2017, and variations in the underlying SVAR model's specification and order. The fiscal policy impacts on output are measured at a granular level, which allows us to benchmark the fiscal multipliers of corporate profit tax, personal income tax and consumption tax; as well as current and capital expenditures, predicted by the AFSM.<sup>22</sup>

The AFSM fiscal multipliers and the empirical estimates are reported in Table 3. The empirical estimates have their limitations but provide a very useful benchmark. They suffer from structural breaks and other uncertainties.<sup>23</sup> The numbers in the square brackets represent a standard-deviation interval of alternative estimates.

**Table 3. Fiscal Policy Multipliers**

	<b>Impact multiplier</b>	<b>1-Year Multiplier</b>	<b>3-Year Multiplier</b>
<i>Tax revenues</i>			
Consumption tax	-0.7 [-1.8, -0.4]	-0.5 [-2.3, -0.2]	-0.4 [-1.7, 0.2]
Personal income tax	-0.4 [-4.4, 0.3]	-0.7 [-2.7, 0.8]	-1.3 [-1.7, 0.6]
Corporate profit tax	-0.2 [-4.4, -0.9]	-0.2 [-2.3, 0.8]	-0.4 [-1.7, 0.3]
<i>Expenditures</i>			
Current expenditures	0.8 [-0.2, 1.4]	0.6 [-0.3, 1.0]	0.5 [-0.3, 0.4]
Capital expenditures	1.5 [0.1, 1.1]	0.9 [-0.7, 1.1]	0.9 [-0.4, 0.7]

**Source:** Authors' calculations based on the AFSM.

**Note:** The multipliers are defined as the cumulative change in output over the cumulative change in the relevant fiscal variable. The headline numbers are the AFSM predictions. The numbers in brackets are empirical estimates from Fukač et al. (2021), Tables 5 and C3.

Overall, the AFSM-implied fiscal multiplier fall within the measured empirical ranges. The multipliers of tax policies are closer to more moderate values; while the multipliers of

<sup>22</sup> Fukač et al. (2021) also provides the estimates of aggregate tax and revenue multipliers, and the multipliers vis-à-vis the aggregate demand components (private and public consumption and investment, exports, and imports). For the sake of space, we report here only selected estimates.

<sup>23</sup> The empirical estimates suffer from structural uncertainty, are conditional on a specific identification of fiscal shocks, and the measurements include potential endogenous policy responses. In contrast, the model predictions are conditional on a no-policy change assumption. When we simulate a tax policy shock in the model, we assume that fiscal expenditures remain at their steady-state levels.

expenditure policies are closer to the values associated with more potent expenditure policies. However, they are in line with the multipliers estimated or simulated in the literature.<sup>24</sup>

A past performance is not an indicator of the future. The Armenian government’s plans for strengthening the management of public finance—improving fiscal accountability and transparency—and improving investment projects governance will, in our view, strengthen the general transmission mechanism of fiscal policy. The AFSM is built and calibrated to accommodate the increased potency of expenditure policies.

## 5 Capturing the Fiscal Rules Taxonomy of Armenia

This section describes the way that the specific fiscal rules of Armenia, which were described in Section 2, can be formally captured by the model-based analysis. These rules are part of a satellite model, but not of the AFSM, because they occasionally bind and may be subject to exclusions and the activation of different fiscal instruments, which implies complex non-linearities.

To formally capture these rules, we introduce three logistic functions that are calibrated to mimic switches that activate the relevant constraints, when the rules are binding. Specifically, the switch,  $r_{n,t}$ , is defined as

$$r_{n,t} = \frac{1}{1 + \exp(-A(b_t - \bar{b}_n))} \quad \text{for } n = 1, 2, 3.$$

The switches are linked to the three debt-to-GDP thresholds  $\bar{b}_n = \{40, 50, 60\}_{n=1}^3$ . The logistic function is calibrated so that its values are bounded between 0 and 1.  $r_{n,t}$  is zero if the actual debt is below the critical threshold and approaches 1, as the debt exceeds a particular threshold  $\bar{b}_n$ . The parameter  $A$  captures the speed at which the fiscal rule switches on when such a breach occurs, and is calibrated in a way to ensure a rapid switching.

The switches affect the level of current and capital expenditures and activate the fiscal rules prescribed by the law. Specifically, the modified rule for nominal capital expenditures takes the form

$$P_t \tilde{I}_t^g = (1 - r_{1,t}) P_t I_t^g + r_{1,t} D_t.$$

When  $b_t < \bar{b}_1$ , then  $r_{1,t} = 0$ , and the total level of capital expenditures  $\tilde{I}_t^g$  is equal to the level  $I_t^g$  implied by the baseline AFSM model without the non-linear fiscal rules. When  $b_t \geq \bar{b}_1$ , then  $0 < r_{1,t} \leq 1$ , and the level of capital expenditures is constrained to be equal to the overall

---

<sup>24</sup> The literature survey conducted by Ramey (2019) points to similar values of government consumption multipliers based on DSGE models, falling in the range of 0.7 to 1.4. Empirically estimated multipliers fall into wider ranges. A more detailed discussion regarding the literature on fiscal multipliers can be found in Fukac et. al. (forthcoming).

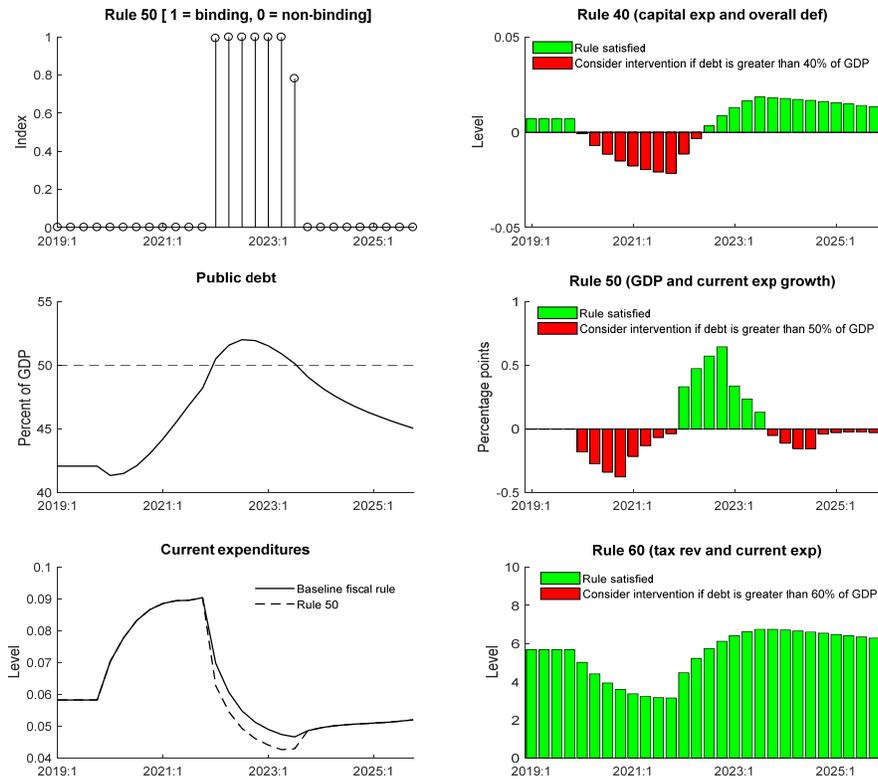
deficit,  $D_t$ . The potential increase in capital spending comes at the expense of current expenditures. We will refer to this rule as Rule 40.

Similarly, the modified rule for nominal current expenditures takes the following form:

$$P_{d,t}\tilde{C}_t^g = (1 - r_{2,t})P_{d,t}C_t^g + r_{2,t}(1 + \Delta_{20}NGDP_t)P_{d,t}\tilde{C}_{t-1}^g.$$

When  $b_t < \bar{b}_2$ , then  $r_{2,t} = 0$ , and the level of current expenditures  $\tilde{C}_t^g$  is equal to the level  $C_t^g$  implied by the baseline AFSM model. When  $b_t \geq \bar{b}_2$ , then  $0 < r_{2,t} \leq 1$ , and nominal expenditures increase at the average growth rate of nominal GDP over the past 20 quarters,  $\Delta_{20}NGDP_t$ . We will refer to this rule as Rule 50.

**Figure 7. The Fiscal Speed Limit Monitor**



**Source:** Authors' calculations.

**Note:** This figure shows the impulse responses to unanticipated shocks to primary deficits. Specifically,  $\varepsilon_t^{pd} = 1$  for  $t = 2020:Q1 - 2021:Q4$ . The shocks are designed to gradually increase the levels of public debt to breach the threshold of 50 percent of GDP. The panels on the left show the activation of Rule 50. The panels on the right show the indicators of the fiscal speed limit monitor. The traffic lights for Rule 40 are green, when government capital spending is larger than the overall deficit. They are red otherwise. The traffic lights for Rule 50 are green, when current expenditures grow at a slower rate than nominal GDP over the past five years. They are red otherwise. The traffic lights for Rule 60 are green, when the current expenditures are less than tax revenues. They are red otherwise. The red lights are necessary but not sufficient conditions for an intervention. It is up to the user to design the intervention. An intervention is called when the monitor flags it and, at the same time, the debt level breaches the critical thresholds.

Finally, the modified rule for nominal current expenditures, when the debt levels exceed 60 percent of GDP takes the following form:

$$P_{d,t}\tilde{C}_t^g = (1 - r_{2,t})P_{d,t}C_t^g + r_{2,t}[(1 - \tau_{k,t}^h)R_t^{k,h}K_{h,t-1} + (1 - \tau_{k,t}^d)R_t^{k,d}K_{d,t-1} + \tau_{N,t}V_tN_t + \tau_{C,t}P_tC_t].$$

When  $b_t < \bar{b}_3$ , then  $r_{3,t} = 0$ , and the level of current expenditures  $\tilde{C}_t^g$  is equal to the level  $C_t^g$  implied by the baseline AFSM model. When  $b_t \geq \bar{b}_3$ , then  $0 < r_{3,t} \leq 1$  and nominal expenditures are equal to the total tax revenues less corporate tax deductibles,  $R_t$ ,

$$R_t = (1 - \tau_{k,t}^h)R_t^{k,h}K_{h,t-1} + (1 - \tau_{k,t}^d)R_t^{k,d}K_{d,t-1} + \tau_{N,t}V_tN_t + \tau_{C,t}P_tC_t.$$

We will refer to this rule as Rule 60.

In the AFSM, we consider only the generic primary balance rule. The rules described above are used in a satellite model. However, we still monitor the adherence to the *de jure* rules in the AFSM. To do so, we introduce a *fiscal speed limit monitor*, which is a traffic light that monitors the evolution of current and capital expenditures, as in the *de jure* rules. If capital or current expenditures violate the constraints of Rules 40, 50, or 60, then the monitor highlights the development in red, requiring a fiscal intervention. It is up to the AFSM user to design the necessary intervention that is prescribed by the *de jure* rules to bring the debt level back to desired levels. By default, the baseline AFSM is using the current spending as the primary fiscal variable that adjust. In the satellite model that contains the non-linear *de jure* rules explicitly, the fiscal intervention is endogenous.

To illustrate the workings of the *de jure* rules and the fiscal speed limit monitor, consider the following experiment. For the calibration described in Section 4, there is a series of shocks to the primary balance that, over two years (2020 and 2021), increase the debt level above 50 percent of GDP, so that Rule 50 becomes binding.

Figure 7 summarizes the results of this experiment. The left three panels show the switch for Rule 50 ( $r_{2,t}$ ), public debt, and current expenditures. As a result of the shocks, current expenditures increase by 30 percent. Since they are primarily debt financed, public debt increases. As debt exceeds the 50 percent threshold, the switch turns from 0 to 1. Rule 50 then prescribes a faster reduction of expenditures than the baseline fiscal rule of the AFSM. With this, debt levels off in 2022 and begins to return back to its target. Rule 50 is then rolled back as the debt goes down the 50 percent threshold, and the fiscal rule switch goes back to 0.

The right three panels illustrate the fiscal speed limits monitor for Rules 40, 50 and 60. The Rule 50 monitor (middle right panel) calls for a fiscal intervention because current expenditures grow faster than the nominal GDP. Since debt is still below the 50 percent threshold, expenditures still follow the baseline rule. Once the debt exceeds the critical threshold, the fiscal intervention of Rule 50 is activated, and the monitor indicates that current expenditures satisfy the rule's requirements. Later in 2024, the monitor again red flags that current expenditures grow faster than nominal GDP. There is no need for fiscal intervention in this case, as debt is on a

descending path. For illustration purposes, Rule 40 is not activated, and the monitor correctly flags its violation in red (top right panel). But as Rule 50 becomes binding in late 2021, it also helps align capital expenditures prescribed by Rule 40. Rule 60, on the other hand, is always satisfied and no intervention is needed. This highlights non-trivial overlaps of the three rules suggesting that the satellite extension to the AFSM provides a good environment for the policymakers to study the complexities of the fiscal rules.

## **6 Policy Scenario Applications**

This section showcases two applications of the AFSM to demonstrate its flexibility as a policy scenario analysis tool. The applications illustrate how the AFSM can be used to quantify the macroeconomic effects of fundamental shocks and policies and, in this manner, help formulate a forward-looking fiscal strategy.

### **6.1 An Assessment of the First Wave of the Covid-19 Pandemic**

The Armenian economy was hit hard by the Covid-19 pandemic. In March 2020, tackling the health risks became the Government's top priority. The MOF estimated that the GDP could contract by 3.7 percent in 2020, due only to lockdowns and other public-health-related measures.<sup>25</sup> After a long month of lockdown, in April 2020, a substantial disruption of both the demand and supply sides of the economy materialized. The service sector, which is about one half of the economy, suffered the most due to the constraints on international travel, social events, and physical distancing in general. Construction was the second most affected sector. This translated into major job losses.

The Macroeconomic Policy Department of the MOF was asked to use the AFSM to assess possible scenarios associated with the pandemic. The AFSM-based analysis was expected to provide a quantification of the macroeconomic effects of the pandemic as well as the mitigating effects of policy responses, including the potential policy trade-offs. In this section, we provide a description of this assessment that took place during the period April-October of 2020. We present this description as it was done in that period before knowing the actual macroeconomic and fiscal outcomes for 2020.<sup>26</sup>

We classify the shocks associated with the pandemic into foreign and domestic shocks. The domestic shocks mainly originate from the health situation in the country, lockdowns, and economic uncertainties that affect consumption and investment. The foreign shocks are mainly related to the collapse in foreign demand, a decline in remittances, and an increase in country-risk premia.

---

<sup>25</sup> These estimates were obtained by separating the marginal impacts of domestic shocks (such as of lockdowns and other restrictions), based on the actual sectoral developments of the economy between January and June of 2020.

<sup>26</sup> Note that we use present tense.

The size and duration of all these shocks are calibrated using different sources. For foreign shocks, we use the IMF forecasts of October 2020; while for domestic shocks, we use information and forecasts about the domestic economy from the MOF. Based on this information, we calibrate the shocks in the AFSM as follows:

- The pandemic is expected to worsen in the second quarter of 2020, and the recovery starts in the third quarter.
- A sharp decline in trading partners output immediately reduces the demand for Armenian exports (tourism, transportation, and manufacturing). In 2020, this demand is expected to contract on average by 7.4 percent, with the largest decline in the second quarter and the recovery starting in the third quarter.<sup>27</sup> In 2021, the average growth of export demand is assumed at 2.2 percent, with countries closing the output gap only at the end of the year. The estimated contraction includes the impact of restrictions on tourism, air transportation, border closure, etc. In the AFSM simulations, we introduce this judgement through a sequence of foreign demand shocks by reducing foreign output.<sup>28</sup>
- Remittances are expected to decline by 9.5 percent, in 2020—mainly because of the contraction in Russia—and slowly recover by 4.1 percent in 2021. We use the shock to remittances to calibrate their annual growth rates.<sup>29</sup>
- The country-risk premium shock is calibrated to match increases in the interest rate spread for Eurobonds (relative to U.S. government bonds) of 0.8 and 0.4 percentage points in 2020 and 2021, respectively, and dissipate afterwards.
- Since consumption is expected to be negatively impacted by the pandemic, we impose a shock to the marginal propensity to consume. This captures the effects of lockdowns, increased economic uncertainty, and precautionary savings motives. Absent other shocks, consumption is expected to decrease by 7.8 percent, in 2020, and increase by 2.2 percent, in 2021.
- To reflect the pandemic negative effect on investment, we use sector-specific shocks to the real returns on capital, capturing the protracted uncertainty that reduces firms' willingness to investment. The shocks profile is calibrated to obtain, absent other shocks, an average contraction of total investment of 21.7 percent in 2020, and an increase of 2.2 percent, in 2021. After that, investment growth is assumed to return gradually to its trend level by 2023.

Using these calibrated shocks, the AFSM is simulated to quantify their macroeconomic effects. The simulations are summarized in Figures 8-12 and Table 4. The results underscore the severe impact that the pandemic can have on the Armenian economy. GDP decreases by 12.9 percent in

---

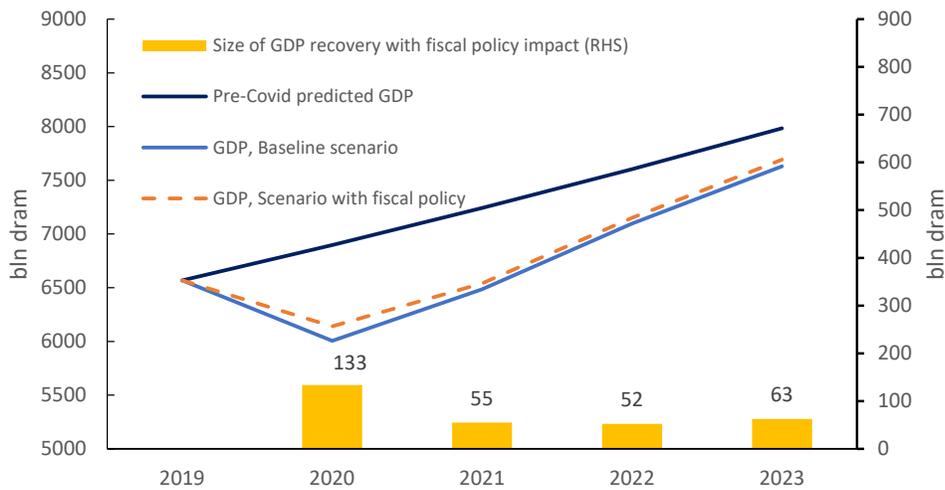
<sup>27</sup> The foreign demand is calculated using export-weighted average growth rates of the Russian Federation, Euro Area, China, and the U.S.

<sup>28</sup> The analysis assumes that other foreign variables, such as inflation and interest rate, do not vary. Of course, relaxing this assumption can be easily accommodated in the analysis. Future work will impose more structure in the determination of the dynamics of variables for the foreign sector.

<sup>29</sup> The shock is calibrated using econometric estimates of elasticities and the IMF's WEO forecast for the GDP growth rates of Russia, while accounting for the travel restrictions of 2020.

2020, and slowly recovers in the horizon period (Figures 8 and 9). Consumption also declines by 11.7 percent, while investment and exports are hit the hardest, falling by more than 20 percent (Figure 11 and Table 4). The estimated direct and cumulative macroeconomic GDP losses can get as high as 38 percent of GDP over the period 2020-2023, relative to the pre-crisis level. Inflation will be 2.5 percentage points below its target in 2020 and returns to it in the medium-term. In response to lower inflation, the CBA reduces the policy interest rate by 2.1 percentage points which, in tandem with the external shocks, induces a nominal depreciation of about 4 percent in 2020. However, in the medium-term the exchange rate appreciates.

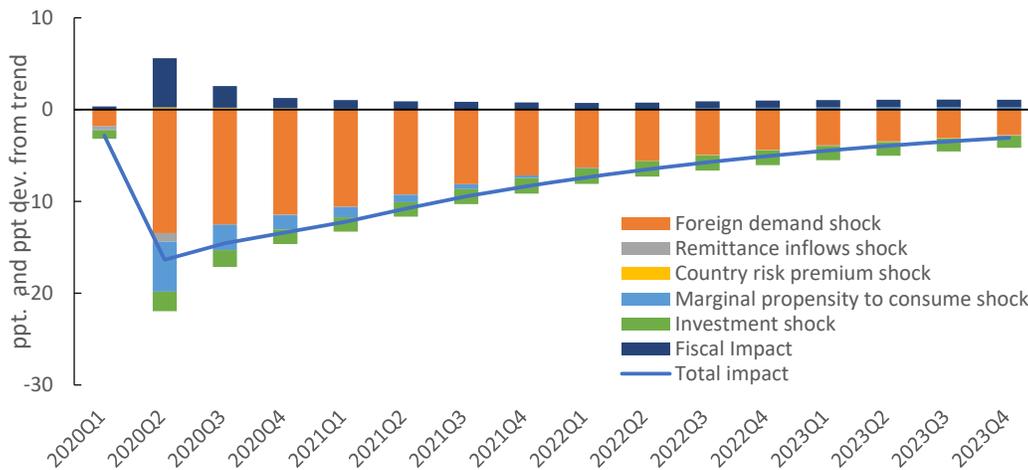
**Figure 8. Gains in Real GDP due to Fiscal Policy**



**Source:** Authors' calculations.

**Note:** Pre-covid predicted GDP was calculated by increasing the nominal GDP in 2019 with 5% balanced growth. The size of GDP recovery with fiscal policy is the difference of GDP levels between the baseline and the fiscal policy scenarios.

**Figure 9. Real GDP Shock Decomposition**



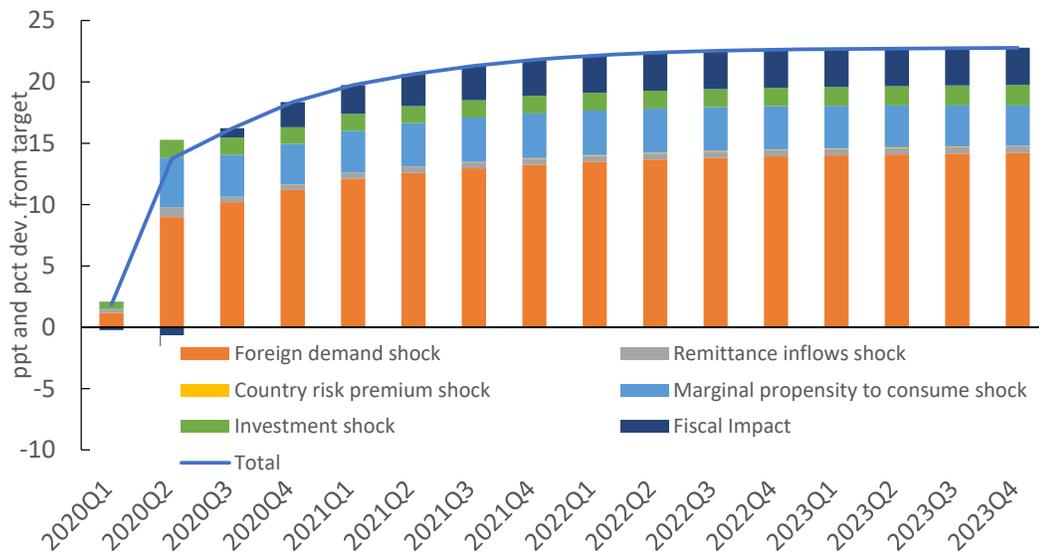
**Source:** Authors' calculations.

**Note:** The simulation represents both the baseline and fiscal policy scenarios.

The financial position of the government dramatically deteriorates with the pandemic. The AFSM results for the fiscal sector are summarized in Figures 10 and 12. Because of the reducing tax base (consumption, wages, profits), the tax revenues drop significantly. As a result, the tax to GDP ratio is projected to decrease by 3.7 and 2.7 percent below the long run levels, in 2020 and 2021, respectively, and remain at 1 percent below its steady-state value, over the medium term. This causes a widening of the primary deficit by 6.5 and 4.7 percentage points of GDP, in 2020 and 2021, respectively (Figure 12). To finance the increased deficit, the government requires additional financing through more borrowing. And this, together with lower GDP and the exchange rate depreciation, pushes public debt-to-GDP ratios up (Figure 10). The AFSM simulations reveal that, by the end of 2023, the public debt-to-GDP ratio can increase by about 19 percentage points and stay at a higher level, in the medium term, absent any fiscal consolidation.

A shock decomposition reveals that two thirds of the macro-fiscal effects are due to the external shocks alone. We use the AFSM to isolate the quantitative impacts of individual shocks. Figures 9 and 10 show the results for GDP and public debt, respectively. As can be observed, the shock landscape is dominated particularly by the foreign demand shock (as well as by the country-risk premium and remittances shocks). In the third quarter of 2020, GDP is expected to fall by almost 15 percent below its long-term potential level, and just the collapse in the foreign demand explains more than 75 percent of that fall. A similar pattern is observed for the public debt-to-GDP ratio. By the end of 2023, more than 75 percent of the almost 20 percentage points increase in this ratio is explained by external shocks, including the foreign demand shock.

**Figure 10. Public Debt Shock Decomposition**

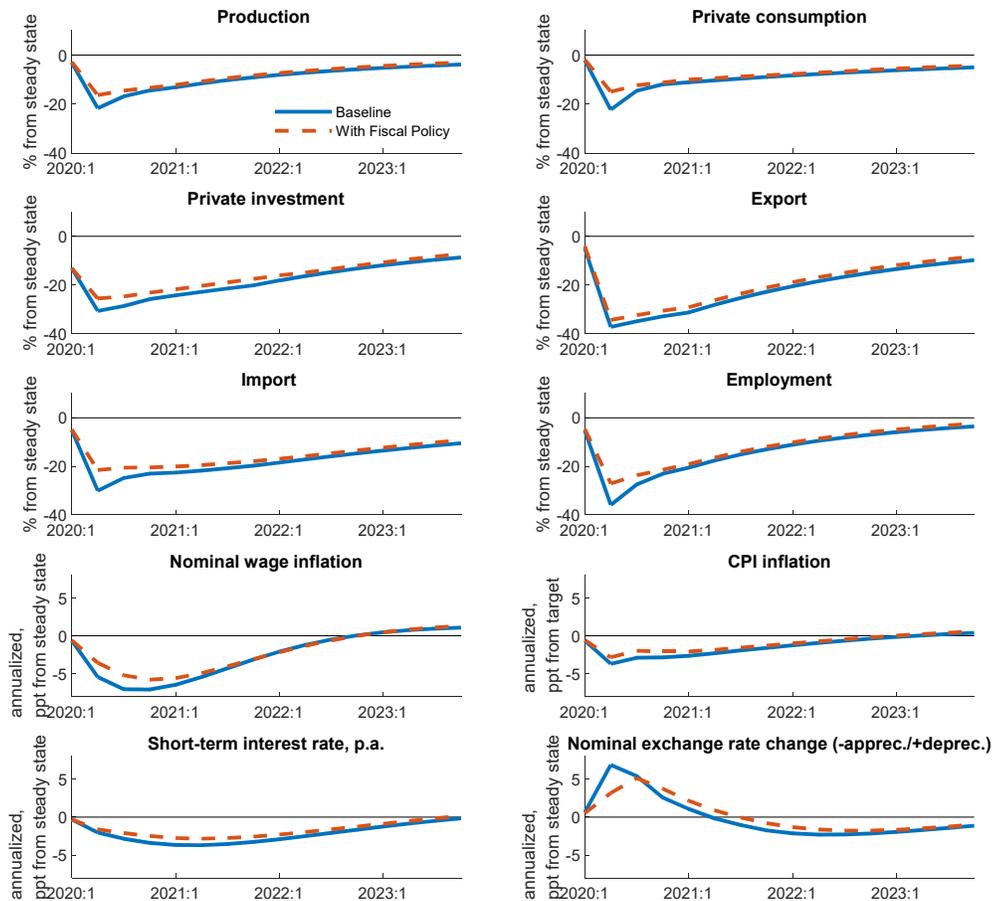


**Source:** Authors' calculations.

**Note:** The simulation represents both the baseline and fiscal policy scenarios.

The benefit of a structural model, such as the AFSM, is that we can use it to understand the transmission mechanisms of the calibrated shocks associated with the pandemic. Using the impulse responses in Figures 11 and 12, one can provide a consistent economic story, based on the AFSM structure. The task may be challenging sometimes, since these impulse responses show *net* effects of shocks that may be pulling variables in opposite directions. But the quantification of net effects is precisely one of the advantages of DSGE models. We illustrate this point next, by highlighting some key points of the transmission mechanism of all the pandemic related shocks.

**Figure 11. The Impact of the Covid-19 Pandemic on the Macroeconomy**



**Source:** Authors' calculations.

First, and to recap, note that the simulations of the “first wave” of the pandemic reveal that the associated shocks can cause, in fact, a severe contraction of the economy and a deterioration of the fiscal outlook. More specifically these shocks significantly reduce output, private consumption and investment, exports, imports, and employment (Figure 11). In addition, they cause declines in wage- and price- inflation as well as nominal interest rates, while inducing a nominal (and real) exchange rate depreciation. Absent any policy measure, the shocks lead to a reduction of tax revenues and, therefore, a widening of the primary deficit —and an increase of public debt (Figure 12). Note that government and capital expenditures are kept constant in this scenario, but they increase as a share of GDP because of output contraction.

Second, note that the shocks considered in this scenario affect both demand and supply sides of the economy, leading to a contraction of economic activity. The declines in foreign demand, consumption (via the marginal propensity to consume) and investment (via the real returns on capital) affect directly and negatively exports, consumption and investment. Even the decline in remittances induce liquidity-constrained consumers to cut back consumption expenditures. In contrast, the increase in the country-risk premium can lead to an export expansion via an exchange rate depreciation.<sup>30</sup>

Third, we focus on the main transmission mechanisms of the pandemic related shocks, using the structure of the AFISM. A sharp decline in export demand, private consumption (in part because of the fall of remittances) and private investment negatively affects economic activity in both sectors. Facing a lower demand for their output, firms cut back output and at the same time prices—inflation then falls below its target. Producers also demand less labor, capital, and imported inputs, which helps induce a decline in all these factors of production—this is reinforced by the negative shock on investment. In fact, in equilibrium employment, capital, and imported inputs contract. Moreover, wage inflation falls, due to a drop in reservation wages, which in turn is mostly driven by the decline in consumption.

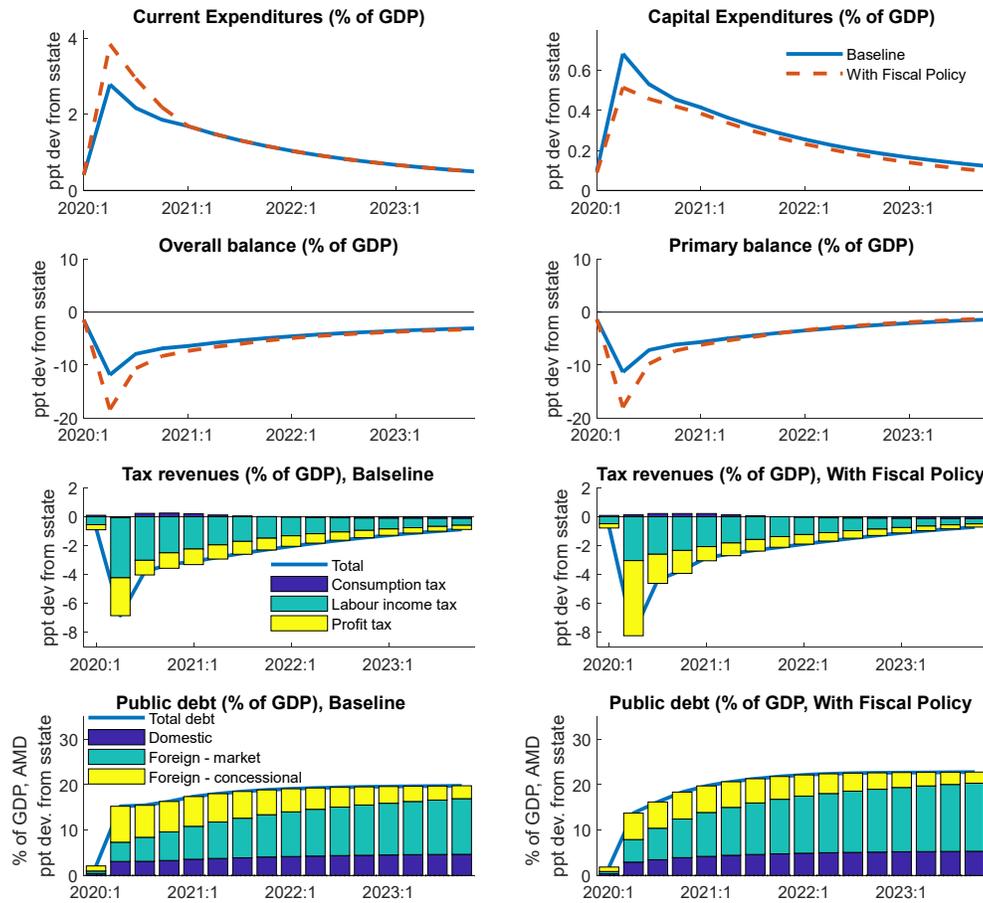
The outlook of slowing economic activity and consumer prices gives the CBA room to provide monetary accommodation through lower interest rates. With a relatively open capital account, this policy leads to capital outflows and a nominal (and real) depreciation of the exchange rate. The net effect of lower nominal interest rates and reduced inflation is an initial increase in real rates. Savers then reduce their consumption, but less than the liquidity-constrained peers, since they can use their assets to smooth consumption. In the end, the drop in aggregate demand for consumption goods negatively impacts the non-traded sector production.

The fall in consumption, labor, taxes, and imports reduces the tax base, which translates into a fall of fiscal revenues. Since government current and capital expenditures are kept constant, a fall in revenue widens the primary deficit. And absent any policy measure, this higher primary deficit induces, overtime, an increase in public debt.

---

<sup>30</sup> Other supply shocks can be incorporated, such as those affecting labor productivity in production.

**Figure 12. The Impact of the Covid-19 Pandemic on Fiscal Stance and Public Debt**



**Source:** Authors' calculations.

Note that the resulting nominal exchange rate depreciation has important consequences. It cushions the decline of output in the traded sector and provides support to liquidity-constrained households, as they receive remittances in foreign currency. However, other factors—the declines in export demand and labor income—seem to dominate, so in the end there is a contraction of the traded sector and a fall in liquidity-constrained households' consumption. In the case of imports, all the factors seem to point in the same direction. That is, imports decline because they are affected negatively by both the depreciation and lower consumption and investment. Note also, that even if import prices increase due to depreciation, CPI inflation is still below the target in the face of weak demand and low pass-through. Last, the resulting

depreciation exacerbates the public debt burden, since an important part of this debt is in foreign currency.<sup>31</sup>

The monetary policy response and fiscal rule help stabilize the economy after the shocks, although it takes a prolonged time. In the medium-term lower real interest rates stimulate consumption of savers and investment. Economic activity then increases, leading to higher employment, disposable income, and further stimulating the aggregate demand. On the other hand, the primary deficit fiscal rule helps to stabilize debt in the medium term—even if debt reaches a much higher level—, avoiding debt explosive dynamics

### ***Fiscal Policy Responses***

The Government’s fiscal response to the Covid-19 pandemic was a combination of tax and expenditure measures. In March 2020, the Government announced a socio-economic support package of AMD 150 billion (2.5 percent of GDP), to be implemented in the second quarter. In addition, it initiated a corporate income tax moratorium to mitigate the tight cashflow and liquidity pressures that taxpayers faced due to the lockdowns.

We used the AFSM to quantitatively assess the mitigating effects of the fiscal package, matching the policy actions with the available policy instruments in the model. In the process, we also used our judgement to ensure that the simulations captured the general gist of the fiscal package.

We present the description of the analysis as it was done during April-October 2020, before knowing the actual macroeconomic and fiscal outcomes. The socio-economic programs and their AFSM representations (including their calibration) are the following:

- **Economic support program of AMD 33.5 billion (0.5 percent of GDP).**<sup>32</sup> It aims at supporting businesses (particularly SMEs). It includes helping with loan servicing, providing co-lending together with commercial banks, or providing direct subsidies and grants to help manage the cashflow challenges caused by the lockdowns. The pre-allocated amount is AMD 23.5 billion, with AMD 10 billion as reserves. This program is modeled through a government current spending shock,  $\varepsilon_t^{pd}$ , which is calibrated to take the values of 0.26 percent of (quarterly) GDP in the second quarter, 0.19 percent in the third quarter, and 0.08 percent in the fourth quarter of 2020.
- **Social support and wage subsidy program of AMD 36.5 billion (0.6 percent of GDP).** It aims at helping the vulnerable population. It includes lump-sum transfers to families with or

---

<sup>31</sup> An ex-post analysis of comparing these AFSM outcomes with actual Armenia data revealed that some shocks and transmission mechanisms may have been over- and/or under-stated. For instance, inflation in 2021 went up and not down as suggested by the model simulations, pointing to the presence of other specific shocks not accounted by the model-based analysis or even to challenges of capturing the different pace of adjustment of the supply and demand sides of the economy during the pandemic.

<sup>32</sup> Shares here and for the other programs are expressed in percent of *annual* GDP.

expecting children, people who needs assistance with utility bills, and individuals who are unemployed or part-time employed as a result of the pandemic. The program is modeled as a transfer to liquidity-constrained households. Specifically, the transfers shocks,  $\varepsilon_t^{tl}$ , is calibrated to take the values of 0.5 percent of GDP in the second quarter, 0.07 percent in the third quarter, and 0.03 percent in the fourth quarter of 2020.

- **Limited corporate income tax payments deferral and corporate tax reform of AMD 65 billion (1.1 percent of GDP)** These measures aim at allowing taxpayers missing tax advance payments in the second quarter of 2020 without any penalty. The tax pre-payments are based on the previous year profits. The measure is intended to further mitigate the tight liquidity and cashflow pressures that taxpayers are facing due to the lockdowns. Instead, the prepayments are calculated based on the actual turnover in the previous quarter. The corporate tax still needs to be paid with the 2020 tax return, but it is paid after the actual 2020 profits are known. The tax payment deferral and the tax reform are modeled through the corporate profit tax. Specifically, the shocks to the corporate profit tax in both the traded and non-traded sectors,  $\varepsilon_t^{\tau^h}$  and  $\varepsilon_t^{\tau^d}$ , are calibrated to take the values of -0.71 percent of GDP in the second quarter, -0.23 percent in the third quarter, and -0.12 percent in the fourth quarter of 2020.
- **Private investment support program of AMD 80 billion (1.3 percent of GDP)** The program aims at promoting long-term private investment by helping co-finance new and innovative private investment projects. The program modalities are modeled through effects on the real return on investments in the traded sector. Specifically, we calibrate the shock to the real return on capital in the traded sector to take the values of 40 percent of program amount in the third quarter (0.51 percent of GDP), and the rest in the fourth quarter (0.77 percent of GDP).

The AFSM simulations show that the macroeconomic benefits of the fiscal package outweigh its immediate fiscal costs, and the Armenian economy can perform better. The total budgeted costs of AMD 215 billion help cushion about AMD 303 billion (4.6 percent of GDP) in contracting economy. Just in 2020, the model estimates that the program can help cushion 1.9 percentage points of GDP (Figure 8), and 3.7 percentage points of employment (Figure 11). In our calculations, the latter is equivalent to protecting 35,460 jobs that may be lost otherwise.

One can ask whether the size of the fiscal package is sufficiently large, given the expected economic contraction and the sight of unemployment. Under exceptionally high uncertainty, the MOF is trying to act prudently. It considers the possibility of increasing the rescue package, but an additional fiscal expansion is currently judged as a very risky strategy from a fiscal sustainability perspective.<sup>33</sup> The actual policy programs' cost is already expected to stretch the fiscal situation. The AFSM simulations project that the primary balance can deteriorate by 2.6 percentage points of GDP, relative to the baseline scenario, from -9.5 to -12.1 percent, because

---

<sup>33</sup> The fiscal space is depleted, with weak prospects for improvements. And a larger rescue package makes its financing unfeasible given the already expected large increase in public debt.

of the increasing public spending and declining tax revenues. And public debt as a share of GDP is projected to increase by 3 percentage points relative to the baseline (Figure 12) and then stabilize in the medium term. With a larger fiscal package, AFSM simulations reveal that public debt can increase to unsustainable levels, given the weak economic outlook, increasing the debt service burden.

The model predictions are in line with the fiscal developments in Armenia. The Government activated the escape clause of the fiscal rule and, because of the pandemic and the related mitigating policies, public debt surpassed the threshold of 60 percent of GDP. The escape clause was also in place in 2021. But in 2022, the Government announced its commitment to adhere to the fiscal rules and the implementation of a 5-year fiscal consolidation program.

Table 4 summarizes the quantitative impact of the policy package on GDP and demand components. Clearly, the rescue package can help cushion the economic downturn, and the economy can perform better relative to scenario with no policy action. The cushion in GDP for 2020 is estimated to be 1.9 percentage points. Moreover, by targeting the stabilization of disposable income, firms' cashflow and liquidity, the package can benefit consumption and investment the most. It can offset about 2.2 and 2.3 percentage points, respectively, of their expected contraction in 2020. The social measures targeted to help the most vulnerable population are estimated to mitigate the expected decline of consumption of low-income households by about 5.8 percentage points. Exports and imports can also benefit from the package by falling 1.6 and 3.1 percentage points less, in 2020, relative to the scenario of no fiscal package.

**Table 4. The Net Impact of the Fiscal Package on GDP and Components**

	GDP		Consumption		Investment		Exports		Imports	
	Baseline	Fiscal Policy	Baseline	Fiscal Policy	Baseline	Fiscal Policy	Baseline	Fiscal Policy	Baseline	Fiscal Policy
2020	-12.9	-11.0	-11.7	-9.5	-21.7	-19.4	-23.4	-21.8	-18.4	-15.3
2021	-10.4	-9.7	-9.5	-8.8	-19.9	-17.9	-23.6	-22.2	-19.1	-17.3
2022	-6.7	-6.0	-7.2	-6.7	-14.5	-13.2	-16.2	-14.8	-15.2	-14.1
2023	-4.4	-3.7	-5.5	-4.8	-9.8	-8.6	-11.0	-9.6	-11.3	-10.2

**Source:** Authors' estimates and calculations.

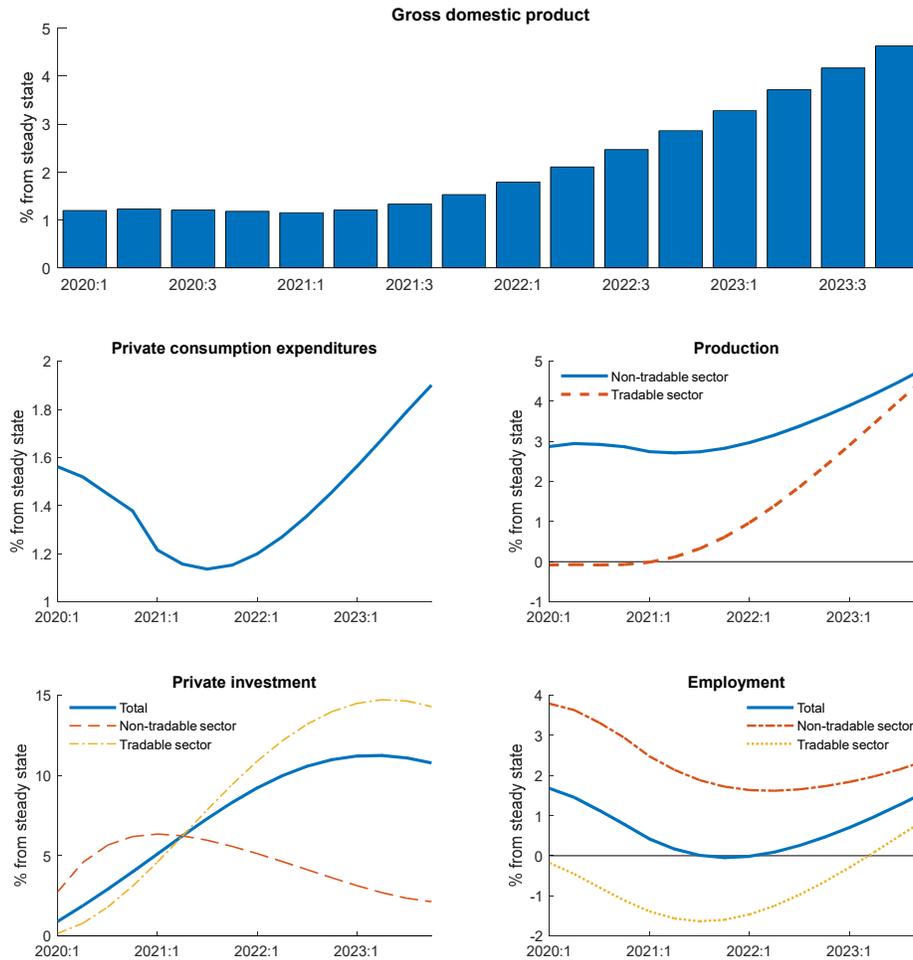
**Note:** All values are percentage deviations from the long-term trend (steady state).

The different fiscal package components are supposed to work through different mechanisms. Most of them are embedded in the AFSM and fiscal policy scenario and help explain the differences between scenarios in Figures 11 and 12, as we explain next.

**Economic support program.** The increase in current government spending is targeted at stabilizing the economy. Since government spending has both domestic and imported components, there are positive effects on both production and imports. The improved production

positively affects the demand for labor, helping to mitigate the decline employment due to the pandemic.

**Figure 13. Baseline Scenario: Macroeconomic Outcomes**



**Source:** Authors' calculations.

**Social support program.** The increase of government transfers is projected to positively contribute to the aggregate demand by directly increasing households' income. The government mainly targets vulnerable households—e.g., liquidity-constrained consumers—to aim at stimulating consumption via increased disposable income. The increase in consumption is expected to mitigate the negative impact of domestic and external shocks on production.

**Corporate tax reform.** The decline of the effective corporate income tax is primarily expected to affect firms, creating incentives to invest and increase employment. More investment can help

dampen the effects of other shocks by stimulating demand in the short term and increasing production (via accumulation of more capital) in the medium term.

**Private investment program.** This program is expected to positively affect productive capital formation, and therefore production, in the medium term. As the main incentives for investment are in the traded sector, the program can offset the export contraction, and help mitigate the negative pressures on the trade balance created by the economic and social support programs—these programs are expected to increase imports.

In all these programs, there is a presumption that, relative to the case of no policy package, an increase in demand can prompt firms to produce more and demand more labor. This can translate at some point into more employment. In addition, a smaller decline in marginal costs of production can induce a smaller drop in CPI inflation. In response to this, the CBA will call for a timid reduction in the policy rate and, therefore, induce a smaller exchange rate depreciation. Again, all these mechanisms and outcomes are captured by the AFSM simulations in Figure 11.

## 6.2 Comparing Alternative Policies in the Context of Public Investment Under-Execution

After the 2018 Velvet revolution, fiscal efforts concentrated on increasing the effectiveness of budget expenditures. During this process, a full-scale review revealed inefficiencies specifically in public infrastructure programs. Inefficiencies were identified in all stages, from a project selection to implementation. This forced the government to take drastic actions—e.g., change managers and contractors, and prosecute them in some cases. As a result, in both 2018 and 2019, capital expenditures were under-executed by 30 percent. This situation raised uncertainty about the implementation speed of investment projects in the medium term and questions about what the government should do with the associated “savings.”

In 2019, we used the AFSM to investigate alternative policies assuming public investment under-execution would continue in the medium term. The analysis aimed at quantifying the costs and benefits for the economy of several fiscal measures, including their trade-offs. To achieve this, we designed a baseline scenario replicating the main policy dimensions of the 2020-2022 Medium-Term Expenditure Framework (MTEF). Then we used the AFSM to assess the following three policy alternatives: (i) reallocating the saved budget funds to debt repayments, (ii) reallocating these funds to social spending, and (iii) increasing the efficiency of public investment. In what follows, we present the description of this assessment as it was done in the fall of 2019.<sup>34</sup>

### *Baseline Scenario*

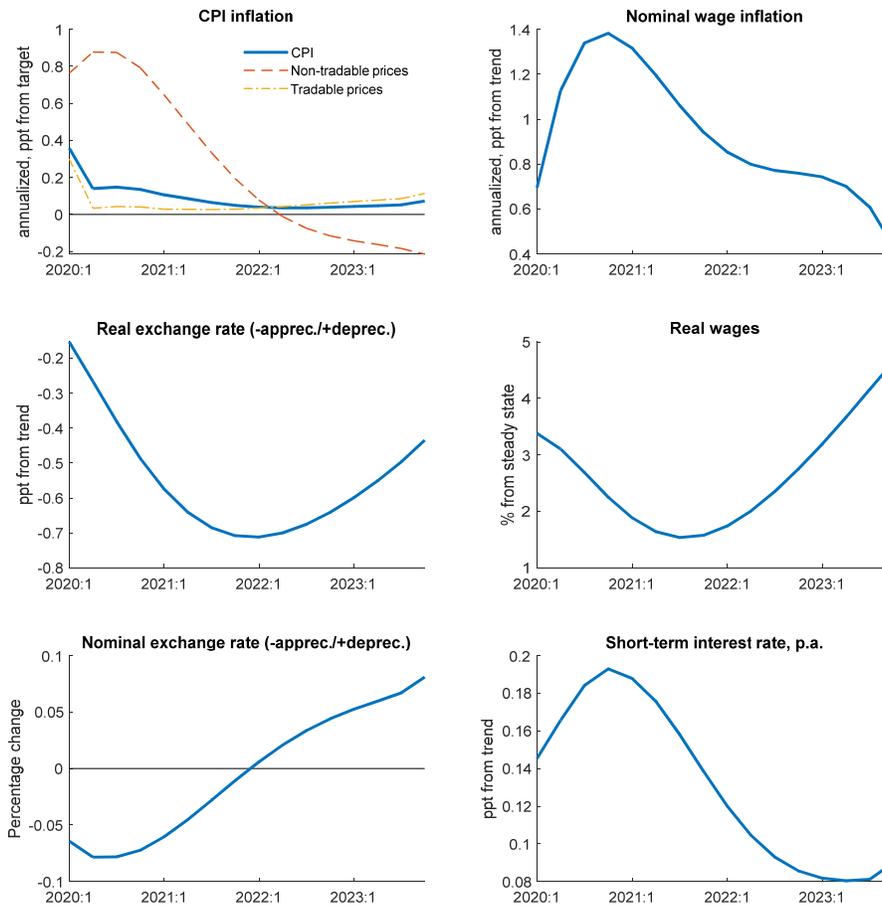
This scenario simulates the effects of fiscal policy as proposed in MTEF. The simulation horizon is the period 2020-2023, and the scenario includes the following measures: i) a permanent

---

<sup>34</sup> Note that we use present tense.

increase of public investment by 1.9 percentage points of GDP in the first year, and then by 0.3 percentage points annually for the following years; (ii) a permanent decrease of current expenditures by 0.2 percentage points of GDP for the entire period; and (iii) an increase of tax revenues (by raising tax rates) equivalent to 0.3 percent of GDP, starting from 2021. It is also assumed that the expenditure increase is financed through debt accumulation in the first year, and through additional tax revenues for the rest of the simulation period.

**Figure 14. Baseline Scenario: Prices, Interest and Exchange Rates**



**Source:** Authors' calculations.

To calibrate the shocks of this scenario, we apply the following strategy. First, we use the public investment shocks, so the public investment to GDP shares match the following path of increases: 1.9 percentage points in 2020, 2.2 percentage points in 2021, 2.5 percentage points in 2022, and 2.8 percentage points in 2023. Second, we use shocks to the primary deficit, to calibrate the reduction of the share of current expenditures as an annual decline of 0.2 percentage points of GDP, for the entire simulation period. Third, the changes in the tax rates are

modeled by imposing judgement on the tax rate shocks, such that they generate an increase in total tax revenues equivalent to 0.3 percent of GDP, starting from 2021. Last, the debt-to-GDP ratio is assumed to increase by 0.2 percentage points in 2020, and stay constant at its initial value, for the rest of the period. Any fiscal discrepancies are balanced by endogenously adjusting the lump-sum taxes on savers.

The AFSM simulations show that the baseline policy scenario of the MTEF improves the economic outlook.<sup>35</sup> These MTEF policies induce an expansion of GDP, and crowd in private investment and consumption (Figure 13). Specifically, the permanent increase in public capital expenditures raises the productivity of labor and private capital, which stimulates investment and employment. Consumption also increases, because the liquidity-constrained consumers raise their consumption expenditures, as a result of the positive effect of the MTEF policies on their disposable income. On the other hand, a higher aggregate demand pushes wages and consumer prices up (Figure 14). In response to these inflationary pressures, the CB responds by increasing interest rates. The higher interest rates attract capital inflows, inducing a nominal exchange rate appreciation, which together with the inflation outcome causes a real appreciation. Although the economic stimulus is debt-financed, primary deficits are modest, and public debt is estimated to accumulate by about 1 percentage point of GDP.

#### ***Alternative Policy Scenario 1: Debt Repayment***

This scenario quantifies the macroeconomic effects of re-allocating the saved funds to foreign debt repayments. The scenario imposes different trajectories of debt and public investment on top of the baseline. Capital expenditure under-execution is modeled by adjusting the calibration of the shocks to public investment to match the under-executed levels. That is, the public investment level in the alternative scenario is lower than in the baseline scenario, and the size of this difference matches the under-executed amount.<sup>36</sup> Then the foreign public debt of the baseline is reduced by the size of under-executed funds (“savings”).

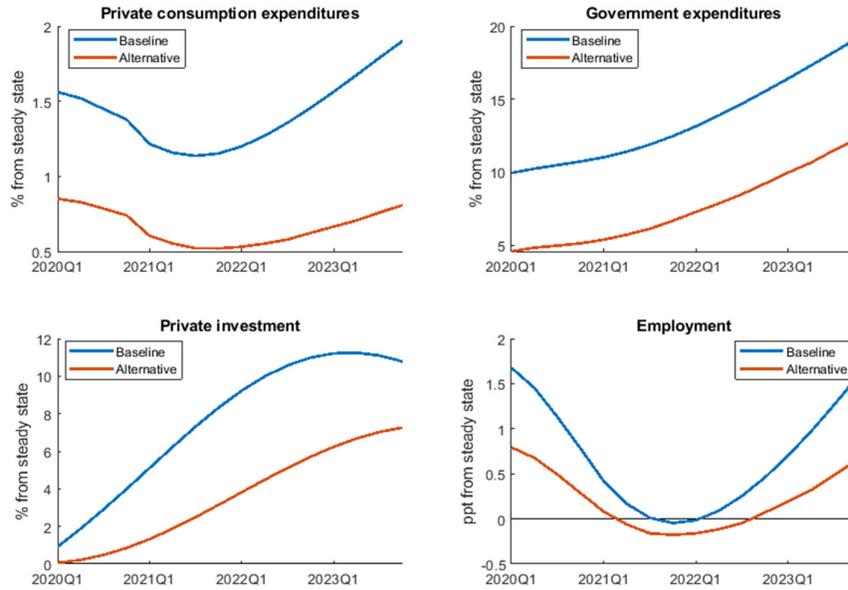
In contrast to the baseline scenario, the under-execution of capital expenditures combined with debt repayments yields worse economic outcomes (Figure 15). As expected, the economy’s productive capacity is lower than in the baseline, which leads to lower output, weaker demand, and less employment. The crowding in effects on consumption and investment are also smaller. The main tangible benefit is on the fiscal side since, by construction, public debt is put on a deleveraging path (Figure 16) and fiscal space is created in the medium-term. Note that debt repayments may have positive effects in terms of lowering the country risk premium and increasing fiscal credibility. However, those effects may not fully offset the negative effects from the decline in productive capacity.

---

<sup>35</sup> Although the figures for the baseline and alternative scenarios seem to suggest unstable dynamics—i.e., variables do not appear to converge to steady state values—, this is just a consequence of the selected short time horizon to match the MTEF. The convergence of the simulated macro variables to the steady state is guaranteed and would become visible if we had chosen longer time horizons for the figures.

<sup>36</sup> There is no under-execution at the steady state.

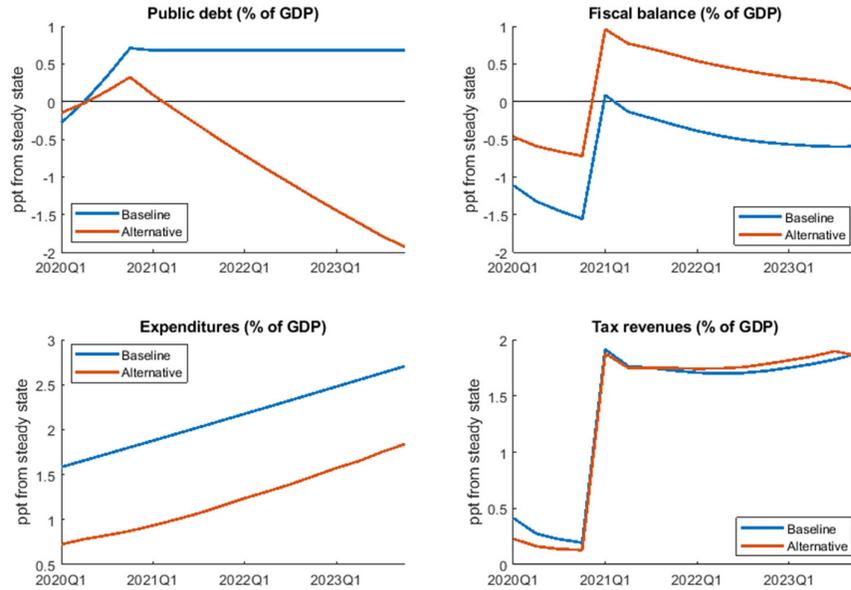
**Figure 15. Debt Repayment (Alternative): Macroeconomic Outcomes**



**Source:** Authors' calculations.

**Notes:** The baseline corresponds to permanently higher capital expenditures, lower current expenditures, and higher taxes. The alternative assumes the same shocks as in baseline, with lower level of capital expenditures (under-execution), and a negative shock to the debt-to-GDP ratio.

**Figure 16. Debt Repayment (Alternative): Fiscal Outcomes**



**Source:** Authors' calculations.

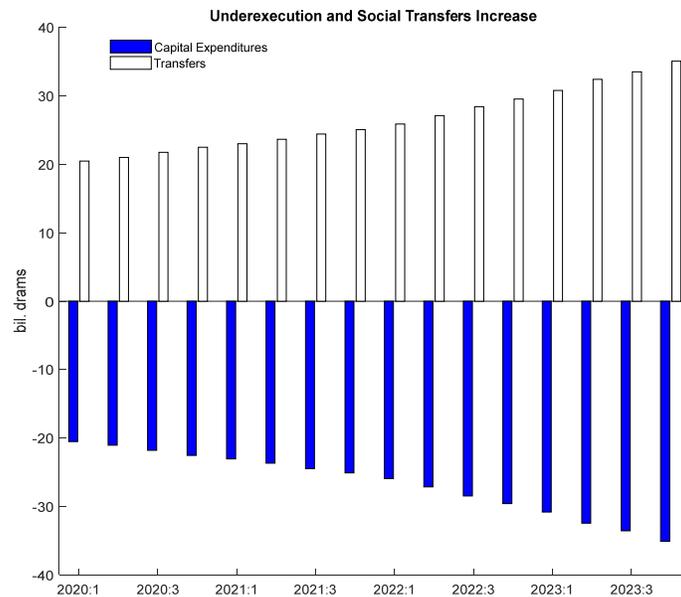
**Notes:** The baseline corresponds to permanently higher capital expenditures, lower current expenditures, and higher taxes. The alternative assumes the same shocks as in baseline, with lower level of capital expenditures (under-execution), and a negative shock to the debt-to-GDP ratio.

### *Alternative Policy Scenario 2: Increasing Social Benefits*

The second option for reallocating the unintended budget surpluses is an increase of pensions and other social benefits. In this alternative scenario, this increase is reflected by a calibrated positive shock to the transfers to the liquidity-constrained households, to match the amount of saved budget funds associated with the under-execution (Figure 17).

Relative to the baseline, the under-execution of capital expenditures and increase of social benefits stimulate consumption but reduce GDP and investment (Figure 18). The social transfers boost private consumption, since the liquidity-constrained households are their direct beneficiaries. Even though the Government achieves its objective of helping the most vulnerable population, as the consumption of low-income households increase more than the consumption of middle- and high-income households, this alternative policy does not expand the economy's productive capacity. If anything, it leads to the crowding out of private investment. As a result, capital and employment increase by less, and output is lower in the medium term, than in the baseline scenario.

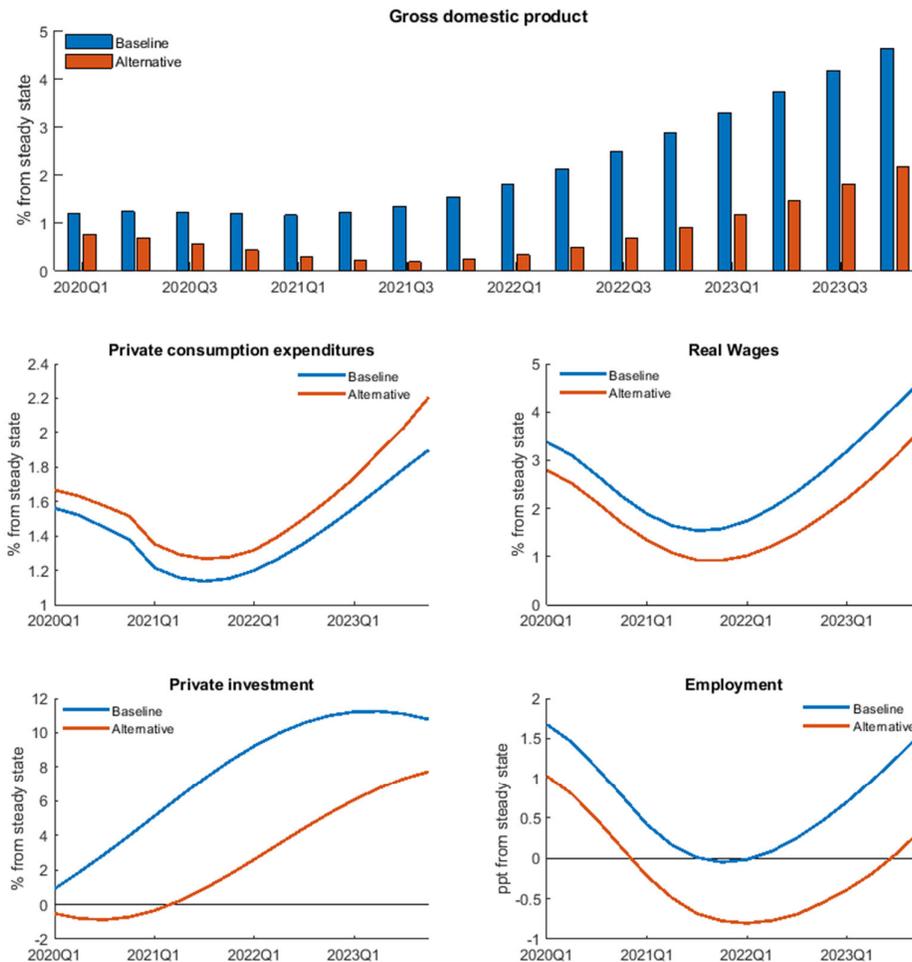
**Figure 17. Increasing Social Benefits (Alternative): A Social Transfer Increase**



**Source:** Authors' calculations.

The fiscal effects of the increase of social benefits are also grimmer than those of the baseline scenario (Figure 19).<sup>37</sup> Raising transfers to liquidity-constrained consumers have a negative impact on the primary fiscal balance, which leads to debt accumulation and higher public debt-to-GDP ratios. This is reinforced by the lower increase in GDP in this alternative scenario. In fact, under this alternative policy the debt-to-GDP ratios breach the threshold of 50 percent.

<sup>37</sup> In the simulation of this scenario, current expenditures are not adjusted in response to debt accumulation.

**Figure 18. Increasing Social Benefits (Alternative): Macroeconomic Outcomes**

**Source:** Authors' calculations.

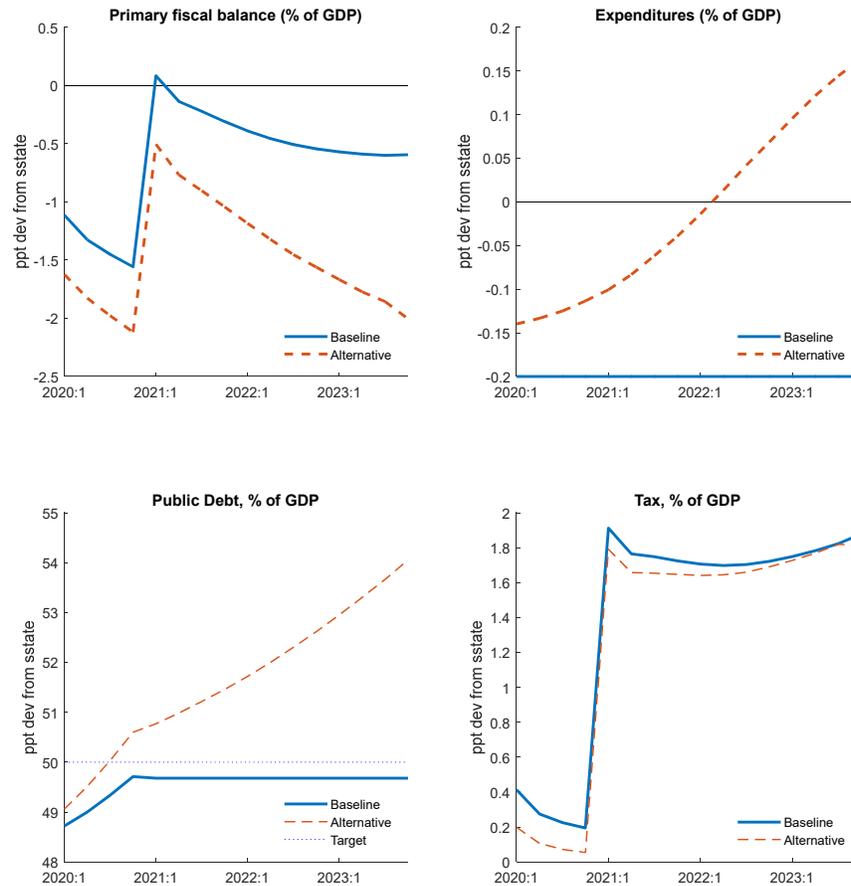
**Notes:** The baseline corresponds to permanently higher capital expenditures, lower current expenditures, and higher taxes. The alternative assumes the same shocks as in baseline, with lower level of capital expenditures (under-execution), and a positive shock to transfers to liquidity constrained households.

### ***Alternative Policy Scenario 3: Increasing Public Investment Efficiency***

The third scenario reflects the government plan of improving the efficiency of public investment. This efficiency is relatively low in Armenia. Out of a Dram of investment, only about 60 percent turns into productive capital. The alternative scenario is then designed to compensate for the negative macroeconomic outcomes of the capital expenditure under-execution by increasing the efficiency of new projects. Thus, the level of public investment is the same as in the previous two scenarios. However, with the same amount of investment, more public capital is accumulated under this policy scenario, relative to the previous two. To capture this, the marginal efficiency of public investment is calibrated to fully offset the expected fall in

public capital associated with the under-execution. That is, with less public investment, the government is still able to achieve the same increases in the economy's productive capacity.

**Figure 19. Increasing Social Benefits (Alternative): Fiscal Outcomes**

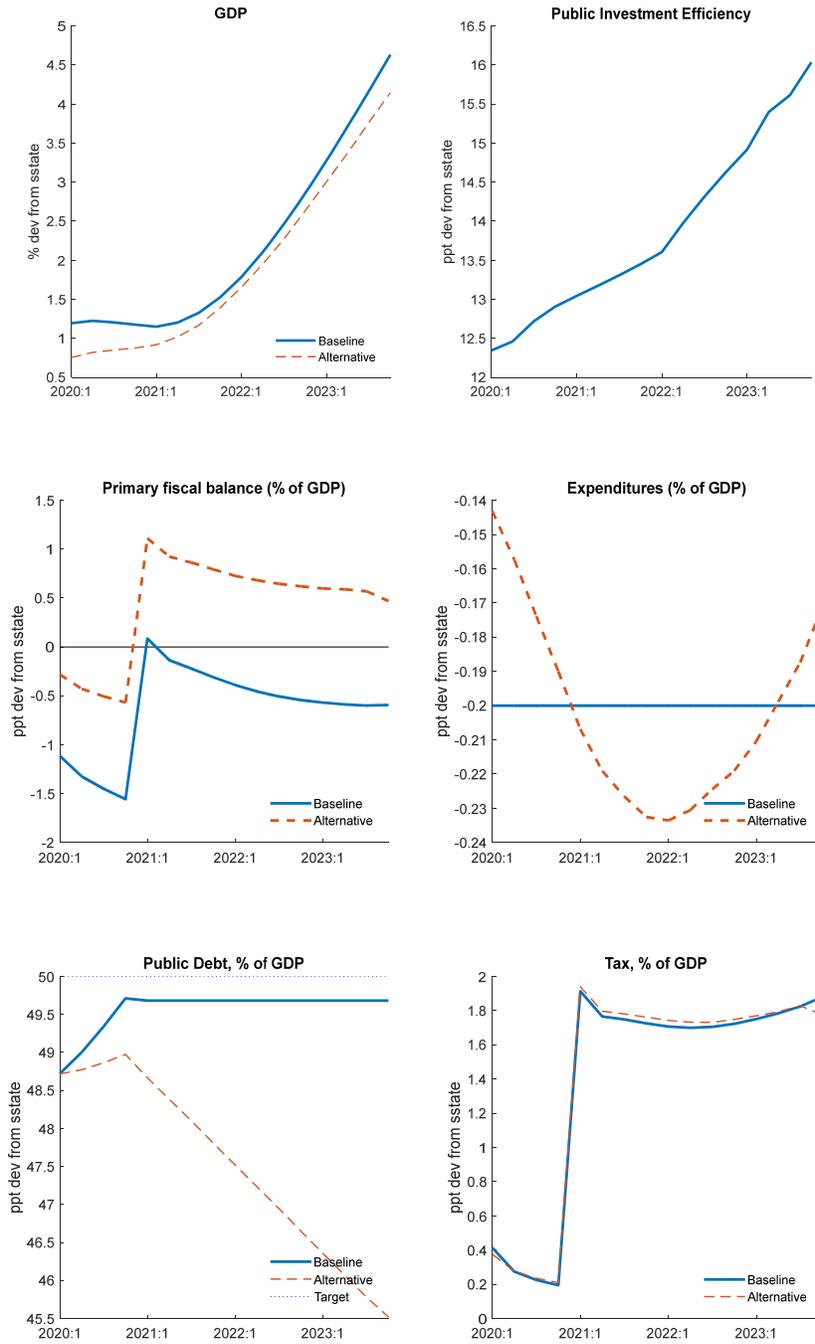


**Source:** Authors' calculations.

**Notes:** The baseline corresponds to permanently higher capital expenditures, lower current expenditures, and higher taxes. The alternative assumes the same shocks as in baseline, with lower level of capital expenditures (under-execution), and a positive shock to transfers to liquidity constrained households.

In comparison with the baseline, increasing the efficiency of public investment delivers similar effects on GDP and improves the fiscal outlook, in the medium term. This is quite surprising given that in the baseline scenario, there is no under-execution. The required increase in efficiency is estimated to be about 16.5 percentage points, over the simulation period (Figure 20). This seems ambitious, given that the implementation and associated effects of structural reforms take time to materialize. However, provided such an increase in efficiency is feasible, it will lead to lower public expenditures and put public debt on a decreasing path over the medium term, relative to the baseline scenario.

**Figure 20. Increasing Public Investment Efficiency (Alternative): GDP and Fiscal Outlook**



**Source:** Authors' calculations.

**Notes:** The baseline corresponds to permanently higher capital expenditures, lower current expenditures, and higher taxes. The alternative assumes the same shocks as in baseline, with lower level of capital expenditures (under-execution), and a positive shock to the efficiency parameter of capital expenditures (public investment).

A comparison across alternative policies reveals that increasing public investment efficiency dominates the other two policies. The scenarios of debt repayment and increasing social spending deliver worse economic outcomes in terms of GDP than increasing public investment efficiency.<sup>38</sup> In addition, the latter can also ensure a declining medium-term debt path. These results underscore the key role and call for structural reforms that can help improve the efficiency of public investment. At the same time, these results raise questions about how quickly these reforms can actually take place to deliver the positive macroeconomic and fiscal effects.

## 7 Final Remarks

The AFSM is one of the outcomes of a multi-year IMF technical assistance (TA) project for the MOF of Armenia. The project focused on institutional capacity development (CD) by helping the MOF develop a fully operational model-based framework, the AFSM, feeding into policy discussions, decisions, and processes. The buy-in from country officials, specifically managers, was crucial for the effectiveness and high institutional CD impact. The TA project involved a “coaching” approach, which was key to ensure ownership by country officials, who were heavily involved in the development and adaptation of the model. This required support and guidance by the IMF team, during missions and in-between missions. This also involved working on the technical and non-technical aspects associated with the model and presentations to managers to the point where MOF staff could work independently and use the AFSM for scenario analysis and inform policy decisions.

This paper describes the structure of the ASFM, which captures key characteristics of the Armenian economy, including the fiscal rules framework. In designing the AFSM, we took a Lego-like approach. We started with the simplest version of the model as possible, and then added gradually more blocks. The version described in this paper represents what we consider the first generation of the AFSM, which allows MOF staff to do policy scenario analysis in a (nearly) holistic way. It can help provide insights and quantify the effects of fiscal policies on the Armenian economy, as well as study their transmission mechanisms and potential policy tradeoffs.

The first generation of the AFSM is backed as much as possible by empirical facts about the Armenian economy.<sup>39</sup> This should be one of the guiding principles in maintaining the model

---

<sup>38</sup> This comparison underestimates, however, the positive impact that some social spending may have on boosting productivity. This assumption may make increasing the efficiency of public investment more attractive, since in the AFSM public capital complements other production factors and increases their productivity.

<sup>39</sup> There are of course other features not captured in the AFSM that overtime could be incorporated into the model if the MOF deems it necessary. These include financial and housing sectors or features related to investment in green technology, climate change, expanding the tax base, improving tax compliance, and increasing social spending. On expanding the tax base and improving tax compliance, it is possible to introduce other frictions to reflect the degree of tax compliance—although note that the tax rates in the model are calibrated as *effective* tax rates. On social spending, one could think of modeling not only the fiscal cost, but also its effect on boosting productivity.

structure parsimonious, while allowing for some extensions. More specifically, any future extension should be justified at least by two criteria: (i) it must be backed as much as possible by statistically significant and persuasive evidence; and (ii) it should be quantitatively important to affect the impact and transmission of fiscal policy. Not necessarily all extensions should make it to the baseline model structure.

This paper illustrates how the AFSM can be used for policy analysis by describing the following two applications: (i) a quantitative assessment of the macroeconomic impact of the “first wave” of the Covid-19 pandemic, as well as the mitigating effects of the fiscal package that the government implemented during this difficult juncture; and (ii) a comparison of alternative policies to reallocate the “savings” associated with a potential public investment under-execution.

Besides these applications, the AFSM has been also used in other macro analyses to inform internal policy discussions, frameworks, and processes at the MOF. These include the following: (i) the analysis of the macroeconomic effects and risks of the debt-financed increase of capital expenditures; (ii) the simulation of the economic and fiscal effects of increasing the minimum wage, (iii) the evaluation of the medium- and long-term macro-fiscal effects of introducing a comprehensive mandatory health insurance system financed by a new health tax on employees; and (iv) the design of the macro-fiscal framework for the 2021-2023 MTEF and the 2021 budget plan. Going forward, MOF staff are working on implementing a logistical plan that delineates the steps to further formalize the use of the AFSM in the regular policy process of the institution.

## References

- Adrian, T., Gaspar, V., and F. Vitek, (2021), “A Medium-Scale DSGE Model for the Integrated Policy Framework,” *IMF Working Paper*, forthcoming.
- Adrian, T., Erceg, C., Lindé, J., and Zabczyk, P. and J. Zhou, (2020), “A Quantitative Model for the Integrated Policy Framework,” *IMF Working Paper*, WP/ 20/122.
- Barro, R. and X. Sala-i-Martin (2004), *Economic Growth*, second edition, MIT Press.
- Barseghyan, G. (2013), “An Estimated Dynamic Stochastic General Equilibrium Model for Armenian Economy”, *EERC Working Paper Series 13/11e*, EERC Research Network, Russia and CIA.
- Blanchard, O. (1985), “Debt, Deficit, and Finite Horizon,” *The Journal of Political Economy*, vol. 93, pp. 223-247.
- Blanchard, O. and R. Perotti (2002), “An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output”, *Quarterly Journal of Economics*, vol. 117, pp. 1329–1368.
- Berg, A., Buffie, E., Pattillo, C., Portillo, R., Presbitero, A., and L.-F. Zanna (2018), “Some Misconceptions about Public Investment Efficiency and Growth,” *Economica*, vol. 86, pp. 409-430.
- Buffie, E., Berg, A., Pattillo, C., Portillo, R., and L.-F. Zanna (2012), “Public Investment, Growth, and Debt Sustainability: Putting Together Pieces,” *IMF Working Paper Series*, WP/12/144.
- Boz, E., Unsal, F., Roch, F. Basu, S., and G. Gopinath (2020), “A Conceptual Model for the Integrated Policy Framework,” *IMF Working Papers*, WP/20/121.
- Christiano, L.J., Eichenbaum, M., and C.L. Trabandt (2018), “On DSGE Models,” *Journal of Economic Perspectives*, vol. 32(3), pages 113–140.
- Christiano, L.J., Eichenbaum, M., and C. L. Evans (2005), “Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy,” *Journal of Political Economy*, vol. 113(1), pages 1–45.
- Dabla-Norris, E, Brumby, J., Kyobe, A., Mills, Z., and C. Papageorgiou (2011), “Investing in Public Investment: An Index of Public Investment Efficiency,” *IMF Working Paper Series*, WP/11/37.
- Erceg, C. J., Guerrieri, L., and C. Gust (2006), “SIGMA: A New Open Economy Model for Policy Analysis,” *International Journal of Central Banking, International Journal of Central Banking*, vol. 2(1), pages 1-50.

- Fukac, M., Babajanyan, V., Harutyunyan, A., Karapetyan, N., Pashinyan, B., Petrosyan, G., Hakobyan, E., and L.-F. Zanna (2021), “Estimates of Fiscal Multipliers for Armenia,” *mimeo*.
- Gali, J. and T. Monacelli, (2005), “Monetary Policy and Exchange Rate Volatility in a Small Open Economy,” *Review of Economic Studies*, vol. 72(3), pages 707-734.
- Gupta, S., Alvar, K., Papageorgiou, C., and W. Abdoul (2014), “Efficiency-Adjusted Public Capital and Growth,” *World Development*, vol. 57, pp. 164–178.
- Hakobyan, E. and N. Karapetyan (2018), “How to Ensure Debt Sustainability and React to Economic Cycles? The Upgrade of Fiscal Rules in Armenia,” in Russian, *Financial Journal*, Financial Research Institute, Moscow, issue 4, pages 10-20.
- Harberger, A. (1962), “The Incidence of the Corporation Income Tax,” *The Journal of Political Economy*, vol. 70, pp. 215-240.
- Igityan, H. (2016), “Migration in the Estimated New Keynesian DSGE Model for Armenia and Russia”, *Central Bank of Armenia Working Paper Series*, no
- Igityan, H. (2018), “Asymmetric effects of monetary policy in different phases of Armenia’s business cycle”, *Central Bank of Armenia Working Paper Series*, no. 19/3/08.
- International Monetary Fund (2021), “Managing Volatile Capital Flows in Asia: Policy Insights from Empirical Evidence and DSGE Models Calibrated to the Region,” Asian and Pacific Department and Institute for Capacity Development, Departmental Paper, Forthcoming.
- International Monetary Fund (2017), “Armenia: Technical Assistance Report-Upgrading Fiscal Rules. Fiscal Affairs Department,” Technical Assistance Report. IMF Country Report No. 17/330.
- Kumhof M., Laxton, D., Muir, D., and S. Mursula (2010), “The Global Integrated Monetary and Fiscal Model (GIMF) – Theoretical Structure,” *IMF Working Papers Series*, WP/10/34.
- Kydland, F. and E. Prescott (1982), “Time to Build and Aggregate Fluctuations,” *Econometrica*, vol. 50, pp. 1345-1370.
- Melina, G. Yang, S.-C., and L.-F. Zanna (2016), “Debt Sustainability, Public Investment, and Natural Resources in Developing Countries: The DIGNAR Model,” *Economic Modelling*, vol. 52(PB), pages 630-649.
- Ramey, V. (2019), “Ten Years After the Financial Crisis: What Have We Learned from the Renaissance in Fiscal Research?,” *Journal of Economic Perspectives*, vol. 33(2), pages 89-114.
- Remo, A., Baksa, Sabuga, I., and L.-F. Zanna (2022), “STAMP: A DSGE Model for Structural Analysis of Macroeconomic Policies,” *mimeo*.
- Rotemberg, J. (1982), “Sticky Prices in the United States,” *Journal of Political Economy*, vol. 90, pp. 1187-1211.

Wenyi, S., Yang, S.-C., and L.-F Zanna (2018), “Government Spending Effects in Low-Income Countries,” *Journal of Development Economics*, vol. 133(C), pages 201-219.

Smets, F. and R. Wouters (2003), “An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area.” *Journal of the European Economic Association*, vol. 1(5), pages 1123–1175.

Smets, F. and R. Wouters (2007), “Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach,” *American Economic Review*, vol. 97(3), pages 586–606.

Stepanyan, A., Dabla-Norris, E., and A. Mkrtchyan (2009), “A New Keynesian Model of the Armenian Economy,” *IMF Working Papers Series*, WP/09/99.

Woodford, M. (2003), *Interest and Prices: Foundations of a Theory of Monetary Policy*, first edition, Princeton University Press.

Yaari, M. (1965), “Uncertain Lifetime, Life Insurance, and the Theory of the Consumer,” *Review of Economic Studies*, vol. 32, pp. 137-150.



# PUBLICATIONS

The Ararat Fiscal Strategy Model: A Structural Framework for Fiscal Policy Analysis in Armenia  
Working Paper No. WP/2022/118