FOR INFORMATION

FO/DIS/21/62

April 21, 2021

To: Members of the Executive Board

From: The Secretary

Subject: **Republic of Mozambique—Technical Assistance Report—Inflation Targeting and Model-Based Monetary Policy Analysis**

Board Action: Executive Directors' **information**

Publication: Yes, after Wednesday, April 28, 2021

Questions: Ms. Moyo, MCM (ext. 34037)

TECHNICAL ASSISTANCE REPORT

REPUBLIC OF MOZAMBIQUE

Inflation Targeting and Model-Based Monetary Policy Analysis

February 2021

Prepared By

Kristin Gulbrandsen (Long-term Expert, MCM), Karsten R. Gerdrup, Kenneth Sæterhagen Paulsen, and Øistein Røisland (External Experts, Norges Bank)

Authoring Department:

Monetary and Capital Markets Department

Contents Page

GLOSSARY

BM	Bank of Mozambique
DEE	Department of Economic Research
DSGE	Dynamic Stochastic General Equilibrium
FEVD	Forecast Error Variance Decomposition
FPAS	Forecasting and Policy Analysis System
FX	Foreign exchange
GDP	Gross Domestic Product
ICD	IMF International Capacity Development
IMF	International Monetary Fund
IRF	Impulse-Response Functions
IRIS	Macroeconomic modeling and forecasting toolbox in matlab
IT	Inflation Targeting
MCM	Monetary and Capital Markets Department
MPC	Monetary Policy Committee
MZN	Mozambique Metical
NEER	Nominal Effective Exchange Rate
NTF	Near-Term Forecasting
QPM	Quarterly Projection Model
SVAR	Structural Vector-Autoregressive Regression
TA	Technical Assistance
USD	US dollar

PREFACE

At the request of the Bank of Mozambique (BM), a Monetary and Capital Markets Department (MCM) Technical Assistance (TA) mission, comprising two one-week visits, took place in Maputo, Mozambique; the first on July 6–10 and the second on September 16–20, 2019. Kenneth Sæterhagen Paulsen was a short-term expert in July, while the mission team in September comprised of Øistein Røisland and Karsten Gerdrup. All the three experts are from Norges Bank. The MCM Resident Advisor in Mozambique on Central Bank Modernization, Kristin Gulbrandsen, led the mission. The mission is part of the Norwegian-funded, multi-year, central bank modernization program covering the main areas of central banking activities. Since October 2017, the modernization project has delivered missions on near-term forecasting, on monetary policy communication, on monetary policy implementation and FX policy, and also provided capacity building to improve the analytical skills and tools of the forecasting team and the sector experts. This mission was the fifth on Forecasting and Policy Analysis System (FPAS) under the program.

The experts worked daily with management and staff of the Department of Economic Research (DEE). The September mission also met with the Board member and Executive Director of Monetary Stability Directorate, Mr. Jamal Omar.

The mission wishes to thank the staff of the Bank of Mozambique for their warm hospitality, productive cooperation and candid discussions, making the mission effective as well as inspiring. Special thanks are given to Ms. Ilda Elizabeth Comiche, Mr. Pinho José Ribeiro, and Mr. Helder S. Armando.

EXECUTIVE SUMMARY

The purpose of the mission was to improve the understanding of the conduct of monetary policy in an inflation targeting (IT) central bank. During the September visit, the mission provided capacity building through daily morning seminars, giving an introduction to modern theory of monetary policy in small-open economies, and by performing monetary policy analyses based on BM's quarterly projection model (QPM) in the afternoons. The target group was primarily the staff of the Department of Economic Research (DEE). However, a broader audience, with economists from departments [1] having a seat on the Monetary Policy Committee (MPC), participated in the theory-based seminars. The purpose of the July part of the mission was to make necessary preparation for the model-based monetary policy afternoon exercises in September. The expert worked hands-on with the forecasting team to develop a certain set of codes, including routines to perform impulse-responses, historical shocks decompositions, forecast error variance decompositions and recursive forecasting analysis. In addition, a series of other improvements in the QPM infrastructure was made. These procedures can be used by BM's forecasting team to improve their understanding of QPM and to identify inadequate features and calibrations in the model. Thus, the improved infrastructure may enable the BM to experiment and further enhance development of the Forecasting and Policy Analysis System (FPAS).

During the mission, an outline of a seminar series for the MPC was discussed and drafted. The goal of the seminars will be to reach a common understanding of the monetary policy framework and the path towards IT and of the merits of the modeling system to support interest rate decisions. These seminars could be an important first step in developing a monetary policy strategy for BM.

Further technical assistance for maintaining and developing BM's quarterly projection model QPM is needed. IMF/ICD provided TA for the years 2008–17. However, the BM has not received any further assistance since October 2017. The modernization project has so far mainly provided FPAS TA on near-term forecasting, but will adjust the program and assist the BM in making improvements in the QPM model and the forecasting process.

[1] The following departments participated in the seminars in the morning session: Market and Reserve Management, Macroprudential Analysis, Prudential Supervision and Communication.

Table 1. Key Recommendations

Recommendations and Authority Responsible for Implementation	Priority	Timeframe[1]
DEE arrange seminars for MPC on; (i) the reforming of the monetary policy framework into a system closer to IT; and (ii) the merits of the modeling system to support interest rate decisions.	High	Near-term
Revise the modeling of the exchange rate in QPM	High	Near-term
Actively use tools introduced by the July and September missions to understand the features of QPM and suggest improvements in the model	High	Near-term

[1]Near term: < 12 months; Medium term: 12 to 24 months.

I. INTRODUCTION

1. The BM is reforming its monetary policy framework by moving it closer to IT. IT can also be framed as targeting inflation *forecasts.* The forecasting system rests on two pillars: a system for near-term forecasting and a quarterly model for medium-term forecasting and analysis. The IMF/ICD provided technical assistance for developing and maintaining QPM for the purpose of medium-term forecasting from 2008 to 2017. The modernization program has provided capacity building and technical assistance on near-term forecasting since 2017. The BM has a core modeling team which uses the QPM to provide inputs for the MPC's monetary policy deliberations. The forecasting capabilities have improved, and DEE is actively using models for near-term forecasting introduced in a TA mission under the modernization program in May 2019.

2. The aim of this mission was to assist in improving the understanding of the conduct of monetary policy in an IT central bank. The capacity building was provided partly through seminars with an introduction to modern theory on monetary policy in small-open economies, and partly by performing exercises based on QPM. The target group was primarily the staff of the Department of Economic Research (DEE). A broader audience participated in the seminars.

3. In addition, the mission team worked together with DEE on developing an outline for seminars for the MPC. The goal of the seminars would be to reach a common understanding of the monetary policy framework and its transition towards IT and of the merits of the modeling system to support interest rate decisions. This kind of seminars could be important first steps in developing a monetary policy strategy for the BM.

4. The model-based exercises were based on QPM and Matlab procedures introduced in the July 2019 part of the mission. In the latter mission, a set of codes were developed, including routines to perform impulse-responses, historical shocks decompositions forecast error variance decompositions and recursive forecasting. In addition, a series of other improvements in the QPM infrastructure was made. The procedures can be used by the forecasting team in DEE to improve their understanding of QPM and to identify inadequate features and calibrations in the model.

5. The mission team also suggested areas for further capacity building in the FPAS missions ahead under the modernization project. In particular, the planned March 2020 mission[2] could focus on empirical analysis of the transmission mechanisms of monetary policy, exchange rate shocks and on the improvement of the fiscal block. Furthermore, the mission planned for the first quarter of 2021 could work on improving the features of QPM and its calibration. The QPM has not been revised since October 2017, when ICD had a joint mission with the modernization project.

[2] The March 2020 mission was delivered remotely in July 2020 due to the COVID-19 pandemic.

II. THE CURRENT SITUATION

A. Monetary Policy Framework

6. The BM is evolving its monetary policy regime towards IT. Currently the BM operates a forecasting and policy analysis system (FPAS), publishes a monetary policy communique and a monetary policy report in conjunction with the monetary policy meetings, and sets the policy rate, MIMO, with a view of promoting price stability (i.e., inflation within single digits). In addition, the BM makes a thorough assessment of risks surrounding the forecasts, and provides alternative scenarios.

7. The transition of the monetary policy framework towards IT has still a way to go. Examples of challenges are: reforming the central bank law establishing a clear *de jure* mandate and enhancing operational independence; setting an explicit medium-term inflation objective; developing a clear communication strategy to anchor inflation expectations and improve accountability; and including explicit medium-term forecasts and alternative scenarios. The five daily morning seminars, on each of the mission days in September, presented the main ingredients of a modern IT regime, and sought to actively engage the participants in discussions to raise awareness of best practice and of the special challenges faced by BM.

B. Medium-term Projection Model (QPM) to Support IT

8. QPM is used actively to provide inputs for the MPC's monetary policy deliberations. The interest rate based framework, which was introduced in April 2017, has helped in this regard. The IMF has provided technical assistance for developing and maintaining QPM for the purpose of medium-term forecasting since 2008. BM has a core modeling team that operates QPM. The forecasting capabilities have improved, and DEE is now actively using several small models for near-term forecasting introduced by the May 2019 and earlier missions. The near-term forecasts serve as starting points for the medium-term forecasts using the QPM.

9. DEE's capabilities to analyze various aspects of QPM has improved. The July 2019-mission added some procedures to the modeling system to make DEE able to analyze impulse-responses (IRF), historical shock decompositions forecast error variance decompositions (FEVD) and recursive forecasting. DEE had prepared exercises based on these procedures to the September part of the mission. During this second visit, some new procedures was added; e.g., for performing optimal policy using QPM and for constructing a policy frontier. Optimal policy implies minimization of a loss function under commitment or discretion. A policy frontier depicts the trade-off between output and inflation, given different Taylor rules for monetary policy. The objective of the exercises was to shed light on the merits of alternative reaction functions. The exercises were done using the IRIS program.

10. QPM was used actively during the mission. The model was used to analyze the transmission mechanisms of different shocks, trade-offs in monetary policy and how these trade-offs depend on the size of various shocks, the effects of changes in model parameters, preliminary optimal policy exercises, etc., see the agenda for the September visit in Appendix 1 for an overview of the exercises.

11. Some shortcomings in QPM were identified during the exercises. In several cases, the impulse-response functions (IRF) and the forecast-error variance decompositions (FEVD) did not reflect the views of DEE staff on how the Mozambican economy works. Firstly, it is reason to believe the role of international factors are more important for output variability than QPM would suggest. Secondly, many IRFs showed very short-lived effects, and much shorter than evidence from other countries (at least more developed countries). This topic should be explored further, e.g., by using structural vector-autoregressive models (SVAR). Lastly, the exchange rate is not responsive to changes in the interest rate. This is probably caused by the way the exchange rate is modeled, with a high weight on the equilibrium exchange rate, measured as the trend, and less on current and future interest rates.

12. Simple improvements can be made in QPM. It is possible to introduce shock processes as AR1-equations, and estimate the AR1-coefficients as well as the standard deviations of shocks. Such estimations will shed some light on the size and effects of shocks in QPM. As of now, the model has many shocks that are calibrated. Historical shock decompositions will give a wrong impression of which shocks are driving economic developments in Mozambique if the standard deviations are not estimated properly.

13. It appears that the QPM implies a constant nominal exchange rate in the long run. The version of the QPM model used by DEE, was developed for a policy regime that can be characterized as a hybrid regime—partly exchange rate targeting and partly inflation targeting. A property of this version of the model is that the nominal exchange rate is automatically reverting to the (implicit/explicit) exchange rate target in the long run. This also implies that the domestic price-level is mean-reverting to a level that is consistent with a given real exchange rate equilibrium and the nominal exchange rate target. This has implications for monetary policy and inflation dynamics. If inflation, after a shock, is above target, inflation will come below target in subsequent periods in order to bring the price-level in accordance with the exchange rate target. The oscillatory over- and undershooting of inflation will happen partly independent of the monetary policy response. DEE should think carefully about whether the exchange rate specification in the QPM is a reasonable description of the foreign exchange market and the monetary policy regime in Mozambique. There could be arguments for using a version of QPM where the nominal exchange rate is non-stationary, such as in the version used by, e.g., the Reserve Bank of South Africa.

14. The output gap calculated in QPM is very volatile and does not have a clear role in current discussions on inflationary pressures or discussions on monetary policy trade-offs.

This partly reflects the high volatility in GDP data, but some noise filtering of data can be done. Furthermore, the merits of output stabilization in addition to inflation and exchange rate stabilization should be analyzed further.

III. Further Capacity Development and Technical Assistance

15. The BM should work out a strategy for developing the monetary policy framework towards IT. During this mission, an outline of seminars for the MPC was discussed and drafted. The goal of these presentations would be to reach a common understanding of the monetary policy framework and its way towards IT and of the merits of the modeling system to support interest rate decisions. DEE staff presented a prelimary agenda for two presentations for the MPC at the last day of the mission. These presentations can be built on the theoretical presentations as well as QPM model-exercises. This kind of seminars could be an important first step in developing a monetary policy strategy for BM. More TA could be provided to assist in developing the strategy.

16. Further technical assistance for maintaining and developing BM's quarterly projection model QPM is needed. IMF provided TA for the years 2008–17. However, the BM has not received any further assistance since October 2017. The modernization project has so far mainly provided FPAS TA on near-term forecasting, but will adjust the program and assist the BM in making improvements in the QPM model and the forecasting process.

17. During the mission, a peer-to-peer workshop with the South African Reserve Bank (SARB) was proposed. Their forecasting model is built on the same foundation as BM's QPM. A topic for the workshop could be to compare and discuss the QPM models, monetary policy frameworks, and challenges faced by sub-Sahara African central banks. An improved network between central banks could also facilitate development of internal modeling skills at BM.

APPENDIX I. OUTLINE OF THE PROGRAM FOR THE SEPTEMBER PART OF THE MISSION

Day 1.
09:00-12:00 Lecture (Røisland)

Inflation targeting as a monetary policy framework

- What are the goals of monetary policy?
- Alternatives to inflation targeting
    - exchange rate target
    - money growth target
    - price-level target
    - nominal GDP target
- The choice of inflation target
    - target level
    - point target versus interval
    - the choice of price index
    - who sets the target?
- Accountability and transparency

13:30-16:00 Information on current monetary policy challenges and QPM model features (Gerdrup/modeling team)

Background

- Show latest presentation to the MPC on the MPR.
- Role of medium-term forecasts in the Monetary policy report (MPR).
- Current monetary policy challenges, trade-offs between inflation, exchange rate, output, and interest rate volatility. Nowcasts, current gaps – underlying driving forces of the economy.

QPM model

- Short historical background of the model.
- Go through the main building blocks of the model (presentation/other material that outlines the model? Alternatively, we can go through the model file together):
    - IS curve
    - Philips curve
    - Exchange rate determination and risk premium (May want to talk with Markets Division to get a better understanding of the money market and exchange rate determination.)
    - Fiscal policy, public debt, external debt
    - Foreign block

    - Interest rates (Taylor rule, policy rate, money market rates, bank rates, spreads)
    - Role of expectations
    - Any role for commodities?
- Do you capture the main channels in the model?

16:00-18:00 Preparing presentation (All)

Day 2.
09:00-12:00 Lecture (Røisland)

The standard New Keynesian model and its implications for monetary policy

- The model and the assumptions it is built on
- Monetary policy as "management of expectations"
- The loss function
- Targeting rules versus instrument rules
- Responses to shocks
- Limitations of the standard NK-model

13:30-16:00 QPM model properties (Gerdrup/modeling team)

- Stylized facts. Look at the raw data and historical gaps used in the model. What are main correlations in the economy between inflation, GDP (growth and/or gap), and exchange rate (growth and/or gap)? Any empirical analysis (surveys) on inflation expectations?
- Impulse-response functions (IRF) – shock to monetary policy, fiscal policy, exchange rate risk premium, demand, etc. (Are the irfs comparable with countries with similar economic structure? Any available structural VAR evidence?)
- Historical shock decomposition. Does the historical interpretation of QPM of shocks hitting Mozambique economy make good sense?
- Forecast-error-variance decomposition (FEVD) – summary of contributions of structural shocks in explaining the fluctuations in the variables in the model.
- General view on whether QPM is calibrated appropriately or not?
- (Forward guidance puzzle? See the effect of inflation shocks at different points in future. Does the effect of future shocks to current output and inflation become amplified the further out in future the shock happens?)

16:00-18:00 Preparing presentation (All)

Day 3.
09:00-12:00 Lecture (Røisland)

Monetary policy in an open economy

- A simple small open economy model
- Optimal responses to domestic and foreign shocks

13:30-16:00 QPM model exercises using different Taylor rules (Gerdrup/modeling team)

- Different assumptions about the conduct of monetary policy (Taylor rule / instrument rule) affect the transmission of shocks in the economy.[3]
    - More weight on exchange rate stabilization. (Higher variation in output?)
    - More or less flexible inflation targeting?
    - Targeting money growth?
    - Targeting nominal GDP?
    - Targeting average inflation (past and future) as an approximation to price level targeting?
    - Targeting different sub-components of CPI? (may not be feasible)
- Each Taylor rule results in a certain combination of, e.g., inflation and output variability[4]
    - Assess the effect of parameter changes in Taylor rule on medium-term forecast paths (which "looks good") and hence underlying trade-offs between output, inflation, exchange rate, and interest rate. (Financial stability considerations given high level of non-performing loans in Mozambique?)
    - Run a counterfactual analysis—what if monetary policy was different during the recent episode of turmoil and large swings in exchange rate?
    - Effect of more or less forward-looking behavior in Taylor rule (target forecasts of inflation or current inflation?)
    - Policy frontier, i.e., how is the trade-off between variation in inflation and output being affected by changes in the Taylor rule, and what shocks affect this trade-off the most? E.g., if more weight is put on targeting exchange rate, does output vary relatively more than inflation for certain shocks? Given the shocks hitting

[3] https://www.nber.org/papers/w14510

[4] https://www.norges-bank.no/globalassets/upload/publikasjoner/economic_bulletin/2005-01/mccaw.pdf

Mozambique economy, can we assess an appropriate Taylor rule (not necessarily in a formal way / what "looks good" / do we achieve our objectives)?

- What inflation level to target? (general discussion)
- (Compare trade-offs with optimal policy (discretionary/commitment) vs. Taylor rules (if feasible). Gains from commitment? Draw an efficient policy frontier (variation in, e.g., inflation and output) for different weights on, e.g., output in the loss function.)

16:00-18:00 Preparing presentation (All)

Day 4.
09:00-12:00 Lecture (Røisland)

Part 1. Monetary policy under uncertainty

- Types of uncertainty
  - additive uncertainty
  - multiplicative uncertainty
  - risk versus uncertainty
- Certainty equivalence
  - when does it hold and when does it not hold?
- Parameter uncertainty and the Brainard principle
- Model uncertainty and robust simple rules
- Mini-max strategies
- Dealing with uncertainty in practice – risk management

Part 2. Towards a monetary policy strategy

- What is a monetary policy strategy, and (why) do we need a strategy?
- Elements of a strategy

13:30-16:00 QPM model exercises (Gerdrup/modeling team)

- Analyze relevant alternative scenarios of economic developments
- What if transmission channel is different (change key parameters in, e.g., Philips curve). What if inflation is driven solely by the exchange rate or inflation expectations matter less?
- What is the effect of parameter changes on FEVD, IRF, historical shock decompositions, and medium-term forecasts.
- Any robust Taylor rule that produce a lower loss in terms of output and inflation variability across different scenarios?
- Compare different rules with "standard" Taylor rule.

16:00-18:00 Preparing presentation (All)

Day 5.
09:00-12:00 Lecture (Røisland)

The time-inconsistency problem and central bank independence

- What is the time-inconsistency problem?
- Modelling the time-inconsistency problem
    - Barro-Gordon framework
- How can the time-inconsistency problem be solved/reduced?
    - Rogoff's "conservative" central banker
    - Other solutions
- How independendent should central banks be?
    - Independence versus democratic accountability
- Time-inconsistency and forward guidance

13:30-16:00 Finalizing model exercises and presentation (Gerdrup/modeling team)

- Results from exercises during the week.
- Define a set of criteria for a good interest rate path (interest path that strikes the right balance between different objectives). What kind of Taylor rule is appropriate?
- Exchange rate stabilization vs inflation stabilization and/or output stabilization?

16:00-18:00 Presentation (staff)