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# **A Joint Foreign Currency Risk Management Approach for Sovereign Assets and Liabilities**

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**A Joint Foreign Currency Risk Management Approach  
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**Prepared by M. Coskun Cangoz, Olga Sulla, Chun Lan Wang and Christopher Dychala**

**Abstract**

An asset and liability management framework for managing risks arising from sovereign foreign exchange obligations requires a joint analysis of (i) the external financial liabilities resulting from a country's sovereign debt and (ii) the foreign exchange assets of its central bank. Governments often issue sizable amounts of debt denominated in foreign currencies, subjecting their fiscal positions to foreign exchange volatilities. Prudent management of a sovereign's foreign exchange position under an asset and liability management framework enables governments to mitigate risks at the lowest possible cost, hence increasing resilience to external shocks. Based on the challenges associated with the implementation of an asset and liability management framework, this study recommends a practical approach that includes analysis of the foreign exchange positions of central bank reserves and central government debt portfolios and optimization of the net position. The proposed model is tested, using the foreign exchange reserve and external debt data of seven countries (Albania, Ghana, FYR Macedonia, South Africa, the Republic of Korea, Tunisia, and Uruguay). The paper employs quantitative methods to explore the impact of an overarching asset and liability management strategy and integrated approach on the efficient management of foreign exchange risk. It provides policy recommendations on ways to minimize the risk of foreign exchange mismatches and increase the return on foreign exchange reserves.

JEL Classification Numbers: E61, E63, F31, F34, F37, G11, G15, G17, G18, H63, H68

Key Words: Exchange Rate Risk, Asset and Liability Management, Public Debt, Sovereign Balance Sheet, Macro Hedging, Portfolio Optimization, International Reserves, Strategic Asset Allocation

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All errors, omissions, and inconsistencies that may appear in this work are the authors' sole responsibility.

## Abbreviations

ALM	Asset and Liability Management
CB	Central Bank
CVaR	Conditional Value at Risk
DM	Debt Management
EM	Emerging Markets
EUR	Euro
FX	Foreign Exchange
GDP	Gross Domestic Product
IMF	The International Monetary Fund
JPY	Japanese Yen
MBS	Mortgage Based Securities
MSCI	Morgan Stanley Capital International
MTDS	Medium Term Debt Strategy
RM	Reserve Management
SDR	Special Drawing Rights
USD	United States Dollar
VaR	Value at Risk
WB	The World Bank

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## I. Introduction

Since the global financial crisis, government debt has increased by \$19 trillion in advanced economies and \$9.6 trillion in emerging markets.<sup>2</sup> At the same time, the value of assets held in central banks, sovereign funds and public pension funds hit \$36 trillion in 2017, which is equal to 45% of global GDP.<sup>3</sup> Fiscal Transparency Evaluations conducted by the International Monetary Fund (IMF) suggest that many countries may not be using these assets to efficiently manage their foreign currency obligations because they do not manage their assets and liabilities in an integrated fashion (Sayegh 2017). World Bank–IMF Guidelines for Public Debt Management suggest countries to adopt a “holistic” risk management framework based on a government’s overall balance sheet. The outcome is a cost and risk analysis of sovereign debt based on a government’s net revenues. This full picture enables governments to design a comprehensive strategy to reduce balance sheet risk and lower hedging costs, thereby efficiently improving a country’s ability to absorb exogenous shocks.<sup>4</sup>

Multiple resources address sovereign asset and liability management (ALM) at the conceptual level (Cassard and Folkerts-Landau 1997, Velandia 2002, Wheeler 2004, Das et al 2012). Although there are significant challenges to its implementation, such as lacking legal framework, difficulties in valuation of the assets, diverse and sometimes conflicting objectives across entities, and different accounting systems, the benefits of ALM are widely accepted both by practitioners and academicians.

Sovereign assets and liabilities have different objectives and are traditionally managed separately. Foreign exchange (FX) reserve portfolio is likely the largest asset on a sovereign’s balance sheet and is managed to meet balance of payment requirements and provide macro-economic stability in the medium and long term (see Das et al, 2012). On the liability side, similar to the FX reserves, government debt is often the largest and the most complex component of a country’s liability portfolio. The main objective of public debt management is to raise the required amount of funds with the lowest possible cost and at an acceptable risk level.

Governments often issue sizable amounts of debt in foreign currencies and their fiscal positions are frequently subject to foreign exchange volatility. An ALM framework for managing risks arising from sovereign FX obligations requires joint analysis of (i) the financial liabilities resulting from sovereign debt and (ii) the FX reserve assets of its central bank.<sup>5</sup> This study recommends a practical approach based on the challenges associated with the implementation of an ALM framework. It suggests optimizing a country’s net FX position based on an analysis of its central bank’s FX reserve positions and central government debt portfolios.

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<sup>2</sup> Institute of International Finance, Global Debt Monitor October 2017.

<sup>3</sup> Real Momentum: Global Public Investors and the Real Assets Market, OMFIF, 2018.

<sup>4</sup> Society of Actuaries (2003) defines ALM as “the ongoing process of formulating, implementing, monitoring and revising strategies related to assets and liabilities to achieve an organization’s financial objectives, given the organization’s risk tolerances and other constraints.”

<sup>5</sup> Sovereign liabilities could also include government contingent liabilities and local government as well as debt of state-owned enterprises (SOEs). Sovereign assets may include any holdings of sovereign wealth funds or public pension funds. In this study, we limit the analysis to central government debt and central banks’ FX reserves.

The authors tested the proposed model using FX reserve and external debt data from seven countries—Albania, Ghana, the former Yugoslav Republic of Macedonia, South Africa, the Republic of Korea, Tunisia and Uruguay. Among the ones disclosing currency composition of international reserves and external debt portfolio, the sample countries were selected based on three main criteria, including broad regional representation; issuance of foreign currency debt; and minimum reserves benchmark of three months of imports and short-term foreign currency debt service.<sup>6</sup>

The objective of the paper was to explore the impact of an overarching ALM strategy and integrated approach on the efficient management of FX risk. The outcome of this process is several policy recommendations on ways to minimize the risk of FX mismatches and increase the return on public FX reserves.

This paper is comprised of six sections. Section II provides a brief overview of the sovereign asset and liability management approach. Section III discusses the challenges of managing FX risk and opportunities under a joint ALM approach. Section IV assesses the status of FX risk in the selected country sample. Section V measures the impact of a joint ALM approach on portfolio optimization. Finally, section VI offers policy recommendations that account for governance and institutional constraints.

## **II. Sovereign Asset and Liability Management**

The Revised Guidelines for Public Debt Management recommends establishing and executing a debt management strategy that enables a government to raise required amount of funds at the lowest possible cost over the medium to long term with a prudent level of risk. Key elements of this approach include the identification of the preferred composition of a debt portfolio, including the share of debt denominated in foreign currency. The structure of preferred debt portfolio and the degree of risk exposure may differ based on the size and types of debt portfolios and the level of risk aversion of the decision makers.

Identifying the appropriate share of debt denominated in foreign currency is a multi-step process. First, a debt manager must define the share of foreign currency debt given the inability of issuance of desired amount of debt with local currency (Melecky, 2007). Having identified the level of local currency debt, the debt manager decides the currency composition of the FX debt portfolio, ideally, by finding a basket of currencies that has the lowest variance with local currency.

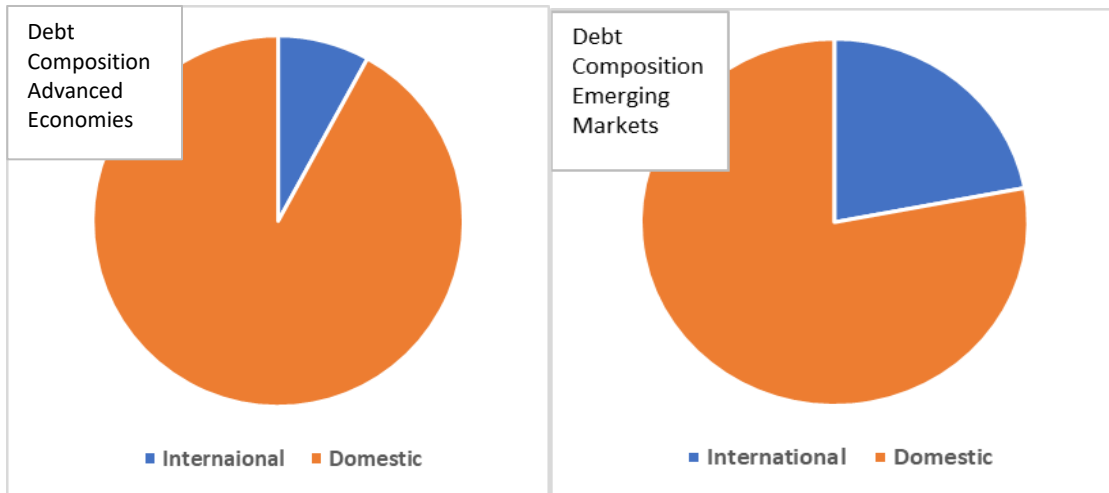
Emerging markets hold a much larger share of debt denominated in foreign currency than advanced economies, largely because the smaller size of domestic capital markets constrains their ability to issue debt in local currency (Figure 1).

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<sup>6</sup> Countries with floating exchange rate regimes, such as Uruguay, South Africa and Albania, are less likely to use reserve assets to execute exchange rate interventions. Others, such as Tunisia, with its crawling peg, or FYR Macedonia, with its currency stabilized against the EUR, may require additional FX reserves to maintain this flexibility.



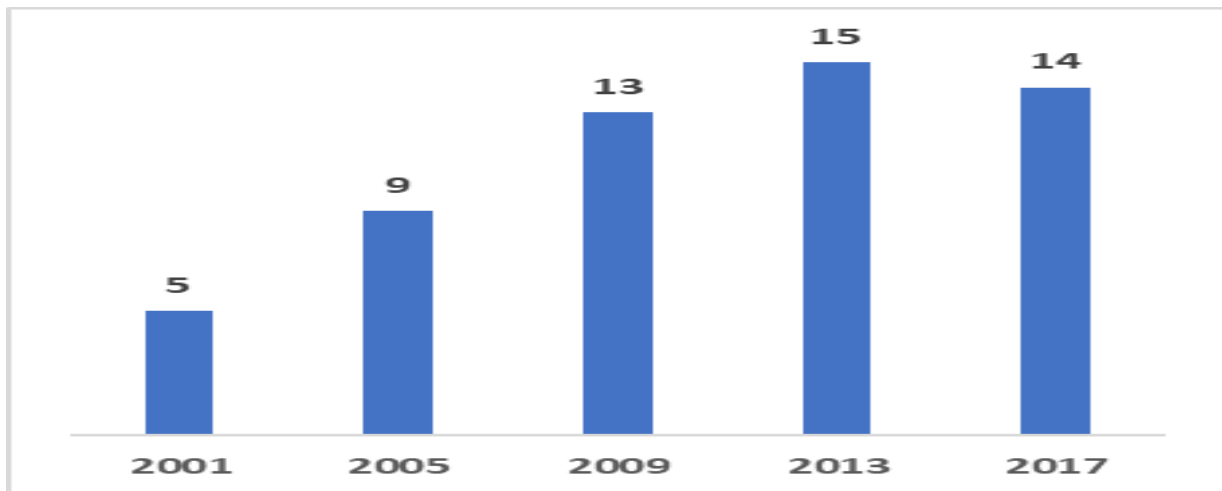
**Figure 1: Composition of Foreign and Domestic Debt in Advanced and Emerging Economies**



Another critical aspect of ALM is having sufficient assets in the right foreign currency mix available to cover national foreign liabilities, be they the cost of imports or short-term external debt. Optimizing ALM also involves generating income on that portion of reserve assets that exceeds these traditional adequacy metrics and amounts needed for exchange rate intervention.

In recent years, countries’ foreign exchange reserves have risen to unprecedented levels, almost doubling as a share of GDP in the last decade. To minimize the opportunity cost arising from this change, income generation has become an increasingly important element of ALM (IMF, 2014).

**Figure 2: Global FX Reserves as % of GDP**



Source: Sunner, 2017

ALM achieves these goals through setting investment objectives such as liquidity, capital preservation and return generation. Reserve managers assess the currency allocation decision for reserve holdings separately from the choice of asset exposures. For example, a reserve manager may decide on an asset allocation and then use other financial instruments such as

foreign exchange swaps or options to achieve the desired currency exposure. Holding unhedged foreign currency assets (whereby the currency exposure is not converted back to local currency with derivatives) results in an exposure to exchange rate fluctuations in addition to interest rate risk and credit risk on foreign currency investments (see Sunner, 2017).

Government debt can be a major source of financial vulnerability. In the early 1990s, Mexico was over-reliant on short term dollar-linked debt (Tesobonos). Its maturing debt was almost double its foreign currency reserves, prompting an exchange rate crisis to become a debt service crisis. In the late 1990s, the Russian Federation's foreign exchange reserves declined sharply as foreign investors were reluctant to roll over short-term government bonds. In 2002 increased dollarization and a rise in short-term debt led to a balance of payment crisis in Argentina whose currency was pegged to the dollar. The drivers of these crises can be traced to some of the weaknesses of a conventional macro-fiscal approach to debt management, focusing on deficits and gross debt: such as considering fiscal risks independent of rather than related to one another, neglecting the asset side of the sovereign balance sheet, and failure to comprehend changes in valuation.

In a period of financial turmoil, prudent reserve management may reduce vulnerabilities through bilateral foreign exchange swap lines, uncollateralized deposit exposures with foreign banks and accommodating unexpected liquidity needs, such as those that arose during the global financial crisis. Sufficient reserves can serve as insurance to defend a currency's value from destabilizing capital outflows; grant emergency foreign currency liquidity assistance to banks; and serve as a bulwark against disorderly market conditions and/or valuation overshooting. Since liabilities create the institutional and economic context of reserve management, liquidity and safety are paramount investment objectives (Jones, 2018).

External shocks may have substantial impact on sovereign balance sheets. The fiscal cost of macroeconomic shocks is equivalent to around 9 percent of GDP while the impact on the financial sector is equal to about 10 percent of GDP (Bova et al 2016). ALM, as a holistic approach, can serve as an effective way to address these issues since it can generate resources to mitigate risks arising from a variety of sources that may be highly correlated (Table 1). Managing sovereign balance sheets in a coordinated fashion helps public officials develop a comprehensive understanding of risk factors both for assets and liabilities. ALM approach can enable governments to identify vulnerabilities, such as currency and maturity mismatches, risks from contingent liabilities, exposure to macroeconomic shocks and commodity price and revenue volatility. Understanding these risk factors also enables governments to assess and measure them to employ different risk management techniques such as natural hedges, hedging residual risk and risk mitigation tools for contingent liabilities. A coordinated approach to ALM not only ensures sovereigns to reduce overall risk of the balance sheets but also can establish a robust framework for forming and bolstering governance arrangements applicable to sovereign balance sheet management.

**Table 1 - Stylized Sovereign Balance Sheet and Associated Risks**

Associated Risks	Assets	Liabilities	Associated Risks
	Financial Assets	Government Debt	
Interest rate risk Currency risk Liquidity risk Commodity price risk Credit Risk	- Cash and deposits	- Local-currency debt	Interest rate risk Refinancing risk
Commodity price risk	- Equity investments	- Foreign-currency debt	Interest rate risk Currency risk Refinancing risk
Interest rate risk Currency risk Credit risk	- Loans and Receivables	Payables	Interest rate risk Currency risk Liquidity risk
Interest rate risk Liquidity risk Credit risk	- Other financial assets	Other liabilities	Liquidity risk
Interest rate risk Currency risk Credit risk Liquidity risk	FX reserves		
Liquidity risk Disaster risks	Fixed and other assets	Net worth	Residual risks
Associated Risks	Contingent Assets	Contingent Liabilities	Associated Risks
Disaster risks	Insurance	Guarantees	Interest rate risk Currency risk Demand risk Credit risk
Legal risk	Lawsuits	Lawsuits	Legal risk
Commodity price risk	Windfall gains	Disasters	Disaster risks

### III. A Joint ALM Approach for Managing Foreign Currency Risk

Defining the sensitivity of a government's liability portfolio to exchange rate volatilities is critical to managing foreign currency risk. The first step in developing this understanding is determining the portfolio's foreign currency exposure.

Traditionally, debt managers derive the currency composition of a debt portfolio as an output of strategic benchmarks that minimize funding costs at certain risk levels (see Melecky, 2007 and Papaioannou, 2009 for alternative approaches for exchange rate risk measurement and management).

An ALM approach requires joint management of balance sheet risks which refers to a joint decision making at the policy level and a seamless coordination at the technical level. To this end, sovereigns identify net foreign currency exposure, through an assessment of the central government's balance sheet and the central bank's balance sheet. This process allows sovereigns to optimize their foreign currency position in light of several factors. These include the composition of government revenues/assets by currency and the currency structure of export revenues or capital flows.

**Figure 3: Sovereign's Net Foreign Currency Position**

Central Government Balance Sheet		Central Bank Balance Sheet	
Assets	Liabilities	Assets	Liabilities
<b>Foreign Currency Assets</b> Deposits at Central Bank	<b>Foreign Currency Liabilities</b> International Bonds Official and Commercial Loans	<b>Foreign Currency Assets</b> International Reserves	<b>Foreign Currency Liabilities</b> Central Government Deposit
<b>Local Currency Assets</b> Deposits at Central Bank Deposits at commercial banks Onlending Receivables Equity in Public Companies	<b>Local Currency Liabilities</b> Government bonds & bills Payables Other liabilities	<b>Local Currency Assets</b> Claims on banks Other assets	<b>Local Currency Liabilities</b> Currency in circulation Central Government deposit Bank deposits Other liabilities
<b>Fixed assets</b>	<b>Equity (net worth)</b>	<b>Fixed assets</b>	<b>Equity</b>

Consolidated Balance Sheet	
Assets	Liabilities
<b>Foreign Currency Assets</b> International Reserves	<b>Foreign Currency Liabilities</b> International Bonds Official and Commercial Loans
<b>Local Currency Assets</b> Claims on banks Deposits at commercial banks Onlending Receivables Equity in Public Companies Other Central Bank assets	<b>Local Currency Liabilities</b> Currency in circulation Government bonds & bills Bank deposits Payables Other liabilities
<b>Fixed assets</b>	<b>Equity (net worth)</b>

The ALM approach produces two specific advantages. First, it enables debt managers to use a preferred currency composition that minimizes their costs at an acceptable risk level. Second, it helps FX reserve managers define a strategic asset allocation to maximize risk-adjusted returns. This approach also allows debt and reserve managers to match cash flows from assets and liabilities denominated in the same currency.

A joint ALM approach does not involve merging or combining debt and reserve management activities. Rather, a holistic approach comprises effective coordination between these functions at the levels of policy, technical implementation and data sharing. Debt and reserve management have different objectives and tools and their effectiveness depends in part on their individual pursuit of their core objectives. However, a joint ALM approach generates synergies for net worth management through increasing efficiency and risk reduction using natural hedges (see Blommestein and Turner, 2012).

### **Box 1: Why Is the Coordination of Debt and Reserves Management Necessary?**

Sovereigns can face substantial costs from efficiency losses and unhedged FX positions when they do not undertake a holistic ALM approach. In many countries, two factors determine currency selection for government borrowing: the funding cost and the availability of the funds. Therefore, foreign currency composition of the current debt portfolio is a result of the governments' previous funding decisions and this decision may take place years before repayment is due. Ensuring that sufficient funds in the right currency are available on the loan's maturity date requires ongoing coordination between a central bank and debt management office. Otherwise, the consequences can be severe.

In the mid-1990s, a major municipality in an emerging country financed an infrastructure project via a government guaranteed loan denominated in Korean won (KRW). It was the first KRW loan ever borrowed by a public institution and, prior to the transaction, the government's debt portfolio had no exposure to KRW. At the time, neither the municipality nor the government had KRW cash inflows. Moreover, the value of the country's imports from the Republic of Korea (\$719mio or 1.6% of total exports) was more than seven times the value of its exports (\$101mio or 0.4% of total exports) and the exchange rate was approximately 57.30 (KRW/USD rate was 785.55).

Despite this exposure, the municipality did not hedge its position mainly due to the cost concerns and lack of technical capacity. Soon after the first disbursement of the loan, the municipality called the guarantee and not only the KRW denominated loan but also the currency mismatch transferred to the central government balance sheet. During the life span of the loan, until the mid-2000s, the KRW exchange rate against local currency appreciated by 2,258% and reached up to 1,293.57 (KRW/USD rate increased to 1038.42).

A holistic risk management approach could have helped the government to save its debt servicing cost and mitigate the foreign currency risk. In this regard, on the asset side of the sovereign balance sheet KRW could have been swapped to any reserve currency to create KRW assets. On the liability side, the KRW loan could have been swapped to a loan (or a bond) denominated by a reserve currency. Another option was to pay off the outstanding balance of the KRW loan either through local currency cash reserves or local currency loan/bond.

### **III. I. Natural Hedge**

By its very nature, a balance sheet, as a statement of different types of financial and non-financial assets and liabilities, focuses on stocks rather than flows. Financial assets include currency and deposits, FX reserves, loans, equity, investment fund shares and receivables. Fixed assets, land, mineral deposits and energy resources qualify as non-financial assets. Liabilities comprise debt, provisions and payables.

On a typical sovereign balance sheet, government debt is usually the biggest subcomponent of liabilities while international reserves are the biggest asset. In most countries, reserve managers subdivide their portfolio into tranches based on policy requirements, investment objectives and operational needs. They usually hold some FX reserves in a “liquidity tranche” typically comprised of easily convertible assets. These holdings are available to reduce exchange rate volatility and the likelihood of a balance of payments crisis. Some also hold an “investment tranche” of “excess reserves” with assets of a duration that matches the government’s foreign currency debt.

Ensuring the availability of the required amount of foreign currency for the external debt payments in the liquidity tranche is critical for effective coordination between reserve and debt management. Furthermore, matching the currency composition of FX inflows and outflows enables “natural hedging”. This technique uses stable cash flows to minimize the cost of hedging and reduce credit/counterparty risk. Natural hedging reduces risk, associated with exchange rate volatility, allowing portfolio managers to minimize the amount of uncovered liabilities denominated in foreign currency risks of different portfolios, exposed to exchange rate fluctuations.

### **III. II. Macro Hedging**

Joint sovereign ALM can help address the main risks associated with foreign exchange exposure – balance sheet risk (exchange rate fluctuations) and liquidity risk (availability of foreign currency when needed) through adjusting the cost and risk structure of the debt portfolio with the currency composition maximizing the risk-adjusted return of the country’s international reserves. This approach produces comprehensive benefits including (i) a balance sheet’s desired foreign exchange risk exposure; (ii) minimized foreign currency mismatches in assets and liabilities; (iii) distortionary spillover mitigation; and (iv) spillover crisis containment.

Effective governance is critical to generating the benefits of joint ALM and may be facilitated by committees that bring together debt and reserve managers. These include a high-level body comprising senior staff that (i) makes final decisions on the scope and the fundamentals of the ALM framework; and (ii) provides a mechanism for demonstrating commitment, promoting technical coordination, and relieving “road blocks.” A technical committee can enhance the impact of the high-level body through oversight of preparatory work and developing recommendations for decision. Its scope of responsibilities would include (i) obtaining cash flow forecasts that account for debt service and borrowing; and (ii) developing strategies for issuance of short-term securities and investment of government deposits where relevant.

Even with these governance structures in place, the shape of coordination among reserve and debt managers will depend on several other factors. These include how monetary policy is implemented; the ability to conduct overnight borrowing from the central bank; rules on profit distribution between the ministry of finance (MoF) and central bank, and the operation of the Treasury Single Account (TSA), e.g., targeting a tight range versus a broader range. A Memorandum of Understanding/Service Level Agreement/Investment Management Agreement may be helpful in formalizing the ultimate arrangement.

Like effective governance, adopting a macro hedging<sup>7</sup> approach can help mitigate potential conflicts among institutions and functions involved in joint ALM. Under this approach, a debt management office and central bank reserves management unit still optimize their portfolios separately in line with their mandates. At the same time, they consolidate foreign exchange risk and manage it to mitigate threats arising from macroeconomic events.

In practice, two main functional desks at the debt management office (DM desk) and central bank reserve management unit (RM desk) operate seamlessly to hedge foreign currency risk, simply using internal swaps to meet the cost and risk objectives of debt management and hedging of the residual risk with external parties in line with the defined range of risk-based return objectives of reserve management. Proposed joint risk management approach suggests the following framework (i) the debt management office decides on the desired debt portfolio, including its allocation between local and external debt and the currency composition of the external debt, (ii) DM desk hedges the foreign currency risk in the debt portfolio in two ways, offsetting certain liabilities with revenues in the same currency or fixing exchange rates on portions of the debt using derivative market transactions, (iii) DM desk transfers any residual risk to the RM desk, and (iv) RM desk eliminates the consolidated risks around macroeconomic events.

In this framework, the central bank sets the level of foreign exchange reserves and identifies the strategic asset allocation considering the defined range of its objectives. Meanwhile, the debt management office defines the desired debt portfolio, specifying the composition of local and foreign currency denominated debt and the currency composition of debt denominated in foreign currency.

#### **IV. Assessing the Status of FX Risk in a Sample of Countries**

In this section, we assess seven countries' central government external debt and foreign exchange reserve portfolios, focusing on the stock of foreign currency-denominated assets and liabilities, their currency composition, and the currency share in each portfolio. These countries fall into three groups—those with net FX asset positions (Korea, South Africa); zero FX positions (Albania, FYR Macedonia, Uruguay); and net FX liability positions (Ghana, Tunisia). Net FX asset positions are beneficial for developing countries seeking protection against external shocks. If their local currency depreciates FX values increase, providing insurance in times of stress. In contrast, countries with net FX liability positions are at greater risk because local currency depreciation increases the value of FX liabilities. Assessing currency mismatches between asset

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<sup>7</sup> Macro-hedging is a holistic and dynamic risk management approach in which asset-liability mismatch is hedged at the aggregate level, as opposed to hedging of individual transactions. Through risk aggregation, macro-hedging may reduce the transaction cost and counterparty risk due to fewer transactions and provide higher risk-return efficiency when used for the mitigation of interest rate risk and exchange rate risk.

and liability portfolios (both in terms of volume and composition) may help to identify vulnerabilities as well as potential opportunities to benefit from a consolidated balance sheet approach.

#### IV.I. Countries with Net FX Asset Positions

##### A. South Africa

South Africa has a liquid and relatively developed local currency bond market. The central government uses this market to meet most of its financing needs, so external debt represents a small share (around 10 percent) of the government's total debt portfolio (Table 2). This falls below the current government benchmark of 15 percent (external debt as percent of total debt).

**Table 2 – South Africa: Composition of Debt**  
*as of March 31, 2017, USD bil eq.*

	Amount	Percent
Domestic Debt	149.0	89.5
External Debt	17.5	10.5
Total	166.5	100.0

Most of the external debt share is comprised of USD-denominated bond issuances in international capital markets (93 percent). The National Treasury has also issued small amounts of EUR- and JPY-denominated bonds and used cross-currency swaps to hedge its exposure to this non-USD denominated debt. The South African Reserve Bank (SARB) maintains a significant amount of reserves—its external debt-to-reserves ratio is 0.43—and the USD share of its reserves sufficiently covers its amount of USD-denominated external debt. The USD debt-to-reserves ratio is 0.7 (Table 3).

**Table 3 – South Africa: Composition of Foreign Currency Debt and Reserves**  
*as of March 31, 2017, USD billion eq.*

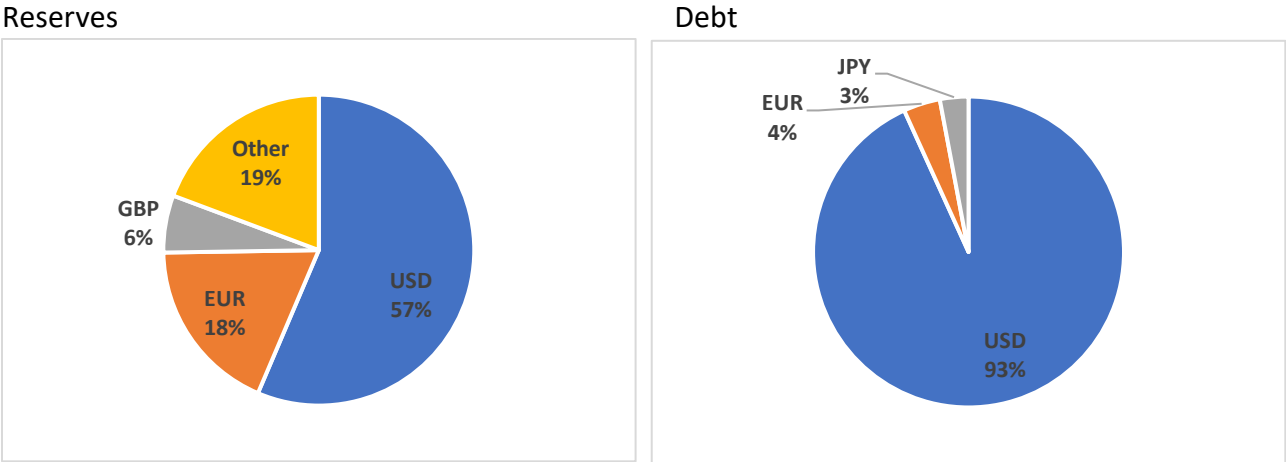
		USD	EUR	JPY	GBP	Other	Total
Reserves	USD bil. eq.	23.2	7.6	-	2.5	7.9	41.2
	Percent of total	56.4	18.3	-	6.0	19.3	100.0
	Percent of GDP	7.8	2.6	-	0.8	2.7	13.9
External Debt (by currency of issuance)	USD bil. eq.	16.3	0.7	0.5	-	-	17.5
	Percent of total	93.0	4.0	3.0	-	-	100.0
	Percent of GDP	5.5	0.2	0.2	-	-	5.9
Concentration	Ratio FX debt/ reserves	0.70	0.09	n/a	n/a	n/a	0.43

Source: National Treasury, Bloomberg and South African Reserve Bank  
*Applied FX Rate: 13.4136 ZAR/USD as of March 31, 2017*



In terms of composition, the central government’s USD debt reflects a much larger share of external debt (93 percent) than the USD share of SARB’s foreign exchange reserves (56 percent). EUR reserves constitute a much larger share of reserves (18 percent) than EUR-denominated debt in the government’s external debt portfolio (4 percent, see Figure 4).

**Figure 4 – South Africa: FX Currency Composition of:**



These mismatches are not a significant concern because the amount of foreign exchange reserves is more than sufficient to cover outstanding external debt in the event of a significant depreciation that leads to rising external debt servicing costs. Furthermore, despite recent volatility, the authorities’ commitment to the maintenance of a flexible exchange rate regime leaves intact the key adjustment mechanism to external shocks, making the use of reserves as a mechanism to defend the exchange rate less important.

**B. Republic of Korea**

Korea has a liquid and developed domestic debt securities market. Thus, most central government debt is denominated in KRW, while external debt comprises a very small share of its overall portfolio (less than 1 percent, see Table 4).

**Table 4 – Republic of Korea: Composition of Debt**  
*as of end December 2016, billions USD*

	Amount	Percent
Domestic Debt	487.2	99.3
External Debt	3.7	0.7
Total	490.9	100.0

Foreign currency debt is denominated in three currencies—USD, EUR and JPY. These are the three currencies in which Korea has issued external debt in the international capital markets but in small amounts relative to the total debt stock.

**Table 5 – Republic of Korea Composition of Foreign Currency Debt and Reserves**  
as of end December 2016, billions USD

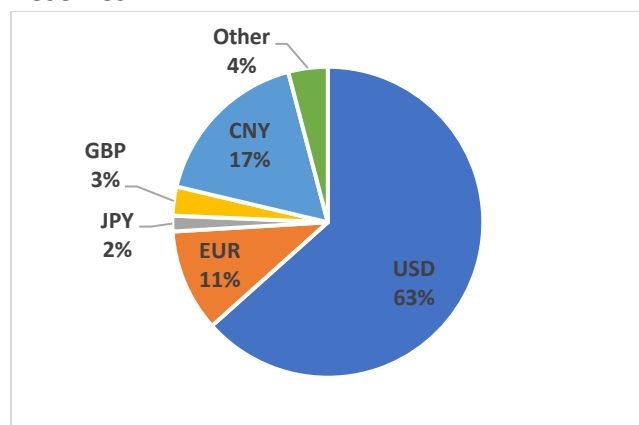
		USD	EUR	JPY	GBP	CNY	Other	Total
Reserves*	USD bil. eq.	232	39	6	11	63	15	366.0
	Percent of total	63.3	10.8	1.8	2.9	17.1	4.1	100.0
	Percent of GDP	16.4	2.8	0.4	0.8	4.5	1.1	25.9
External Debt	USD bil. eq.	2.6	0.81	-	-	0.25	-	3.7
	Percent of total	71.2	22.0	-	-	6.8	-	100.0
	Percent of GDP	0.2	0.1	-	-	0.02	-	0.3
Concentration	Ratio FX debt/ reserves	0.01	0.02	n/a	n/a	n/a	n/a	0.01

Source: Ministry of Strategy and Finance and Kim and Lee, April 2017.

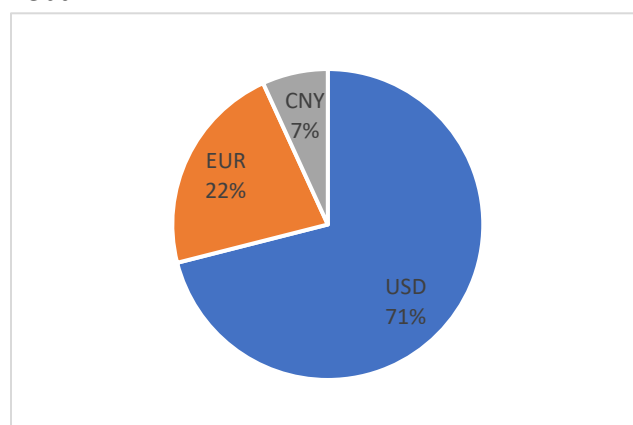
\*Estimates of the reserve composition as of 2014 data, Kim and Lee, April 2017.

Korea maintains a large amount of foreign reserves, and an estimate (Kim and Lee, 2017) of the composition indicates that the largest share is denominated in USD followed by CNY and EUR (Table 5). Korea has a de jure and de facto floating exchange rate regime.

**Figure 5 – Republic of Korea: FX Currency Composition of:**  
Reserves



Debt



Considering that the FX debt/reserves ratio is only 0.01, mismatches between debt and reserves composition are not a concern. Similar to South Africa, the flexible exchange rate regime works as a mechanism to adjust the exchange rate against external shocks, and the level of reserves is high enough to defend the exchange rate.

#### IV. II. Countries with Zero FX Positions

##### A. Albania

Albania has almost equal shares of domestic debt and external debt (see Table 6). In recent years, Albania has issued bonds in EUR, including a EUR450 million international bond in 2015.

**Table 6 – Albania: Composition of debt**

As of end December 2016, millions EUR

	Amount	Percent
Domestic Debt	3,884	51.0
External Debt	3,731	49.0
Total	7,615	100.0

Its foreign exchange reserves cover approximately 80 percent of external debt (FX debt-to-reserves ratio of 1.23, see Table 7). While the amount of USD-denominated debt is roughly half that of USD reserves (ratio 0.53), Albania's EUR-denominated debt is 1.15 times greater than its EUR reserves.

**Table 7 – Albania: Composition of Foreign Currency Debt and Reserves**

as of end December 2016, millions EUR

		USD	EUR	JPY	GBP	SDR	Other	Total
Reserves	EUR mil. eq.	662	1,848	-	83	-	451	3,045
	Percent of total	21.7	60.7	-	2.7	-	14.8	100.0
	Percent of GDP	5.9	16.4	-	0.7	-	4.0	26.9
External Debt	EUR mil. eq.	348	2,124	74	-	998	188	3,731
	Percent of total	9.3	56.9	2.0	-	26.7	5.0	100.0
	Percent of GDP	3.1	18.8	0.7	-	8.8	1.7	33.0
Concentration	Ratio FX debt/ reserves	0.53	1.15	n/a	n/a	n/a	0.42	1.23

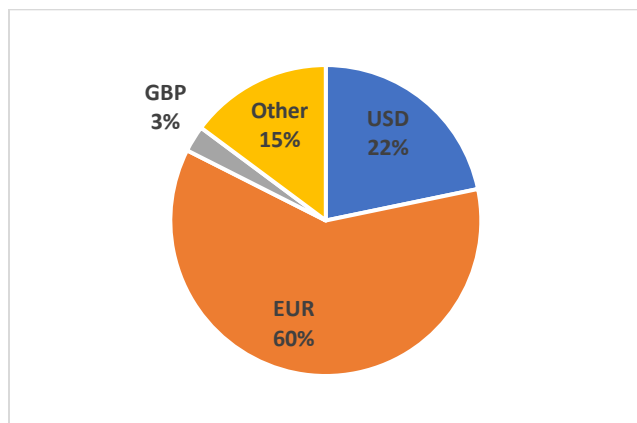
Source: General Public Debt Directorate and Bank of Albania

*Applied FX Rate: end December 2016 135ALL/EUR*

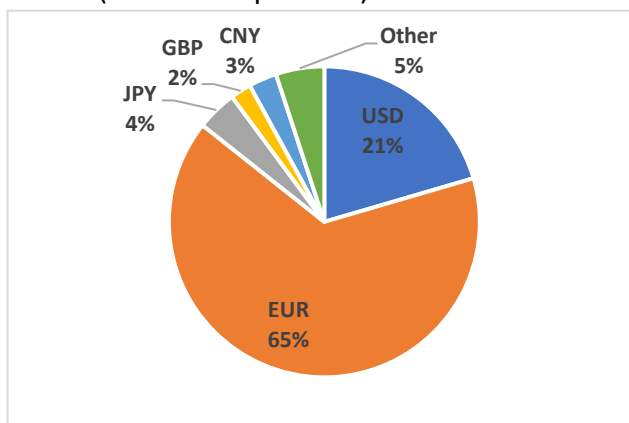
In terms of composition, shares of EUR and USD assets and liabilities are quite closely matched, particularly after breaking out SDR<sup>8</sup> into its component currencies (post break out USD is 22 percent of reserves and 21 percent of external debt; EUR is 60 percent of reserves and 65 percent of external debt, see Figure 6).

<sup>8</sup> The value of the SDR is based on a basket of five major currencies – the US dollar, the euro, the Chinese renminbi, the Japanese yen, and the British pound sterling. The current weights are 41.7 percent for USD, 30.9 percent for EUR, 10.9 percent for RMB, 8.3 percent for JPY, and 8.1 percent for GBP.

**Figure 6 – Albania: FX Currency Composition of:  
Reserves**



**Debt (SDR in components)**



Albania has been awarded candidate status by the European Union. This provides a strong rationale for the high share of EUR denominated debt and assets. Albania has a de jure floating exchange rate regime with limited intervention to calm volatility.

#### **B. Former Yugoslav Republic of Macedonia**

Government debt has increased since 2008 and is financed mostly through external debt due to the shallow domestic debt market. As a result, external debt represents a significant share of FYR Macedonia’s central government debt (79 percent, see Table 8). Between 2014 and 2016, the central government issued three EUR-denominated international bonds, totaling more than EUR1 billion.

**Table 8 – FYR Macedonia: Composition of Debt**  
*as of end December 2016, millions EUR*

	Amount	Percent
Domestic Debt	809	21.5
External Debt	2,952	78.5
Total	3,760	100.0

The amount of foreign exchange reserves nearly matches the amount of external debt (FX debt-to-reserves ratio of 1.03). However, there is a notable mismatch in the composition (see Table 9).

**Table 9 – FYR Macedonia: Composition of Foreign Currency Debt and Reserves**  
as of end December 2016, millions EUR

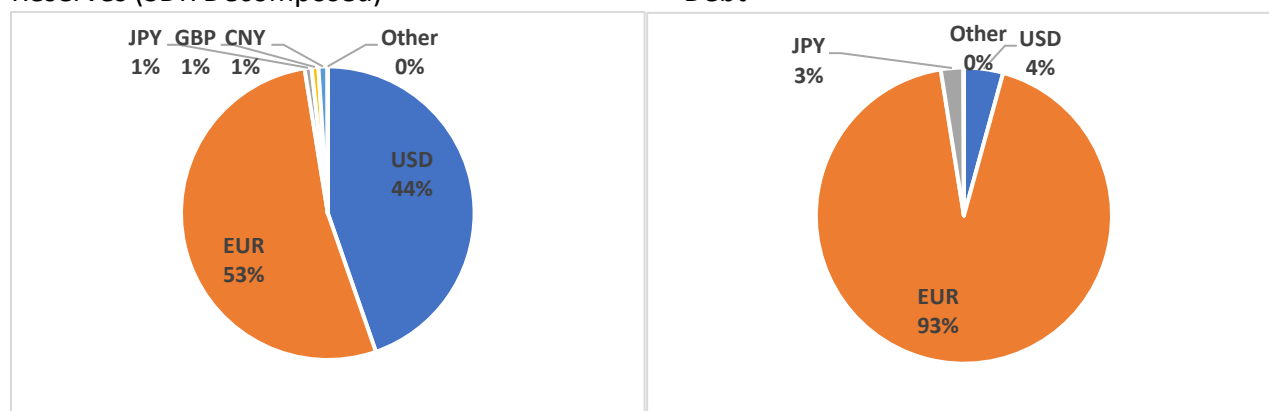
		USD	EUR	JPY	GBP	SDR	Other	Total
Reserves	EUR mil. eq.	1,173	1,434	-	-	264	0.7	2,872
	Percent of total	40.8	49.9	-	-	9.2	0.02	100.0
	Percent of GDP	11.5	14.0	-	-	2.6	0.01	28.1
External Debt	EUR mil. eq.	124	2,707	71	-	-	49	2,952
	Percent of total	4.2	91.7	2.4	-	-	1.7	100.0
	Percent of GDP	1.2	26.5	0.7	-	-	0.5	28.9
Concentration	Ratio FX debt/ reserves	0.11	1.89	n/a	n/a	n/a	70.0	1.03

Source: Ministry of Finance and National Bank of the Republic of Macedonia

Applied FX Rate: as of end December 2016 61.518 dinar/EUR

Almost all of FYR Macedonia’s external debt is denominated in EUR (92 percent), while only half of its reserves are in EUR (53 percent after SDR decomposition) with nearly the other half (44 percent) in USD. Accordingly, the concentration ratio is almost double in EUR while around 1/10 in USD.

**Figure 7 – FYR Macedonia: FX Currency Composition of:**  
Reserves (SDR Decomposed)                      Debt



FYR Macedonian currency, the dinar, has an exchange rate that is closely tied to the EUR and FYR Macedonia has also been awarded candidate status by the European Union. Despite being a de jure floating exchange rate regime, the National Bank of the Republic of Macedonia maintains a de facto stabilized arrangement, participating in the foreign exchange market to maintain a stable exchange rate within a narrow fluctuation band against the EUR.

### C. Uruguay

Uruguay has made strides in developing its local currency debt market and decreasing dependence on USD-denominated funding from external sources. While Uruguay continues to issue in the international market, the external debt share of total debt has fallen from 85 percent

in 2006 to 55 percent in 2016 (see Table 10). Uruguay has increased its offering of local currency instruments including nominal peso bonds and wage-indexed bonds, in addition to its existing issuance of inflation-indexed securities.

**Table 10 – Uruguay: Composition of Debt**  
as of end December 2016, USD billion

	Amount	Percent
Domestic Debt	11.7	45.0
External Debt	14.4	55.0
Total	26.1	100.0

The amount of Uruguay’s foreign exchange reserves is slightly higher than its external debt and the FX debt/reserves ratio is 0.97 (Table 11).

**Table 11 – Uruguay: Composition of Foreign Currency Debt and Reserves**  
as of end December 2016, billions USD

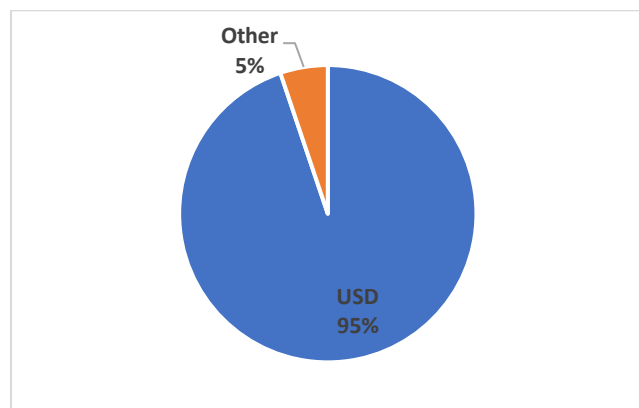
		USD	Other	Total
Reserves	USD bil. eq.	14.7	0.8	15.5
	Percent of total	95.0	5.0	100.0
	Percent of GDP	27.9	1.5	29.4
External Debt	USD bil. eq.	14.4	0.8	15.1
	Percent of total	94.8	5.2	100.0
	Percent of GDP	27.3	1.5	28.7
Concentration	Ratio FX debt/ reserves	0.98	1.0	0.97

Source: Ministry of Economy and Finance, Banco Central de Uruguay, IMF.

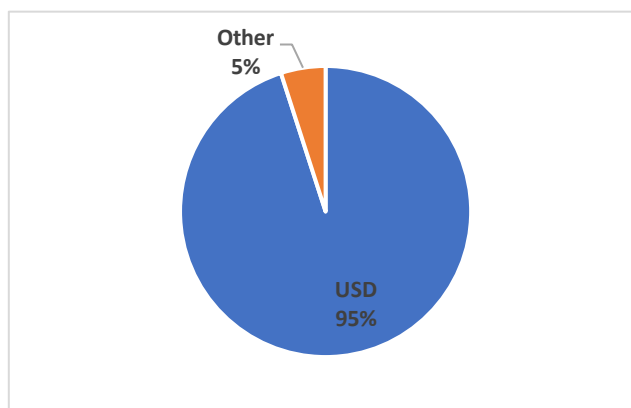
Uruguay’s foreign exchange reserves and external debt are very closely matched not only in terms of amount but also the composition and both are 95 percent in USD (Figure 8).

**Figure 8 – Uruguay: FX Currency Composition of:**

Reserves



Debt



Uruguay has a de jure and de facto floating exchange rate regime. Besides, the level and composition of reserves and FX debt, showing an exact match, improve the sovereign's resilience to external exchange rate shocks.

#### IV.III. Countries with Net FX Liability Positions

##### A. Ghana

Government debt is above 70 percent of GDP but in a downward path with increasing share of domestic debt. Concessional funding has been a significant source of the external financing program but since 2013 Ghana has been active in issuing USD-denominated bonds in the international capital markets. External debt represents slightly more than half of the government's overall debt portfolio (55 percent, see Table 12).

**Table 12 – Ghana: Composition of Debt**  
*as of end December 2016, millions USD*

	Amount	Percent
Domestic Debt	12,776	45.3
External Debt	15,442	54.7
Total	28,218	100.0

Ghana's external debt is 2.35 times greater than the stock of its foreign exchange reserves. USD reserves cover more than half of the country's USD-denominated debt. However, Ghana has almost no reserves in EUR to cover a sizeable amount and share of EUR-denominated debt (USD 1.6 billion and 11 percent respectively, see Table 13).

**Table 13 – Ghana: Composition of Foreign Currency Debt and Reserves**  
*as of end December 2016, millions USD*

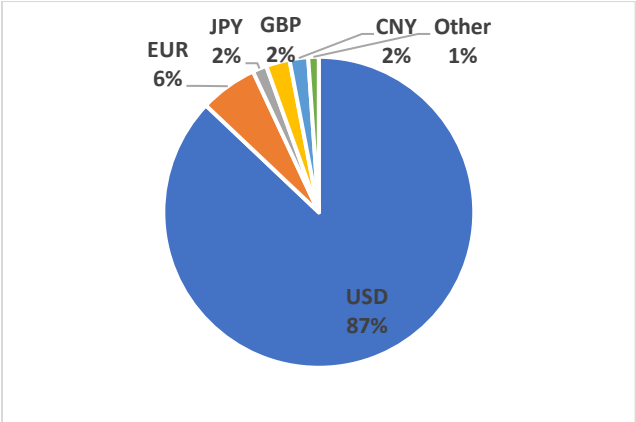
		USD	EUR	CNY	GBP	SDR	Other	Total
Reserves	USD mil. eq.	5,244	33	-	68	1,164	72	6,581
	Percent of total	79.7	0.5	-	1.0	17.7	1.1	100.0
	Percent of GDP	12.3	0.1	-	0.2	2.7	0.2	15.4
External Debt	USD mil. eq.	9,176	1,631	268.7	-	3,434	933	15,442
	Percent of total	59.4	10.6	1.7	-	22.2	6.0	100.0
	Percent of GDP	21.4	3.8	0.6	-	8.0	2.2	36.1
Concentration	Ratio FX debt/ reserves	1.75	49.42	n/a	n/a	2.95	12.96	2.35

Source: 2017 MTDS report and Bank of Ghana 2016 Annual Report  
*Applied FX Rate: End December 2016 4.2002GH/USD*

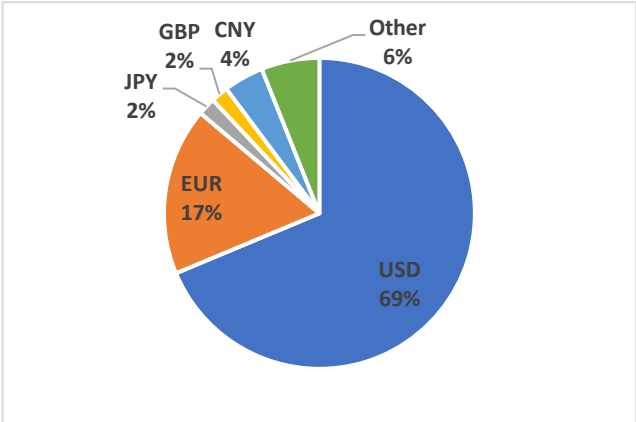
Ghana has a significant share of SDR both in its debt portfolio (22.2 percent) and reserves portfolio (17.7 percent). When these SDR amounts are broken down into its components USD comprises the largest share in each portfolio but is more highly weighted in reserves than in debt (87 percent to 69 percent, see Figure 9). The EUR share of reserves comprises 6 percent of reserves to cover a EUR external debt share of 17 percent.

**Figure 9 – Ghana: FX Currency Composition of:**

Reserves



Debt



Ghana has a de jure and de facto floating exchange rate regime.

**B. Tunisia**

The Central Bank of Tunisia has been active in recent years in issuing USD-, EUR- and JPY-denominated international bonds. Approximately two-thirds of the central government’s debt portfolio consists of external debt (65 percent) while the remainder (35 percent) is denominated in Tunisian dinars (see Table 14).

**Table 14 – Tunisia: Composition of Debt**  
as of end December 2016, EUR millions

	Amount	Percent
Domestic Debt	8,060	35.0
External Debt	14,993	65.0
Total	23,053	100.0

By volume, Tunisia’s external debt is nearly three times greater than its foreign exchange reserves (external debt-to-reserves ratio of 2.78, see Table 15), and the amount of USD- and EUR-denominated debt is more than double the amount of corresponding reserves.



**Table 15 - Tunisia: Composition of Foreign Currency Debt and Reserves**  
as of end December 2016, millions EUR

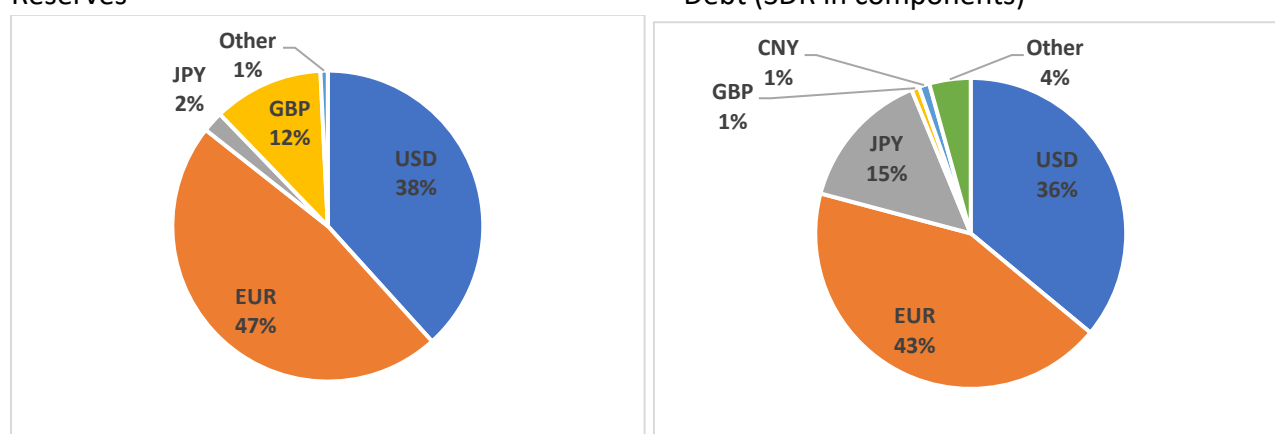
		USD	EUR	JPY	GBP	SDR	Other	Total
Reserves	EUR mil. eq.	2,064	2,550	117	617	-	41	5,389
	Percent of total	38.3	47.3	2.2	11.4	-	0.8	100.0
	Percent of GDP	5.2	6.4	0.3	1.5	-	0.1	13.5
External Debt	EUR mil. eq.	4,768	5,997	2,069	-	1,514	645	14,993
	Percent of total	31.8	40.0	13.8	0.0	10.1	4.3	100.0
	Percent of GDP	11.9	15.0	5.2	-	3.8	1.6	37.5
Concentration	Ratio FX debt/reserves	2.31	2.35	17.68	n/a	n/a	15.73	2.78

Source: Ministry of Finance and Banque Centrale de Tunisie

Applied FX Rate: 1.05USD/EUR; 1.17 EUR/GBP; 123JPY/EUR; 2.4 TND/EUR as of Dec. 31, 2016

The currency composition of this external debt reflects large shares of EUR and USD debt followed by obligations in JPY and SDR (40 percent, 32 percent, 14 percent and 10 percent respectively). The largest shares of Tunisia’s foreign exchange reserves are also held in USD and EUR (38 percent and 47 percent respectively) and the composition of shares for reserves and debt match relatively closely. When the SDR holdings are broken into their components, reserves and debt composition match even more closely (47 percent and 43 percent for EUR and 38 percent and 36 percent for USD, see Figure 10).

**Figure 10 – Tunisia: FX Currency Composition of:**  
Reserves



Despite its high FX debt-to-reserves ratio, Tunisia has a history of intervening in the foreign exchange market, selling reserves to smooth excessive fluctuations in the dinar’s exchange rate. Since May 2016, the dinar has traded more flexibly, abandoning its history of crawling within a 2

percent band against a USD/EUR basket because of excessive external pressure and overvaluation. The move towards a de facto floating exchange rate regime and limiting currency interventions should help boost Tunisia's foreign exchange reserves.<sup>9</sup>

#### **IV.IV. Summary of Sample Cases**

All countries in our sample, except for Uruguay, showed some degree of FX currency mismatches between assets and liabilities. This section also briefly highlights the exchange rate regime of each country to recognize the important fact that reserves serve other vital purposes beyond external debt coverage, including in some cases exchange rate interventions. This puts countries with insufficient reserves coverage and managed exchange rate regimes at even greater risk.

In terms of currency composition, Korea, FYR Macedonia and South Africa show clear evidence of currency mismatches. However, in the case of South Africa and Korea, the amount of foreign exchange reserves in each currency is sufficiently large to cover the amount of external debt obligations. In FYR Macedonia, despite a relatively close match between the total amount of external debt and foreign exchange reserves, there is a significantly higher share and amount of EUR-denominated debt relative to reserve assets.

In Ghana and Tunisia, a relatively close match of currency shares masks a mismatch in overall amounts. In Tunisia, the amount of foreign exchange reserves in each currency is insufficient to cover the corresponding currency amounts of external debt stock. In Ghana, external debt is significantly higher than reserves and there is almost no coverage of EUR-denominated debt.

Both Albania and Uruguay show relatively close matches between foreign exchange reserves and external debt in both currency share and amount. For Uruguay, the match between the amounts of assets and liabilities and their currency compositions is nearly identical.

Where mismatches exist, they are observable in the ratios of total external debt-to-reserves and currency concentration. Korea and South Africa have an external debt-to-reserves ratio of less than one, indicating foreign exchange reserves exceed the amount of external debt. FYR Macedonia and Uruguay have coverage ratios close to one, demonstrating some degree of matching between the amount of external debt and foreign exchange reserves. Albania, Ghana and Tunisia have coverage ratios greater than one, showing the amount of external debt is greater than foreign exchange reserves.

For all countries in the sample, the currency that comprises the largest share of external debt also represents the largest share of their foreign exchange reserves. However, only in South Africa and Korea is the currency concentration ratio for this currency less than one and only in Uruguay is it close to one. This suggests that, for the others, they may need to increase the amount of their reserves in these currencies.

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<sup>9</sup> IMF Article IV Tunisia 2017.

## **V. Measuring the Impact of Joint ALM through Portfolio Optimization**

By transferring a national treasury's FX risk to the central bank, a joint ALM approach paves the way for more efficient risk management and higher investment returns on foreign exchange reserves. It makes possible a potentially less costly way of managing risk than using derivative markets because, in certain circumstances, a central bank may use its foreign exchange reserves to offset the currency risk arising from external debt (Romanyuk, 2010). In addition, by consolidating a country's FX risk on one balance sheet, this collaboration allows for the application of portfolio optimization techniques to a country's excess reserves. These gains are one measure of the positive impact of a joint approach to ALM.

This section demonstrates the impact of hedging foreign exchange risk using a portfolio optimization model which applied to consolidated FX debt and FX reserve portfolios for six countries.<sup>10</sup> The model simulates how a DM desk passes FX risk to the RM desk and optimizes the subsequent reserve portfolio as described in Section III.

### **V.I. Portfolio Optimization**

We performed an optimization model for foreign exchange reserves in which foreign currency exposure budgeting of each portfolio can be based on the institutions' own independent decisions. Therefore, both the DM desk and the RM desk may have a non-zero FX exposure budget in their respective independent desired portfolios. However, in this study, to simplify the analysis, we assumed the currency exposure of debt portfolio is totally passed to the RM desk for hedge and the desired foreign exchange exposure of each desk is zero. On the other hand, when the notional amount of foreign currency debt and the international reserves do not match, it is assumed that the DM desk and RM desk hedge foreign exchange exposure proportionally for each currency exposure.

For this study, an interactive tool has been designed to simulate the DM desk passes a foreign exchange exposure hedge ratio parameter or the hedge notional amounts specific by currency to the RM desk for portfolio optimization. ALM based reserve management approach could be illustrated and analyzed through this tool which allows DM desk to pass any number referring to the hedge ratio parameter or notional amounts, based on the debt managers' assessment and risk preferences.

The optimization tool also reflects recommendations on best practices contained in the IMF Revised Guidelines for Foreign Exchange Reserve Management. Specifically, it models actual practice by assuming foreign exchange reserves are not exclusively used to hedge the currency risk of government debt. Instead, the program analyzes a reserve portfolio split into two tranches—one for providing liquidity and one for investment. The size and risk tolerance of the first is set to meet the central bank's working capital and short-term liquidity needs. The

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<sup>10</sup> Ghana is excluded because its amount of foreign exchange debt is higher than its international reserves. It therefore has no excess reserves for investment.

remainder comprises the second tranche, which uses these “excess reserves” to generate returns and reduce the currency exposure mismatch based on the DM desk’s hedging parameter. The tool implements this two-tranche structure based on the following constraints:

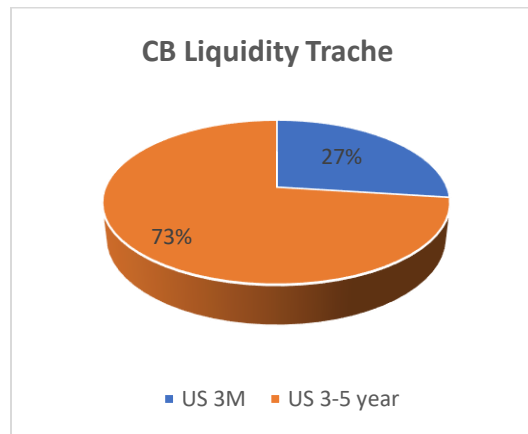
- Liquidity tranche covers short-term foreign currency debt payments for up to 1 year and may have a negative return probability of less than 3% at a 95% of confidence.
- The investment tranche’s maximum allowable currency mismatch between external debt and its assets is 2%.

The tool optimizes the investment tranche only after the user sets a given risk level for its holdings. It then divides its capital among multiple classes of financial instruments according to the best practice for active return enhancement of public foreign exchange reserves (Claessens and Kreuser, 2006). The allocation represents a point on the efficient frontier for the selected risk level and meets the currency mismatch constraint. For the study, the tool set this level at 6% volatility.

Given the residual risk is transferred to the RM desk, consolidated management of foreign currency exposure would lower transaction cost, may increase return on reserves portfolio and improve operational efficiency due to the offsetting of exposures of assets and liabilities of the government’s balance sheet, investing in a more diversified set of assets for the optimization of strategic foreign exchange reserve management. Therefore, in the analysis, the liquidity tranche is allocated to global fixed income assets. On the other hand, due to the nature of the central bank reserve management and the objective of capital preservation, some of the alternative asset classes are excluded while the investment tranche is allocated in a more diversified investment universe of asset with a profile of higher return and risk. The tool allows for the following asset classes to comprise possible investment tranche assets: government securities in multiple currencies, USD Spread instruments including US Agency/US MBS, and MSCI US EQ and EM EQ.

The portfolio optimization for the short-term liquidity tranche is conducted under a forecasting scenario that uses a forward yield conversion method for expected returns. In order to limit the loss probability to maximum of 3%, implied portfolio composition involves USD liquidity assets with short maturity. Figure 11 illustrates, the portfolio composition of the short-term liquidity tranche, which is composed of USD single currency portfolio with 73% of USD 3-5-year instrument and 27% of US 3M instrument, to meet the constraint described above.

**Figure 11 – Portfolio Allocation**



In the optimization of investment tranche, the tool implements foreign exchange hedge and multiple asset return enhancement transactions at the same time. The portfolio construction can be analyzed and compared under the following two scenarios: (i) hedge foreign exchange exposure of debt portfolio together with the foreign exchange reserve portfolio optimization; and (ii) hedge a portion of the foreign currency debt exposure together with the foreign exchange reserve portfolio optimization and hedge another portion of the foreign currency debt exposure using foreign exchange contracts in the derivative markets. Since the tool allows for the RM desk to hedge only a portion of a subject’s external debt exposure, it may be used for countries that allocate a substantial amount of their reserve assets to low or even negative return financial instruments, such as those denominated in euros.

In the standard approach, foreign currency debt exposure may be hedged by debt management offices under different scenarios and through different approaches. On the other hand, the FX reserve management unit constructs its reserve management base and executes the process independently. Hedging the debt and reserve portfolio’s foreign currency exposure separately will increase the hedging costs and may create additional credit risk and other operational costs. On the other hand, as illustrated in Table 16, a joint ALM framework tends to generate higher expected returns on reserves by comparing the outcomes of two strategies: (i) separately managing assets and liabilities, which requires managing foreign exchange reserves according to a capital preservation mandate; and (ii) a joint approach that allows for managing excess reserves under a portfolio optimized to maximize investment returns for a given level of risk.<sup>11</sup>

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<sup>11</sup> Taking net external debt composition into consideration reduces the currency mismatch between assets and liabilities on the sovereign balance sheet, mitigating foreign currency risk for the consolidated balance sheet. As a result, the joint approach allows the central bank to optimize the investment of excess reserves with assets that are more diverse and risky compared to the assets used when managing the balance sheets separately.

**Table 16 –Optimization results**

Country	Portfolio Indicator	Liquidity Tranche (using the same reference base for all the countries)	Investment Tranche – Standard Approach (using the same constraints with liquidity tranche)	Investment Tranche - Joint ALM Approach (using high risk assets)
		(%)	(%)	(%)
<b>Albania</b>	<i>Return</i>	1.7	1.7	2.7
	<i>CvaR</i>	-1.0	-1.0	-9.0
	<i>Volatility</i>	1.2	1.2	5.6
<b>Macedonia, FYR</b>	<i>Return</i>	1.7	1.7	1.0
	<i>CVaR</i>	-1.0	-1.0	-2.0
	<i>Volatility</i>	1.2	1.2	1.6
<b>South Africa</b>	<i>Return</i>	1.7	1.7	4.3
	<i>CVaR</i>	-1.0	-1.0	-8.0
	<i>Volatility</i>	1.2	1.2	6.0
<b>Tunisia</b>	<i>Return</i>	1.7	1.7	3.4
	<i>CVaR</i>	-1.0	-1.0	-9.0
	<i>Volatility</i>	1.2	1.2	6.0
<b>Uruguay</b>	<i>Return</i>	1.7	1.7	4.3
	<i>CVaR</i>	-1.0	-1.0	-7.0
	<i>Volatility</i>	1.2	1.2	6.0
<b>Korea, Rep.</b>	<i>Return</i>	1.7	1.7	4.3
	<i>CVaR</i>	-1.0	-1.0	-8.0
	<i>Volatility</i>	1.2	1.2	6.0

As for the short-term liquidity tranche, we use the same reference base of portfolio construction for all the countries. Therefore, as shown in Table 16, the same portfolio characteristics result for all countries, a return of 1.7% and CVaR<sup>12</sup> of -1. In practice, reserve managers may employ different constraints for the investment tranche, but for the simplicity of the analysis, for the portfolio construction for the investment tranche in the standard approach, we assumed the same reference base with the liquidity tranche, which resulted in the same risk and return levels for all countries.

After hedging foreign currency debt exposure, total return of the investment tranche is about 3% - 4% with a volatility around 6% for the investment tranche in all countries, except for FYR Macedonia. In the case of FYR Macedonia, as there is a big portion of euro exposure in its FX debt

<sup>12</sup> CVAR: Conditional Value at Risk (CVaR) also known as the expected shortfall is a risk assessment measure that quantifies the amount of tail risk an investment portfolio has. CVaR is derived by taking a weighted average of the “extreme” losses in the tail of the distribution of possible returns, beyond the value-at-risk (VaR) cutoff point.

portfolio (Table 17), a bigger portion of reserve needs to be allocated to French assets to reduce the currency mismatch and mitigate foreign currency risk. This brings down the expected return from its investment portfolio due to relatively lower expected return on French asset classes.

**Table 17 – Foreign Currency Debt %**

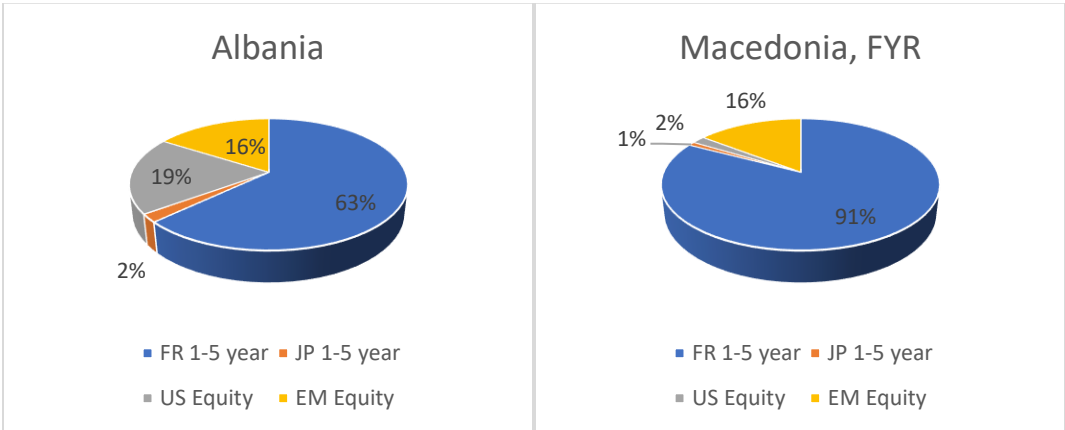
	Albania	Macedonia, FYR	South Africa	Tunisia	Uruguay	Korea, Rep.
USD	0.21	0.04	0.93	0.36	0.95	0.99
EUR	0.65	0.93	0.04	0.43	0.00	0.01
JPY	0.04	0.03	0.03	0.15	0.00	0.00
Other	0.10	0.00	0.00	0.06	0.05	0.00

In summary, the joint ALM approach allows the RM desk to conduct optimization of the investment tranche with more diversified and riskier assets. If the RM desk is asked to take the foreign currency debt composition into consideration, by reducing the currency exposure mismatch between assets and liabilities on the sovereign balance sheet, foreign currency risk is mitigated to some extent for the whole balance sheet.

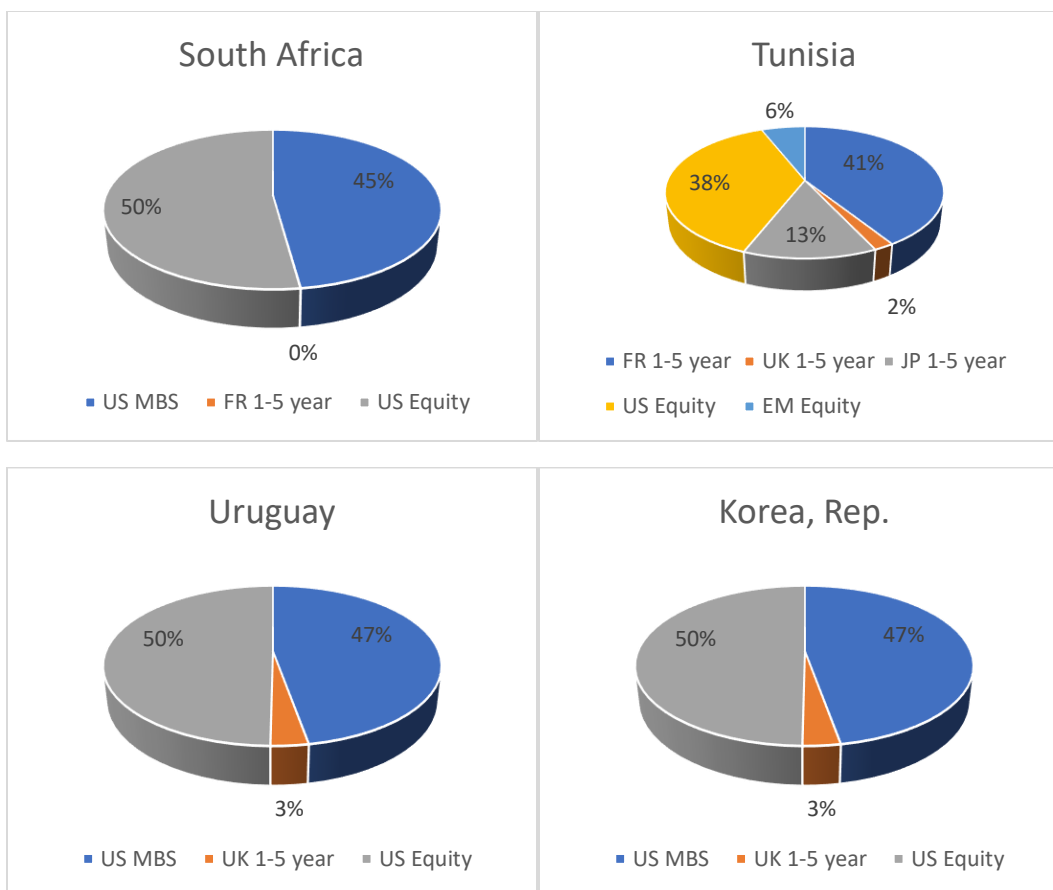
**V. II. Asset Allocation and Portfolio Currency Composition**

The countries analyzed in this study have external debt exposure and foreign exchange reserves of different amounts and composition.<sup>13</sup> Simultaneously hedging this risk and maximizing expected returns on excess reserves therefore requires different asset allocations. Figure 12 shows the different allocations the tool identified for the six countries to achieve these outcomes.

**Figure 12 - Asset allocation**



<sup>13</sup> See Section IV.



In this model, for the investment tranche, it might be a case to see some similar currency composition with that of the foreign currency debt portfolio.

## VI. Conclusions and Policy Recommendations

Currency mismatches between a sovereign’s external debt obligations and foreign exchange reserves increase the risk of financial crises (Claessens, 2005; Wheeler, 2004). Based on this paper’s assessment, awareness of this concern appears to be widespread: all governments in the sample maintained the largest share of their reserves in the currency that comprised the highest share of their external debt. To some extent, this is evidence of their use of a joint ALM approach even in the absence of official implementation frameworks.<sup>14</sup> Still, the assessment also found that these imbalances endure – and in some cases they were significant. This suggests there appears to be room for improvement when it comes to prudently managing national finances.

Countries have several options for reducing financial risks arising from currency mismatches on their balance sheets. Since sovereigns receive most of their revenues in domestic currency, issuing debt in the same denomination would end this risk outright. However, given the extent of public financing needs, this practice is only possible in the presence of deep and liquid local capital markets. On the other hand, developing local capital markets is a long-term process that

<sup>14</sup> Several countries in the sample have received advisory services from the World Bank Treasury in debt and reserves management, potentially contributing to a greater awareness of asset and liability matching already.



requires significant policy and financial infrastructure.<sup>15</sup> In the interim, access to international lenders and managing exchange rate fluctuations are critical to financing national priorities. In these circumstances, configuring an effective and cost-efficient foreign currency risk management framework has substantial importance.

To this end, joint management of foreign exchange assets and liabilities helps almost all countries. Supported by a well-organized governance structure and clearly defined information-sharing processes, this approach can improve risk management across the national balance sheet and increase national wealth. It has the potential to reduce currency mismatches through low- or no-cost natural hedges and internal swap transactions that do not involve counterparty risk, collateral exchanges or complex modeling. It also creates the opportunity for optimizing expected returns on excess reserves. The outcome of these efficiency improvements may be greater credibility and operational independence for debt and reserve management institutions arising from enhanced track records for delivering on their mandates.

Implementing a joint approach has its challenges. For example, it demands substantial coordination between ministries of finance and central banks, which have different objectives, priorities, risk tolerances and models to optimize risk-adjusted financing expenses and returns.<sup>16</sup> These obstacles, however, are not insurmountable, especially since these institutions often work together at the technical and even policy levels to fulfill their respective mandates.<sup>17</sup> Moreover, aspects of this coordination are complementary to their different objectives. Through natural hedging, joint ALM allows a debt manager to minimize financing costs at a certain risk level. By clearly defining and consolidating external debt exposure in one institution, it enables a reserve manager to maximize expected risk-adjusted returns on excess reserves.

Seamless coordination could be best achieved under the ALM approach. Within this framework, each portfolio could be optimized in line with the related institutional mandate which allows

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<sup>15</sup> Highly developed local capital markets need a stable and credible macroeconomic policy framework; sound fiscal and monetary policies; effective legal, tax, and regulatory infrastructure; smooth and secure settlement arrangements; and a liberalized financial system with competing intermediaries (The World Bank and the IMF Government Bond Markets Handbook).

<sup>16</sup> For central banks, these typically include building international reserves to support and maintain confidence in the policies for monetary and exchange rate management; limiting external vulnerability by maintaining foreign currency liquidity; building capital markets' confidence that a country can meet its current and future foreign currency obligations; assisting the government in meeting its foreign exchange needs and external debt payments; supporting domestic currency using assets denominated in foreign currency; and maintaining a reserve for national disasters or emergencies. Consistent with these objectives and subject to risk and liquidity constraints, their reserve management functions invest foreign exchange reserves to generate reasonable risk-adjusted returns over the medium to long term. (IMF Revised Guidelines for Foreign Exchange Reserve Management). By contrast, debt management offices seek to ensure that government financing needs are met at the lowest possible cost over the medium to long term, consistent with a prudent degree of risk (IMF/World Bank Revised Guidelines for Public Debt Management).

<sup>17</sup> A reserve manager often uses a debt manager's projections for the government's foreign currency flows as a key input for defining the reserve portfolio's strategic asset allocation. Likewise, a debt manager depends on the reserve manager for access to the foreign currency needed to meet sovereign external debt obligations on the date payment is due. Debt and reserve managers may also coordinate on strategy alignment to address financial risks associated with a country's external debt position and the volatility of its capital flows.

reserve management to maximize risk-adjusted return and debt management to minimize cost at a certain risk level. The government's cost and risk preference imply a currency composition for the debt portfolio. On the other side, government's financial assets denominated with foreign currency would generate natural hedging for foreign currency debt. Furthermore, the residual risk of foreign currency debt could be transferred to the reserve management desk through an internal swap transaction between the debt management office and reserve management unit. This model enables debt management offices to minimize foreign currency risk without taking or giving collateral and having counterparty risk, furthermore without a cost. As for the reserve management, consolidated management of foreign currency risk would be consistent with its broader mandate. On the other hand, this model offers an opportunity especially to the countries with limited access to the derivatives market.,

At the same time, the fact that all countries in the sample maintain the largest share of their reserves in the currency in which they have the highest share of external debt is reassuring. To some extent, this demonstrates an informal implementation of a sovereign joint ALM approach even if an official framework is not in place.<sup>18</sup> However, there is still much room for improvement and potential to pursue a more formal sovereign ALM approach, enhancing coordination and information sharing to manage risks across the government balance sheet. In some countries, there are still large mismatches in the amount of external debt relative to foreign reserves and the currency composition of each.

Moreover, as the du-fold quantitative analysis conducted in Sections 4 and 5 demonstrates, the joint ALM approach has clear benefits both for central banks and ministries of finance. Central banks are benefiting from the point of view of generating greater expected returns on their excess reserves while ministries of finance are actively managing their foreign currency risk without having counterparty risk and by minimizing the operational cost and risk. In fact, the analysis indicates that the ALM approach allows sovereigns first to benefit from natural hedges without a specific need for modelling, then to optimize the reserve portfolio ensuring that higher level objectives of reserve management have been met.

It is important to note with caution that even though ALM could address several concerns and reduce FX risk, the amount of external debt is influenced by the degree of domestic debt market development. As almost all the government revenues are denominated in domestic currency, access to international markets is limited and exchange rate fluctuations have been an important source of concern, it might be a natural hedging mechanism for many developing and emerging countries to issue in local currency denominated debt. However, as indicated by the joint The World Bank and the IMF Government Bond Markets Handbook, developing a deeper and more liquid local currency capital market is a long and dynamic process which requires a stable and credible macroeconomic policy framework; sound fiscal and monetary policies; effective legal, tax, and regulatory infrastructure; smooth and secure settlement arrangements; and a liberalized financial system with competing intermediaries. Therefore, for almost all developing and

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<sup>18</sup> Several countries in the sample have received advisory services from the World Bank Treasury in debt and reserves management, potentially contributing to a greater awareness of asset and liability matching already.

emerging countries configuring an effective and cost-efficient foreign currency risk management framework has a critical importance. To this end, joint management of foreign currency assets and liabilities enables sovereigns to benefit from higher return or to minimize the cost of the overall portfolio while mitigating the foreign currency risk through using natural hedges and effective management of residual risks. Furthermore, due to the improved coordination between the central bank and debt management office, the joint ALM approach maintains and could even strengthen the operational independence of each institution when the objectives and tools are well articulated and coordinated and governance structure is well organized.

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## Technical Annex:

### I. Data Sources for Portfolio Optimization Analysis

<b>Data Inputs to the Portfolio Optimization</b>	
(amounts in USD eq. unless otherwise specified)	
Total reserves	IFS
Share of each currency reserves in CB reserves (%)	website of institutional institutions
CB NFA	IFS
CB NDA	IFS
CB capital	IFS
Monetary base	IFS
CB Total assets	IFS
2016 Q4 ST total external debt	JDEH
Central Government Total Debt	website of institutional institutions or MTDS
Central Government Debt, Domestic currency	website of institutional institutions or MTDS
Central Government Debt, Foreign currency	website of institutional institutions or MTDS
Share of each currency in foreign Central Government Debt (%)	website of institutional institutions or MTDS
Total reserves in months of imports (months)	WDI
2016 GDP (Nom. USD)	IMF WEO

The current and forward yield curve simulation scenario are generated by using the market yield data (Jan 2004 to Dec. 2017). Based on the simulated yield curve, the return forecasting modeling is conducted for the following asset classes. The table below contains the asset return generated based on the forward yield curve simulation scenario.

<b>Investment Assets</b>	<b>Exp. Ret.</b>	<b>Vol.</b>
US Govt 0-1Y	1.54	019
US Govt 0-3 Index	1.65	0.59
US Govt 1-3 Index	1.66	0.80
US Govt 1-5 Index	1.67	1.66
US Govt 3-5 Index	4.35	2.20
US Agency 1-3 Index	1.73	0.68
US MBS Master	1.90	2.10
German Govt1-5 Index	0.10	0.03
French Govt 1-5 Index	0.40	0.30
UK Gilts 1-5 Index	1.70	1.50
Japanese Govt 1-5 Index	1.10	0.30
Australian Govt 1-5 Index	1.69	1.30
Canadian Govt 1-5 Index	1.65	0.80
EUR 1-5 Index AAA/AA	0.02	0.03
US_EQ	6.57	11.15
EM_EQ	6.71	17.69

#### **Exchange Rate Change 11/30/16 to 11/30/17**

	<b>Albania</b>	<b>Macedonia, FYR</b>	<b>South Africa</b>	<b>Tunisia</b>	<b>Uruguay</b>	<b>Korea, Rep.</b>
<b>USD</b>	15.19%	12.71%	2.53 %	-6.54%	8.54%	8.35%



EUR	2.38%	0.18%	-8.87%	-16.90%	-10.30%	-3.69%
JPY	13.15%	10.72%	0.72%	-8.19%	-0.93%	6.44%

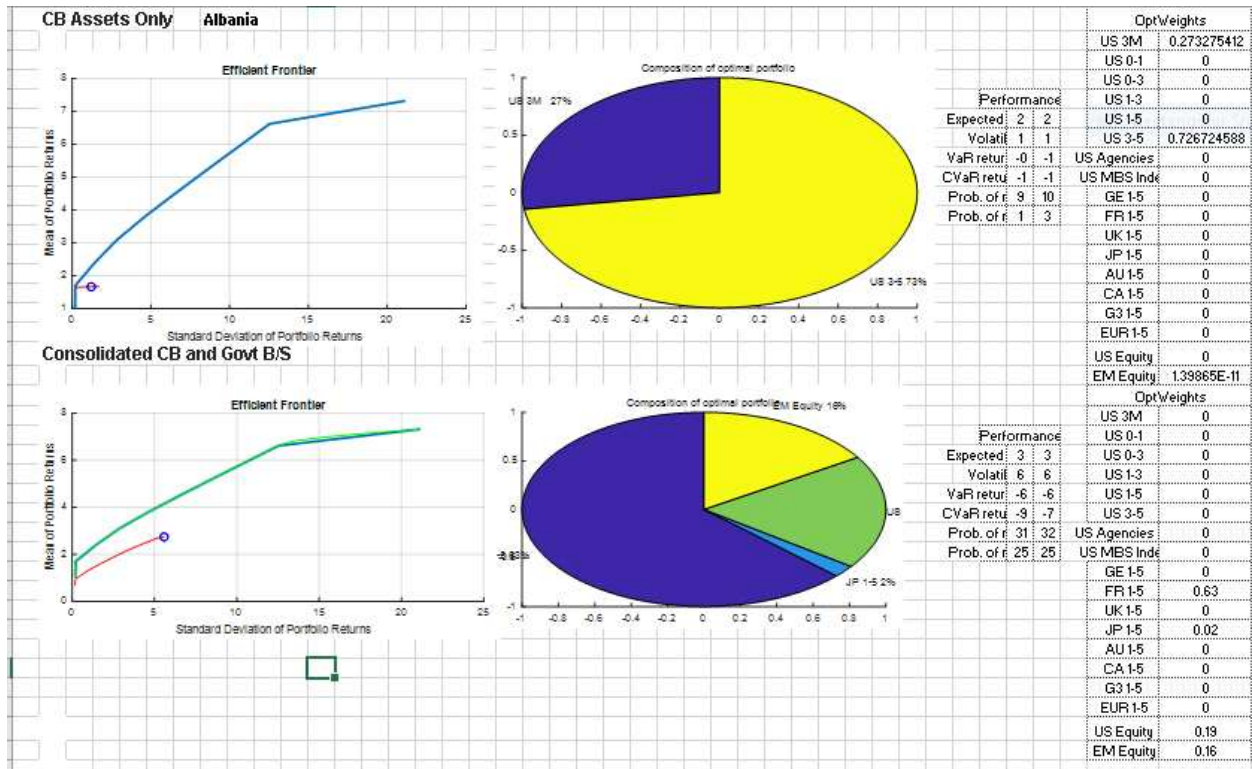
#### Estimation of debt currency hedge through sperate FX hedge transactions

	Country Currency Basket <sup>19</sup>
Albania	5.3%
Macedonia, FYR	1.0%
South Africa	2.0%
Tunisia	10.8%
Uruguay	0.8%
Korea, Rep.	8.3%

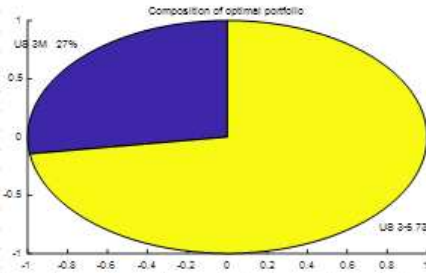
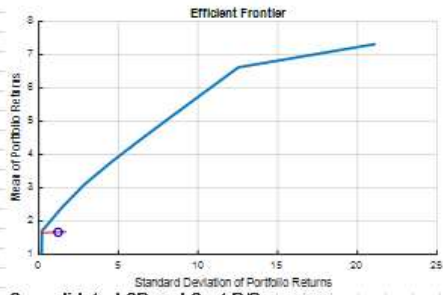
<sup>19</sup> Country Currency Basket impact is calculation of the FX Profit and Loss of FX hedge using debt FX composition percentage as weight.

## II. Detailed Optimization Results

Our optimization approach considers the characteristics and constraints from the liability in a consolidated ALM framework. The portfolio optimization results for a reference base portfolio of the central bank short term liquidity tranche portfolio and the FX excess reserve portfolio after balance sheet consolidation with debt FX exposure is taken into consideration are displayed below for the studied countries. These results are generated under the forward yield projecting scenario.

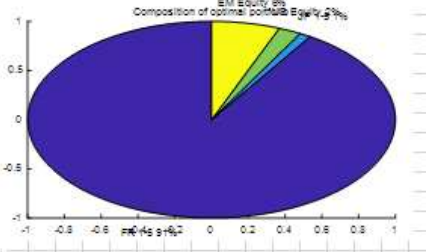
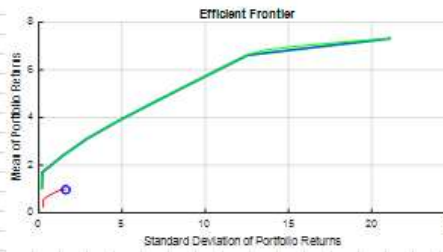


**CB Assets Only  
Macedoni**



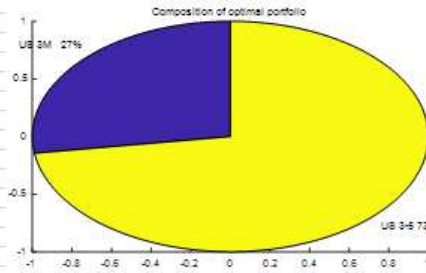
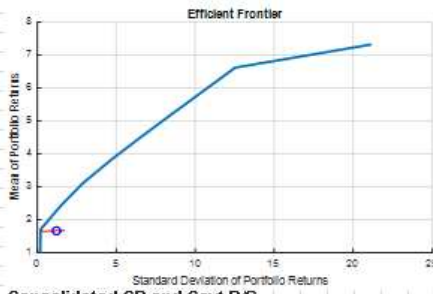
Performance		OptWeights		
Expected	2	2	US 3M	0.273275412
Volatili	1	1	US 0-1	0
VaR return	-0	-1	US 0-3	0
CVaR return	-1	-1	US 1-3	0
Prob. of f	9	10	US 1-5	0
Prob. of f	1	3	US 3-5	0.726724588
			US Agencies	0
			US MBS Inde	0
			GE 1-5	0
			FR 1-5	0
			UK 1-5	0
			JP 1-5	0
			AU 1-5	0
			CA 1-5	0
			G3 1-5	0
			EUR 1-5	0
			US Equity	0
			EM Equity	1.39865E-11

**Consolidated CB and Govt B/S**



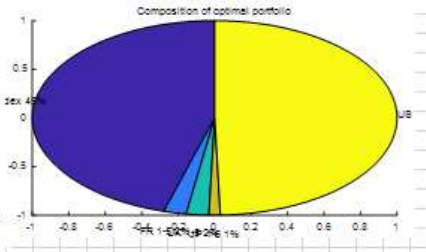
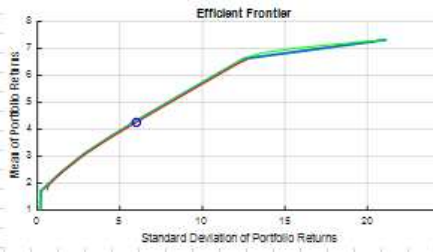
Performance		OptWeights		
Expected	1	1	US 3M	0
Volatili	2	2	US 0-1	0
VaR return	-2	-2	US 0-3	0
CVaR return	-2	-2	US 1-3	0
Prob. of f	27	28	US 1-5	0
Prob. of f	11	11	US 3-5	0
			US Agencies	0
			US MBS Inde	0
			GE 1-5	0
			FR 1-5	0.91
			UK 1-5	0
			JP 1-5	0.01
			AU 1-5	0
			CA 1-5	0
			G3 1-5	0
			EUR 1-5	0
			US Equity	0.02
			EM Equity	0.06

**CB Assets Only South Africa**



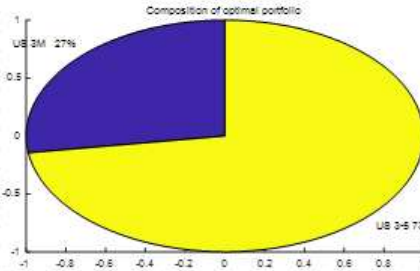
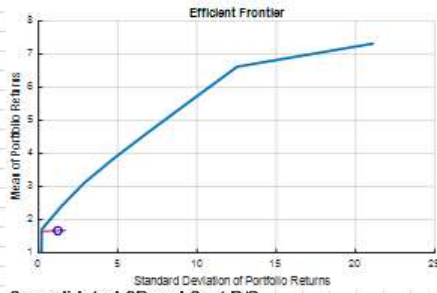
Performance		OptWeights		
Expected	2	2	US 3M	0.273275412
Volatili	1	1	US 0-1	0
VaR return	-0	-1	US 0-3	0
CVaR return	-1	-1	US 1-3	0
Prob. of f	9	10	US 1-5	0
Prob. of f	1	3	US 3-5	0.726724588
			US Agencies	0
			US MBS Inde	0
			GE 1-5	0
			FR 1-5	0
			UK 1-5	0
			JP 1-5	0
			AU 1-5	0
			CA 1-5	0
			G3 1-5	0
			EUR 1-5	0
			US Equity	0
			EM Equity	1.39865E-11

**Consolidated CB and Govt B/S**



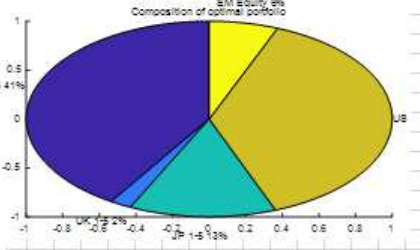
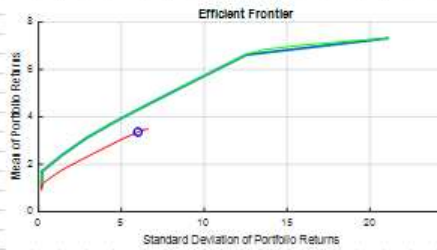
Performance		OptWeights		
Expected	4	4	US 3M	0
Volatili	6	6	US 0-1	0
VaR return	-6	-5	US 0-3	0
CVaR return	-8	-7	US 1-3	0
Prob. of f	24	25	US 1-5	0
Prob. of f	19	19	US 3-5	0
			US Agencies	0
			US MBS Inde	0.454969107
			GE 1-5	0
			FR 1-5	0.02
			UK 1-5	0.02
			JP 1-5	0.01
			AU 1-5	0
			CA 1-5	0
			G3 1-5	0
			EUR 1-5	0
			US Equity	0.495030893
			EM Equity	0

**CB Assets Only Tunisia**



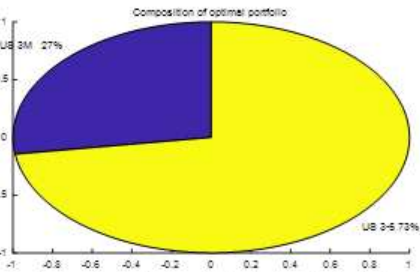
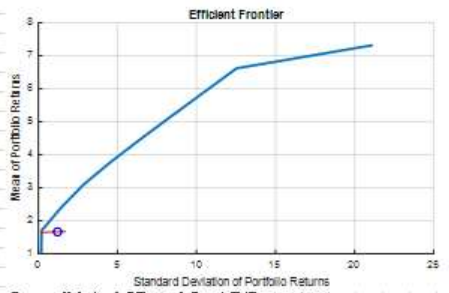
Performance		OptWeights	
Expected	2.2	US 3M	0.273275412
Volatit	1.1	US 0-1	0
VaR retur	-0.1	US 0-3	0
CVaR retur	-1.1	US 1-3	0
Prob. of f	9.10	US 1-5	0
Prob. of f	1.3	US 3-5	0.726724588
		US Agencies	0
		US MBS Indx	0
		GE 1-5	0
		FR 1-5	0
		UK 1-5	0
		JP 1-5	0
		AU 1-5	0
		CA 1-5	0
		G3 1-5	0
		EUR 1-5	0
		US Equity	0
		EM Equity	1.39865E-11

**Consolidated CB and Govt B/S**



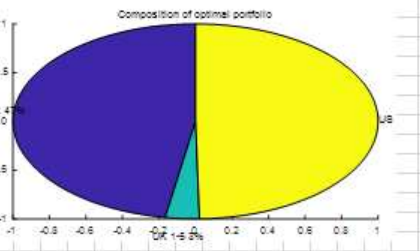
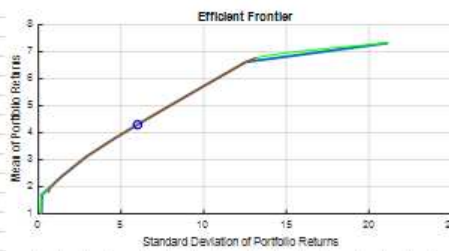
Performance		OptWeights	
Expected	3.3	US 3M	0
Volatit	6.6	US 0-1	0
VaR retur	-7.6	US 0-3	0
CVaR retur	-9.8	US 1-3	0
Prob. of f	29.29	US 1-5	0
Prob. of f	23.23	US 3-5	0
		US Agencies	0
		US MBS Indx	0
		GE 1-5	0
		FR 1-5	0.41
		UK 1-5	0.019136238
		JP 1-5	0.13
		AU 1-5	0
		CA 1-5	0
		G3 1-5	0
		EUR 1-5	0
		US Equity	0.38
		EM Equity	0.060863762

**CB Assets Only Uruguay**



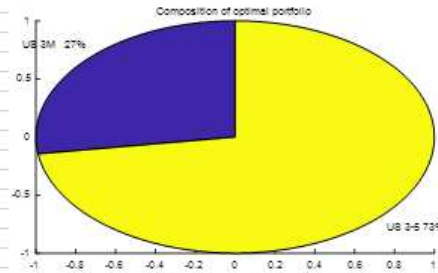
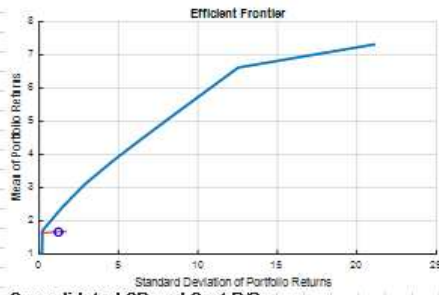
Performance		OptWeights	
Expected	2.2	US 3M	0.273275412
Volatit	1.1	US 0-1	0
VaR retur	-0.1	US 0-3	0
CVaR retur	-1.1	US 1-3	0
Prob. of f	9.10	US 1-5	0
Prob. of f	1.3	US 3-5	0.726724588
		US Agencies	0
		US MBS Indx	0
		GE 1-5	0
		FR 1-5	0
		UK 1-5	0
		JP 1-5	0
		AU 1-5	0
		CA 1-5	0
		G3 1-5	0
		EUR 1-5	0
		US Equity	0
		EM Equity	1.39865E-11

**Consolidated CB and Govt B/S**



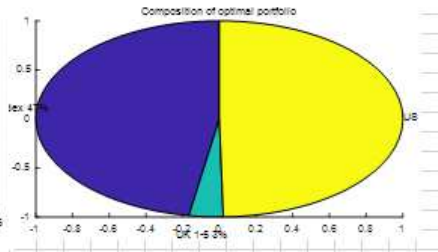
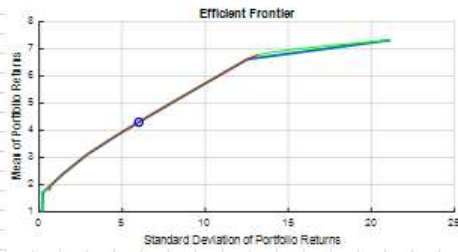
Performance		OptWeights	
Expected	4.4	US 3M	0
Volatit	6.6	US 0-1	0
VaR retur	-6.5	US 0-3	0
CVaR retur	-8.7	US 1-3	0
Prob. of f	24.24	US 1-5	0
Prob. of f	19.19	US 3-5	0
		US Agencies	0
		US MBS Indx	0.473416632
		GE 1-5	0
		FR 1-5	0
		UK 1-5	0.03
		JP 1-5	0
		AU 1-5	0
		CA 1-5	0
		G3 1-5	0
		EUR 1-5	0
		US Equity	0.496583368
		EM Equity	0

**CB Assets Only Korea**



Performance		OptWeights
Expected	2.2	US 3M 0.273275412
Volatili	1.1	US 0-1 0
VaR retur	-0.1	US 0-3 0
CVaR retur	-1.1	US 1-3 0
Prob. of r	9.10	US 1-5 0
Prob. of r	1.3	US 3-5 0.726724588
		US Agencies 0
		US MBS Indé 0
		GE 1-5 0
		FR 1-5 0
		UK 1-5 0
		JP 1-5 0
		AU 1-5 0
		CA 1-5 0
		G3 1-5 0
		EUR 1-5 0

**Consolidated CB and Govt B/S**



Performance		OptWeights
Expected	4.4	US 3M 0
Volatili	6.6	US 0-1 0
VaR retur	-6.5	US 0-3 0
CVaR retur	-8.7	US 1-3 0
Prob. of r	24.24	US 1-5 0
Prob. of r	19.19	US 3-5 0
		US Agencies 0
		US MBS Indé 0.473416632
		GE 1-5 0
		FR 1-5 0
		UK 1-5 0.03
		JP 1-5 0
		AU 1-5 0
		CA 1-5 0
		G3 1-5 0
		EUR 1-5 0
		US Equity 0.496583368
		EM Equity 0