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The Morocco Policy Analysis Model: Theoretical Framework and Policy Scenarios

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The Morocco Policy Analysis Model: Theoretical Framework and Policy Scenarios[1]

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Abstract

The Morocco Policy Analysis model (MOPAM) was created in the Bank Al-Maghrib to simulate the impact of external developments, domestic macroeconomic policies, and structural reforms on key macroeconomic aggregates. We describe its structure and demonstrate its operation on two medium-term scenarios: (1) fiscal consolidation to stabilize the debt-to-GDP ratio and (2) the effects of the COVID-19 shock, including the endogenous fiscal and monetary policy response.

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I. INTRODUCTION

The paper describes the Morocco Policy Analysis Model (MOPAM), a large-scale macroeconomic model developed at the Bank Al-Maghrib (BAM), and demonstrates how it can be used to simulate complex structural and long-term policy scenarios. We present two scenarios, one analyzing the long-term effects of fiscal consolidation and the other providing an early assessment of the impact of the COVID-19 pandemic and the results of the fiscal policy measures adopted.

The MOPAM is based on the Flexible System of Global Models (FSGM) modeling framework (Andrle and others 2015) as adjusted to single-country setup to capture the main features of the Moroccan economy and its policies. The MOPAM is able to capture a range of monetary and fiscal regimes—a welcome feature in an economy that is undergoing a series of gradual reforms as it moves toward greater exchange rate flexibility, a more open capital account, and a wider social safety net. The model strikes a balance between economic theory and the empirical and policy idiosyncrasies of the Moroccan economy. The model itself is a mix of traditional dynamic stochastic general equilibrium (DSGE) segments and ad hoc, data-driven segments, with the choice of segments driven by their ability to support a clear economic interpretation.

Repeated application of the model, which the BAM has been using since the mid-2010s, has demonstrated how useful it is in scenarios requested by the Moroccan policymakers. For example, the MOPAM has been used to assess the economic impact of pension reform of 2016, the transition to a more flexible exchange rate regime in 2017, and the minimum wage increase of 2019. We hasten to say that the MOPAM is not a forecasting framework but a simulation tool designed to stimulate policy discussion. The BAM uses a different modeling framework for forecasting, and official BAM and IMF forecasts for Morocco should not be compared with the MOPAM simulation results. Instead, the MOPAM simulations explore counterfactual scenarios based on defined assumptions and expert judgment with respect to a baseline that either reflects the official macroeconomic forecast or assumes that policies are unchanged.

The paper has various readers in mind. Those who want to understand the broad structure of MOPAM may find Section III useful. Modelers will find detailed model description in the Annex II. Economists and policymakers looking for answers to questions related to the long-term effects of fiscal policy reforms and potential medium-term impacts of the COVID-19 pandemic should turn their attention to Section IV and Section V, respectively.

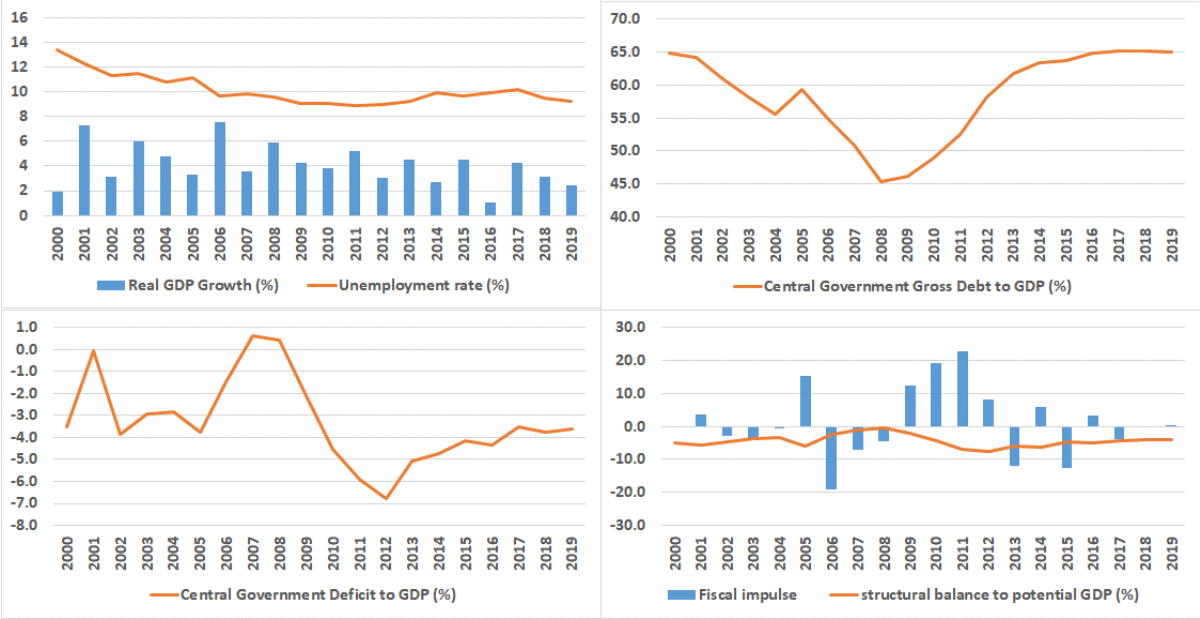
In the paper, we (1) outline recent economic developments and the policy scenarios being considered; (2) sketch the MOPAM structure (see the detailed description in Annex II); (3) lay out the policy scenarios; (4) discuss the simulation results and summarize their policy implications; and (5) draw conclusions.

II. MOROCCO: ECONOMIC GROWTH SINCE THE GLOBAL FINANCIAL CRISIS

Although a textbook countercyclical response to the global financial crisis (GFC) helped Morocco to escape recession, it failed to address the ensuing growth slowdown (Figure 1).

For 2001– 08, real GDP growth averaged 5.25 percent, reducing unemployment from more than 13 percent to less than 10 percent in 2008, and lowering the gross debt-to-GDP ratio from 65 to 45 percent. After a massive fiscal expansion as the 2008 structural balance of about 0 percent of GDP turned to –8 percent in 2012 and –6 percent in 2013, post-GFC real GDP growth has averaged only 3.5 percent and unemployment is stubbornly high at about 10 percent.

Figure 1. Morocco: Real GDP Growth, Unemployment, and Fiscal Indicators, 2000–19



Sources: The National Statistical Agency of Morocco (HCP) calculates real GDP using the 1993 System of National Accounts (SNA) and publishes the unemployment rate, using the Harmonized ILO definition. Morocco's Ministry of Finance (MoF) publishes the central government deficit, which includes grants, privatization receipts, and monopoly revenues. The MoF also publishes central government gross debt, which includes all creditors, maturities, and currencies; the 2019 observation is preliminary. The structural balance, potential GDP, and the fiscal impulse (the year-on-year change in the structural balance) are calculated using the IMF's WEO estimates in the October 2019 *World Economic Outlook*.

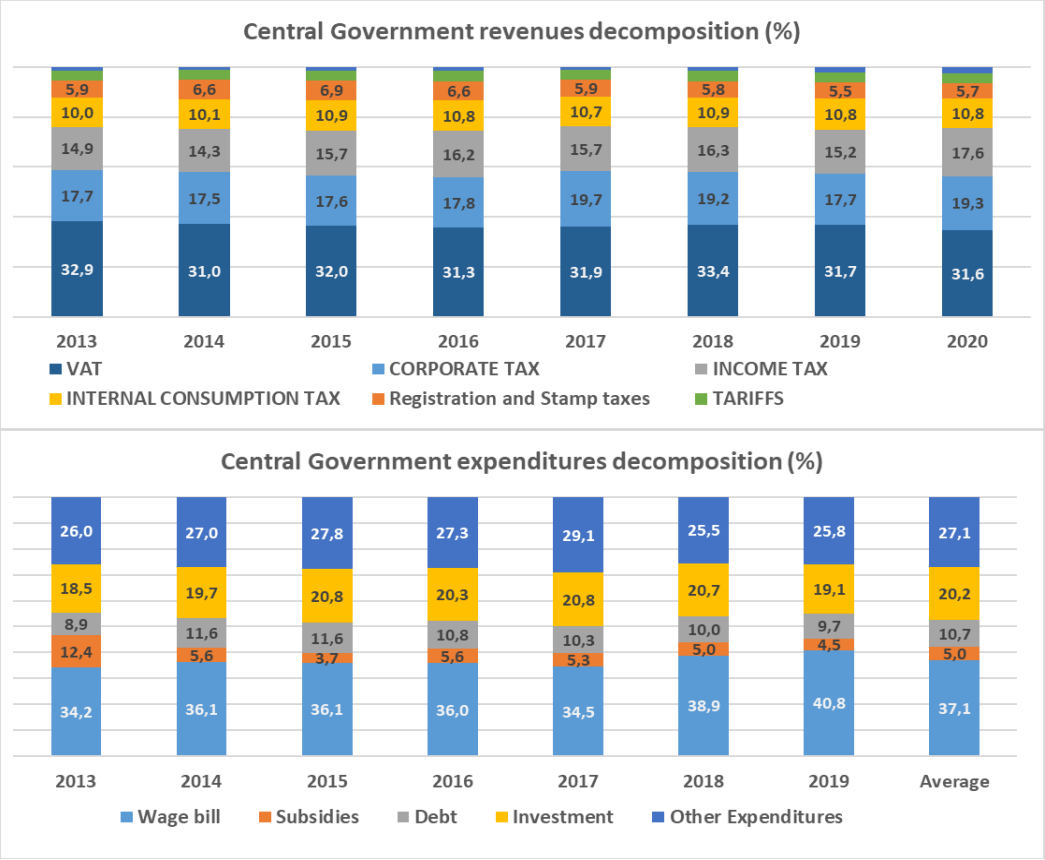
The recent period of loose fiscal policy—in 2010–16 the overall fiscal deficit exceeded 4 percent of GDP every year—pushed up public debt considerably. The gross debt-to-GDP ratio rose from its trough of 45 percent in 2008–09 to more than 65 percent in 2019. While continuously assessed as sustainable,[2] as early as 2012 rising public debt was recognized as a long-term risk, leading Morocco to request three successive IMF-supported, precautionary arrangements and launch important fiscal reforms which initially gave priority to removing costly budget subsidies and restructuring the pension system. [3] As oil prices fell in 2017–19, the budget deficits narrowed to less than 4 percent of GDP.

[2] For debt sustainability assessment, see IMF 2019a.

[3] The first two Precautionary and Liquidity Line (PLL) arrangements were designed as purely precautionary. The authorities made a purchase in April 2020, however, at the start of the COVID-19 pandemic.

The main budget ratios were stable (Figure 2). Most notable was the drop in subsidies, from 12.5 percent of total spending in 2014 to 4.5 percent in 2019. The share of the wage bill in spending was high—at almost 40 percent of total spending or about 10 percent of GDP. With the debt-to-GDP ratio up by about one-half from its pre-GFC level, the cost of servicing stabilized at about 10 percent of total spending, helped by long maturities.

Figure 2. Morocco: Central Government Revenues and Expenditures, 2014–20, Percent



Sources: The General Treasury Department of the MoF publishes data on central government revenues and spending; the 2020 figures are the projected budget. Annual data are calculated from monthly published data.

For the third IMF-supported arrangement, approved in December 2018, Morocco made two fiscal commitments: (1) to stabilize the overall deficit at about 3 percent of GDP by 2020 and (2) to bring public debt down to 60 percent of GDP over the medium term. These ambitious objectives required higher revenues and lower spending. Revenue measures considered included boosting tax collections, reducing tax exemptions, better enforcing tax payment discipline by the self-employed and the liberal professions, and simplifying and re-aligning value-added tax (VAT) rates. Spending measures included stabilizing the government wage bill, removing subsidies, and switching to targeted social transfers.

The impact of these planned reforms would be felt outside of public finance as most of them will affect the supply side, the demand side, or both sides of the economy. Assessing the total

impact of these reforms on the economy has been challenging, given the offsetting effects of some measures. Using a rich modeling framework, such as the one described here, should help in this task.

III. THE MODELING FRAMEWORK

The Morocco Policy Analysis Model (MOPAM) is an annual model based on the FSGM, a semi-structural, multi-country modeling framework originally designed by the IMF Research Department for macroeconomic analysis of structural problems or issues that involve a large number of countries.[4] The BAM has used the framework, adapted to fit the needs of a single small-economy analysis, to study counterfactual macroeconomic and structural scenarios that are of interest to policymakers (see, for example, Achour and Chafik 2019). Significant adjustments have been made to the original FSGM single-country block to adapt the model to the structure of the Moroccan economy, such as adding sector-specific dynamics, including the traditional agricultural and phosphate sectors; extending the monetary block for capital account regulation; and adapting the policy reaction functions to capture monetary and fiscal regimes as they evolve. The monetary regime when this paper was written combined a fixed exchange rate with a partially open capital account, thus giving the central bank a degree of monetary autonomy. On the fiscal side, the MOPAM incorporates energy subsidies and a flexible system of fiscal rules.

The MOPAM is designed to strike a balance between economic theory and empirical insights. It incorporates both traditional theory-driven DSGE segments and ad hoc, data-driven segments when these perform better than the DSGE ones— examples include the supply side, especially the labor market, and the monetary and capital account blocks. For a detailed description of the model see Annex II.

A. The MOPAM Building Blocks

The model is subdivided into four blocks: core, supply, government, and monetary. The core block, which is micro-founded describes private consumption and private investment of overlapping-generation (OLG) households. Households optimize utility with respect to their budget constraint while accounting for human and financial wealth. The use of OLG households allows us to break down Ricardian equivalence and government debt neutrality. We also introduce in this block financially constrained ("hand-to-mouth") households whose consumption equals their wage and transfer income and that can neither save nor borrow. Private investment follows the Tobin's Q model augmented with real adjustment costs.

The supply block is semi-structural: Output follows the Cobb-Douglas production function with steady-state labor and capital. Total factor productivity (TFP) incorporates second-round effects of commodity prices and public investment in aggregate supply. The labor force and the participation rate are treated as exogenous; steady-state labor is calculated with respect to the nonaccelerating inflation rate of employment (NAIRU). Core inflation is modeled with an open-economy hybrid Phillips curve that reflects price stickiness, inflation

[4] The MOPAM was developed between 2015 and 2019 by BAM staff, with support from the IMF Research Department and Institute for Capacity Development as part of a project financed by the government of Canada.

expectations, and changes in marginal costs as captured by the output gap and the real exchange rate gap. Nominal wage inflation follows a similarly defined Phillips curve and Okun's law. Noncore inflation, namely food and energy, reflects world prices and the nominal exchange rate dynamics.

The MOPAM government block is rich, as necessitated by the policy questions the model is tasked to answer. We capture detailed revenue and expenditure breakdown as well as alternative fiscal rules that can target either a long-term debt-to-GDP ratio or a long-term deficit. The government chooses among alternative fiscal instruments, which affect the demand side (the value added tax, transfers to households), the supply side (tax on capital), or both (public investment). The MOPAM includes distortionary taxes on both labor and capital) in addition to lump-sum taxes to further relax Ricardian equivalence.

Finally, we strive to capture the current monetary regime in Morocco, which deviates from the two regimes commonly studied in small open economies: either a float or a peg, typically with an open capital account. Morocco has maintained as an exchange rate anchor a composite comprising the euro and the US dollar. In January 2018 Morocco changed its official arrangement from "conventional peg" to "pegged exchange rate within horizontal bands" when the fluctuation band for the dirham was widened to ±2.5 percent (IMF 2019b); in March 2020 the band was again widened to ±5 percent.[5] As the capital account is only partly open, such a regime creates some policy space to actively stabilize inflation and growth (Obstfeld et al. 2005). In addition, in the MOPAM we can easily introduce a range of intermediate exchange rate regimes and policy reaction functions that reflect different stages of the process of making the exchange rate more flexible.[6]

B. Policy Scenarios: How Should We Read Them?

We demonstrate the richness and flexibility of the MOPAM framework using two counterfactual policy scenarios where all variables are expressed as deviations from a control simulation. (1) Building on the government commitments listed in the IMF-supported Precautionary and Liquidity Line arrangement and the 2019 National Conference on Taxation, we draft a scenario that encompasses all the main elements of the medium-term, multipronged fiscal consolidation. (2). We draft a second scenario that captures the impact of the COVID-19 pandemic on Morocco and some of the government's policy choices. Unless stated otherwise, all variables are expressed as a percentage point deviation from a control simulation that would have been expected without either the fiscal consolidation or the COVID pandemic The steady state corresponds to an "unchanged policy" scenario, where the long-term ratios reflect past behavior. Both scenarios then incorporate a new set of initial conditions and a path for the long-term ratios leading to the new steady states that reflect the post-consolidation or the post-COVID situation.

[5] Decision N°49/W/20 available at: http://www.bkam.ma/content/download/700120/8116644/D%C3%A9cision%20Bank%20Al%20Maghrib_49W20.pdf.

[6] In the mid-2010s the Moroccan authorities launched a program of gradually making the exchange rate more flexible, with an eventual transition to a floating rate and inflation targeting (IMF 2018, Benlamine et al. 2018).

Both simulations need to be understood as counterfactual policy scenarios rather than forecasts. The difference? A forecast is a statement of what is judged likely to happen in the future. In macroeconomics, it is typically our best guess about future GDP growth, inflation, and the corresponding policies. A counterfactual scenario is based on a hypothesis that is contrary to some facts in the control scenario. In policy modeling we call such facts "the control" and our counterfactual scenarios are expressed as deviations from controls. In practice, the controls can be previous forecasts, even with a different model; projections based on unchanged policies; and so on. The scenario then asks "what if" some components of the scenario evolve differently from the control—for example, "What if the Moroccan authorities introduce a fiscal consolidation program? How would macroeconomic developments compare to the (control) scenario without consolidation?"

The question and the design of the scenario matter, of course. The fiscal consolidation scenario enumerates potential long-term benefits from gradual, long-lasting fiscal efforts. Most of the measures are structural, such as changes in the tax rates or redirection of public spending. These measures are firmly guided by announced policy decisions. In contrast, the COVID-19 scenario enumerates the possible costs of the recent pandemic, effectively focusing on downside risks. The largely exogenous effects are driven by experience in other countries, economic theory, and authors' judgment.

IV. The Fiscal Consolidation Scenario

Morocco's fiscal outlook has been anchored to stabilization of the overall deficit at about 3 percent of GDP and a gradual decline in public debt to 60 percent of GDP. How to achieve these objectives inclusively and equitably? What would be the macroeconomic impact of the related policy actions? Regarding the former, the 2019 National Conference on Taxation provided some guidance for policymakers. Regarding the latter, we build a scenario consistent with guidance from the Conference and simulate its macroeconomic effects. Our simulations suggest that a well-executed fiscal reform, accompanied by appropriate monetary and structural policies, could very well deliver the expected results of stabilizing debt and permanently increasing real GDP: we estimate the cumulative gain in present-value terms at about 7 percent of GDP.

A. Lessons from the 2019 Conference and Other Communications

Let us reiterate that the scenario being considered is the basis for analyzing long-run effects of a comprehensive fiscal consolidation plan on the assumption that the COVID-19 pandemic has not happened and relative to a no-consolidation scenario. Naturally, any fiscal consolidation plans formulated before the pandemic would need to be reassessed once the pandemic is over.

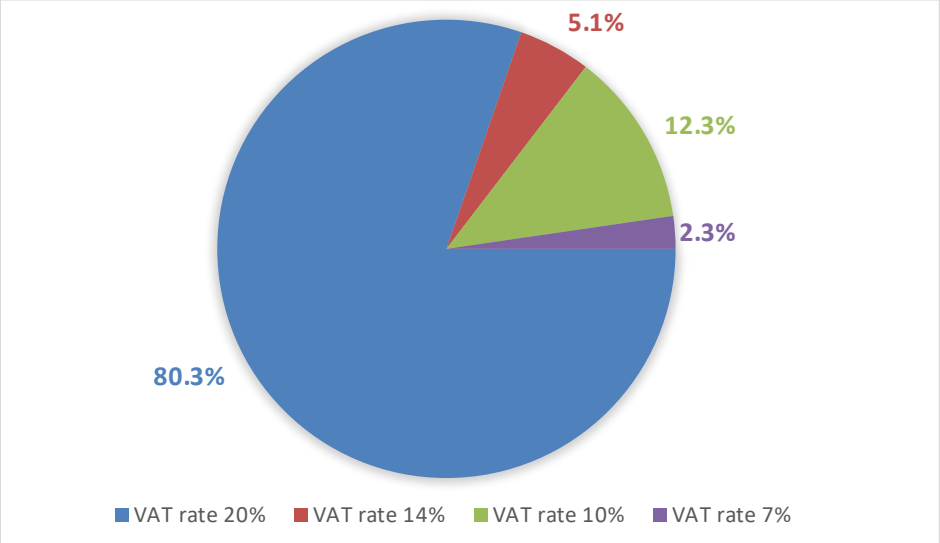
The Government of Morocco convened the National Conference on Taxation with stakeholders on May 3–4, 2019 to debate how fiscal consolidation could proceed. Although most of the recommendations were general, the conference did provide specific guidance on several aspects of this process:

1. The fiscal reforms will be anchored in a Framework Law that would describe the tax measures to be implemented during the first 5 years.

2. To balance distributional and efficiency concerns, revenue gains, from both better enforcement and a wider tax base, will be split between funding the social safety net and reducing income tax rates.
3. The complicated system of multiple VAT rates will be simplified, with a default rate of 20 percent.
4. The conference recommended a more progressive tax system in order to increase the disposable incomes of middle-class and poor households.
5. Liberal professions, which have been paying very little personal income tax, will be brought into the system.
6. Digitizing the tax system will address tax exemptions and leakages.

Changes to the VAT are expected to have pronounced effects. The current system of four nonzero VAT rates plus excluded and zero-rated items will be simplified to one zero-rate and two nonzero rates, with a default rate of 20 percent for most goods and services. In the current system, with rates of 0, 7, 10, 14, and 20 percent, about 80 percent of total VAT revenue comes from 20 percent-rated items and 12 percent from 10-percent rated items (Figure 3), giving us the reference VAT rate of almost 17 percent (0.1685).

Figure 3. Morocco: Contributions to VAT Collection, 2017, Percent



Source: Morocco Tax Administration, https://www.lavieeco.com/economie/rendement-de-la-tva-le-taux-de-20-rapporte-80-des-recettes/.

The current VAT system leaks: the *effective* VAT tax rate—VAT collection divided by the VAT base—is only about 11.5 percent, implying the so-called C-efficiency ratio well below 1, with the remainder accounted for by policy and compliance gaps (Keen 2013; Hutton 2017).[7] The Ministry of Finance stated that in 2017 the "policy gap" in terms of tax expenditures—effectively exemptions from tax obligations,—reached DH 28.5 billion,

[7] The C-efficiency ratio is defined as the share of the VAT in consumption divided by the standard VAT rate and it is a widely used as a measurement of authorities' ability to collect indirect taxes.

almost 2.75 percent of GDP.[8] A part of the policy gap will be closed in the proposed new system of zero-rated items (necessities); 10-percent items (mass consumption products); and 20-percent items (luxury goods) that is expected to raise the effective VAT tax rate by about half a percentage point, to almost 12 percent, based on 2017 final consumption data.

Furthermore, the authorities want to gradually address some of the compliance gaps in the tax system. The former head of the General Tax Administration said in a press interview that total VAT tax leakages could be as high as 3.5 percent of GDP, DH 40 billion.[9] Taking this estimate at face value and using the VAT tax expenditure of DH 14 billion, the VAT compliance gap (tax noncompliance, avoidance, etc.) can be estimated at almost DH 26 billion, 2.5 percent of GDP. In our simulations we do not expected that the policy and compliance gaps will be closed fully or immediately.

The key expenditure measure in the scenario is keeping the public wage bill below 10.5 percent of GDP over the medium term, a measure carried over from previous policy statements. Convergence to the wage bill target is expected to be slow, however, because in 2019 long-delayed wage increases were granted.

B. Scenario Assumptions

We now translate these announcements and policy guidance into steady-state model variables. Because the scenario assumes less crowding-out and a higher share of consumption (non-distortionary) taxes, the consolidation scenario should expand output. We first summarize the main scenario simulation assumptions, as listed in Table 1.

- Over the medium term *the debt-to-GDP ratio* drops from 65 to 60 percent.
- Over the medium term *the public wage bill* stabilizes at 10.5percent of GDP.
- *Realignment of the VAT rates and the partial recovery of leakages* pushes the effective VAT rate up from 13 to 14.5 percent, and total collections up by almost 1 percent of GDP.[10] These collection gains result from: (1) merging the 7 percent rate into the 10 percent rate and the 14 percent rate into the 20 percent rate yield about 0.5 percentage point increase in the VAT effective tax rate; and (2) transferring one-half of the VAT exemptions and zero-rated items to the 10 percent rate yields an additional 1 percentage point.

[8] About half of all tax expenditures appear to be in VAT (DH14 billion) and one-sixth each in corporate income tax (CIT) and personal income tax (PIT). The main beneficiaries have been the construction and energy sectors and these exemptions have proven difficult to repeal. The Tax Expenditures Report is a part of the 2019 budget law draft: https://tax.gov.ma/wps/wcm/connect/d9b1e5b0-a320-479a-8367-181dd4c027e3/Rapport+sur+les+d%C3%A9penses+fiscales+-+Ann%C3%A9e+2019+_fr.pdf?MOD=AJPERES&CACHEID=d9b1e5b0-a320-479a-8367-181dd4c027e3.

[9] The interview is available at https://lnt.ma/m-omar-faraj-dg-impots-question-de-lequite-fiscale-place-publique/. Given the 2017 VAT collection of 81 billion dirhams, we see his figure as being on the high side of plausible estimates. He also estimated CIT evasion at DH 12 billion and PIT evasion by liberal professions at about DH 5 billion, or about 1.5 percent of GDP in total.

[10] In these calculations we assume that the elasticity of consumer demand to the tax rate is zero, i.e., consumption of an item does not change when its VAT rate changes.

Table 1. Fiscal Reform: Scenario Assumptions, Deviation from the Control

Variable	Change over the Long Term	Time to Converge to the New Level	Comments
Simulation 1			
Government debt-to-GDP ratio	–6 p.p.*	6 years	The judgment captures stabilization of the government debt at 60 percent of GDP.
Government current spending-to-GDP ratio	–1.1 p.p.	5 years	The judgment captures stabilization of the government wage bill at 10.5 percent of GDP.
Simulation 2 (judgments applied jointly with the judgments above)			
Consumption tax rate	+1.5 p.p.	1 year	The judgment captures the VAT tax reform.
Simulation 3 (judgments applied jointly with the judgments above)			
Capital revenue tax rate	–1 p.p.	1 year	The judgment captures the corporate income tax reform.
Simulation 4 (judgments applied jointly with the judgments above)			
Fuel subsidy-to-GDP ratio	–0.75 p.p.	5 years	The judgment captures elimination of the fuel subsidy.
Government investment-to-GDP ratio	+0.38 p.p.	5 years	50% of the savings from fuel subsidy removal used for public investment. The remaining part is devoted to poor households in the form of cash transfers.

Note: p.p. = percentage point.

- The *corporate income tax change* from a proportional to a progressive rate calculation leaves CIT collection slightly lower. Although the tax rates of both systems are almost identical (Table 2), our calculations using the 2017 Moroccan firm balance sheet data suggest that the effective tax rate would fall from 29.5 to 28.5 percent for nonfinancial firms. The reason is that the underlying tax bases are calculated differently: in the proportional system the same rate is applied to the entire profit; in the progressive system a different rate is applied for each of the three profit brackets.

Table 2. Morocco: The Corporate Tax Rates, Percent

Profit (DH Thousands)	Proportional Tax Rates 2016	Progressive Tax Rates 2019
[0 to 300]	10 percent all profits	10 percent for profits up to DH 300,000
]300 to 1,000]	20 percent all profits	17½ percent for profits of DH 300,000 to 1,000,000
]1,000 to 5,000]	30 percent all profits	31 percent for profits above DH1,000,000
> 5,000	31 percent all profits	

Source: Ministry of Finance, 2016 and 2019 budget laws.

C. Simulation Results

The impact of fiscal consolidation on output and its composition is positive and the welfare gains are substantial; however, the consolidation program as outlined in Section IV.A has the usual features of a Keynesian contractionary stabilization because we discount the possibility of a non-Keynesian expansionary stabilization (see, e.g., Giavazzi and Pagano 1996 and Alesina and Ardagna 2010).[11] All simulations are expressed as deviations from the control.

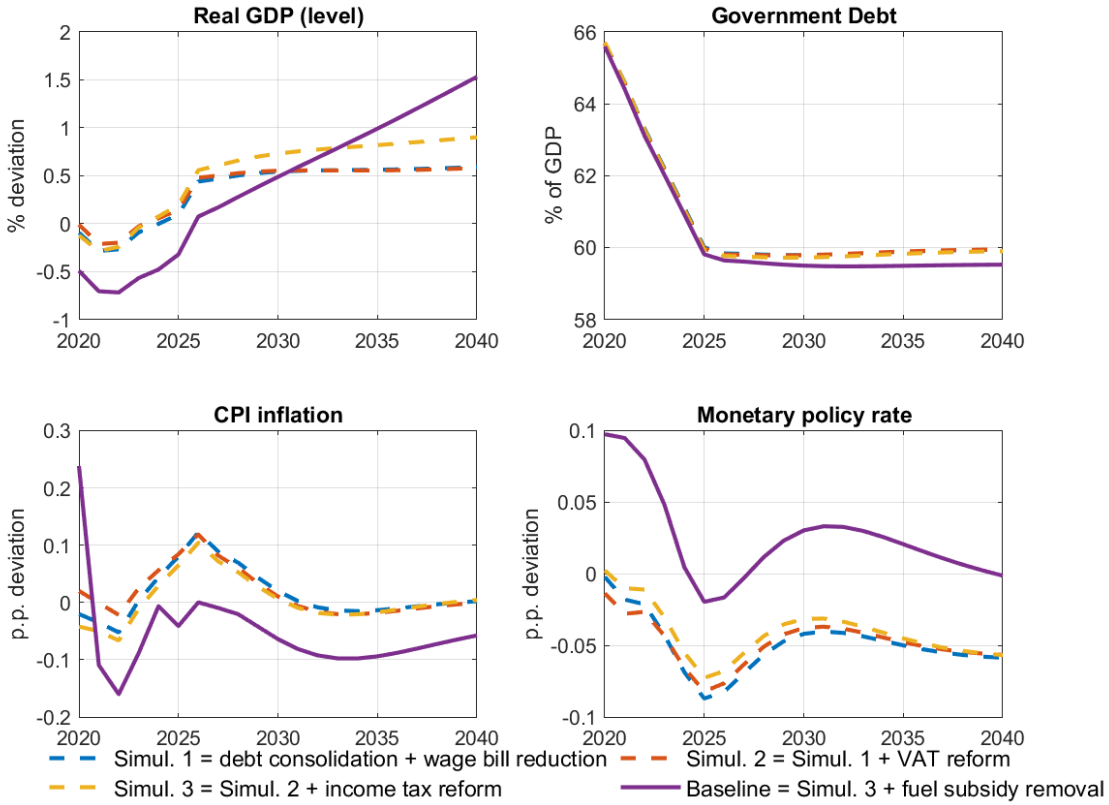
We start with the short-term results: Real GDP falls below the control through 2025 and unemployment stays high (see Figure 4 and Annex Figure A.1). However, government deficits fall, financed by permanently higher revenue and temporary cuts in spending—real government absorption falls permanently relative to the control. A lower wage bill pushes the gross debt-to-GDP ratio from almost 65 percent in 2019 to the new steady state of 60 percent (Simulation 1; blue line), helped by higher indirect taxes (Simulation 2; red line); the income tax changes have negligible impact (Simulation 3; yellow line). Finally, gradual removal of the remaining fuel subsidies brings down public debt, but the drop is offset by higher public investment and targeted social transfers (Simulation 4; purple line).

The removal of fuel subsidies has a notable negative impact on real GDP in the short and medium term, through both consumption and investment channels. While efficiency gains might be expected from the subsidy removal because fuel subsidies tend to benefit the wealthiest households, those effects are largely offset by a temporary fall in private consumption and investment because the OLG households have less disposable income. Unlike liquidity-constrained households (LIQ), which are fully compensated through cash transfers and whose consumption remains unchanged, OLG households are only partly compensated. Moreover, higher retail energy prices depress private investment to the extent that demand for fuel is inelastic: especially in agriculture, higher prices force reallocation of resources to energy at the expense of other production factors. Furthermore, the cut in energy subsidies is gradual and the efficiency gains and increases in public investment are small, not enough to offset the immediate negative income effect on OLG households.

[11] It has been argued that a large fiscal adjustment today removes expectation of both future harsher adjustments and future tax hikes, thus stabilizing expectations, increasing expected consumer disposable income, boosting the confidence of investors, and thus stimulating private demand on impact.

In summary, the mix of fiscal measures in the scenario is expected to have an offsetting long-run impact on output (see Figure 4). (1) the reduction in public indebtedness is expected to lower the country risk premium and the cost of funds, and (2) the switch from direct to indirect taxes can be expected to generate efficiency gains, with both channels generating a substantial long-run increase in private investment. These two positive effects are partly offset by removing the fuel subsidy that leads to higher energy prices, which at first have a negative impact on private investment.

Figure 4. Morocco: Developments Resulting from Fiscal Consolidation (Deviation from the control unless noted otherwise)



Notes: The *control* simulation is a "no-policy-change" scenario in which steady-state parameters remain constant at either their historic averages or the latest expert-judgment values. The *baseline* simulation encompasses all fiscal consolidation elements decomposed into four layers: the debt target and wage bill reductions (Simulation 1); plus the VAT reform (Simulation 2); plus the income tax reform (Simulation 3); plus removal of the fuel subsidy.

Source: MOPAM; authors' simulations.

The general equilibrium, long-run benefits of fiscal consolidation are considerable: GDP increases by about 1.5 pp in Simulation 4 (Figure A1) relative to the control and the economy eventually stabilizes at a permanently higher level of output, equivalent to about 7 percent of GDP in present value terms. Private consumption—after the initial decline brought about by the negative fiscal impulse—is expected to recover after about three years and stabilize some 2 pp above the control, which underscores the positive welfare effect of fiscal consolidation.

The fiscal measures in our simulation are broadly supported by accommodative monetary policy (Figure A.1; bottom panel). However, in the case of the fuel subsidy removal, the slight increase in the policy interest rate follows an upward pressure on the neutral interest rate which results from higher public investment and improvement in potential GDP. Of course, the need to keep the exchange rate within the ±5 percent band limits monetary policy options. The BAM is expected to adjust its stance only marginally with inflation in line with the control. Given the energy share of the headline consumer price index, removing the fuel subsidy causes a short-lived spike in headline inflation.

The nominal and real exchange rate both depreciate. Because the exchange rate is managed, the nominal exchange rate depreciates only slightly, leaving the real exchange rate to depreciate through internal devaluation—in the baseline scenario headline inflation stays below the control and by 2040 the price is expected to be more than 3 pp below the control. In the long run, the trade and current account balances are expected to be close to the controls.

The fiscal consolidation simulations suggest that the long-term gains offset the short-term costs. The initial drop in GDP peaks in 2022 at –0.7 percent. However, after the initial decline in output, output stabilizes at a permanently higher level, equivalent to about 7 percent of GDP in present value terms. A permanently lower debt-to-GDP ratio lowers the country risk premium and creates space for eventual expansion of targeted social transfers (the transfers-to-GDP ratio goes up by more than 2.5 pp). Higher public investment eventually boosts potential output, observed GDP, and private consumption. While consolidating debt by 1 pp annually may seem ambitious, note that in 2000–08 Morocco's public debt declined twice as fast as in this simulation.

V. THE COVID-19 PANDEMIC AND MOPAM POLICY OPTIONS

The ambitious fiscal consolidation scenario naturally did not anticipate the COVID-19 pandemic. The planned fiscal reforms were temporarily mothballed, and attention turned to policies to ease the impact of the pandemic. We therefore built a "harsh reality" scenario that encompassed the authorities' actions through the first half of 2020 and some assumptions about the short and medium term both abroad and at home that seemed realistic at the time of writing. Our simulations—predicated on these assumptions—suggest that even with a well-coordinated fiscal-monetary mix, returning to the pre-COVID level of real GDP will take several years and that pandemic-related debt will be difficult to extinguish. With hindsight, some of these assumptions may have been too pessimistic.

Besides the obvious external demand assumptions, we also make a judgment call about medium-term supply-side disruptions due to the pandemic. Tourism travel restrictions extending into 2021, or even 2022, and a sustained decline in demand for Morocco's exports are likely to slow investment in both physical and human capital. The corresponding slowdown in productivity growth and disruptions in supply chains will depress potential GDP growth for some time. The judgment call was guided by the estimated declines in the natural rate of interest due during past pandemics (Jordà and others 2020); Penn Wharton model estimates of lasting macroeconomic impacts of the coronavirus on the U.S. (Dinerstein and Huntley 2020); and corresponding calculations for emerging market economies (S&P Global Ratings 2020).

Note that the fiscal scenario was designed by the authors of this paper, not by the Moroccan authorities, the IMF, or its Executive Board. However, we did draw on all available information and attempted to limit judgment calls. Early on, to combat the COVID-19 pandemic the Moroccan authorities imposed a lockdown whose stringency was in the top decile of the Oxford database, and the negative impact on economic activity was correspondingly strong.[12] And because the scenario is designed as a counterfactual COVID-19 scenario, we excluded from the initial conditions and near-term forecasts some events that manifested themselves in 2020 but were not related to the pandemic, such as a below-average harvest.[13] These were included in the control. Finally, we decided to limit the content of the initial conditions to information available in June 2020 and did not update the simulations for new information that became available later.

A. Economic Impact of the Pandemic: Demand, Supply, Both, or Something More?

We divide our discussion of the COVID-19 scenario into four parts: domestic demand and supply factors; external demand and supply factors; developments in commodity markets; and budgetary factors. Because the scenario assumes massive joint supply and demand shocks (Guerrieri and others 2020), it is expected to lead to a pronounced, though short-lived, recession, with fiscal and monetary policies only partly offsetting the first-round shock.

Domestic factors: demand and supply

The strictly enforced domestic lockdown had the dual supply and demand effects seen in other countries. As this paper was being written, nonagricultural total factor productivity was estimated to be down by some 5 percent in and labor participation rate by about 4 percent, on the base of firms' surveys (HCP). As for demand, households and firms reacted to the general heightened uncertainty by cutting back on consumption (by about 3 percent) and investment (by about 10 percent).

During the lockdown, according to the July 2020 national survey, 84 percent of Moroccan firms interrupted their activities.[14] Hotels, restaurants, and textile industries were totally shut down and nearly 50 percent of all respondents said they will need one year or more to again reach pre-pandemic production levels. Mid-2020 macroeconomic data released by HCP supported these statements: 2020 nonagricultural GDP was expected to decline by 5.25 percent, year on year; unemployment rate jumped to 12.25 percent; and average hours worked per week plunged from 45 to 22 hours. Of the firms surveyed, 44 percent did not expect to meet their 2020 investment plans. For publicly owned firms, the 2020 budget amendment anticipates a drop of 28 percent in investment relative to pre-pandemic plans.[15]

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[12] Morocco scored more than 90 points on the 0-to-100 scale. See the Coronavirus Government Response Tracker: https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker. The medical emergency was declared on March 19, 2020 and extended twice until June 9, 2020.

[13] Such forward-looking judgmental adjustments are done through so-called "tunes," where we override the model simulations with an explicit value or impose a shock in future periods of the simulations.

[14] See "2ème enquête sur l'impact de la Covid-19 sur l'activité des entreprises", HCP, July 2020; https://www.hcp.ma/Reprise-d-activite-des-entreprises-suite-a-la-levee-du-confinement_a2578.html.

[15] See https://www.finances.gov.ma/Publication/db/2020/np-plfr2020-fr.pdf.

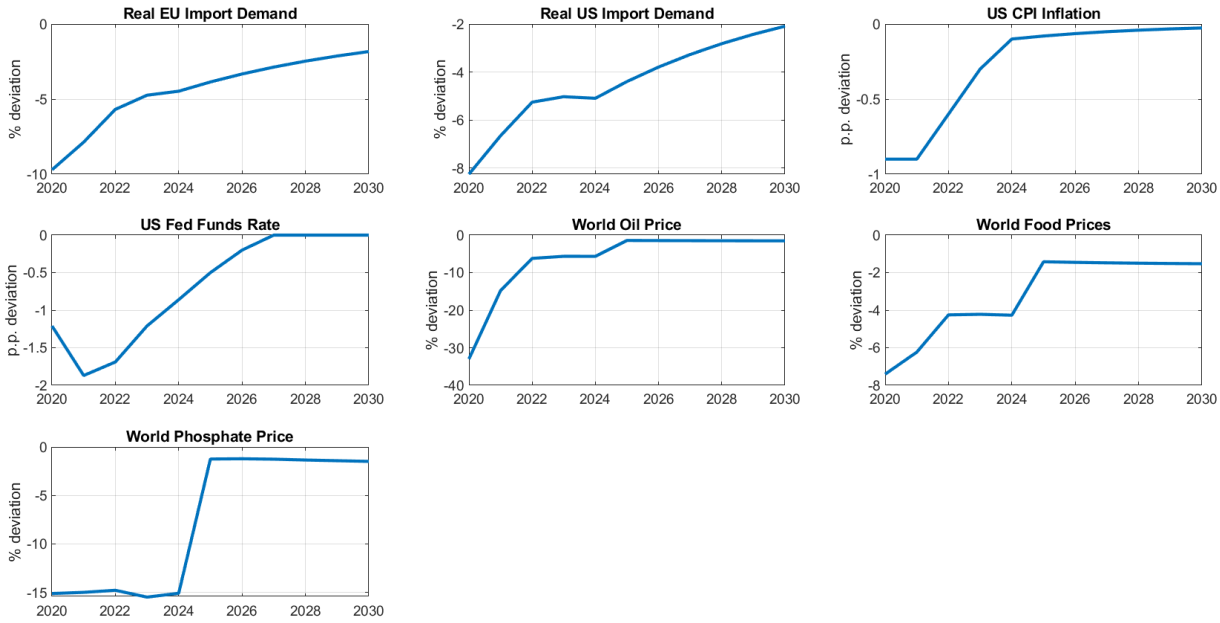
Despite government financial transfers that boosted household incomes, household consumption is expected to decline by more than 5 percent year on year as projected by HCP.

External factors

The slowdown in trading partner countries interrupted supply channels for Moroccan manufacturers, especially in the automotive sector. Lack of international travel hit tourism hard; for 2020 revenues were expected to fall by 60–70 percent. Recessions in host countries displaced Moroccan workers; as a result, compared to 2019 remittances in 2020 were expected to be down 25 percent.[16] The COVID shock was mostly disinflationary in developed countries, thus pushing down the contribution of imported inflation to headline CPI. Figure 5 shows projections for the main foreign sector and commodity market variables

Figure 5. Projected External Developments, 2020–30

(Deviation from the control)



Notes: All projections were extracted from the databases in Spring 2020.

Sources: Global Projection Model Network; World Bank; IMF *World Economic Outlook*.

Commodity markets

The impact on Morocco's terms of trade was balanced. For exports, the international price of phosphates, its main export commodity, declined by about 15 percent in 2020. As for imports, in 2020 oil prices were lower by about 33 percent and food prices by about 7 percent (Figure 3).

[16] The assumption of 25 percent decline in remittances is hypothetical and linked to preliminary information at the time of writing. Recent data show a greater resilience in Moroccan remittances.

Budget developments

Evolution of the fiscal balances reflects four major developments: (1) As economic activity slowed, so did revenue collection, especially nontax revenue and consumption taxes. (2) Spending on health went up, mostly for COVID prevention, testing, and treatment. (3) During the lockdown, cash transfers to vulnerable households jumped by almost 1.5 percent of GDP. (4) The government cut most nonurgent expenditures. Overall, we estimate that the fiscal impulse only partly offset the shortfall in private demand—at the cost of pushing the projected debt-to-GDP ratio to about 75 percent in 2020.

B. Scenario Assumptions

This scenario incorporates assumptions that affect initial conditions and near-term developments, as shown in Table 3. Particularly significant is our assumption about the fiscal stimulus in 2020 and 2021: In 2020, the Moroccan government chose to mitigate the economic and social impact of the COVID crisis primarily through cash transfers and guarantees.[17] At the date of this writing, there is considerable uncertainty as to the stance of fiscal policy for 2021, we thus assume a generally neutral fiscal stance that would stabilize public debt at about 75 percent of GDP, with transfers being the residual item in our simulations. Please note that this frequently used modeling choice to balance the fiscal block is only one of many possible spending strategies, it is not a policy recommendation.

C. Simulation Results

The impact of the pandemic on Morocco crucially depends on the assumptions about its duration in the industrial countries (as outlined in Section IV.B and summarized in Figure 5). Because EU and US demand for imports is expected to stay depressed until the late 2020s and the phosphate price is not expected to recover until 2025, the impact on the Moroccan economy is likely to be long-lasting (see Figure 6 and Annex Figure A.2). The instantaneous drop in real GDP—without the fiscal package adopted by the Moroccan government—is projected to be equivalent to some 10 pp below the control,[18] and the fiscal response would limit the decline to about 6 pp below the control. In 2020–21 the fiscal stimulus would push public debt some 10 pp above the control, to about 75 percent of GDP, delaying fiscal consolidation. Note that while real GDP is expected to be below its potential over the simulation horizon, in 2021 economic growth is expected to again turn positive. Given the magnitude of the shock, however, the rate of growth would not be sufficient to bring real GDP back to its pre-COVID-19 level by 2030.

[17] See the cover note of the amended Finance Law for 2020; https://www.finances.gov.ma/Publication/db/2020/np-plfr2020-fr.pdf.

[18] The steady-state rate of growth of real GDP was calibrated at 3.5 percent in the control.

Table 3. The COVID-19 Pandemic: Scenario Assumptions and Judgment Calls (Deviation from the control)

Variable	Magnitude in 2020	Comments
External environment[19]		
EU demand for imports	–9.7%	Gradual recovery with demand; in 2030 still below the control by 2 percent.
US demand for imports	–8.3%	Gradual recovery with demand; in 2030 still below the control by 2 percent.
US CPI inflation	–0.9 pp	Inflation is expected to pick up starting in 2022, with the inflation gap largely closed by 2024.
US Fed funds rate	–1.2 pp	Deviation from the control peaks in 2021 (–1.9 pp) and dissipates by 2027.
World oil price	–33%	Oil prices are expected to recover by 2022.
World food prices	–7%	Food prices are expected to fully recover by 2025.
World phosphate prices	–15%	Phosphate prices are expected to recover by 2025.
Perception of risk		
Sovereign premium	+100 bp	A temporary shock, largely dissipating in 2021.
Corporate risk premium	+100 bp	The corporate risk premium goes gradually back to zero over the next five years.
Retail risk premium	+100 bp	A temporary shock, dissipating by 2022.
Supply-side judgments		
Unemployment rate	+8.5 pp	Model-determined after 2020.
Labor participation rate[20]	–4 pp	Model-determined after 2020.
Total factor productivity in the nonagricultural sector	–5.2%	Expected to mostly recover by 2022.

[19] External environment judgments are based on forecasts from the Global Projection Model Network, the source of global economy projections for the BAM. The judgments are derived from revision of these forecasts between January and June 2020. The only exception is the forecast for phosphate prices, which is based on revision of World Bank projections for October 2019 through June 2020.

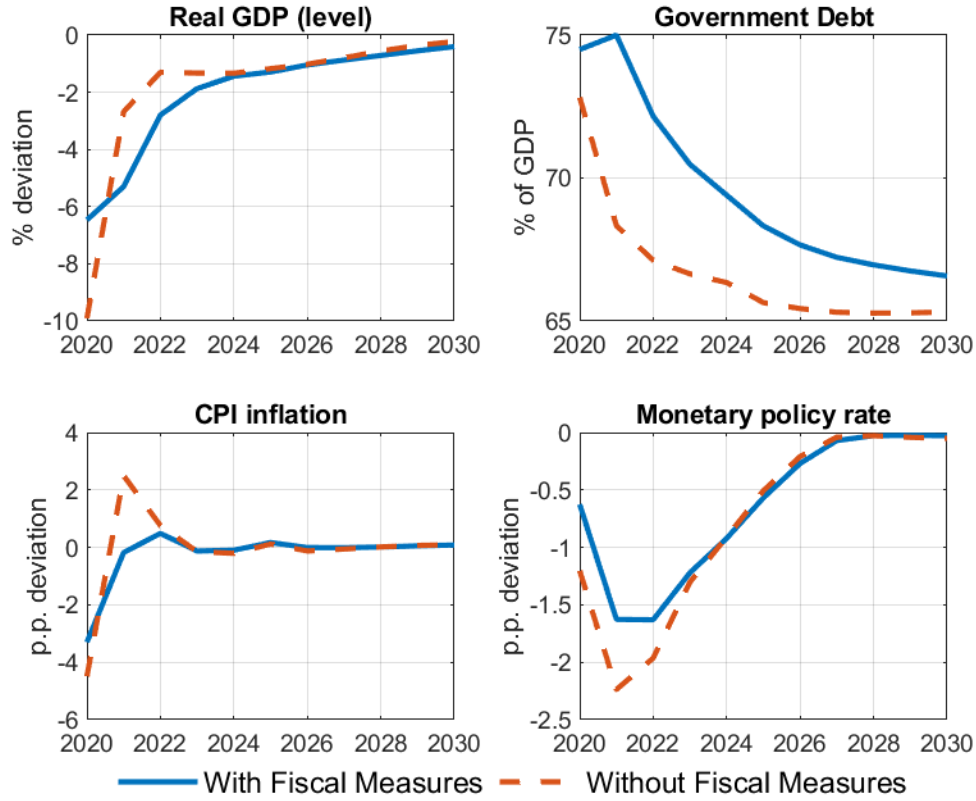
[20] Although not considered in the presented scenarios, the model could also be used to simulate a hypothetical scarring effect of the pandemic in which case the decline in labor force would be more persistent (even permanent in the extreme case).

Variable	Magnitude in 2020	Comments
Demand-side judgments		
Households' marginal propensity to consume	–3%	Model-determined after 2020.
Remittances	–25%	Model-determined partial recovery starting in 2022.
Idiosyncratic drop in export demand	–10%	Model-determined after 2020. The shock is in addition to weaker export demand from abroad because lockdowns and travel restrictions have had a more pronounced impact on the export sectors (e.g., tourism).
Real private investment	–10%	Model-determined after 2020.
Fiscal judgments		
Public deficit-to-GDP ratio	+4 pp	Model-determined after 2020.
Public debt-to-GDP ratio	Delayed consolidation	Fiscal consolidation delayed beyond 2021; debt kept at 75% of GDP (debt ceiling) in 2021. Model-determined after 2021.
Public consumption-to-GDP ratio	+0.2 p.p.	Model-determined after 2020.
Public investment-to-GDP ratio	+0.8 p.p.	Model-determined after 2020.

Source: MOPAM; authors' calculations.

The simulation results for output are predicated on a fiscal multiplier of about 0.4 because the 2020 fiscal stimulus package was implemented mostly through transfers, which typically have a higher short-term multiplier than the spending multipliers of about 0.1–0.3 documented in Batini et al. (2014). The multiplier assumption and the nature of the stimulus package explain the substantial difference in GDP between the scenarios with and without fiscal measures. In addition, in the scenario without fiscal measures, the government would cut transfers to offset the revenue loss and stabilize public debt, effectively introducing an additional negative fiscal impulse. Furthermore, one would expect that a lack of government response to the pandemic would lead to high uncertainty that is not explicitly modeled in the MOPAM: a wave of bankruptcies, financial instability, and permanent job losses.

Figure 6. Morocco: The Impact of the COVID-19 Pandemic, 2020–30
(Deviation from the control unless noted otherwise)



Notes: The *control* simulation is a "no-policy-change" and "no-COVID" scenario in which the steady-state parameters hold constant at either their historic averages or the latest expert-judgment values. The *baseline* simulation (blue line labeled "with fiscal measures") encompasses all the elements of the COVID-19 pandemic scenario: (1) the external shock; (2) domestic effects of the lockdown; (3) monetary easing; and (4) the fiscal stimulus as of mid-2020. The simulation labeled "without fiscal measures" (red dashed line) encompasses only elements (1), (2), and (3).

Source: MOPAM; authors' simulations.

The simulation paints a picture of massive simultaneous negative demand and supply shocks. In the no-fiscal-package simulation, all demand components decline precipitously, especially remittances from Moroccans abroad, which are assumed to drop by a staggering 25 percent relative to the control. Labor supply, which declined as a result of the lockdown, recovers only slowly. Private investment dives; it is expected to stay below the control until 2024.

What is the appropriate response of monetary policy and how should we model it? Should we tune the policy response so that it is identical with and without fiscal policy options? Or should we leave the policy response to be fully state-dependent? And should we apply judgments and impose, for example, a limit on the lower bound of the policy response? Each of these options could be justified by alternative objectives for the simulations. Since the objective of the paper is to demonstrate MOPAM capabilities, we chose to let the policy response to be fully endogenous, to reflect the state of the economy. Evolution of the policy

interest rate and the exchange rate therefore reflects only the current policy reaction function and its calibration.

Consistent with the scenario of a massive demand shock and a sluggish recovery is a decline in the policy interest rate toward the zero lower bound and some depreciation of the dirham. Given the persistence of the policy rate in the reaction function and the observed increase in the country risk premium in 2020, in the scenario with fiscal measures the decline in the policy rate is about 50 basis points relative to the control, with an additional 100 basis points in 2021, when the risk premium shock is expected to dissipate.

Predictably, endogenous monetary easing is larger in the scenario without fiscal measures because the much larger negative output gap at the beginning of the simulation necessitates further rate cuts to stabilize the economy. Without fiscal measures, the policy rate would be expected to decline to zero—a somewhat unrealistic prediction given the policymaker's preference for keeping a healthy positive interest rate differential vis-à-vis the euro and the US dollar. Morocco has little the room for monetary policy maneuver because of its exchange rate regime and limited international reserves.

Furthermore, the endogenous monetary policy stance should be interpreted with caution as the BAM has executed monetary policy through channels in addition to the policy rate in its multi-dimensional framework. For example, movements in the required reserve ratio have been used more often than interest rate adjustments (Benlamin and others 2018). The MOPAM, however, does not consider a nexus between required reserves, lending conditions, and the credit risk premium. This is a problem common to most DSGE models: the simulated endogenous policy rate path does not map the headline rate exactly and it should be interpreted as a general direction of loosening or tightening. In other words, we interpret our simulations as monetary loosening that can be effected through a combination of policy rate cuts and other instruments at the disposal of the BAM.

The nominal exchange rate is projected to depreciate by about 1 pp against the control—still well within the current ±5 percent fluctuation band of the dirham. Such a mild depreciation is supported by two policy decisions.[21] First, a higher level of international reserves, following the PLL purchase, that created a credible buffer to support the current exchange rate framework. It is worth mentioning that no FOREX interventions were carried out by the BAM during 2020, however. Second, a 10-pp increase in import tariffs, primarily designed to discourage imports of consumption goods, improve the trade balance, and thus limit short-term depreciation pressures on the dirham. Although the trade balance is expected to improve initially relative to the control as imports in local currency terms decline by more than exports in local currency terms, it is projected to worsen in 2021 and stay below the control until 2025.

The projected fiscal response assumes accumulation of additional debt in response to the pandemic, which will be gradually brought back to 66 percent of GDP over the next 10 years

[21] On April 7, 2020 the Moroccan authorities used all available resources (equivalent to about US$ 3 billion) under the Precautionary and Liquidity Line (PLL) arrangement with the IMF, thus creating a buffer to support the current exchange rate framework. The March 2020 budget amendment proposed increasing import duties applicable to a range of finished consumer products from 30 percent to 40 percent, with an explicit objective of protecting COVID-affected industries and alleviating the pressure on international reserves: https://www.finances.gov.ma/Publication/db/2020/np-plfr2020-fr.pdf.

or so. This results in public debt that in 2021–24 is higher on average by 3–5 percentage points than in the no-fiscal-response simulation. The fiscal response is a combination of announced fiscal measures and expert judgment about gradual removal of the stimulus. Regarding the former, we incorporated measures announced and applied by mid-2020. Regarding the latter, we assumed that the implicit debt target of 65 percent of GDP will be temporarily disactivated in 2020–21 and reactivated only in 2022.

The MOPAM simulations suggest a difficult tradeoff. On one hand, a gradual withdrawal of the stimulus would limit the short-term negative impact on growth. Of course, higher public debt will crowd out private investment and will come at the cost of a somewhat higher country risk premium and a higher neutral real interest rate that could further depress private investment and long-term growth.[22] We can see this channel operating in Figure A2: in the no-fiscal-response simulation real private investment is 2–3 pp higher than in the fiscal-response simulation. On the other hand, a faster fiscal consolidation that would stabilize debt-to-GDP ratio at 66 percent in 2–3 years would limit debt sustainability risks and bring down the neutral real interest rate, thus supporting private investment. However, we need to remind ourselves of the central lesson from the GFC: excessive austerity at the time of crisis is often counterproductive—in our simulations output would stay below potential for longer.

VI. CONCLUSIONS

Here we describe an approach to simulating macroeconomic variables using MOPAM, a large-scale macroeconomic, semi-structural model developed at the Bank Al Maghrib. MOPAM is based on the IMF's Flexible System of Global Models, which has been adjusted to single-country setup to capture the main features of the Moroccan economy and policy, striking a balance between economic theory, empirics, and policy idiosyncrasies. The model is a mix of traditional DSGE segments and ad hoc, data-driven segments, with the choice of segments driven by their ability to provide a clear economic interpretation. We present the model and demonstrate its policy simulation capabilities using two scenarios, one analyzing the long-term effects of fiscal consolidation and the other providing an early assessment of the impact of the COVID-19 pandemic and the attenuating role of the fiscal policy measures adopted. The simulations in the paper describe theoretical scenarios based on a set of assumptions and expert judgments and should not be interpreted as either Moroccan authorities or IMF forecasts.

The fiscal consolidation scenario summarizes the assumptions and then simulates the impact of the framework proposed at the 2019 National Conference on Taxation, finding that consolidation has a generally positive impact. The starting assumptions include (1) adopting a credible Framework Law; (2) splitting gains from additional revenue and removal of the fuel subsidy between funding the social safety net and reducing income tax rates; (3) simplifying the complicated system of multiple VAT rates; (4) increasing the progressivity of the tax system; (5) widening the tax base; and (6) addressing tax exemptions

[22] See Engen and Hubbard 2004, Jaramillo and Weber 2012, and Schumacher and Żochowski 2017 for empirical estimates of this channel.

and leakages. The scenario assumes that there are no changes to the current monetary and exchange rate system.

The outcome of this scenario has the usual features of a short-lived Keynesian contractionary stabilization: government deficits fall, financed by permanently higher revenue and temporary cuts in spending, and the gross debt-to-GDP ratio falls to the target of 60 percent. On one hand, the reduction in public indebtedness and a switch from direct to indirect taxes generate efficiency gains and lead to a substantial increase in private investment. On the other, removal of the fuel subsidy lowers disposable income, thus limiting investment. The total medium-term impact on output is positive and large. The permanently lower debt-to-GDP ratio lowers the country risk premium and creates space for eventual expansion of targeted social transfers.

The COVID-19 pandemic scenario encompasses the authorities' actions during the first half of 2020 and makes assumptions about short- and medium-term developments, finding that even with a well-coordinated fiscal-monetary mix, the return to the pre-COVID level of real GDP will take several years, with a lasting increase in public debt. The starting assumptions include the initial demand shortfall and medium-term supply-side disruptions. Productivity slowdown and disruptions in the supply chains would depress potential GDP growth for some time.

External developments drive the impact of the COVID pandemic on the Moroccan economy; demand for Moroccan imports and tourism is expected to remain depressed. The demand developments are amplified by a combination of supply shocks. A two-year stimulus in 2020 and 2021 would push public debt 10 pp above the control, to about 75 percent of GDP. The fiscal measures introduced by mid-2020 softened the blow from the negative demand shock, shielded liquidity-constrained households from deprivation, and prevented financial sector scarring. Still, real GDP growth in 2020 is estimated at about 6 pp below the pre-COVID control.

The pandemic scenario is consistent with a decline in the monetary policy rate and a small depreciation, well within the current fluctuation band. The key policy dilemma is the how quickly to withdraw the fiscal stimulus after 2021: a gradual withdrawal will limit the short-term negative impact on growth but at the cost of a higher country risk premium, smaller private investment, and lower long-term growth. In contrast, faster fiscal consolidation would limit debt sustainability risks but keep output below its potential longer. The dilemma cannot be decided in a macroeconomic model; it needs to be addressed by the public authorities, though credible modeling and well-specified scenarios may help guide the discussion.

MOPAM has proved its worth as an analytical tool for a variety of policy and structural simulations. The BAM has at its disposal a rich and flexible model that can be used for a wide range of theoretical scenarios, two of which are demonstrated here. The main advantage of MOPAM is that it can be readily adapted to changes in the fiscal, monetary, and exchange rate regimes. Such adaptability will be crucial in assessing the impact of the numerous reform challenges that lie ahead.

REFERENCES

Alesina, Alberto, and Silvia Ardagna, 2010, "Large Changes in Fiscal Policy: Taxes versus Spending," *Tax Policy and the Economy*, Vol. 24, pp. 35–68.

Andrle, Michal, Patrick Blagrave, Pedro Espaillat, Keiko Honjo, Benjamin Hunt, Mika Kortelainen, René Lalonde, Douglas Laxton, Eleonora Mavroeidi, Dirk Muir, Susanna Mursula, and Stephen Snudden, 2015, "The Flexible System of Global Models – FSGM," IMF Working Paper 15/64. (Washington: International Monetary Fund). Available at: https://www.imf.org/~/media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2015/_wp1564.ashx.

Achour, Aya, and Omar Chafik, 2019, "Salaire minimum au Maroc: faits stylisés et impacts économiques," *Bank Al-Maghrib Working Papers Series*, No 2019-3. (Rabat: Bank Al-Maghrib:). Available at: http://www.bkam.ma/content/download/683186/7841547/SMIG_Maroc_dt_final.pdf.

Benlamine, Mokhtar, Aleš Bulíř, Meryem Farouki, Ágnes Horváth, Faical Hossaini, Hasnae El Idrissi, Zineb Iraoui, Mihály Kovács, Douglas Laxton, Anass Maaroufi, Katalin Szilágyi, Mohamed Taamouti, and David Vávra, 2018, "Morocco: A Practical Approach to Monetary Policy Analysis in a Country with Capital Controls," IMF Working Paper 18/27. (Washington: International Monetary Fund). Available at: http://www.imf.org/~/media/Files/Publications/WP/2018/wp1827.ashx.

Dinerstein, Marcos, and Jon Huntley, 2020, "Lasting Macroeconomic Impacts of the Coronavirus Crisis, Absent Fiscal Policy Response," Penn Wharton Budget Model Blog. Available at: https://budgetmodel.wharton.upenn.edu/issues/2020/3/27/macroeconomic-impacts-coronavirus.

Engen, Eric, and R. Glenn Hubbard, 2004, "Federal Government Debt and Interest Rates," NBER Working Paper 10681 (Cambridge, MA: National Bureau of Economic Research). Available at: http://www.nber.org/papers/w1068.

Giavazzi, Francesco, and Marco Pagano, 1996, "Non-Keynesian Effects of Fiscal Policy Changes: International Evidence and the Swedish Experience," *Swedish Economic Policy Review*, Vol. 3, pp. 67–112.

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, Iván Werning, 2020, "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?" NBER Working Paper 26918 (Cambridge, MA: National Bureau of Economic Research). Available at: https://www.nber.org/papers/w26918.pdf.

Hutton, Eric, 2017, "The Revenue Administration – Gap Analysis Program: Model and Methodology for Value-Added Tax Gap Estimation," FAD Technical Notes and Manuals 17/04. (Washington: International Monetary Fund). Available at: https://www.elibrary.imf.org/doc/IMF005/24113-9781475583618/24113-9781475583618/Other_formats/Source_PDF/24113-9781475592856.pdf.

IMF (International Monetary Fund), 2018, "Morocco: 2017 Article IV Consultation – Staff Report," (Washington: International Monetary Fund). Available at: https://www.imf.org/~/media/Files/Publications/CR/2018/cr1875.ashx.

——, 2019a, Morocco: 2019 Article IV Consultation –Staff Report," (Washington: International Monetary Fund) Available at: https://www.imf.org/~/media/Files/Publications/CR/2019/1MAREA2019003.ashx.

——, 2019b, *Annual Report on Exchange Arrangements and Exchange Restrictions 2019*, (Washington: International Monetary Fund). Available at: https://www.elibrary-areaer.imf.org/Documents/YearlyReport/AREAER_2019.pdf.

——, 2020, "Morocco Draws on Funds Available under the Precautionary and Liquidity Line to Address COVID-19 Pandemic," (Washington: International Monetary Fund). Available at: https://www.imf.org/en/News/Articles/2020/04/08/pr20138-morocco-draws-funds-available-under-precautionary-liquidity-line-covid19-pandemic.

Jaramillo, Laura, and Anke Weber, 2012, "Bond Yields in Emerging Economies: It Matters What State You Are In." IMF Working Paper 12/198 (Washington: International Monetary Fund). Available at: https://www.imf.org/~/media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2012/_wp12198.ashx.

Jordà, Òscar, Sanjay R. Singh, and Alan M. Taylor, 2020, "Longer-run Economic Consequences of Pandemics," NBER Working Paper No. 26934 (Cambridge, MA: National Bureau of Economic Research). Available at: https://www.nber.org/papers/w26934.pdf.

Keen, Michael, 2013, "The Anatomy of the VAT," IMF Working Paper 13/111, (Washington: International Monetary Fund). Available at: https://www.imf.org/external/pubs/ft/wp/2013/wp13111.pdf.

Obstfeld, Maurice, Jay C. Shambaugh, and Alan M. Taylor, 2005, "The Trilemma in History: Tradeoffs Among Exchange Rates, Monetary Policies, and Capital Mobility." *Review of Economics and Statistics*, Vol. 87, pp. 423–438.

S&P Global Ratings, 2020, "Economic Research: COVID-19 Deals A Larger, Longer Hit To Global GDP," Comments published on April 16, 2020. Available at: https://www.spglobal.com/ratings/en/research/articles/200416-economic-research-covid-19-deals-a-larger-longer-hit-to-global-gdp-11440500.

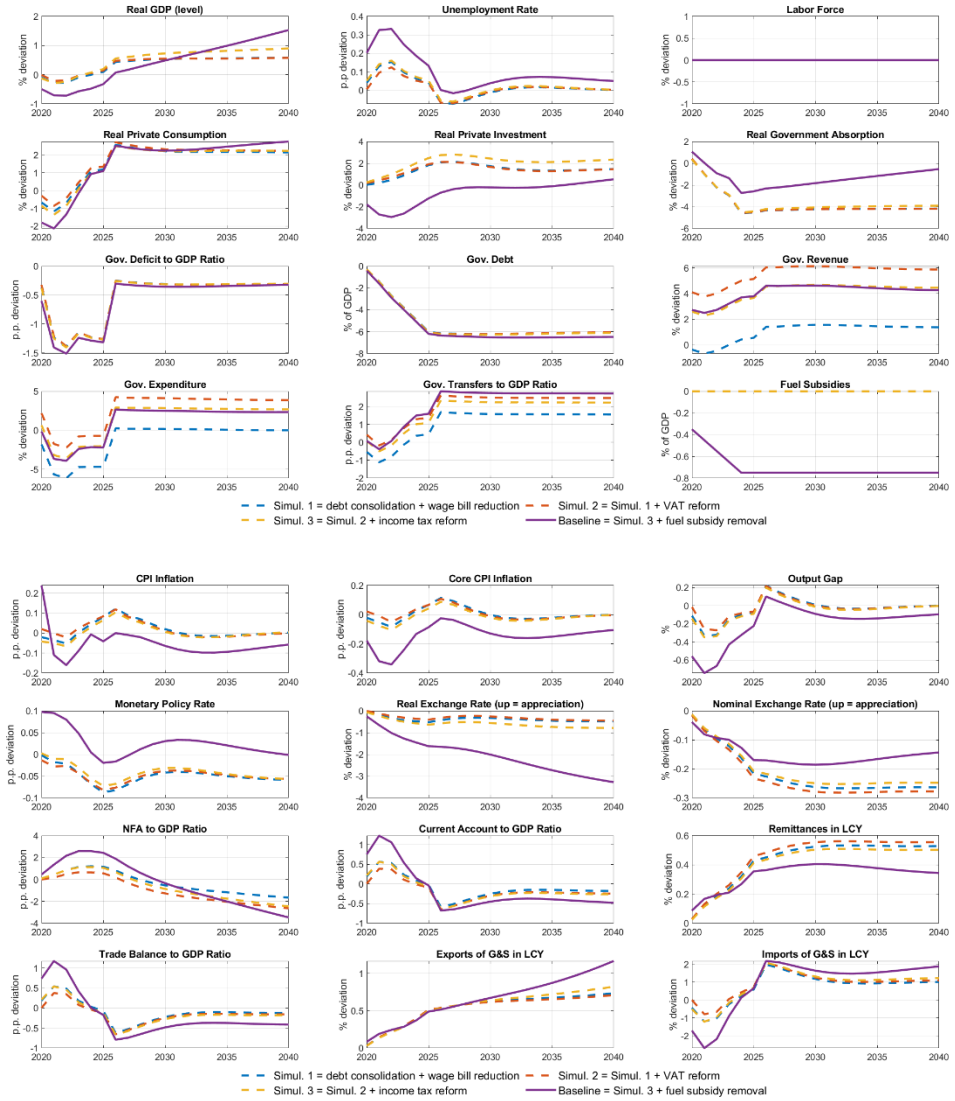
Schumacher, Malte, and Dawid Żochowski, 2017, "The Risk Premium Channel and Long-term Growth," ECB Working Paper No 2114 (Frankfurt: European Central Bank). Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2114.en.pdf.

ANNEX I

Simulation Results

1. The Fiscal Consolidation Simulation Results

Figure A1. Morocco: Selected Variables, 2020–30
(Deviation from the control unless noted otherwise)

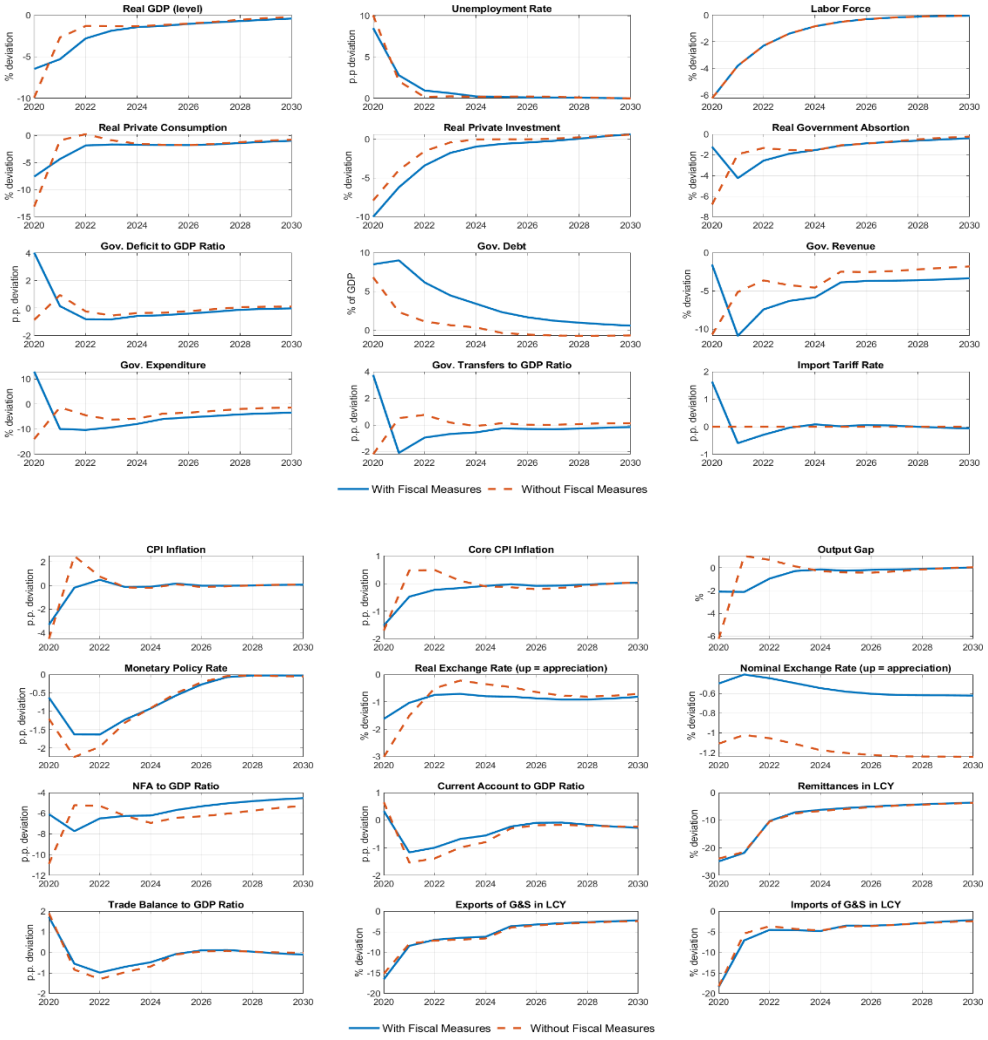


Notes: The *control* simulation is a "no-policy-change" scenario in which the steady-state parameters remain constant at either historic averages or the latest expert-judgment values. The *baseline* simulation encompasses all the fiscal consolidation elements decomposed into four layers: debt target and wage bill reduction (Simulation 1); plus VAT reform (Simulation 2); plus income tax reform (Simulation 3); plus fuel subsidy removal.

Source: MOPAM; authors' simulations.

2. *The COVID-19 Simulation Results*

Figure A2. Morocco: Selected Variables, 2020–30
(Deviation from the control unless noted otherwise)



Notes: The *control* simulation is a "no-policy-change" scenario in which the steady-state parameters remain constant at either historic averages or the latest expert-judgment values. The *baseline* simulation (blue line labeled "with fiscal measures") encompasses all the elements of the COVID-19 pandemic scenario: (1) the external shock; (2) domestic effects of the lockdown; (3) monetary easing; and (4) the fiscal stimulus as of mid-2020. The simulation labeled "with fiscal measures" (red dashed line) encompasses only elements (1), (2), and (3).

Source: MOPAM; authors' simulations.

ANNEX II

A The Structure of the Morocco Policy Analysis Model

A.1 Model Overview

The Morocco Policy Analysis Model (MOPAM) is derived from the Flexible System of Global Models (FSGM) which the IMF Research Department developed to facilitate macroeconomic analysis of a wide range of issues in open economies that experience major cross-country spillovers. Working with the FSGM, we customized the original model to the Moroccan economy. Several aspects were altered or added to take into account specific sectoral dynamics, capital account regulation, current Moroccan policy, and the importance of traditional agriculture, and the adaptation paid special attention to phosphate exports. The model also addresses monetary policy, which in Morocco combines a fixed exchange rate with a partly open capital account. Tailored to fiscal policy, the MOPAM incorporates energy subsidies and proactive use of import tariffs to alleviate pressures on the currency.

The eclectic MOPAM approach strikes a balance between theory and empirical insights. It has four blocks: The core block, fully micro-founded, describes private consumption and the private investment of overlapping generations (OLG) households. Households optimize their utility with respect to their budget constraints while accounting for different sources of wealth, human and financial. The use of OLG households rather than infinitely-lived ones, breaks down the Ricardian equivalence and removes government debt neutrality. The model also comprises households that because of their financial situation can neither save nor borrow; their consumption equals their income from wages and government transfers. Private investment follows the Tobin's Q model augmented by real adjustment costs, and capital stock can be inferred from the law of capital accumulation.

The supply block is semistructural. The production function is Cobb-Douglas, with labor and private capital as production factors. Total factor productivity (TFP) includes the effects of accumulation of public capital and the second-round effects of commodity prices to capture their impacts on aggregate supply. Total labor force is determined by an exogenous participation rate, and the labor supply is then determined by the unemployment rate, which is modeled by a reduced-form version of Okun's law. In the MOPAM core consumer price inflation is described by a reduced-form, hybrid, open-economy Phillips curve, to reflect the price stickiness and changes in marginal costs captured by the output gap and developments in the real exchange rate and oil prices. Non-core prices of food and energy are determined by world prices and the exchange rate, and for food also by the domestic food supply. Wage inflation is modeled by a wage Phillips curve.

As for the government block, both revenue and expenditure sides of the government balance are captured, and different fiscal rules can be explored depending on the government's objectives for long-term debt or the long-term deficit. To meet its objectives, the govern-

ment chooses fiscal instruments that affect either the demand side (consumption tax, transfers to households); the supply side (tax on capital); or both (public investment). Distortionary taxes weaken the Ricardian equivalence.

Finally, we model carefully Morocco's current monetary regime, which is quite different from the floating or fixed exchange rate regimes that are commonly studied, and which are accompanied by an open capital account. As this paper was being written, Morocco fixed its exchange rate against a basket of currencies, with weights equal to 60% for the euro and 40% for the US dollar. With the partly open capital account and active use of import duties, such a regime opens up maneuvering space to achieve such internal objectives as stabilizing inflation and growth. The MOPAM can also capture a wide range of intermediate and hybrid exchange rate regimes and monetary policy reaction functions that correspond to different stages in making the dirham more flexible.

Before we describe the main equations of the model we must make a crucial comment about notation: All nonstationary real variables in the equations below are detrended by an exogenous trend in technology ($\overline{G}$), all nominal prices by the price of the core consumption basket (P^{core}) and all other nonstationary nominal variables by the trends in technology and the core consumption price ($P^{\text{core}}\overline{G}$). Also, variables with periods after the current period refer to rational expectations for the variables in the future period (i.e., for brevity, we omit the expectations operator). Further, an increase in the exchange rate, whether nominal or real, always means appreciation of the currency. The MOPAM is an annual model and, hence, all growth rates, inflation rates and interest rates are annualized rates.

A.2 Private Consumption

To introduce non-Ricardian features into the MOPAM, the model includes two types of households: those with overlapping generations (OLG) features and those that are liquidity-constrained (LIQ). The share of the LIQ households in the population is λ_{LIQ}. OLG households can accumulate wealth and draw it down, but LIQ households consume only out of current labor income, remittances, and net transfers from the government. Total household consumption is

$$C_t = C_t^{\text{OLG}} + C_t^{\text{LIQ}} \tag{1}$$

A.2.1 OLG Households

OLG consumption is a time-varying proportion of wealth with respect to the marginal propensity to consume:

$$P_t^C \, C_t^{\text{OLG}} = MPC_t \, W_t \tag{2}$$

The marginal propensity to consume is given by expected future nominal interest rates (r^C), the tax rate on consumption (τ^C), the tax rate (τ^{B^*}) on changes in household net foreign assets positions (B^*), the probability of dying (ρ) and the stochastic pricing kernel (j):

$$MPC_t^{-1} = 1 + \tau_t^C + \frac{\tau^{B^*}}{2}\left(\frac{B_t^* - B_{t-1}^*}{P_t^C C_t^{\text{OLG}} Z_t}\right)^2 + \frac{\rho j_t \pi_{t+1}}{1 + r_t^C} MPC_{t+1}^{-1} \tag{3}$$

$$j_t = \left(\beta \frac{1 + r_t^C}{\pi_{t+1}} \frac{1 + \tau_t^C}{1 + \tau_{t+1}^C}\right)^{\frac{1}{\sigma}} \left(\frac{C_t^{\text{OLG}}}{C_{t-1}^{\text{OLG}}} \Delta\overline{G}\right)^{\gamma \frac{\sigma - 1}{\sigma}} \tag{4}$$

The wealth of OLG households has four components: financial wealth (WF), capital wealth (WK), human wealth (WH) and other wealth (WO),

$$W_t = WF_t + WK_t + WH_t + WO_t \tag{5}$$

Financial wealth is the current value of domestic government bonds and net foreign assets converted to the domestic currency:

$$WF_t = \left(1 + r_{t-1}^B\right) \frac{B_{t-1}}{\pi_t^{\text{core}} \Delta\overline{G}} + \left(1 + r_{t-1}^{B^*}\right) \frac{B_{t-1}^*}{Z_t \pi_t^* \Delta\overline{G}} \tag{6}$$

Capital wealth is the value of accumulated capital at the beginning of the current period; the price of the capital (QR) is the Tobin's Q:

$$WK_t = QR_t \frac{K_{t-1}}{\Delta\overline{G}} \tag{7}$$

Human wealth is the present value of expected future labor income after tax, dis-counted by both the OLG household's probability of dying (ρ) and the decline in labor productivity over the life of the household (χ),

$$WH_t = \left(1 - \tau_t^L\right) WN_t \, L_t^{\text{OLG}} + \frac{\rho \, \chi \, \Delta\overline{G}}{(1 + r_t^C)} \, WH_{t+1} \tag{8}$$

where τ^L is the labor income tax rate, WN is the nominal wage, and L^{OLG} is the supply of labor by the OLG household.

Other wealth is the present value of current and future lump-sum transfers from the government, both general (TF) and targeted (TF^{OLG})), less lump-sum taxes (TAX^{ls}), royalties from phosphate production paid to the government ($RYLT$) and remittances received from abroad ($REMIT^{\text{OLG}}$)

$$\begin{aligned} WO_t = {} & (1 - \lambda_{\text{LIQ}}) \left(TF_t - TAX_t^{\text{ls}}\right) + TF_t^{\text{OLG}} - RYLT_t + REMIT_t^{\text{OLG}} \\ & + \frac{\rho \, \Delta\overline{G}}{(1 + r_t^C)} \, WO_{t+1}. \end{aligned} \tag{9}$$

A.2.2 Liquidity-constrained Households (LIQ)

Liquidity-constrained households consume up to their net labor income, net government transfers, and remittances from abroad:

$$\left(1+\tau_t^C\right) P_t^C \, C_t^{\text{LIQ}} = \left(1-\tau_t^L\right) WN_t \, L_t^{\text{LIQ}} + WN_t^{\text{Agr}} \, L_t^{\text{Agr}} + TF_t^{\text{LIQ}} + \lambda_{\text{LIQ}} \left(TF_t - TAX_t^{\text{ls}}\right) \tag{10}$$

The MOPAM assumes that some LIQ households work in the traditional agriculture sector (TAS), which is not subject to income taxes. LIQ household income therefore includes income from work in TAS ($W^{\text{Agr}} \, L^{\text{Agr}}$).

A.3 Aggregate Supply

A.3.1 The Traditional Agricultural Sector (TAS)

The TAS produces unprocessed food, uses only labor as an input, is not subject to business cycles, and is not the target of any special transfers,

$$Y_t^{\text{Agr}} = A_t^{\text{Agr}} \, L_t^{\text{Agr}}. \tag{11}$$

All TAS labor is provided by LIQ and the share of such households employed in TAS is λ_{Agr}. Thus, the shares of OLG and LIQ households in non-TAS labor are

$$\frac{1-\lambda_{\text{LIQ}}}{1-\lambda_{\text{LIQ}} \, \lambda_{\text{Agr}}} \qquad \text{and} \qquad \frac{\lambda_{\text{LIQ}} \left(1-\lambda_{\text{Agr}}\right)}{1-\lambda_{\text{LIQ}} \, \lambda_{\text{Agr}}}. \tag{12}$$

A.3.2 Nonagriculture Sectors

Nonagricultural production follows the Cobb-Douglas production function

$$Y_t^{\text{ExAgr}} = A_t \, K_{t-1}^{\alpha_t} L_t^{1-\alpha_t}, \tag{13}$$

The labor share α_t in equation 13 is time-varying in order to capture the observation that the wage share increases during cyclical upswings.

A.3.3 Private Capital and Investment

Private capital evolves according to the capital accumulation equation:

$$K_t = (1-\delta) \, \frac{K_{t-1}}{\Delta \overline{G}} + I_t. \tag{14}$$

The shadow price of investment (Tobin's Q) is based on the after-tax return on the investment (PR^K) adjusted by tax deductions for depreciation,

$$QR_t = \frac{\left(1-\tau^K_{t+1}\right) PR^K_{t+1} + \tau^K_{t+1}\,\delta\, QR_{t+1} + (1-\delta)\, QR_{t+1}}{1+r^{\text{corp}}_t}, \tag{15}$$

where δ is the depreciation rate of capital and τ^K is the capital tax rate, and r^{corp} is the corporate interest rate.

The supply of investment is then given by the following equation:

$$QR_t = P^I_t + q_1 \left(P^I_t \frac{I_t(I_t - I_{t-1})}{I_{t-1}} - \frac{\rho \Delta \overline{G} \pi_{t+1}}{1+r^{\text{corp}}_t} P^I_{t+1} \left(\frac{I_{t+1}}{I_t}\right)^2 \left(\frac{I_{t+1}}{I_t} - 1\right)\right) \tag{16}$$

The equation assumes investment adjustment costs of

$$\frac{q_1}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 \tag{17}$$

A.3.4 Labor Supply

For use in the MOPAM, potential labor supply is defined with respect to the nonaccelerating inflation rate of unemployment (NAIRU),

$$\overline{L}_t = \left(1 - \overline{U}_t\right) LF_t. \tag{18}$$

where $\overline{U}$ is the NAIRU and LF is labor force.

Because the TAS labor supply is exogenous and acyclical,

$$L^{\text{Agr}}_t = \lambda_{\text{LIQ}}\, \lambda_{\text{Agr}}\, LF_t \tag{19}$$

,

the labor supply in non-TAS sectors is given by:

$$L_t = (1 - U_t)\left(LF_t - L^{\text{Agr}}_t\right), \tag{20}$$

$$L^{\text{OLG}}_t = \frac{1-\lambda_{\text{LIQ}}}{1-\lambda_{\text{LIQ}}\,\lambda_{\text{Agr}}}\, L_t, \tag{21}$$

$$L^{\text{LIQ}}_t = \frac{\lambda_{\text{LIQ}}\,(1-\lambda_{\text{Agr}})}{1-\lambda_{\text{LIQ}}\,\lambda_{\text{Agr}}}\, L_t. \tag{22}$$

A.4 Business Cycle Features

A.4.1 The Phillips Curve for Core Inflation

The MOPAM assumes a sticky-price Phillips curve for core CPI inflation with forward-looking inflation expectations; the output gap as a measure of domestic producer marginal costs; and depreciation of the real exchange rate as a measure of importer costs and a specific term for pass-through from oil price inflation (after oil subsidies):

$$\begin{aligned}\log\left(\pi_t^{core}\right) =& c_1 \log\left(\pi_{t-1}^{core}\right) + (1-c_1)\log\left(\pi_{t+1}^{core}\right) + c_2 \log\left(\frac{Y_t}{\overline{Y}_t}\right) \\ &+ c_3 \Delta \log\left(Z_t\right) + c_4 \log\left(\frac{\pi_t^{\text{oil}}}{\pi_{target}^{\text{core}}}\right) + \varepsilon_t^{\pi}\end{aligned} \tag{23}$$

A.4.2 Domestic Oil Prices

Domestic oil prices are determined by international oil prices and imposed oil subsidies. The oil subsidy costs are:

$$GSUB_t^{\text{oil}} = \left(\frac{P_t^{*,\text{oil}}}{Z_t} - P_t^{\text{oil}}\right) C_t^{\text{oil}}. \tag{24}$$

In the MOPAM domestic oil prices after subsidy (P^{oil}) can be determined in two ways: They are either directly set at a government-defined price or endogenously adjusted, depending on the total costs of the subsidy the government is willing to absorb ($GSUB^{\text{oil}}$)

A.4.3 Domestic Food Prices

Domestic food prices depend on domestically produced food, Y_t^{Agr}, which is inelastic to prices, and net imports of food, $\left(M_t^{\text{food}} - X_t^{\text{food}}\right)$:

$$P_t^{\text{food}} C_t^{\text{food}} = P_t^{Agr} Y_t^{Agr} + \frac{P_t^{*,food}}{Z_t}\left(M_t^{\text{food}} - X_t^{\text{food}}\right), \tag{25}$$

where P_t^{Agr} is the price of domestically produced food and $P_t^{*,food}$ is the price of traded food.

A.4.4 The Wage Phillips Curve

Wage inflation is modeled by a wage Phillips curve linking wages to the output gap and the time-varying share of labor in production $(1-\alpha)$:

$$\begin{aligned}\log\left(\pi_t^W\right) = c_1^W\ \log\left(\pi_{t-1}^W\right) + \left(1-c_1^W\right)\log\left(\pi_{t+1}^W\right) \\ + c_2^W\ \log\left(\frac{Y_t}{\overline{Y}_t}\right) + c_3^W\ \log\left(\frac{1-\overline{\alpha}}{1-\alpha_t}\right) + \varepsilon_t^{\pi^W}\end{aligned} \tag{26}$$

The output gap in the equation captures the procyclical nature of wages, and the labor share term ensures the long-term stability of the labor share.

A.4.5 Cyclical Unemployment and Okun's Law

Because the NAIRU is exogenous, cyclical unemployment is based on Okun's law,

$$U_t = \overline{U}_t + c_1^U\left(U_{t-1} - \overline{U}_{t-1}\right) - c_2^U\ \left(\frac{Y_t}{\overline{Y}_t}\right), \tag{27}$$

and cyclical unemployment is negatively linked to the output gap.

A.5 Monetary Policy, the Exchange Rate Regime and Capital Controls

The MOPAM is flexible in order to capture alternative monetary and exchange rate regimes, the degree of capital controls, and residents' access to foreign assets.

The MOPAM assumes first that the monetary policy interest rate, r_t^{MP}, follows the forward-looking reaction function, which takes into account rate-setting inertia, the neutral interest rate, the inflation differential, and the output gap. When the monetary policy pursues also exchange rate stabilization objective and capital account is not fully open (more details below), the interest rate rule also takes into account an interest rate differential stemming from capital account restrictions ($Cprem$).

$$\begin{aligned}\left(1+r_t^{MP}\right) = \left(1+r_{t-1}^{MP}\right)^{c_1^r}\left(\left(1+r_t^{Neutral}\right)\left(\frac{\pi_t^{core}}{\pi_{target}^{core}}\right)^{c_2^r}\left(\frac{Y_t}{\overline{Y}_t}\right)^{c_3^r}\right)^{(1-c_1^r)} \\ \sum_{i=1}^{6}\left(1+Cprem_{t+i}\right)\ *\ exp(\varepsilon_t^{r^{MP}})\end{aligned} \tag{28}$$

If the central bank also chooses to control exchange rate movements while preserving (some degree of) monetary policy autonomy, it needs to adopt capital account restrictions. The

restrictions cause a discrepancy in the uncovered interest rate parity (UIP) that is captured by $Cprem$. The UIP conditions with capital restrictions are

$$1 + r_t^{MP} = (1 + Cprem_t)\,(1 + r_t^*)\,\frac{S_t}{S_{t+1}}\tau^{B^*}\,\frac{\frac{\left(B_{t+1}^* - B_t^*\right)\pi_t^*\,\Delta\overline{G}}{P_{t+1}^C C_{t+1}^{\text{OLG}} Z_{t+1}}}{1 + \frac{B_t^*\left(B_t^* - B_{t-1}^*\right)}{P_t^C C_t^{\text{OLG}} Z_t}} * exp(\varepsilon_t^S) \tag{29}$$

where the last term results from restrictions on changes in households net foreign asset (NFA) positions. The parameter $capopen$ determines the extent of tolerated deviations of exchange rate (S) from the targeted value achieved by imposing capital account restrictions. The effect of restrictions is an endogenous "premium" ($Cprem$) which weakens the relationship between the domestic and foreign returns on capital. The trade-off between the exchange rate stabilisation objective and resulting premium is captured by the equation:

$$1 = \left(\frac{S_t}{S^{target}}\right)^{(1-capopen)} \left(\frac{1}{1 + Cprem_t}\right)^{capopen}. \tag{30}$$

When the $capopen$ is set to zero, the model operates as a closed capital account regime with a currency peg, effectively decoupling domestic and foreign interest rates (as if the UIP condition was not part of the model). When the $capopen$ is equal to one, the capital account is fully open, the UIP condition holds, and thus $Cprem$ equals zero at all times.

It is worth mentioning that $capopen$ does not represent any specific measures (e.g. taxes or administrative restrictions). It rather represents a weight the monetary policy puts on exchange rate stabilization achieved by imposing unspecified capital control measures. Stable $capopen$ does not imply stable capital flow restrictions either. The implicit capital control measures can be changing with stable $capopen$ depending on exchange rate pressures.

A.6 Fiscal policy

A.6.1 Debt Accumulation

The government budget constraint is

$$B_t = \frac{B_{t-1}}{\Delta\overline{G}\pi_t^{\text{core}}} + DEF_t = \frac{B_{t-1}}{\Delta\overline{G}\pi_t^{\text{core}}} + EXP_t - REV_t. \tag{31}$$

A.6.2 Government Expenditures

Expenditures (EXP) are broken into seven categories: government consumption (GC); public investment (GI); general subsidies ($GSUB$); transfers targeted to OLG and LIQ

households (STF^{OLG} and STF^{LIQ}); general (not targeted) transfers (GTF); and interest payments ($INTP$):

$$EXP_t = GC_t + GI_t + GSUB_t + STF_t^{\text{OLG}} + STF_t^{\text{LIQ}} + GTF_t + INTP_t. \tag{32}$$

Nominal interest payments are given by

$$INTP_t = r_{t-1}^B \frac{B_{t-1}}{\Delta \overline{G} \pi_t^{\text{core}}}. \tag{33}$$

The model takes into account the government energy subsidy system, $GSUB$, which is defined in equation 24.

The other expenditure items—government consumption, public investment, specific transfers to OLG and LIQ households, and general targeted transfers—are treated as a fixed proportion of GDP unless otherwise specified in scenario simulations.

A.6.3 Government Revenues

Similarly, revenues are broken into seven components: taxes on consumption (TAX^c); labor (TAX^l) and capital (TAX^k) income; tariffs on imports (TAX^m); lump sum taxes paid by OLG and LIQ households ($TAX^{\text{ls, OLG}}$ and $TAX^{\text{ls, LIQ}}$); and phosphate royalties ($RYLT^{phos}$).

$$\begin{aligned} REV_t = {} & TAX_t^C + TAX_t^L + TAX_t^K + TAX_t^M + TAX_t^{\text{ls, OLG}} \\ & + TAX_t^{\text{ls, LIQ}} + RYLT_t^{phos}. \end{aligned} \tag{34}$$

The individual categories are treated as a product of the relevant tax rate and tax base:

$$TAX_t^C = \tau_t^C \, C_t \tag{35}$$

$$TAX_t^L = \tau_t^L \, W_t \, L_t \tag{36}$$

$$TAX_t^K = \tau_t^K \left(PR_t^K - \delta \, Q_t \right) \frac{K_{t-1}}{\Delta \overline{G}} \tag{37}$$

$$TAX_t^M = \tau_t^M \, P_t^M \, M_t \tag{38}$$

Except for the tax on imports, the tax rates are exogenous; the import tax rate adjusts endogenously in order to stabilize the real exchange rate:

$$\tau_t^M = \bar{\tau}^M - c^{\tau^M} \Delta \log \left(Z_t \right) + \varepsilon_t^{\tau^M}. \tag{39}$$

Lump sum taxes are divided proportionally between the OLG and LIQ households:

$$TAX^{\text{ls, OLG}} = (1 - \lambda_{\text{LIQ}}) \, TAX_t^{\text{ls}} \tag{40}$$

$$TAX^{\text{ls, LIQ}} = \lambda_{\text{LIQ}} \, TAX_t^{\text{ls}}. \tag{41}$$

A.6.4 Fiscal Rules

The government targets a constant debt-to-GDP ratio ($B_t^{rat,\text{tar}}$). Overall and primary deficit-to-GDP ratios consistent with the debt target are thus:

$$DEF_t^{rat,\text{tar}} = B_t^{rat,\text{tar}} - \frac{B_t^{rat,\text{tar}}}{\Delta\overline{G}\pi_{target}^{\text{core}}} + \varepsilon_t^{DEF^{rat,\text{tar}}}, \tag{42}$$

$$PDEF_t^{rat,\text{tar}} = DEF_t^{rat,\text{tar}} - r_t^b \frac{B_t^{rat,\text{tar}}}{\Delta\overline{G}\pi_{target}^{\text{core}}} + \varepsilon_t^{PDEF^{rat,\text{tar}}} \tag{43}$$

The MOPAM has two main alternative fiscal policy rules. Policy can follow the rule for the overall deficit:

$$DEF_t^{rat} = DEF_t^{rat,\text{tar}} - 100 * c_1^{DEF} \log\left(\frac{Y_t^{\text{ExAgr}}}{\bar{Y}_t^{\text{ExAgr}}}\right) - c_2^{DEF}\left(B_t^{rat} - B_t^{rat,\text{tar}}\right) \tag{44}$$

or the rule for the primary deficit:

$$\begin{aligned} PDEF_t^{rat} = PDEF_t^{rat,\text{tar}} &- 100 * c_1^{PDEF} \log\left(\frac{Y_t^{\text{ExAgr}}}{\bar{Y}_t^{\text{ExAgr}}}\right) \\ &- c_2^{PDEF}\left(B_t^{rat} - B_t^{rat,\text{tar}}\right). \end{aligned} \tag{45}$$

Both rules aim at keeping government debt as targeted while allowing for countercyclical fiscal policy.

Because the fiscal rule on the overall or the primary deficit determines the total budget envelope, the MOPAM includes simple policy rules for revenue and expenditure components. Most of the tax rules assume constant rates, and expenditure rules assume constant spending-to-GDP ratios. For the fiscal block to work with either of the deficit rules, one of the budget components is always endogenously determined by the deficit rule and the rules on all other budget components. The choice of which budget component is treated as endogenous depends on the simulation.

A.7 External Sector

A.7.1 Current Account Balance and Net Foreign Assets

The current account balance, CB_t, is a sum of the trade balance, TB_t, net remittances inflow ($REMIT_t$), and the current value of the previous-period interest on net foreign assets (B^*):

$$CB_t = TB_t + REMIT_t + r_{t-1}^{B^*} * \left(\frac{S_{t-1} B_{t-1}^*}{S_t Z_{t-1} \pi_t^{\text{core}} \Delta \overline{G}} \right), \tag{46}$$

The export and import components of the trade balance will be explained later.

Remittances are modeled as

$$REMIT_t = REMIT_{t-1}^{c_1^{REMIT}} \left(\left(\frac{Z_t}{\tilde{Z}_t} \right)^{c_2^{REMIT}} Act_t^* c_3^{REMIT} \right)^{1-c_1^{REMIT}} \exp\left(\varepsilon_t^{REMIT}\right), \tag{47}$$

where $\tilde{Z}_t$ is a five-year moving average of the real exchange rate, Z_t, centered at the current year t. Act_t^* measures the extent of foreign economic activity and is defined as the weighted average of the outputs of foreign countries. The formulation of equation (47) makes remittances increase in foreign currency terms when the domestic currency appreciates (relative to the moving average exchange rate, $\tilde{Z}$) or foreign activity goes up (which implies that the incomes of the Moroccan diaspora also go up).

The NFA accumulation process assumes that the assets depend on the current account balance and the last-period value of NFA:

$$\frac{B_t^*}{Z_t} = CB_t + \left(\frac{S_{t-1} B_{t-1}^*}{S_t Z_{t-1} \pi_t^{\text{core}} \Delta \overline{G}} \right). \tag{48}$$

A.7.2 Exports

The MOPAM covers three export products: manufactured goods (X^{man}), food items (X^{food}), and phosphate (X^{phos}):

$$P_t^X X_t = P_t^{X^{\text{man}}} X_t^{\text{man}} + P_t^{X^{\text{food}}} X_t^{\text{food}} + P_t^{X^{\text{phos}}} X_t^{\text{phos}}. \tag{49}$$

Manufactured Exports

$$\begin{aligned} \Delta \log\left(X_t^{man}\right) = {} & c_1^{X^{man}} \Delta \log\left(Act_t^*\right) - c_2^{X^{man}} \Delta RCI_t \\ & + c_3^{X^{man}} \left(-c_4^{X^{man}} RCI_{t-1} + \log\left(\frac{Act_{t-1}^*}{X_{t-1}^{man}} \right) + c_5^{X^{man}} \right) \\ & + \Delta \varepsilon_t^{X^{man}}, \end{aligned} \tag{50}$$

where X_t^{man} denotes manufactured exports, Act_t^* is the foreign activity index, and RCI denotes the manufactured goods competitiveness index (see equation 56).

Food Exports

$$\begin{aligned}\Delta \log\left(X_t^{food}\right) &= c_1^{X^{food}} \Delta \log\left(Act_t^{*,food}\right) \\ &- c_2^{X^{food}} \Delta \log\left(RP_t^{*,food}\right) \\ &+ c_3^{X^{food}} \log\Big(\left(RP_{t-1}^{*,food}\right)^{-c_7^{X^{food}}} * \frac{Act_{t-1}^{*,food}}{X_{t-1}^{food}}\Big) \\ &+ c_5^{X^{food}} \left(\log\left(\frac{P_{t-1}^{*,food}}{P_{t-1}^{\text{Agr}}}\right) + c_8^{X^{food}}\right) \\ &+ c_6^{X^{food}} \left(\log\left(\frac{P_t^{*,food}}{P_t^{\text{Agr}}}\right) - \log\left(\frac{P_{t-1}^{*,food}}{P_{t-1}^{\text{Agr}}}\right)\right) \\ &+ \Delta\varepsilon_t^{X^{food}},\end{aligned} \tag{51}$$

where X_t^{food} denotes food exports, $Act_t^{*,food}$ is the foreign food activity index, $RP_t^{*,food}$ denotes world food prices relative to the world overall price level, $P_t^{*,food}$ denotes world food prices, and P_t^{Agr} denotes prices of domestic food production.

Phosphate Exports

$$\begin{aligned}\Delta \log\left(X_t^{phos}\right) &= c_1^{phos} \Delta \log\left(Act_t^{*,phos}\right) \\ &- c_2^{phos} \Delta \log\left(RP_t^{*,phos}\right) \\ &+ c_3^{phos} \left(\log\left(\left(RP_{t-1}^{*,phos}\right)^{-c_4^{phos}} \frac{Act_{t-1}^{*,phos}}{X_{t-1}^{phos}}\right) + c_5^{phos}\right) \\ &+ \Delta\varepsilon_t^{X^{phos}},\end{aligned} \tag{52}$$

where X_t^{phos} denotes phosphates exports, $Act_t^{*,phos}$ is the foreign phosphates activity index, and $RP_t^{*,phos}$ denotes world phosphate prices relative to world overall price level.

Foreign Activity Indexes and World Prices

Foreign activity is defined in terms of the trade weights of US and EU imports:

$$Act_t^* = \left(M^{US} * c_1^{US} + M^{EU} * c_2^{EU}\right). \tag{53}$$

Similarly, foreign food and foreign phosphate activity indexes are based on food and phosphate imports, taking into account the applicable trade weights.

The export prices of manufactured goods are given as:

$$\begin{aligned}\Delta \log\left(P_t^{X,man}\right) = {} & c_1^{PX^{man}} \Delta \log\left(P_t^{GDP,\text{ExAgr}}\right) \\ & + \left(1 - c_1^{PX^{man}}\right) \Delta \log\left(P_t^{*,man}\right) \\ & + c_2^{PX^{man}} \log\left(\frac{P_{t-1}^{GDP,\text{ExAgr}}}{P_{t-1}^{X,man}}\right) \\ & + c_3^{PX^{man}} + \varepsilon_t^{PX^{man}},\end{aligned} \tag{54}$$

where $P^{X,man}$ represents the domestic price of manufactured exports and $P^{*,man}$ the world price of manufactured goods which is defined as:

$$\begin{aligned}\log\left(P_t^{*,man}\right) = {} & w_{US}^{share} \log\left(P_t^{X^{US}} * Z_t^{US}\right) + w_{EU}^{share} \log\left(P_t^{X^{EU}} * Z_t^{EU}\right) \\ & - \log\left(Z_t\right).\end{aligned} \tag{55}$$

The difference relates to the manufactured goods competitiveness index:

$$RCI_t = \log\left(\frac{P_t^{X,man}}{P_t^{*,man}}\right). \tag{56}$$

For relative world food prices ($RP^{*,food}$) we differentiate between trend and cyclical components:

$$\log\left(RP_t^{*,food}\right) = \log\left(\overline{RP}_t^{*,food}\right) + \log\left(\widehat{RP}_t^{*,food}\right), \tag{57}$$

$\overline{RP}^{*,food}$ is the trend component and $\widehat{RP}^{*,food}$ is the cyclical component, where:

$$\log\left(\overline{RP}_t^{*,food}\right) = c_1^{\overline{RP}^{*,food}} + \varepsilon_t^{\overline{RP}^{*,food}} \tag{58}$$

and

$$\begin{aligned}\log\left(\widehat{RP}_t^{*,food}\right) = {} & c_1^{\widehat{RP}^{*,food}} \log\left(\widehat{RP}_{t-1}^{*,food}\right) + c_2^{\widehat{RP}^{*,food}} \log\left(\frac{Y_t^*}{\overline{Y}_t^*}\right) \\ & + \varepsilon_t^{\widehat{RP}^{*,food}}.\end{aligned} \tag{59}$$

World phosphate and oil prices relative to the world price level ($RP^{*,phos}$ and $RP^{*,oil}$) are defined the same way as food prices.

A.7.3 Imports

Imports consist of manufactured good (M^{man}), food (M^{food}), and oil (M^{oil}):

$$P_t^M M_t = P_t^{M^{man_{adj}}} M_t^{man} + P^{M_t^{food}} M_t^{food} + P^{M_t^{oil}} M_t^{oil}. \tag{60}$$

Manufactured Imports

Demand for manufactured goods imports, M_t^{man}, is a function of the domestic activity index (Act_t), applicable import tariffs, (τ_t^M), their price after import tariffs, ($P_t^{M_{adj}^{\text{man}}}$), and the non-agriculture real GDP gap, $\widehat{Y}_t^{\text{ExAgr}}$:

$$\begin{aligned}\Delta \log\left(M_t^{\text{man}}\right) = \; & c_1^{M^{\text{man}}} \Delta \log\left(Act_t\right) - c_2^{M^{\text{man}}} \Delta \log\left(P_t^{M_{adj}^{\text{man}}}\right) \\ & - c_3^{M^{\text{man}}} \log\left(\frac{1+\tau_t^M}{1+\tau_{t-1}^M}\right) \\ & + c_4^{M^{\text{man}}} \log\left(\left(P_{t-1}^{M_{adj}^{\text{man}}}\right)^{-m5} \frac{Act_{t-1}}{M_{t-1}} + c_6^{M^{\text{man}}}\right) \\ & + \; c_7^{M^{\text{man}}} \Delta \widehat{Y}_t^{\text{ExAgr}} + \Delta \varepsilon_t^{M^{\text{man}}}.\end{aligned} \tag{61}$$

The price of imported manufactured goods before import tariffs ($P_t^{M^{\text{man}}}$) is determined by the relative import shares of the US and the EU, their real exchange rates, export prices, and the domestic exchange rate:

$$\begin{aligned}\log\left(P_t^{M^{\text{man}}}\right) = \; & m_{US}^{share} \log\left(P_t^{X^{US}} * Z_t^{US}\right) + m_{EU}^{share} \log\left(P_t^{X^{EU}} * Z_t^{EU}\right) \\ & - \log\left(Z_t\right) + c^{P^{M^{\text{man}}}} + \varepsilon_t^{P^{M^{\text{man}}}}.\end{aligned} \tag{62}$$

Oil Imports

Demand for oil imports, M_t^{oil}, is modeled similarly:

$$\begin{aligned}\Delta \log\left(M_t^{\text{oil}}\right) = \; & c_1^{M^{\text{oil}}} \Delta \log\left(Act_t\right) - \; c_2^{M^{\text{oil}}} \Delta \log\left(P_t^{\text{oil}}\right) \\ & + \; c_3^{M^{\text{oil}}} \left(-c_4^{M^{\text{oil}}} \log\left(P_{t-1}^{\text{oil}}\right) + \log\left(\frac{Act_{t-1}}{M_{t-1}^{\text{oil}}}\right) + c_5^{M^{\text{oil}}}\right) \\ & + \; c_6^{M^{\text{oil}}} \Delta \widehat{Y}_t^{\text{ExAgr}} + \Delta \varepsilon_t^{M^{\text{oil}}}.\end{aligned} \tag{63}$$

Food Imports

The food import function also incorporates the effects of prices of domestic food production (P_t^{Agr}):

$$\begin{aligned}\Delta \log\left(M_t^{\text{food}}\right) = \; & c_1^{M^{\text{food}}} \Delta \log\left(Act_t\right) - \; c_2^{M^{\text{food}}} \Delta \log\left(\frac{P_t^{*,\text{food}}}{Z_t}\right) \\ & + \; c_3^{M^{\text{food}}} \left(-c_4^{M^{\text{food}}} \log\left(\frac{P_{t-1}^{*,\text{food}}}{Z_{t-1}}\right) - c_5^{M^{\text{food}}} \log\left(\frac{P_{t-1}^{*,\text{food}}}{Z_{t-1} P_{t-1}^{\text{Agr}}}\right)\right. \\ & \left. + \log\left(\frac{Act_{t-1}}{M_{t-1}^{\text{food}}}\right) + c_6^{M^{\text{food}}}\right) + \; c_7^{M^{\text{food}}} \Delta \widehat{Y}_t^{\text{ExAgr}} \\ & - c_8^{M^{\text{food}}} \Delta \log\left(\frac{P_t^{*,\text{food}}}{Z_t P_t^{\text{Agr}}}\right) + \Delta \varepsilon_t^{M^{\text{food}}}.\end{aligned} \tag{64}$$

A.7.4 Market Clearing Conditions

The MOPAM has three consumption goods: core, food, and oil. Therefore, total consumption is

$$P_t^C C_t = P_t^{\text{core}} C_t^{\text{core}} + P_t^{\text{food}} C_t^{\text{food}} + P_t^{\text{oil}} C_t^{\text{oil}}. \tag{65}$$

The total production consists of TAS and non-TAS production

$$P_t^Y Y_t = P_t^{GDP,ExAgr} Y_t^{ExAgr} + P_t^{Agr} Y_t^{Agr}, \tag{66}$$

and must equal aggregate demand:

$$P_t^Y \, Y_t = P_t^C \, C_t + P_t^I \, I_t \left(1 + \frac{q_1}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right) + P_t^G \, G_t + P_t^X \, X_t - P_t^M \, M_t \tag{67}$$

Consumption of food and oil must satisfy

$$C_t^{\text{core}} = M_t^{\text{oil}} \tag{68}$$

$$C_t^{\text{food}} + X_t^{\text{food}} = Y_t^{\text{Agr}} + M_t^{\text{food}}, \tag{69}$$

and total consumption is the sum of consumption of both types of household:

$$C_t = C_t^{\text{OLG}} + C_t^{\text{LIQ}}. \tag{70}$$

A.8 Calibration

Estimating the model size of a MOPAM for a country like Morocco is not feasible. Instead, we calibrate the model parameters to correspond with Moroccan data. We also use extensive predefined simulations to assess the behavior of the calibrated model and further improve the calibration. The tables below summarize the steady-state values for main MOPAM variables, the monetary policy rule coefficients and the assumptions about capital account openness.

Table 4. Real and Nominal Growth Rates, Percent

Variable	Value
Real GDP growth	3.500
Nominal GDP growth	5.570

Table 5. Nominal GDP by Expenditures, Percent

Variable	Value
Private consumption to GDP	58.60
Private investment to GDP	26.00
Government absorption to GDP	23.50
Trade balance to GDP	−8.10

Table 6. Nominal GDP by Source, Percent

Variable	Value
Export commodity production to GDP	82.90
Food production to GDP	13.00
Phosphates production to GDP	4.10

Table 7. Consumption Shares, Percent

Variable	Value
LIQ households share of consumption	47.82
Oil share of consumption	7.00
Food share of consumption	37.00

Table 8. Government Overview, Percent of Nominal GDP

Variable	Value
Government deficit	3.48
Primary government balance	2.29
Public debt	66.00

Table 9. Government Revenues, Percent of Nominal GDP

Variable	Value
Tariff revenues	0.80
Tax revenue	21.00
Consumption tax revenue	10.50
Capital tax revenue	5.24
Labor tax revenue	2.96
Phosphate royalties	0.52
Lumpsum tax revenue	0.98

Table 10. Government Expenditures, Percent of Nominal GDP

Variable	Value
Government expenditures	24.48
Government consumption	17.00
Government investment	6.50
Government subsidies	0.75
Interest cost	5.77

Table 11. Balance of Payments, Percent of Nominal GDP

Variable	Value
Current account balance	−4.33
Trade balance	−8.10
Remittances	6.10
Net foreign assets	−82.16

Table 12. Exports, Percent of Nominal GDP

Variable	Value
Total exports	35.00
Manufactured goods	26.00
Food	4.50
Phosphates	4.50

Table 13. Imports, Percent of Nominal GDP

Variable	Value
Total imports	43.10
Manufactured goods	32.10
Oil	7.00
Food	4.00

Table 14. Capital

Variable	Unit	Value
Capital stock	% of nominal GDP	179.310
Capital share of income	fraction	0.500
Depreciation rate of private capital	fraction	0.110
Return on private capital	Local currency yield (LCY) per unit of capital	0.243

Table 15. Labor, Percent

Variable	Unit	Value
Labor force	% of total population	40.95
Employment in agriculture	% of labor force	40.00
Unemployment rate	% of labor force	9.00
Labor age population	% of total population	65.00
Participation rate	% of labor age population	63.00
Labor income	% of nominal GDP	50.00

Table 16. Inflation Measures, Percent

Variable	Value
Headline CPI inflation	2.0
Core CPI inflation	2.0
Wage inflation	5.7

Table 17. Monetary policy and capital account strategy

Coefficient	Description	Value
$capopen$	Capital account openness	0.1
τ^{B^*}	NFA adjustment costs	0.6
c_1^r	MP rule inertia	0.3
c_2^r	Inflation gap weight	0.2
c_3^r	Output gap weight	0.0