TECHNICAL ASSISTANCE REPORT

SURINAME

Liquidity Forecasting and Participation in Money Market Operations

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Glossary

ARIMA	Auto Regressive Integrated Moving Average
CBC	Central Bank Certificates
CBvS	Centrale Bank van Suriname
CiC	Currency in Circulation
ETS	Exponential Smoothing
MAE	Mean Absolute Errors
MCM	Monetary and Capital Markets Department
MCMCO	MCM's Central Bank Operations Division
ME	Mean Error
Min T	Minimum Trace
NFA	Net Foreign Assets
OLS	Ordinary Least Squares
OMO	Open Market Operation
RMSE	Root Mean Square Error
SNEPS	Suriname National Electronic Payments System
TBATS	Trigonometric Seasonality, Box-Cox Transformation, ARMA Errors, Trend and Seasonal
TD	Term Deposits

Preface

At the request of the Centrale Bank van Suriname, a Monetary and Capital Markets (MCM) Department mission visited Paramaribo from April 2–5, 2024, to assist the authorities in liquidity forecasting.

The mission met with the Governor, the Deputy Governor, Directors, staff members, and the commercial banks. The mission wishes to thank the Centrale Bank van Suriname for their cooperation, productive discussions, and their hospitality.

Executive Summary

After shifting from an exchange rate to a monetary targeting regime, the Centrale Bank van Suriname (CBvS) initiated open market operations (OMOs) in July 2021. While this transition marked a significant change in its monetary policy approach to enhance its framework and tackle economic challenges more effectively, new challenges also emerged. Amid the move to a freely floating exchange rate, the Suriname dollar devalued by 182.5 percent from September 2020 to June 2021, leading to various macroeconomic problems, including inflation rates above 60 percent given high exchange rate pass-through. This situation prompted households and economic entities to hedge against further currency depreciation, leading to a widespread financial dollarization. In July 2021, Suriname started to conduct market operations using mainly term deposits.

The CBvS has been facing challenges to manage persistently high excess reserves. Repeated target shortfalls prompted the CBvS to adjust its monetary policy. To help absorb excess liquidity, the CBvS added Central Bank Certificates (CBCs) to its monetary tools in June 2022. In April 2023, the CBvS increased the reserve requirement ratio from 39 to 44 percent and established a 20 percent annual credit growth cap for banks in April 2023. Nonetheless, in March 2024, the CBvS had underperformed on the reserve money target by SRD 537.7 million. Moreover, banks' low engagement in auctions and their submission of disproportionately high rates compared to their bid quantities have further complicated the situation.

The mission supported the CBvS by providing advanced statistical models for liquidity forecasting, a crucial element for the success of the monetary targeting regime. Currently, the CBvS calibrates its monetary operations primarily utilizing OMOs to meet its reserve money targets. To achieve this goal, it is essential for the CBvS to comprehend the behavior of both monetary policy counterparties and non-monetary policy counterparties. In addition to qualitative data obtained through bank surveys and information sharing systems, statistical liquidity forecasts can enhance the CBvS' ability to anticipate projections based on historical time series data.

The mission deployed the statistical forecasting framework developed by MCMCO to refine CBvS' liquidity forecasting, ultimately enhancing its operations. The IMF framework comprises 12 forecasting models across three categories: exponential smoothing (simple, with exogenous regressors, and seasonal), Auto Regressive Integrated Moving Average (ARIMA, simple, with exogenous regressors, and seasonal), Trigonometric Seasonality, Box-Cox Transformation, ARMA Errors, Trend and Seasonal (TBATS), and volatility models. It features an out-of-sample performance testing system grounded in four criteria that evaluate accuracy, bias, and confidence intervals. The framework enables model selection, forecast generation, and forecast reconciliation to enhance forecast accuracy. The mission covered the framework's essential components, facilitated simulations for staff training, and provided code packages for forecasting autonomous factors and reserve demand.

A liquidity forecasting table was developed during the mission to be used to track predictions on the system's available reserves and the demand for excess reserves, facilitating the calibration of weekly OMOs. The liquidity supply flows in the system are captured by autonomous factors and the maturity of previous OMOs, whereas the demand for reserves is determined by excess reserves and reserve requirements. By calculating the difference between the liquidity supply and the demand for reserves, the liquidity gap is identified, guiding the allotment decisions for the volume of open market operations to be conducted.

The model that was developed is robust and the staff were very dedicated in learning the new methodology. Nonetheless, the CBvS should ensure that efforts will be done to collect daily data and

complete the implementation of the full granular version of the model as soon as possible, avoiding delays potentially caused, for example, by institutional impairments or limited capacity. In addition, the CBvS should consider integrating the IMF liquidity forecasting framework into its current forecasting operations to enhance overall forecasting effectiveness and reliability.

To understand the challenges that banks face in managing their liquidity and the patterns in auction activities, the mission carried out a survey targeting commercial banks and organized a joint workshop with the CBvS and these banks. During the workshop, the concerns raised by the banks were discussed, providing a comprehensive platform for dialogue. In addition, the IMF and the CBvS provided technical guidance for a comprehensive understanding of the monetary targeting framework and operations. This detailed discussion not only fostered a clearer comprehension among the participants but also set the stage for a more collaborative approach moving forward.

Banks mostly expressed concerns about the policy on CBCs and their impact on the market, the high reserve requirements, and about high OMO interest rates, which are notably influenced by their own high bid rates at TD and CBC auctions. Other factors cited consisted of the absence of a well-functioning money market, challenges in the FX market, and supervision requirements. Banks also provided suggestions on how the authorities could help to address these challenges, which were discussed in the workshop.

Going forward, the CBvS should review some aspects of its strategy using CBCs and the two parallel systems in requiring reserves to be held in the system. As the CBvS also communicated in the workshop, the strategy in using CBCs should be carefully reviewed. Specifically, the CBvS should consider the possible repercussions of non-banks purchasing CBCs, the risks associated with longer tenors and high interest rates of dampening investment and spending, a potential exacerbation of liquidity buffers and the CBC's ultimate impact on the key CBvS' objective macroeconomic variables. Key elements to be reviewed are the eligible criteria, the tenors of the certificates, the frequency of the auctions and the communication strategy. In addition, the existence of two separate systems should be reviewed and simplified to provide an accurate understanding of the actual amount excess and precautionary reserves in the system and facilitate the calculations for both the CBvS and banks. Ultimately, enhancing the system and addressing the potential causes for maintaining a precautionary liquidity buffer are crucial for improving the accuracy of liquidity forecasting.

The CBvS, working closely with the government, when necessary, should escalate its initiatives to modernize its infrastructure, a move that would not only foster the development of the interbank market but also fortify its understanding of the banking sector's dynamics and improve their participation in auctions. The CBvS stated that it is in the process of developing a fully automated platform for the standing facilities. A pivotal aspect of this modernization is the full transition towards digitalization, particularly by embracing electronic signatures for auction-related documents, which would streamline processes and increase efficiency. Moreover, conducting comprehensive surveys to gauge the banking sector's expectations concerning key variables of the monetary targeting regime is essential. This would provide valuable insights into how banks perceive and react to monetary policy changes, allowing the Central Bank to tailor its strategies more effectively. Together, these steps would not only enhance operational efficiencies, but also equip the CBvS with a more nuanced understanding of the sector, ultimately contributing to more informed policymaking.

Recommendations

Table 1. Key Recommendations

Recommendations and Authority Responsible for Implementation	Priority	Timeframe[1]/
Liquidity Forecast		
1. Implement forecast with statistical models to produce demand of reserve forecast. (¶12)	High	Short-term
2. Complement the CBvS' forecast with statistical models to produce forecast for autonomous factors. (¶21)	High	Short-term
3. Collect daily level data for autonomous factors, specifically for liabilities to government and net foreign assets. (¶24)	High	Short-term
4. Consider reconciliating the IMF liquidity forecasting framework into current forecast operations. (¶27)	Medium	Medium-term
Participation in Money Market Operations		
5. The eligibility criteria to participate in OMOs should be redirected only to entities subject to the CBvS' reserve requirements. (¶42)	High	Short-term
6. The tenors of the CBCs for structural operations should be reduced to a maximum of 180 days and operations with term deposits should be limited to maximum three different tenors, for instance with 1 week, 30 days and 90 days, ideally indexing them to inflation to ensure its real value. (¶42)	High	Short-term
7. Ad-hoc fine-tuning operations should be considered for large and unpredicted fluctuations in liquidity. (¶44)	High	Medium-term
8. The CBvS should strictly follow the planned schedule auctions as previously communicated. (¶46)	High	Short-term
9. The CBvS should conduct a survey on a regular basis (preferably monthly) to understand banks' expectations regarding the key macro variables related to CBvS' objective. (¶47)	Medium	Medium-term
10. The CBvS, in collaboration with the government, should make further efforts to modernize its infrastructure to improve the development of the interbank market, fortify its understanding of the banking sector's dynamics and improve banks' participation in auctions. (¶52)	High	Short-term
11. The existence of the two separate systems requiring holding reserves in the system should be simplified. (¶60)	High	Short-term

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

I. Introduction

1. **Suriname initiated open market operations in July 2021, when it shifted from an exchange rate to a monetary targeting regime.** This comprehensive framework is designed to achieve the CBvS' objective of price stability. The process starts with establishing the policy objective, which is the ultimate goal of monetary policy and the sole responsibility of the CBvS. Broad money and bank credit are defined as intermediate targets to guide policy decisions, enhancing the central bank's ability to achieve its objectives with greater precision. Subsequently, M0 is set as the operating target to direct ongoing central bank operations, ensuring alignment with the intermediate target over time and clearly signaling the policy stance. To achieve the operational target, the central bank utilizes mainly term deposits (TD) and central bank deposit certificates (CDs) as monetary policy instruments.

2. **Accurate liquidity forecasting is essential for the effectiveness of monetary policy targeting regime and recognizing the importance of refining their model, the CBvS sought assistance from the IMF to enhance this aspect.** The central bank must accurately predict the quantity of money to be absorbed (or provided) so the monetary target can be successfully achieved. Furthermore, accurate liquidity forecasting enables the central bank to craft more strategic, data-driven decisions, enhancing the effectiveness of open market operations, interest rate adjustments, and other monetary policy tools. This, in turn, helps in maintaining economic stability, fostering investor confidence, and guiding the economy towards its desired trajectory. The entire process demands a robust analytical framework, comprehensive data analysis, and the flexibility to adjust policy tools in response to changing economic conditions and new information. To enhance the CBvS' forecasts accuracy, the mission provided advanced statistical models for liquidity forecasting.

3. **The CBvS has been facing challenges to manage persistent excess reserves, notably underperforming in achieving its monetary targets since March 2024 amid low participation of banks in OMOs.** High inflation, exchange rate fluctuations, and expansionary fiscal policies contributed to a rise in base money and a surge in credit, particularly after June 2022, negatively impacting the foreign currency situation. Despite significant increases in average bid rates by the end of the year, the CBvS's efforts to mop up excess liquidity were unsuccessful, leading to frequent failures in meeting its targets. The participation of banks in the auctions are relatively low, with banks often demanding particularly high interest rates. For a successful monetary targeting regime, it is important to understand and address challenges that banks face in managing their liquidity and the obstacles to develop the markets.

4. **The mission implemented the MCMCO-developed statistical forecasting framework to enhance the CBvS' liquidity forecasting and assessed challenges that banks face in managing their liquidity and the obstacles to develop the markets.** The IMF framework consists of 12 forecasting models and includes a system for testing out-of-sample performance based on accuracy, bias, and confidence intervals. It supports model selection, forecast creation, and reconciliation to improve accuracy. The mission introduced its key elements, conducted simulations for staff training, and supplied code packages for forecasting autonomous factors and reserve demand. In addition, to understand the challenges for banks to manage their liquidity and their low participation in the market operations, the mission conducted a survey among commercial banks and organized a workshop in collaboration with the CBvS. The report extensively used available data to quantitatively substantiate the survey's findings.

5. **The report is structured to provide a comprehensive analysis of liquidity management, divided into four main sections.** The first section, "Estimating Demand for Reserves," begins with an examination of the commercial bank reserves balance and excess reserves. The second section, "Forecasting Autonomous Factors and Net Liquidity," explains the models used to forecast key items of the CBvS' balance sheet. The third section, "Liquidity Table and Calibration," presents a detailed liquidity table and discusses the calibration techniques used to estimate and manage liquidity more effectively. The final section, "Participation in Money Market Operations," explores the engagement of market participants in liquidity management activities, providing empirical data and findings from a survey conducted among commercial banks. The last section concludes.

II. Estimating Demand for Reserves

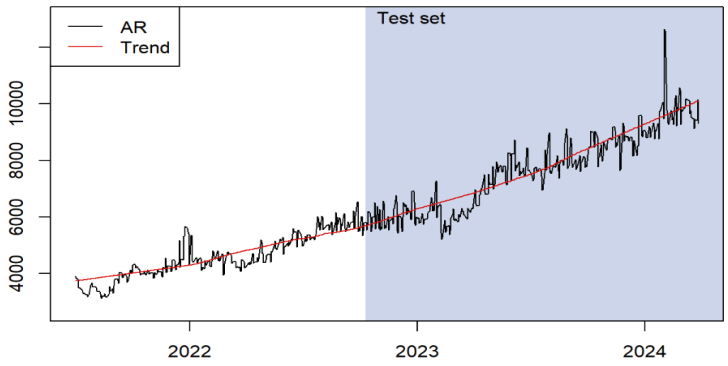
A. Commercial Bank Reserves Balance

6. **The commercial bank reserves balance follows an upward trend starting from July 2021 with weekly and quarterly seasonality.** This is a clear upward trend along the historical data; however, a drop was observed from January to February 2023 (Figure 1). Furthermore, the spike observed at the end of January 2024 can be attributed to a 45.45 percent increase in the required reserve at the beginning of February 2024 for two days. The reserve balance of commercial banks follows a weekly seasonal pattern (Figure 2). The day-of-the-week is encoded using binary indicator variables (four indicators included in the model). An addition of regressors is selected, including one transitory structural break starting from January 31 until February 3, 2024, Moreover, 10 trigonometric indicators are utilized to capture seasonality in the longer-term forecast, such as quarterly and/or yearly forecasts.

7. **ARIMA with regression emerges as the best model to predict the commercial bank balance across time horizon and performance metrics are shown in Figure 3.** The IMF Liquidity Forecasting Framework encompasses both time series and volatility models. It incorporates four types of time series models: Naïve, Exponential Smoothing, ARIMA, and TBATS. The GARCH model family is utilized for forecasting series with high volatility. Technical details regarding the different forecasting modeling specifications can be found in Annex II. The performance metrics contains two indicators of accuracy, including Root Mean Square Error (RMSE) and Mean Absolute Errors (MAE), one indicator of bias Mean Error (ME), and one indicator assessing how well the 95 percent prediction intervals capture the real distribution of the observed data (Mean Interval Score, MIS). MAE is known to be less sensitive to outliers compared to RMSE in terms of forecast accuracy. ARIMA with regressors has the best out-of-sample forecast performance, considering the best forecast accuracy and improving forecast compared to a random walk (the Naïve). In terms of forecast bias, the seasonal ARIMA seem to have better performance. The mean error (ME) for forecast bias in forecasting is a measure of the average deviation of forecasted values from the actual observed values. Values closer to zero suggest that the forecast is relatively unbiased. If the ME is larger than zero, the forecast is overestimating, while the forecast is underestimating if the mean error lower than zero. Figure 4 shows the actual forecast of bank reserve with prediction intervals, using selected model ARIMA with regression and equally weighted average of all models. The darker bands indicate an 80 percent prediction interval, while the lighter bands indicate a 95 percent prediction interval. The observed data is shown in black. A narrower band signifies that the model has greater confidence in its predictions, reflecting less uncertainty regarding the forecasted values. The forecast band of ARIMA with regression is narrower than that produced by using the average of all models. This suggests that

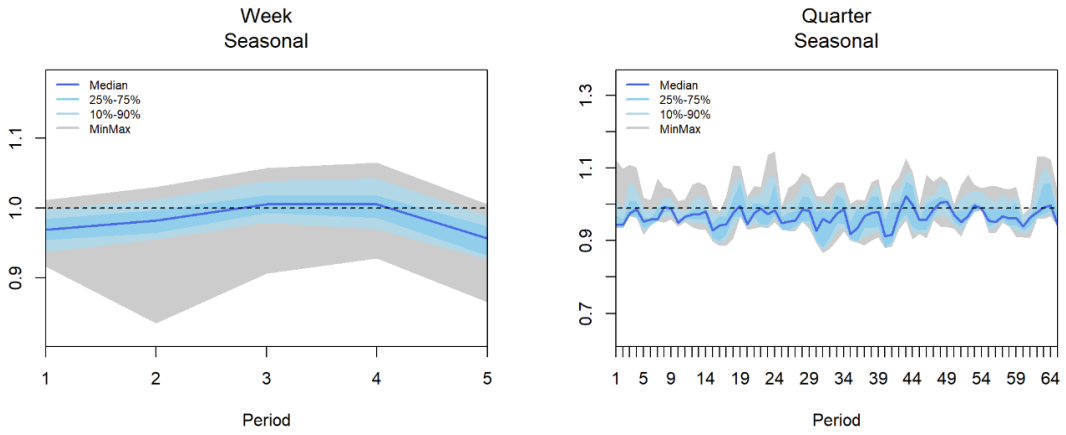
ARIMA with regression is the preferred choice compared to the average across all models.

Figure 1. Historical Trend of Bank Reserves Balance (SRD Millions)



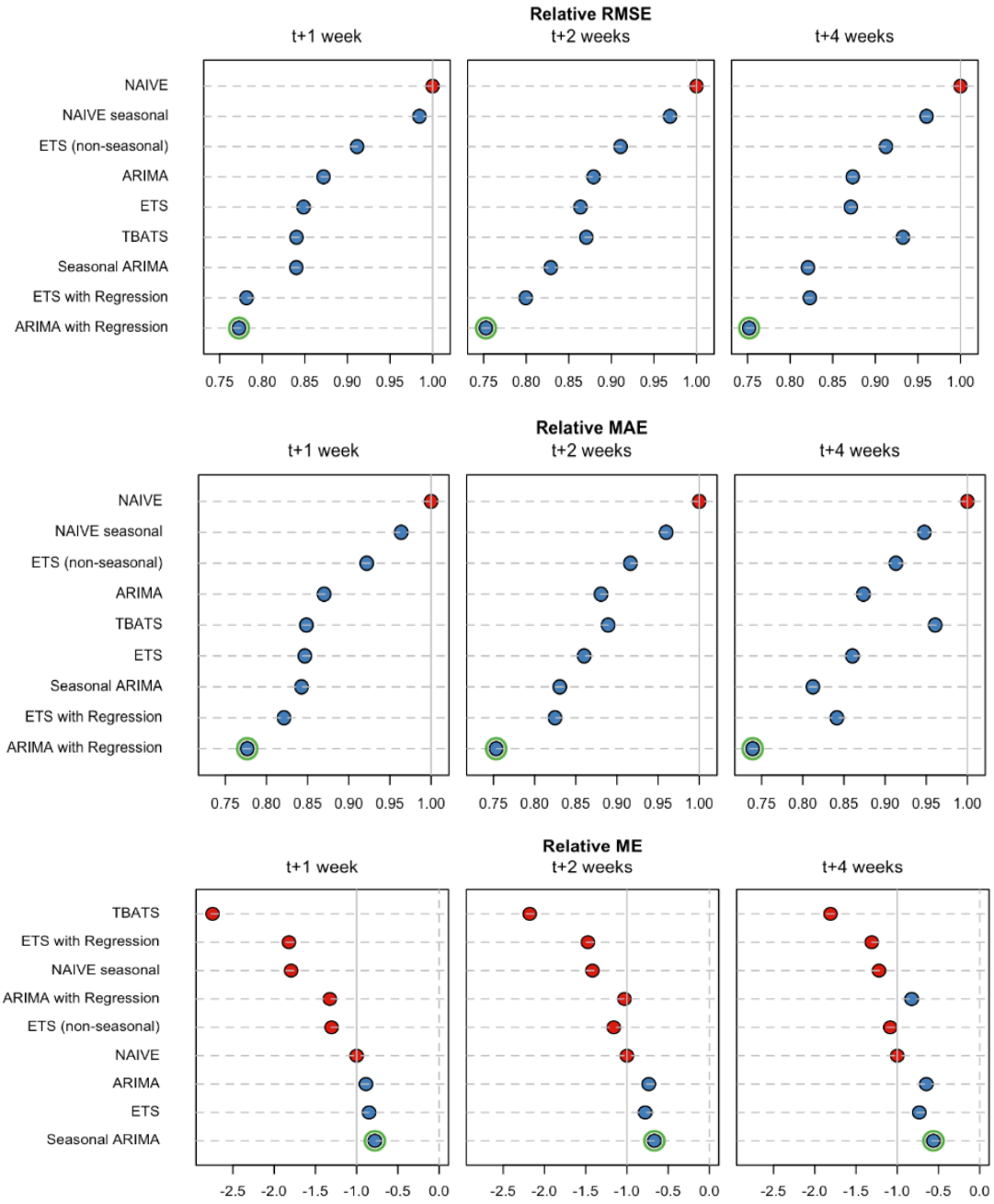
Source: IMF staff calculation, Centrale Bank van Suriname.

Figure 2. Seasonality Analysis of Bank Reserves Balance (SRD Millions)



Source: IMF staff calculation.
Note: Y axis is detrended time series.

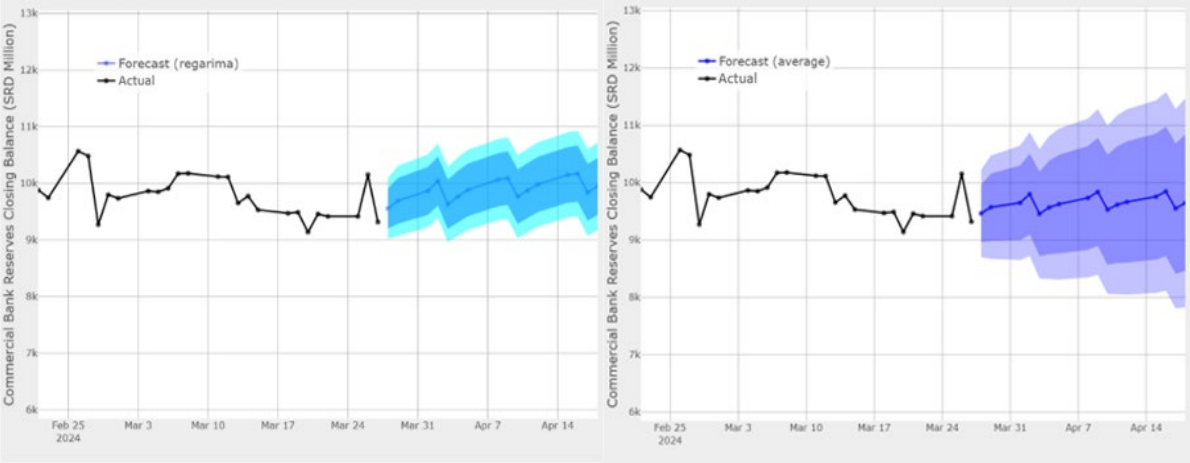
Figure 3. Predictive Accuracy and Bias of Forecasting Models for Bank Reserves Balance



Source: IMF staff calculation.

Notes: The best forecast for each horizon is highlighted with a green circle. A blue circle indicates that the model's performance is superior compared to the naïve model. Any forecast less accurate than the naïve model is represented by a red circle.

Figure 4. Bank Reserves Balance Forecast Using ARIMA with Regression and Average of All Models



Source: IMF staff calculation.

B. Excess Reserves

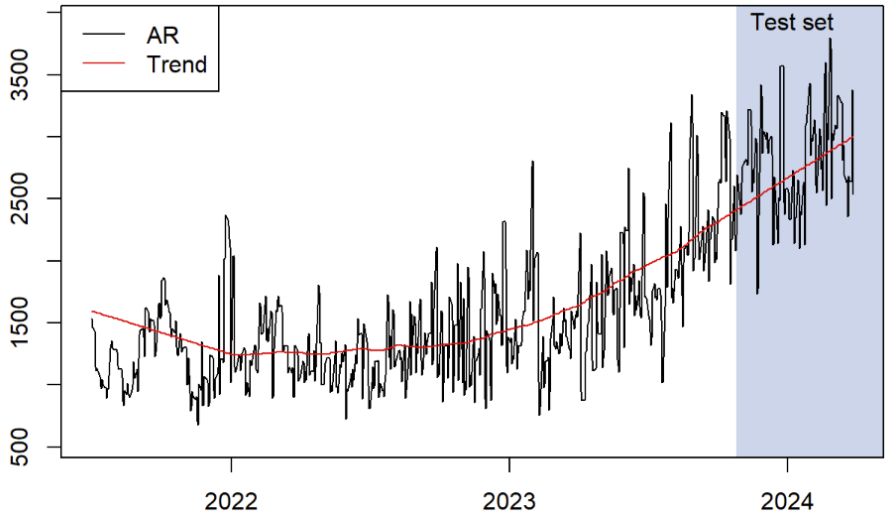
Statistical Models for Forecasting Excess Reserves

8. **Excess reserves are defined as the difference between the bank reserve balance on account and the reserve requirement in the current CBvS liquidity monitoring framework.** Also, it is recorded as the daily working balance of the commercial bank on the CBvS framework. The CBvS framework also has the five percent SNPES (Suriname National Electronic Payments System)[1] as an extra buffer for getting effective excess reserve. The excess reserves exhibit large volatility in the past three years but an overall upward trend (Figure 5). Excess reserves have seasonality shown on a weekly and quarterly basis (Figure 6).

9. **Forecast model selection process for bank reserves balance in the previous section is used for excess reserves.** Both time series and variance models were tested for excess reserves and the time series model was proved to be the better options with higher forecast accuracy. ARIMA with regression is selected as the best model with the lowest RMSE and MAE in all forecast horizon. In terms of the forecast bias, EST with regression has the most unbiased forecast among the model family in t+1 and t+2 weeks, while EST is the best model for longer horizon t+4 weeks (Figure 7).

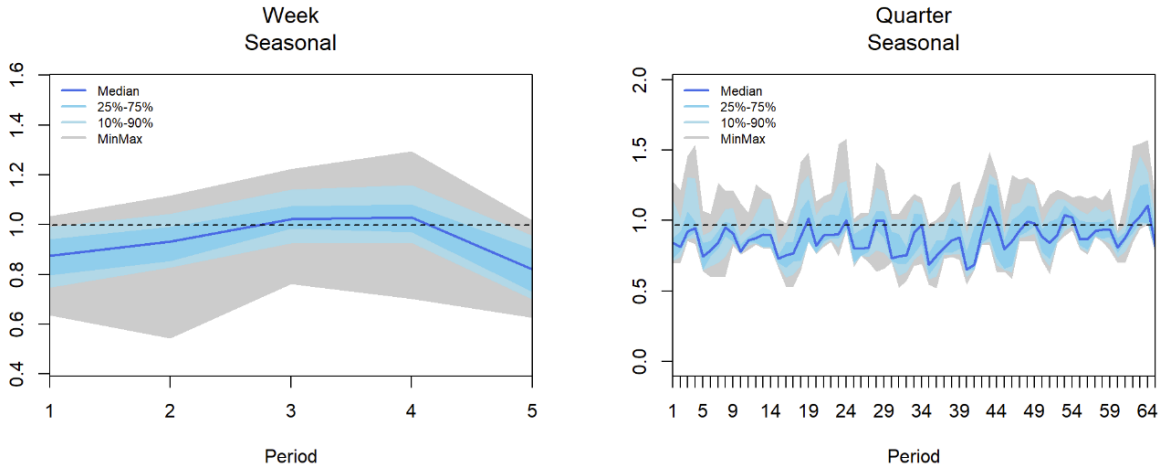
[1] The calculation of effective excess reserves subtracts an additional five percent for the SNEPS payment system, according to the CBvS' methodology defining effective excess reserves.

Figure 5. Historical Trend of Excess Reserves (SRD Millions)



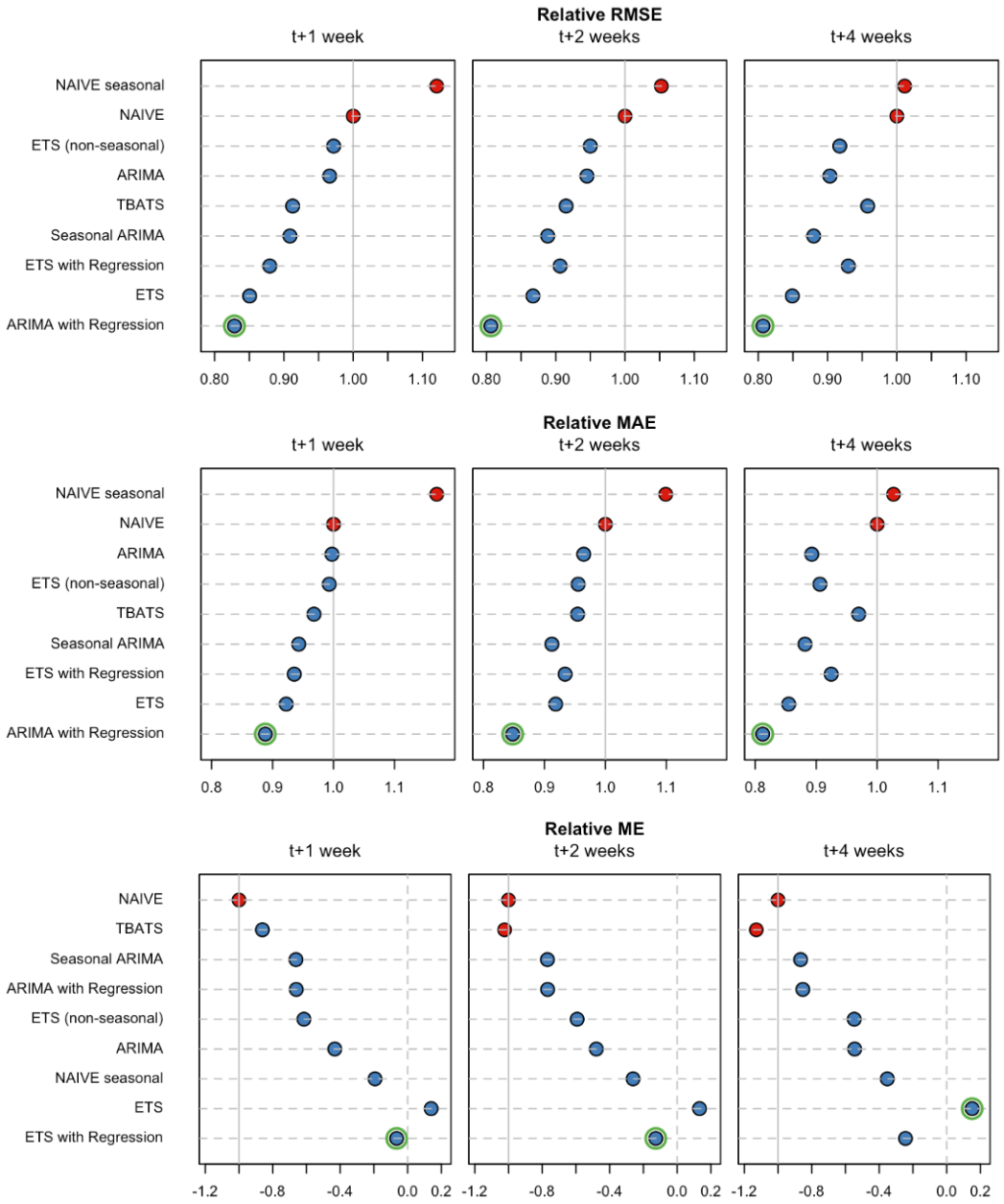
Source: IMF staff calculation, Centrale Bank van Suriname.

Figure 6. Seasonality Analysis of Excess Reserves (SRD Millions)



Source: IMF staff calculation.
Note: Y axis is detrended time series.

Figure 7. Predictive Accuracy and Bias of Forecasting Models for Excess Reserves



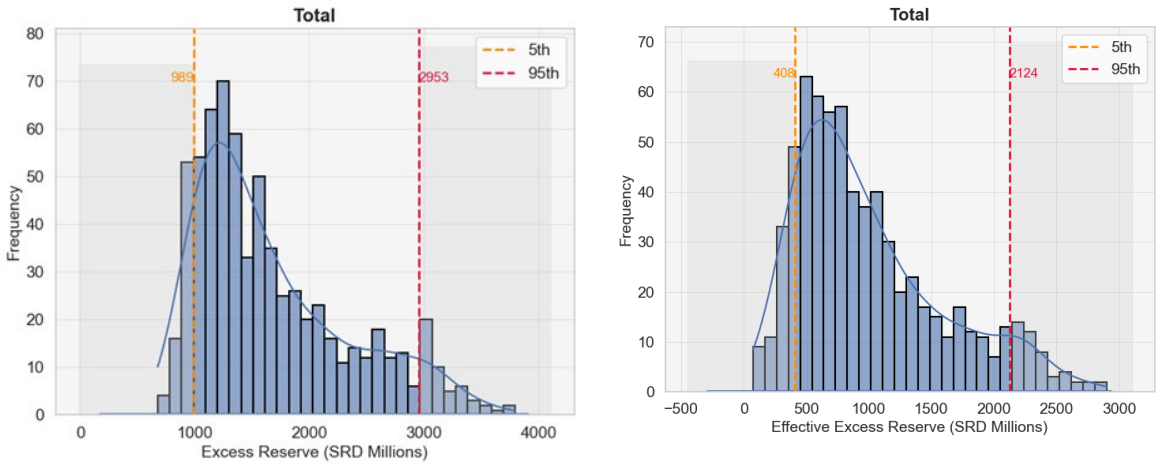
Source: IMF staff calculation.
Note: The best forecast for each horizon is highlighted with a green circle. A blue circle indicates that the model's performance is superior compared to the naïve model. Any forecast less accurate than the naïve model is represented by a red circle.

Precautionary Liquidity Buffers

10. **Liquidity buffers are part of the excess reserves held by each bank, usually held for precautionary purposes.** This methodology was introduced during previous MCM TA mission to help estimate each bank's available excess liquidity and their distinct liquidity risk profiles. Regular reviews of precautionary liquidity buffers can provide information on demand changes from the banks'

perspective and supplement the reconciliation of statistical forecasts of excess reserves with operational activities. The estimation of liquidity buffers is based on the historical weekly average distributions of excess reserves, both on an aggregated basis and individually by bank. It's essential that these buffers are periodically reviewed, considering the establishment of excess reserve thresholds at the 5th and 95th percentiles. Between July 2021 and March 2023, according to Figure 8, the 95th percentile for the entire banking system's excess reserves was 2953 million SRD, and the 5th percentile was 969 million SRD. The calculation of effective excess reserves subtracts an additional five percent for the SNEPS payment system, according to the CBvS' methodology defining effective excess reserves. For effective excess reserves, the thresholds are set at 2124 million SRD for the 95th percentile and 408 million SRD for the 5th percentile. Table 2 and 3 specify the threshold ranges for each bank, while Annex I provides detailed distribution figures for individual banks.

Figure 8. Distributions of Weekly Average Total (Effective) Excess Reserve



Source: IMF staff calculation, Centrale Bank van Suriname.
Note: The excess reserves based on bank working accounts in the CBvS' framework.

Table 2. Weekly Average Excess Reserve by Bank

Bank #	5th Percentile	95th Percentile
Bank 1	306	1278
Bank 2	54	386
Bank 3	130	932
Bank 4	28	186
Bank 5	43	205
Bank 6	67	293
Bank 7	12	64
Bank 8	7	65
Bank 9	4	69

Source: IMF staff calculation, Centrale Bank van Suriname.

Table 3. Weekly Average Effective Excess Reserve by Bank

Bank #	5th Percentile	95th Percentile
Bank 1	117	1001
Bank 2	-74	218
Bank 3	43	844
Bank 4	-44	97
Bank 5	25	182
Bank 6	-6	221
Bank 7	0	52
Bank 8	-20	39
Bank 9	-3	51

Source: IMF staff calculation, Centrale Bank van Suriname.

11. **The mission recommends incorporating statistical models for demand for reserve forecasts for the central bank to extract available information from historical trends of time series.** The CBvS will be able to combine the forecast and additional statistical information with qualitative evaluations such as bank surveys, demand curves, or precautionary liquidity buffers to better understand the liquidity from the demand side.

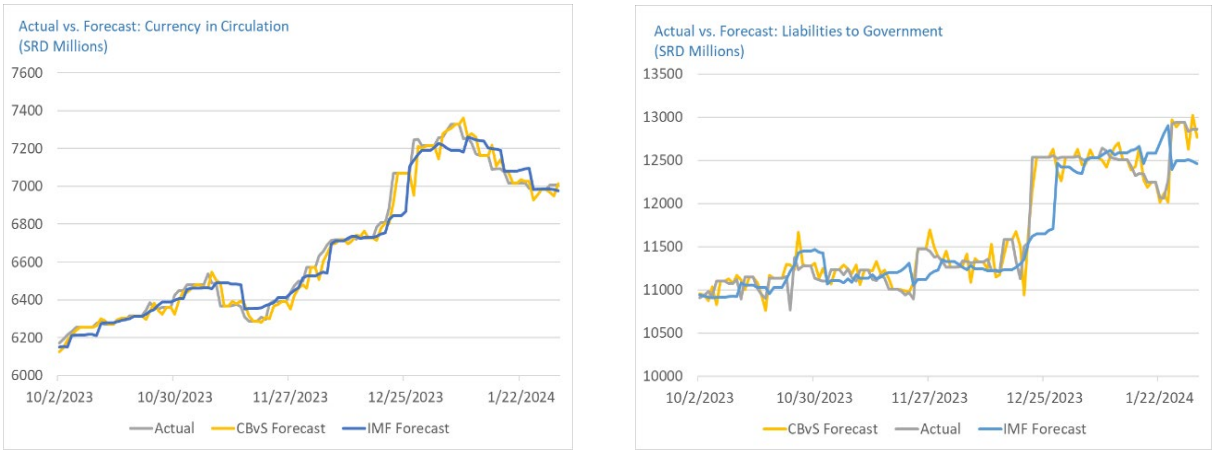
III. Forecasting Autonomous Factors and Net Liquidity

12. **The objective of adopting a liquidity forecasting framework (e.g., the IMF framework used during the mission) is to introduce statistical models and reconciliation techniques to obtain the forecast of autonomous factors on net liquidity.** The framework includes a forecast of currency in circulation and central bank liabilities to the government. Then, it uses statistical techniques to reconcile the sum of the two autonomous factors with the forecast of the total aggregated liquidity. Finally, the framework also provides information on forecast uncertainty by utilizing the confidence interval generated from the forecast.

13. **The mission also benchmarks the IMF framework with the CBvS' autonomous factor forecasting.** The CBvS is currently using an ARIMA model to project the daily currency in circulation and to model monthly CiC as a function of monthly lagged inflation and seasonal factors. The CBvS also conducts daily forecasts for changes in government ordinary transactions by revenues and expenditures. The forecasts are updated on a weekly basis. Figure 9 compares the forecast of currency in circulation and liabilities to the government in the past three months. The CBvS forecast tracks the outliner changes accurately, while the IMF framework is following the trend but is relatively less sensitive to the big jump during the end of 2023. Compared to the purely statistical forecast method, the forecast from the CBvS benefits from the qualitative and other internal information regarding the potential large transaction by the government. Such

information would be decisive in influencing the forecast in some cases. Therefore, combining statistical forecasts with policy judgment would be recommended during the actual operational process. Additionally, liabilities to the government are computed by tracking net changes from the initial value at the start of the time series in the IMF framework, due to availability of daily data on the level liabilities to government. The data transformation from different sources of data between level and net change[2] may have introduced additional uncertainty into forecasting models.

Figure 9. Back-testing Forecasts for Liabilities to Government and Currency in Circulation



Source: IMF staff calculation, Centrale Bank van Suriname.

A. Currency in Circulation

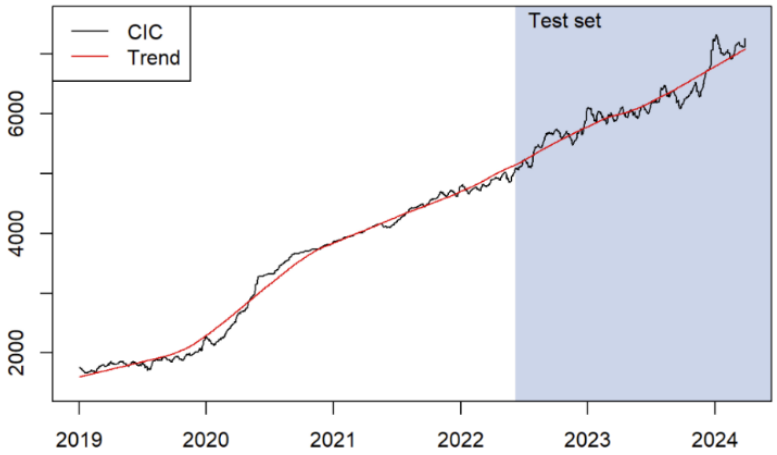
14. **The mission forecasted total currency in circulation (CiC) and the aggregated basis of currency in circulation with two components, cash outside the bank and cash in vault.** The total currency in circulation shows an upward trend in general (Figure 10). Weekly, quarterly, and yearly seasonal patterns can be detected in cash outside the bank and cash in vault. However, only weekly and quarterly seasonal patterns are indicated in total currency in circulation. The seasonal patterns show that the currency in circulation tends to increase at the end of each year and then follow a decrease during the first quarter of the next year (Figure 11).

15. **ARIMA with Regression is selected for CiC for all one-week, two-week, and four-week forecasts.** Along with two benchmarking models Naïve and Naïve seasonal, 7 models were tested for CiC. The ARIMA with Regression is ranked the top in terms of accuracy, testifying to the valuable addition of regressor. Based on information criteria, the framework determines a list of regressors to be included in the model. Beyond the day-of-the-week that is encoded using binary indicator variables (four indicators), an addition of four trigonometric indicators is used for longer-term seasonality. In terms of mean error, the ARIMA and seasonal ARIMA have the closest distance to zero scores in one-week and two-week forecasts, respectively. The ARIMA with regressor has the lowest forecast in a four-week forecast. When considering the forecast bias, ARIMA, seasonal ARIMA and ARIMA with regression is the best model for t+1, t+2 and t+4 weeks separately, while the ME among the three models is relatively small (Figure 12).

[2] The daily net change were retrieved from liquidity monitoring table from the CBvS, while the initial level of liabilities to government was captured in monthly data from the Ministry of Finance.

16. **Model reconciliation improves the forecast quality of CiC.** RMSE at the one, two, and four-week horizons are lower for the reconciled forecasts (Figure 13) than the non-reconciled one with the chosen reconciliation method STR, showing that additional information is processed in the series of cash outside the bank and currency in vault. ARIMA with regression reconciled by STR appears to be the best-performing forecast for CiC in terms of RMSE at all horizons.

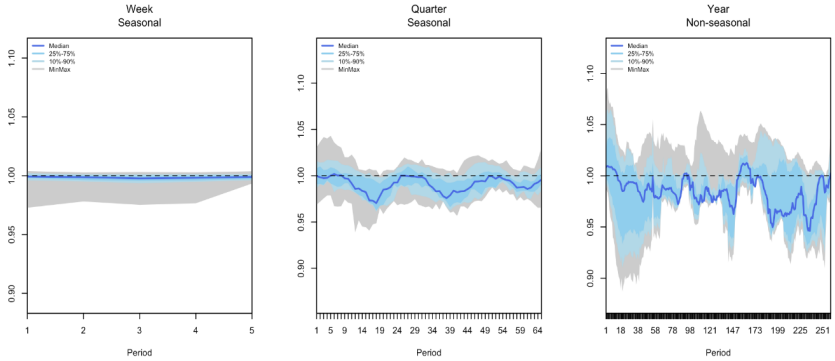
Figure 10. Historical Trend of Currency in Circulation



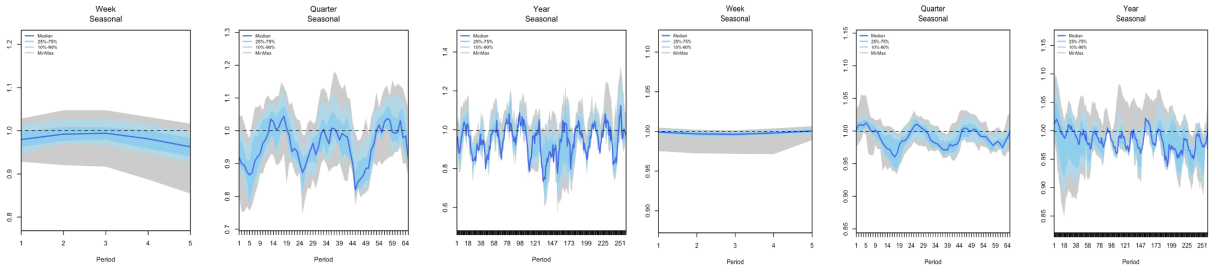
Source: IMF staff calculation, Centrale Bank van Suriname.

Figure 11. Seasonality Analysis of Currency in Circulation (SRD Millions)

1. Total Currency in Circulation Currency

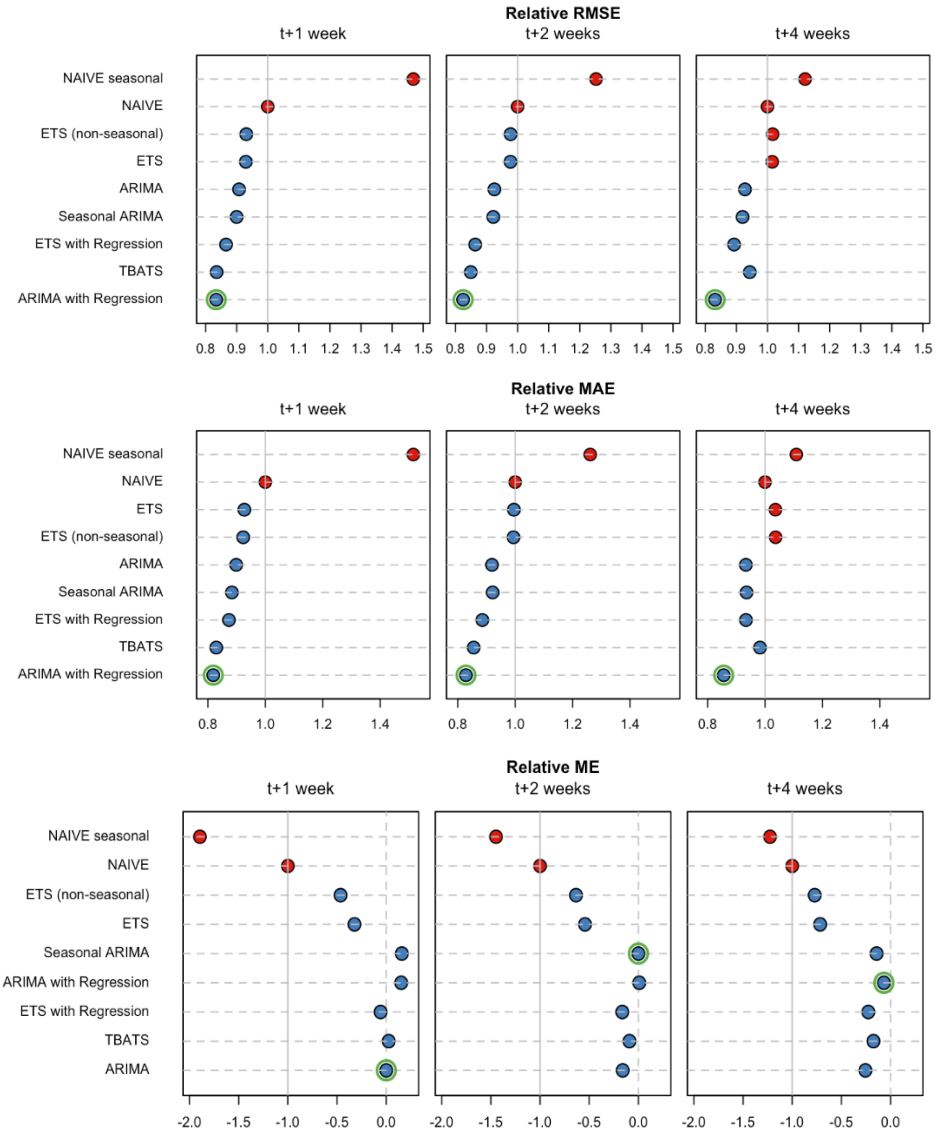


2. Cash in Vault and Cash Outside Bank



Source: Staff calculation.
Notes: Y axis is detrended time series.

Figure 12. Predictive Accuracy and Bias of Forecasting Models for Currency in Circulation



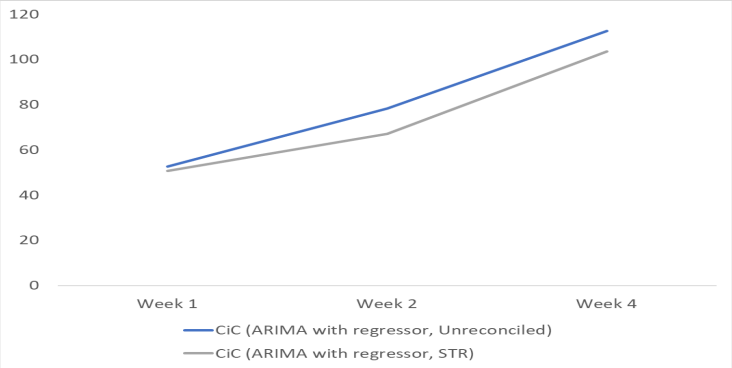
Source: Staff calculation.
Note: The best forecast for each horizon is highlighted with a green circle. A blue circle indicates that the model's performance is superior compared to the naïve model. Any forecast less accurate than the naïve model is represented by a red circle.

Table 4. Model Selections for Currency in Circulation

Series	Best Model Selection
Currency Outside Banks	ARIMA with Regression
Cash in Vault	ETS with Regression
Currency in Circulation	ARIMA with Regression

Source: IMF staff calculation.

Figure 13. RMSE: Aggregated and Reconciled CiC



Source: IMF staff calculation.

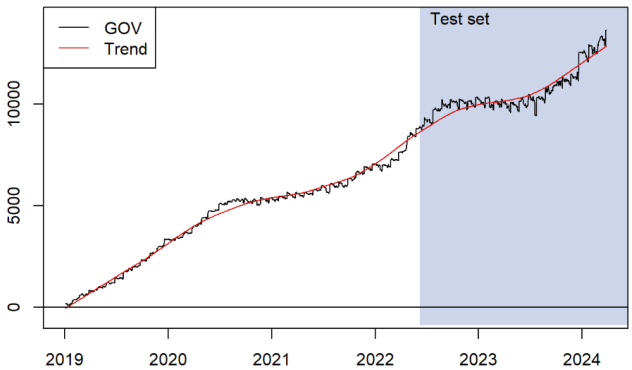
B. Liabilities to Government

17. **Seasonal patterns can be observed in monthly and quarterly distributions in Figure 14.** The quarterly seasonal pattern shows that the liability to the government in Q2 and Q3 is relatively lower compared to Q1 and Q4, which indicates that the government tends to have larger expenditures during Q2 and Q3, while government revenue increases during Q1 and Q4. Figure 15 illustrates the distribution by different frequencies. While the monthly and quarterly patterns are pronounced, the weekday distribution is relatively stable.

18. **TBATS is ranked as the model with the best performance in terms of forecast accuracy in Figure 15.** TBATS model allows multiple seasonality. It combined trigonometric terms, exponential smoothing, ARMA errors, and the Box-Cox transformation in the TBATS model. When considering forecast bias, seasonal ARIMA shows a closer distance to the unbiased position at zero.

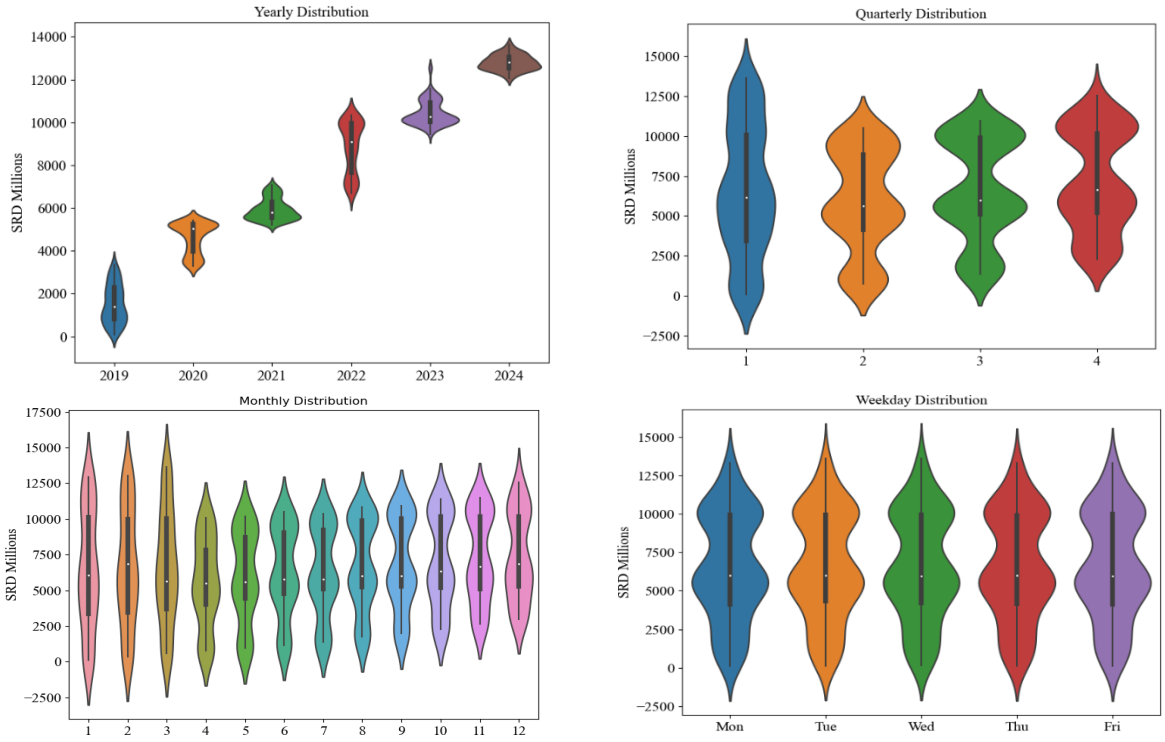
19. **Daily data of liabilities to government should be considered in future data collection operations.** The model is using the stock of liabilities to government calculated by net changes of liabilities to government with an initial value at the beginning of 2019 as the input data. The level data will also provide more information on the trend and evolution from the past which has positive contribution to the CBvS' current forecasting framework.

Figure 14. Historical Trend of Liabilities to Government



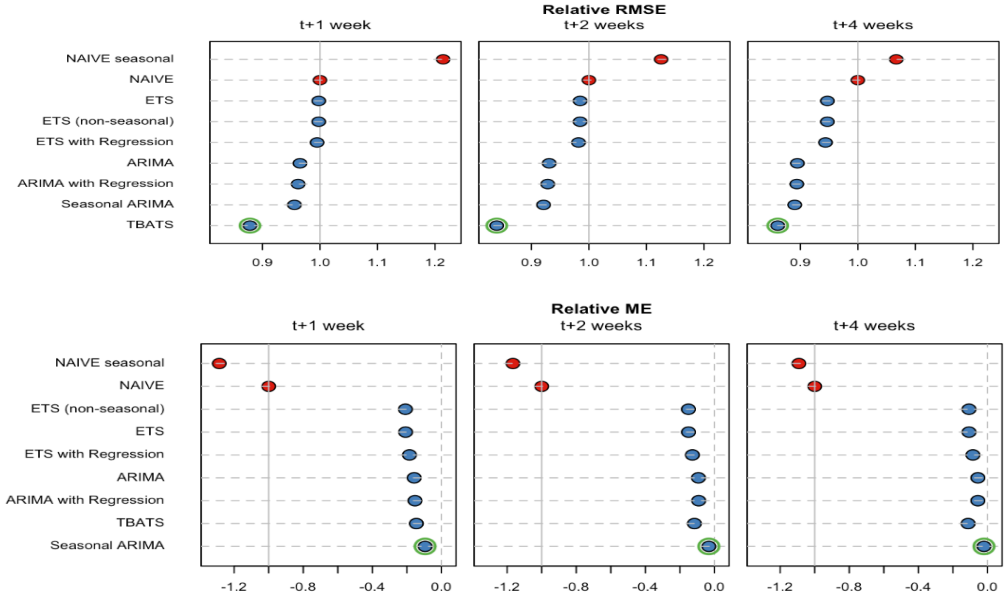
Source: IMF staff calculation, Centrale Bank van Suriname.

Figure 15. Seasonal Patterns in Liabilities to Government



Source: IMF staff calculation, Centrale Bank van Suriname.

Figure 16. Predictive Accuracy and Bias of Forecasting Models for Liabilities to Government



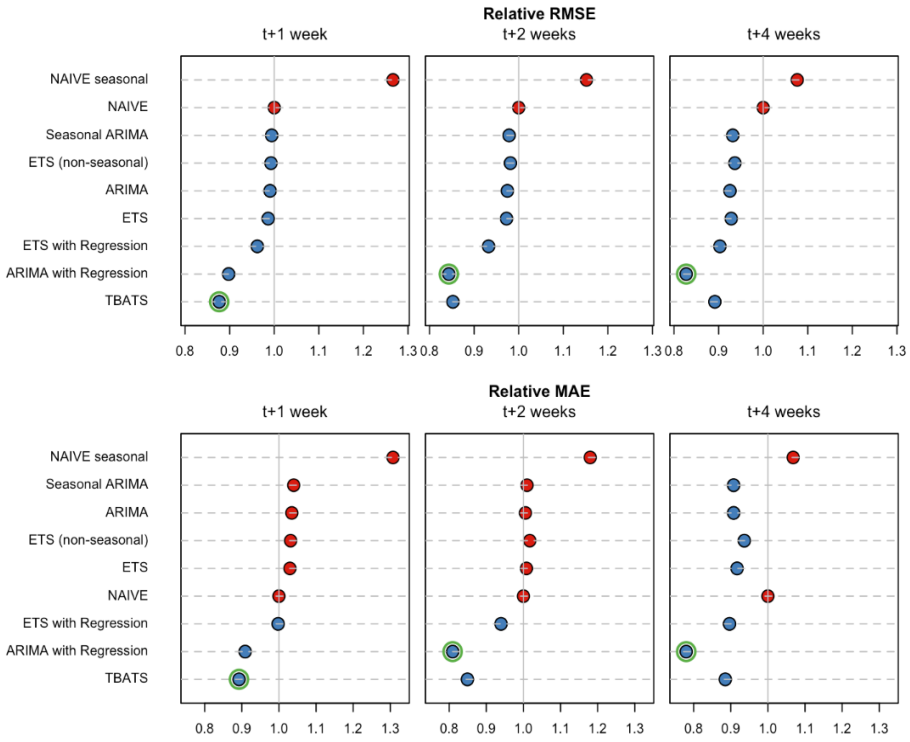
Source: IMF staff calculation.
Note: The best forecast for each horizon is highlighted with a green circle. A blue circle indicates that the model's performance is superior compared to the naïve model. Any forecast less accurate than the naïve model is represented by a red circle.

C. Net Liquidity

20. **The IMF framework also includes the forecast for net liquidity by combining the autonomous factors to get the aggregated net liquidity and TBATS is selected as the model of best forecast performance with the lowest RMSE and MAE score for t+1 week, shown on Figure 17.** The model comparisons show that TBATS has relatively higher performance for +1 week, while ARIMA with Regression has better performance during t+2 and t+4 weeks. The TBATS is selected to capture the nearest forecast horizons which aligns with the weekly maintenance period.

21. **The forecasts for the autonomous factors and net liquidity are reconciled with the STR method, which is the recommended reconciliation method for a 1-week horizon.** The reconciliation step including methods of bottom up, MinT, STR and OLS, in order to further improve the forecast performance for net liquidity (See technical details on the advantages of utilizing reconciliation for forecasting net liquidity in Annex II). Table 5 provides the results for the alternative reconciliation methods. For longer horizons such as two weeks and four weeks, the bottom-up method is the best option with the lowest RMSE and MAE. This method forecasts all components of the net liquidity separately and aggregates them to the forecasting of the net liquidity. However, when the forecast horizon is shortened to one week, the STR approach shows the highest forecast accuracy. In terms of bias, the bottom-up approach has the lowest ME scores across all horizons.

Figure 17. Predictive Accuracy and Bias of Forecasting Models for Net Liquidity



Source: IMF staff calculation.
Note: The best forecast for each horizon is highlighted with a green circle. A blue circle indicates that the model's performance is superior compared to the naïve model. Any forecast less accurate than the naïve model is represented by a red circle.

Table 5. Reconciled Forecast Accuracy and Bias for Net Liquidity

Method	RMSE			MAE			ME		
	Week1	Week2	Week4	Week1	Week2	Week4	Week1	Week2	Week4
STR	**227.38**	**284.67**	**384.07**	**152.92**	**204.24**	**284.29**	**4.44**	**16.65**	**37.34**
OLS	227.70	286.35	388.31	153.31	205.77	288.19	5.64	18.91	42.31
Bottom Up	**228.71**	**283.05**	**376.95**	**153.44**	**202.22**	**277.23**	**0.86**	**9.89**	**22.42**
Base (Unreconciled)	229.48	291.35	399.39	155.02	210.05	297.97	8.03	23.42	52.26
MinT	245.19	299.03	390.35	169.17	215.38	290.62	-5.78	-3.18	-0.12

Source: IMF staff calculation.

22. **The mission recommends the CBvS to incorporate the IMF liquidity forecasting framework into its current liquidity forecasting framework.** Based on the current operational framework, the mission customized the liquidity forecasting framework to align with the weekly maintenance period starting every Wednesday with five-day horizons until the next maintenance day on Wednesday. The update of the forecast generated from the model is recommended to be conducted every week. In addition, the mission recommends evaluating the model selection periodically (i.e., run model validations every month or every quarter, etc.) to change the model selection, if necessary, to get updated input from the latest data feed.

23. **The mission recommends including collecting daily level data for autonomous factors into operations to monitor the trend and seasonal variations of time series more accurately.** The CBvS is using net government transactions as the data input, however, the forecast would benefit from transmitting the transaction data to daily stock data of liabilities to the government. In addition, the CBvS should also consider incorporating the net foreign asset into the current forecasting framework.

IV. Liquidity Table and Calibration

24. **A liquidity forecasting table (Table 6) can be used to summarize information and record forecasts on reserves available in the system and the demand for excess reserves to calibrate the weekly open market operations.** This table has three sections: (i) flows of liquidity supply; (ii) flows of liquidity demand; and (iii) the conclusion of forecasted liquidity gap which leads to the suggested operations. The table can also be used to include the forecasts in levels. The first three items, which include autonomous factors and maturity of previous open market operations, provide liquidity supply flows to the system. The forecasts of autonomous factors are generated from the IMF framework on a daily basis for a horizon of five days ahead, skipping weekends and aligning with the current weekly liquidity maintenance period. In addition, the forecast can be extended to a longer horizon if needed. The upcoming maturity amount of the previous OMO is based on the CBvS' record. Starting from the fourth item, the table collaborates projections from the demand for excess reserves. The table uses the CBvS' forecast averaging for four weeks as input, given that the reserve requirements remain the same for a five-day ahead horizon and that forecast error of reserve requirement in the longer term now is relatively small. Combining reserve requirements and excess reserves, the framework generates the total forecasted liquidity demand.

Table 6. Liquidity Forecasting Table

Flows	Source	t+1	t+2	t+3	t+4	t+5
1. Autonomous Factors (a+b)		53.3	25.8	6.0	17.2	24.7
a. Currency in Circulation (a1+a2)		14.9	-19.2	-26.8	-14.4	-4.5
a1. Currency Outside Banks	IMF Forecasting Framework	12.6	23.5	9.7	-6.2	-14.2
a2. Cash in Vault		-27.5	-9.6	-6.5	29.1	29.7
b. Liabilities to Government		38.4	45.0	32.8	31.6	29.2
2. Maturity of Previous Open Market Operations	CBvS	729.6	0.0	0.0	0.0	721.1
3. Liquidity Supply Flows (1+2)	Sum	782.9	25.8	6.0	17.2	745.8
4. Commercial Bank Reserves (a+b)	Sum	142.9	50.5	131.9	154.1	-418.8
a. Reserve Requirement	CBvS	0.0	0.0	0.0	0.0	0.0
b. Excess Reserves	IMF Forecasting Framework	142.9	50.5	131.9	154.1	-418.8
b1. 5% SNEPS requirement	CBvS	0.0	0.0	0.0	0.0	0.0
b2. Effective Excess Reserves (b-b1)	Sum	0.0	0.0	0.0	0.0	0.0
5. Total Open Market Operations (4-3)	Sum	-640.0	24.7	125.9	136.9	-1164.6

Source: IMF staff calculation.

25. **Based on the information from both supply and demand, the CBvS will be able to calculate the amount of the difference between available reserves and reserve demand from the banks for the liquidity gap.** The training on the IMF framework were provided to the technical staff, and the CBvS now can maintain and update the IMF liquidity framework. In addition, the mission conducted a simulation with the CBvS staff to practice using the liquidity forecasting table introduced by the mission, updating the table with the most recent data as new inputs for generating the forecast results.

26. **The CBvS should consider to reconciliate IMF liquidity forecasting tool into current forecast operations as next step.** The IMF framework provides the CBvS with a methodology for using pure statistical models to estimate the liquidity gap, which will serve as a guide for estimating the issuance amount of term deposits. However, the mission understands that the CBvS still needs guidance for implementation before fully integrating the IMF framework in actual operations. This includes aligning with reserve money targets, consolidating information from institutional arrangements and sources, and navigating scenarios that demand expert judgment. The time series data employed for the projections already incorporate the maturing securities, thereby accounting for this additional liquidity. To avoid misleading estimations in liquidity, especially when a significant volume of securities is set to mature within the projection period, the CBvS should calibrate its projection results by considering the additional volume from these maturing securities in the auctions. This adjustment could be achieved by setting a specific threshold based on historical distributions of maturing securities. Meanwhile, the estimations of precautionary liquidity buffers in the previous section could also serve as a threshold to monitor bank's behavior from the demand side when considering the liquidity forecasting.

V. Participation in Money Market Operations

27. **Following the transition from an exchange rate regime to a monetary targeting regime, Suriname commenced open market operations in July 2021.** The adoption of the reserve targeting monetary regime made a strategic shift in its approach to monetary policy, reflecting Suriname's efforts to strengthen its monetary policy framework and address economic challenges more efficiently. However, between September 2020 and June 2021, the Suriname dollar experienced a 182.5 percent devaluation while transitioning to a freely floating exchange rate system. The substantial devaluation resulted in numerous macroeconomic challenges, including

inflation rates that exceeded 60 percent in the following months given a high pass-through effect, which led households and economic agents to hedge against further depreciation, resulting in an extensive financial dollarization. In June 2021, Suriname started its first market operations aiming at achieving its M0 target.

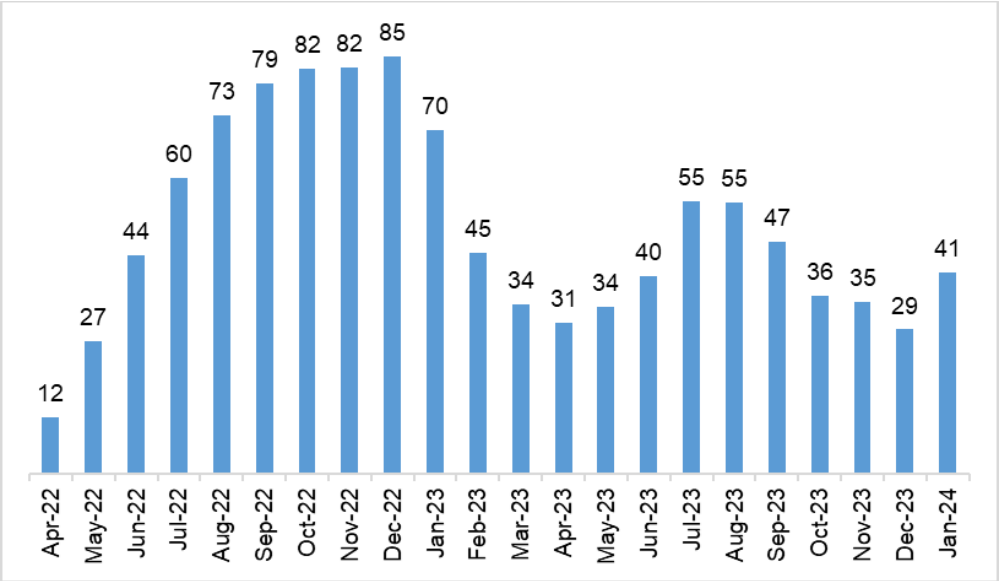
28. **The CBvS has two main instruments in its open market operations toolkit: term deposits (TDs) and Central Bank Certificates (CBCs).** The CBvS conducts weekly multiple price auctions for term deposits, offering tenures of one week, one month, and three months for banks. The quantity is announced, and the counterparties bid the desired volume and the rates. The cut-off rate, which is determined by the highest acceptable bid until the total quantity of the auction is reached. In addition, there are also quarterly auctions for central bank certificates (CBCs) with tenures of six and nine months.

29. **CBCs are viewed as unconventional instruments of a temporary nature by the CBvS, issued to absorb structural excess liquidity in the financial system.** CBCs were introduced in June 2022 and are not part of the standard monetary policy toolkit. They are used as an additional tool to manage liquidity conditions, so far employed to absorb excess reserves. In addition, the CBvS also aimed at further stimulating the development of the money and capital market, including interest rate transmission mechanism. Besides banks, CBCs are available for wholesale and retail segments, encompassing non-bank financial institutions, legal entities, and households.[3]

30. **The CBvS has been facing challenges to absorb the persistently high excess reserves.** Persistent high inflation, exchange rate volatility, and expansionary fiscal policies led to increases in the base money and to a surge in credit, in particular after June 2022, further affecting foreign currency. Notably, the average bid rates increased substantially until the end of the year (Figure 18) while the CBvS was not successful in mopping up the excess liquidity. Frequent failures to meet targets led the CBvS to revise its monetary policy. In response to the excessive growth in credit and in the money supply, the CBvS also introduced Central Bank Certificates (CBCs) in its monetary policy toolkit as an attempt to further absorb liquidity. In addition, in April 2023, the CBvS increased the reserve requirement ratio from 39 to 44 percent and imposed a 20 percent limit on annual credit growth for the banking sector as a response. As of March 2024, the CBvS has realized an underperformance of SRD 537.7 million (see Figure 19).

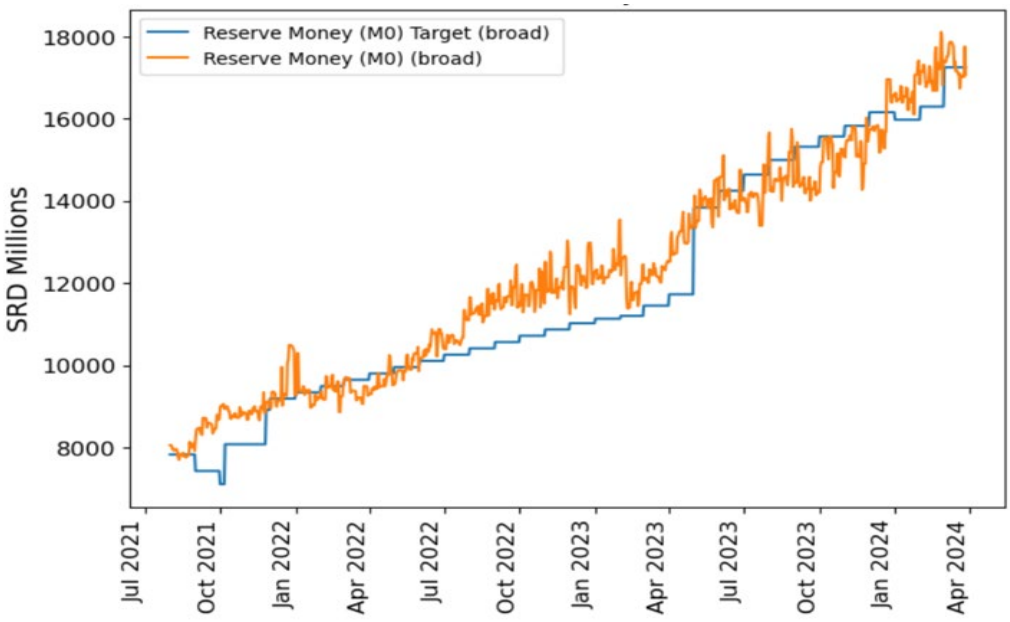
[3] Wholesale segment includes general banks, non-bank financial institutions, and legal entities, with a minimum deposit of SRD 50,000, accessible through auctions. Retail segment comprises natural persons, including households, and other legal entities like companies, with a minimum deposit of SRD 10,000, accessible through registration at respective banks.

Figure 18. Average Monthly Bid Rates—One Week Tenor (In Percent)



Source: Centrale Bank van Suriname.

Figure 19. M0: Target versus Actual (In SRD Millions)



Source: Centrale Bank van Suriname.

31. **To shed light on the challenges faced by the banks in managing their liquidity and on the patterns observed in the auction's activities, the mission surveyed commercial banks.** The survey received responses from seven out of nine banks, covering approximately 92 percent of the total banking sector assets. The questionnaire contained 27 questions about liquidity management as well as about the market environment.

32. **The mission also held a workshop with the central bank to discuss the findings of the survey and clarify monetary policy framework and operations.** During the workshop, the concerns raised by the banks were discussed, providing a comprehensive platform for dialogue. The issues surrounding liquidity management and money market participation, as highlighted in the survey, were thoroughly examined with the intent to align the banks' operational strategies with the central bank's monetary policy objectives. This detailed discussion not only fostered a clearer comprehension among the participants but also set the stage for a more collaborative approach moving forward. Nonetheless, some issues remained unclear, specifically the large discrepancy between the rates demanded with respect to the quantities bid and the substantial range between the rates themselves. To shed light on these issues, further analysis is conducted. The outcomes and detailed analysis of these discussions are elaborated in the first subsection of Section A of the report.

A. Challenges in Managing Liquidity: Results from the Commercial Banks Survey

33. **The survey with commercial banks assessed their liquidity management challenges, including in relation to their participation in money market operations.** The financial sector of Suriname is dominated by the banking sector, which covers approximately 76.5 percent of the financial assets of the country, which is equivalent of 91 percent of GDP.[4] There are currently nine active banks, of which four are classified as systemic. Only one bank is under foreign ownership. From the domestic banks, six are majority private domestically banks and two are fully stated-owned banks.

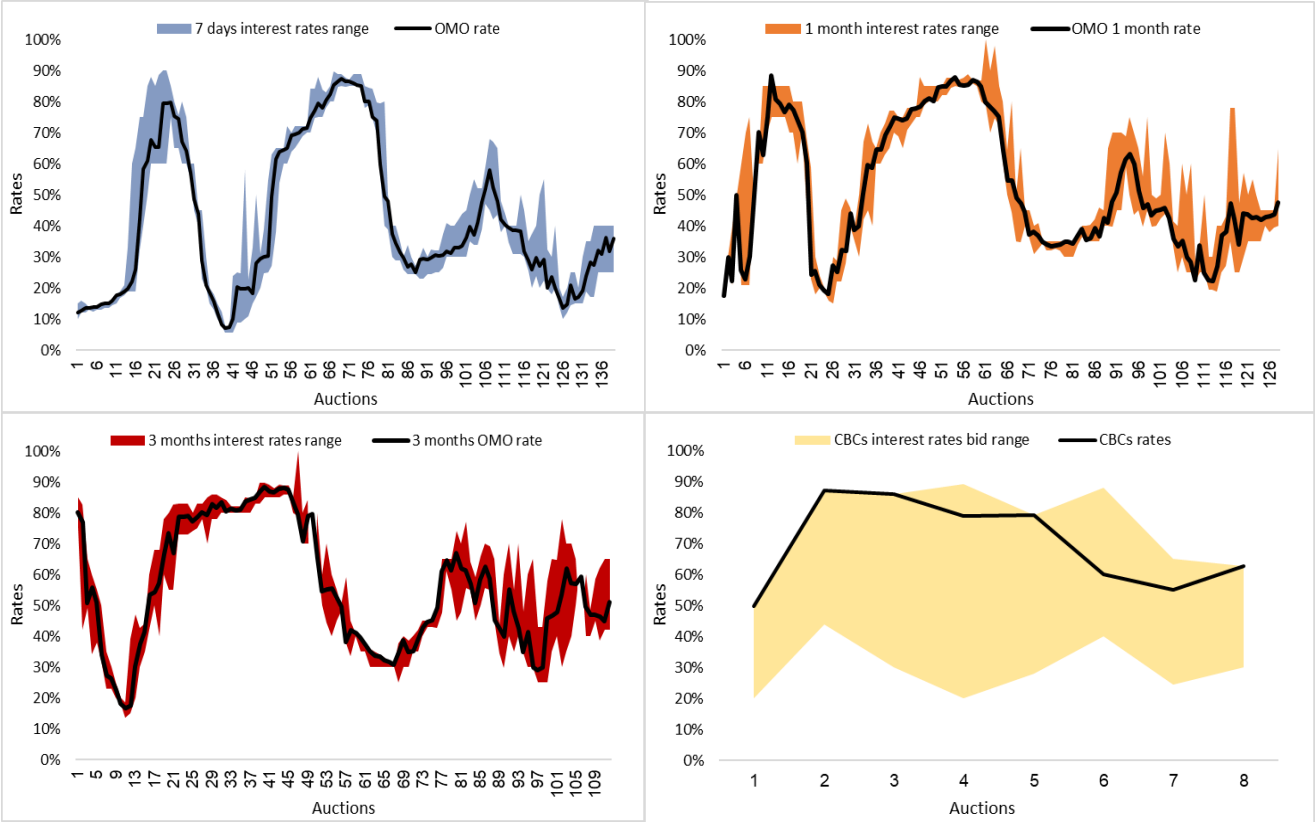
34. **High OMO interest rates, the CBCs policy and its impact in the market as well as high reserve requirements were the most frequently cited concerns from banks.** Banks did not unanimously identify one specific challenge to liquidity management. However, most banks see aspects related to CBvS's current policy as the main source of their liquidity management issues, such as high OMO interest rates, certain elements of the CBCs policy and its impacts on the market as well as high reserve requirements. Other factors cited were the absence of a well-functioning money market, challenges in the FX market, and supervision requirements. Banks also provided suggestions on how the authorities could help to address these challenges, which were discussed in the workshop.

High OMO Rates and the Impact of Central Bank Certificates in the Market

35. **Alongside the low participation of banks in auctions, the rates submitted by the banks are notably high and often disproportional with respect to the quantities bid.** There is a high discrepancy across the rates bid by the banks, both for TDs and CBCs (Figure 20). According to the CBvS, smaller banks often propose the highest bids for low volumes, whereas larger banks typically demand larger amounts for relatively lower rates, in particular for TDs. In fact, the reserve demand curve illustrated in Figure 21 from an auction offering one-week tenors from December 2022 shows that the largest bid came from the largest bank while the marginal amounts were demanded by smaller banks for higher rates.

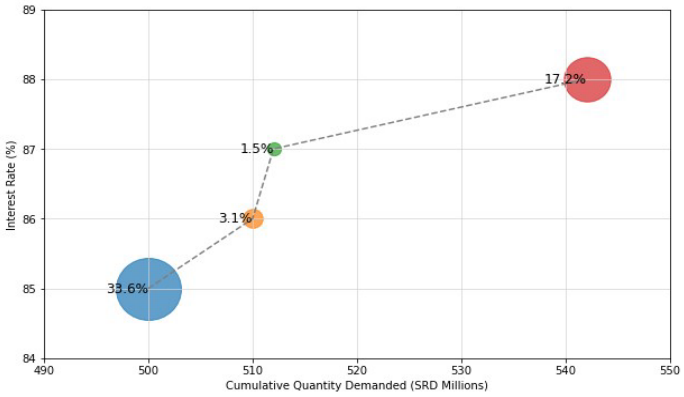
[4] Data from Central Bank of Suriname, Financial Stability Report, published in October 2023.

Figure 20. OMO and CBCs Rates
(In Percent)



Source: Centrale Bank van Suriname, IMF staff calculations.
Note: OMO auctions started on 21 July 2021. CBCs auctions started on 16 June 2022, with tenors of three, six and nine months. The nine months tenor was issued on 14th March 2024.

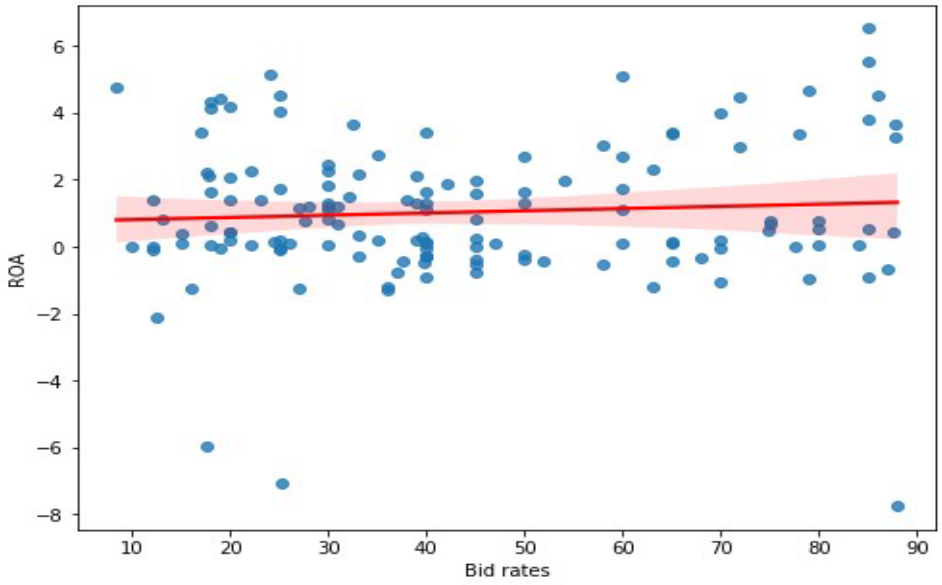
Figure 21. Reserve Demand Curve and Size of Banks



Source: Centrale Bank van Suriname, IMF staff calculations.
Note: The bubbles indicate the size of each bank as a percentage of the total assets within the banking sector. Auction of December 7, 2022, one week tenor. The volumes in axis X are displayed as cumulative sums.

36. **The reasons behind this bidding pattern are not totally clear and remained undisclosed after the discussions with banks.** Some possible explanations could be the urge to boost profits and compensate for compressed margins and/or or acting for third parties to attract clients.[5] Interest from OMOs had a contribution of approximately 70 percent in the net income of the banks in 2023 which could be a drive for participation. The scatter plot in Figure 22 shows a univariate regression using data points that represent the relationship between bid rates and Return on Assets (ROA) of different banks for one week tenor auctions. The shaded area around the line represents the confidence interval for this trend, indicating that there is also a significant degree of uncertainty while the red line suggests that there is a weak or complex relationship between these two variables. Other factors than profitability may also play a role in determining bid rates and further empirical exercises should be conducted to investigate it, considering also other tenors.[6]

Figure 22. Relationship Between Banks Profitability and Bid Rates

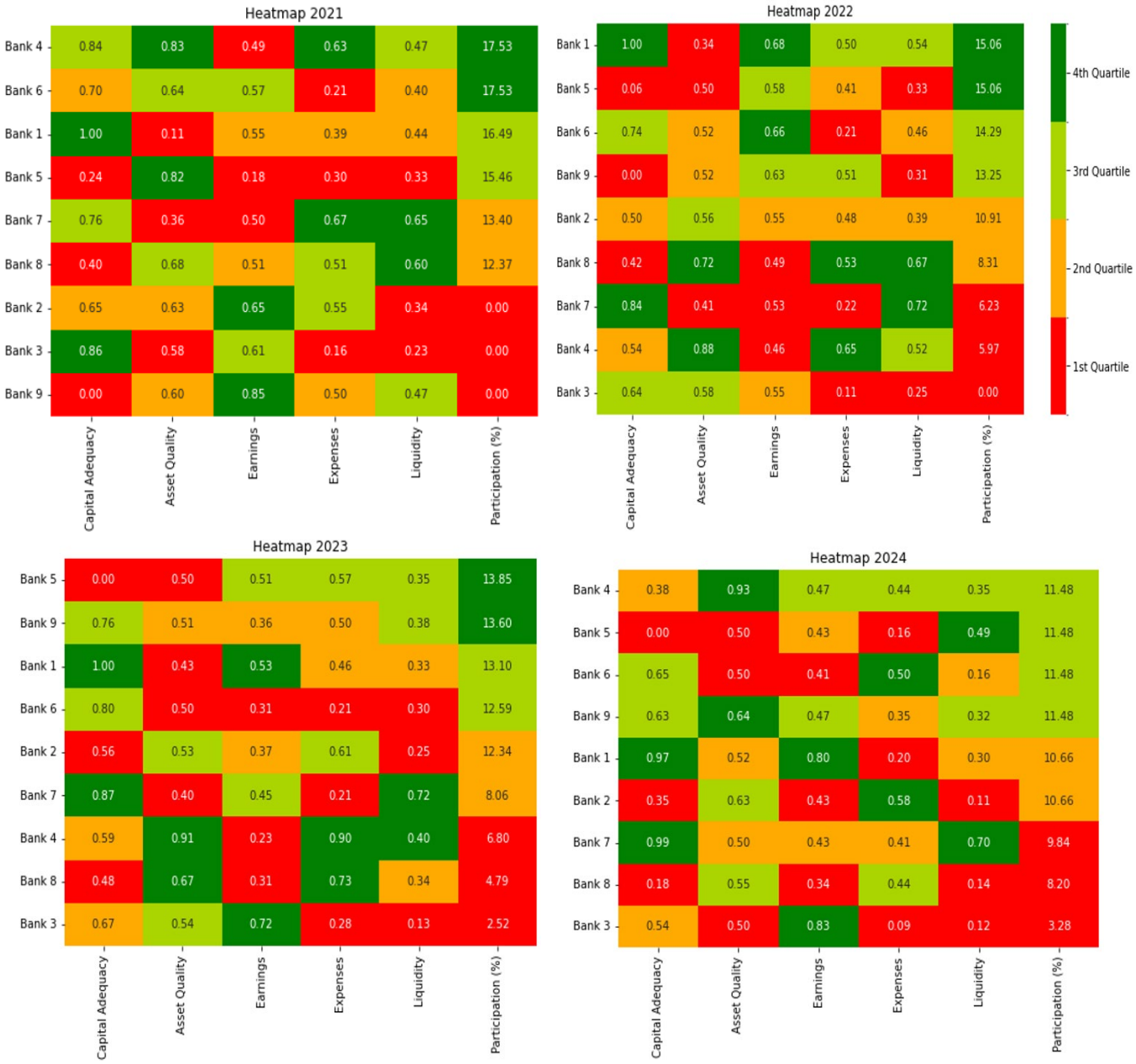


Source: Centrale Bank van Suriname.

[5] Acting in auctions on behalf of third parties is not allowed, but evidence from supervisory data show that some banks are able to circumvent this rule.

[6] For example, an econometrics exercise using panel techniques with fixed effects including financial indicators of the banks with quarterly frequency could be conducted.

Figure 23. Banking Sector Indicators and Frequency of Participation in Auctions



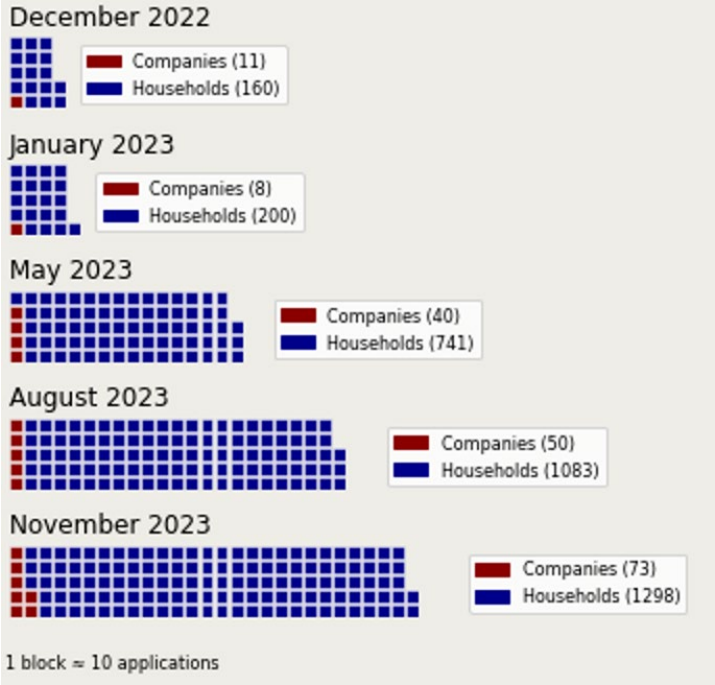
Source: Centrale Bank van Suriname, IMF staff calculations.
Note: The banks are ordered according to the frequency of their participation in auctions per year, measured as a percentage and illustrated in the last column. The indicators were created by averaging and normalizing various financial metrics. Capital adequacy is composed of regulatory capital to risk-weighted assets, regulatory Tier I capital to risk-weighted assets and capital (net worth) to assets. Asset quality is composed of foreign currency loans to total loans, NPLs to gross loans, NPLs net of provisions to capital and large exposures to capital. Earnings is composed of ROA, interest margin to gross income and spread between reference loan and deposit rates. Expenses are composed of Noninterest expenses to gross income and personnel expenses to noninterest expenses. Liquidity is composed of liquid assets to total assets, liquid assets to total short-term liabilities, FX liabilities to total liabilities and net position in foreign currency to capital Auctions in 2021 started in July. For 2024, the data available goes until April 2024.

38. **There has been a rise in the participation frequency of banks in auctions since they started in July 2021, with an increasing number of banks taking part of them (Figure 23).** More than half of the participations in auctions have been typically taken by the same banks, compounding approximately 55 percent of total assets of the banking sector. In 2021, the four most active banks in auctions participated in 77 percent of the auctions whereas three banks did not participate at all. In 2024, the four most active banks engaged in 46 percent of the auctions, whereas all banks took part in some of them. While it is not straightforward to establish a relationship between the financial indicators of the banks and the frequency of their participation in auctions, the heatmaps in Figure 23 suggest that banks with lower asset quality and relatively worse liquidity position were the ones with a more frequent participation in auctions in 2022 and 2023. The CBvS could conduct further analysis with more granular data at higher frequency to observe the evolution of the indicators and the participation in the auctions, given the seasonal behavior of some of these financial indicators

39. **Amid a fragmented banking sector with limited monetary policy transmission, some banks view the elevated OMO rates as an obstacle to liquidity management.** Banks' deposit rates increased sharply, in particular with a tenure of three months, following the first issue of CBCs in June 2022. On average, deposit rates increased from 7.1 percent in August 2022 to 11.6 percent in January 2024. At the same time, lending rates are more volatile and increased only marginally from 14.8 percent to 15.1 percent in the same period, largely driven by the increase of the reserve requirements from 39 percent to 44 percent in April 2023. In a fragmented banking sector, some banks may experience a heightened need for funds and may face tighter margins, particularly if they struggle to compete for deposits. On the other hand, banks with a more abundant supply of funds can maintain their margins and are less impacted by the rates set in OMOs, as their market and financial position allow them to manage liquidity more effectively without the pressure of immediate fund requirements.

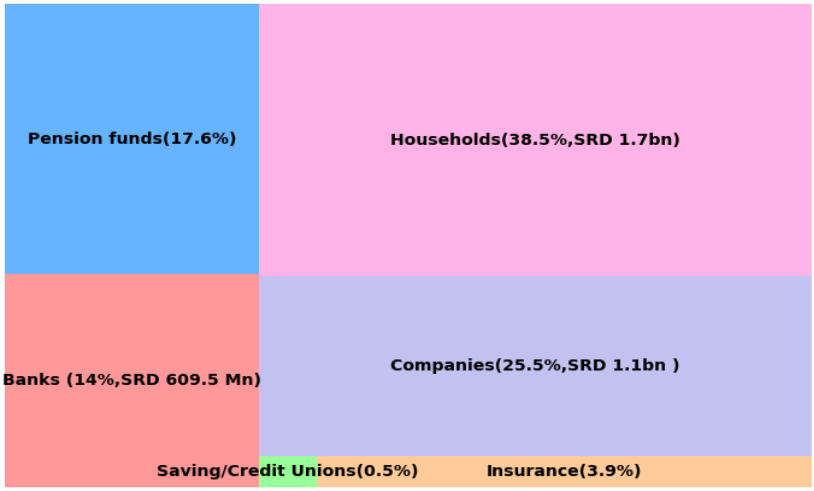
40. **Furthermore, with non-bank financial institutions and households eligible to participate in CBCs, banks have raised concerns about potential fund withdrawals aimed at investing in these certificates.** Banks highlighted that this situation could intensify the fund scarcity faced by some banks, as high rates can lead to significant liquidity outflows, increasing stability risks in the banking sector. Some banks highlighted that it is not possible to provide rates akin to CBs for clients, and that there is a risk of competition for funds with the central bank and of crowding out investments. The applications from households increased more than 700 percent in one year, reaching 1298 in November 2023 (Figure 24). Households also have become the most significant participants by volume in CBCs, with their participation amounting to 1.6 billion, representing 38.5 percent of the total volume (SRD 4.3 bn), followed by companies (25.5 percent) and banks (14 percent) (Figure 25).

Figure 24. Retail Applications for Six-months CBCs Auctions



Source: Centrale Bank van Suriname, IMF staff calculations.

Figure 25. Total Participation in CBCs by Sector



Source: Centrale Bank van Suriname, IMF staff calculations.

41. **Banks' suggestions to lower the OMO rates as well as the volumes and frequency of CBCs were extensively discussed and addressed in the workshop.** The CBvS and the Fund staff highlighted that in the current RTM framework, the rates are set by the banks in the auctions, while the central bank focuses on narrow money as its operational target. The cut-off rate is determined by the highest acceptable bid until the total quantity of the auction (OMO volume) is reached. Recently (since March 2024), the CBvS has realized an underperformance with respect to the target. Consequently, the cut-off bid in their auctions has equaled the highest bid submitted, in some cases as high as 70 percent. The workshop therefore was useful to clarify that

the high level of OMO rates is not a result of a direct policy decision set by the central bank whereas the limitations of the monetary policy transmission were also highlighted.

42. **The strategy to use CBCs should be carefully reviewed, as also acknowledged by the CBvS.** The CBvS communicated in the workshop that it will review the policy regarding the issuance of CBCs, without disclosing further details. In this review, it is important to include the reassessment of the eligibility criteria, the tenors of the certificates and the range of available tenors. The CBvS should evaluate whether all these aspects are adequate for CBCs to achieve its final objective without major side effects. Specifically, the eligibility criteria should be redirected only for entities that are subject to reserve requirements and are supervised by CBvS. Allowing participants that do not have reserves in the CBvS to participate in OMOs could indeed impair the CBvS' ability to meet its reserve money target and result in adverse effects, affecting mainly banks with liquidity shortages.[7] In contrast, allowing banks to sell CDs to additional investors in the secondary market under clear rules could be a better option to strengthening the transmission and shield more vulnerable banks from potential liquidity outflows. In addition, given the uncertainty in the country, tenors of the structural operations using CBCs should be reduced to maximum 180 days. Finally, the operations using term deposits should be limited to maximum three different tenors, for instance with one week, 30 days and 90 days. Ideally, the securities would be indexed to inflation to ensure its real value.[8] Limiting the maturity options of the securities to short, medium, and longer terms is a more effective approach to setting a benchmark for trading and enhancing transmission mechanisms.

43. **The potential impact of CBCs on the achievement of CBvS' final objective and on key macroeconomic variables should be evaluated.** Providing high return investment options for an extended period for the private sector and households might impair investments and spending in the country. High-return investments can draw capital away from other sectors that are relatively less attractive, including both the private and public sectors. If these investments offer significantly higher returns compared to traditional investment options, capital that might otherwise have financed new business ventures, expansions, or public projects (like infrastructure) might instead flow into these high-return options. In addition, if the certificates are redeemed at a time when inflation aligns with the target, this could potentially disrupt the efforts aimed at maintaining price stability, especially if the redeemed volume is significant. Market confidence issues concerning the CBvS, and macroeconomic conditions might cause banks with long-term CBCs to hold larger precautionary buffers than normal, as longer times horizon implies higher uncertainty.[9] That would exacerbate the amount of excess liquidity in the system. On the other hand, abruptly halting the issuance of CBCs could also pose a risk of promoting excessive liquidity growth, particularly if the CBvS is unable to continue absorbing liquidity with TD instruments. Thus, careful consideration should be given to the pace at which these issuances are phased out.

44. **Ad-hoc fine-tuning operations should be considered for large and unpredicted fluctuations in liquidity.** When the main need of the CBvS is to address large and unpredicted movements in

[7] The restriction of the eligibility criteria for only for institutions that hold reserves at the central bank to make part of OMOs was also recommended in the TA report "Monetary Policy Framework and Foreign Exchange Operation," from December 2020.

[8] To achieve this, a clear policy framework with legal and regulatory support is needed, alongside a market assessment to gauge demand. Strong government commitment and an education campaign for investors are crucial. Carefully designed securities, considering index choice, maturity terms, and interest structures should be aligned with the recommended ones in this report. Necessary regulatory amendments and market infrastructure development are essential. A robust monitoring system should track performance and impact.

[9] The use of fine-tuning operations was also recommended in the TA report "Monetary Policy Framework and Foreign Exchange Operation," from December 2020.

liquidity, the institution should consider implementing fine-tuning ad hoc operations that clearly articulate this objective.[10] This approach would improve the CBvS's capacity to meet the monthly target regarding average excess reserves and respond to unexpected situations.

45. **Concerns about the CBvS' communication on CBCs were also raised.** One bank mentioned that the communication regarding the CBCs should be limited to a short period and not communicated for the entire year to avoid driving up interest rates. In 2024, CBvS has decided to have two issuances in the first quarter due to liquidity stance, despite the earlier communication of one issuance per quarter.

46. **The CBvS should maintain its actions aligned with its communication strategy, which is vital for maintaining its credibility.** It is important that the CBvS designs a well-defined strategy and is transparent about it in its communication. When the CBvS communicated plans for a single issuance of CBCs but ultimately conducted two, it heightens market uncertainty by acting in a discretionary manner, given that it contradicted the initial forward guidance. Consistent and predictable communication is key to maintaining market stability and trust in the CBvS. Such discrepancies between communicated intentions and actions can undermine the central bank's credibility and lead to increased speculation and volatility in financial markets, as participants adjust to unexpected shifts in operations. A TA focused on communications was also requested by the CBvS and will take place still in 2024.

47. **The CBvS lacks a clear understanding of the market expectations regarding its key objectives, which is crucial for further understanding the behavior of the banks.** This lack of clarity can lead to misalignment between the central bank's policies and market needs, potentially causing inefficiencies in financial markets and hindering effective monetary policy implementation. Understanding market expectations is essential for the central bank to anticipate and respond to shifts in banking practices and financial market dynamics effectively. Therefore, the CBvS should conduct a survey asking bank's expectations on the key variables involved in its framework, i.e., inflation, GDP growth, base money, and reserve money. Initially, the frequency could be set on a monthly basis to gain insights into the banking sector, before transitioning to a quarterly schedule if necessary.

Absence of Money Market

48. **Interbank lending market has been historically low in Suriname while FX claims dominates the composition of interbank claims.** Interbank lending in Suriname has been minimal, accounting for approximately 0.2 percent of the total balance in 2019, further declining to 0.1 percent in 2023. Following a standstill period from November 2022 to June 2023 of no transactions, only two banks resumed the activities in July 2024, trading a monthly amount of 250 million, with interest rates initially at 60 percent, later decreasing to 30 percent by January 2024.The composition of interbank claims is primarily made up of FX claims, constituting 94.7 percent of total claims. The remaining claims are on SRD (1.8 percent) and shares (3.5 percent). Within the FX claims category, long-term claims exceeding one year account for 76 percent, short-term claims of up to one year represent two percent, current account deposits are 12 percent, short-term deposits are eight percent, and time deposits with a maturity of over one year make up the remaining two percent.

[10] The ad hoc use of fine-tuning operations to address unpredictable and large liquidity swings was also recommended in the TA report "Monetary Policy Framework and Foreign Exchange Operation," from December 2020.

50. **Banks attribute the underdevelopment of the interbank market to several factors, including funding scarcity, market imbalances, limited data, and significant financial risks.** Some banks mentioned the scarcity of SRD funding as the main obstacle to develop the interbank market, while others mentioned the absence of an active secondary market for overnight and short-term placements in both local and foreign currencies. Additionally, banks' reliance on the OMO rates as a reference makes interbank lending for some banks prohibitively expensive, exacerbating the disadvantage of some market participants in an already non-level play field constellation. The market's development is further hampered by insufficient public data from certain financial institutions, leading to potential risk management challenges. Banks also mentioned country and counterparty risks, coupled with an illiquid stock market, as playing a significant role in preventing the development of the interbank markets. Furthermore, some banks pointed out that the interbank market is affected by highly volatile interest rates, which introduce further uncertainty and instability.

51. **Banks have primarily suggested to the CBvS to focus on improving infrastructure and general conditions to develop the interbank market.** Banks suggested the CBvS to establish an automated borrowing and placement facility accessible on a single platform, eliminating the need for paper approvals. Currently, all the transactions must be conducted on paper as the CBvS is legally prohibited to accept electronic signatures. Banks also suggest the introduction of more financial instruments such as repurchase agreements (repos), Treasury Bills (T-Bills), and other fixed-income instruments, which could also facilitate better liquidity management over the mid to long term. Additionally, banks urge the further development of economic conditions to boost market confidence and advocate for the reduction of SRD interest rates. They also propose the introduction of a modern stock exchange market and suggest that the CBvS and the Ministry of Finance actively buy and sell financial instruments to bolster the local market.

52. **The CBvS, in collaboration with the government, should make further efforts to modernize its infrastructure to improve the development of the interbank market.** The CBvS stated that it is in the process of developing a fully automated platform for the standing facilities. A standardized digital process would help to avoid most of the errors during the auction process by banks, for example incorrect order number on the bid form,[11] missing bank stamps and late submissions. While this initiative is very important, a crucial aspect of this modernization is the substitution of paper approvals in transaction processes to more efficient and secure digital systems, which can streamline operations, reduce administrative burdens, and secure the process. This change would not only expedite transactions but also significantly boost market confidence and the speed of the process.

FX Market Challenges

53. **In February 2023, the Supervision Department of the CBvS updated its regulations on banks' open currency positions (NOP), setting a limit of 10 percent of Tier 1 capital for each foreign currency.** Banks with NOPs exceeding this limit were required to sell the excess to the CBvS. The regulation was revised because several banks were accumulating foreign currency well above the maximum during the period of depreciation of the local currency. Given that under such circumstances the banks gained from a NOP in excess of the maximum requirement, banks exacerbated the shortage of supply of foreign currency for the import demand, resulting in ongoing local currency depreciation. Once the demand and supply

[11] When submitting multiple bids, banks are required to follow a specific sequence in the form, which frequently becomes a source of errors in the auction process.

conditions on the FX market became more balanced, banks do not benefit anymore from a NOP in excess of the maximum limit.

54. **Banks raised concerns about non-compliance of the open currency position, the high influx of foreign exchange, the increasing difficulty to sell foreign exchange and the unrealized losses.** Banks claim that following the high inflow of FX in the country, they must purchase all the FX that exporters request to sell to them. Banks reported that it is very difficult to refuse these transactions but at the same time, in recent months, it has been increasingly challenging to sell this foreign exchange to other clients. Banks suggested that the CBvS should buy all the FX above the open currency limits from the commercial banks. Furthermore, banks consider their experiences with FX operations involving the CBvS either neutral, complicated, or very complicated. Therefore, some banks suggested that an automated FX platform should be launched to improve the efficiency of the operations.

55. **Under the Extended Fund Facility, the CBvS is restricted to purchasing FX from banks and exchange offices (cambios) exclusively through auctions.**[12] Suriname is implementing an economic reform agenda aimed at restoring fiscal and debt sustainability through fiscal consolidation and debt restructuring, upgrading the monetary and exchange rate policy framework.[13] These policies are supported by the EFF arrangement, which was approved by the IMF Executive Board in December 2021. As one of the objectives of the program is to rebuild Suriname's foreign reserves, the CBvS is restricted to purchasing FX from banks and exchange offices (cambios) exclusively through auctions.[14]

56. **After losing correspondent relationships with foreign banks, some banks are hindered in transporting cash FX independently and are urging the CBvS to conduct more frequent FX shipments.** While some banks have reestablished or formed new correspondent relationships, they are hesitant to transport cash FX due to the stringent compliance demands of their correspondent banks. The FX market mainly sources cash euros from visitors from French Guiana and the Netherlands, who exchange them for local currency at cambios. Although banks buy some of these cash euros from cambios, the predominant demand from households and businesses is for cash and non-cash U.S. dollars. The CBvS does the cash transportations on a quarterly basis under strict compliance requirements of the service provider. The CBvS communicated that it is very cautious in increasing the frequency of the cash FX transportations.

57. **The CBvS communicated that it is making efforts to address the concerns of the banks within the existing constraints.** The CBvS communicated that it exercises caution in acquiring FX to avoid exacerbating the existing concern of surplus SRD liquidity in the banking system and exert upward pressure on the exchange rate. In addition, the CBvS has noticed a decrease in the FX demand, primarily due to reduced purchasing power among households and businesses stemming from high inflation, and decreased demand from foreign-owned fuel companies. However, the CBvS reiterated that it remains cautious in their evaluation about the effects of its active participation in the FX market on the absorption of excess SRD liquidity in the banking system. Furthermore, the CBvS is in a process to complete the development of an electronic FX trading platform. In the first stage of the process, the CBvS has conducted several sessions to

[12] A more complete information regarding the approval of the Extended Arrangement Under the Extended Fund Facility for Suriname can be found in the link https://www.imf.org/en/News/Articles/2021/12/22/pr21400-imf-executive-board-approves-extended-arrangement-under-the-extended-fund-facility-suriname. Information about the fourth review of the program can be accessed in this link: https://www.imf.org/en/News/Articles/2023/12/15/pr23456-imf-completes-fourth-review-under-the-eff-suriname.

[13] Among other objectives, the program also aims at protecting the vulnerable by expanding social protection, addressing the financial sector's vulnerabilities, and advancing the anti-corruption and governance agenda.

[14] FX purchases are restricted only through auctions that satisfy Fund's Article VIII considerations.

test the functioning of the electronic FX trading platform with the banks and cambios, receiving feedback to improve the usability. Going forward, the CBvS will gradually allow other participants (exporters and cambios) on the FX trading platform.

"Tight" Monetary Stance and Supervision Requirements

58. **Some banks characterized the monetary policy as "tight," particularly pointing to high reserve requirements as a significant challenge for maintaining liquidity.** Banks indicated that high reserve requirements limit the amount they can use for lending and other investments, thereby constraining their liquidity. In addition, some banks considered the averaging mechanism strict and punitive. In response to these concerns, the Fund and the CBvS clarified the RTM mechanism in the workshop, highlighting that the reserve requirements are a tool aiming to curb inflation and stabilize the economy. It was also explained that the averaging system aims to provide some flexibility in contrast to banks in meeting their requirements in comparison to the alternative with no averaging. The commercial banks are allowed to use up to 20 percent of their required reserves as a buffer to absorb short-term liquidity shocks. The concepts of excess reserves and precautionary buffers were also extensively discussed, as the latter seems to be an important factor in Suriname's banking system.

59. **The two different requirements for holding reserves at the CBvS complicates the assessment of the actual total excess reserves in the system.** Currently, on top of the 44 percent reserve requirement within a 14-day maintenance period based, there is a five percent non-binding liquidity buffer that are calculated based on the reserve base (a different account than the one used to calculate the reserve requirement), which is treated as an indicative precautionary balance by the CBvS. The period used to make this calculation does not coincide with the period used to calculate the reserve requirements. The CBvS also faced challenges in aligning the two calculations initially.

60. **The existence of two separate processes for reserve requirements may heighten the challenges to calculate the precise amount of liquidity buffers for the banks, potentially exacerbating the urge to hold excess liquidity.** Annex III shows the behavior of the banks with respect to liquidity management during the maintenance period. The charts in the left indicate how banks manage liquidity on average to meet the reserve requirements, currently established at 44 percent. The charts show neither front nor back-loading of reserve requirement fulfillments, and the majority of the banks seem to meet the requirements with a considerable margin. However, after the five percent SNEPs are discounted, the data indicates that banks often face scarcity of funds in their work accounts. This could be an additional incentive for banks to hold precautionary buffers. Given the reasons listed in this and in the previous paragraph, the existence of these two separate systems should be reviewed and simplified.[15] Ultimately, enhancing the system and addressing the potential causes for maintaining a precautionary liquidity buffer are crucial for improving the accuracy of liquidity forecasting.

61. **Some banks also view the supervision requirements as a key obstacle to manage liquidity.** Banks are required to maintain a buffer of freely available (unencumbered) high-quality liquid assets to protect against a range of stress scenarios, including those involving loss or impairment of unsecured and normally available funding sources. Some banks believe that these requirements tie up funds that could otherwise be used for profit-generating activities, like loans or investments. Banks should also ensure that there are no legal, statutory, or operational restrictions on the use of these resources to meet the funding requirement. In addition, banks

[15] The TA report "Monetary Policy Framework and Foreign Exchange Operation," from December 2020, recommended that the five percent liquidity buffer should be phased out.

must have a formal Contingency Funding Plan (CFP) describing their strategies for dealing with liquidity shortages in various emergency situations, including rules for managing different stress scenarios, a clear definition of responsibilities and procedures for implementing the plan. Dome banks claim that it can be resource-intensive and may divert attention from other business priorities.

62. **The CBvS reiterated its view that the regulation is not restrictive, and it is not an obstacle for efficient liquidity management by the banks.** CBvS is implementing strategic adjustments to its liquidity rules, acknowledging that the realizable value of assets has been overestimated in previous stress tests. Concurrently, an enhanced oversight mechanism is being established for Anti-Money Laundering and Counter-Terrorism Financing (AML/CFT) along with regulations on credit classification and provisioning. In addition to these actions, CBvS has conducted Asset Quality Reviews (AQRs) for the years 2022 and 2023, has been involved in recapitalization efforts, and issued directives on Non-Performing Loans (NPLs). Furthermore, the CBvS indicated that it is formulating regulations to ensure fair competition in the financial sector without providing further details.

Conclusion

63. **In conclusion, the Centrale Bank van Suriname (CBvS) embarked on a transformative journey in its monetary policy approach by shifting from an exchange rate to a monetary targeting regime and initiating open market operations (OMOs) in July 2021.** This transition aimed to tackle economic challenges more effectively but also introduced new obstacles, notably the devaluation of the Suriname dollar and the subsequent financial dollarization. The CBvS has employed various strategies to manage these challenges.

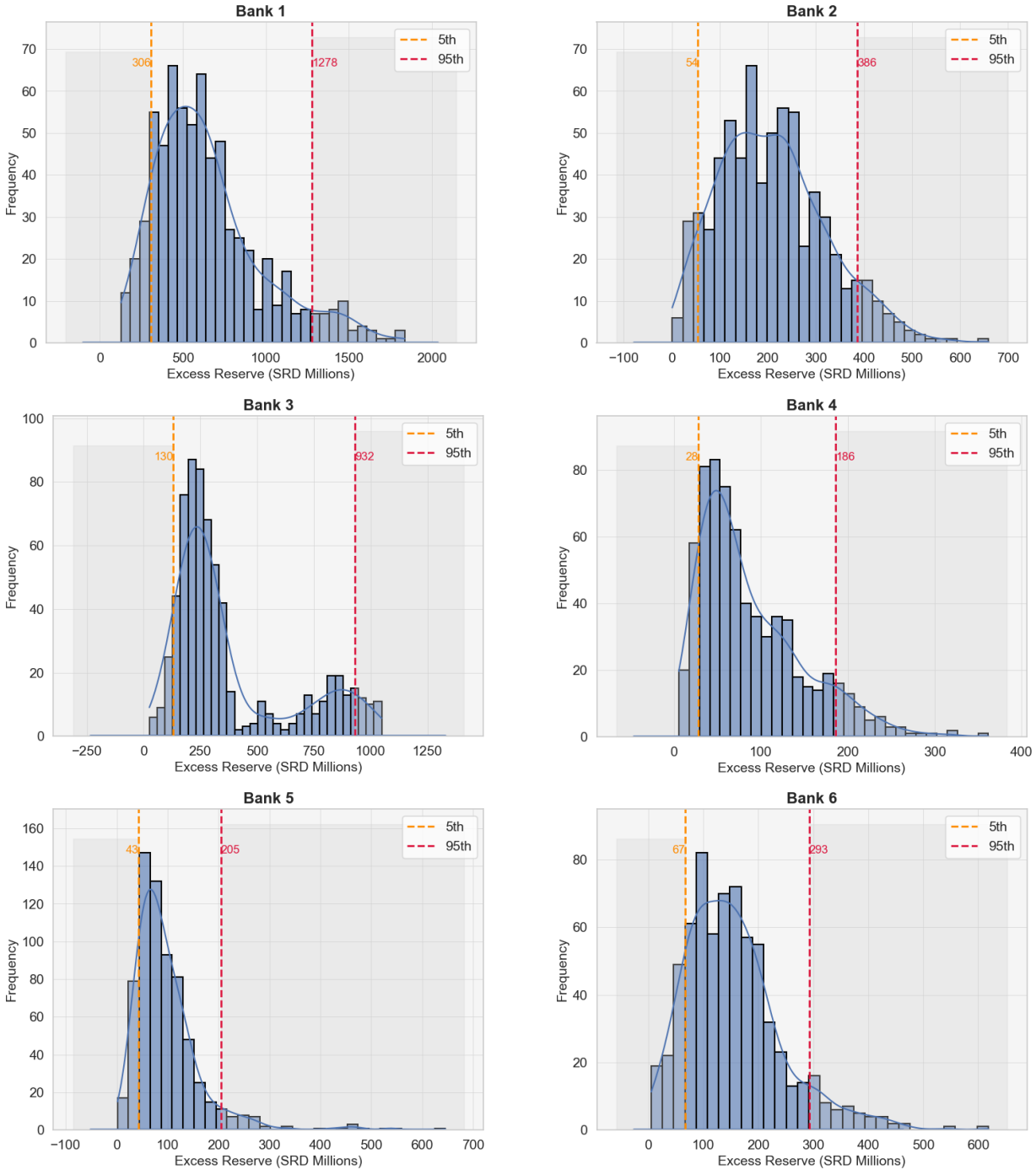
64. **To support the CBvS, the mission provided advanced statistical models for liquidity forecasting, a crucial element for the success of the monetary targeting regime.** This included the development of a forecasting framework comprising 12 models across three categories, enhancing the CBvS's ability to anticipate future liquidity needs and adjust its OMOs accordingly. Additionally, a liquidity forecasting table was developed to facilitate the calibration of weekly OMOs, and efforts were made to ensure staff dedication to learning the new methodology.

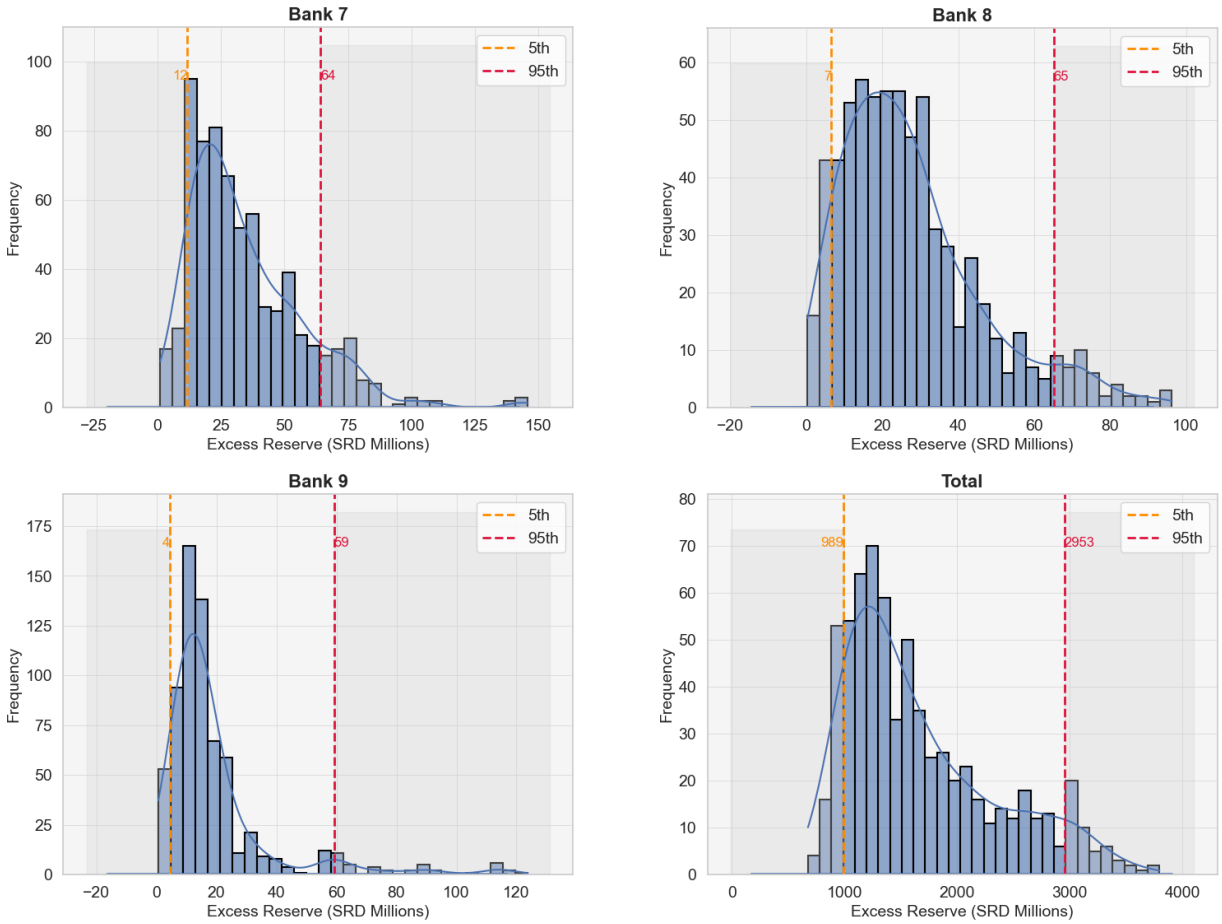
65. **Furthermore, the CBvS conducted a survey and workshop with commercial banks to address their concerns regarding CBCs, reserve requirements, and OMO interest rates.** This dialogue fostered a collaborative approach and highlighted the need for the CBvS to review its strategy concerning CBCs and the dual systems of requiring reserves.

66. **Moving forward, the CBvS should continue to refine its liquidity management strategies and consider simplifying its systems to improve forecasting accuracy.** Moreover, modernizing its infrastructure and developing a fully automated platform for standing facilities will be critical in fostering the development of the interbank market and enhancing the understanding of the banking sector's dynamics. By taking these steps, the CBvS can improve its operational efficiencies, tailor its strategies more effectively, and ultimately contribute to more informed policymaking in the face of ongoing economic challenges.

Annex I. Excess Reserve Distribution by Bank

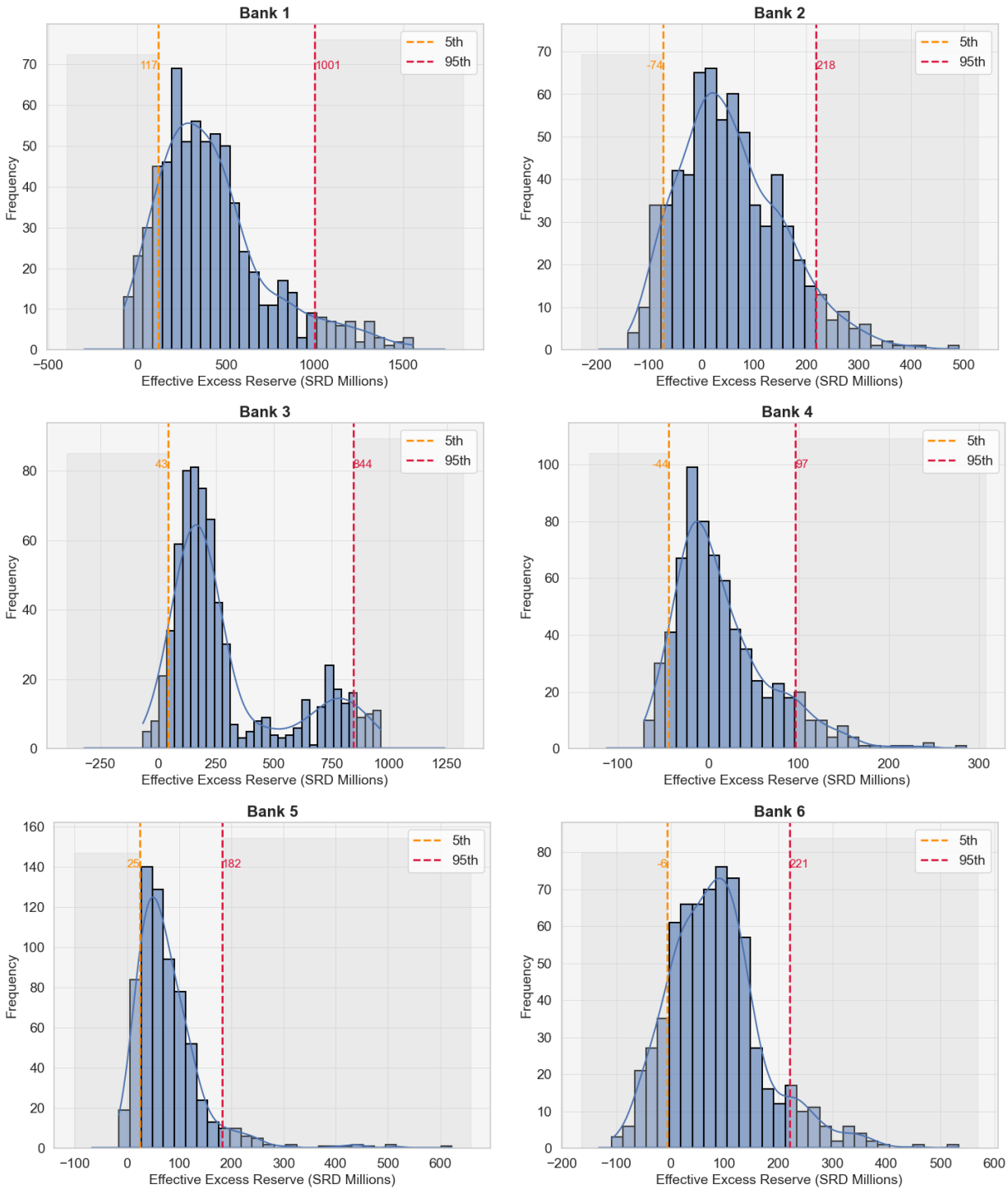
Figure I-1. Distributions of Weekly Average Excess Reserve by Bank

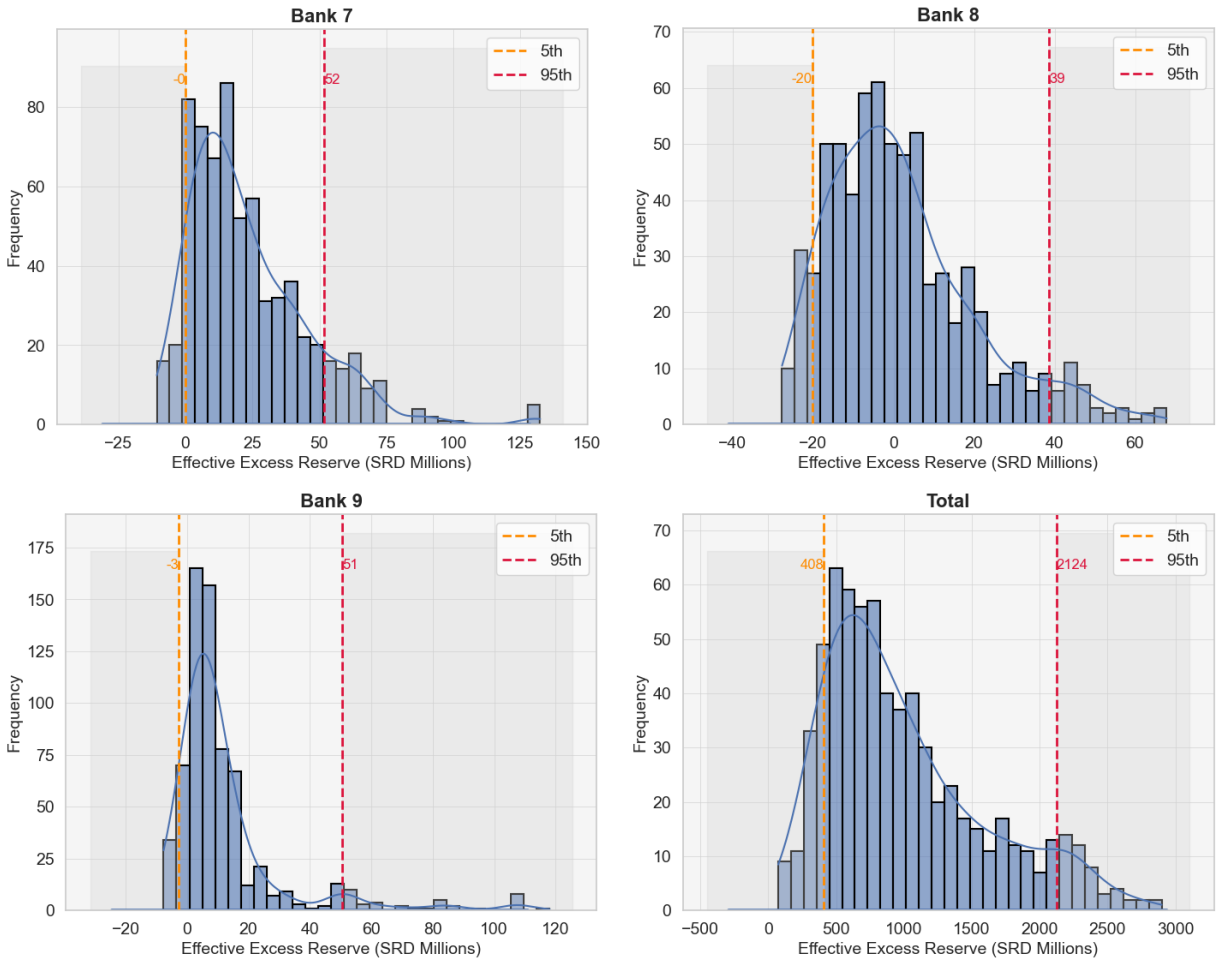




Source: IMF staff calculation, Centrale Bank van Suriname.
Note: Observations starting from 07-06-2021 to 03-27-2024.

Figure I-2. Distributions of Weekly Average Effective Excess Reserve by Bank





Source: IMF staff calculation, Centrale Bank van Suriname.
Note[1]/ Observations starting from 2021-07-06 to 2024-03-27.
Note[2]/ the definition of effective excess reserve based on the CBvS framework.

Annex II. Statistical Models Used in the Liquidity Forecasting Framework

1. **The time series models are normally forecast currency in circulation and government accounts balance, which focus on modelling the trend and seasonality.** The IMF's Liquidity Forecasting Framework include 4 types of time series models: the Naïve, Exponential Smoothing, ARIMA and TBATS.

2. **The Naïve model (random walk) is often used as the simplest forecast benchmark.** The Naïve forecast assumes that the time series has no structure, while at the same time requires no parameter estimation or any other modelling choices. The forecast is generated as:

$$\hat{y}_{t+h} = y_t,$$

Where y_t is the observation at time t, $\hat{y}_{t+h}$ is the forecast for period $t+h$, and h is the forecast horizon. The intuition behind the Naïve forecast is that all forecasted values are equal to the last observation, and therefore there is no additional information to model. Arguably, this is an inappropriate model to forecast liquidity, but it does make it a useful benchmark. More complex modelling approaches are often not transparent or intuitive enough in what they do. Therefore, at a minimum, they must outperform such a simple forecast. A helpful modification of the Naïve is its seasonal counterpart, where instead of repeating the last observation, the last seasonal period is repeated:

$$\hat{y}_{t+h} = y_{t-s+h},$$

Where s is the seasonal period, corresponding to the number of days in the week (5 without the weekend).

3. **Each observation in a time series contains both structure and noise.** The structure makes up the part of the series that can be modelled and used to inform our forecasts. The noise part is inherently random and unforecastable. Let y_i be an observation of a time series at period i, and:

$$y_i = \mu_i + \varepsilon_i,$$

Where μ_i denotes the structure of the time series and ε_i the randomness. In forecasting, the main challenge is to identify a model that can separate the structure from noise, as well as to correctly characterize the patterns in the structure (e.g., slope, seasonality). If the forecasting model is appropriate for the data, the noise part should have no patterns and be random. Therefore, the noise can only be characterized in terms of the statistical distribution it follows. Usually, it is assumed to follow the normal distribution, and therefore $\varepsilon \sim N(0, \sigma^2)$. In other words, the noise is normally distributed with zero mean and standard deviation σ. A well-specified model should provide a function for μ_i as well as an estimated $\hat{\sigma}$. Note that neither μ_i nor ε_i are observable, and therefore it is the task of the modeler to specify a forecasting model that clearly separates them from the observed y_i.

4. **Exponential smoothing models operate by modelling the time series as a collection of patterns, namely level, trend, and seasonality.** Usually, exponential smoothing (ETS) is framed within a state-space model, where each component of the time is a state, and together they produce the forecast $\hat{y}_i$, as:

$$\hat{y}_i = f(\hat{\mu}_i, \varepsilon_i)$$

$$\hat{\mu}_i = g(level_i, slope_i, season_i)$$

The functions $f(\cdot)$ and $g(\cdot)$ can be either additive, multiplicative, or have some mixed form. The figure below provides an example of the decomposition of a time series into separate components by exponential smoothing. Observe that the level, slope, and season components together can explain most of the time series, with any unexplained part attributed to the noise component. The level tracks the local mean of the time series, while the slope models how the level increases or decreases over time (e.g., a slope of +2 suggests an upward movement by two units per period). Finally, the season component models any periodic patterns in the data. Not all time series require all components to be modelled, as some may be absent.

In the fully additive case, the model becomes:

$$\hat{y}_i = \hat{\mu}_i + \varepsilon_i$$
$$\hat{\mu}_i = level_i + slope_i + season_i$$

Each of the states ($level_i$, $slope_i$, and $season_i$) is structured similarly. For example, the additive $level_i$ is:

$$level_i = level_{i-1} + \alpha e_{i-1},$$

Where α is a smoothing parameter between 0 and 1 and e_{i-1} is the previous period error. Intuitively, this equation suggests that the current level estimate is updated by α times the last error. Given that the error is the difference between the actuals (y_i) and the forecast $(\hat{y}_i)$ for the case of the exponential smoothing that has only an additive level, the model can be written in two alternative forms to help explain its function:

$$\hat{y}_i = \hat{\mu}_i + \varepsilon_i$$
$$\hat{\mu}_i = level_i$$
$$level_i = level_{i-1} + \alpha e_{i-1}$$

Or equivalently:

$$\hat{y}_i = \hat{\mu}_i + \varepsilon_i$$
$$\hat{\mu}_i = level_i$$
$$level_i = \alpha \cdot actuals_{i-1} + (1-\alpha) level_{i-1}$$

The second set of equations suggest that the smoothing parameter α decides by how much to update the previous level with the last observed actuals. Noting that $0 < \alpha < 1$, a percentage contribution interpretation becomes possible. For example, if $\alpha = 0.2$, the last estimated level is updated by 20 percent of the last observation. All other states operate similarly, requiring an additional parameter for each additional state, and a model may have any of these states on their own or together.

5. **A useful way to see how exponential smoothing operates is to consider the equations across time, which makes each component an exponentially weighted moving average.** For example, using $\alpha = 0.2$, the most current actual is weighted by 0.2, while the one before is weighted by $\alpha(1-0.2)^2$. The calculation becomes apparent if we replace (in the equations above) the $level_{i-1}$ with its respective state equation:

$$level_i = \alpha \cdot actuals_{i-1} + (1-\alpha) level_{i-1}$$
$$level_{i-1} = \alpha \cdot actuals_{i-2} + (1-\alpha) level_{i-2}$$

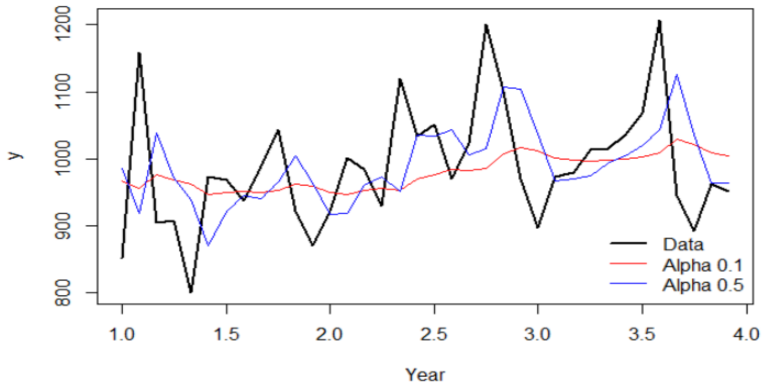
→

$$level_i = \alpha \cdot actuals_{i-1} + (1-\alpha)(\alpha \cdot actuals_{i-2} + (1-\alpha) level_{i-2})$$

$$\rightarrow$$

$$level_i = \alpha \cdot actuals_{i-1} + \alpha \cdot actuals_{i-2} + (1-\alpha) level_{i-2} - \alpha^2 \cdot actuals_{i-2} - \alpha(1-\alpha) level_{i-2}$$
$$level_i = \alpha(1-\alpha)^0 \cdot actuals_{i-1} + \alpha(1-\alpha) actuals_{i-2} + (1-\alpha)^2 level_{i-2}$$

and so on. More generally the jth previous observation is weighted by $\alpha(1-\alpha)^{j-1}$. All weights will by construction be between 0 and 1, and sum up to 1, forming a weighted moving average. Therefore, each state in exponential smoothing models is a component of the time series (level, slope, or season) and achieves that by filtering the noise by using long averages. As the noise is randomly distributed, a sufficiently long average will tend to cancel out the positive and negative "errors," leaving the underlying structure. This is exemplified in the figure below, where the models for $\alpha = 0.1$ and $\alpha = 0.5$ are presented for a simulated time series (with a mean of 1,000) and additive normally distributed noise (with a standard deviation of 100). Observe that the model with $\alpha = 0.1$ is closer to the underlying mean, using a long average of historical values and therefore canceling out the noise. On the other hand, with $\alpha = 0.5$ the model is very reactive to noise, giving the wrong impression of additional fluctuations in the underlying time series structure (where all these fluctuations are due to the unforecastable noise). Naturally, in this case, a simulated time series was used with a known underlying data generating process. In practice, setting the appropriate parameters is a more challenging task as the underlying structure is unknown.



Source: IMF staff computations.

6. **The smoothing parameter for each component defines how reactive that component is to new information.** It is helpful to consider the extremes of 0 and 1. A 0-value smoothing parameter suggests that the component (e.g., level) is not updated at all by the observed data. On the other hand, a smoothing parameter of 1 suggests that the component is fully updated by the last observation and does not retain any underlying structure. More generally, low parameters can be interpreted as long-weighted moving averages that are resilient to increased noise and outliers. High parameters function oppositely, resulting in very reactive components. Although the parameters could be set manually for simple models (e.g., level-only exponential smoothing), numerical optimization is typically preferable. This is especially true for models with more parameters, which can automatically identify reasonable parameters for both simple and complex models.

7. **For numerical optimization, an appropriate loss function needs to be specified, typically based on quadratic errors.** To do this, the errors for the in-sample data that were used to fit the model are recorded. Quadratic errors, as summarized in the Mean Squared Error (MSE), track the mean of a time series. The numerical optimization provides the smoothing parameters—one corresponding to each state of the model—minimizes the number of errors.

8. **The appropriate exponential smoothing model form can be identified using a suitable information criterion, such as the Akaike Information Criterion (AIC).** The intuition behind such metrics is that they attempt to balance how well a model fits the data against the complexity of the model, as captured by its various parameters. A model without enough complexity—in the case of exponential smoothing, one without the appropriate states that capture the level, slope, and seasonality in a time series—will underfit the time series and provide poor forecasts. On the other hand, a model with superfluous complexity will overfit the data, which means that it will attempt to model the normally unforecastable noise and thus mistakenly model non-existing patterns in the time series structure. In general, a more complex model (i.e., a model with more parameters) is more flexible to fit better to the in-sample data, and therefore potentially overfit. Overfit models can provide substantially inaccurate forecasts. A simplified view of the AIC is:

$$AIC = 2\sqrt{MSE} + 2k,$$

Where k is the number of model parameters. For exponential smoothing. k is connected with the number of states/components in the model. The first half of the equation improves as the model fit becomes better, minimizing the errors between the in-sample observations and the model output. This typically correlates with the model having more parameters. The second half of the equation is minimized when the number of parameters is as small as possible, which typically happens when the model underfits, and therefore has larger in-sample errors. The model with the lowest AIC is preferable because it forces a balance between model fit and model complexity. This results in selecting models that can forecast well.

9. **To include regressors, the model can be augmented by adding them to the description of μ_t in the same fashion as with conventional regression modeling.** Additional details about ETS can be found in Hyndman et al. (2008)[1] and Ord, Fildes, and Kourentzes (2017).[2]

10. **The Autoregressive Integrated Moving Average (ARIMA) family of models is a flexible class of models used for time series forecasting in a wide range of settings.** In general, the ARIMA model is defined as:

$$(1 - \phi(B))(1 - B)^d y_t = (1 + \theta(B))\epsilon_t$$

Here B is the backshift operator that lags a variable, i.e., $By_t = y_{t-1}$,$By_t = y_{t-2}$, etc. The order of differencing d is typically equal to 1 (or in rare cases 2) for nonstationary series and 0 for stationary series. The term $\big(1 - \phi(B)\big) = 1 - \phi_1 B - \phi_2 B^2 - \cdots - \phi_p B^p$ is known as the autoregressive (AR) polynomial (or order p) and the term $\big(1 + \theta(B)\big) = 1 + \theta_1 B + \theta_2 B^2 + \cdots + \theta_p B^p$ is known as the moving (MA) polynomial (or order q). The term ϵ_t is a random "noise" or "innovation" term. The nomenclature ARIMA (p,d,q) is used to describe an ARIMA model. For example, an ARIMA model with $p = 2$, $d = 1$ and $q = 2$ would be referred to as an ARIMA (2,1,2) model.

For all ARIMA models, the order of $\boldsymbol{p, d, q, P, D, and\ Q}$ must be made. The estimation is done using the stepwise algorithm of Hyndman and Kandakar (2008):[3]

[1] Hyndman, R., A. B. Koehler, J. K. Ord, and R. D. Snyder. 2008. *Forecasting with Exponential Smoothing: The State Space Approach*. Berlin: Springer Science and Business Media.

[2] Ord, K., R. Fildes, and N. Kourentzes. 2017. *Principle of Business Forecasting*, 2nd ed. New York: Wessex Press.

[3] Hyndman, R. J., and Y. Khandakar. 2008. "Automatic Time Series Forecasting: The Forecast Package for R." *Journal of Statistical Software* 27 (3): 1-22.

i. Find d using the KPSS (Kwiatkowski–Phillips–Schmidt–Shi) test.

ii. Estimating four initial models and choose the best.

iii. Expand the candidate model set by considering models that have p or q differing from the current best by 1.

iv. Iterate until no improvement is made.

The criterion for selection is the Akaike Information Criterion corrected for small sample size (AICc). The algorithm implemented in Auto ARIMA function within the forecast package in the R software environment. The same algorithms can be modified and applied to seasonal ARIMA and seasonal ARIMA using the regression described below.

An important extension to ARIMA models is seasonal ARIMAs (SARIMA), which allows for the modelling of patterns that repeat themselves every $\boldsymbol{m}$ observations. In general, SARIMA take the form:

$$(1-\phi(B))(1-\Phi(B^m))(1-B)^d(1-B^m)^D y_t = (1+\theta(B))(1+\theta(B^m))\epsilon_t$$

Where P, D, and Q are the orders of the seasonal AR component, seasonal differencing, and seasonal MA component. The nomenclature ARIMA(p,d,q)(P,D,Q)[m] is used to describe such models, for instance an ARIMA(1,0,0)(0,1,1)[5] model would be equivalent to:

$$y_t = y_{t-5} + \phi(y_{t-1} - y_{t-6}) + \epsilon_t - \epsilon_{t-5}$$

Seasonal ARIMA models of this form are only capable of explicitly capturing one form of seasonality. Fortunately, the ARIMA model can easily incorporate covariates by extending its equation in the same manner as with conventional regression modelling. Additional details for ARIMA models can be found in Ord, Fildes, and Kourentzes (2017).

11. **Seasonality can be modelled using indicator variables.** This approach is particularly well suited when the length of the seasonal pattern is short and when the pattern is not necessarily smooth. For example, flexible day of week effects can be modelled using only four variables of the form:

$$D_t^{(Sun)} = \begin{cases} 1 \text{ if day t is a Sunday,} \\ 0 \text{ otherwise.} \end{cases}$$

Similar dummies can be defined for Mon, Tue, Wed, Thur. These indicators are then included in a vector of covariates x'_t and the ARIMA model has the same specification as before, but with y_t replaced by $y_t - x'_t\beta$. A similar modification occurs for ETS. A similar approach is used to encode holidays and special events. Structural breaks can be encoded using a continuous indicator:

$$\mathrm{D}_t = \begin{cases} 1 \text{ if t occurs after the structural break,} \\ 0 \text{ otherwise.} \end{cases}$$

12. **Daily time series can exhibit multiple seasonal cycles that must be accounted for in the modeling.** These include day in the week, day in the month, and day in the year, corresponding to different cyclicities in the data. This substantially complicates the creation of forecasts, as many models typically incorporate a single seasonal periodicity. Three elements are of interest in modelling multiple seasonalities: the length of the seasonal cycles, their encoding, and the efficiency of the latter, as we aim for parsimonious models. To resolve questions raised by the first element, one counts how many days are in each periodicity. For example, there are five days in the week (without weekends). However, day in the month seasonality is more challenging as months have a different

number of days. To overcome this, quarterly seasonality is used, as a quarter contains a fixed number of weeks, and by extension days.

13. **The multiple seasonal cycles are encoded using trigonometric indicator variables.** Given the length of a season of s periods, $s/2$ pairs of trigonometric variables are constructed, with $i = 1, \dots, s/2$:

$$d_i = cos\left(\frac{2i\pi t}{s}\right),$$

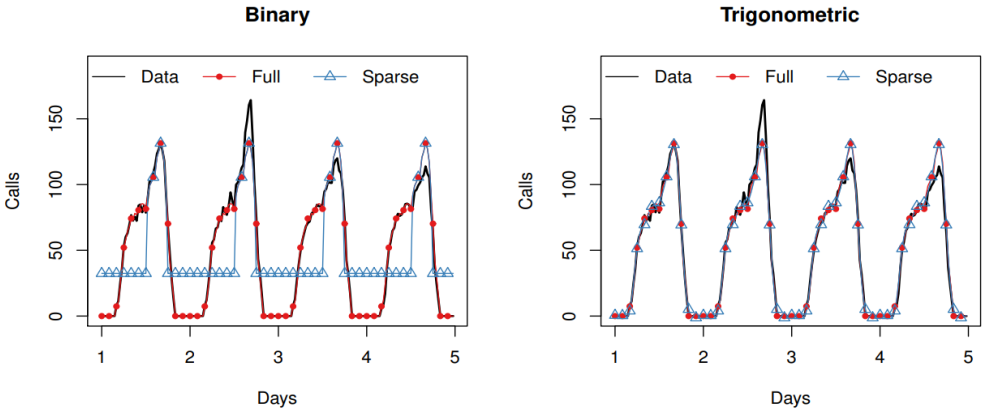
$$d_{i+s/2} = sin\left(\frac{2i\pi t}{s}\right),$$

Where $t = 1, \dots, n$ (with n being the sample size). When s is an odd number, $s/2$ is rounded up to the closest integer. This encoding is mathematically equivalent to using s binary indicator variables, in which case each binary indicator would encode the level of a particular day in the season. Note that in some cases one of the indicators will correspond to a constant, resulting in $s - 1$ informative indicator variables. One major advantage of the trigonometric representation is that it can encode complex seasonal effects, such as leap years. This is not possible with binary indicator encoding. For binary encoding, the number of trigonometric pairs is calculated as the floor of the true s. For example, for the day in the year we will have 260/2 cosines and 260/2 sines (five-day week years contain 260 days).

14. **To obtain parsimony, redundant seasonal indicators are filtered.** To do this, the time series trend is removed using a centered moving average (Ord, Fildes, and Kourentzes 2017). The centered moving average simply calculates the average of all values within a season that effectively models the trend in the time series. This is subtracted from the data, and the residuals are then modelled with different trigonometric indicator variables as explanatory variables. This is done using a regression model. However, they eliminate less informative inputs and help obtain a sparse representation, a lasso regression is used. Lasso regression is tasked to find a good compromise between how well the model fits the data and its complexity as measured by the number of parameters it has. The idea is that models with more parameters (and therefore input variables) are better able to model the observations, but can potentially overfit, capturing the randomness in the time series instead of just the structure. More details about the lasso regression can be found at Ord, Fildes, and Kourentzes (2017) and Kourentzes and Sagaert (2018).[4]

15. **An advantage of trigonometric indicator variables is that they provide an efficient sparse approximation of seasonal patterns.** The figure below exemplifies this. Using all indicators, binary and trigonometric variables (for integer s) provide the same output. However, when terms are eliminated, binary encoding omits all seasonal information for that period, while the trigonometric encoding merely provides a smoother approximation of the seasonal profile.

[4] Kourentzes, N., and Y. R. Sagaert. 2018. "Incorporating Leading Indicators into Sales Forecasts." *Foresight: The International Journal of Applied Forecasting* 48: 24-40.



Source: IMF staff computations.

16. **The TBATS model incorporates many of the features of the models already introduced.** With TBATS, seasonality and trend are handled via exponential smoothing (using trigonometric terms for the former), a Box-Cox transformation is used, and ARIMA innovations are incorporated. This allows seasonality to change over time. A particularly attractive feature of the TBATS model is its ability to handle multiple calendars. Additional details about the TBATS model can be found in de Livera, Hyndman, and Snyder (2011).[5]

17. **Volatility models are appropriate for forecasting series with high volatility.** Normally, these models will be applied to forecast Net Foreign Assets. Three classes of models are fitted.

18. **The most popular family of conditional volatility models is the GARCH model.** The variance is modeled as:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \, \sigma_{t-i}^2 + \sum_{i=1}^{p} \alpha_i \, e_{t-i}^2$$

The specification of the exponential GARCH model (eGARCH) is given by:

$$\log\sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \log\sigma_{t-i}^2 + \sum_{i=1}^{q} \alpha_i \, g(\epsilon_{t-i}).$$

Where $g(\epsilon_t) = \theta\epsilon_t + \lambda\big(|\epsilon_t| - E(|\epsilon_t|)\big)$. An advantage of this specification is its asymmetry since the sign and magnitude of innovations have different effects on the variance.

The GJR (Glosten-Jagannathan-Runkle)-GARCH specification is given by:

$$\sigma_t^2 = \omega + \delta\sigma_{t-1}^2 + \alpha\epsilon_{t-1}^2 + \phi\epsilon_{t-1}^2 I_{t-1}$$

Where $I_{t-1} = 0$ if $\epsilon_{t-1} \geq 0$ and $I_{t-1} = 1$ if $\epsilon_{t-1} < 0$. Like eGARCH, this specification allows for asymmetric effects.

19. The generated forecasts (including prediction intervals) for all autonomous factors and NL can be reconciled together in a combined NL forecast. The net liquidity injection (net foreign assets, currency in circulation, and state account balance) is the main quantity of interest. One approach would be to

[5] De Livera, A. M., R. J. Hyndman, and R. D. Snyder. 2011. "Forecasting Time Series with Complex Seasonal Patterns Using Exponential Smoothing." *Journal of the American Statistical Association* 106 (496): 1513-1527.

simply add up the forecasts of the autonomous factors in a bottom-up fashion, while a second approach would be to develop a forecasting model for the total of the autonomous factors. Alternatively, forecasts can be produced for each autonomous factor and the total. An advantage of this approach is that it hedges against model misspecification in the forecasting of the total if the misspecified features are captured in the forecasts of the individual autonomous factors. It also hedges against misspecification in the bottom level (due to noise) by forecasting the smoother total series. The downside of this approach is that the forecasts are no longer guaranteed to add up correctly.

Let the vector of four points forecasts that do not add up according to the hierarchical structure be given by $\hat{y}$.

$$S = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Let the matrix be the summing matrix. By construction, reconciled forecasts that are guaranteed to add up correctly can be found via:

$$\tilde{y} = S(S'S)^{-1}S'\hat{y}.$$

This approach is referred to as OLS reconciliation due to its resemblance with the matrix in Ordinary Least Squares regressions that project data onto fitted values.

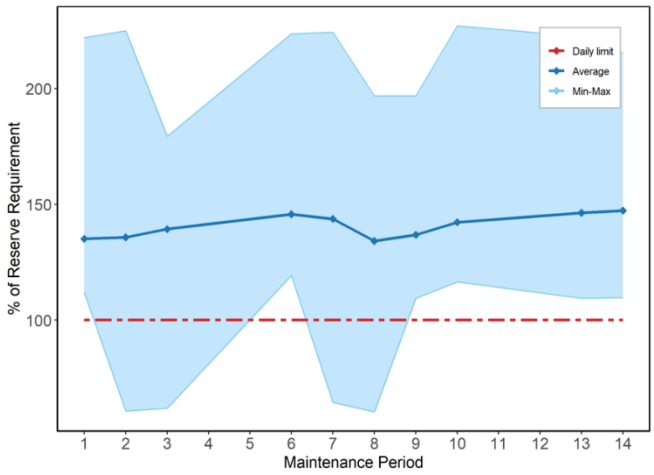
20. The MinT method is an even better approach because it exploits the correlation between forecast errors. Forecasts that are guaranteed to add up correctly are found as $\tilde{y} = S(S'\Sigma^{-1}S)^{-1}S'\Sigma^{-1}\hat{y}$. The matrix Σ is the covariance matrix of one-step-ahead forecasting errors. More details about the MinT method can be found in Wickramasuriya, Athanasopoulos, and Hyndman (2019).[6]

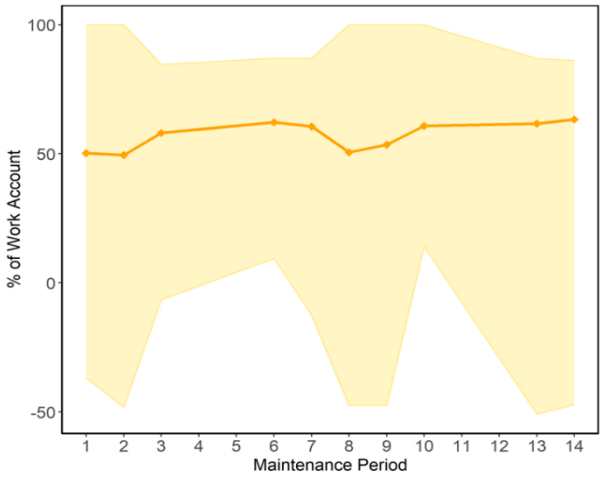
[6] Wickramasuriya, S. L., G. Athanasopoulos, and R. J. Hyndman. 2019. "Optimal Forecast Reconciliation for Hierarchical and Grouped Time Series through Trace Minimization." *Journal of the American Statistical Association* 114 (526): 804-819.

Annex III. Banks Behavioral Profile in the Maintenance Period

The charts below represent the behavior of the banks with respect to liquidity management during the maintenance period. The charts in the left indicate how banks manage liquidity on average to meet the reserve requirements, currently established at 44 percent. The blue line represents the average of the reserves kept in the central bank for each maintenance day since June 2021 as a percentage of the reserve requirements. The blue range represent the minimum and the maximum in terms of percentage of reserve requirements that were maintained in each maintenance period. The charts on the right indicate the liquidity situation of banks after the 5 percent SNEPs are discounted from their work account. The yellow line represents therefore the *effective* excess reserves as a percentage of the work account.

Bank 1





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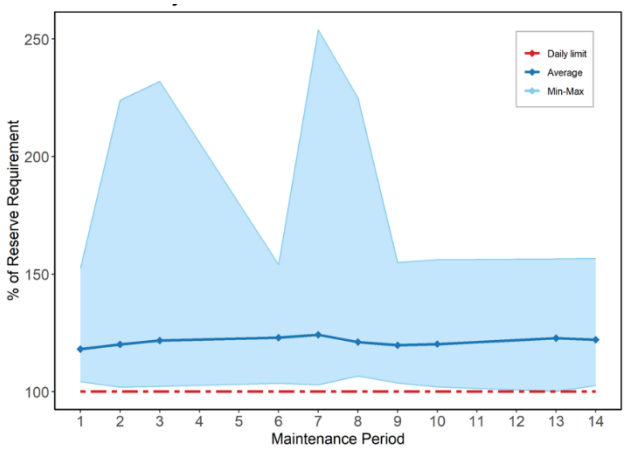

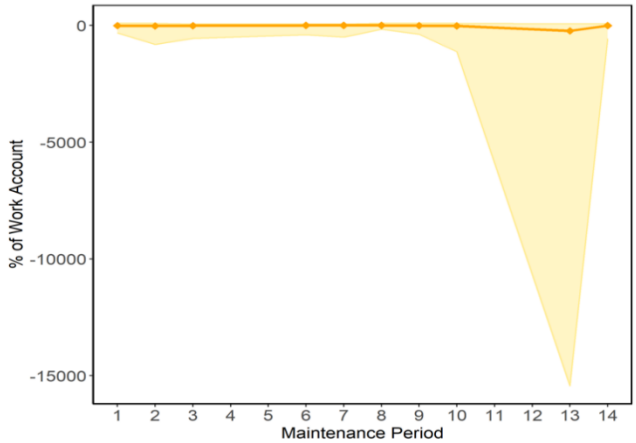

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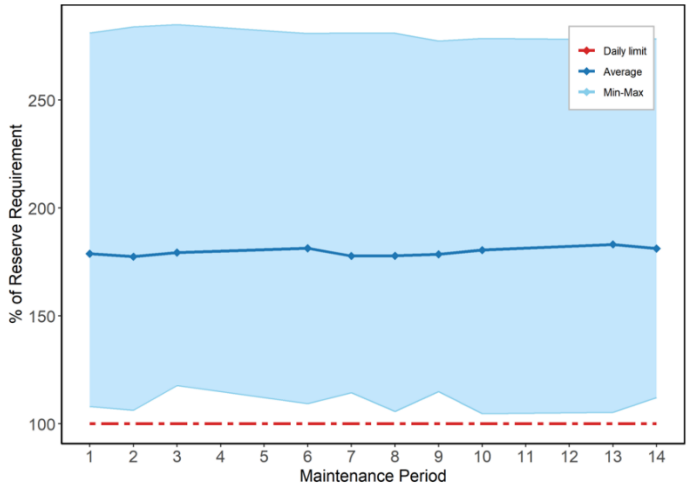

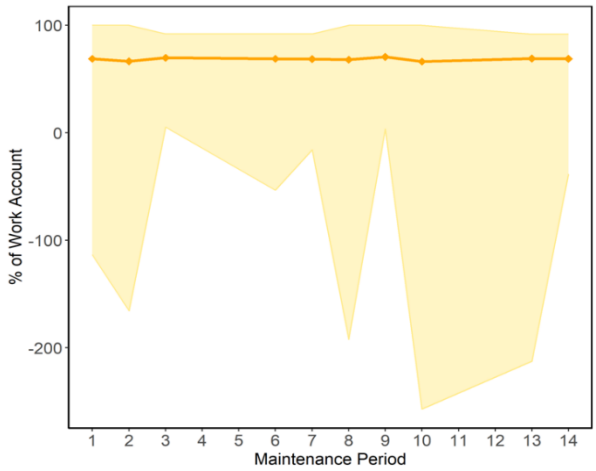

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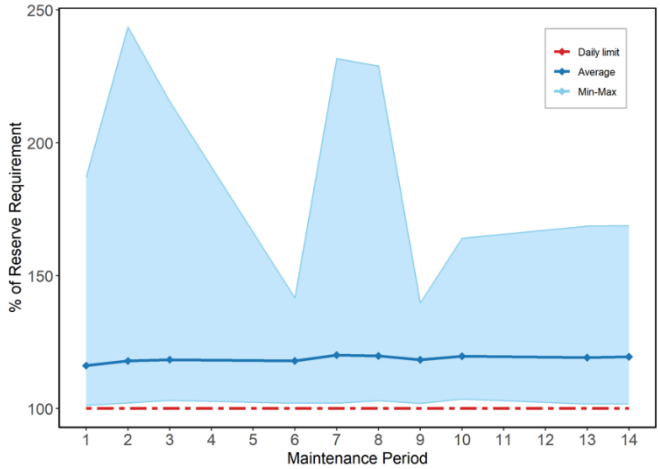
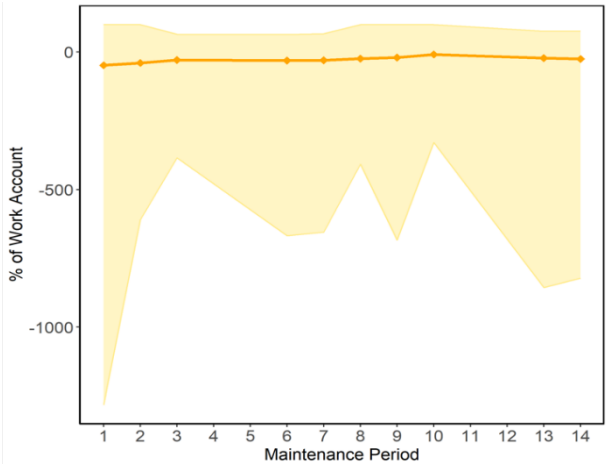
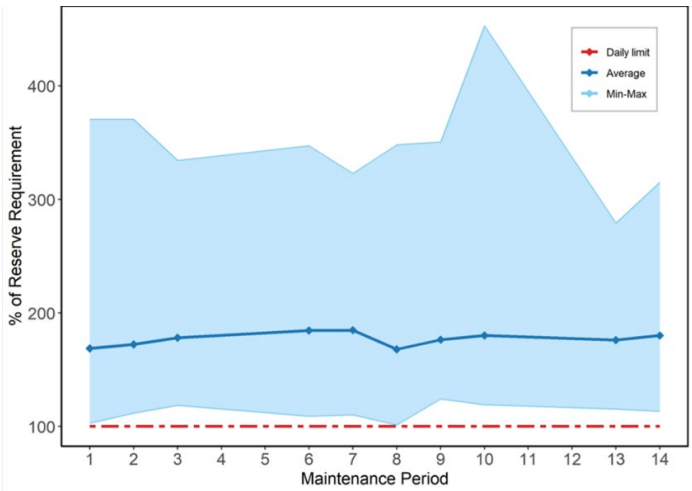
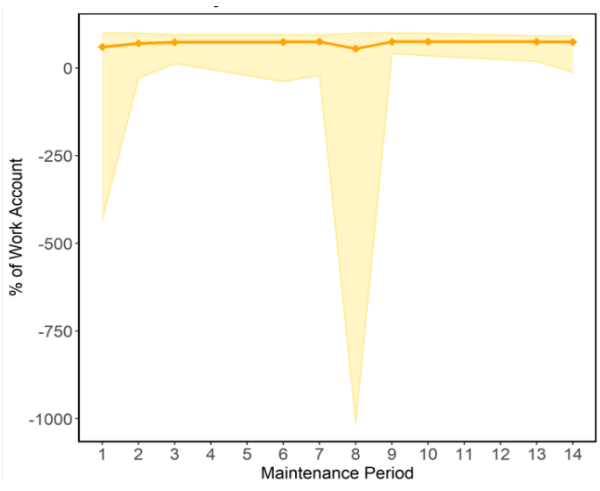




Bank 5





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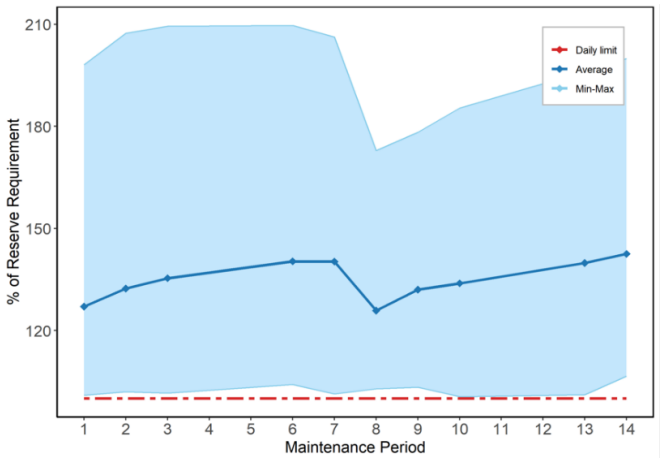
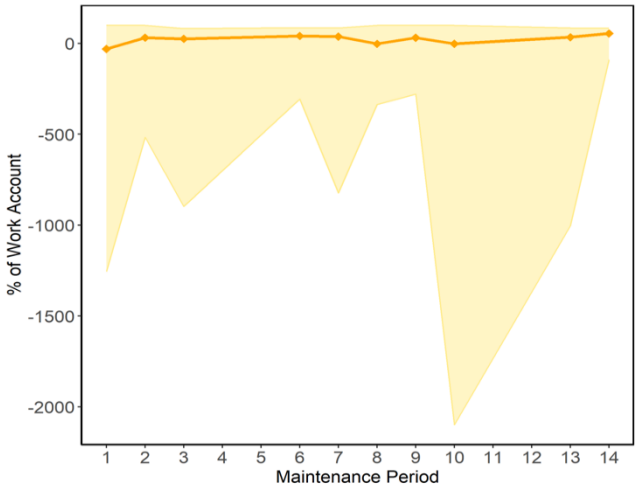
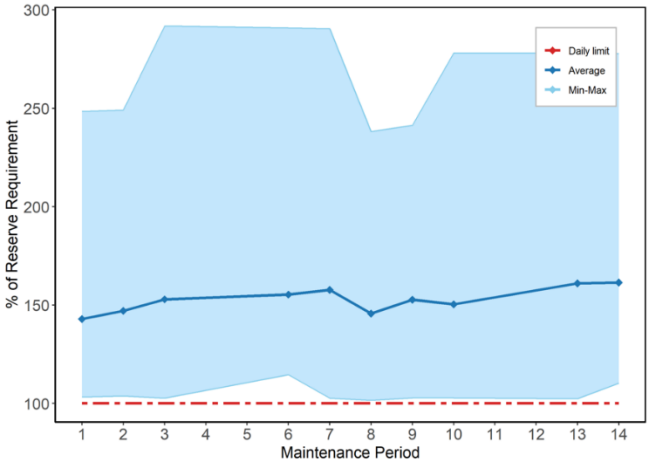
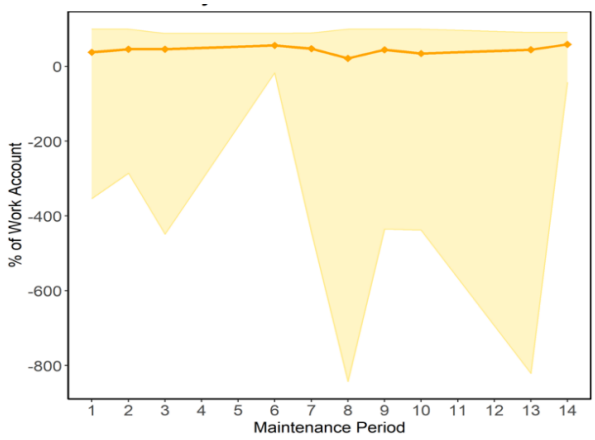




Bank 7





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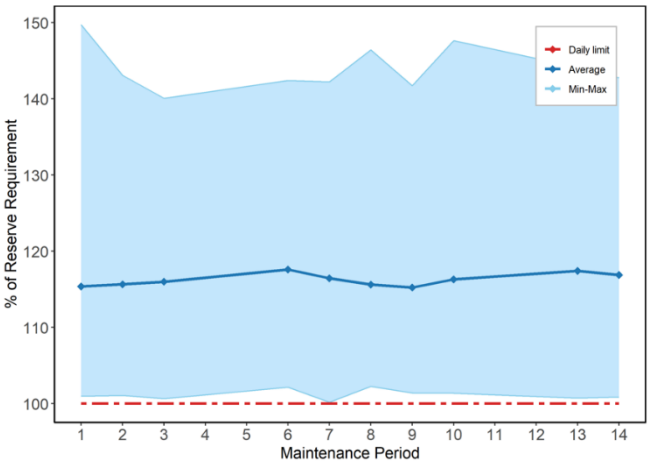
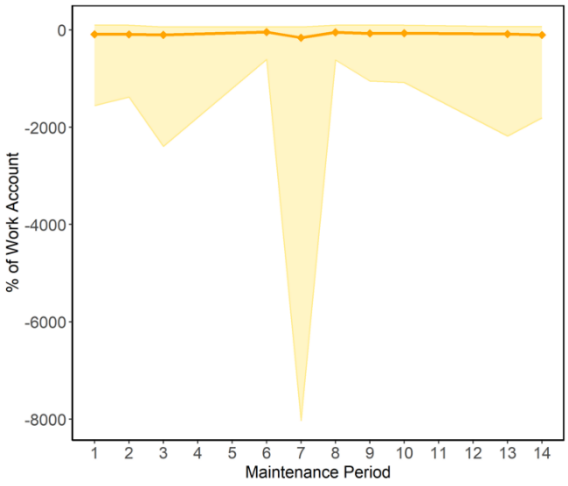
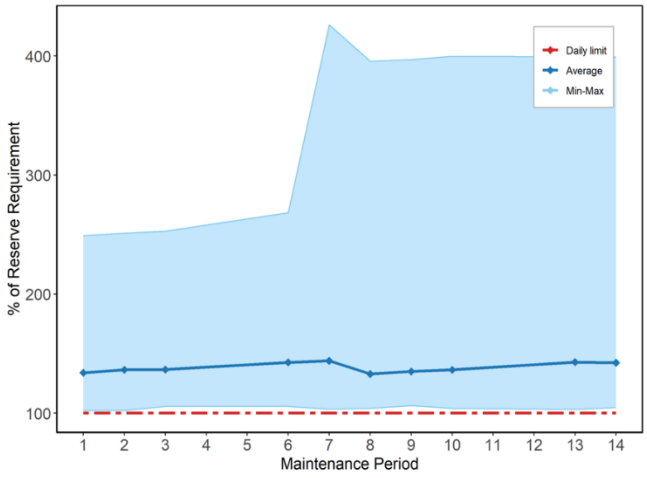
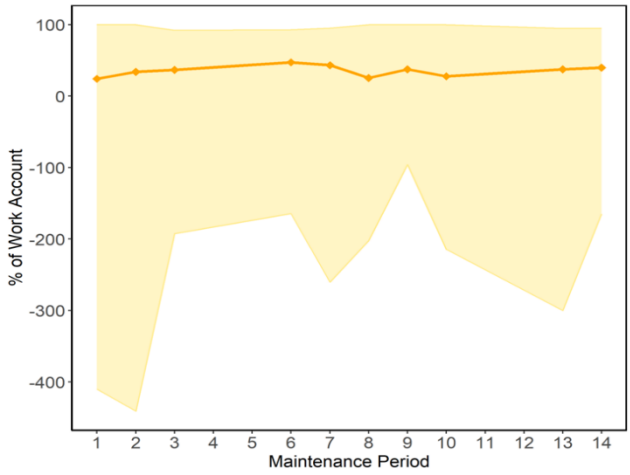




Bank 9


Daily limit
Average
Min-Max
% of Reserve Requirement
100
200
300
400
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Maintenance Period


% of Work Account
100
0
-100
-200
-300
-400
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Maintenance Period