

Optimal Asset Allocation for Sovereign Wealth Funds: Theory and Practice

Zvi Bodie, Boston University

Marie Brière, Amundi, Paris Dauphine University, Université Libre de Bruxelles



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Zvi Bodie

Professor of Management – Boston University

Marie Brière

Head of Investor Research Center - Amundi

Associate Professor - Paris Dauphine University

Associate Researcher - Université Libre de Bruxelles

Solvay Brussels School of Economics and Management - Centre Emile Bernheim, Belgium

marie.briere@amundi.com

About the authors



Zvi Bodie is the Norman and Adele Barron Professor of Management at Boston University.

He holds a PhD from the Massachusetts Institute of Technology and has served on the finance faculty at the Harvard Business School and MIT's Sloan School of Management.

Professor Bodie has published widely on pension finance and investment strategy in leading professional journals. His books include *The Future of Life Cycle Saving and Investing* and *Foundations of Pension Finance*. His textbook, *Investments*, coauthored by Alex Kane and Alan Marcus is the market leader and is used in the certification programs of the CFA Institute and the Society of Actuaries.

His textbook *Financial Economics* is coauthored by Nobel Prize winning economist, Robert C. Merton. His latest book is *Worry Free Investing: A Safe Approach to Achieving Your Lifetime Financial Goals*. In 2007 the Retirement Income Industry Association gave him their Lifetime Achievement in Applied Retirement Research Award.



Marie Brière, PhD, is Head of Investor Research Center at Amundi in Paris. She is also Associate Professor with Paris Dauphine University and Associate Researcher with the Centre Emile Bernheim at Solvay Business School, Université Libre de Bruxelles. Since 2012, she is the new Editor of the scientific Journal “Bankers Markets and Investors”.

Marie Brière started her working career in 1998 as a quantitative researcher at the proprietary trading desk at BNP Paribas. She joined Credit Lyonnais Asset Management in 2002 as a fixed income strategist, then a Head of Fixed Income, Forex and Volatility Strategy at Credit Agricole Asset Management. She has taught in several universities and business schools. Since 2012 she teaches empirical finance, portfolio management and quantitative investment strategies at Paris Dauphine University.

Marie Brière is the author of a book on anomalies in the formation of interest rates, and a number of her scientific articles have been published in books and leading academic journals including the *Financial Analyst Journal*, *Journal of Banking and Finance*, *Journal of Money, Credit and Banking*, *Journal of Portfolio Management*, etc.

Abstract

This paper addresses management of sovereign wealth from the perspective of the theory of contingent claims. Starting with the sovereign's balance sheet, we frame sovereign fund management as an asset-liability management (ALM) problem, covering all public entities and taking explicit account of all sources of risks affecting government resources and expenditures. Real-life SWFs asset allocations differ strongly from theoretical ones. Financial management of the sovereign balance sheet is hampered by a lack of aggregate data, which compromises the coordination of sovereign wealth management with fiscal policy, monetary policy and public debt management. In this framework, we suggest institutional arrangements that could overcome this obstacle and enable efficient coordination.

Keywords: *Asset-Liability Management, Balance Sheet, Contingent Claim Analysis, Sovereign Wealth Funds, Central Bank Reserves.*

JEL codes: *G11, G18, H11, H50, H63*

1. Introduction

Interest in sovereign wealth funds (SWFs) as key players in financial markets has grown rapidly over the last years. A large number of sovereign wealth funds (SWFs) have been set up to collect and manage the tax revenues that states receive from natural resources or exports. SWFs serve various economic objectives, such as budget stabilization, diversification from commodities, saving for future generations. They may also pursue political strategies, such as controlling politically sensitive industries, or supporting the domestic economy (Avendano and Santiso, 2009; Ang, 2012). SWFs can be managed by different institutional structures, from central banks to independent financial corporations.

A large body of empirical research has analysed the public investment strategies of sovereign wealth funds and their performance. Although this takes into account only a fraction of SWF investments, mainly equity stakes in listed firms, it shows that SWFs tend to invest in large foreign firms, often in the finance and energy sectors, with low diversification and poor medium-term performance (Bernstein et al., 2013; Chhaochharia and Laeven, 2009; Dyck and Morse, 2011; Bortolotti et al., 2013). SWFs also served as “investors of last resort” during the last crises, intervening to support their domestic financial markets (Clark and Monk, 2010; Raymond, 2010). Research on optimal sovereign wealth management is scarcer. Scherer (2009a and b), Brown et al. (2010), Martellini and Milhau (2010) have addressed the optimal allocation for an SWF by examining non-tradable commodity wealth in the SWF or exogenous liabilities set by the government and proxied by an inflation-linked investment benchmark. But the example of the recent crisis clearly shows that other sovereign liabilities have to be taken into account: debt, contingent liabilities, etc. Moreover, when a government is short of liquidity to meet its debt payments, the SWF’s assets are often available to substitute for the funds initially earmarked for this purpose. In 2010, for example, in the wake of the subprime crisis, Russia, Ireland, Kazakhstan and Qatar used SWFs or public pension

fund assets to invest in banks or shore up equity markets. In a recent paper (Bodie and Brière, 2014), we proposed estimating the whole sovereign economic balance sheet using the theory of contingent claims and considering the joint management of all sovereign assets and liabilities in an ALM framework. The “sovereign” is considered in the broad sense, including all the related institutions (budgetary government, central bank, SWFs, pension funds and public entities placed under the sovereign's authority).

Managing the wealth of a sovereign is not very different from managing the wealth of an individual (Merton, 1969; Bodie et al., 1992; Bodie et al., 2008), a pension fund (Bodie et al., 2009) or a foundation (Merton, 1993). The central government receives tax revenues each year. Part of this income can be spent, and the residual saved in the SWF, central bank reserves, or the public pension fund. How much should be saved and how it should be invested is a classic ALM problem. The optimal allocation and expenditures of the sovereign will crucially depend on the nature and size of its assets and liabilities, and the sources of their uncertainty. Merton (1993) solved a similar problem for a university endowment fund. In our sovereign case, the optimal sovereign allocation differs slightly. It can be broken down into a performance-seeking portfolio and three additional portfolios hedging for the variability of the fiscal surplus and external and domestic debt. Financial management of government resources and expenditures raises difficult issues in practice. Standard macroeconomic tools are ill-suited to estimating sovereign economic balance sheets. Most of the macroeconomic variables monitored at present describe flows, not stocks, and are unsuitable for valuing intangible assets such as human and natural capital (Aglietta, 2010). Moreover, traditional macroeconomic data lack a significant dimension, namely risk (Gray et al., 2007). This lack of aggregate data makes it difficult to coordinate sovereign wealth management with fiscal policy, monetary policy and public debt management.

In this paper, we review the literature on SWF investment, both from a theoretical and an empirical point of view, and we show how real-life SWFs asset allocations differ from theoretical ones (Section 2). We present our conceptual framework for optimal sovereign wealth management (Section 3). We then discuss its practical implementation, giving country examples and suggesting possible institutional arrangements that would enable efficient coordination (Section 4). We finally conclude (Section 5).

2. Sovereign Wealth Fund Investment

While there is an abundant literature on the allocation of foreign-exchange reserves, there are only a few papers devoted to SWF optimal asset allocation. The two topics are nevertheless interlinked, since the funds invested in SWFs often come from foreign exchange reserves. We start this section with a state of the art review for these two topics.

Caballero and Panageas (2005a and b), Beck and Rhababi (2008), Beck and Weber (2011) examine the optimal allocation of foreign exchange reserves in the event of a sudden slowdown in private capital inflows (“sudden stop”). The central bank uses its reserves to repay the short-term foreign debt and minimize the variance of its portfolio in real terms. In this framework, optimal portfolio weights depend, in addition to the standard minimum variance demand term, on the extent to which the assets can be used to hedge against sudden stops. In their empirical investigation, Caballero and Panageas (2005b) suggest the use of assets based on the S&P 500 implied volatility index, providing efficient protection against sudden stops in emerging markets, often linked to global liquidity crises. Beck and Rhababi (2008) show that dollar-denominated assets are a better hedge for global stops and for regional stops in Asia and Latin America, whereas the euro is a better hedge in Emerging Europe.

The authors do not have a uniform view of SWFs' objectives. This reflects the different roles that governments assign to SWFs in practice. Aizenman and Glick (2010) compare the optimal allocations of foreign-exchange reserves by the central bank and by an SWF, which have different objectives: (1) reducing the probability of sudden stops for the central bank, and (2) maximizing the expected utility of a domestic representative agent for the SWF. In this framework, the authors show that the SWF must hold a riskier foreign-asset allocation than the central bank. Brown et al. (2010) propose an allocation model for different types of SWFs, with either a pure return objective or a fiscal smoothing objective. Scherer (2009a and b) considers that SWFs of commodity-producing countries implicitly possess a stock of non-tradable wealth, and shows that in this case the optimal asset allocation of the SWF should include a hedging demand against commodity price variations. Martellini and Milhau (2010) propose a dynamic asset allocation framework for SWFs having liabilities exhibiting inflation indexation. In a recent study (Bodie and Briere, 2013), we proposed a framework for optimal asset allocation of sovereign wealth, taking explicit account of all sources of risk affecting the sovereign's balance sheet. We used Merton's approach (1974) to estimate the process of the country's assets, and then we optimized the balance sheet using the ALM approach.¹ This framework expanded previous results on SWFs' optimal asset allocations by introducing three additional sources of risk affecting the sovereign balance sheet. We showed that the optimal composition of sovereign wealth should involve a performance-seeking portfolio and three hedging demand terms for the variability of the fiscal surplus and external and domestic debt. Comparing theory on optimal SWF asset management with real-life data could provide interesting insights. Unfortunately, a large portion of SWF investments remains private, and most authors concentrate on SWFs' equity interests in listed companies. Dyck and Morse (2011) and Bernstein et al. (2013) show that SWF portfolios tend to be insufficiently

¹ Das et al. (2012) offer a literature review on the use of ALM techniques applied to sovereign fund management.

geographically diversified, with a strong home bias. SWFs tend to have significant holdings in large companies in politically sensitive industries, like energy,² finance and telecommunications (Bertoni and Lugo, 2012, Bortolotti et al, 2013; Chhaochharia and Laeven, 2009), contradicting the principles of sound diversification. They also tend to take large stakes in companies facing financial difficulties, both abroad and domestically (Raymond, 2010). During the subprime crisis, some SWFs³ played the role of “investor of last resort”, rescuing major Western banks or recapitalizing their home equity markets. The performance of those investments is generally poor in the long run, even if the announcement of SWF investments yields positive abnormal stock-price returns in the very short run (Bortolotti et al, 2013).

3. Conceptual Framework

We consider the concept of “sovereign” in the broad sense, including not just the state’s budgetary institutions and monetary authorities (central bank), but also the other institutions related to it, such as pension funds, SWFs and state-owned enterprises.⁴ The sovereign has a multitude of objectives. Some are purely financial, such as debt repayment and setting aside foreign exchange reserves to cope with liquidity crises. Others are social, including pensions and financing of social services (infrastructure such as hospitals, roads, education, defence, etc.). Still others are economic, such as investment in key sectors or industries for future growth. To achieve its objectives, the sovereign has a variety of resources, particularly future

² Even when the country is producing commodities

³ For example in China, Hong Kong, Kuwait, Qatar, Russia, Saudi Arabia and Singapore.

⁴ Distinctions among various state entities are less and less meaningful, as recent crises have shown. In 2010 several countries turned to public institutions for assistance in coping with the crisis-related credit crunch. Some countries used the assets of SWFs or national pension funds to invest in bank deposits (Russia and Kazakhstan) or to support equity-market liquidity (Kuwait). Others used the resources to directly recapitalise ailing banks (Ireland, Kazakhstan and Qatar). For this purpose, states modified their funds’ investment rules on a discretionary basis, exposing them to new risks. Finally, in some countries with greater borrowing capacities, the state tweaked the funds’ regulations to allow them to buy a larger share of the sovereign debt. These recent examples clearly show that a state facing a crisis can elicit contributions from the “off-budget” entities that it owns or controls in order to meet its short-term obligations without unduly worsening the fiscal deficit.

tax revenues, as well as income from other sources such as state-owned enterprises, fees, seigniorage, and possibly a stock of financial assets (foreign exchange reserves, SWF assets, public pension funds, etc.).

Defining the Sovereign Economic Balance Sheet

The sovereign’s global economic balance sheet is key to a full understanding of its situation and risks (Gray et al., 2007). The idea is to estimate all the state’s assets and liabilities at market price, and to measure the risks (volatility and sensitivity to economic shocks) associated with each balance sheet item. Just as a company’s balance sheet is regularly used to assess the risk of bankruptcy (Merton, 1974 and 1977; KMV, 2002), the same analytical framework may be applied to a state. This is useful not only with regard to the state’s debt repayment capacity (Gray et al., 2007; Gray and Malone, 2008), which is obviously a minimal objective, but more generally, as we shall see, with regard to its ability to meet its long-term social and economic objectives. Table 1 gives a simplified example of a sovereign balance sheet.

Table 1: Simplified Presentation of a Sovereign Balance Sheet

ASSETS	LIABILITIES
Foreign reserves, gold, Special Drawing Rights	Base money
Pension fund assets	Local currency debt
SWF	Foreign currency debt
Other public-sector assets (state-owned enterprises, real estate)	Pension fund liabilities
Present value of future taxes, fees, seigniorage	Contingent claims: implicit guarantees (to banks, etc.)
	Present value of expenditures on economic and social development, security, government administration, benefits to other sectors
	Present value of target wealth to be left to future generations

An initial approach to measuring a sovereign's economic balance sheet is to estimate the market price and volatility of all its component assets and liabilities separately. However, to do this, the present value of future income and expense flows has to be estimated. An alternative method is to estimate the market's valuation of the balance sheet, as described by Merton (1974, 1977) and Gray et al. (2007). An implied value for the sovereign's assets can be estimated from the observed prices of liabilities. To do this, it is necessary to rearrange the balance sheet entries and adopt an integrated presentation, subtracting the present value of expenses from the present value of income, and subtracting the value of contingent liabilities from assets. The two liabilities can then be valued as contingent claims on sovereign assets. The foreign currency debt is considered as a "senior claim", and the local currency debt plus base money as a "junior claim", which can be modelled as a call option on the total value of the sovereign's assets. The value of the sovereign's assets and their volatility can then be estimated as a function of the default barrier (promised payments in foreign currencies), (Gray et al, 2007; Bodie and Brière, 2014).

Optimal Sovereign Wealth Management

From a theoretical standpoint, managing the wealth of a sovereign is similar to managing the wealth of an individual (Merton, 1969; Bodie et al., 1992; Bodie et al., 2008), a pension fund (Bodie et al., 2009) or a foundation (Merton, 1993). The sovereign receives tax revenues each year. Part of these revenues are spent, and the residual is saved in SWFs, central bank reserves, or public pension funds. Determining how much should be saved and how it should be invested is a standard ALM problem.

We assume that the sovereign's objective is to maximise its expected utility, which is a function of its Global Sovereign Surplus (GSS),⁵ depending on the allocation of the

⁵ Measured as sovereign assets minus sovereign liabilities.

sovereign's assets.⁶ The optimal allocation and the optimal expenditures of the sovereign crucially depend on the nature and size of the fiscal asset and unconditional liabilities, and the sources of their uncertainty. Bodie and Brière (2014) solve this problem analytically and show that the optimal portfolio w^* can be broken down into a performance-seeking portfolio and three hedging demand terms for the variability of the fiscal surplus and external and domestic debt:

$$w^* = \frac{1}{(\rho - 1)\alpha} \Omega_{FA}^{-1} \mu_{FA,t} - \frac{(1 - \alpha)}{\alpha} \Omega_{FA}^{-1} \Omega_{FA,FS} + \frac{\beta}{\alpha} \Omega_{FA}^{-1} \Omega_{FA,FL} + \frac{(1 - \beta)}{\alpha} \Omega_{FA}^{-1} \Omega_{FA,DL} \quad (5)$$

with μ_{FA} the vector of annualized expected returns of the n financial assets in the portfolio over the investment horizon, Ω_{FA} their covariance matrix, α the fraction of total sovereign assets dedicated to financial wealth (the remainder is the fiscal surplus), β the fraction of total sovereign liabilities dedicated to foreign debt (the remainder is domestic debt), $\Omega_{FA,FS}$, $\Omega_{FA,FL}$, $\Omega_{FA,DL}$ the covariance of the financial asset returns with the fiscal surplus, foreign liabilities and domestic liabilities respectively.

These results shed new light on the optimal allocation of the sovereign's wealth. We generalize previous results on SWFs' asset allocations by introducing three additional sources of risk affecting the sovereign balance sheet. Martellini and Milhau (2010) express the SWF's preference in real terms and observe a hedging demand against realized inflation. Scherer (2009a and b) identifies the optimal asset allocation of an SWF with non-tradable wealth and observe a hedging demand against oil price variations. In a more general framework, taking explicit account of all sources of risk affecting the sovereign balance sheet, three hedging demand terms are added to the speculative portfolio. We recommend taking into account not only the risks from inflation and fluctuations in natural resource prices, which both influence

⁶ We disregard other potential macroeconomic decision variables (tax rate, etc.), considered as constant, in order to concentrate on the asset allocation choice.

the variability of the fiscal surplus, but all the risks stemming from the fiscal surplus, and from foreign and domestic liabilities. Moreover, the fiscal surplus variability is influenced not only by commodity prices and inflation volatility, but also by the sovereign's policies on natural resource extraction, taxation, and so on.⁷

4. Practical Implementation

The practical implementation of sovereign ALM raises several difficulties. Traditional public finance data are often incomplete and ill-suited to accurately estimation of the sovereign economic balance sheet. This lack of data compromises the coordination of sovereign wealth management with fiscal policy, monetary policy and public debt management. We discuss institutional arrangements that could enable efficient coordination.

Traditional Public Finance Data and their limitations

To implement sovereign ALM, what really needs to be measured is the actual nature of macroeconomic and financial risks, with their non-linear features (contingent liabilities modelled as options, etc.), and the accumulation phenomena that lead to systemic risks. Flow of funds statistics available in many countries provide balance sheet estimates of the government sector but do not fully correspond to what is actually needed. The definition of the “government” entity differs between countries⁸ and may not correspond exactly to our broad definition of the sovereign. The IMF's GFS database, created in 2001, remedies these differences with a unified base of 153 countries' data on government balance sheets, with a

⁷ This leads to another important difference from the previous literature. In our framework, the variability of the flow of revenues from the sale of natural resources needs to be hedged, not the fluctuations in commodity prices themselves (Scherer (2009a, 2009b)). This has important implications, as the fiscal surplus may not have a sensitivity of one to natural resource prices, as we will see in our estimation for Chile in Section 3.

⁸ In the US, the “Flows of Funds” statistics consider state and local governments (excluding employee retirement funds), the federal government (including government-owned corporations and agencies that issue securities individually) and the monetary authority. In Europe, the European Central Bank and Eurostat “Euro Area Accounts” have a more restrictive definition. The general government sector comprises only central, state (regional) and local government and the social security or pension funds belonging to it. It does not include public enterprises, which are included in the corporate or financial sector and cannot be disentangled from it.

particularly broad scope for the sovereign.⁹ The IMF's GFS data nonetheless have significant limitations. There is no evaluation of the present value of future tax revenues, or expenditures. Moreover, there are no estimates of contingent liabilities, such as too-big-to-fail guarantees to the financial sector and implicit guarantees to provide social benefits when various needs arise. Finally, these data, which are purely accounting-based and generally available on an annual basis, are not sufficient to measure the risks associated with each item. In the case of sovereign balance sheets, risks are related on the one hand to market price fluctuations (for commodities, exports, wage costs, etc.) that cause the government's income and expenditures to fluctuate, and on the other hand to inventory changes (natural resource depletion, population growth, etc.).

In 2000 the World Bank took the unprecedented step of measuring the wealth of nations (World Bank, 2006 and 2011). The total wealth of each nation is estimated as the present value of future flows of consumption. Consumption levels are based on past historical data but are adjusted to be "sustainable".¹⁰ Total wealth is broken down into: (1) produced capital (machinery, structures and urban land), (2) natural capital (energy resources, mineral resources, timber resources, non-timber forest resources, cropland, pastureland and protected areas) and (3) intangible capital (human, etc.), calculated as a residual, the difference between total wealth and the sum of produced and natural capital. These data are a very useful supplement to the existing figures because they provide an estimate of stocks¹¹ of natural resources and intangible assets. World Bank estimates of natural and human capital can be used to estimate the present value of the fiscal surplus, given a certain level of desired

⁹ It comprises not just the central government budgetary authority but also the central bank, SWFs, pension funds, deposit insurance funds, state-owned enterprises, subnational governments and other government agencies.

¹⁰ For years when adjusted net savings are negative, the actual consumption rate is added to adjusted net savings.

¹¹ Flow variables are also available: depletion of natural resources, investment in education, domestic net investment.

taxation. Unfortunately, these data were estimated in 2000 and 2006 for the World Bank's 2006 and 2011 reports and are not available as a historical series.

The need for central coordination

To implement sovereign ALM in practice, there needs to be a high level of coordination between institutions that control sovereign assets and sovereign liabilities (at least the central bank, the debt management office, the treasury and the ministry of finance). What the most efficient institutional arrangement would be is still an open question, and the few country examples show that very different organizations are possible. New Zealand, Canada, Denmark, Britain, South Africa and Turkey are the handful of countries that have made significant steps in the direction of developing an ALM framework. In New Zealand and South Africa, there is a specialized asset-liability management unit that analyses the sovereign's balance sheet. In New Zealand, the mandate of the debt management office is to keep the net foreign currency position close to zero, explicitly matching foreign currency assets and liabilities and hedging exchange-rate movements. In Canada, ALM was introduced for the tactical management of foreign reserves in 1997, with the goal of minimizing currency and interest-rate risks by matching the assets to the liabilities funding them. In Turkey, debt management is also defined in an ALM framework, in close cooperation with the reserve management office.

In most of the example countries cited (Canada being an exception), the ALM exercise has been performed by the debt management office, already responsible for cash management and treasury services. This is not without drawbacks since the issuance of government debt might also respond to other, possibly conflicting, objectives. Government debt has public good characteristics, including setting the risk-free yield curve and providing highly liquid securities. In Australia and Norway, for example, the government decided to continue debt issuance even though there was no need for government borrowing, because of the

importance of sustaining functioning capital markets. On the other hand, assigning ALM to the asset management offices would also make sense. The example of Canada, which gave the central bank tactical reserves management office an ALM mandate, is a good example of this. But responsibility for the wider government balance sheet would sit uneasily with central bank independence, and there could be potential conflicts of interest with monetary policy. The sovereign wealth fund would actually be an excellent candidate for the job of implementing the sovereign ALM. In many countries, this may be facilitated by the fact that the finance ministry is responsible both for debt issuance and fiscal policy and for determining the SWF's strategic asset allocation.

In any case, a coordinated approach to the management of the national balance sheet would necessitate central responsibility. Probably the most realistic scenario would be to encourage more links and consultation between the different agencies, with detailed instructions from the ministry of finance. South Africa has organized such a framework with a common committee bringing together the South African reserve bank and the treasury. When South Africa had a net negative forward currency position in the late 1990s, a strategy was developed jointly by the reserve bank and the treasury to bring down this exposure. The finance ministry might be the best candidate to lead this coordination, but the optimal institutional arrangement may in the end depend on the political organization of each country.

5. Conclusion

This paper presents an analytical framework for sovereign wealth and risk management, extending the theory of contingent claims analysis, and discusses its practical implementation. A complete approach to the sovereign balance sheet is necessary to fully understand the country's risks and determine how it can best manage its wealth. This supposes the broadest possible definition of the sovereign, including, in particular, entities subordinated to the state,

such as the central bank, SWFs, pension funds, government agencies and state-owned enterprises. The reason is that the funds, even if located in different entities, become fungible if a crisis arises. This approach also requires all balance sheet items, both assets and liabilities, as well as their risks, to be measured precisely. To do this, it is necessary to measure not only the sovereign's financial wealth, but also its human and natural capital. Similarly, a relatively precise understanding of the government's economic objectives and an accurate estimate of contingent liabilities are also needed. A sovereign ALM strategy can thus be developed for managing asset risks in a way that is consistent with the sovereign entity's liabilities. One significant application of this analytical framework is the management of financial wealth under direct state control. The optimal allocation of sovereign wealth should involve a performance-seeking portfolio and three hedging portfolios for the variability of the fiscal surplus and external and domestic debt.

Our ambitious approach has limitations. First, to concentrate on asset allocation, we consider macroeconomic variables as exogenous. In practice however, the sovereign benefits from many more policy instruments, including taxation level. It can also inflate or repudiate its debt (Landon-Lane and Oosterlinck, 2006). A general equilibrium model endogenizing all of the state's decision variables would be more realistic, but also much more complex. Second, the practical implementation of our ALM framework requires reliable macroeconomic data on a regular basis. Moreover, strong coordination is needed between the sovereign entities. This coordination involves the institutions that manage both sides of the balance sheet: the central bank and sovereign wealth fund on the asset side, and the debt management office on the liability side. The ministry of finance is particularly well positioned as a central institution to facilitate this coordination. However, even if the implementation of the ALM framework for SWF asset allocation is an unfeasible first-best solution for many countries, far removed from current practice, it can nevertheless be thought of as providing useful guidelines for efficient

management of sovereign wealth. In particular, it should help to improve the diversification of sovereign assets and the hedging of important risk factors affecting the sovereign balance sheet.

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