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## A Simple Macrofiscal Model for Policy Analysis: An Application to Morocco

by Dániel Baksa, Aleš Bulíř, and Roberto Cardarelli



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**A Simple Macrofiscal Model for Policy Analysis: An Application to Morocco**[1]

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**Abstract**

The paper describes a semistructural macrofiscal approach to simulating and forecasting macroeconomic policies. The model focuses on only a few variables that are consistent with the New Keynesian framework. Thanks to its simplicity, it facilitates an initial and intuitive understanding of monetary and fiscal policy transmission channels, and their main impact on economic activity. The model is adapted to Morocco and we demonstrate its application with an illustrative scenario of policy responses to a slower-than-expected recovery from the Covid-19 pandemic, under different monetary policy and exchange rate regimes.

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[1] The views expressed in this paper are those of the authors and not necessarily those of the Moroccan authorities, the International Monetary Fund, or its Executive Board.

# Contents

## I. INTRODUCTION

In this paper, we develop a parsimonious, semi-structural model of the Moroccan economy, in order to assess how a few key shocks are propagated into the economy, their medium- and long-term impact, and the likely effect of alternative domestic macro-economic policy responses. We calibrate the model so that it captures key stylized facts of Morocco's economy, and use it to present a few scenarios of possible policy responses to the Covid-19 pandemic under different monetary policy regimes. In particular, we focus on differences across monetary and fiscal policy responses under a peg exchange rate regime, an intermediate monetary policy regime based on a peg with a band (the current one) and an inflation targeting regime with flexible exchange rate.

The model focuses on only a few variables that are consistent with the New Keynesian framework. The key benefit of this model is therefore that it limits the number of macroeconomically relevant variables while retaining theoretical consistency. For the sake of parsimony, we drop sectors and variables that are less relevant to the specific analysis or that cannot be modeled easily for Morocco. Similarly, as the supply side in the semi-structural models is largely exogenous, there is little to gain from modeling specific revenue and expenditure components. Therefore, in our model the fiscal authority chooses a single policy variable, the cyclically adjusted primary balance. While the model could be easily extended, or supplemented by satellite models, one would need to consider the cost of such extension in term of the likely loss of simplicity and tractability.

More complex, DSGE models for the Morocco economy are already available, including the Morocco Policy Analysis Model (MOPAM) developed by Bank Al-Maghrib (BAM) also with IMF technical assistance (Achour et al. 2021), and the model used in Sarr, Benlamine, and Munkacsi (2019). While gifted with a much richer structure, the complexity of these model makes them less usable for regular, more high frequency analysis of policy-relevant questions. The model presented here could hence be a useful addition to the standard toolkit available to analyze scenarios for macroeconomic policy.[2]

The rest of the paper is organized as follows: Section II describes the model, Section III discusses its calibration, Section IV illustrates its applications to assess potential policy responses to a slower than expected recovery of Moroccan economy to the Covid-19 shock, and Section V concludes.

## II. THE MODEL

We present a semi-structural, steady-state model: the dynamics embedded in the model describe the transition from one steady state to another, so that solving the model produces a

[2] This paper is part of a broader ICD project, "Financial Programming 2.0" (FP 2.0), which aims at developing and applying a suite of analytical tools and models, from almost pure accounting to sophisticated general equilibrium models, to facilitate better macroeconomic forecasting and policy analysis, both for TA and training delivery and for use at the Fund. Another example of this framework is a paper by Baksa, Bulíř, and Heng (2020).

transitional steady-state solution for its variables—over time they will vary because movements from one point to another are not instantaneous. In addition, because some variables are taken to be exogenous and thus treated as determined outside the model economy, they need not be at their steady-state values in any period. As attention has been centered on the "gap" between the steady-state estimate, $z_t^*$, and the observed value, $z_t$, it therefore becomes natural to convert all the variables in the model to the gap format, producing what are often called "gap models" or "trend-gap models."

We have extended the model to incorporate a rudimentary fiscal and debt-accounting block, recast it to annual frequency, and calibrated it to capture the stylized facts of Moroccan macroeconomic policies. It blends the New Keynesian emphasis on nominal and real rigidities and a role of aggregate demand in output determination with the real business cycle methods of DSGE modeling with rational expectations (Berg, Karam and Laxton 2006). Rather than deriving the baseline model from strictly microeconomic foundations, we pragmatically allow both backward- and forward-looking expectations and substantial inertia in the equations to match the data.

The model has five building blocks, as summarized in Figure 1:

- The *aggregate demand* is split into agricultural and nonagricultural parts. The nonagricultural demand equation is described by the IS curve that relates the level of real activity to expected and past real activity, the real interest rate, the real exchange rate, the fiscal impulse, and foreign demand. The agricultural part is described as an exogenous component.

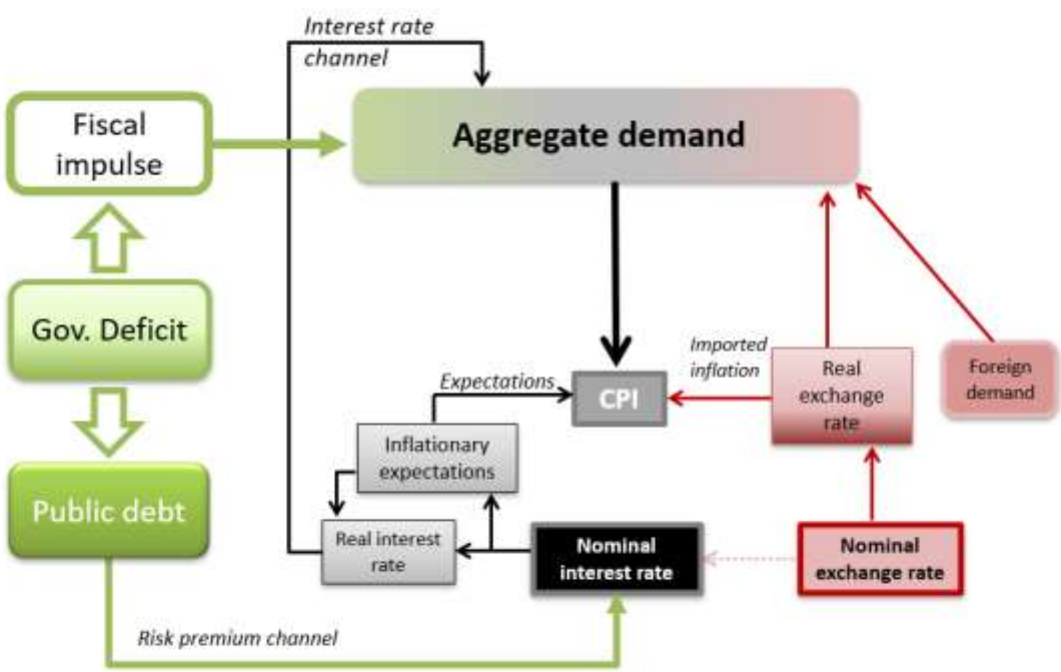
- Due to the relatively large weight of food, commodity and regulated prices, the model distinguishes the *core and non-core components of the CPI*. The Phillips curve gives price-setting equation for the core components that relates current inflation to past and expected inflation, the output gap, the exchange rate, and the pass-through of non-core items. The non-core prices are function of oil prices, agricultural production and exogenous shocks.

- The *monetary policy* framework reflects the existence of an exchange rate peg with a horizontal band, and a relatively closed capital account. This means that in our model the key exogenous monetary policy variable is the nominal exchange rate. However, limited capital mobility (mainly on resident investors) gives the central bank the ability to influence the market interest rate relative to the world interest rate. The interest rate is therefore a weighted average of the central bank policy rate and the uncovered interest parity (UIP) implied interest rate (that is, the foreign interest rate plus the country risk premium). Given Morocco's ongoing transition to an inflation targeting monetary policy framework, the model can also accommodate a different monetary policy regime, where the domestic interest rate is the main policy instrument set through a standard forward-looking policy reaction function and the exchange rate fully reflects UIP conditions (see Benlamine et al 2018).

- The model is expanded to incorporate a *fiscal policy reaction function*. The fiscal authority decides on a cyclically adjusted primary deficit, stabilizing output fluctuations with a countercyclical fiscal policy stance while at the same time stabilizing gross debt around a certain threshold. While Morocco does not have an explicit fiscal rule based on a gross debt anchor, the authorities' desire to stabilize debt is consistent with their commitment to long-term fiscal objectives, including under recent PLL arrangements with the IMF. These arrangements have assumed that Morocco's debt would stabilize at around 60 percent of GDP, a conventional prudential threshold for emerging market countries.

- The model also includes a *debt dynamic equation* and formalizes the authorities' choice of financing deficits through the accumulation of either domestic or foreign currency denominated debt. The level of net debt (defined as gross public debt less foreign reserves accumulated by the central bank) matters for market interest rates: when the gross public sector debt rises above its threshold level, the risk premium increases, and so does the neutral real interest rate. This effect can be partly offset by an increase of international reserves above their steady-state level.

**Figure 1. Key Links in the Moroccan Macrofiscal Model**




*Source*: The authors.

## A. Aggregate Demand

The aggregate demand relationship—the IS curve—links the domestic nonagricultural output gap to past and expected nonagricultural output gaps, monetary conditions, the fiscal stance, and the foreign output gap:

$$\hat{y}_t^{NAgr} = a_1 \hat{y}_{t-1}^{NAgr} + a_2 E_t \hat{y}_{t+1}^{NAgr} - a_3 mci_t + a_4 f_t^{imp} + a_5 \hat{y}_t^* + \varepsilon_t^y \,, \qquad (1)$$

where $\hat{y}_t^{NAgr}$ is the nonagricultural output gap, defined as the deviation of the log of real output from its trend; $mci_t$ denotes the real monetary conditions index; $f_t^{imp}$ is the fiscal impulse, $\hat{y}_t^*$ is the foreign output gap, and $\varepsilon_t^y$ is an aggregate demand shock.

All parameters—$a_i$, $b_i$, $e_i$, $f_i$, and $g_i$—have positive values and $E_t$ denotes model-consistent ("rational") forward-looking expectations. The gaps, denoted with *hats*, are calculated as differences of the actual (observed) variables from their estimated trends, denoted with *tildes*,

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

The real monetary conditions index ($mci$) is defined as a weighted average of the deviations of the real interest rate, the credit spread, and the real exchange rate from their trends:

$$mci_t = a_6(\hat{r}_t^{mix} + cr\_spread_t) + (1 - a_6)(-\hat{z}_t), \tag{2}$$

where $\hat{r}_t^{mix}$ is the weighted average of the deviation of one-year and longer-term domestic real government bond rates from their trend level; $cr\_spread_t$ is the exogenous credit spread; and $\hat{z}_t$ is the deviation of the real exchange rate from its trend. For simplicity, we assume that the one-year bond rate equals the domestic monetary policy rate (see Section II.C), while the longer-term rate is derived adding a term premium to the domestic monetary policy rate.[3]

The log of real exchange rate (see more in Section C) is defined as the nominal exchange rate adjusted for differences in the domestic and world inflation rates, $\Delta z_t = \Delta s_t^{MAD/EUR} + \pi_t^* - \pi_t$, where $s_t$ are units of domestic currency, the dirham, per euro; $\pi_t^*$ is the foreign and $\pi_t$ the domestic CPI inflation rate. Thus, an increase (decrease) in $z_t$ implies a more depreciated (appreciated) value of the domestic currency in real terms.

The fiscal impulse, $f_t^{imp}$, indicates whether current fiscal policy is adding to or subtracting from aggregate demand, and depends on the change in the cyclically-adjusted primary fiscal balance, $cad_t$, (see more on the $cad$ variable in Section D) and also a shock to the gross debt threshold ($f_4\varepsilon_t^{b^{tar}}$) :

$$f_t^{imp} = (cad_t - cad_{t-1}) + f_4\varepsilon_t^{b^{tar}}, \tag{3}$$

[3] Central banks control the short end of the yield curve and, hence, the policy rate is equivalent to both the short-term interbank rate and the short-term treasury bill rate. A longer-term rate with a maturity of $k$ quarters, $i_t^k$, is a function of all expected future policy rates. Hence, $i_t^k = i_t^{MP} + \sum_{i=1}^{k} \frac{E_t i_{t+i}^{MP}}{k} + tprem$, where $i_{t+i}^{MP}$ is the policy rate and $prem$ is a term premium (see Bulíř and Vlček (2021) for the empirical evidence for Morocco and other emerging market and low-income countries). Our model is in annual frequency and for simplicity we extend the policy control to the one-year bond, adjusted for risk premium.

where a positive (negative) value of the parameter $f_4$ captures the expansionary (contractionary) effects of a larger debt threshold.[4]

Monetary policy affects aggregate demand through the real exchange rate and the real interest rate gaps, as aggregated in the monetary conditions index, $mci_t$. Tighter monetary policy (a higher $mci_t$) reduces the output gap either through a higher real interest rate (a higher $\hat{r}_t$) or an appreciated real exchange rate (a lower $\hat{z}_t$). Fiscal policy directly affects aggregate demand through the fiscal impulse—the parameter $a_4$ is equivalent to the impact multiplier.

## B. Aggregate Supply

Within the aggregate supply block the inflation is separated into core and noncore part. The core inflation follows the market-driven behavior and the cyclical changes of the aggregate demand. The Phillips curve links core inflation, $\pi_t^{Core}$to forward-looking inflation expectations ($E_t\pi_{t+1}^{Core}$), backward-looking expectations ($\pi_{t-1}^{Core}$), and the real marginal costs ($rmc_t$).

$$\pi_t^{Core} = b_1\pi_{t-1}^{Core} + (1-b_1)E_t\pi_{t+1}^{Core} + b_2 rmc_t + \varepsilon_t^{\pi,Core} \quad , \tag{4}$$

$$rmc_t = b_3\hat{y}_t^{NAgr} + (1-b_3)\hat{z}_t^{Core}. \tag{5}$$

The term *rmc* captures the weighted average of the real marginal costs for domestic nonagricultural producers (proxied by the output gap, $\hat{y}_t^{NAgr}$) and those for importers (proxied by the core-based real exchange rate gap, $\hat{z}_t^{Core}$). The core-based real exchange rate is defined as the dirham-to-euro exchange rate adjusted for the difference between the foreign and domestic core inflation ($\Delta z_t^{Core} = \Delta s_t^{MAD/EUR} + \pi_t^* - \pi_t^{Core}$).[5] The calibrated value of $b_1$ is our best guess about the share of backward-looking agents in the price-setting process. The product $b_2 \cdot b_3$ measures the slope of the Phillips curve with respect to the non-agricultural output gap.

Noncore inflation contains all regulated prices, commodity prices, and volatile food prices. Its dynamics depends on administrative decisions, global price developments, and the exchange rate and it is modeled using the "noncore Phillips curve" equation:

$$\pi_t^{NCore} = b_4\pi_{t-1}^{NCore} +$$

$$(1-b_4)(\pi_t^{Tar,NCore} - b_5\hat{y}_t^{Agr} - b_6(1-w_{CPI})\widehat{rp}_t) + b_7\Delta\pi_t^{Oil} + \varepsilon_t^{\pi,NCore} \,, \tag{6}$$

---

[4] The latter case, $f_4$ <0, is of course equivalent to expansionary fiscal consolidations as in Alesina and Ardagna (2010).

[5] The adjusted real exchange rate implicitly means that the nonagricultural producers compare their prices to foreign ones, and disregard the real exchange rate volatility that arises from domestic food and non-core prices.

where the $\hat{y}_t^{Agr}$ denotes the agricultural output gap, $\widehat{rp}_t$ denotes the relative price gap between the noncore and core prices that captures the pass-through from core in noncore components, and $\Delta\pi_t^{Oil}$ denotes imported oil price inflation.[6]

Total inflation is then the weighted average of the two components:

$$\pi_t = w_{CPI}\pi_t^{Core} + (1 - w_{CPI})\pi_t^{NCore}.$$

As is common in models that are designed to capture business cycle fluctuations, aggregate supply is largely an exogenous process. The economy grows along a calibrated potential output path that can be altered by either movement in the equilibrium real interest rate or by non-Keynesian expectations of future fiscal policies. This limitation of macroeconomic models is often addressed in policy simulation scenarios using expert judgment, for example, by augmenting the steady-state rate of potential growth. We return to the debt-to-potential-growth nexus in Section II.D.

### C. The Exchange Rate, Uncovered Interest Rate Parity, and the Policy Reaction Function

*Current regime (peg plus band)*

The exchange rate and monetary policy regimes are modeled to reflect Morocco's ongoing transition toward an inflation targeting regime with a more flexible exchange rate.[7] Currently, Morocco monetary policy framework is based on an exchange rate peg regime, with a horizontal band of ±5 percent, and a relatively closed capital account. Under the interim regime the Dirham's nominal exchange rate against the Euro is determined by the weighted average of two effects: (1) the currency basket; (2) the market effect that adds volatility to the exchange rate through the fluctuation band. The calibrated weight considers the recent volatility of the nominal exchange rate and the progress the central bank achieved in the way of transition:

$$s_t^{MAD/EUR} = \omega^{PEG} s_t^{MAD/EUR,PEG} + (1 - \omega^{PEG}) s_t^{MAD/EUR,FL}, \qquad (7)$$

where $\omega^{PEG}$ denotes the weight of the currency basket-based exchange rate $s_t^{MAD/EUR,PEG}$ and $s_t^{MAD/EUR,FL}$ is the implicit exchange rate that adds more volatility to the exchange rate through the uncovered interest rate parity condition.

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[6] Under the current monetary regime, the nominal anchor is the exchange rate peg. One can derive the steady state value for core inflation (an implicit core inflation target) and, after adjusting for the trend in relative prices, also the steady state value for noncore inflation (an implicit noncore inflation target, $\pi_t^{Tar,NCore}$).

[7] The Mundell-Fleming trilemma says that a country must choose between the objectives of free capital mobility, exchange-rate management, and monetary autonomy, as only two can be pursued simultaneously (Obstfeld, Shambaugh, and Taylor 2005).

The currency basket is defined as the weighted average of the exchange rate vis-à-vis the Euro and the US dollar, with weights equal to 60 and 40 percent, respectively:

$$
\begin{aligned}
s_t^{Basket} &= \omega^s s_t^{MAD/EUR,PEG} + (1-\omega^s) s_t^{MAD/USD,PEG} \\
&= s_t^{MAD/EUR,PEG} + (1-\omega^s) s_t^{EUR/USD},
\end{aligned} \tag{8}
$$

where $s_t^{Basket}$ is decided exogenously by the central bank. Since the authorities have no control over the cross-exchange rate, then through the currency basket, they also impose an implicit target for the $s_t^{MAD/EUR,PEG}$.

Adding flexibility through the fluctuation bands implies a bigger role for market forces in determining the exchange rate in the short run, and this channel is modeled by the uncovered interest parity condition:

$$
s_t^{MAD/EUR,FL} = E_t s_{t+1}^{MAD/EUR} + i_t^{EUR} - i_t + prem_t + \varepsilon_t^s, \tag{9}
$$

where the volatile part of the exchange rate depends on the expected nominal exchange rate, foreign and domestic interest rate differentials $i_t^{EUR} - i_t$ and the risk premium $prem_t$, $\varepsilon_t^s$ denotes the transitory shock to the exchange rate.

It is useful to recall what a credible exchange rate commitment implies for competitiveness: the country cannot restore price competitiveness by devaluing the nominal exchange rate. In the case of Morocco, the currency is still constrained by the central parity of the peg, irrespective of the width of the fluctuation band. Should the real exchange rate become misaligned—for example, overvalued due to either a negative productivity shock or higher domestic inflation relative to its trading partners—the eventual realignment must come through lower-than-trading-partner wage and price inflation, i.e., internal devaluation. The peg is then effectively equivalent to a price-level targeting regime that ensures that purchasing power parity (PPP) holds in the medium term. Thus, in our notation

$$
\Delta\tilde{z} = \Delta\tilde{s}^{MAD/EUR} + \pi^{Tar,EUR} - \pi^{Tar}, \tag{10}
$$

where $\tilde{z}$ denotes the trend rate of growth of the real exchange rate, i.e., "equilibrium" appreciation or depreciation; $\tilde{s}^{MAD/EUR}$ is the trend rate of growth of the nominal exchange rate; and $\pi^{Tar,EUR}$ and $\pi^{Tar}$ indicate foreign and domestic inflation objectives. As long as the nominal exchange rate is pegged ($\Delta\tilde{s}^{MAD/EUR} = 0$) and the country desires to keep price competitiveness at the current level (hence, $\Delta\tilde{z} = 0$), foreign and domestic price levels have to grow at the same pace over the medium term, $\pi^{Tar,EUR} = \pi^{Tar}$.

Due to the presence of capital controls (mainly limiting residents' access to foreign assets), in the short run the central bank can set the domestic policy rate independently from external considerations, while keeping an exchange rate peg. However, in the long run the central bank needs to accommodate foreign financial conditions, as implied by the real UIP and purchasing power parity conditions. Thus the interest rate that affects the behavior of economic agents in the IS schedule (Equation 1 and 2) has two components: (1) a peg-based interest rate, with a weight of $\omega^{PEG}$; (2) a $(1-\omega^{PEG})$ weighted shadow interest rate consistent with a flexible exchange rate and inflation targeting (or some other price-stability oriented regime). The peg-based interest rate is the weighted average of two components: (1) the policy rate set by Bank Al-Maghrib to keep expected inflation around a desired level (the first term in square brackets, weighted by $c_1$) and (2) the 'financial market driven' interest rate as implied by shadow UIP conditions proxied by the expected exchange rate depreciation and foreign interest rate (the second term in square brackets, weighted by $(1-c_1)$ :

$$\begin{aligned} i_t = \omega^{PEG} \Big[ & c_1[c_2 i_{t-1} + (1-c_2)(\tilde{i}_t + c_3(E_t\pi_{t+1} - \pi^{Tar}))] \\ & + (1-c_1)\big[E_t \Delta s_{t+1}^{MAD/EUR} + i_t^{EUR} + prem_t\big]\Big] + \\ & +(1-\omega^{PEG})[c_1^{IT} i_{t-1} + (1-c_1^{IT})(\tilde{i}_t + c_2^{IT}(E_t\pi_{t+1} - \pi^{Tar}))] \\ & +\varepsilon_t^i, \end{aligned} \tag{11}$$

The parameter $c_1$ denotes the ability of the central bank to set, through its sterilization policy, a domestic interest rate that is different from the foreign one, thus effectively proxying the impact of capital controls. The IT-based part, weighted by $(1-\omega^{PEG})$, is the function of the interest rate smoothing and central bank's reaction to the inflation gap. In the current regime with a more flexible exchange rate the additional inflationary reaction through $c_2^{IT}$ is needed to stabilize prices and cyclical fluctuations. In summary, the parameter $\omega^{PEG}$ provides a convenient proxy to capture the degree to which the economy is insulated by the capital flow controls and foreign exchange interventions. Finally, $\varepsilon_t^i$ denotes the monetary policy shock.

The risk premium is expected to increase (decrease) as government net debt (defined as gross public debt less central bank foreign reserves) raises (falls) relative to the threshold:

$$prem_t = c_4 prem_{t-1} + (1-c_4)\big[\overline{prem} + c_5[(b_t - b_t^{tar}) - (res_t - res_t^{tar})]\big] + \varepsilon_t^{prem}, \tag{12}$$

where the $\overline{prem}$ is the steady-state level and $(1-c_4) * c_5$ is the elasticity of the risk premium vis-à-vis public net debt.[8]

*Inflation targeting regime*

The structure of the model can be easily changed to accommodate a different monetary and exchange rate regime. For example, under an inflation targeting regime the inflation target $(\pi^{Tar})$ becomes the new nominal anchor and the central bank sets the interest rate according to a forward-looking policy reaction function to keep inflation from deviating from the target:

$$i_t = c_1^{IT} i_{t-1} + (1-c_1^{IT})(\tilde{i}_t + c_2^{IT}(E_t\pi_{t+1} - \pi^{Tar})) + \varepsilon_t^i, \tag{13}$$

[8] As shown in the calibration section, the debt elasticity of risk premium is calibrated to be fairly small at 0.03 (or 3 basis point for each 1-percent increase in debt), based of the available empirical evidence (Schumacher and Żochowski 2017). In reality, risk premiums behave in a nonlinear way: they tend to move little when debt remains at low levels but could move a lot when the new level of debt is deemed "unsafe." Of course, the inflection point is virtually impossible establish in advance as it is state dependent (Jaramillo and Weber 2012).

In this regime, the nominal exchange rate is an endogenous variable that moves according to the UIP also in the short run.[9]

$$\Delta s_t = [E_t \Delta s_{t+1} + i_t^{EUR} + prem_t] + \varepsilon_t^s, \qquad (14)$$

While the switch to a different monetary policy regime is likely to have long-run consequences on the structure of the economy, for the sake of scenario comparability, we keep the rest of the model and its calibration unchanged.[10]

## D. The Fiscal Block

The model is closed with an aggregated fiscal block that anchors expectations of the public about fiscal sustainability and links the fiscal policy (flow) variable with financing (stock) variables. Here, the fiscal authority decides on a sole policy variable, namely the cyclically adjusted primary balance, guided by the country's cyclical position and its debt-to-GDP ratio. We justify this high level of aggregation by noting that our semi-structural framework has an exogenously set supply side: the rate of potential growth does not depend on the mix of direct and indirect taxes, or fiscal spending, but it is calibrated and assumed to remain constant for the duration of the simulations. Identifying fiscal revenues or expenditures separately would thus add little to the model, given the lack of feedback to the supply side. While aggregating all fiscal operations into a single variable prevents a more granular analysis of multipliers and composition effects of fiscal policy, such decomposition is better left for a fully micro-founded DSGE model. Also, the specific revenue/spending composition of fiscal policy can be reflected in this model simply by changing the calibration of the aggregate fiscal multiplier parameter.

The fiscal policy process involves two separate decisions: (1) the policymaker decides on the cyclically adjusted primary fiscal deficit ($cad_t$)[11] and (2) on whether to finance the fiscal deficit through foreign or domestic debt accumulation (or how to repay debt, if there is a surplus).

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[9] In the model, the objective of a smooth nominal exchange rate trajectory is achieved through the design and calibration of the UIP—we want to avoid having an explicit exchange rate objective in the policy reaction function.

[10] In the long run, one would expect the monetary regime change to significantly affect the behavior of agents in the economy. For example, the relative weight of backward- and forward-looking expectations in the Phillips curve would change; the curve itself would become flatter; the increased volatility of the nominal exchange rate would affect the composition of the monetary conditions index in the aggregate demand equation; and so on.

[11] The cyclically adjusted budget balance is the balance that would obtain when GDP reaches its potential. The cyclically adjusted measure better describes the stance of fiscal policy than the headline balance, as it removes the endogenous components of spending and revenues. In our model we use the common definition of the cyclically adjusted balance, see Fedelino and others (2009): $cad = -\epsilon\hat{y}$, and our calibration of $\epsilon$ follows Price and others (2015).

The first decision is based on a fiscal policy reaction function with two competing objectives. First, the fiscal authority wants to avoid large swings in the fiscal balance compared to last period but also to smooth output fluctuations, by responding to a positive or negative output gap ($\hat{y}_t$) with a tighter or looser deficit. Second, the authorities want to stabilize gross public debt around a certain threshold level, and therefore set the cyclically-adjusted balance to a level that is ex-ante consistent with that threshold ($cad_t^{tar}$) adjusted for the current-period deviation of debt from such level ($b_t^{dev}$). Intuitively, a higher-than-targeted debt ($b_t^{dev} > 0$) implies a tighter fiscal policy in the future, producing either a surplus or a smaller deficit than in the case of no deviation ($b_t^{dev} = 0$)

$$cad_t = f_7(cad_{t-1} - f_{10}\hat{y}_t) + (1 - f_7)(cad_t^{tar} - f_8 b_t^{dev}) + \varepsilon_t^{cd}. \quad (13)$$

The obvious implication of these two competing objectives is that, in the short run, neither might be fully achievable: while the fiscal authority facing a negative output gap may want to stimulate the economy by running a larger cyclically adjusted deficit, it could be held back by debt concerns. Similarly, a desire to lower debt could be held back by concerns about a lack of domestic demand. The deviation from the debt target ($b_t^{dev}$) is a forward-looking process as the fiscal authority assesses both the current deviation and the expected future path, where the debt target itself could be time-varying:

$$b_t^{dev} = f_9(b_t - b_t^{tar}) + (1 - f_9)E_t b_{t+1}^{dev}. \quad (15)$$

The government also decides about the structure of deficit financing. Gross public debt ($b_t$) has both a domestic and a foreign component. Domestic debt is decomposed further into one-year ($b_t^{1Y}$) and five-year ($b_t^{5Y}$) maturities, while foreign debt ($b_t^{F5Y}$) has maturity of five years:

$$b_t = b_t^{1Y} + b_t^{5Y} + b_t^{F5Y} \quad (16)$$

For one-year domestic debt the law of motion is the usual:

$$b_t^{1Y} = \theta_t^{1Y}(d_t + \Delta x_t) + b_{t-1}^{1Y}/(1 + g_t), \quad (17)$$

where $\theta_t^{1Y}$ is the time-variant share of the deficit financed with one-year domestic bonds. The law of motion for the five-year domestic bond is the sum of the new and last four years of bond issuances.

$$\begin{aligned} b_t^{5Y} &= b_t^{5Y,New} + b_{t-1}^{5Y,New}/(1 + g_t) \\ &+ b_{t-2}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})] + b_{t-3}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})] \\ &+ b_{t-4}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})(1 + g_{t-3})], \end{aligned} \quad (18)$$

where the new bond issuance is given as

$$b_t^{5Y,New} = \theta_t^{5Y}(d_t + \Delta x_t) + b_{t-5}^{5Y,New}/[(1+g_t)(1+g_{t-1})(1+g_{t-2})(1+g_{t-3})(1+g_{t-4})], \quad (19)$$

where $\theta_t^{5Y}$ is the share of the deficit financed with the five-year bonds, and the second term of the equation is the renewal of the five-year domestic bond.

## III. Calibration and Model Validation

We iteratively calibrate the model to capture the country-specific features as suggested by Berg, Karam, and Laxton (2006). The adequacy of the model for policy analysis depends primarily on how well it captures the main transmission channels and whether it generates cyclical variables consistent with a commonly accepted narrative on Moroccan economy. We are guided by two main numerical and visual guideposts. First, can the model reproduce the pattern of unobserved variables (such as potential output or the equilibrium real exchange rate) that would be consistent with the generally accepted narrative about the Morocco business cycle? Second, does the model generate reasonable recursive forecasts, with inflation and output converging to their steady-state values over the medium term?

To a certain extent, however, past developments are an imperfect guide for calibration if the economic structure is changing or if policy changes are envisaged, as it is the case of Morocco. The ongoing transition to inflation targeting is a good example: we have no way of knowing how Bank Al Maghrib would behave in this new regime and the past does not provide much guidance. The modeler would instead need to take a stand on what type of the monetary and fiscal policy reaction functions can be envisaged for Morocco once that transition occurs, specifically, whether it will it be more or less aggressive than in other emerging market central banks.

Our calibration strategy is thus an eclectic one: whenever available, we base the calibration on previously published models for Morocco (e.g., Benlamine and others 2018; Achour and others 2021). Alternatively, we apply judgement based on the relevant literature and past staff practice on modeling for emerging market economies. The calibrations are then iteratively fine-tuned to obtain a “reasonable” and “intuitive” path of unobservable variables, such as the output gap and the real exchange rate gap (Geweke 1999, Fukac and Pagan 2010). Rarely, and only for autoregressive terms, we were guided by OLS regressions. Table 1 provides a list of the main parameters and the calibration choice behind them.

Table 1: Main Parameters and Steady-State Values

| Code | Value | Parameter role | Calibration choice and justification |
|---|---|---|---|
| | | Business cycle parameters | |
| $a_1$ | 0.3 | Output gap persistence | OLS; iterative adjustment |
| $a_2$ | 0.1 | Forward-looking part of aggregate demand | Iterative adjustment; comparative studies |
| $a_3$ | 0.125 | Elasticity of the output gap wrt monetary conditions | Iterative adjustment; comparative studies |
| $a_4$ | 0.6 | Elasticity of the output gap wrt the fiscal impulse | OLS; staff judgment |
| $a_5$ | 0.35 | Elasticity of the output gap wrt foreign demand | OLS; iterative adjustment |
| $b_1$ | 0.35 | Core inflation persistence | OLS; iterative adjustment |
| $b_2$ | 0.065 | Elasticity of core inflation wrt marginal cost | OLS; iterative adjustment |
| | | | |
| | | Monetary Policy Parameters | |
| $\omega^{PEG}$ | 0.8 | The degree to which the economy is insulated from external developments | Current regime; staff judgment |
| $\omega^{PEG}$ | 0.5 | The degree to which the economy is insulated from external developments | Regime with a more extensive use of the ER band; staff judgment |
| $\omega^{PEG}$ | 0.0 | The degree to which the economy is insulated from external developments | Floating exchange rate and inflation targeting; staff judgment |
| $c_1$ | 0.5 | Central bank sterilization capacity under the peg | Staff judgment |
| $c_2$ | 0.6 | Central bank interest rate smoothing under the peg | OLS; iterative adjustment |
| $c_3$ | 0.2 | Central bank inflation aversion under the peg | Staff judgment |
| $c_4$ | 0.75 | Risk premium persistence | Iterative adjustment |
| $c_5$ | 0.03 | Elasticity of the risk premium with respect to debt and international reserves | Schumacher and Żochowski, (2017); iterative adjustment |
| $c_1^{IT}$ | 0.3 | Central bank interest rate smoothing under IT | Annualized from Benlamine et al, 2018 |
| $c_2^{IT}$ | 2.5 | Central bank inflation aversion under IT | Benlamine et al, 2018 |
| | | | |
| | | Fiscal Policy Parameters | |
| $f_7$ | 0.6 | Fiscal policy smoothing | Iterative adjustment; staff judgment |
| $f_8$ | 0.05 | Debt aversion | Iterative adjustment; staff judgment |
| $f_9$ | 0.5 | Debt smoothing | Iterative adjustment; staff judgment |

| | | | |
|---|---|---|---|
| $f_{10}$ | 0.2 | Reaction of fiscal policy to the output gap | Iterative adjustment; staff judgment |
| | | | |
| Steady-state parameters | | | |
| $\overline{prem}$ | 1 | Long-term risk premium | Calibrated to match the historic interest rate differential |
| $\Delta\bar{z}$ | 0 | Long-term (trend) real appreciation | Calibrated to match the historical average |
| $\Delta\bar{y}^{NAgr}, \Delta\bar{y}^{Agr}$ | 4 | Long-term nonagricultural and agricultural GDP growth | Calibrated to match the historical averages |
| $\tilde{\pi}$ | 2 | Implied inflation target | Calibrated to match the PPP with $\Delta\bar{z} = 0$ |
| $\bar{b}^{tar}$ | 0.6 | Long-term debt-to-GDP ratio | Calibrated to match the debt threshold in IMF-supported arrangements |
| $\bar{b}^{1Y,tar}$ | 0.05 | One-year debt-to-GDP ratio | Calibrated to match the historical average |
| $\bar{b}^{5Y,tar}$ | 0.4 | Five-year debt-to-GDP ratio | Calibrated to match the historical average |
| $\overline{res}^{tar}$ | 0.22 | International reserves-to-GDP ratio | Calibrated to match the historical average |

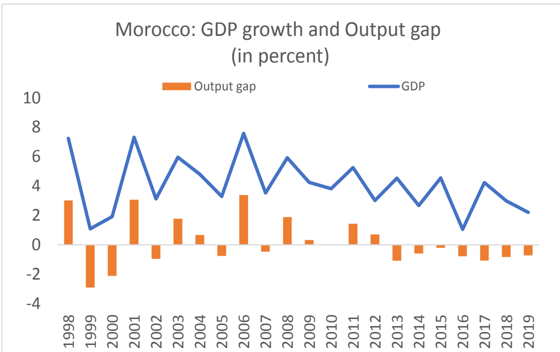
To validate our calibration strategy, we look at key impulse response functions, the estimation of unobserved variables, and recursive forecasts.

**Impulse Responses**

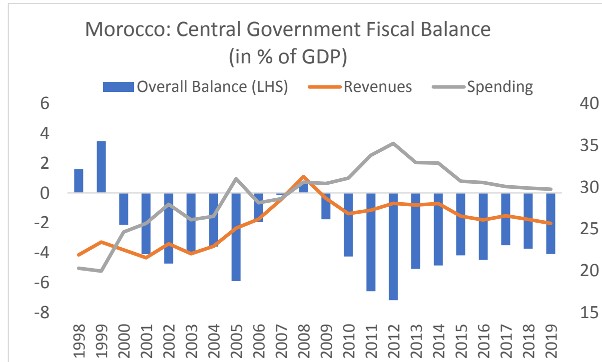
Impulse response functions (IRFs) are the traditional way of assessing model performance, whereby model-based IRRs are typically compared with regression-based IRFs. The model calibration is then fine-tuned so that the model IRFs replicate the empirical IRs. Of course, there is no formal "goodness of fit" test for the model-based IRFs. In the absence of empirical IRFs, as in the Morocco case, we mostly rely on expert judgment whether the shape of the IRFs corresponds to "reasonable" path of the key variables. Whenever possible, we were guided by the observed behavior of key macroeconomic variables in the past (Figure 4). As a reminder, the underlying monetary policy framework for these IRFs is based on an exchange rate peg regime, with a horizontal band, and a relatively closed capital account.

## Figure 4. Main Macro Economic Developments in Morocco, 1998-2019

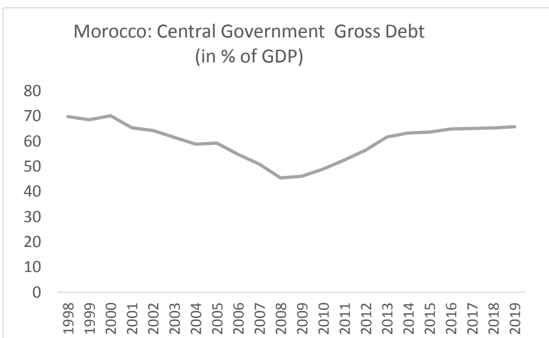
*GDP growth stabilized and accelerated from the 1990s but has slowed somewhat since the late 2000s.*



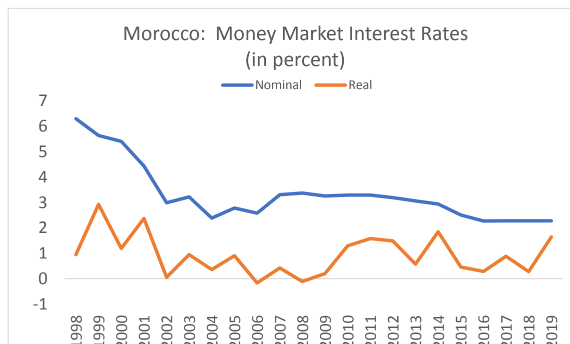

*Stronger revenues improved the fiscal balance before 2008, while greater spending (mainly relecting higher energy subssidies) and stagnant revenues fueled deficits post-GFC.*



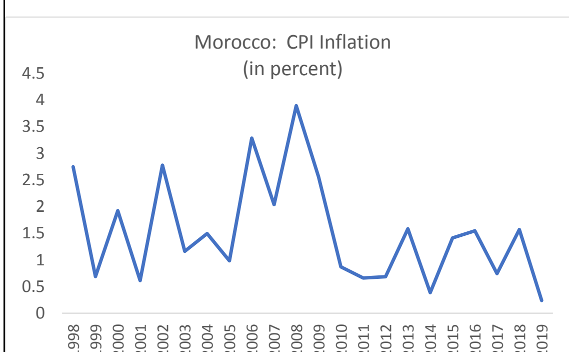

*Slower growth and persistent fiscal deficits have stabilized the debt ratio at higher levels than the minimum reached in 2008.*



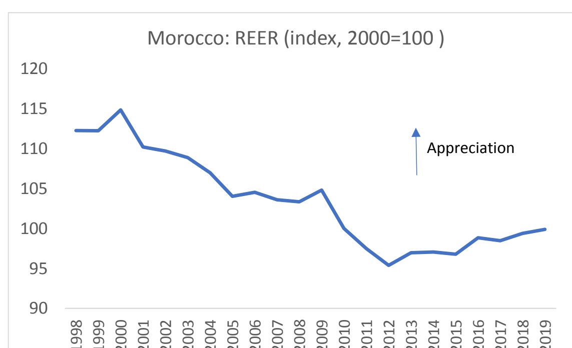

*Both nominal and real interest rates fell ahead of the GFC, and have remained relatively stable thereafter.*




*Slower growth, together with lower energy prices and global low-inflation environment, may help explain weaker inflation pressures since the mid-2010s.*




*The REER appreciated somewhat since 2012, after a steady depreciation over the previous decade.*



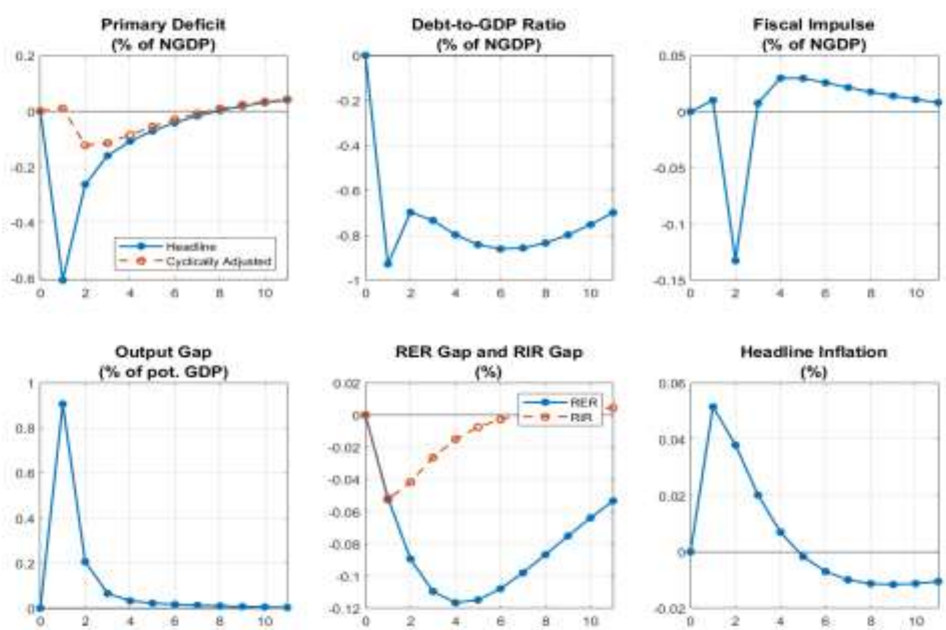

*Source: IMF WEO and IFS.*

We consider three impulse responses: (1) *an aggregate demand shock*, defined as an unexpected opening of a positive (non-agricultural) output gap by 1 percentage point for one year; (2) *a risk premium shock*, defined as an unexpected increase in foreign interest rates by 1 percentage point for one year; and (3) *a fiscal shock*, defined as an unexpected one-year increase of the primary deficit by 1 percentage point of GDP.

- *A temporary positive aggregate demand shock.* As shown in Figure 3, greater tax revenues and lower cyclically adjusted spending bring the headline primary balance into a surplus, although the cyclically adjusted primary balance deficit initially increases because of the positive output gap. The debt-to-GDP ratio initially falls, and the fiscal authority start bringing it back to its steady state level by slowly moving to a deficit. While the nominal exchange rate does not move, domestic inflation increases, causing the real exchange rate to appreciate relative to the steady state, which tightens the monetary policy stance. Though the output gap closes in about five years, gross debt, inflation, or the exchange rate all take longer to return to the steady state, reflecting the calibrated gradual fiscal policy response. Such a slow moving dynamics of public debt, inflation, and real effective exchange rate seems to fit with the observed behavior of these variables in Morocco over the last 30 years—a period in which these variables have moved more as a result of structural changes in economic and policy frameworks than in response to the economic cycle (see Figure 4).

**Figure 3. Dynamic Responses to a Surprise One-Year 1 Percentage Point Increase in the Nonagricultural Output Gap, Exchange Rate Peg with a Band**

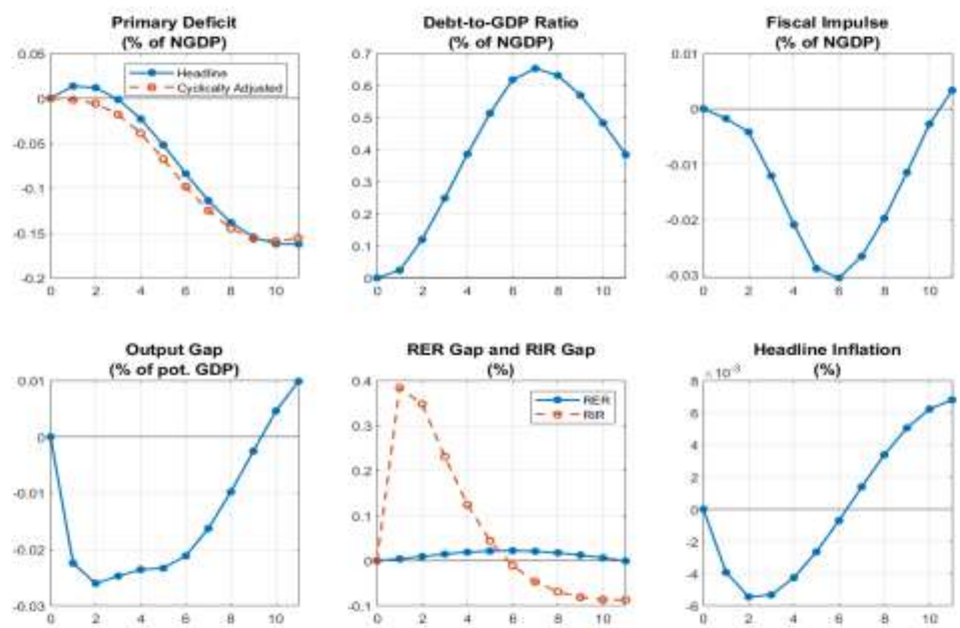
(Shock-minus-Control Responses)




*Notes*: The figure depicts dynamic responses to an increase in the domestic output gap at *t* =1; the fiscal impulse is measured as the difference between the cyclically-adjusted primary deficit in *t* and *t*-1; the RER (real exchange rate) gap is measured as the difference between the current-period value of the real exchange rate and its equilibrium value of the real exchange rate; and the RIR (real interest rate) gap is measured as the difference between the current-period value of the real interest rate and the rate's equilibrium value.

- *A risk premium shock*. Figure 5 illustrates the first-order implications of a short-lived monetary tightening abroad. The real domestic interest rate, $r_t$, increases to accommodate the interest rate increase from abroad, tightening the monetary policy stance. The adverse output impact is relatively small compared to the increase in the debt-to-GDP ratio, so the fiscal authority gradually tightens its stance, attempting to bring the debt level back to the steady state. Relative to the baseline, the primary balance improves by 10-15 basis points. It is worth noting that the return to the steady state takes more than 10 years, even though the initial shock was for one year only. This impulse response fits the post-GFC fiscal consolidation episode in Morocco, which was relatively gradual and only stabilized the public debt to GDP ratio rather than placing it immediately on a downward trend.

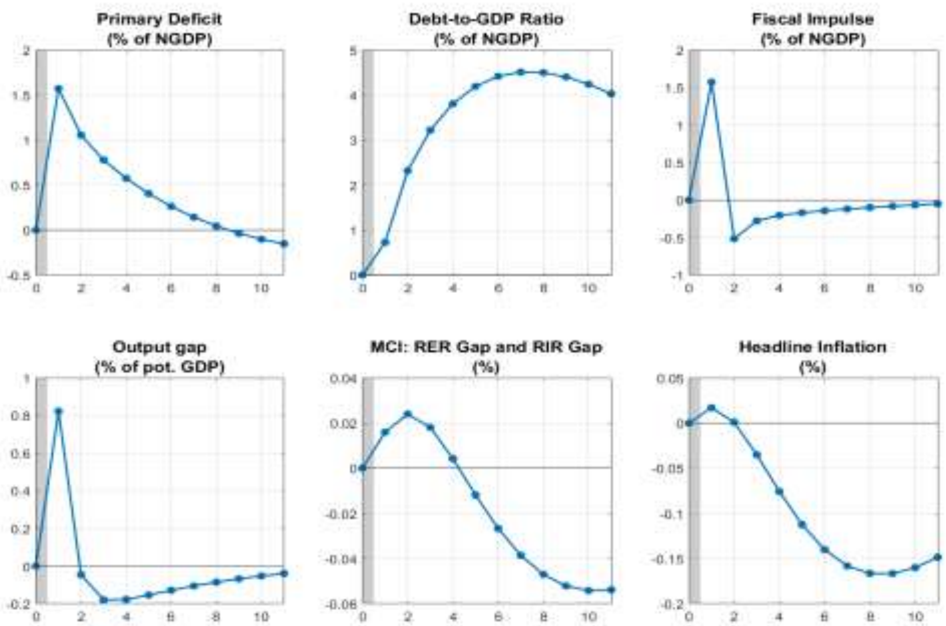
**Figure 5. Dynamic Responses to an Unexpected 1 Percentage Point Rise in the Country Risk Premium for One Year, Exchange Rate Peg with a Band**
(Shock-minus-Control Responses)




*Notes*: The figure depicts dynamic responses to an increase in the primary deficit at *t* =1; the fiscal impulse is measured as the difference between the cyclically-adjusted primary deficit in *t* and *t*-1; the RER (real exchange rate) gap is measured as the difference between the current-period value of the real exchange rate and its equilibrium value; and the RIR (real interest rate) gap is measured as the difference between the current-period value of the real interest rate and the rate's equilibrium value.

- *A fiscal expansion:* after the increase of the primary deficit by 1 percent of GDP (Figure 6), the authorities try and bring the gross debt back to the target level through a long series of primary surpluses, thus withholding aggregate demand from the economy, guided by the fiscal policy reaction function. The long-run multiplier is thus negative for the temporary stimulus, depressing aggregate demand and creating downward pressures on inflation. The return to the original debt-to-GDP ratio, however, occurs very slowly (the ratio starts declining only in the 8th year after the initial stimulus), again in line with the evidence of gradual consolidation after the post-GFC increase in Morocco's fiscal deficit (mainly due to the increase in energy prices that boosted spending on subsidies and triggered their reform in 2013-2105). Subdued inflation during the post-GFC period is also consistent with this simulation.

**Figure 6. Dynamic Responses to an Unexpected Temporary 1 Percentage Point One-Year Stimulus, Exchange Rate Peg with a Band**
(Shock-minus-Control Responses)




*Notes*: The figure depicts dynamic responses to an increase in the primary deficit at $t$ =1; the fiscal impulse is measured as the difference between the cyclically-adjusted primary deficit in $t$ and $t$-1; the RER (real exchange rate) gap is measured as the difference between the current-period value of the real exchange rate and its equilibrium value; and the RIR (real interest rate) gap is measured as the difference between the current-period value of the real interest rate and the rate's equilibrium value.

## Estimation of unobserved variables

We employ the model and the multivariate (Kalman) filter to estimate a few key unobserved economic variables, namely the output, exchange rate, and interest rate gaps). The link between the observed and unobserved variables is represented by the model itself. Conditional on the state form of the model and the observed variables, the multivariate filter can identify all unobserved variables and shocks. For linear systems, the Kalman filter represents an optimum estimate in terms of the least squares criterion (Hamilton 1994). As some variables are nonstationary, without finite value variances, we employ the diffuse Kalman filter (De Jong 1991).

Our multivariate-filter estimates for aggregate demand, aggregate supply, and fiscal variables seem to be well-aligned with IMF staff narrative about recent major episodes of Morocco's business cycle. In particular, our results suggest that Morocco's economy was somewhat overheated before the GFC (with the nonagricultural output gap estimated in the model being close to the output gap in the IMF WEO database and shown in Chart 1), driven both by low interest rates and the undervalued exchange rate (Figure 7). The estimates further suggest that while the fiscal balance worsened after the GFC, GDP growth markedly slowed after the crisis, presumably due to supply-side developments outside of our framework (see Pinto Moreira 2019). There seemed to be only very limited demand-side shocks post-GFC.

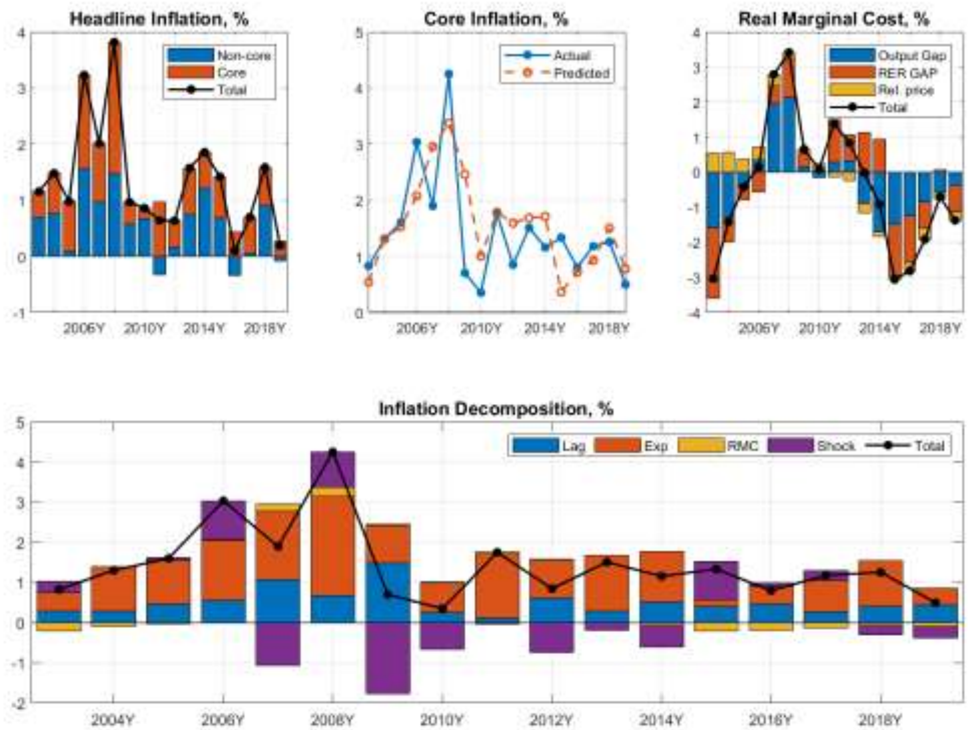
**Figure 7. Morocco: Aggregate Demand and Its Components, 2002–19, Percent of GDP**


*Note*: A negative real exchange rate gap indicates an exchange rate that is overvalued relative to its trend value.

The overheated economy and undervalued exchange rate, as well as an increase in global food-prices, drove inflation to its peak in 2008 (Figure 8). Inflationary pressures however dissipated quickly, and with inflation marginally above the level of Morocco's trading partners the real exchange rate has remained slightly overvalued over the past few years in line with what was suggested by the External Balance Approach cited in the External Sector

Assessment Annexes of recent IMF Article IV Consultation Staff Reports (IMF 2018 and IMF 2019)

**Figure 8. Morocco: Aggregate Supply and Its Components, 2002–19, Percent**



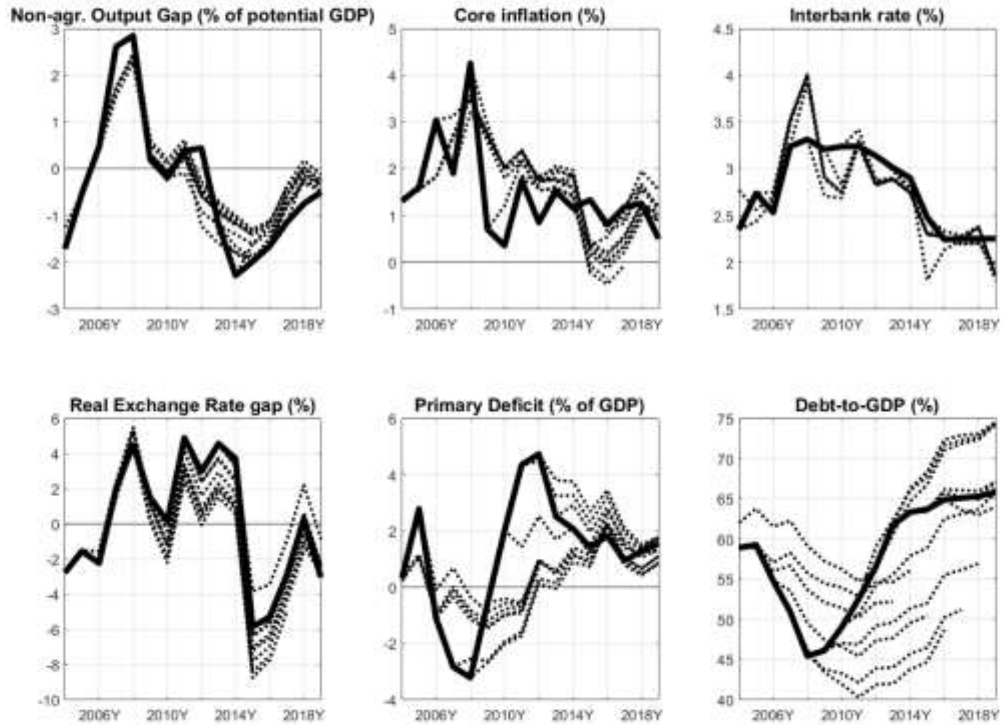

*Source*: Author's simulations.

## Recursive Forecasts

Finally, we use the model-identified unobserved variables to assess the model's predictive ability. Intuitively, we want the model to predict past developments, including the turning points in the business cycle. We employ the Kalman filter to identify the initial conditions for each year ($t$) and make a series of 8-years-ahead recursive forecasts. All domestic variables are forecast endogenously, but we use their actual realizations for foreign variables. We then shift the model-identified initial conditions by one year and make another 8-years-ahead forecast, and so on. Figure 9 summarizes all 6 of our key recursive forecasts—from 2004 to 2019—forming a series of "spaghetti" charts for the variables of interest.

The model generates reasonable recursive forecasts: they predict most of the turning points in output and inflation. The missed turning points can be traced back to supply-side, external, and policy developments that are exogenous to our simple model, such as the post-GFC growth slowdown; the domestic price shock of 2015–16; and the gradual process of fiscal consolidation after the GFC.

**Figure 9. Morocco: Recursive Forecasts, 2004–19**




*Notes*: The figure shows recursive forecasts for the main macroeconomic variables. All domestic variables are forecast endogenously but their actual realizations are used for foreign variables.

## IV. A Policy-Relevant Exercise

In this section we put the model to use by looking at the policy options for Moroccan authorities if the recovery from the economic recession of 2020 were to be slower than expected by staff at the time of the 2020 AIV Staff Report (IMF 2021).

In the staff baseline scenario, the Moroccan economy is expected to recover slowly from the double impact of the COVID-19 and drought shocks of 2020. Growth is expected to rebound from -7 percent in 2020 to 4.5 percent in 2021 and 3.9 percent in 2022, as the harvest returns to historical average, progress in vaccination allows a gradual improvement in domestic and external demand, and monetary and fiscal policies remain supportive (with little to no change in policy interest rates and in the cyclically adjusted primary fiscal balance during 2021). Still, the sizeable output gap that opened in 2020 will be reabsorbed fully (and inflation will return to 2 percent) only in 2025.

A downside scenario, however, can be constructed where slower progress in vaccination and persistent circulation of the virus necessitate an extension of lockdown measures for most of 2021, both in Morocco and its main trading partners. In such a scenario, continued weakness of domestic and external demand and the supply disruptions from the virus containment measures are assumed to slow GDP growth in 2021 to 1.5 percent, keeping the output gap below baseline by about 2 percentage points. GDP growth would gradually return to baseline in the following years, but more persistent weakness of economic activity would bring additional damage to the economy's output potential.

We then use the model to address the following question: how could the Moroccan authorities respond to such developments, given the reduced fiscal and monetary space available at the end of 2020?

***Monetary Policy***

Morocco's central bank (BAM) reacted swiftly to the weakening of economic activity in 2020, adopting a series of measures that eased monetary conditions and provided Moroccan banks with the liquidity needed to respond to the shocks. Among the measures adopted, the Bank cut the policy interest rates by 75 bps in 2020, to 1.5 percent, and moved a step closer to a more flexible exchange rate regime by expanding the band around the peg to ±5 percent in March 2020. As a result of these changes, and following global financial tensions at the onset of the pandemic, the dirham depreciated by 6 percent against the basket in March, before regaining some strength in April and gradually appreciating toward the lower end of the band since then.

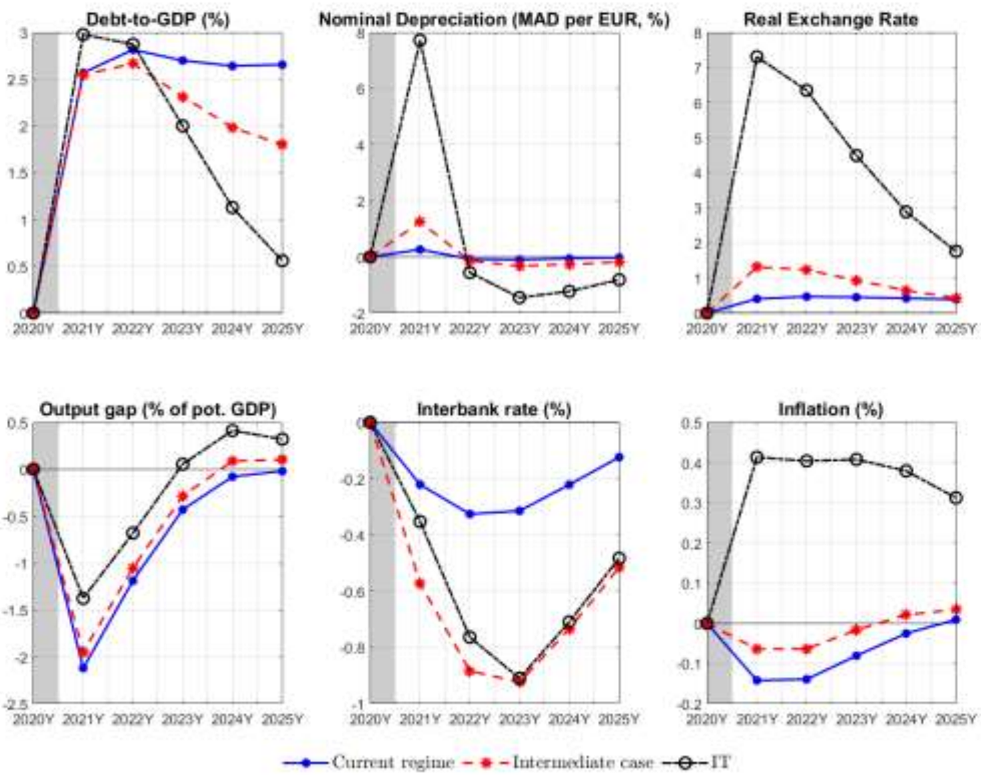
We use the model to compare the room for further monetary policy easing in the downside scenario, under three different exchange rate regimes: 1) one closer to a rigid peg (with very limited use of the flexibility allowed by the band); 2) an intermediate regime where BAM fully utilizes the flexibility allowed by the existence of the band around the peg, and 3) an inflation targeting (IT) regime, where the inflation target is the nominal anchor and the exchange rate is left free to float. The three regimes correspond to three different calibrations of the $\omega^{PEG}$ parameter in equations 7 and 11, with that parameter assuming values of 0.8, 0.5 and 0 respectively in these three scenarios:

- *Peg regime*. The central bank reacts to the negative shock by lowering interest rates by around 30 basis points, with the fall in market interest rates partly offset by the increase of the risk premium arising from the higher debt-to-GDP ratio. The dirham depreciates only marginally, as it only partially responds to the (modest) changes in the interest rate differential. The output gap is slow to close, and the debt-to-GDP ratio remains elevated relative to the baseline by about 2½ percentage points of GDP (Figure 10).

- *Intermediate ER regime.* The central bank cuts the interest rate by almost 100 basis points and this leads to a much larger nominal and real depreciation as compared to the peg regime (with a close to full utilization of the current width of the band). Inflation stays closer to baseline and output recovers somewhat faster. As a result, the debt-to-GDP ratio starts to decline in 2023 but remains close to 200 basis points above the baseline.

- *IT regime*. With the inflation target of 2 percent replacing the exchange rate peg as the credible nominal anchor, the central bank reacts to the negative shock with a more gradual reduction of the policy interest rate compared to the intermediate regime (the rate cut is about 20 bps smaller in 2021, and the policy rates are the same only in 2023). The reason is that the greater nominal (and real) depreciation (under this regime (determined by the UIP condition) offset the deflationary impact of the shock and allows a faster rebound of inflation pressures, with CPI inflation reaching the 2-percent inflation target in 2023. Looser overall monetary conditions limit output losses and close the output gap two years earlier than under the other regimes. Moreover, the stronger GDP growth contribute to keep the debt-to-GDP ratio close to the baseline by 2025.

**Figure 10. Downside scenario under alternative monetary policy regimes**
(Deviations from the baseline)




Note: The downside scenario is based on an extension of lockdown measures into 2021, both in Morocco and its main trading partners. We contrast the macroeconomic developments vis-à-vis the baseline with three simulations: (1) the current regime, approximated by $\omega^{PEG} = 0.8$; (2) an intermediate regime with a full use of the exchange rate band, approximated by $\omega^{PEG} = 0.5$; and (3) a hypothetical inflation targeting regime introduced in early 2021 (approximated by $\omega^{PEG} = 0$).

Source: Authors' simulations.

***Fiscal Policy***

The double shock from the pandemic and drought of 2020 has deteriorated Morocco's fiscal position. The overall fiscal deficit increased from about 4 percent of GDP in 2019 to about 7 percent in 2020. Together with the contraction in output, this led to a 12-percentage point of GDP increase in the central government debt-to-GDP ratio, from 65 to 77 percent at the end of 2020. The gross financing needs of central government rose to about 17 percent of GDP in 2020, from 11 percent the year earlier, and have been satisfied thanks to a greater recourse to both external and domestic financing.

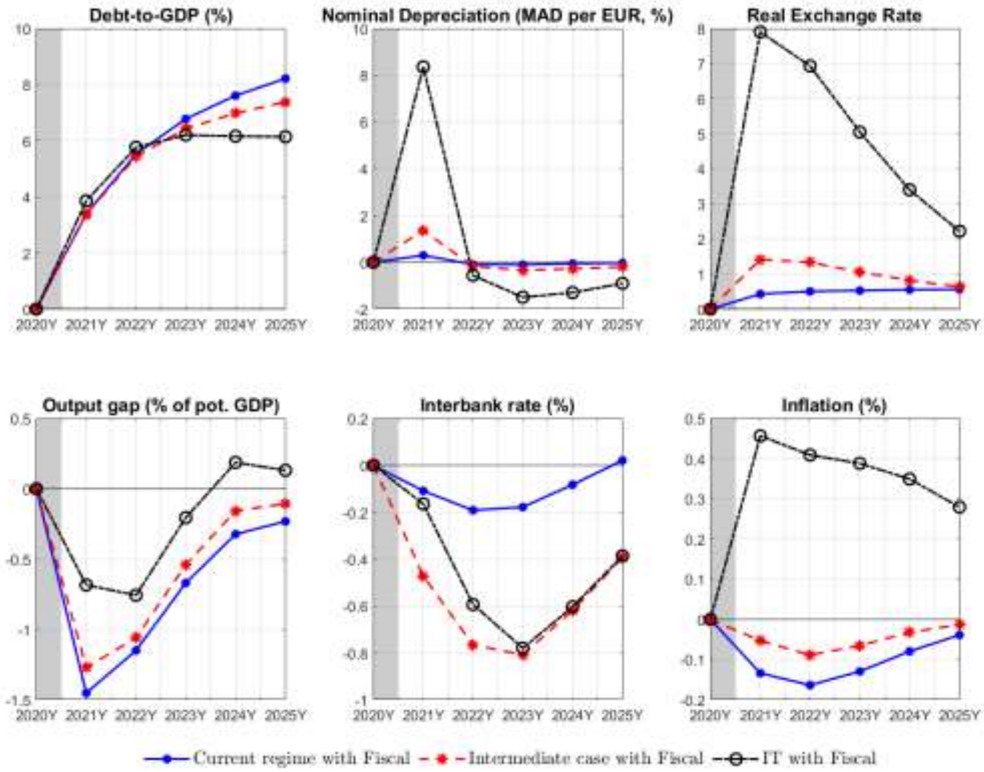
While the recession has obviously reduced Morocco's fiscal space, the model can be used to assess the trade-off that the authorities would face if the recovery from the 2020 recession were to disappoint. In particular, it can be used to simulate a policy response that would help sustain the recovery while having a "moderate" impact on the fiscal deficit and debt-to-GDP ratio.

The fiscal package simulated in this section involves an extension of wage subsidies and cash transfers to households in informal sectors for 2021 and an increase in capital spending. To offset the impact on the fiscal deficit, the authorities accelerate the implementation of the tax reform and reduce the wage bill. All these measures increase the overall fiscal deficit to slightly above 8 percent of GDP in 2021, with an estimated fiscal impulse (increase of the cyclically adjusted primary fiscal deficit) of about 1.5 percent of GDP in 2021. As in the previous section, we show the impact of the fiscal package under alternative monetary regimes (the current regime, the intermediate regime, and IT).

The model simulations in Figure 11 show that *under the exchange rate peg* public debt would climb above 80 percent of GDP in 2021 and 2022 and will continue to increase afterward although at a much slower rate. Gross financing needs would increase at about 19 percent in 2021 and would be covered mostly through increased placement of Treasury bonds with local financial institutions. The higher level of public debt would increase the risk premium and, through this channel, negatively affect domestic demand. Despite the crowding out effect of higher public debt, the fiscal stimulus would help sustain the recovery in 2021, as shown by the smaller output gap compared to the downside scenario.

The monetary policy stimulus described above under *an inflation targeting regime* would improve the debt ratio dynamics, as in this scenario the debt-to-GDP ratio would stabilize as early as in 2023. This reflects both a smaller increase in financing costs from the less pronounced rise of interest rates and faster growth following the stronger easing of monetary conditions from the greater depreciation of the exchange rate, and the smaller crowding out effect on private demand. Indeed, the combined fiscal and monetary policy responses under the IT regime would offset about half of the impact of the negative shock on GDP growth, and allow a faster closure of the output gap (thus likely reducing the risk of scarring).

**Figure 11. Downside scenario with fiscal stimulus and alternative monetary policy regimes**
(Deviations from the baseline)




Note: The downside scenario is based on an extension of lockdown measures into 2021, both in Morocco and its main trading partners. We contrast the macroeconomic developments vis-à-vis the baseline with three simulations: (1) the current regime, approximated by $\omega^{PEG} = 0.8$; (2) an intermediate regime with a full use of the exchange rate band, approximated by $\omega^{PEG} = 0.5$; and (3) a hypothetical inflation targeting regime introduced in early 2021 (approximated by $\omega^{PEG} = 0$). The fiscal package involves full working of automatic stabilizers on the revenue side, an extension of wage subsidies and cash transfers to households in informal sectors, and an increase in capital spending.

Source: Authors' simulations.

## VI. Conclusions

This paper describes an approach to simulating and forecasting macroeconomic variables using a simple macro-fiscal, semi-structural model. The model focuses on only a few variables that are consistent with the New Keynesian framework, as it has become usual practice in modern academic literature, policymaking, and forecasting. Thanks to its simplicity, the model facilitates an initial, clear, and intuitive understanding of both monetary and fiscal policy transmission mechanisms and their main impact on economic activity. Models like this can be extended to reflect further characteristics of the economies considered, in particular, they can be tailored to virtually any fiscal, monetary, or exchange rate policy regimes.

We have outlined a basic version of the model and calibrated a parsimonious version of it for Morocco, validating our calibration by using a few impulse response functions; testing the consistency of unobserved variables against a generally accepted narrative; and assessing the accuracy of our recursive forecasts. We presented an example of how the model can be used in the context of economic surveillance, by assessing  the fiscal and monetary space available for Moroccan authorities under different monetary policy and exchange rate regimes, were they need to react to a slower recovery from the Covid-19 crisis. These simulations illustrate how this type of models can support practical, policy-oriented analysis in the context of Fund surveillance activities.

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**APPENDIXES**

## A. The Model

The key model equations are as follows:

Total GDP:

$$\hat{y}_t = w_{GDP}\hat{y}_t^{NAgr} + (1 - w_{GDP})\hat{y}_t^{NAgr}$$

Nonagricultural output gap (Dynamic IS curve):

$$\hat{y}_t^{NAgr} = a_1\hat{y}_{t-1}^{NAgr} + a_2E_t\hat{y}_{t+1}^{NAgr} - a_3mci_t + a_4f_t^{imp} + a_5\hat{y}_t^{*} + \varepsilon_t^{\hat{y},NAGR}$$

Agricultural output gap:

$$\hat{y}_t^{Agr} = a_7\hat{y}_{t-1}^{Agr} + \varepsilon_t^{\hat{y},AGR}$$

The monetary conditions index:

$$mci_t = a_6(\hat{r}_t^{mix} + cr\_prem_t) + (1 - a_6)(-\hat{z}_t)$$

Real interest rate gap mix:

$$\hat{r}_t^{mix} = w_i\hat{r}_t^{1Y} + (1 - w_i)\hat{r}_t^{5Y}$$

Total inflation (the New-Keynesian Phillips curve):

$$\pi_t = w_{CPI}\pi_t^{Core} + (1 - w_{CPI})\pi_t^{NCore}$$

Core inflation (the New-Keynesian Phillips curve):

$$\pi_t^{Core} = b_1\pi_{t-1}^{Core} + (1 - b_1)E_t\pi_{t+1}^{Core} + b_2rmc_t + \varepsilon_t^{\pi,Core}$$

Real marginal cost:

$$rmc_t = b_3\hat{y}_t^{NAgr} + (1 - b_3)\hat{z}_t^{Core}$$

Non-core inflation:

$$\begin{aligned}\pi_t^{NCore} &= b_4\pi_{t-1}^{NCore}\\ &+(1 - b_4)(\pi_t^{Tar,NCore} - b_5\hat{y}_t^{Agr} - b_6(1 - w_{CPI})\widehat{rp}_t) + b_7\Delta\pi_t^{Oil} + \varepsilon_t^{\pi,NCore}\end{aligned}$$

Currency basket:

$$\Delta s_t = \Delta s_t^{MAD/EUR} + (1 - \omega^s)\Delta s_t^{EUR/USD}$$

Relative prices:

$$rp_t = \pi_t^{NCore} - \pi_t^{Core}$$

Real exchange rate adjusted for relative prices:

$$\hat{z}_t^{Core} = \hat{z}_t + w_{CPI}\widehat{rp}_t$$

Monetary policy rule:

$$i_t = c_1[c_2 i_{t-1} + (1 - c_2)(\tilde{\imath}_t + c_3(E_t\pi_{t+1} - \tilde{\pi}))] \\ + (1 - c_1)\left[E_t\Delta s_{t+1}^{MAD/EUR} + i_t^{EUR} + prem_t\right] + \varepsilon_t^i$$

Risk premium:

$$prem_t = c_4 prem_{t-1} + (1 - c_4)\left[\overline{prem} + c_5[(b_t - b_t^{tar}) - (res_t - res_t^{tar})]\right] + \varepsilon_t^{prem}$$

The fiscal impulse:

$$f_t^{imp} = (cad_t - cad_{t-1}) + f_4\varepsilon_t^{b^{tar}}$$

The fiscal reaction function:

$$cad_t = f_7(cad_{t-1} - f_{10}\hat{y}_t) + (1 - f_7)(cad_t^{tar} - f_8 b_t^{dev}) + \varepsilon_t^{cd}$$

The cyclically-adjusted primary deficit:

$$cad_t = pd_t + f_3\hat{y}_t$$

The total deficit:

$$d_t = pd_t + id_t$$

Expected debt deviation path:

$$b_t^{dev} = f_9(b_t - b_t^{tar}) + (1 - f_9)E_t b_{t+1}^{dev}$$

The total government debt:

$$b_t = b_t^{1Y} + b_t^{5Y} + b_t^{F5Y}$$

one-year domestic debt accumulation:

$$b_t^{1Y} = \theta_t^{1Y}(d_t + \Delta x_t) + b_{t-1}^{1Y}/(1 + g_t)$$

five-year domestic debt accumulation:

$$b_t^{5Y} = b_t^{5Y,New} + b_{t-1}^{5Y,New}/(1 + g_t) + b_{t-2}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})] + b_{t-3}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})] + b_{t-4}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})(1 + g_{t-3})]$$

five-year domestic new bond issuance:

$$b_t^{5Y,New} = \theta_t^{5Y}(d_t + \Delta x_t) + b_{t-5}^{5Y,New}/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})(1 + g_{t-3})(1 + g_{t-4})]$$

five-year foreign debt accumulation:

$$b_t^{F5Y} = b_t^{F5Y,New} + b_{t-1}^{F5Y,New} \cdot (1 + \Delta s_t^{MAD/EUR})/(1 + g_t) + b_{t-2}^{F5Y,New} \cdot \left[\left(1 + \Delta s_t^{MAD/EUR}\right)\left(1 + \Delta s_{t-1}^{MAD/EUR}\right)\right]/[(1 + g_t)(1 + g_{t-1})] + b_{t-3}^{F5Y,New} \cdot \left[(1 + \Delta s_t^{MAD/EUR})(1 + \Delta s_{t-1}^{MAD/EUR})(1 + \Delta s_{t-2}^{MAD/EUR})\right]/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})] + b_{t-4}^{F5Y,New} \cdot \left[(1 + \Delta s_t^{MAD/EUR})(1 + \Delta s_{t-1}^{MAD/EUR})(1 + \Delta s_{t-2}^{MAD/EUR})(1 + \Delta s_{t-3}^{MAD/EUR})\right]/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})(1 + g_{t-3})]$$

five-year foreign new bond issuance:

$$b_t^{F5Y,New} = (1 - \theta_t^{1Y} - \theta_t^{5Y})(d_t + \Delta x_t) + b_{t-5}^{F5Y,New} \cdot \left[(1 + \Delta s_t^{MAD/EUR})(1 + \Delta s_{t-1}^{MAD/EUR})(1 + \Delta s_{t-2}^{MAD/EUR})(1 + \Delta s_{t-3}^{MAD/EUR})(1 + \Delta s_{t-4}^{MAD/EUR})\right]/[(1 + g_t)(1 + g_{t-1})(1 + g_{t-2})(1 + g_{t-3})(1 + g_{t-4})]$$

Foreign Reserve accumulation:

$$x_t = \Delta x_t + (1 + \Delta s_t^{MAD/EUR})x_{t-1}/(1 + g_t)$$

The reserve reaction function:

$$\Delta x_t = g_2 \Delta x_{t-1} + (1 - g_2)(\Delta\tilde{x}_t + g_3\hat{y}_t - g_4\hat{z}_t) + \varepsilon_t^x$$

The total government debt:

$$id_t = id_t^{1Y} + id_t^{5Y} + id_t^{F5Y} - ix_t$$

Interest cost of one-year domestic debt:

$$id_t^{1Y} = i_{t-1}^{1Y} \cdot b_{t-1}^{1Y}/(1+g_t)$$

Interest cost of five-year domestic debt:

$$id_t^{5Y} = i_{t-1}^{5Y} \cdot b_{t-1}^{5Y,New}/(1+g_t) + i_{t-2}^{5Y} \cdot b_{t-2}^{5Y,New}/[(1+g_t)(1+g_{t-1})] + i_{t-3}^{5Y} \cdot b_{t-3}^{5Y,New}/[(1+g_t)(1+g_{t-1})(1+g_{t-2})] + i_{t-4}^{5Y} \cdot b_{t-4}^{5Y,New}/[(1+g_t)(1+g_{t-1})(1+g_{t-2})(1+g_{t-3})] + i_{t-5}^{5Y} \cdot b_{t-5}^{5Y,New}/[(1+g_t)(1+g_{t-1})(1+g_{t-2})(1+g_{t-3})(1+g_{t-4})]$$

Interest cost of five-year foreign debt:

$$id_t^{F5Y} = i_{t-1}^{5Y} \cdot b_{t-1}^{F5Y,New} \cdot (1+\Delta s_t^{MAD/EUR})/(1+g_t) + i_{t-2}^{5Y} \cdot b_{t-2}^{F5Y,New} \cdot \left[(1+\Delta s_t^{MAD/EUR})(1+\Delta s_{t-1}^{MAD/EUR})\right]/[(1+g_t)(1+g_{t-1})] + i_{t-3}^{5Y} \cdot b_{t-3}^{F5Y,New} \cdot \left[(1+\Delta s_t^{MAD/EUR})(1+\Delta s_{t-1}^{MAD/EUR})(1+\Delta s_{t-2}^{MAD/EUR})\right]/[(1+g_t)(1+g_{t-1})(1+g_{t-2})] + i_{t-4}^{5Y} \cdot b_{t-4}^{F5Y,New} \cdot \left[(1+\Delta s_t^{MAD/EUR})(1+\Delta s_{t-1}^{MAD/EUR})(1+\Delta s_{t-2}^{MAD/EUR})(1+\Delta s_{t-3}^{MAD/EUR})\right]/[(1+g_t)(1+g_{t-1})(1+g_{t-2})(1+g_{t-3})] + i_{t-5}^{5Y} \cdot b_{t-5}^{F5Y,New} \cdot \left[(1+\Delta s_t^{MAD/EUR})(1+\Delta s_{t-1}^{MAD/EUR})(1+\Delta s_{t-2}^{MAD/EUR})(1+\Delta s_{t-3}^{MAD/EUR})(1+\Delta s_{t-4}^{MAD/EUR})\right]/[(1+g_t)(1+g_{t-1})(1+g_{t-2})(1+g_{t-3})(1+g_{t-4})]$$

Interest payment foreign reserve:

$$ix_t = i_{t-1}^{EUR} \cdot x_{t-1} \cdot (1+\Delta s_t^{MAD/EUR})/(1+g_t)$$

one-year domestic bond rate:

$$i_t^{1Y} = i_t + tprem_t^{1Y}$$

five-year domestic bond rate:

$$i_t^{5Y} = (1/5) \cdot (i_t + i_{t+1} + i_{t+2} + i_{t+3} + i_{t+4}) + tprem_t^{5Y}$$

five-year foreign bond rate:

$$i_t^{F5Y} = (1/5) \cdot (i_t^{EUR} + i_{t+1}^{EUR} + i_{t+2}^{EUR} + i_{t+3}^{EUR} + i_{t+4}^{EUR} + prem_t + prem_{t+1} + prem_{t+2} + prem_{t+3} + prem_{t+4}) + tprem_t^{F5Y}$$

Purchasing power parity (PPP) condition:

$$z_t = s_t + p_t^* - p_t$$

The real interest rate trend:

$$\tilde{r}_t = h_5 \tilde{r}_{t-1} + (1-h_5)(\Delta \tilde{z}_{t+1} + \tilde{r}_t^{EUR} + prem_t)$$

The country risk premium:

$$prem_t = h_6 prem_{t-1} + (1 - h_6)\left(prem + h_{12}\left(b_t - \bar{b} - (x_t - \bar{x})\right)\right) + \varepsilon_t^{prem}$$

The equilibrium real exchange rate trend:

$$\Delta\tilde{z}_t = h_7 \Delta\tilde{z}_{t-1} + (1 - h_7)\Delta\bar{z} + \varepsilon_t^{\Delta z}$$

Total trend GDP growth:

$$\Delta\tilde{y}_t = w_{GDP}\Delta\tilde{y}_t^{NAgr} + (1 - w_{GDP})\Delta\tilde{y}_t^{Agr}$$

Potential output growth of nonagricultural sector:

$$\Delta\tilde{y}_t^{NAgr} = h_8 \Delta\tilde{y}_{t-1}^{NAgr} + (1 - h_8)\left(\Delta\bar{y}^{NAgr} - h_{13}(\tilde{r}_t^{5Y} - \bar{r})\right) + \varepsilon_t^{\Delta\tilde{y},NAgr}$$

Potential output growth of agricultural sector:

$$\Delta\tilde{y}_t^{Agr} = h_8 \Delta\tilde{y}_{t-1}^{Agr} + (1 - h_8)\Delta\bar{y}^{Agr} + \varepsilon_t^{\Delta\tilde{y},Agr}$$